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Draft Supplemental Environmental Impact Statement for

Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE’s Inventory of Depleted Uranium Hexafluoride

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LOCATIONS: Kentucky, Nevada, Ohio, Texas, and Utah

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This document is available on the DOE NEPA website (http://energy.gov/nepa/nepa-documents), and the Portsmouth/Paducah Project Office website (https://www.energy.gov/em/disposition-uranium-oxide-conversion-depleted-uranium-hexafluoride) for viewing and downloading.

ABSTRACT:

On June 18, 2004, the U.S. Department of Energy (DOE) issued environmental impact statements for the construction and operation of facilities to convert depleted uranium hexafluoride (DUF_6) to depleted uranium (DU) oxide at DOE's Paducah Site (Paducah) in Kentucky and Portsmouth Site (Portsmouth) in Ohio (69 FR 34161). Both the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky Site* (DOE/EIS-0359) and the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the*

Portsmouth, Ohio Site (DOE/EIS-0360) (collectively, the "2004 EISs") were prepared to evaluate and implement DOE's DUF_6 long-term management program.

Records of Decision (RODs) were published for the 2004 EISs on July 27, 2004 (69 FR 44654; 69 FR 44649). In the RODs, DOE decided that it would build facilities at both Paducah and Portsmouth and convert DOE's inventory of DUF_6 to DU oxide. DOE decided the aqueous hydrogen fluoride produced during conversion would be sold for use pending approval of authorized release limits. The calcium fluoride (CaF_2) produced during conversion operations would be reused, pending approval of authorized release limits, or disposed of as appropriate. DOE also decided that the DU oxide conversion product would be reused to the extent possible or packaged in empty and heel cylinders for disposal at an appropriate disposal facility. Emptied cylinders would also be disposed of at an appropriate facility.

DOE had intended to identify disposal locations in the RODs for the 2004 EISs for any declared DU oxide waste. However, prior to issuing the RODs, DOE discovered it inadvertently had not formally provided copies of the Draft and Final EISs to the states of Nevada and Utah, and DOE concluded it was bound by the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations described in 40 CFR 1502.19 to forego decisions on disposal location(s) until it had properly notified these states. Accordingly, in the RODs for the 2004 EISs, DOE did not include decisions with respect to specific disposal location(s) for DU oxide declared waste, but instead informed the public it would make the decisions later, and additional supplemental NEPA analysis would be provided for review and comment.

The purpose and need for this action is to identify and analyze alternatives for the disposition of DU oxide. If a beneficial use cannot be found for the DU oxide, all or a portion of the inventory may need to be disposed of. The proposed scope of this DU Oxide SEIS includes an analysis of the potential impacts from three Action Alternatives and a No Action Alternative (in accordance with 40 CFR 1502.14). Under the Action Alternatives, DU oxide would be disposed of at one or more of the three disposal facilities: (1) the Energy*Solutions* LLC site near Clive, Utah; (2) the Nevada National Security Site (NNSS) in Nye County, Nevada; and (3) the Waste Control Specialists, LLC (WCS) site near Andrews, Texas. Under the No Action Alternative, transportation and disposal would not occur, and DU oxide containers would remain in storage at Paducah and Portsmouth. All other aspects of the DUF_6 conversion activities remain as described previously in the 2004 EISs and RODs and are not within the scope of this DU Oxide SEIS.

Under the Action Alternatives and the No Action Alternative, container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth; there would be no construction or ground disturbance, minor employment, minor utility use, and no routine releases of DU oxide or other hazardous materials. Therefore, potential impacts on site infrastructure; air quality and noise; geology and soils; water resources; biotic resources; public and occupational health and safety (during normal operations, accidents, and transportation); socioeconomics; waste management; land use and aesthetics; cultural resources; and environmental justice at Paducah and Portsmouth would be expected to be minor. A potential release of DU oxide from a container breach would be expected to result in uranium concentrations below benchmark levels, and therefore would have minimal impacts on soils, surface and groundwater quality, biotic resources, and human health.

Transport of the DU oxide by truck or rail to a disposal site would be expected to result in no latent cancer fatalities to workers or the public, although there could be nonradiological fatalities from trauma during a truck or rail accident. Greenhouse gas emissions from transportation vehicles would amount to a very small percentage of United States emissions and would be expected to have a small but indeterminate impact on global climate change. Waste disposal volumes would not be expected to exceed the capacities of the Energy*Solutions*, NNSS, or WCS disposal facilities.

DOE is providing opportunities for public review and comment, including public hearings, on this Draft DU Oxide SEIS. Public hearings will be in the format of a WebEx™ meeting, allowing the public the opportunity to call or log in via an online web link. Public involvement opportunities and WebEx meeting login information will be announced in newspapers in communities near potentially affected areas and in other communications with stakeholders. Comments received during the public comment period will be considered in preparing the Final DU Oxide SEIS. Comments received after the close of the public comment period will be considered to the extent practicable.

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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 ABBREVIATIONS AND ACRONYMS

AEA	Atomic Energy Act of 1954
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
AQCR	Air Quality Control Region
BLS	Bureau of Labor Statistics
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	*Code of Federal Regulations*
CRMP	cultural resource management plan
DD&D	decontamination, decommissioning, and demolition
DNL	day-night average sound level
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
Draft DU Oxide SEIS	*Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride*
DSA	documented safety analyses
DUF_6 PEIS	*Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride*
EA	environmental assessment
EIS	environmental impact statement
EM	Office of Environmental Management (DOE)
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ETTP	East Tennessee Technology Park (formerly K-25 site)
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FTE	full-time equivalent
FWF	Federal Waste Facility

FY	fiscal year
GDP	gaseous diffusion plant
GHG	greenhouse gas
GIS	geographic information system
HMR	hazardous materials regulation
HMTA	Hazardous Materials Transportation Act
ICRP	International Commission on Radiological Protection
IHE	irreversible health effect
IPCC	Intergovernmental Panel on Climate Change
ISC	Industrial Source Complex
KAR	Kentucky Administrative Regulation
KDEP	Kentucky Department of Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	Kentucky Revised Statutes
LCF	latent cancer fatality
L_{eq}	equivalent steady sound level
LLW	low-level radioactive waste
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
NAAQS	National Ambient Air Quality Standard(s)
NCRP	National Council on Radiation Protection and Measurements
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NNSS	Nevada National Security Site
non-DUF_6	non-depleted uranium hexafluoride
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NWS	new waste stream
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PA	performance assessment

PAH	polycyclic aromatic hydrocarbons
PEIS	programmatic environmental impact statement
P.L.	Public Law
PM	particulate matter
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 micrometer or less
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 micrometers or less
PSD	prevention of significant deterioration
PGA	peak ground acceleration
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
ROD	Record of Decision
ROI	region of influence
RWMC	Radioactive Waste Management Complex
SAAQS	State Ambient Air Quality Standard(s)
SHPO	State Historic Preservation Officer
SODI	Southern Ohio Diversification Initiative
SWEI	sitewide environmental impact statement
SWMU	solid waste management unit
SWPPP	Stormwater Pollution Prevention Plan
TCEQ	Texas Commission on Environmental Quality
TRU	transuranic(s)
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USEC	United States Enrichment Corporation
USFWS	U.S. Fish and Wildlife Service
U.S.	United States
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WKWMA	West Kentucky Wildlife Management Area
WM PEIS	*Waste Management Programmatic Environmental Impact Statement*

CHEMICALS

CaF_2	calcium fluoride
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
DU	depleted uranium
DUF_6	depleted uranium hexafluoride
HF	hydrogen fluoride
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyl
SO_2	sulfur dioxide
TCE	trichloroethylene
U	uranium
UF_6	uranium hexafluoride
UO_2	uranium dioxide
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)

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,018.5	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Radiation					
Sieverts	100	Rem	Rem	0.01	Sieverts
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.7854	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

1. INTRODUCTION AND PURPOSE AND NEED FOR AGENCY ACTION

1.1 BACKGROUND INFORMATION

The use of uranium as fuel for nuclear reactors or for military applications requires uranium enrichment; that is, increasing the proportion of the fissile uranium-235 isotope found in natural uranium. Industrial uranium enrichment in the United States began as part of atomic bomb development during World War II. Uranium enrichment for both civilian and military uses was continued by the U.S. Atomic Energy Commission and its successor agencies, including the U.S. Department of Energy (DOE). Uranium enrichment by gaseous diffusion was carried out at three locations now known as the Paducah Site (Paducah) in Kentucky, the Portsmouth Site (Portsmouth) in Ohio, and the East Tennessee Technology Park (ETTP) in Oak Ridge, Tennessee. The United States Enrichment Corporation (USEC) conducted enrichment operations at two of these sites: Paducah and Portsmouth. USEC began as a government agency, was later privatized, and is now Centrus Energy Corporation.

Depleted uranium hexafluoride (DUF_6)[1] results from the uranium enrichment process. The DUF_6 that remains after enrichment is stored in large steel cylinders that each contain approximately 9 to 12 metric tons (10 to 13 tons) of material. **Figure 1-1** shows a typical DUF_6 storage cylinder. The DUF_6 storage cylinders were initially stored at Paducah, Portsmouth, and ETTP where they were generated. However, all DUF_6 cylinders that were stored at ETTP were transported to Portsmouth. At its peak, Paducah stored approximately 46,000 DUF_6 cylinders (560,000 metric tons [617,000 tons]), and Portsmouth approximately 21,000 DUF_6 cylinders (250,000 metric tons [276,000 tons]), for a total of about 67,000 cylinders (810,000 metric tons [893,000 tons]) (PPPO 2018). These cylinders are stored two layers high on outdoor gravel or concrete storage areas known as "yards."

In addition to the DUF_6 cylinders, there are cylinders that contain enriched UF_6 or normal UF_6 or are empty or mostly empty (collectively called "non-DUF_6" cylinders). The *Final Environmental Impact Statement for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site* (DOE/EIS-0359) (Paducah EIS), and *Final Environmental Impact Statement for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site* (DOE/EIS-0360) (Portsmouth EIS) (DOE 2004a, 2004b) (collectively, the "2004 EISs") assumed that the normal UF_6 and enriched UF_6 cylinders from both Paducah and Portsmouth would be put to beneficial uses; therefore, conversion of the contents of the non-DUF_6 cylinders was not considered at that time and are not considered in this *Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride* (DU

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[1] 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 0.707 weight percent found in nature. The uranium in most of DOE's DUF_6 has between 0.2 and 0.4 weight percent uranium-235. DUF_6 is considered a source material, not a waste.

Oxide SEIS). The empty and heel (mostly empty) cylinders[2] (8,483 at Paducah and 5,517 at Portsmouth) could be used as disposal containers for DU oxide. If not used as disposal containers, these cylinders would be disposed of as low-level radioactive waste (LLW) (PPPO 2018). This DU Oxide SEIS evaluates disposal of empty and heel cylinders.

Figure 1-1 Typical Depleted Uranium Hexafluoride Storage Cylinder (Source: ANL 2001)

Pursuant to Council on Environmental Quality (CEQ) and DOE National Environmental Policy Act (NEPA) implementing regulations described in Title 40 of the *Code of Federal Regulations* (40 CFR) Parts 1500–1508 and 10 CFR Part 1021, respectively, DOE evaluated potential broad management options for its DUF_6 inventory in the *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DUF_6 PEIS) (DOE 1999) issued in April 1999. In the DUF_6 PEIS Record of Decision (ROD) (Volume 64 of the *Federal Register*, page 43358 [64 FR 43358], August 10, 1999), DOE decided to promptly convert the DUF_6 inventory to a more stable uranium oxide form and stated it would use the DU oxide[3] as much as possible and store the remaining DU oxide for potential future uses or disposal, as necessary. DOE did not select specific sites for the conversion facilities or disposal at that time, but reserved that decision for subsequent NEPA review.

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[2] Empty cylinders have had the DUF_6 and heel material removed and contain essentially no residual material. Heel cylinders contain less than 50 lb (23 kg) of residual nonvolatile material left after the DUF_6 has been removed.

[3] When generated, DU oxide is considered a resource and may be sold or transferred for beneficial uses. DU oxide only becomes a waste when the sale or beneficial reuse options are exhausted and a decision is made to dispose of a quantity of the material.

In June 2004, DOE issued final EISs for construction and operation of DUF_6 conversion facilities and other actions at Paducah and Portsmouth (69 FR 34161, June 18, 2004). Both 2004 EISs were prepared as a second level of the tiered[4] environmental review process being used to evaluate and implement DOE's DUF_6 long-term management program. The 2004 EISs include evaluations of the environmental impacts of transportation and disposal of DU oxide, empty and heel DUF_6 storage cylinders, and calcium fluoride (CaF_2)—a conversion byproduct—and ancillary LLW and mixed low-level radioactive waste (MLLW) at two potential off-site locations: the DOE LLW disposal facility at the Nevada National Security Site (NNSS) (formerly called the Nevada Test Site) and Energy*Solutions* LLC (formerly known as Envirocare of Utah, Inc.), a commercial LLW disposal facility near Clive, Utah.

RODs were published for the 2004 EISs on July 27, 2004 (69 FR 44654; 69 FR 44649). In the RODs, DOE decided to build facilities at both Paducah and Portsmouth and convert DOE's inventory of DUF_6 to DU oxide. DOE decided the aqueous hydrogen fluoride (HF) produced during conversion would be sold for use pending approval of authorized release limits. The CaF_2 produced during conversion operations would be reused, pending approval of authorized release limits, or disposed of as appropriate. DOE also decided that the DU oxide conversion product would be reused to the extent possible or packaged in empty and heel cylinders for disposal at an appropriate disposal facility. Emptied cylinders would also be disposed of at an appropriate facility. In the ROD for the Portsmouth DUF_6 conversion facility (69 FR 44654), DOE also decided that all DUF_6 cylinders once stored at DOE's ETTP would be shipped to Portsmouth for conversion.

DOE had intended to identify disposal locations in the RODs for the 2004 EISs for any DU oxide declared waste. Prior to issuing the RODs, DOE discovered it inadvertently had not formally provided copies of the Draft and Final EISs to the states of Nevada and Utah, and concluded it was bound by the CEQ NEPA regulations described in 40 CFR 1502.19 to forego decisions on disposal location(s) until it had properly notified these states. Accordingly, in the RODs for the 2004 EISs, DOE did not include decisions with respect to specific disposal location(s) for DU oxide declared waste, but instead informed the public it would make the decisions later and additional supplemental NEPA analysis would be provided for review and comment.

1.2 CHANGES SINCE THE PADUCAH AND PORTSMOUTH EIS'S WERE PREPARED IN 2004

In 2007, DOE prepared a *Draft Supplement Analysis for Location(s) to Dispose of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride* (Draft SA) (DOE 2007), in accordance with DOE NEPA implementing regulations at 10 CFR 1021.314. This Draft SA was prepared in order to determine whether a Supplemental EIS was required prior to making a decision about DU oxide disposal locations as committed to in the 2004 RODs (DOE 2007). DOE prepared the Draft SA and made it publicly available on April 3, 2007 (72 FR 15869). Comments received on the Draft SA suggested that DOE should consider

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[4] According to 40 CFR Part 1500, tiering of EISs refers to a process of addressing a broad, general program, policy, or proposal in an initial EIS, and analyzing a narrower, site-specific proposal related to the initial program, plan, or policy in a subsequent EIS; in this case, an SEIS.

the Waste Control Specialists LLC (WCS) LLW disposal facility near Andrews, Texas, as a reasonable alternative for DU oxide disposal. DOE determined that more time was needed to allow for resolution of regulatory questions at the disposal sites and did not issue a Final SA. In August 2014, WCS was granted a license amendment that allows disposal of bulk uranium. As a result, DOE now assumes, for analysis purposes, that WCS may be a viable disposal site for DU oxide and other wastes.

Both of the Paducah and Portsmouth conversion facilities were operational in 2011. As of February 2018, 2,908 cylinders of DU oxide had been generated at Paducah, and 1,898 cylinders had been generated at Portsmouth (PPPO 2018). These cylinders are being stacked two layers high at the existing outdoor storage yards at Paducah and Portsmouth until a disposition decision is made.

After considering the existing DOE NEPA analyses and changes in the disposition activities currently being considered, DOE determined in March 2016 that an SEIS is warranted due to potentially significant new circumstances or information relevant to environmental concerns (in this case, availability of a new alternative disposal site) since the 2004 Notice of Intent. Accordingly, on August 26, 2016, DOE announced its intent to prepare this DU Oxide SEIS (81 FR 58921). This DU Oxide SEIS represents the third phase of the environmental review process being used to evaluate and implement the DUF_6 long-term management program. This DU Oxide SEIS evaluates only the management of DU oxide, empty and heel cylinders, CaF_2, and ancillary LLW and MLLW. Decisions on the storage of DUF_6, conversion of DUF_6 to DU oxide, and management of HF were already made in the RODs for the 2004 EISs and are not reevaluated in this DU Oxide SEIS.

1.3 PURPOSE AND NEED FOR AGENCY ACTION

The purpose and need for this action to dispose of DU oxide resulting from converting DOE's DUF_6 inventory to a more stable chemical form and to dispose of other LLW and MLLW (i.e., empty and heel cylinders, CaF_2, and ancillary LLW and MLLW) generated during the conversion process. If a beneficial use cannot be found for the DU oxide, all or a portion of the inventory may be characterized as waste and need to be disposed of. This need follows directly from the decisions presented in the 2004 RODs for the 2004 EISs that deferred DOE's decision related to the transportation and disposition of DU oxide at potential off-site disposal facilities.

1.4 PROPOSED ACTION

The scope of this DU Oxide SEIS includes an analysis of the potential impacts from three Action Alternatives and the No Action Alternative (in accordance with 40 CFR 1502.14). Under the Action Alternatives, DU oxide would be transported to and disposed of at one or more of three disposal facilities: (1) the DOE LLW disposal facility at NNSS; (2) the Energy*Solutions* LLW disposal facility near Clive, Utah; and (3) the WCS LLW disposal facility near Andrews, Texas. Under the No Action Alternative, the DU oxide cylinders would remain in storage at Paducah and Portsmouth and would not be transported to a disposal facility. Excess empty and heel cylinders, CaF_2, and ancillary LLW and MLLW would be transported and disposed of under all the evaluated Action Alternatives. All other aspects of the DUF_6 conversion activities, except as discussed in the paragraph below, would remain as described previously in the 2004 EISs and RODs and are not within the scope of this DU Oxide SEIS. **Figure 1-2** shows the locations of facilities discussed in this DU Oxide SEIS.

Under the USEC Privatization Act (Title 42 of the *United States Code* Section [42 U.S.C. §] 2297h-11), DOE is required to accept LLW and mixed-LLW (MLLW) from a uranium enrichment facility licensed by the U.S. Nuclear Regulatory Commission (NRC). If requested by the generator, DOE must accept the DU once it is determined to be LLW. Under the USEC Privatization Act, the licensee must reimburse DOE for its costs to disposition the LLW and MLLW (including DU). At the present time, there are no plans or proposals for DOE to convert additional DUF_6 and dispose of additional DU oxide cylinders, beyond the current inventory for which it has responsibility. In anticipation of the potential future receipt of commercial DUF_6, DOE has estimated the impacts from management of 150,000 metric tons (165,000 tons; approximately 12,500 cylinders) of commercial DUF_6 as a reasonably foreseeable future event for cumulative impacts that would take place after the management of DOE DU oxide. The detailed analysis of the impacts of receipt, conversion, storage, handling, and disposal of commercial DUF_6 is presented in Appendix C of this DU Oxide SEIS. Where appropriate, the impacts of the management of commercial DUF_6 at Paducah and Portsmouth, and the transportation and disposal of this material, are included in the cumulative impacts analysis of this SEIS (Chapter 4, Section 4.5).

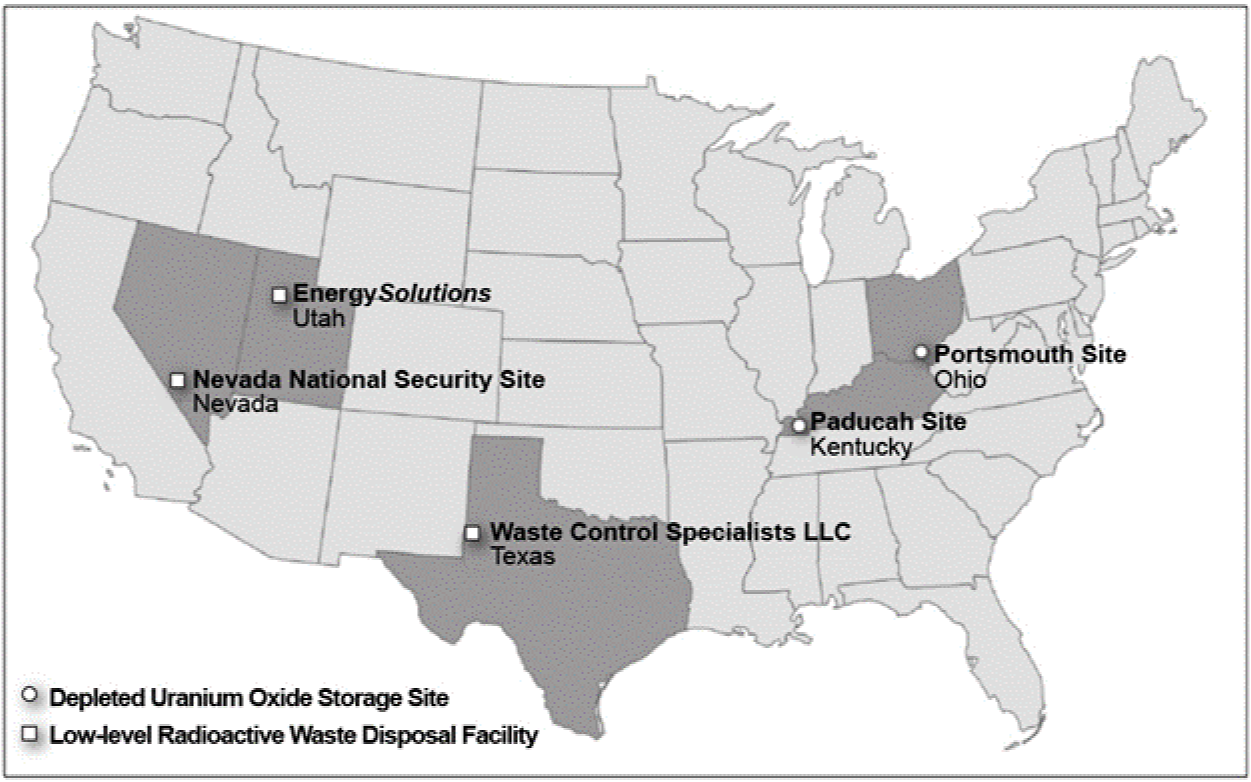

Figure 1-2 Locations of Facilities Discussed in the DU Oxide SEIS

1.5 PUBLIC INVOLVEMENT

A public scoping process is optional for DOE SEISs (10 CFR 1021.311(f)). As described and supported by the discussions in the above sections, the scope of this DU Oxide SEIS is not significantly different from the 2004 EISs (as described in Chapter 1, Section 1.6 of both the Paducah EIS and the Portsmouth EIS) and, therefore, DOE determined that a scoping period was not needed. In accordance with guidance at 10 CFR 1021.311(f), no scoping process was conducted for this DU Oxide SEIS because the scope of this SEIS is not appreciably different from the 2004 EISs and, therefore, DOE determined that a scoping period was not needed.

DOE is providing opportunities for public review and comment, including Web-based public hearings, on this Draft DU Oxide SEIS. Public involvement opportunities and WebEx™ meeting login information will be announced in newspapers in communities near potentially affected areas and in other communications with stakeholders. Comments received during the public comment period will be considered in preparing the Final DU Oxide SEIS. Comments received after the close of the public comment period will be considered to the extent practicable.

1.6 SCOPE OF THIS SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

The scope of an SEIS refers to the range of actions, alternatives, and impacts it considers. In this DU Oxide SEIS, DOE examines potential public health and safety effects and environmental impacts from the Proposed Action within the following general topics: site infrastructure; climate change, air quality, and noise; geology and soils; water resources (surface water and groundwater); biotic resources; public and occupational health and safety (during normal operations, accidents, and transportation); socioeconomics; waste management; land use and aesthetics; cultural resources; environmental justice; and cumulative impacts. This DU Oxide SEIS analyzes in more detail resource areas more likely to exhibit effects from storage, transportation, and disposal of DU oxide; namely, public and occupational health and safety, transportation, and disposal of DU oxide (waste management). The other topics are analyzed in less detail.

1.6.1 Human Health and Safety

This DU Oxide SEIS evaluates radiological and chemical impacts on workers and the public from normal operations and postulated DU oxide storage and handling accidents, as well as intentional destructive acts. The potential for industrial accidents that could impact worker safety are also evaluated.

1.6.2 Transportation

Because the Proposed Action involves the transport of DU oxide and other LLW to disposal facilities across the United States, transportation impacts are an important factor in evaluating impacts and comparing the potential disposal site alternatives. Transportation by truck and rail are evaluated under incident-free and accident conditions. Accidents involving LLW have the potential for both radiological and nonradiological risks to transportation workers and the public. Radiation exposure impacts are evaluated for incident-free transportation and for transportation accidents where the release of radioactive materials is conservatively assumed to occur.

1.6.3 Disposal of Depleted Uranium Oxide and Other Wastes

This DU Oxide SEIS does not evaluate the impacts of handling and disposing of LLW at authorized DOE and commercial disposal facilities. The impacts of handling and disposal have already been evaluated in environmental and permitting documentation for the respective LLW disposal facilities. This DU Oxide SEIS compares the characteristics of the to-be-disposed of LLW to the waste acceptance criteria and capacity of each of the potential disposal facilities. If the LLW is within the waste acceptance criteria and capacity of the disposal facility, the impacts are assumed to be within the bounds of the existing documentation for the facility.

1.7 RELATIONSHIP TO OTHER NEPA REVIEWS

As described in Sections 1.1 and 1.2, this DU Oxide SEIS tiers from the 2004 EISs (DOE 2004a, 2004b), which tier from the DUF_6 PEIS (DOE 1999).

DOE published the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS) (DOE 1997) as a DOE complexwide study of the environmental impacts of managing five types of waste generated by past, present, and future nuclear defense and research activities. The WM PEIS considered alternatives for high-level, transuranic (TRU), LLW, and MLLW, as well as toxic and hazardous wastes. The WM PEIS provided information on the impacts of various siting configurations that DOE used to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste type. DOE published RODs for all the waste types, but only the applicable waste type (LLW) is discussed here. In the ROD for LLW (65 FR 10061, February 25, 2000), DOE decided to perform minimal treatment of LLW at all sites and continue, to the extent practicable, on-site disposal of LLW at a number of sites, including NNSS. DOE's decision regarding LLW does not preclude the use of commercial disposal sites. The WM PEIS did not specifically evaluate management of DU oxide because the decision to produce and dispose of DU oxide had not been made when the WM PEIS was prepared in 1997. Disposal of DU oxide would need to be in accordance with decisions made in the WM PEIS.

Disposal of LLW at NNSS is analyzed in the *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (NNSS SWEIS) (DOE 2013a). The NNSS SWEIS analyzed the disposal of 19.1 million cubic feet (0.54 million cubic meters) of LLW from Paducah and Portsmouth, including waste related to DUF_6 conversion (DOE 2013a). If it is determined that additional site-specific NEPA documentation is needed for the NNSS waste disposition option, DOE would prepare the documentation at that time.

1.8 ORGANIZATION OF THIS SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

This DU Oxide SEIS consists of Chapters 1 through 9 and Appendices A through D. Chapter 1 provides background information; describes the purpose and need; summarizes the Proposed Action; describes the scope of this DU Oxide SEIS; provides a description of related NEPA documents; and describes the organization of this SEIS. Chapter 2 describes the characteristics of DU oxide; describes alternatives for transportation and disposal of the DU oxide; and describes alternatives that were considered but not analyzed in detail. Chapter 2 also includes a comparison of potential impacts under each of the alternatives. Chapter 3 includes brief descriptions of the environments at Paducah, Portsmouth, and the three disposal sites in terms of resource areas or disciplines that establish the baselines for the impact analyses. Chapter 4 describes the potential impacts of the alternatives on the resource areas or disciplines discussed in Chapter 3. Chapter 4 also includes discussions of cumulative impacts; mitigation; unavoidable adverse impacts; irreversible and irretrievable commitments of resources; the relationship between short-term uses of the environment and long-term productivity; and pollution prevention and waste minimization. Chapter 5 describes the environmental, safety, and health permits and compliance requirements. Chapters 6, 7, 8, and 9 list the references cited, the SEIS preparers, a topical glossary, and index, respectively. Appendices A through D contain the list of related *Federal Register* notices; the transportation analysis; the commercial DUF_6 impacts analysis; and the contractor disclosure statements, respectively.

2. DESCRIPTION AND COMPARISON OF ALTERNATIVES

DOE has prepared this DU Oxide SEIS to evaluate alternatives for transportation and disposal of DU oxide[5] from Paducah and Portsmouth in Paducah, Kentucky, and Piketon, Ohio, respectively. The locations of Paducah and Portsmouth are shown in **Figures 2-1** and **2-2**, respectively.

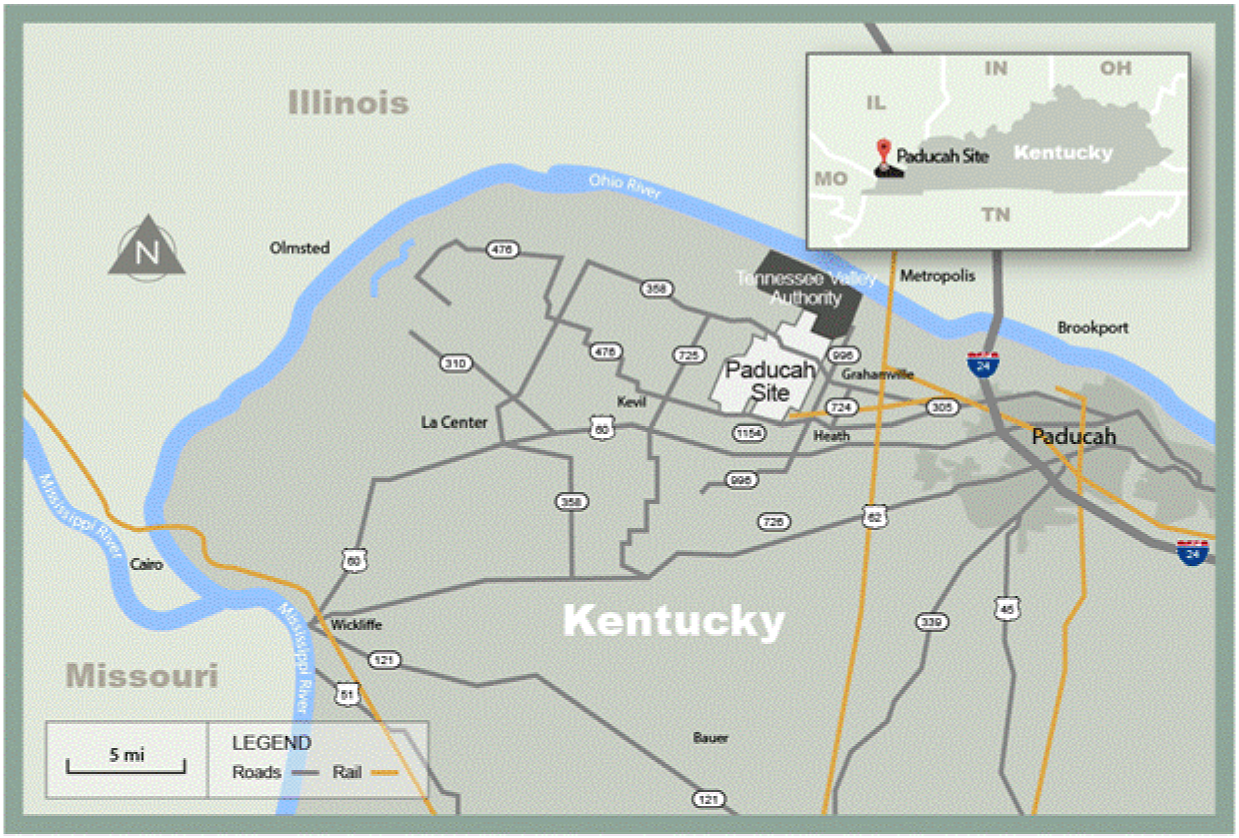

Figure 2-1 Location of the Paducah Site

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[5] This DU Oxide SEIS also evaluates the environmental impacts of transportation and disposal of related waste streams including empty and heel cylinders, CaF_2, and ancillary LLW and MLLW.

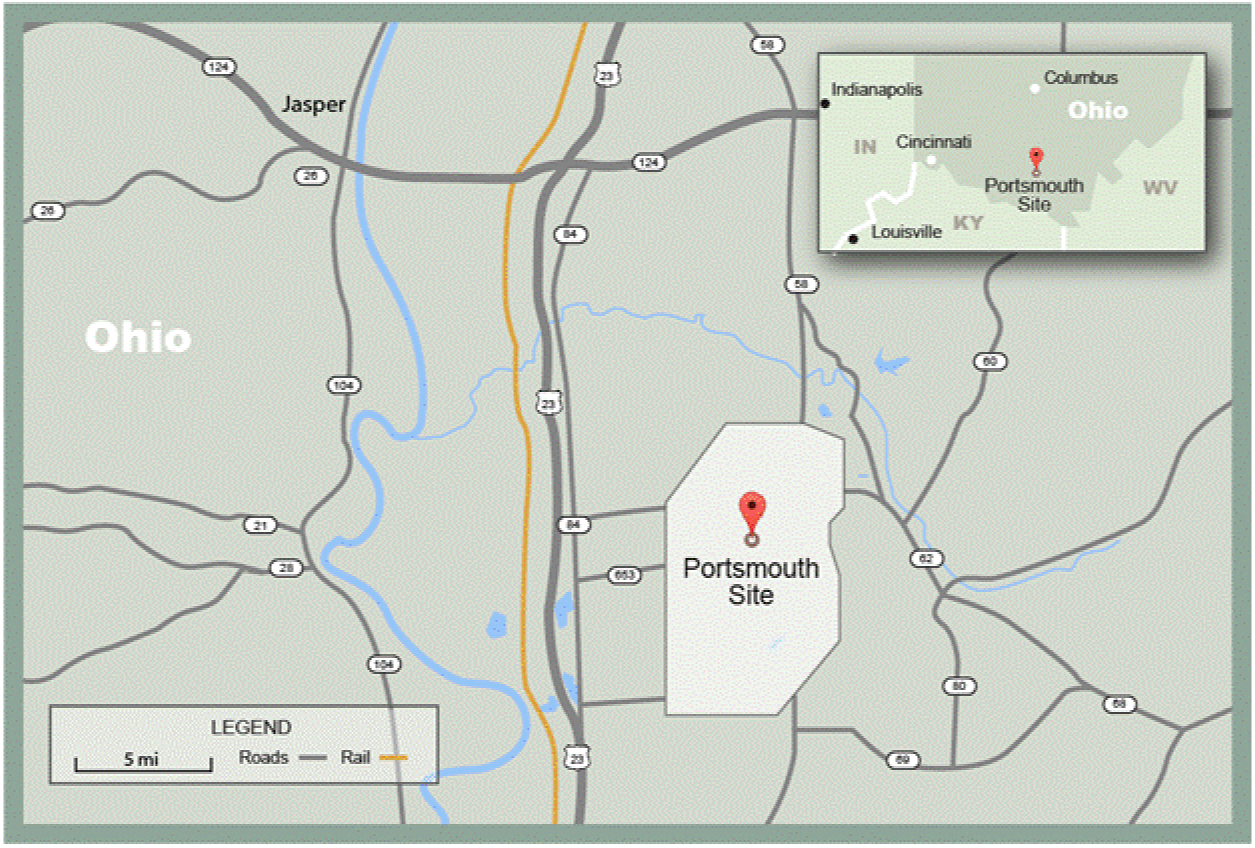

Figure 2-2 Location of the Portsmouth Site

2.1 DESCRIPTION OF RELATED ACTIVITIES AT PADUCAH AND PORTSMOUTH

Facilities for the conversion of depleted uranium hexafluoride (DUF$_6$) to DU oxide at Paducah and Portsmouth became fully operational in 2011. The DU oxide produced is a powder mixture of DU oxides, primarily triuranium octaoxide (U$_3$O$_8$). The U$_3$O$_8$ form is the most stable form, which is also the form most commonly found in nature. Uranium oxide has low solubility in water, has an average density of approximately 2.7 grams per cubic centimeter, and is relatively stable over a wide range of environmental conditions (PPPO 2018).

DU is defined as being less than 0.707 weight-percent uranium-235. Most of DOE's DU inventory contains from 0.2 to 0.4 weight-percent uranium-235 (ANL 2016a). The DU oxide at Paducah and Portsmouth is approximately 99.7 percent uranium-238, 0.25 percent uranium-235, and 0.001 percent uranium-234. Appendix B, Table B-3, of this DU Oxide SEIS shows the assumed isotopic content of the DU oxide including minor impurities.

2.1.1 DUF$_6$ Processing and Cylinder Movement

DUF$_6$ is stored in quarter-inch (approximately two-thirds-centimeter)-thick steel cylinders that are 19, 30, and 48 inches (48, 76, and 122 centimeters) in diameter with the majority being 48-inch-diameter cylinders. The 48-inch-diameter cylinders are either 116 inches (248 centimeters) or

147 inches (360 centimeters) long, depending on the cylinder model. The 48-inch-diameter cylinders hold from 9 to 12 metric tons (10 to 13 tons) of material.

During the conversion process described in detail in the 2004 EISs, DUF_6 is vaporized and converted to a mixture of uranium oxides (primarily U_3O_8) by reaction with steam and hydrogen. The DU oxide design output is approximately 14,300 metric tons (15,763 tons) per year from the Paducah conversion facility and 10,800 metric tons (11,905 tons) per year from the Portsmouth conversion facility. Currently, the DU oxide is collected and packaged for on-site storage in cylinders, emptied of their DUF_6, and processed for this purpose. In the future, DU oxide may be packaged in bulk bags and sent directly to a disposal facility. Approximately 11,000 metric tons (12,000 tons) and 8,300 metric tons (9,000 tons) per year of HF, a coproduct of the conversion reaction, are captured and recycled for commercial use at Paducah and Portsmouth, respectively (PPPO 2018). Approximately 24 metric tons (26.4 tons) per year of CaF_2 are estimated to be generated at Paducah and 18 metric tons (19.8 tons) per year of CaF_2 are estimated to be generated at Portsmouth during the conversion process. Per the 2004 EISs, the CaF_2 may contain very low levels of radionuclide contamination; therefore, this DU Oxide SEIS assumes that the CaF_2 would be disposed of as LLW. Additional CaF_2 (11,800 metric tons [13,000 tons] per year at Paducah and 8,800 metric tons [9,700 tons] per year at Portsmouth) would be generated if HF is not sold and instead converted to CaF_2 for disposal as waste (DOE 2004a, 2004b).

Emptied DUF_6 cylinders are processed to be used for DU oxide packaging for storage, and potentially transportation and disposal. Typically, cylinders emptied of DUF_6 by heating and vaporization at the conversion facility are placed into temporary storage while residual, short-lived radioactivity is allowed to decay. Stabilizing agents are then introduced into the cylinders to neutralize any residual fluoride in the remaining material. After neutralization is complete, a hole is cut on each cylinder head and a flange is welded to the cylinder to facilitate loading with DU oxide. Once filled with DU oxide, a gasket and a cover plate are affixed to the flange (DOE 2004a; PPPO 2018). Filled DU oxide cylinders are moved to the cylinder storage yards for storage pending reuse or disposition.[6]

As described in Chapter 1, Section 1.2, this DU Oxide SEIS evaluates only the management of DU oxide, empty and heel cylinders, CaF_2, and ancillary LLW and MLLW. Decisions on the storage of DUF_6, conversion of DUF_6 to DU oxide, and management of HF were already made in the RODs for the 2004 EISs (69 FR 44654; 69 FR at 44649) and are not reevaluated in this DU Oxide SEIS. **Figure 2-3** shows the activities analyzed in this SEIS.

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[6] As discussed in Chapter 1, DOE considers DU oxide a resource that may be sold or transferred for beneficial uses. It would only become a waste when a decision is made to dispose of a quantity of the material.

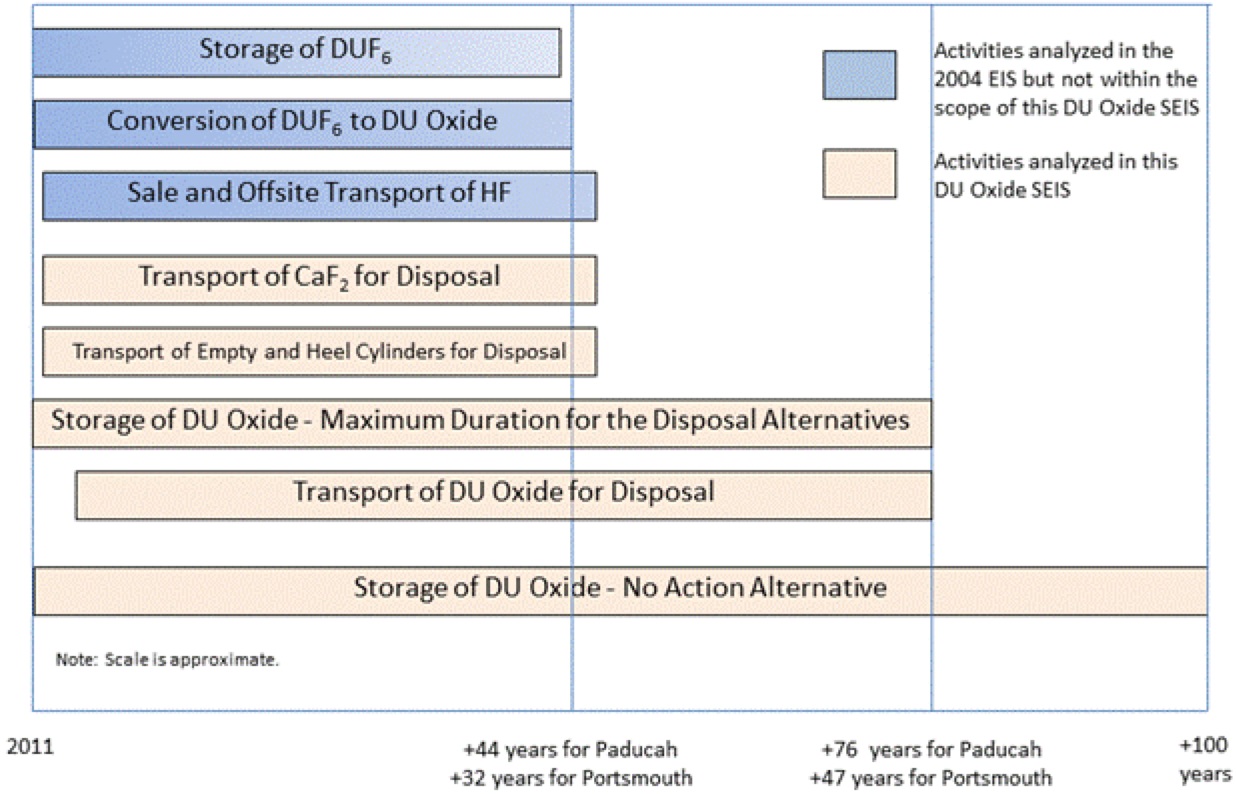

Figure 2-3 Anticipated Activities at the Paducah and Portsmouth Sites Analyzed in this DU Oxide SEIS[7]

2.1.2 Quantities of Depleted Uranium Oxide to be Managed

Prior to the start of conversion operations, there were approximately 560,000 metric tons (617,288 tons) of DUF_6 stored in 46,000 cylinders at Paducah and approximately 250,000 metric tons (275,575 tons) of DUF_6 stored in 21,000 cylinders at Portsmouth (approximately 4,800 of these cylinders were transferred from ETTP). By February 2018, the inventory had been reduced to approximately 523,524 metric tons (577,086 tons) of DUF_6 in 42,961 cylinders at Paducah and approximately 227,439 metric tons (250,709 tons) of DUF_6 in 19,009 cylinders at Portsmouth as the DUF_6 was converted to DU oxide. As the DUF_6 inventory is reduced, the DU oxide inventory at each site will increase. As of February 2018, there were approximately 30,145 metric tons (33,229 tons) of DU oxide stored in 2,908 cylinders at Paducah and approximately 18,570 metric tons (20,469 tons) of DU oxide stored in 1,898 cylinders at Portsmouth (PPPO 2018). By the end of the project, conversion of the entire DUF_6 inventory could result in the generation of a total of approximately 46,150 cylinders (446,515 metric tons [492,193 tons]) of DU oxide at Paducah and

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[7] The 2004 EISs analyzed disposal of DU oxide, empty and heel cylinders, CaF_2, and ancillary LLW and MLLW at NNSS and Energy*Solutions*. The DU Oxide SEIS analyzes revised quantities of these materials for disposal and includes disposal at an additional facility, (i.e., WCS).

approximately 22,850 cylinders (199,337 metric tons [219,729 tons]) of DU oxide at Portsmouth (PPPO 2018).

There are also 205, 55-gallon (208-liter) steel drums of DU oxide stored at Portsmouth (PPPO 2018). These drums were generated during the first five years of conversion facility start-up operations and outages. As many as five drums could be generated at each conversion facility annually during recovery from future off-normal events (PPPO 2018). Therefore, a total of 220 and 365 drums of DU oxide could be generated at Paducah and Portsmouth, respectively.[8]

2.1.3 Container Storage

Cylinders are typically stacked two high in cylinder storage yards such as the one shown in **Figure 2-4**. The storage yards are large outdoor areas that typically have a gravel or concrete base. DU oxide cylinders are stored on concrete pads; only empty and heel cylinders are stored on gravel storage areas. The bottom cylinders are placed on concrete saddles to keep them off the ground (ANL 2016b). DU oxide stored in 55-gallon (208-liter) drums is protected from the elements by storing the drums in intermodal containers (BWXT 2016b).

Figure 2-4 DUF_6 Cylinder Storage Yard (Source: BWXT 2016b)

Figure 2-5 shows the location of the storage yards at Paducah. There are multiple storage yards at Paducah, for a total of approximately 3.6 million square feet (334,451 square meters), or 83 acres (34 hectares), of storage space (PPPO 2018). This is enough space to store nearly 77,000 cylinders. These yards vary in size from 17,000 to 470,400 square feet (1,579 to 43,702 square meters). Seven of the yards are composed of compacted dense-grade aggregate, two are partially dense-grade aggregate and partially concrete, and ten are concrete. All the cylinder

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[8] In order to be conservative, the total DU oxide quantity analyzed in this DU Oxide SEIS for disposal in cylinders or bulk bags includes the quantities that may be generated and disposed of in the 55-gallon steel drums.

storage yards are located inside security fences. As shown in Figure 2-5, two of the cylinder storage yards are located in the northwest portion of Paducah, two are located in the northeast portion of the site, and the remaining 15-cylinder storage yards are clustered in the southern portion of the site (PPPO 2018).

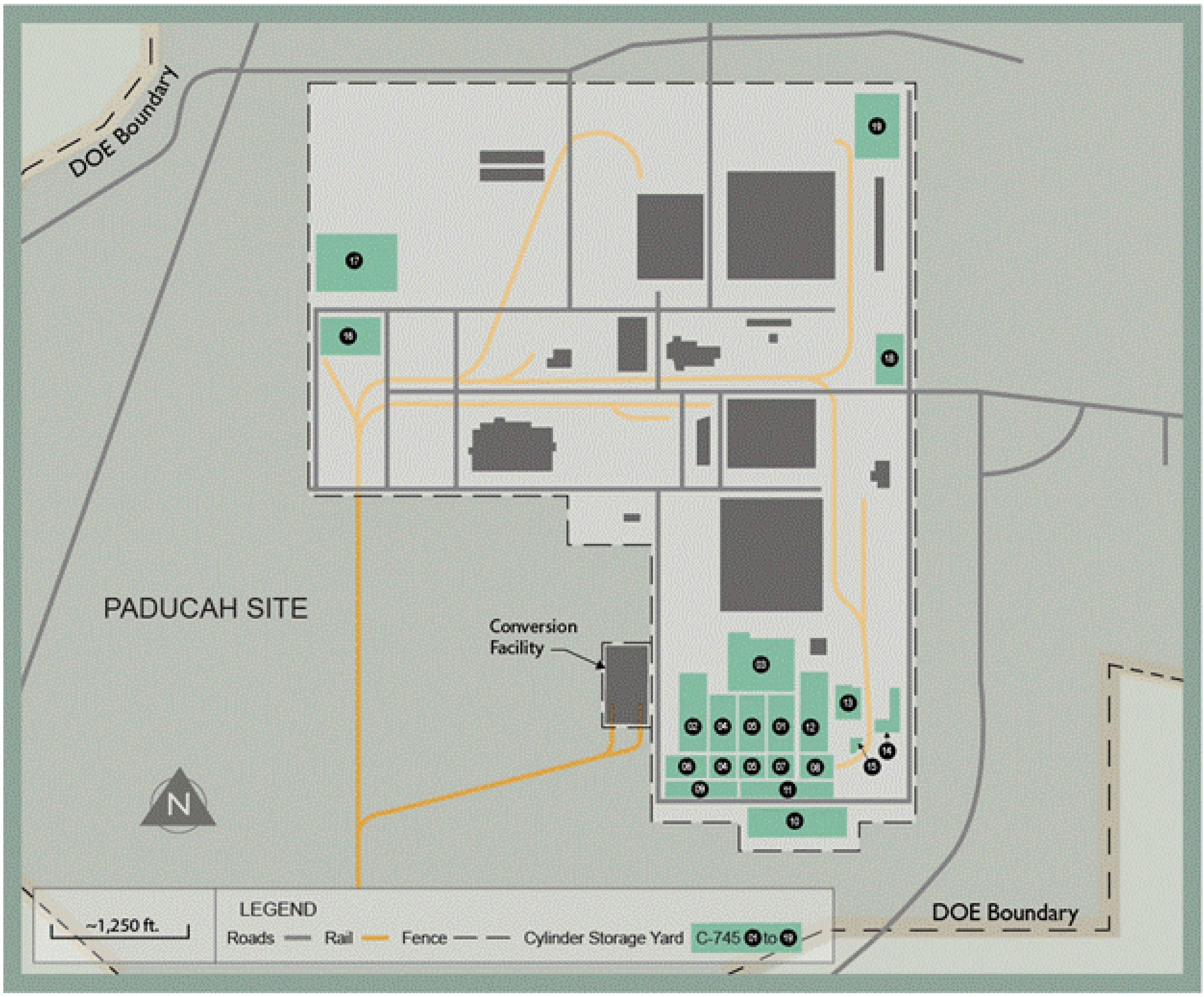

Figure 2-5 Location of Storage Yards at Paducah
Sources: modified from DOE 2004a; PPPO 2018)

Figure 2-6 shows the location of the cylinder storage yards at Portsmouth. The storage yards at Portsmouth provide a total of approximately 1 million square feet (92,903 square meters) or 23 acres (9.3 hectares) of storage space (PPPO 2018). The storage yards have a concrete base and all are located inside security fences. As shown in Figure 2-6, seven of the cylinder storage yards are located inside Perimeter Road in the northern portion of the site and one of the cylinder storage yards is located north of the Perimeter Road (PPPO 2018).

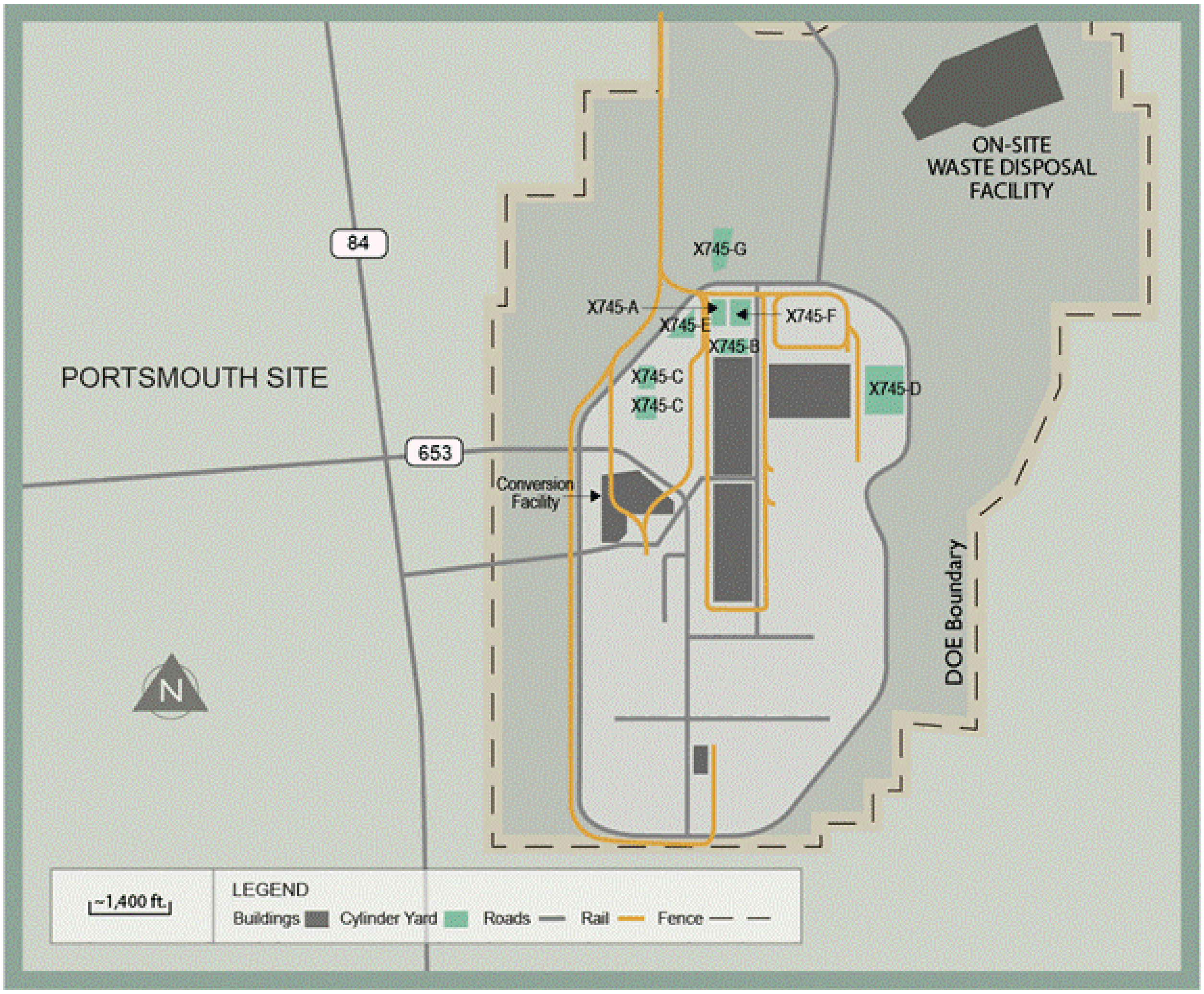

Figure 2-6 Location of Storage Yards at Portsmouth (Sources: modified from DOE 2004b; PPPO 2018)

The Paducah and Portsmouth storage yards are monitored, and the DU oxide cylinders are inspected and maintained in accordance with the Cylinder Surveillance and Maintenance Plan (MCS 2017). This plan describes the methods, organizational structure, and documents involved in cylinder surveillance and maintenance, including the basis for corrosion control and maintenance decisionmaking. In addition, the plan describes the methods associated with the inspection and storage of DU oxide containers. Inspectors performing routine inspections access information in the Cylinder Inventory Database about each cylinder and can enter surveillance data for review and uploading to the database as a permanent record (MCS 2017).

2.2 ALTERNATIVES

This section describes the three Action Alternatives being evaluated for disposal of the DU oxide produced by the conversion process described in Section 2.1.1 and the No Action Alternative, which is required under NEPA. The No Action Alternative is described in Section 2.2.1. The on-site activities common to the three Action Alternatives are described in Section 2.2.2. Sections

2.2.2.1, 2.2.2.2, and 2.2.2.3 provide brief descriptions of the proposed disposal sites and identify the modes of transport for shipments to those sites.

2.2.1 No Action Alternative

Under the No Action Alternative, DU oxide containers would not be transported for disposal. Instead, DU oxide containers would be stored indefinitely at the sites (i.e., Paducah and Portsmouth) where they would be produced. The empty and heel cylinders, CaF_2, and ancillary LLW and MLLW would be shipped to off-site disposal facilities.

Although under the No Action Alternative, the DU oxide containers would remain in storage at Paducah and Portsmouth indefinitely; for analysis purposes in this DU Oxide SEIS and for comparison to the Action Alternatives, the potential impacts of storage are evaluated for 100 years beginning with storage of the first DU oxide cylinders in 2011 and ending in 2110.[9] During the conversion periods, the numbers of DUF_6 cylinders would decrease, while the numbers of DU oxide cylinders would increase until all DUF_6 is converted to DU oxide. Based on the rate of conversion of DUF_6 to DU oxide, DOE estimates that conversion activities will be completed and the last DU oxide cylinders produced between 2044 and 2054 at Paducah and between 2032 and 2042 at Portsmouth (PPPO 2018). Therefore, storage of DU oxide cylinders after the completion of conversion activities would be for 56 to 66 years at Paducah and for 68 to 78 years at Portsmouth. Consistent with the completion dates for conversion activities, disposal of empty and heel cylinders is conservatively analyzed to occur over 34 years at Paducah and over 22 years at Portsmouth.

There are also the 220 and 365, 55-gallon (208-liter) drums of DU oxide that could be generated at Paducah and Portsmouth, respectively (PPPO 2018). The drums of DU oxide would be stored on site in intermodal shipping containers in the cylinder storage yards.

Under the No Action Alternative, DOE would ensure the continued safe storage of the DU oxide containers for as long as they remain in storage by providing site security, and by monitoring and inspecting the storage yards and containers in accordance with the Cylinder Surveillance and Maintenance Plan (MCS 2017) described in Section 2.1.3. The surveillance and maintenance activities include routine surveillance and maintenance of the cylinder yards, container inspections, and repair or replacement of corroded or damaged storage cylinders.

For assessment purposes, the 2004 EISs (DOE 2004a, 2004b) evaluated two cylinder breach cases. In the first case, “controlled corrosion,” it was assumed that the planned cylinder maintenance program and improved storage conditions would maintain the cylinders in a protected condition

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[9] Storage under the No Action Alternative could extend beyond the 100 years analyzed in this DU Oxide SEIS. Storage for longer than 100 years would not change the maximum reasonably foreseeable annual impacts of operations, but would extend the impacts described in this DU Oxide SEIS further out in time. The contributions attributable to those facilities to total lifecycle impacts, such as those for total worker and population dose and latent cancer fatalities (LCFs), and total waste generation, would increase in proportion to the extended period. These impacts can be estimated from the analyses provided in this DU Oxide SEIS under the No Action Alternative by multiplying the additional years of operation by the annual impacts.

and control further corrosion. In that case, it was assumed that some cylinder breaches would occur from handling damage; a total of 36 future breaches were estimated to occur through 2039 at Paducah and 23 at Portsmouth (16 breaches in the Portsmouth cylinders and 7 in the ETTP cylinders). In the second case, "uncontrolled corrosion," it was assumed that external corrosion would not be halted by the improved cylinder maintenance program. In that case, the number of future breaches estimated through 2039 was 444 for cylinders stored at Paducah and 287 for cylinders stored at Portsmouth (74 breaches in the Portsmouth cylinders and 213 in the ETTP cylinders). These breach estimates were determined based on historical corrosion rates when cylinders were stored under poor conditions (i.e., cylinders were stacked too close together, were stacked on wooden chocks, or came into contact with the ground). Because storage conditions have improved dramatically as a result of cylinder yard upgrades and the improved cylinder maintenance program, it is expected that the breach estimates based on historical corrosion rates provide a worst case for estimating the potential impacts from continued cylinder storage (DOE 2004a, 2004b). No new cylinder breaches have occurred at Paducah and Portsmouth since improved storage conditions have been implemented (PPPO 2018).

Table 2-1 summarizes information on cylinder breach scenarios from the 2004 EISs (DOE 2004a, 2004b) and provides the estimated breach rates derived from this data for cylinders from Paducah, Portsmouth, and ETTP.

Table 2-1 Estimate of Potential Cylinder Breach Rates

Site	Number of Cylinders	Storage Period (Years)	Number of Breaches		Breach Rate (per cylinder per year)	
			Controlled Corrosion	Uncontrolled Corrosion	Controlled Corrosion	Uncontrolled Corrosion
Paducah	36,191	40	36	444	2.49×10^{-5}	3.07×10^{-4}
Portsmouth	16,109	40	16	74	2.48×10^{-5}	1.15×10^{-4}
ETTP	4,822	40	7	213	3.63×10^{-5}	1.10×10^{-3}
Portsmouth and ETTP	20,931	NA-	23	287	NA	NA

ETTP = East Tennessee Technology Park; NA = not applicable.
Sources: DOE 2004a, 2004b

Impacts on human health and safety, surface water, groundwater, soil, air quality, and ecology from uranium releases from breached cylinders were assessed in the 2004 EISs (DOE 2004a, 2004b). For all hypothetical cylinder breaches, it was assumed that the breach would be undetected for four 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 (DOE 2004a, 2004b).

The estimated cylinder breach rates shown in Table 2-1 were used to calculate the number of cylinders that could be breached under the various corrosion scenarios and storage periods for the alternatives analyzed in this DU Oxide SEIS. The results of these estimates are presented in **Table 2-2** and are used in the impact analyses presented in Chapter 4 of this DU Oxide SEIS.

Table 2-2 Estimate of Potential Cylinder Breaches for the DU Oxide SEIS Alternatives

Site	Number of Cylinders[a]	Alternative	Storage Period (years)[b]	Number of Breaches[c]	
				Controlled Corrosion	Uncontrolled Corrosion
Paducah	46,150	No Action	100	115	1,415
		Disposal	76	87	1,076
Portsmouth	17,586	No Action	100	44	202
		Disposal	47	21	95
ETTP	5,264	No Action	100	19	581
		Disposal	47	9	273
Portsmouth and ETTP	22,850	No Action	100	63	783
		Disposal	47	30	368

Key: DU = depleted uranium; ETTP = East Tennessee Technology Park; SEIS = supplemental environmental impact statement.

[a] Source: PPPO 2018

[b] In order to produce a conservative estimate of the number of cylinder breaches, the maximum storage period was analyzed for the disposal alternatives (i.e., 76 years at Paducah and 47 years at Portsmouth). The maximum storage period for Paducah includes the storage of DU oxide containers for the 44 years of conversion facility operation plus 32 years to ship all the containers to the disposal facility. The maximum storage period for Portsmouth includes the storage of DU oxide containers for the 32 years of conversion facility operation plus 15 years to ship all the containers to the disposal facility.

[c] Annual rates can be estimated by dividing the total number of cylinder breaches by the duration of the storage period in years.

Under the No Action Alternative, DOE would ship the 14,000 intact empty and heel cylinders (8,843 from Paducah and 5,517 from Portsmouth) for disposal at one or more of three disposal sites (i.e., Energy*Solutions*, NNSS, or WCS). In addition, if DOE is unable to sell the HF, the HF could be converted to CaF_2 for disposal as LLW. Approximately 25,262 bulk bags of CaF_2 at Paducah and 13,559 bulk bags at Portsmouth were analyzed in the 2004 EISs (DOE 2004a, 2004b), while 32,417 bulk bags of CaF_2 at Paducah and 13,554 bulk bags of CaF_2 at Portsmouth would be expected under the quantities analyzed in this DU Oxide SEIS. In addition, ancillary LLW and MLLW would be shipped to the LLW disposal sites. Appendix B of this SEIS includes additional information on how wastes would be shipped to the disposal sites.

DU oxide cylinders are moved around the sites using a straddle buggy or NCH-35, depicted in **Figures 2-9** and **2-10**, respectively (ORNL 1997). The NCH-35 is used at Paducah; both straddle buggy and NCH-35 are used at Portsmouth. Cylinders would be lifted and positioned on the railcars or truck beds using overhead cranes (PPPO 2018). Cylinder movement is performed in accordance with technical procedures. USEC-651, *The UF_6 Manual: Good Handling Practices for Uranium Hexafluoride*, contains specific guidance for processing, handling, and transporting DUF_6 and DU oxide cylinders (USEC 2017). The requirements in this procedure are intended to ensure both safety of personnel and protection of the cylinders from damage during handling and movement.

Rail access is available at both Paducah and Portsmouth and at two of the potential disposal sites: Energy*Solutions* in Utah and WCS in Texas. For these sites, rail transport would be directly from Paducah or Portsmouth to either of these disposal sites. NNSS does not have rail access. Therefore, rail transport to NNSS would not be direct: DU oxide containers would be transferred from railcars to trucks at an intermodal facility for the final leg of the trip to NNSS. For analysis purposes, this DU Oxide SEIS assumes the intermodal facility located in Barstow, California, would be used. **Figures 2-7** and **2-8** show the analyzed routes from Paducah and Portsmouth, respectively, to the potential disposal sites.

The 2004 EISs (DOE 2004a, 2004b) analyzed the transport of empty and heel cylinders, CaF_2, and ancillary LLW and MLLW from Paducah and Portsmouth for disposal at Energy*Solutions* and NNSS. Because the quantities of these wastes have changed and DOE is now considering disposal at WCS, this DU Oxide SEIS is reevaluating the transport and disposal of these wastes for all three sites.

2.2.1.1 Rail Transport

Under the No Action Alternative, 140 railcar shipments would be needed from Paducah and another 90 railcar shipments from Portsmouth to transport the 14,000 intact empty and heel cylinders (8,843 from Paducah and 5,517 from Portsmouth) to the disposal site. As analyzed in the 2004 EISs, 6,316 railcar shipments would be needed from Paducah and 3,390 railcar shipments from Portsmouth to transport the 189,910 cubic yards of CaF_2 (122,500 from Paducah and 67,410 from Portsmouth) to the disposal site. For the quantities analyzed in this DU Oxide SEIS, 8,110 rail shipments would be needed from Paducah and 3,390 railcar shipments from Portsmouth to transport the 224,578 cubic yards of CaF_2 (157,195 from Paducah and 67,383 from Portsmouth) to the disposal site. The small quantities of ancillary LLW and MLLW would be shipped by truck only.

2.2.1.2 Truck Transport

If shipped by truck, 4,240 shipments would be needed from Paducah and another 2,760 truck shipments from Portsmouth to transport the 14,000 intact empty and heel cylinders (8,483 from Paducah and 5,517 from Portsmouth to the disposal site). As analyzed in the 2004 EISs, if shipped by truck, 25,262 truck shipments would be needed from Paducah and 13,559 truck shipments from Portsmouth to transport the CaF_2 to a disposal site. For the quantities analyzed in this DU Oxide SEIS, 32,420 truck shipments would be needed from Paducah and 13,550 truck shipments from Portsmouth to transport the CaF_2 to a disposal site. The small quantities of ancillary LLW and MLLW would require about one truck shipment per year from each site.

2.2.2 Action Alternatives

Under the Action Alternatives, DU oxide would be transported and disposed of at one or more of three disposal sites (i.e., Energy*Solutions*, NNSS, or WCS). The activities at Paducah and Portsmouth would be the same for the three Action Alternatives. Only the destination of the DU oxide cylinder shipments would be different. Under each of the three Action Alternatives, DU oxide containers would be loaded onto either railcars or trucks for transport from Paducah and Portsmouth to the proposed disposal sites. The containers in which the DU oxide is stored would be used as the transportation package and disposal container, and as such would need to meet U.S. Department of Transportation (DOT) transportation requirements and disposal facility waste acceptance criteria. DU oxide containers not meeting transportation requirements would be repaired, replaced, or overpacked[10] before shipment. Approximately 46,150 cylinders of DU oxide would be shipped from Paducah and 22,850 cylinders of DU oxide would be shipped from Portsmouth over the life of the project.

As mentioned in Section 2.2.1, there would be 220 and 365, 55-gallon (208-liter) drums of DU oxide that would be generated at Paducah and Portsmouth, respectively (PPPO 2018). The drums of DU oxide would be shipped to the disposal facilities via truck or rail along with the cylinders of DU oxide under the Action Alternatives.

As an option, this DU Oxide SEIS also evaluates the transport and disposal of DU oxide in bulk bags. The 2004 EISs evaluated shipping approximately 32,840 bulk bags of DU oxide from Paducah and 17,692 bulk bags of DU oxide from Portsmouth over the life of the project (DOE 2004a, 2004b).[11] Because of the larger volume of DU oxide analyzed in this DU Oxide SEIS, it is estimated that approximately 41,016 bulk bags of DU oxide would be generated at Paducah and 18,142 bulk bags of DU oxide would be generated at Portsmouth over the life of the project. Under the bulk bag disposal option, 69,000 volume-reduced empty and heel cylinders (46,150 from Paducah and 22,850 from Portsmouth) would also require disposal.

As described in Section 2.2.1, 14,000 empty and heel cylinders, CaF_2, and ancillary LLW and MLLW would be shipped to the LLW disposal sites. The information from Section 2.2.1 is not repeated here. Additional information on how wastes would be shipped to the disposal sites is included in Appendix B of this DU Oxide SEIS.

The 2004 EISs (DOE 2004a, 2004b) analyzed the transport of DU oxide in cylinders (or bulk bags) from Paducah and Portsmouth for disposal at Energy*Solutions* and NNSS. Because the quantities of these wastes have changed and DOE is now considering disposal at WCS, this DU Oxide SEIS is reevaluating transport and disposal of these wastes for all three sites.

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[10] As defined in the DOT Hazardous Materials Regulations (49 CFR 171.8), an overpack is an enclosure that is used to provide protection or convenience in handling a transportation package or to consolidate two or more packages. An example of an overpack is one or more packages placed in a protective outer packaging such as a crate or drum. The overpack does not include the transport vehicle or freight container.

[11] The 2004 EISs analyzed disposal of DU oxide in bulk bags at NNSS and Energy*Solutions*. This DU Oxide SEIS incorporates those analyses for NNSS and Energy*Solutions* and uses those analyses to estimate impacts for disposal at WCS.

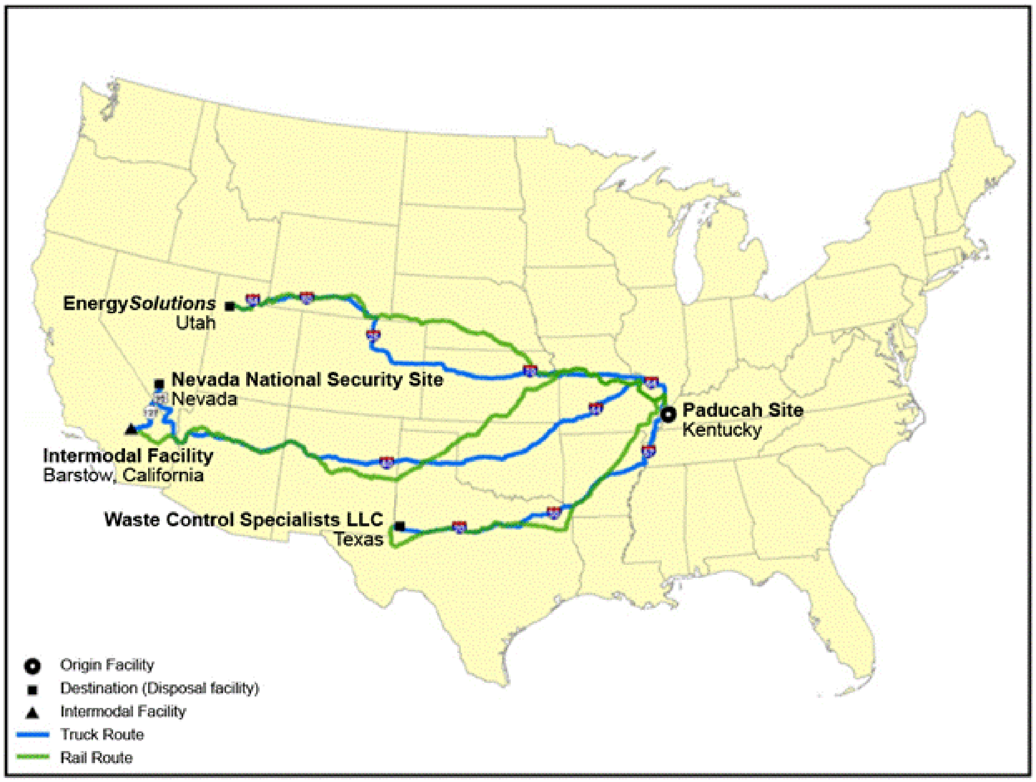

Figure 2-7 Analyzed Rail and Truck Routes from Paducah to Potential Disposal Sites

Figure 2-8 Analyzed Rail and Truck Routes from Portsmouth to Potential Disposal Sites

Figure 2-9 Straddle Buggy

Figure 2-10 NCH-35

2.2.2.1 Rail Transport

Paducah and Portsmouth each have 40 railcars available for transporting the DU oxide cylinders. Trains consisting of 10 railcars, carrying 6 cylinders in each railcar, would transport the DU oxide from Paducah and Portsmouth to the disposal sites. It would take approximately two months for each train to make one complete cycle, which would allow time for the railcars to be loaded, travel to the disposal site, be emptied, and return to the site. This would mean a total of 1,440 cylinders would be transported in 24 rail shipments annually from each site. At this rate, it would take approximately 32 years to transport all the DU oxide cylinders from Paducah and 15 years to transport all the DU oxide cylinders from Portsmouth (PPPO 2018).

As analyzed in the 2004 EISs, 7,240 railcar shipments would be needed from Paducah and 4,200 railcar shipments from Portsmouth to transport the DU oxide in cylinders to the disposal site (DOE 2004a, 2004b). For the quantities analyzed in this DU Oxide SEIS, DOE assumes that approximately 770 rail shipments would come from Paducah and 380 rail shipments from Portsmouth, assuming 10 railcars per shipment.

As analyzed in the 2004 EISs, if bulk bags were used for disposal of DU oxide, a total of 4,105 railcar shipments would be needed from Paducah and 2,212 railcar shipments would be needed from Portsmouth (DOE 2004a, 2004b). For the quantities analyzed in this DU Oxide SEIS, if bulk bags were used for disposal of DU oxide, a total of 5,130 railcar shipments would be needed from Paducah and 2,270 railcar shipments would be needed from Portsmouth. In addition, if bulk bags were used, another 2,460 rail shipments would be needed from Paducah and another 1,275 railcar shipments from Portsmouth to transport the 69,000 volume-reduced empty and heel cylinders (46,150 from Paducah and 22,850 from Portsmouth) to the disposal site.

2.2.2.2 Truck Transport

Because truck shipments would be made by legal-weight semitrailer trucks, only one full DU oxide cylinder would be loaded on each truck. Assuming 1,440 truck shipments were made each year from each site, approximately six trucks would be loaded and leave each site each work day. At this rate, it would take approximately 32 years to transport all of the DU oxide cylinders from Paducah and 15 years to transport all of the DU oxide cylinders from Portsmouth.

As analyzed in the 2004 EISs, if bulk bags were used, two bulk bags would be loaded on each truck. If bulk bags were used, a total of 16,420 truck shipments would be needed at Paducah and 8,846 truck shipments would be needed at Portsmouth (DOE 2004a, 2004b). For the quantities analyzed in this DU Oxide SEIS, a total of 20,510 truck shipments would be needed at Paducah and 9,071 truck shipments would be needed at Portsmouth. In addition, if bulk bags were used, another 4,970 truck shipments would be needed from Paducah and another 2,550 truck shipments from Portsmouth to transport the 69,000 volume-reduced empty and heel cylinders (46,150 from Paducah and 22,850 from Portsmouth) to the disposal site.

Transportation, both by rail and truck, would be in accordance with DOT requirements at 49 CFR Part 173, Subpart I, and DOE Orders and guidance, including Chapter 5, “Protection During Transportation,” of DOE Order 473.3A, *Protection Program Operations.*

Table 2-3 shows the key attributes of the activities analyzed under the DU Oxide SEIS alternatives.

Table 2-3 Attributes of the Activities Analyzed Under the DU Oxide SEIS Alternatives

Activity	Paducah		Portsmouth	
	No Action Alternative	Disposal Alternatives	No Action Alternative	Disposal Alternatives
Evaluated in the 2004 EISs (DOE 2004a, 2004b) but not in this DU Oxide SEIS[a]				
Conversion of DUF_6 to DU Oxide				
Start of Conversion Operations	2011		2011	
Duration of Conversion Operations	34 to 44 years[b]		22 to 32 years[b]	
Evaluated in this DU Oxide SEIS				
Amount of DU Oxide	446,515 MT		199,337 MT	
DU Oxide in Cylinders[c]	46,150 cylinders		22,850 cylinders	
DU Oxide in Drums	220 drums		365 drums	
Disposal of CaF_2[d]	379,000 MT		159,000 MT	
Disposal of Empty and Heel Cylinders	8,483 cylinders		5,517 cylinders	
Start of DU Oxide Storage	2011		2011	
Storage of DU Oxide Containers	100 years[e]	76 years[f]	100 years[e]	47 years[f]
Employment Associated with DU Oxide Container Storage	16 FTEs		12 FTEs	
Transport of DU Oxide Containers to Off-site Disposal Facilities	NA	32 years[g]	NA	15 years[g]
Disposal of DU Oxide at ES, NNSS, or WCS[h]	NA	258,000 cubic yards	NA	128,000 cubic yards

Key: DU = depleted uranium; ES = Energy*Solutions*; FTE = full-time equivalent; LLW = low-level radioactive waste; MT = metric tons; NA = not applicable; NE = not evaluated in this DU Oxide SEIS; NNSS = Nevada National Security Site; SEIS = supplemental environmental impact statement; WCS = Waste Control Specialists LLC.

[a] Storage of DUF_6 cylinders, conversion of DUF_6 to DU oxide, management of hydrogen fluoride, and size reduction of empty and heel cylinders were analyzed in the 2004 EISs (DOE 2004a, 2004b) and are not part of the Proposed Action evaluated in this DU Oxide SEIS, but were considered as part of cumulative impacts.

[b] As described in Section 2.2.1, based on the rate of conversion of DUF_6 to DU oxide, DOE now believes conversion activities would occur over a 34- to 44-year period at Paducah and a 22- to 32-year period at Portsmouth.

[c] As an option, DU oxide could be disposed of in bulk bags. At Paducah 41,016 bulk bags would be needed, while at Portsmouth 18,142 bulk bags would be needed. Under the disposal in bulk bags option, an additional 69,000 empty and heel cylinders would be volume-reduced and disposed of as LLW.

[d] Information is derived from the 2004 EISs (DOE 2004a, 2004b).

[e] For purposes of analysis in this DU Oxide SEIS, under the No Action Alternative, storage of DU Oxide containers was evaluated for 100 years. The impacts of storage beyond 100 years are also discussed.

[f] Based on the DUF_6 to DU oxide conversion rates, DU oxide containers would be stored at Paducah for at least 34 to 44 years, and at Portsmouth for at least 22 to 32 years. Based on the schedule for shipping DU oxide to the disposal sites, DU oxide containers could be shipped from Paducah over a period of 32 years and from Portsmouth over a period of 15 years. Therefore, this DU Oxide SEIS analyzes storage of DU oxide containers for 76 (44 + 32) years at Paducah and 47 (32 + 15) years at Portsmouth. The impact analysis uses the maximum duration and assumes that all DU oxide containers would be stored for this entire period in order to maximize the potential impacts (i.e., be the most conservative).

[g] As described in Section 2.2.2.1, based on the schedule for shipping DU oxide to the disposal sites, DU oxide containers could be shipped from Paducah over a period of 32 years and from Portsmouth over a period of 15 years. This is unlikely because the DU oxide would be generated at Paducah over a period of 34 to 44 years, and at Portsmouth over a period of 22 to 32 years, and much of the DU oxide would likely be shipped as it is generated. Nonetheless, the transportation impacts analysis uses the shipping durations (32 years at Paducah and 15 years at Portsmouth) in order to maximize annual transportation impacts (i.e., be the most conservative).

[h] Information is from Chapter 4, Section 4.2.3.

Source: Information is based on PPPO 2018 except where noted.Disposal of Waste at Energy*Solutions*

Disposal at Energy*Solutions* in Clive, Utah, was evaluated in the 2004 EISs. At that time, the name of the site was Envirocare of Utah, Inc. This site is 5 miles (8 kilometers) south of the Clive exit on Interstate 80 in Tooele County, approximately 80 miles (130 kilometers) west of Salt Lake City, Utah. This site can accept waste by rail or truck transport. The site is approximately 1 square mile (2.6 square kilometers) in size and is licensed to handle and dispose of Class A LLW, naturally occurring and accelerator-produced material, MLLW, and uranium and thorium byproduct material under Utah Radioactive Material License UT2300249. There are more than 8 million cubic yards (6.1 million cubic meters) of licensed/permitted capacity at the Clive site (ES 2016a). As discussed in Chapter 3, Section 3.3 of this DU Oxide SEIS, Energy*Solutions* has applied for a license amendment to construct and operate a dedicated unit for disposal of uranium oxide. This disposal unit is currently designed to accept approximately 378,000 cubic yards (289,000 cubic meters) of DU oxide but could be sized to accommodate the actual disposal volume (Shrum 2016a).

Disposal of Waste at the Nevada National Security Site

The 2004 EISs evaluated disposal at NNSS in Nye County, Nevada. Continued disposal of LLW from DOE and certain U.S. Department of Defense (DoD) facilities at NNSS was also evaluated in the NNSS SWEIS (DOE 2013a). LLW management and disposal occurs within the NNSS Area 5 Radioactive Waste Management Complex (RWMC). Area 5 is an active LLW and MLLW disposal facility, managing and disposing of LLW (and MLLW) generated on site at NNSS. NNSS also accepts wastes for disposal from other approved generators at DOE and National Nuclear Security Administration sites and certain DoD sites throughout the United States. This is consistent with the February 25, 2000, ROD (65 FR 10061) for the WM PEIS (DOE 1997), in which DOE announced that NNSS (called the Nevada Test Site at that time) would be one of two regional sites to be used for DOE-generated LLW and MLLW disposal. NNSS currently has the capacity to dispose of up to 1,778,000 cubic yards (1,359,000 cubic meters) of LLW, and 148,000 cubic yards (113,000 cubic meters) of MLLW.

NNSS does not have rail access. Therefore, DU oxide containers would need to arrive by truck. The containers could be transported either entirely by truck from Paducah or Portsmouth or could travel by rail to an intermodal facility, assumed, for analysis purposes, to be in Barstow, California, where the containers would be transferred from railcars to trucks for the remainder of the trip.

Disposal of Waste at Waste Control Specialists LLC

Disposal at WCS was not evaluated in the 2004 EISs because it was not licensed for disposal of radioactive waste at the time the 2004 EISs were prepared. The WCS site is located near Andrews, Texas, in the western part of the state that borders New Mexico. This facility can accept waste by rail or truck and accepts waste from both commercial and government generators, with separate facilities for each. The Federal Waste Disposal Facility at WCS opened in June 2013 and has a licensed capacity of up to 963,000 cubic yards (736,000 cubic meters) of LLW and MLLW. The facility was constructed solely for the disposal of waste for which the Federal Government is responsible, as defined by the Low-Level Radioactive Waste Policy Act, as amended (WCS 2016c). The Federal Waste Disposal Facility is licensed through September 2024, with provision for 10-year renewals thereafter under Texas Commission on Environmental Quality (TCEQ) Radioactive Material License CN60061689. DOE has signed an agreement to take ownership of the Federal Waste Disposal Facility after the postclosure care period.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

As described in Section 2.2, this DU Oxide SEIS analyzes the potential impacts from on-site storage of DU oxide at Paducah and Portsmouth, and transport and disposal of DU oxide at the Energy*Solutions* site near Clive, Utah; NNSS in Nye County, Nevada; and the WCS site near Andrews, Texas. DOE identified the following additional Action Alternatives that it considered for evaluation but ultimately dismissed from detailed study, as discussed in Sections 2.3.1 through 2.3.4: (1) transportation alternatives, (2) on-site disposal of DU oxide, (3) disposal of DU oxide at other LLW disposal facilities, and (4) disposal of DU oxide at WIPP.

2.3.1 Transportation Alternatives

Alternatives considered but not analyzed in detail in the 2004 EISs (DOE 2004a, 2004b) include those for alternative modes of transportation. The 2004 EISs included a discussion of why transportation of DUF_6 cylinders between the Paducah and Portsmouth conversion facilities by either air or barge was not reasonable and therefore not carried forward for detailed analysis. Although this DU Oxide SEIS is analyzing DU oxide transport to disposal sites, rather than DUF_6 transport between the conversion facilities, similar conditions apply.

Air transportation was eliminated from detailed analysis in the 2004 EISs because of the types and quantities of materials that would be shipped. Those reasons are also valid for the proposed shipments of DU oxide for disposal. The physical nature of the DU oxide (e.g., uranium powder), the packaging in large containers (i.e., steel cylinders or bulk bags), the large number of cylinders (69,000) or bulk bags (59,158), and both the weight of the individual containers and the total weight of DU oxide to be transported (approximately 645,852 metric tons [711,923 tons]), makes air transport impractical.

In addition, Paducah and Portsmouth and the Energy*Solutions* and WCS sites are not directly adjacent to an airport capable of handling large aircraft. Therefore, the DU oxide could not be transported directly by air between Paducah or Portsmouth and the disposal sites; intermodal transport would be required. In order to fly the DU oxide containers, they would first need to be loaded onto trucks or railcars at Paducah or Portsmouth for transport to an airport where the containers would be loaded onto the airplanes, transported by air, and then offloaded onto trucks or railcars for the final leg to the Energy*Solutions* and WCS disposal facilities. DOE maintains an airstrip at NNSS. Even air transport to NNSS would involve transporting the DU oxide containers from Paducah and Portsmouth by truck or rail to an airport capable of handling large aircraft. Therefore, because of the large mass of DU oxide to be shipped, the size and weight of the individual containers, and the unduly complex and time-consuming effort involved with air transport relative to transport by truck or rail, transport by air is eliminated from detailed analysis in this DU Oxide SEIS.

Barge transportation was eliminated from detailed analysis in the 2004 EISs because of the lack of barge facilities at the conversion facilities and in proximity to the proposed disposal sites. None of the proposed disposal sites is situated directly on a river or other waterway navigable by barges. Even if there were waterways and barge terminals in reasonably close proximity to the selected disposal location, containers of DU oxide would need to be transported by truck from Paducah and Portsmouth to the barge terminals where the containers would be loaded onto the barges, transported by barge, and then offloaded onto trucks for the final leg to the disposal site. Depending on the disposal site, the barge routes could involve long distances on intracoastal and coastal waterways, the open ocean, and major rivers. Intermodal barge transportation would be unduly complex and time-consuming relative to shipment by truck or rail. Therefore, transport by barge is eliminated from detailed analysis in this DU Oxide SEIS.

2.3.2 On-Site Disposal of DU Oxide

Disposal of DU oxide as LLW on site at Paducah or Portsmouth would require site-specific studies and technical analyses to identify suitable on-site disposal locations and to develop design, construction, and operational parameters for the proposed disposal units to ensure that releases of radionuclides to the environment, particularly radon isotopes, and impacts on members of the public would be maintained within regulatory-prescribed limits for potentially thousands of years following disposal. Several years could be required to complete the required studies and analyses, as well as the processes for regulatory review and permitting before construction could begin. Because of uncertainties about the timing for availability of on-site disposal capacity specifically for DU oxide, and the expected availability of disposal capacity at the three off-site disposal facilities evaluated in this DU Oxide SEIS (see Section 2.4), on-site disposal for DU oxide is eliminated from detailed analysis in this DU Oxide SEIS.

2.3.3 Disposal of Wastes at Other LLW Disposal Facilities (e.g., Barnwell, Hanford)

Commercial LLW disposal facilities not evaluated as alternatives in this DU Oxide SEIS are those in operation in Barnwell County, South Carolina, and at the Hanford Site in the state of Washington. Disposal of LLW at these facilities is limited to LLW generated by members of state compacts established pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). Disposal of LLW at the Barnwell facility is limited to non-DOE generators in states comprising the Atlantic Compact (Connecticut, New Jersey, and South Carolina), while disposal of LLW at the commercial facility at the Hanford Site is limited to non-DOE generators in states comprising the Northwest and Rocky Mountain Compacts (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington, Wyoming, Colorado, Nevada, and New Mexico). DOE would not be able to dispose of DU oxide at either facility without approval by these compacts to accept DOE LLW, which would not be a certainty and would likely involve a long, time-consuming process.[12] Therefore, disposal of DU oxide at the Barnwell and Hanford commercial facilities is eliminated from detailed analysis in this DU Oxide SEIS.

In its February 25, 2000, ROD for the WM PEIS (65 FR 10061), DOE established the Hanford Site and NNSS as regional LLW and MLLW disposal sites for the DOE complex. However, with certain limitations and exceptions, the DOE facility at the Hanford Site does not accept LLW or

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[12] It is expected that any future LLW compact facilities, even those that would include waste generated in Ohio or Kentucky, would have similar restrictions, requirements, and uncertainty for approval for disposal of DOE waste. According to DOE Manual 435.1-1, DOE has a longstanding practice of avoiding actions with the potential to affect State Compact disposal facilities. DOE would only consider the use of State Compact disposal facilities if petitioned by a State Compact for reasons such as economic feasibility.

MLLW generated from off-site sources, but may do so in the future after the on-site Waste Treatment Plant is in operation.[13] DOE does not expect full operation of the Waste Treatment Plant until 2039, although operation of the plant for treatment of some waste is expected sooner (TCH 2015). Because of uncertainty about the timing for availability of the Hanford Site for disposal of DU oxide, disposal at the Hanford Site is eliminated from detailed analysis in this DU Oxide SEIS.

2.3.4 Disposal of Wastes at the Waste Isolation Pilot Plant

The Waste Isolation Pilot Plant Land Withdrawal Act (Public Law 102-579) restricts materials to be disposed of at WIPP, a deep geologic repository in New Mexico, to transuranic waste[14] generated from the Nation's atomic energy defense activities. The DU oxide destined for disposal is classified as LLW rather than transuranic waste. Therefore, disposal of the DU oxide (and other LLW that would be generated under the Proposed Action) is not authorized under the Act, and could not be disposed of at WIPP without a statutory amendment to the Act. Furthermore, disposal of DU oxide at WIPP would unnecessarily use limited disposal space in a geologic repository intended for waste requiring a higher degree of isolation from the environment. For these reasons, disposal of DU oxide at WIPP is eliminated from detailed analysis in this DU Oxide SEIS.

2.4 COMPARISON OF ALTERNATIVES

2.4.1 General Information

This section summarizes estimated potential impacts on the environment, including impacts on workers and members of the general public, under the No Action Alternative and the Action Alternatives for disposal of DU oxide[15] at Energy*Solutions* near Clive, Utah; NNSS in Nye County, Nevada; and WCS near Andrews, Texas. This section also describes the potential for cumulative impacts (Section 2.4.3).

This DU Oxide SEIS does not address the impacts of the storage of DUF_6 cylinders, conversion of DUF_6 to DU oxide, and the management and disposition of HF. These activities were evaluated in the 2004 EISs (DOE 2004a, 2004b) and decisions announced in RODs for these EISs (69 FR 44654; 69 FR 44649). The impacts of these activities are considered as part of potential cumulative impacts.

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[13] In DOE's December 13, 2013, ROD (78 FR 75913) for the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (DOE/EIS-0391) (DOE 2013b), DOE deferred a decision on importing wastes from other sites (with limited exceptions) for disposal at the Hanford Site at least until the Waste Treatment Plant at Hanford becomes operational.

[14] Transuranic waste is radioactive waste that is not classified as high-level radioactive waste and that contains more than 100 nanocuries (3,700 becquerels) per gram of alpha-emitting transuranic isotopes with half-lives greater than 20 years, except for waste that DOE has determined, with EPA concurrence, does not need the degree of isolation called for by 40 CFR Part 191, or waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61 (DOE Order 435.1).

[15] This DU Oxide SEIS also evaluates the environmental impacts of transportation and disposal of related waste streams including empty and heel cylinders and CaF_2.

No Action Alternative: As described in Section 2.2.1, under the No Action Alternative, DU oxide would continue to be stored at Paducah and Portsmouth. DU oxide would not be disposed of as LLW. For purposes of analysis, the duration of the No Action Alternative at Paducah and Portsmouth is 100 years beginning with storage of the first DU oxide cylinders in 2011, and ending in 2110.[16] Based on the rate of conversion of DUF_6 to DU oxide, DOE believes conversion activities will occur over a 34-year period at Paducah and over a 22-year period at Portsmouth (PPPO 2018). The time period considered for conversion of DUF_6 to DU oxide at Paducah and Portsmouth under this alternative is 44 and 32 years, respectively (PPPO 2018).[17] This corresponds with the duration of conversion activities plus a 10-year cushion to account for unanticipated outages. Therefore, for purposes of this analysis, under the No Action Alternative, storage of DU oxide cylinders after the completion of conversion activities would be for at least 56 to 66 years at Paducah and for at least 68 to 78 years at Portsmouth.

This DU Oxide SEIS considers impacts associated with the following activities under the No Action Alternative: (1) long-term storage of DU oxide containers, (2) surveillance and maintenance of the containers including routine inspections, (3) release of DU oxide from damaged or breached containers, and (4) repair of any containers that might be damaged or breached. These activities are described in Chapter 2, Section 2.2.1. Because no DU oxide would be shipped from Paducah or Portsmouth to the disposal sites under the No Action Alternative, there would be only incremental impacts at the Energy*Solutions*, NNSS, or WCS sites from the disposal of the 45,971 bulk bags of CaF_2 (if HF could not be sold), 14,000 empty and heel cylinders, and ancillary LLW and MLLW from container surveillance and maintenance activities.

Action Alternatives: As described in Section 2.2.2, under the Action Alternatives, DU oxide would be disposed of at one or more of three disposal facilities (i.e, Energy*Solutions*, NNSS, and WCS). This section presents the following estimated potential environmental impacts for these alternatives: (1) impacts from storage of DU oxide at Paducah and Portsmouth until shipment to the disposal site, (2) impacts from transportation of the DU oxide to the disposal site, and (3) impacts on the capacity of the disposal facility. For purposes of analysis and to bound the impacts under each Action Alternative, it was assumed that all 69,000 DU oxide cylinders (or 59,000 bulk bags and 69,000 volume-reduced empty and heel cylinders), all remaining 14,000 empty and heel cylinders, all 46,000 bulk bags of CaF_2, and all ancillary LLW and MLLW would be disposed of at each disposal site (i.e., Energy*Solutions*, NNSS, or WCS). In practice, waste could be disposed of at more than one disposal site.

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[16] Storage under the No Action Alternative could extend beyond the 100 years analyzed in this DU Oxide SEIS. Storage for longer than 100 years would not change the maximum annual impacts of operations, but would extend the impacts described in this DU Oxide SEIS further out in time. The contributions attributable to those facilities to total life-cycle impacts, such as those for total worker and population dose and LCFs, and total waste generation, would increase in proportion to the extended period. These impacts can be estimated from the analyses provided in this DU Oxide SEIS under the No Action Alternative by multiplying the additional years of operation by the annual impacts.

[17] The storage periods for DU oxide were assumed based on current plans and schedules and could vary somewhat upon implementation. Any dates cited in this DU Oxide SEIS are for purposes of analyses only.

DU oxide would be stored at Paducah and Portsmouth until it is shipped to the disposal site. As described in Section 2.2.1, based on the rate of conversion of DUF_6 to DU oxide, DOE now believes conversion activities will occur over a 34- to 44-year period at Paducah, and a 22- to 32-year period at Portsmouth (PPPO 2018).[18] Because the shipment schedule is uncertain, it was assumed that the entire inventory of DU oxide would be stored for the entire conversion period.

DOE has conservatively assumed (likely overestimating potential annual impacts) that shipping DU oxide cylinders to a disposal facility would not occur until after conversion is complete and all DU oxide has been generated. It is assumed that DOE would then begin shipping DU oxide cylinders to a disposal facility and would continue shipping until all DU oxide was disposed. It is estimated that transport of DU oxide from Paducah via truck or rail would require about 32 years, based on transport of up to 1,440 cylinders per year. About 46,150 cylinders, containing 447,000 metric tons (492,000 tons) of DU oxide, would be transported from Paducah. The transport of DU oxide from Portsmouth via truck or rail requires about 15 years, also based on the transport of up to 1,440 cylinders per year. About 22,850 cylinders, containing 199,000 metric tons (220,000 tons) of DU oxide, would be transported from Portsmouth (PPPO 2018).

This is a conservative assumption that likely over-estimates the impacts of storage at Paducah and Portsmouth because: (1) DU oxide would be generated over the duration of the conversion period by conversion from DUF_6 and (2) DU oxide would likely be shipped off site for disposal soon after it is generated and not stored for the entire storage and shipping periods.

Because bulk bags would only be used if they could be sent directly to a disposal facility, DOE assumes that shipping DU oxide in bulk bags to a disposal facility would occur as soon as the bags are filled. Therefore, bulk bags would be shipped during the 34-to-44-year conversion period at Paducah and the 22-to-32-year conversion period at Portsmouth. DOE assumes transport would occur over the shorter periods to provide a conservative estimate of annual impacts.

This DU Oxide SEIS describes the impacts on disposal facility capacity. Other potential environmental impacts of disposal are not analyzed in this SEIS. Consistent with common practice, as long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, the impacts of disposal have already been considered and found to be acceptable as part of the licensing and permitting process. Chapter 5, Section 5.4, of this DU Oxide SEIS briefly describes the licenses and permits held by the disposal sites.

2.4.2 Summary and Comparison of Potential Environmental Impacts of the Alternatives

Potential environmental impacts associated with the Action Alternatives and the No Action Alternative could include impacts on the following resource areas: site infrastructure; climate, air quality, and noise; geology and soils; water resources; biotic resources; public and occupational health and safety (during normal operations, accidents, and transportation); socioeconomics; waste management; land use and aesthetics; cultural resources; and environmental justice. The potential

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[18] The storage periods for DU oxide were assumed based on current plans and schedules and could vary somewhat upon implementation. Any dates cited in this DU Oxide SEIS are for purposes of analyses only.

environmental impacts at Paducah and Portsmouth under the No Action and Action Alternatives are summarized in **Table 2-4**. The potential environmental impacts of transportation and the impacts on the capacity of the three disposal sites (i.e., Energy*Solutions*, NNSS, and WCS) under the No Action and Action Alternatives are presented in **Table 2-5**. The tables are intended to facilitate comparison among the alternatives. Additional details and discussion are provided in Chapter 4 for each alternative and resource area.

Table 2-4 Summary Comparison of Potential Environmental Impacts of the Alternatives at the Paducah and Portsmouth Sites

Resource Area / Parameter		Paducah		Portsmouth	
		Action Alternatives	No Action	Action Alternatives	No Action
Site Infrastructure	Electricity (MWh/yr) (percent of current use)	0.167 (2)	0.167 (2)	0.167 (0.8)	0.167 (0.8)
	Water (gal/day) (percent of current use)	230,000 (7)	230,000 (7)	73,000 (4)	73,000 (4)
	Diesel Fuel (gal/yr) (percent of current use)	15,600 (NA)	Minimal (NA)	15,600 (NA)	Minimal (NA)
	Gasoline (gal/yr) (percent of current use)	2,080 (NA)	Minimal (NA)	2,080 (NA)	Minimal (NA)
	Discussion: There would be no new construction and no substantial change in DU container storage, maintenance, and handling activities at Paducah and Portsmouth. Annual utility use including DU container storage, maintenance, and handling activities would be little changed from existing utility use. Infrastructure needs would be small when compared to site capacity and current use. Long term storage of cylinders may require maintenance, repair, or replacement of select infrastructure if the storage duration exceeds designed life. Therefore, impacts on infrastructure at Paducah and Portsmouth would be expected to be minor.				
Climate, Air Quality, and Noise	**Climate and Air Quality**	There would be no construction, and little painting or other industrial processes requiring fossil fuel combustion or other release of hazardous air pollutants, criteria air pollutants, or GHG to the environment.			
		Emissions from diesel and gasoline fuel combustion associated with container handling, loading, and shipment of DU oxide, ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 would be minimal whether DU oxide was disposed of in cylinders or bulk bags, and would not contribute to any exceedances of ambient air quality standards.	Minimal	Emissions from diesel and gasoline fuel combustion associated with container handling, loading, and shipment of DU oxide, ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 would be minimal whether DU oxide was disposed of in cylinders or bulk bags, and would not contribute to any exceedances of ambient air quality standards.	Minimal
	Noise	Container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, and no increase in activities above current operations that would contribute to the noise environment. Any increase in noise due to shipment of DU oxide, ancillary LLW and MLLW, empty and heel containers, and/or CaF_2 would be minimal and likely imperceptible in the context of the existing traffic in the region around the sites and the millions of trucks, trains, and general transportation vehicles traveling public roadways and rails that could be used to transport materials associated with the project.			
	Discussion: Potential impacts on air quality, climate, and noise would be expected to be minor.				

Resource Area / Parameter		Paducah			Portsmouth		
		Action Alternatives		No Action	Action Alternatives		No Action
Geology and Soils	Discussion: Container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, no use of geologic and soils materials, and no routine releases of DU oxide or hazardous materials. The release of uranium as a result of a potential cylinder breach would result in soil concentrations considerably below the EPA health-based value for residential exposure. Therefore, potential impacts on geology and soils would be expected to be minor.						
Water Resources	Discussion: Container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, no increases in water use and wastewater discharge, no change to groundwater recharge, and no routine releases of DU oxide or hazardous materials. As described in Site Infrastructure, water usage would be a very small percentage of current use. Therefore, potential impacts on water resources would be minor. Potential impacts on surface and groundwater quality as a result of a release associated with a potential container breach would result in uranium concentrations below radiological benchmark levels (i.e., 30 micrograms per liter Safe Drinking Water Act maximum contaminant levels).						
Biotic Resources	Discussion: Container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction and no routine releases of DU oxide or hazardous materials. Therefore, potential impacts on biotic resources would be expected to be minor. Potential impacts on biotic resources as a result of a release associated with a potential container breach indicate that groundwater uranium concentrations could exceed the ecological screening value for surface water (2.6 microgram per liter). However, contaminants in groundwater discharging to a surface water body, such as a local stream, would be quickly diluted to negligible concentrations.						
Human Health and Safety – Normal Operations	Radiological Exposure						
	Involved workers	*DU Cylinder Storage and Shipment*	*DU Bulk Bag Option*		*DU Cylinder Storage and Shipment*	*DU Bulk Bag Option*	
	Average dose (millirem/yr)	480	430	74	510	240	63
	Annual LCF risk	3×10^{-4}	3×10^{-4}	4×10^{-5}	3×10^{-4}	2×10^{-4}	4×10^{-5}
	Total dose (person-rem)	170	68	120	69	30	76
	Total health effects (LCFs)	0 (0.1)	0(0.04)	0 (0.07)	0 (0.04)	0 (0.02)	0 (0.05)
	Discussion: Doses would be below regulatory limits and no LCFs would be expected. 10 CFR Part 835 imposes an individual worker dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017g). The average dose for the Action Alternatives is associated with loading DU oxide containers for shipment to the disposal facility and assumes the same team performs all loading operations.						
	Noninvolved workers						
	Maximum dose to MEI (millirem/yr)	0.15		0.15	0.15		0.15
	Total dose (person-rem)	0.2		0.3	0.05		0.1
	Total LCF risk	0 (1×10^{-4})		0 (2×10^{-4})	0 (3×10^{-5})		0 (6×10^{-5})
	Discussion: Doses would be below regulatory limits and no LCFs would be expected. 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017g). Values presented are for DU cyinder storage and shipment. Implementation of the bulk bag option would not result in any incremental noninvolved worker impacts above the impacts associated with the DU cylinder storage and shipment option.						

Resource Area / Parameter		**Paducah**		**Portsmouth**	
		Action Alternatives	**No Action**	**Action Alternatives**	**No Action**
	General public				
	MEI dose (millirem/yr)	5.0	5.0	1.3	1.3
	Annual LCF risk	3×10^{-6}	3×10^{-6}	8×10^{-7}	8×10^{-7}
	Total dose (millirem)	220	500	42	130
	Total LCF risk	0 (1×10^{-4})	0 (3×10^{-4})	0 (3×10^{-5})	0 (8×10^{-5})
	Discussion: MEI doses would be well below regulatory limits for radiation exposure to a member of the public established by EPA and DOE and no LCFs would be expected. The EPA has set a radiation dose limit to a member of the general public of 10 millirem per year from airborne sources (40 CFR Part 61). DOE Order 458.1 imposes an annual individual dose limit of 10 millirem from airborne pathways, 100 millirem from all pathways, and 4 millirem from the drinking-water pathway.				
	Population dose (person-rem/yr)[a]	0.01	0.01	0.002	0.002
	Total dose (person-rem)	0.76	1.0	0.094	0.2
	Total health effects (LCFs)	0 (5×10^{-4})	0 (6×10^{-4})	0 (6×10^{-5})	0 (1×10^{-4})
	Discussion: Because of the distance from the DU oxide storage containers, members of the general public would receive no direct radiation dose. DU oxide released in potential cylinder breaches due to corrosion would result in a very small likelihood, (about 1 in 1,700 at Paducah and 1 in 10,000 at Portsmouth) of any additional cancer fatalities in the general population associated with cylinder storage. Therefore, no LCFs would be expected in the general population. Values presented are for cylinder storage and shipment. Implementation of the bulk bag option would not result in any incremental general public impacts above the impacts associated with the DU cylinder storage and shipment option.				
	Chemical exposure (hazard index [HI])[b]				
	Worker MEI	<1	<1	<1	<1
	General public MEI	<0.1 air <0.05 water	<0.1 air <0.05 water	<0.1 air <0.05 water	<0.1 air <0.05 water
	Discussion: The Hazard index (HI) associated with airborne releases of uranium would be less than 0.1 and the HI for releases into the waters around Paducah and Portsmouth would be less than 0.05. Therefore, no adverse impacts would be expected from chemical exposure.				
Human Health and Safety – Accidents	Bounding accident	Hopper - Broken Discharge Chute	Hopper - Broken Discharge Chute	Hopper - Broken Discharge Chute	Hopper - Broken Discharge Chute
	Release amount (kilograms)	6	6	6	6
	Radiological exposure				
	Noninvolved workers				
	Dose to MEI (rem)	1.3	1.3	1.3	1.3
	Risk of LCF	8×10^{-4}	8×10^{-4}	8×10^{-4}	8×10^{-4}
	General public				
	Dose to MEI (rem)	0.0065	0.0065	0.0065	0.0065
	Risk of LCF	4×10^{-6}	4×10^{-6}	4×10^{-6}	4×10^{-6}
	Chemical exposure (hazard index [HI])				
	Chemical Exposure (HI)	<1	<1	<1	<1

Resource Area / Parameter		Paducah		Portsmouth	
		Action Alternatives	No Action	Action Alternatives	No Action
	Discussion: All accidents that involved DU oxide storage were found to have low unmitigated (without preventive or mitigative features) radiological and chemical consequences to facility or collocated workers and negligible radiological and chemical consequences to the public. As a result, no DU oxide storage accidents were evaluated in detail. The DU oxide powder hopper accident bounds the potential consequences of events for DU oxide container storage. Note: The accident analyses are conservative. Preventative and mitigative measures may reduce consequences, as discussed in Chapter 4, Section 4.1.1.6.				
Socioeconomics	Employment (FTEs)	16	16	12	12
	Discussion: There would be no construction activities.The employment associated with DU oxide container storage, maintenance, and handling (i.e., 16 FTEs for Paducah and 12 FTEs for Portsmouth) would be approximately 1 percent of total site employment and approximately 5 to 6 percent of conversion facility employment. Disposal of DU oxide in bulk bags would likely be similar to disposal of DU oxide in cylinders since bulk bags would require fewer bags than DU oxide in cylinders (less labor) but would generate a greater number of volume-reduced empty and heel cylinders (more labor). In addition, management of large quantities of CaF_2 would only be required if the DOE was unable to sell HF; in which case, staff assigned to manage HF could manage CaF_2. Therefore, because of the small numbers of employees involved, no appreciable in-migration or out-migration is expected, and there would be no impacts on population and regional growth, housing, or community services in the Paducah and Portsmouth ROIs.				
Waste Management	Ancillary LLW (yd^3/yr) (percent of current generation)	2.1 (1.0)	2.1 (1.0)	1.6 (1.0)	1.6 (1.0)
	Ancillary MLLW (yd^3/yr) (percent of current generation)	0.014 (1.0)	0.014 (1.0)	0.010 (1.0)	0.010 (1.0)
	LLW – empty and heel cylinders (yd^3 / yr) (percent of current generation)	1,400 (NWS)	1,400 (NWS)	1,400 (NWS)	1,400 (NWS)
	LLW – CaF_2 (yd3/yr) (percent of current generation)	4,600 (NWS)	4,600 (NWS)	3,700 (NWS)	3,700 (NWS)
	Discussion: Container storage, maintenance, and handling are projected to generate small amounts of LLW and MLLW. In addition, empty and heel cylinders (also LLW) and CaF_2 (assumed to be LLW) could be generated. All LLW and MLLW generated during storage and maintenance of DU oxide containers at Paducah and Portsmouth would be transported to off-site facilities for treatment and/or disposal. Although these empty and heel cylinders and CaF_2 would be very large percentages of current LLW generation, the site waste management infrastructure was modified during construction of the conversion facilities to handle these volumes of wastes. Therefore, managing these waste would not adversely affect the waste management infrastructure. Any trash or sanitary wastewater generated would represent small fractions of the same types of waste generated by all site personnel and would be managed with no impacts on site capacities.				
Land Use and Aesthetics	Discussion: Container storage, maintenance, and handling activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no new construction and no change in land use. Therefore, potential impacts of the No Action and Action Alternatives on land use and aesthetics would be minor.				
Cultural Resources	Discussion: Container storage, maintenance, handling activities, and routine shipping of wastes off-site would occur within the industrialized areas of Paducah and Portsmouth and there would be no new construction. The existing storage yards at Paducah and Portsmouth are located in previously disturbed areas that were graded during original storage yard construction, and are unlikely to contain cultural properties or resources listed on or eligible for listing on the NRHP. There would be no impacts and no effects on historic properties at either location. In addition, there would be no impacts on religious or sacred sites, burial sites, or resources significant to Native Americans because none have been identified at these locations.				

Resource Area / Parameter		Paducah		Portsmouth	
		Action Alternatives	**No Action**	**Action Alternatives**	**No Action**
Environmental Justice	Discussion: Minimal impacts on the general public related to air quality, climate, noise, and water resources have been identified, including at the population and individual level. In addition, accidents were found to have negligible radiological and chemical consequences to the public. There would be no disproportionately high and adverse impacts on minority or low-income populations.				

Key: CEQ = Council on Environmental Quality; DOE = U.S. Department of Energy; DU = depleted uranium; DUF_6 = depleted uranium hexafluoride; EPA = U.S. Environmental Protection Agency; FTE = full time equivalent; GHG = greenhouse gas; HAP = hazardous air pollutant; HF = hydrogen fluoride; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed (off-site) individual; MLLW = mixed low-level radioactive waste; NA = not applicable; NWS = new waste stream; NRHP = National Register of Historic Places; TSCA = Toxic Substances Control Act.

[a] Based on a population within 50 miles of the site of 534,000 people for Paducah and 677,000 people for Portsmouth.

[b] The hazard index (HI) is the 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.

Notes: To convert cubic yards (solid) to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533; kilograms to pounds, multiply by 2.2046.

Table 2-5 Summary Comparison of Potential Environmental Impacts of Transportation and Disposal at Energy*Solutions*, Nevada National Security Site, or Waste Control Specialists LLC

Resource Area / Parameter		Action Alternatives			No Action
		Energy*Solutions*	**NNSS**	**WCS**	
Transportation DU oxide in cylinders option	*Rail - Incident-free*				
	Crew dose (person-rem)	100	145[a]	84	0.2
	Crew LCF	0 (0.06)	0 (0.09)[a]	0 (0.05)	0 (0.0002)
	Population dose (person-rem)	135	216[a]	135	0.4
	Population LCF	0 (0.08)	0 (0.1)[a]	0 (0.08)	0 (0.0002)
	Rail – Accidents				
	Population LCF risk	3×10^{-3}	3×10^{-3}(a)	5×10^{-3}	2×10^{-6}
	Traffic fatalities	1.0	2.0[a]	1.4	0.2
	Truck – Incident-free				
	Crew dose (person-rem)	224	276	155	0.3
	Crew LCF	0 (0.1)	0 (0.2)	0 (0.09)	0 (2×10^{-4})
	Population Dose (person-rem)	590	722	403	0.7
	Population LCF	0 (0.3)	0 (0.4)	0 (0.2)	0 (4×10^{-4})
	Truck - Accidents				
	Population LCF risk	4×10^{-4}	5×10^{-4}	3×10^{-4}	1×10^{-7}
	Traffic fatalities	11	11	10	1
Transportation DU oxide in bulk bags and 69,000 empty and heel cylinders[c]	*Rail – Incident-free*				
	Crew dose (person-rem)	1,356	1,610[a*]	< Energy*Solutions*[c,g]	0.2
	Crew LCF	1 (0.8)	1 (1)[a*]		0 (0.0002)
	Population dose (person-rem)	56	56[a*]	< or = to Energy*Solutions* or NNSS	0.4
	Population LCF	0 (0.03)	0 (0.03)[a*]		0 (0.0002)
	Rail – Accidents				
	Population LCF risk	1×10^{-2}	1×10^{-2}(a*)	< or = to Energy*Solutions* or NNSS	2×10^{-6}
	Traffic fatalities	2	2[a*]		0.2
	Truck – Incident-free				
	Crew Dose (person-rem)	571	655	< Energy*Solutions*	0.3
	Crew LCF	0 (0.3)	0 (0.4)		0 (2×10^{-4})

Resource Area / Parameter		**Action Alternatives**			**No Action**
		Energy*Solutions*	**NNSS**	**WCS**	
	Population dose (person-rem)	273	319	< or = to Energy*Solutions* or NNSS	0.7
	Population LCF	0 (0.2)	0 (0.2)		0 (4×10^{-4})
	Truck – Accidents				
	Population LCF risk	4×10^{-2}	2×10^{-2}	< or = to Energy*Solutions* or NNSS	1×10^{-7}
	Traffic fatalities	4	5		1
	Discussion: Transport of radioactive wastes from Paducah and Portsmouth to the disposal sites would likely result in no LCFs, but there could be nonradiological fatalities from trauma during the accident.				
Transport of CaF_2[d]	Truck: Traffic Fatalities	6.4	7.0	5.8	5.8 to 7.0
	Rail: Traffic Fatalities	1.0	2.50	1.2	1.0 to 2.5
	Discussion: Transport of CaF_2 from Paducah and Portsmouth to the disposal sites could result in nonradiological fatalities from trauma during an accident.				
Waste Management (cubic yards) Percent of disposal facility capacity in parenthesis	LLW – DU oxide	386,000 (100)[b]	386,000 (22)	386,000 (40)	NA
	LLW – ancillary waste	140 (0.0034)	140 (0.0080)	140 (0.015)	370 (0.0088 to 0.038)
	MLLW – ancillary waste	0.92 (0.00026)	0.92 (0.00062)	0.92 (0.00010)	2.4 (0.00025 to 0.0016)
	LLW – intact empty and heel cylinders	78,300 (1.9)	78,300 (4.4)	78,300 (8.2)	78,300 (1.9 to 8.2)
	LLW – volume-reduced empty and heel cylinders (if bulk bags were used)	38,600 (0.9)	38,600 (2.2)	38,600 (4.0)	NA
	LLW – CaF_2	225,000 (5.4)	225,000 (13)	225,000 (24)	225,000 (5.4 to 24)
	Discussion: Wastes would be within the capacities of the three disposal facilities.				
Greenhouse Gas Emissions (CO_2e tons/yr)	*Rail Transport*	14,701	20,113[a]	10,037	6,943
	Truck Transport	14,253	17,913	9,731	6,792
	Discussion: Total annual GHG emissions from transportation of waste to the disposal sites would be minimal in comparison to national GHG emissions from rail and truck transportation of 52,500,000 and 449,100,000 tons per year, respectively.				

Key: CO_2e = carbon dioxide equivalents; DOE = U.S. Department of Energy; DU = depleted uranium; GHG = greenhouse gas; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; MLLW = mixed low-level radioactive waste; NA = not applicable; NNSS = Nevada National Security Site; WCS = Waste Control Specialists LLC.

Resource Area / Parameter	Action Alternatives			No Action
	Energy*Solutions*	NNSS	WCS	

[a] Because NNSS lacks a direct rail connection for waste delivery, truck transports were evaluated for shipments from an intermodal facility to NNSS. For purposes of analysis and consistent with the NNSS SWEIS (DOE 2013a); the intermodal facility was assumed to be the rail yard in Barstow, California. The impacts for the entire transportion route are reported in this table.

[a*] The 2004 EISs (DOE 2004a, 2004b) assume rail connections to NNSS are available. Therefore, no intermodal facility was used.

[b] DU oxide would be disposed of in a separate disposal unit sized to receive all DU oxide waste. Therefore, the percent capacity will always be 100 percent.

[c] These analyses use the transportation risks presented in the 2004 EISs (DOE 2004a, 2004b) to calculate impacts using the revised DU oxide (in bulk bags) and empty and heel cylinder (volume-reduced) shipments to Energy*Solutions* and NNSS as estimated in this DU Oxide SEIS. This DU Oxide SEIS incorporates those analyses for NNSS and Energy*Solutions* and uses those analyses to comparatively estimate impacts for disposal at WCS. The risk in terms of crew or population dose from transporting DU oxide in bulk bags to WCS would be less than or equal to those calculated for Energy*Solutions* based on the results of the analysis of transporting DU oxide in cylinders.

[d] Although conservatively considered LLW for purposes of disposal, the CaF_2 has such low levels of radiation it would provide a negligible dose to the crew and the public during transport. The impacts of the transport of CaF_2, if it were to occur, could lead to additional traffic fatalities.

[e] Bulk bags are not appropriate for long-term storage and, therefore, would not be used under the No Action Alternative.

[f] The risk in terms of crew dose from transporting DU oxide in bulk bags is dependent on the duration of the trip, which is related to the mile traveled. The crew dose risks are higher for shipping DU oxide in cylinders to Energy*Solutions* as compared to WCS; hence, the risk of transporting DU oxide in bulk bags to WCS is expected to be less than that calculated for Energy*Solutions* because the distance traveled to WCS is shorter.

[g] The population dose risk from transporting DU oxide in bulk bags is dependent on the populations along the routes to the disposal facilities. Therefore, the population dose risk results of the bulk bag scenario presented in the 2004 EISs for Energy*Solutions* and NNSS cannot be proportioned to estimate impacts for transport to WCS. However, because the population dose risks are higher for shipping DU oxide in cylinders to Energy*Solutions* and NNSS as compared to WCS, the risk of transporting DU oxide in bulk bags to WCS is expected to be less than or equal to that calculated for Energy*Solutions* or NNSS.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

2.4.3 Cumulative Impacts

CEQ regulations define cumulative impacts as the effects on the environment that result from implementing the Proposed Action or any of its alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions (40 CFR 1508.7). Thus, the cumulative impacts of an action can be viewed as the total impact on a resource, ecosystem, or human community of that action and all other activities affecting that resource irrespective of the source. Noteworthy cumulative impacts can result from individually small, but collectively significant, effects of all actions.

Cumulative impacts were assessed by combining the effects of alternative activities evaluated in this DU Oxide SEIS with the effects of other past, present, and reasonably foreseeable actions in the regions of influence (ROIs). These actions may occur at different times and locations and may not be truly additive. The effects were combined irrespective of the time and location of the impact to envelop any uncertainties in the projected activities and their effects. This approach produces a conservative estimation of cumulative impacts for the activities considered.

This section summarizes the cumulative impacts of activities at Paducah and Portsmouth, disposal of DU oxide and other wastes at the Energy*Solutions*, NNSS, and WSC disposal sites, and nationwide impacts from transportation and on climate change.

Paducah and Portsmouth – DOE's missions involve ongoing activities at Paducah and Portsmouth including continued management of DUF_6 cylinders; operation of the facilities for DUF_6-to-DU oxide conversion; waste management; decontamination, decommissioning, and demolition (DD&D) of surplus facilities; and environmental remediation (contributing to "Existing Conditions" in Tables 2-6 and 2-7). The affected environment information presented in Chapter 3 of this DU Oxide SEIS reflects the impacts of ongoing activities at Paducah and Portsmouth. Future activities that are being considered for Paducah include additional DD&D of surplus facilities, disposal of LLW from remediation (i.e., Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]) activities in an on-site disposal facility, land and facilities transfers, conversion of additional commercially generated DUF_6,[19] and construction of a laser enrichment facility. Future activities at Portsmouth include additional DD&D of surplus facilities, disposal of LLW from remediation (CERCLA) activities in an on-site disposal facility, land and facilities transfers, and conversion of additional commercially generated DUF_6. Other actions occurring in the ROIs near Paducah and Portsmouth that could contribute to current and future cumulative impacts include electrical power generation, conversion of uranium ore to UF_6, and industrial and commercial development. For more information, see Chapter 4, Section 4.5, of this DU Oxide SEIS.

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[19] In anticipation of the potential future receipt of commercial DUF_6, DOE has estimated the impacts from management of 150,000 metric tons (approximately 12,500 cylinders) of commercial DUF_6. The detailed analysis of the impacts of the receipt, conversion, storage, handling and disposal of commercial DUF_6 is presented in Appendix C of this DU Oxide SEIS. For purposes of the cumulative impacts analysis in this SEIS and as a conservative measure of impacts, DOE assumes that the entire mass of commercial DUF_6 (150,000 metric tons) could be managed at either Paducah or Portsmouth.

As summarized in Section 2.4.2, the alternatives evaluated in this DU Oxide SEIS would be expected to cause little to no impacts on the following resource areas: site infrastructure, air quality and noise, geology and soils, water resources, biotic resources, socioeconomics, land use, cultural resources, and environmental justice in the Paducah and Portsmouth ROIs. Because the alternatives would be expected to produce little or no impacts on these resource areas, they would not substantially contribute to cumulative impacts. Thus, this section analyzes cumulative impacts on the remaining resource areas: public and occupational health and safety and waste management for the Paducah and Portsmouth ROIs. The results of the cumulative impacts analyses for Paducah and Portsmouth are summarized in **Tables 2-6** and **2-7**, respectively.

Table 2-6 Annual Cumulative Impacts at the Paducah Site

		DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[i]			Cumulative Impacts[e]	
Impact Category	Existing Conditions[a]	Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage	Other Actions[d]	Action Alternatives	No Action Alternative
Public and Occupational Safety and Health								
Worker dose[f] (person-rem/yr)	6.2	3.6	1.2	16[j]	17[j]	14.7[g]	49.5	39.1
Worker LCFs	0 (0.004)	0 (2×10^{-3})	0 (7×10^{-4})	0 (0.01)[j]	0 (0.01)[j]	0 (0.01)[g]	0 (0.01)	0 (0.01)
Public dose (person-rem/yr)	0.89	0.01	0.01	0.003	0.003	3.81[g]	4.7	4.7
Public LCFs	0 (0.0005)	0 (5×10^{-6})	0 (5×10^{-6})	0 (2×10^{-6})	0 (2×10^{-6})	0 (0.002)[g]	0 (0.003)	0 (0.003)
Off-site MEI dose (millirem/yr)	4.5[j]	5.0[j]	5.0[j]	0.2	0.2	0.57[g7]	6.1[h,i]	6.1[h,i]
Waste Management								
LLW (including empty and heel cylinders and CaF_2) (yd^3/yr)	210	6,790[i]	6,030[i]	5,960	5,540	92[h]	7,090[l]	6,330[l]
MLLW (yd^3/yr)	1.4	0.014	0.014	0.014	0.014	52[h]	54[l]	54[l]

Key: DD&D = decontamination, decommissioning, and demolition; DU = depleted uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; SEIS = supplemental environmental impact statement; yd^3 = cubic yard; yr = year.

[a] Based on information presented in Chapter 3, Section 3.1, of this DU Oxide SEIS.

[b] Based on results presented in Chapter 4, Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS.

[c] Impacts from the conversion of 150,000 metric tons (165,000 tons) of commercial DUF_6 and storage or disposal of the converted commercial DU oxide (see Appendix C of this DU Oxide SEIS).

[d] Includes impacts of other actions as described in Section 4.5.2 of this DU Oxide SEIS.

[e] Cumulative impacts equal the sum of the impacts of the management alternative and other past, present, and reasonably foreseeable future actions. The cumulative impacts of the Action Alternatives include the sum of existing conditions; DU Oxide SEIS alternatives – Action Alternatives; commercial conversion scenarios – Conversion and Disposal; and other actions. The cumulative impacts of the No Action Alternative include the sum of existing conditions; DU Oxide SEIS alternatives – No Action Alternative; commercial conversion scenarios – Conversion and Storage; and other actions. This is a conservative assumption because some site activities are counted twice and some will not occur concurrently. For example: (1) LLW and MLLW from existing conditions include wastes generated from conversion of DOE DUF_6 to DU oxide and (2) conversion of DOE DUF_6 to DU oxide may not occur in the same years that conversion of commercial DUF_6 to DU oxide would occur.

[f] Includes involved and noninvolved worker doses.

[g] Impacts from operation of the Honeywell Metropolis Works, a uranium conversion facility in Metropolis, Illinois (Enercon 2017; NRC 2006).

[h] The MEI doses occur at different locations for different facilities. Therefore, adding the MEI doses is a very conservative estimate of potential cumulative doses to an MEI.

[i] The off-site MEI dose reported in Section 3.1.6 of this SEIS for existing conditions and in Sectinos 4.1.1.6 and 4.2.1.6 for each of the alternatives includes the same direct radiation dose from cylinders stored in the cylinder yard (4.2 millirem per year). When calculating the cumulative MEIS dose, this direct exposure was only counted once.

[j] The increased generation of LLW during the alternatives primarily reflects the assumed increased generation of LLW in the form of empty and heel cylinders and CaF_2 (PPPO 2018). DU oxide is not considered in this estimate because it is a resource until shipped off site for disposal.

Impact Category	Existing Conditions[a]	DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[l]		Other Actions[c]	Cumulative Impacts[d]	
		Action Alternatives	No Action Alternative	Conversion and Storage	Conversion and Disposal		Action Alternatives	No Action Alternative

[k] Reflects generation of LLW and MLLW from DD&D of the oxide conversion capability (DOE 2004a). Approximately 3.2 million cubic yards (2.5 million cubic meters) of lightly contaminated LLW, 70,708 cubic yards (54,060 cubic meters) of MLLW, and 356 cubic yards (272 cubic meters) of TSCA waste could be generated from future environmental restoration and DD&D activities over the period from 2018 through 2065 (see Table 3-10). DOE is currently evaluating the potential to dispose of 3.2 million cubic yards of lightly contaminated LLW in the OSWDF.

[l] The scenarios for conversion of commercial DUF_6 were not added to the cumulative annual impacts because the majority of these activities would not take place at the same time as the management of DOE DU oxide. Therefore, only the maximum values between the DU Oxide SEIS alternatives and the commercial conversion scenarios were used in the totals.

Sources: DOE 2004a; PPPO 2018

Table 2-7 Annual Cumulative Impacts at the Portsmouth Site

Impact Category	Existing Conditions[a]	Impacts of DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[c]		Impacts of Other Actions[d]	Cumulative Impacts[e]	
		Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative
Public and Occupational Safety and Health								
Worker dose[f] (person-rem/yr)	2.5	3.8	0.76	13	13	No Data	19.3	16.3
Worker LCFs	0 (3×10-4)	0 (2.3×10^{-3})	0 (4.6×10^{-4})	0 (0.008)	0 (0.008)	No Data	0 (0.01)	0 (0.01)
Public dose (person-rem/yr)	0.22	0.002	0.002	2×10^{-3}	2×10^{-3}	No Data	0.22	0.22
Public LCFs	0 (1×10^{-4})	0 (1.2×10^{-6})	0 (1.2×10^{-6})	0 (9×10^{-7})	0 (9×10^{-7})	No Data	0 (1×10^{-4})	0 (1×10^{-4})
Off-site MEI dose (millirem/yr)	1.1	1.3	1.3	0.4	0.4	No Data	2.8[g]	2.8[g]
Waste Management								
LLW (including empty and heel cylinders and CaF_2) (yd^3/yr)	160	5,050[h]	4,470[h]	4,480	4,170	92[i]	5,300[j]	4,720[j]
MLLW (yd^3/yr)	1.0	0.010	0.010	0.010	0.010	52[i]	53[j]	53[j]

Key: DD&D = decontamination, decommissioning, and demolition; DU = depleted uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; SEIS = supplemental environmental impact statement; yd^3 = cubic yard; yr = year.

[a] Based on information presented in Chapter 3, Section 3.2 of this DU Oxide SEIS.

[b] Based on results presented in Chapter 4, Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS. No action impacts were considered over 100 years. Action Alternative impacts were considered for 22 or 32 years, whichever had the greatest impacts.

[c] Impacts from the conversion of 150,000 metric tons (165,000 tons) of commercial DUF_6 and storage or disposal of the converted commercial DU oxide (see Appendix C of this SEIS).

[d] Includes impacts of other actions as described in Section 4.5.3. The impacts of other future actions on public and occupational safety and health is unknown, but would be limited by compliance with applicable regulations.

[e] Cumulative impacts equal the sum of the impacts of the management alternative and other past, present, and reasonably foreseeable future actions. The cumulative impacts of the Action Alternatives include the sum of existing conditions; DU Oxide SEIS alternatives – Action Alternatives; commercial conversion scenarios – Conversion and Disposal; and other actions. The cumulative impacts of the No Action Alternative include the sum of existing conditions; DU Oxide SEIS alternatives – No Action Alternative; commercial conversion scenarios – Conversion and Storage; and other actions. This is a conservative assumption because some site activities are counted twice and some will not occur concurrently. For example: (1) LLW and MLLW from existing conditions include wastes generated from conversion of DOE DUF_6 to DU oxide and (2) conversion of DOE DUF_6 to DU oxide may not occur in the same years that conversion of commercial DUF_6 to DU oxide would occur.

[f] Includes involved worker and noninvolved worker doses.

[g] The MEI doses occur at different locations for different facilities operations. Therefore, adding the MEI doses is a very conservative estimate of potential cumulative doses to an MEI.

[h] The increased generation of LLW during the alternatives primarily reflects the assumed increased generation of LLW in the form of empty and heel cylinders and CaF_2 (PPPO 2018). DU oxide is not considered in this estimate because it is a resource until shipped off site for disposal.

Impact Category	Existing Conditions[a]	Impacts of DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios [i]		Impacts of Other Actions[c]	Cumulative Impacts[d]	
		Action Alternatives	No Action Alternative	Conversion and Storage	Conversion and Disposal		Action Alternatives	No Action Alternative

[i] Reflects generation of LLW and MLLW from DD&D of the oxide conversion capability (DOE 2004b). Approximately 1.26 million cubic yards (0.96 million cubic meters) of lightly contaminated LLW, and 100 cubic yards (76 cubic meters) of MLLW are estimated to be generated from future environmental restoration and DD&D activities (see Table 3-23). Approximately 1.14 million cubic yards (0.87 million cubic meters) of LLW are estimated to be disposed of in the OSWDF.

[j] The scenarios for conversion of commercial DUF_6 were not added to the cumulative annual impacts because the majority of these activities would not take place at the same time as the management of DOE DU oxide. Therefore, only the maximum values between the DU Oxide SEIS alternatives and the commercial conversion scenarios were used in the totals.

Sources: DOE 2004b; PPPO 2018

As shown in Tables 2-6 and 2-7, the cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 millirem per year to the off-site maximally exposed individual (MEI) for the No Action and Action Alternatives and below the limit of 25 millirem per year specified in 40 CFR Part 190 for uranium fuel cycle facilities. Doses to individual involved workers would be below the regulatory limit of 5,000 millirem per year (10 CFR Part 835) and less than an administrative limit of 2,000 millirem per year (DOE 2017g).

As described in Chapter 4, Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS, impacts associated with chemical exposure are expected to be very small under the No Action and Action Alternatives, respectively. Impacts from the cumulative exposure to chemicals are unlikely due to regulations that limit the release of hazardous chemicals, and the distances to other potential sources of these chemicals.

As shown in Tables 2-6 and 2-7, the alternatives evaluated in this DU Oxide SEIS would generate LLW in the form of empty and heel cylinders, CaF_2, and small quantities of ancillary LLW and MLLW. The quantities of waste generated under the alternatives evaluated in this SEIS could be a large percentage of cumulative waste generation. The cumulative quantities of all wastes generated from activities at Paducah and Portsmouth would be managed using existing and planned on-site[20] and off-site capabilities (see Chapter 3, Sections 3.1.8 and 3.2.8) and would not be expected to result in substantial cumulative impacts on the waste management infrastructure represented by those facilities.

Waste Disposal Facilities – As shown in **Table 2-8**, the cumulative impacts of the disposal of DU oxide and other wastes would not exceed the planned capacities of any evaluated disposal facility, even if each facility received all DU oxide and other waste from both Paducah and Portsmouth. However, as discussed in Sections 4.5.2.1 and 4.5.3.1, about 3.6 million cubic yards (2.75 million cubic meters) of waste from environmental restoration and DD&D activities may be generated at Paducah as well as about 1.36 million cubic yards (1.04 million cubic meters) at Portsmouth. At this time, the total quantities of LLW and MLLW that would be generated from DD&D activities that could require off-site disposition is uncertain, but initial estimates indicate 9,559 cubic yards (7,308 cubic meters) of LLW and 70,708 cubic yards (54,061 cubic meters) of MLLW from Paducah and approximately 53,600 cubic yards (40,980 cubic meters) of additional LLW and MLLW from Portsmouth would be disposed of at off-site facilities, such as Energy*Solutions*, NNSS, and WCS. In the event that most of this waste would require off-site disposition, then the total quantity of waste that could be disposed of at any single facility could challenge that facility's disposal capacity. Impacts on any facility's capacity could be reduced by distributing waste shipments to multiple disposal facilities, or by developing additional capacity at one or more disposal sites.

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[20] No LLW generated under the alternatives evaluated in this DU Oxide SEIS are planned for on-site disposal.

Table 2-8 Cumulative Impacts on Radioactive Waste Disposal Capacity (cubic yards)

		Wastes Generated at Paducah and Portsmouth						Cumulative Total (Percent of Capacity in Parenthesis)[e]	
			DU Oxide SEIS Alternatives[c]		Commercial Conversion Scenarios				
Waste	**Facility Capacity[a]**	**Existing Operations[b]**	**Action Alternatives**	**No Action Alternative**	**Conversion and Disposal**	**Conversion and Storage**	**Other Actions[d]**	**Action Alternatives**	**No Action Alternative**
Energy*Solutions*									
LLW – DU oxide	Dedicated cell	NA	386,000	0	69,900	0	NA	456,000 (100)[f]	0 (NA)
LLW – empty and heel cylinders	4,300,000	12,200	117,000	78,300	4,200	4,300	520	134,000 (3.1)	95,300 (2.2)
LLW - CaF_2	4,300,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (6.2)	264,000 (6.2)
MLLW	354,000	68	0.92	2.4	0.70	1.4	290	360 (0.10)	362 (0.10)
Nevada National Security Site									
LLW – DU oxide	1,800,000	NA	386,000	0	69,900	0	NA	456,000 (25)	0 (NA)
LLW – empty and heel cylinders	1,800,000	12,200	117,000	78,300	4,200	4,300	520	134,000 (7.4)	95,300 (5.3)
LLW - CaF_2	1,800,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (15)	264,000 (15)
MLLW	148,000	68	0.92	2.4	0.70	1.4	290	360 (0.24)	362 (0.24)
Waste Control Specialists LLC									
LLW – DU oxide	955,000	NA	386,000	0	69,900	0	NA	456,000 (48)	0 (NA)
LLW – empty and heel cylinders	955,000	12,200	117,000	78,3000	4,200	4,300	520	134,000 (14)	95,300 (10)
LLW - CaF_2	955,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (28)	264,000 (28)
MLLW	955,000	68	0.92	2.4	0.70	1.4	290	360 (0.04)	362 (0.04)

		Wastes Generated at Paducah and Portsmouth						Cumulative Total (Percent of Capacity in Parenthesis)[e]	
			DU Oxide SEIS Alternatives[c]		Commercial Conversion Scenarios				
Waste	Facility Capacity[a]	Existing Operations[b]	Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage	Other Actions[d]	Action Alternatives	No Action Alternative

Key: DOE = U.S. Department of Energy; DU = depleted uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; SEIS = supplemental environmental impact statement.

[a] Based on information presented in Chapter 3, Sections 3.3, 3.4, and 3.5, of this DU Oxide SEIS.

[b] Based on current generation rates for LLW and MLLW as described in Chapter 3, Sections 3.1.8 and 3.2.8, of this DU Oxide SEIS, except for empty and heel cylinders, for 44 and 32 years, respectively, for Paducah and Portsmouth. Current waste generation is due to on-site activities including DU oxide conversion and ongoing remediation and decontamination and decommissioning activities.

[c] Based on results presented in Chapter 4, Sections 4.1, 4.2, 4.3, and 4.4, of this DU Oxide SEIS. No Action Alternative impacts were considered over 100 years. Action Alternative impacts were considered for operations over 44 or 32 years, respectively, for Paducah and Portsmouth. Wastes include those from DU oxide, ancillary LLW and MLLW, empty and heel cylinders, and CaF_2.

[d] Reflects waste from decontamination and decommissioning of the oxide conversion capabilities at Paducah and Portsmouth (DOE 2004a, 2004b). Additional waste will be generated from future environmental restoration and DD&D activities at Paducah and Portsmouth. Initial estimates indicate 9,559 cubic yards (7,308 cubic meters) of additional LLW and 70,708 cubic yards (54,061 cubic meters) of MLLW from Paducah and approximately 53,600 cubic yards (40,980 cubic meters) of additional LLW and MLLW from Portsmouth would be disposed of at off-site facilities, such as Energy*Solutions*, NNSS, and WCS (see Section 4.5.4).

[e] Cumulative impacts equal the sum of the impacts of the alternative and other past, present, and reasonably foreseeable future actions. Volumes and projected impacts on waste disposal facility capacities reflect the assumption that each facility receives all LLW and MLLW from both Paducah and Portsmouth. The Action Alternatives include waste from the Conversion and Disposal Scenario; the No Action Alternative includes waste from the Conversion and Storage Scenario.

[f] There would be no impacts on disposal capacity at Energy*Solutions* from disposal of DU oxide because, as described in Chapter 3, Section 3.3, of this DU Oxide SEIS, the disposal unit that would receive the DU oxide would be separate from the other disposal units at the site and, would be designed to receive all DU oxide that may be sent from both Paducah and Portsmouth.

Notes: To convert cubic yards to cubic meters, multiply by 0.76456.

Transportation – Rail and truck shipments associated with the alternatives evaluated in this DU Oxide SEIS could result in maximum doses (and latent cancer fatalities [LCFs]) of 1,610 person-rem (1 LCF) to workers (if bulk bag packagings are used) and 216 person-rem (0 [0.1] LCF) to the public (if cylinder packagings are used) for rail transportation. Maximum doses (and LCFs) for truck transportation would be 655 person-rem (0 [0.4] LCF) to workers (if bulk bag packagings are used) and 722 person-rem (0 [0.4] LCF) to the public (if cylinder packagings are used). Shipments associated with DOE management of commercial DUF_6 could result in additional maximum doses (and LCFs) of 310 person-rem (0 [0.2] LCF) to workers (if bulk bag packagings are used) and 146 person-rem (0 [0.03] LCF) to the public (if cylinder packagings are used) for rail transportation. Maximum doses (and LCFs) for truck transportation would be an additional 135 person-rem (0 [0.08] LCF) to workers (if bulk bag packagings are used) and 146 person-rem (0 [0.09] LCF) to the public (if cylinder packagings are used). Based on the cumulative impacts analysis presented in Table 4-48 of the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015), other past, present, and reasonably foreseeable radioactive material transport activities could result in population doses (and LCFs) for workers and the public of 421,000 person-rem (253 LCFs) and 436,000 person-rem (262 LCFs), respectively. Therefore, the impacts of transportation activities related to the actions evaluated in this DU Oxide SEIS, including DOE management of commercial DUF_6, would be very small in comparison and would not be expected to appreciably add to cumulative impacts.

Climate Change – The “natural greenhouse effect” is the process by which part of terrestrial radiation is absorbed by gases in the atmosphere, warming the Earth’s surface and atmosphere. This greenhouse effect and the Earth’s radiation balance are affected largely by water vapor, carbon dioxide (CO_2), and trace gases, which absorb infrared radiation and are referred to as “greenhouse gases” (GHGs) (DOE 2015a).

The GHGs emitted by the activities analyzed in this DU Oxide SEIS would add a small increment to emissions of these gases in the United States and the world. Overall GHG emissions in the United States during 2014 totaled about 7.57 billion tons (6.87 billion metric tons) of carbon dioxide equivalent (CO_2e) (EPA 2016a). By way of comparison, the maximum annual CO_2e emissions under the DU Oxide SEIS alternatives would be approximately 20,113 tons (18,244 metric tons), an exceedingly small percentage of the United States’ total emissions. Emissions from the Proposed Action could contribute in a small way to the climate change impacts described above.

2.5 PREFERRED ALTERNATIVE

DOE has no Preferred Alternative at this time. DOE expects to announce a Preferred Alternative in the Final DU Oxide SEIS.

3. AFFECTED ENVIRONMENT

In accordance with the Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) regulations (40 CFR Parts 1500–1508) and DOE's NEPA implementing procedures (10 CFR Part 1021), this chapter succinctly describes those areas that could be affected by the Proposed Action. This chapter includes descriptions of the physical and natural environment and the ROI at Paducah and Portsmouth, the two sites where DUF_6 is currently stored. This chapter also includes descriptions of three potential sites for the disposal of DU oxide: the Energy*Solutions* site near Clive, Utah; the NNSS in Nye County, Nevada; and the WCS site near Andrews, Texas.

The affected environment descriptions in this chapter provide the context for understanding the potential direct, indirect, and cumulative environmental effects of each of the alternatives described in Chapter 4 of this DU Oxide SEIS, and serve as baselines from which any potential environmental impacts can be evaluated.

The discussion is categorized by resource area to ensure that all relevant issues are included. This chapter discusses the following resource areas, and includes other topic areas that support the impact assessment in Chapter 4.

- Site Infrastructure
- Climate, Air Quality, and Noise
- Geology and Soils
- Water Resources
- Biotic Resources
- Public and Occupational Safety and Health
- Socioeconomics
- Waste Management
- Land Use and Aesthetics
- Cultural Resources
- Environmental Justice

3.1 PADUCAH SITE

This section presents a brief description of the affected environment at the Paducah Site commensurate with the level of analysis required in this DU Oxide SEIS. Additional information on the affected environment for Paducah is presented in the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site* (DOE 2004a) and the *Paducah Site Annual Site Environmental Report for Calendar Year 2015* (DOE 2017a).

The Paducah Site is located in western Kentucky, in the northwestern portion of rural McCracken County, about 10 miles (16 kilometers) west of the City of Paducah and 3.5 miles (5.6 kilometers) south of the Ohio River (see **Figure 2-1**). The Paducah Site encompasses 3,556 acres (1,439 hectares) (DOE 2017a). Approximately 837 acres (339 hectares) of the site are within a fenced security area, approximately 600 acres (243 hectares) are located outside the security fence, 133 acres (54 hectares) are in acquired easements, and the remaining 1,986 acres (803 hectares) are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA) for use in wildlife conservation and for recreational purposes (DOE 2004a, 2017d). The former Paducah Gaseous Diffusion Plant (Paducah GDP) occupies a 750-acre (303-hectare) area within the Paducah Site fenced security area (see **Figure 2-5**). The fenced area also contains the Conversion Facility. The Paducah GDP included about 115 buildings with a combined floor space of approximately 8.2 million square feet (0.76 million square meters) (DOE 2004a). The Paducah GDP ceased operations in 2012 and is now undergoing DD&D activities (DOE 2015b). The Paducah Conversion Facility includes four major buildings with a combined floor space of about 87,693 square feet (8,147 square meters) (PPPO 2018).

3.1.1 Site Infrastructure

3.1.1.1 Transportation

The Paducah Site is within a well-established transportation network. This includes Interstate Highway 24; several U.S., Kentucky, and local highways; the Paducah and Louisville Railway; and the Barkley and Metropolis Municipal airports. Because McCracken County is predominantly a residential, commercial, industrial, and medical services area, its traffic is heavily influenced by peak travel patterns of commuting workers (DOE 2015b).

Traffic on Interstate Highway 24 ranges from 26,400 to 35,500 cars per day (DOE 2015b). In addition to Interstate Highway 24, U.S. Highways 60 and 45 presently carry more than 25,000 vehicles per day. Paducah Site-associated traffic is about 1,200 vehicle trips a day, which is less than 5 percent of daily traffic volume on U.S. Highway 60 and Interstate Highway 24 (DOE 2015b).

The Paducah Site is served by several rail lines, and there are nine miles of rail spurs providing access throughout the site; rail spurs lie in close proximity to the cylinder storage yards (DOE 2012).

The Paducah Site can be served indirectly by barge transportation on the Ohio River (PPPO 2018). The nearest existing barge terminal is approximately 20 to 30 miles (32 to 48 kilometers) from the Paducah Site, requiring on-land transport by truck or rail (DOE 2004a). Loading and unloading of cargo is done by a flat top tower crane at the Paducah-McCracken County Riverport Authority open-air terminal. The Ohio River provides barge access to the Gulf of Mexico via the Mississippi River (PPPO 2018).

Commercial air service to the Paducah Site is limited. Barkley Regional Airport, the nearest commercial airport, is located approximately 10 miles (16 kilometers) east of the plant (PPPO 2018). This airport provides jet service to Chicago O’Hare Airport. Barkley Regional Airport also serves private aircraft owners and business travelers. Two international airports are located within a 3-hour drive of the Paducah Site: the St. Louis Lambert International Airport and the Nashville International Airport (PPPO 2018).

3.1.1.2 Water

At present, Paducah gets all of its water from the Ohio River through an intake near the Shawnee Fossil Plant (DOE 2015b). The amount of water withdrawn from the Ohio River varies, but it averaged about 15 to 26 million gallons (57 to 98 million liters) per day with peaks of up to 30 to 32 million gallons (114 to 121 million liters) per day during the 8-year period through 2012 when the Paducah GDP was still operating (DOE 2012, 2015b). Groundwater directly beneath Paducah is not used as a domestic, municipal, or industrial water supply.

With the USEC shutdown of the Paducah GDP and transition of the Paducah Site back to DOE, the total amount of water withdrawn from the Ohio River has decreased significantly and usage varies from 3 to 4 million gallons (11 to 15 million liters) per day (PPPO 2018). DOE treats the water on the site before using it, and about 15 percent of the flow receives additional treatment and goes to the potable water system (DOE 2015b). The design capacity for the potable water system is 8.6 million gallons per day (PPPO 2018).

3.1.1.3 Electricity

The Tennessee Valley Authority (TVA), Kentucky Utilities Company, Jackson Purchase Energy Corporation, and Electric Energy Corporation provide electricity to the Paducah Site (DOE 2015b). The TVA power grid is a generating system with more than 34,000 megawatts of generating capacity, which is about 5,000 megawatts above recent summer peak demand needs (DOE 2015b).

The Paducah Site historically operated four electrical switchyards to handle electrical requirements (DOE 2015c). These switchyards were found to be inefficient to operate and expensive to maintain. The Paducah GDP design enrichment capacity was 3,040 megawatts and operated approximately at a maximum of slightly above 2,000 megawatts. The future site projected peak demand is between 25 and 35 megawatts. In May 2015 a project was completed to supply the Paducah Site's electrical requirements from a single switchyard. Projects are underway to separate the remaining three switchyards from the external area electrical grid (PPPO 2018). With the termination of production activities, the average electrical power demand for 2017 was approximately 12 megawatts (PPPO 2018).

3.1.1.4 Natural Gas

Atmos Energy Corporation provides natural gas to the Paducah Site, local residences, and other buildings (DOE 2015b). Natural gas lines at the site are plentiful in the industrial area where most activities have taken place (DOE 2015b). The design capacity for the natural gas line supplying the Paducah site is 100 million cubic feet per hour (2.8 million cubic meters per hour). Natural gas usage at the site in 2017 was approximately 154,000 million cubic feet (4,360 million cubic meters) (PPPO 2018).

3.1.1.5 Steam

For more than 62 years, the Paducah Site operated three coal-fired boilers, each capable of supplying 100,000 pounds (45,000 kilograms) of steam per hour (DOE 2015d). The steam was used for site projects as well as building heat. The Paducah Site decommissioned these coal-fired boilers. The Paducah Site has installed five gas-fired package boiler units (22,500 pounds per hour each) to meet reduced site demands resulting from termination of gaseous diffusion plant operations. Two of the five units are capable of running on either gas or fuel oil. The new site demand of up to 100,000 pounds per hour can be provided by the installed package systems. A connection for a sixth package boiler is available should it be determined that additional steam capacity is required.

3.1.2 Climate, Air Quality, and Noise

3.1.2.1 Climate

The location of the Paducah Site is classified as the humid continental zone, characterized by warm summers and moderately cold winters (DOE 2017a). The annual average temperature for the period from 1981 through 2010 is 57.8 degrees Fahrenheit (°F) (14.9 degrees Celsius [°C]) (NWS 2016), with July the hottest month (average temperature of 79.0°F [26.1°C]) and January the coldest month (average temperature of 35°F [1.67°C]). Annual precipitation averages about 49.0 inches (124.5 centimeters), primarily as rain (DOE 2017a). Precipitation is relatively evenly distributed throughout the year but is somewhat higher in spring and summer than in winter and fall. Snowfall in Paducah averages 9.0 inches (22.86 centimeters) per year, typically occurring from December to March (NWS 2016). The comfort index,[21] which is based on humidity during the hot months, is a 28 out of 100, where higher is more comfortable. The U.S. average on the comfort index is 44 (Sperling 2016).

Wind data collected at Barkley Regional Airport about 5 miles (8 kilometers) to the southeast of the Paducah Site were evaluated. For the period from 1981 through 2010, the average wind speed was about 6.4 miles per hour (10 kilometers per hour) (NWS 2016). The dominant wind direction was from the south-southwest (DOE 2017a). The highest wind speed was approximately 37 miles per hour (60 kilometers per hour) from the west-southwest (NWS 2016).

Tornadoes are rare in the area surrounding the Paducah Site, and those that do occur are less frequent and destructive than those occurring in other parts of the Midwest. For the period from 2011 through 2015, only five tornadoes were reported in McCracken County, Kentucky (NCDC 2016). All of those tornadoes were relatively weak; at most, F2 on the Fujita tornado scale (average winds from 113 to 157 miles per hour).[22]

3.1.2.2 Air Quality

The Paducah Site is located near the center of the Paducah (Kentucky)-Cairo (Illinois) Interstate Air Quality Control Region (AQCR) (40 CFR 81.69), which includes 17 counties in Kentucky and 6 in Illinois. **Table 3-1** provides baseline annual emissions data obtained from the EPA's 2014 National Emissions Inventory (NEI) for McCracken County and the Paducah-Cairo AQCR (EPA 2018a). The data include emissions from point sources, area sources, and mobile sources. Point sources are stationary sources that can be identified by name and location. Area sources are stationary sources from which emissions are too low to track individually, such as a home or small

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[21] The comfort index gives a numerical value reflecting outdoor atmospheric conditions of temperature and humidity as a measure of comfort (or discomfort) during the warm season of the year.

[22] The Fujita Scale, developed by Tetsuya Fujita in 1971 at the University of Chicago, is a scale for rating tornado intensity, based primarily on the damage tornadoes inflict on human-built structures and vegetation. The scale ranges from F0 (<73 miles per hour average winds) to F5 (261 to 318 miles per hour average winds).

office building, or a diffuse stationary source, such as wildfires or agricultural tilling. Mobile sources are any kind of vehicle or equipment with gasoline or diesel engine, an airplane, or a ship. Currently, areas within the Paducah Site and its surrounding counties are in attainment for all National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (EPA 2016b). The Kentucky State Ambient Air Quality Standards (SAAQS) for six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter with a diameter less than or equal to 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$, respectively), and lead (Pb) are the same as the NAAQS (KAR 2016). Ozone is not emitted directly into the air but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) (EPA 2017). Therefore, ozone is analyzed and reported as NO_x and VOCs throughout this document.

Table 3-1 Baseline Criteria Pollutant Emissions Inventory for McCracken County and the Paducah-Cairo AQCR

Region	Criteria Pollutant Emissions (tons per year)					
	CO	NO_2	PM_{10}	$PM_{2.5}$	SO_2	VOC
McCracken County	13,217	15,200	2,464	826	30,162	6,378
Paducah-Cairo Interstate AQCR	156,682	73,542	81,595	19,676	107,285	151,620

Key: AQCR = air quality control region; CO = carbon monoxide; NO_2 = nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Source: EPA 2018a

Major air pollution sources around the Paducah Site in Kentucky include the TVA’s coal-fired Shawnee Fossil Plant, about 3 miles (5 kilometers) northeast of the Paducah Site (Source Watch 2016). In Illinois, the Joppa Power Plant and Lafarge Corporation are major sources, located 7 miles (11 kilometers) north-northwest of the Paducah Site. The Paducah Site operates under Kentucky Department of Environmental Protection (KDEP) Title V Conditional Major, Construction/Operating Permit V-14-012 R1, issued on August 14, 2015. The Paducah Site has two emission points. Emission point EP 01 is the stack for the Conversion Building. Emission point EP 02 is the HF storage and load-out area. Air that is displaced during filling and emptying of HF storage tanks is vented through a dedicated scrubber system. On February 4, 2014, USEC applied for a renewal of its Title V permit. This permit application added 21 emergency motor emission units under 40 CFR Part 63, Subpart ZZZZ, “National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines.” On October 21, 2014, at the termination of USEC’s lease and prior to issuance of a renewed permit, USEC transferred its Title V Air Permit to Fluor Federal Services (FFS) (DOE 2016a).

KDEP issued a Title V Permit V-14-012 to FFS. On February 10, 2015, FFS applied to KDEP for a significant revision to the Title V permit that proposed adding five new low and ultra-low emission package boilers to replace three coal-fired boilers. KDEP issued the Title V permit revision, V-14-012 R1, on August 14, 2015 (DOE 2017a). The coal-fired boilers are no longer in use and have been replace by the efficient, low-emission boilers currently in operation.

Prevention of significant deterioration (PSD) regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations SO_2, NO_2, and PM_{10} above established baseline levels. 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. Class I areas are areas of special national or regional natural, scenic, recreational, or historic value for which the PSD regulations provide special protection. Class I and Class II areas are subject to maximum limits on air quality degradation called air quality increments (often referred to as PSD increments). Class II area air quality increments are more stringent than the NAAQS, though less stringent than in Class I areas. The nearest Class I PSD areas are Mingo National Wildlife Refuge in Missouri, about 70 miles (113 kilometers) west of the Paducah Site, and Mammoth Cave National Park, about 140 miles (225 kilometers) east of the Paducah Site. These Class I areas are not located downwind of prevailing winds at the Paducah Site.

The "natural greenhouse effect" is the process by which part of the terrestrial infrared radiation is absorbed by gases in the atmosphere, thereby warming the Earth's surface and atmosphere. This greenhouse effect and the Earth's radiative balance are affected largely by water vapor, CO_2, and trace gases, all of which are absorbers of infrared radiation and commonly referred to as "greenhouse gases" (GHGs). Other trace gases include nitrous oxide, chlorofluorocarbons, methane, and sulfur hexafluoride. Current EPA reporting for the NEI does not include GHGs. CO_2, methane, and nitrous oxide annual GHG emissions data for both McCracken County and the Paducah-Cairo AQCR from the EPA's 2011 NEI are provided in **Table 3-2**.

Table 3-2 Baseline Greenhouse Gas Emissions Inventory for McCracken County and the Paducah-Cairo Interstate AQCR

Region of Interest	Greenhouse Gas (tons per year)			
	CO_2	CH_4	N_2O	Total CO_2e[a]
McCracken County	490,751	67	17	497,850
Paducah-Cairo AQCR	4,725,572	1,294	125	4,795,202

Key: AQCR = air quality control region; CH_4 = methane; CO_2 = carbon dioxide; CO_2e = carbon dioxide equivalent; N_2O = nitrous oxide.

[a] CO_2e is the internationally recognized measure of GHGs, which weights GHGs based on their Global Warming Potential (GWP) and the chemical's ability to impact global warming.

Source: EPA 2016c

3.1.2.3 Noise

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978; 42 U.S.C. §§ 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 A-weighted decibels (dBA) as the day-night average sound level (DNL) to protect against outdoor activity interference and annoyance; 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 (EPA 1974). For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an average noise level during a 24-hour period (L_{eq}/24 h) of 70 dBA or less.

The noise-producing activities within the Paducah Site are associated with remediation 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 dBA, is high at public grade crossings. Currently, rail traffic noise is not a factor in the local noise environment because of infrequent traffic (DOE 2015b).

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 mile (2 kilometers) from the Paducah Site. Ambient noise levels around the Paducah Site are relatively low. Measurements taken at the nearest residence ranged from 44 to 47 dBA when the Paducah GDP was in operation (DOE 2004a). At nearby residences, noise emissions from the plant were reported as undetectable from background noise. While more recent noise data at nearby residences is not available, it is highly likely that current noise levels resulting from Paducah Site operations would be in a similar range (PPPO 2018). In general, the background environment is typical of rural areas; DNL is estimated to be about 52 dBA (EPA 1974) based on the population density in McCracken County.

3.1.3 Geology and Soil

3.1.3.1 Geology

Western Kentucky geology has gently rolling terrain between 330 and 500 feet (101 and 152 meters) above mean sea level. Within the boundaries of the Paducah Site security fence, the maximum variation in elevation is about 10 feet (3 meters) (DOE 2004a).

The stratigraphic sequence found beneath the Paducah Site is as follows (from oldest to youngest): limestone and shale bedrock; Clayton and McNairy Formations, sand with frequent lenses of silt and clay in its upper portions; Porters Creek Clay, silt with sand and clay interbeds (only beneath the southern portion of the Paducah Site); Continental Deposits, lower gravel or sandy gravel unit and an upper clay-sand unit; and loess, wind-blown silt. The combined thickness of the upper Continental Deposits and loess at Paducah is commonly about 60 feet (18 meters) (DOE 2004a, 2015b)

The Paducah Site is in the New Madrid Seismic Zone. No known faults underlie the Paducah Site (PPPO 2018). The largest recorded earthquakes in this seismic zone occurred in 1811 and 1812 in and near New Madrid, Missouri. The town of New Madrid, about 70 miles (113 kilometers) southwest of Paducah, was completely destroyed during these earthquakes. The largest earthquakes since the 1811 and 1812 events had magnitudes of 6.0 and 6.2 and occurred in 1843 and 1895, respectively. Seven additional events with magnitudes greater than 5.0 have occurred. Since 1895, the zone has experienced more than 4,000 earthquakes, most too small to be felt (DOE 2004a).

The U.S. Geological Survey reports 447 earthquakes occurred within 100 miles (161 kilometers) of Paducah between January 1973 and June 2016. The largest event occurred on September 26, 1990, with an epicenter approximately 2.5 miles (4 kilometers) southeast of Chaffee, Missouri (approximately 43 miles [69 kilometers] west of the Paducah Site) and an estimated magnitude of 4.8. Only 10 of the 447 earthquakes had a magnitude greater than 4.0 (USGS 2016a).

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of the Earth's gravity). Probabilistic peak (horizontal) ground acceleration (PGA) data from the U.S. Geological Survey were used to indicate seismic hazard. The PGA values cited are based on a 2-percent probability of exceedance in 50 years. This corresponds to an annual occurrence probability of about 1 in 2,500. At the Paducah Site, the calculated PGA is approximately 0.8 *g* (USGS 2014a, 2014b).

3.1.3.2 Soils

Soils within the industrialized portion of the plant have been heavily disturbed and have lost much of their original character. As such, they are classified as "Urban Land." Soils of the Calloway-Henry Association and Grenada-Calloway Association cover most of the remainder of the Paducah Site. 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 centimeters/hour (0.20 to 2.0 inches/hour) (DOE 2004a).

As part of ongoing CERCLA and Resource Conservation and Recovery Act (RCRA) investigations of Paducah Site operable units, soils in several areas have been identified as contaminated with radionuclides and chemicals. The prevalent contaminants are metals (including uranium), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) [benzo(a)pyrene equivalents], and radionuclides (including uranium radioisotopes). Five priority contaminants of concern based on a chemical-specific excess lifetime cancer risk (ELCR) $> 1 \times 10^{-4}$ or chemical-specific hazard quotient[23] (HQ) > 1 were identified based on results at one or more solid waste management units (SWMU) or areas of concern (AOC): total PCBs, arsenic, thallium, uranium, and uranium-238 (DOE 2016b). DOE is in the process of examining potential remedial actions for these contaminants.

3.1.4 Water Resources

3.1.4.1 Surface Water

The Paducah Site is situated in the western part of the Ohio River drainage basin. Surface water from the east side of the Paducah Site flows east-northeast toward Little Bayou Creek, an intermittent stream that flows north toward the Ohio River along a 7-mile (11-kilometer) course, while surface water from the west side of the plant flows west-northwest toward Bayou Creek, a perennial stream that flows toward the Ohio River along a 9-mile (14-kilometer) course. The two creeks converge 3 miles (5 kilometers) north of the plant before emptying into the Ohio River.

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[23] A hazard quotient is a ratio of the estimated intake versus the level below which adverse effects are not expected. A hazard quotient of less than one means no adverse health effects are expected.

Maps of the calculated 100-year flood elevations show that all three drainage systems have 100-year floodplains located within the DOE boundary at the Paducah Site, but only slightly within the industrialized area (DOE 2015b, 2017d). The cylinder storage yards are not within the 100-year floodplain (DOE 2015b). At present, DOE operates a nontransient, noncommunity water system at the Paducah Site and gets its water from the Ohio River at an intake north of the facility (DOE 2015b).

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 (DOE 2015b). All effluent discharges are regulated under permits from the Kentucky Pollutant Discharge Elimination System (KPDES). There are a total of 15 KPDES outfalls authorized to DOE and its contractors (DOE 2017a).

In 2016, as part of environmental surveillance monitoring, surface water was sampled quarterly at four locations for radiological parameters, and two background locations were sampled annually. Additionally, a location in the Ohio River immediately downgradient of Paducah, and a location near the nearest public water withdrawal location, Cairo, Illinois, were sampled (DOE 2017a). This sampling was performed to evaluate potential radiological effluents leaving the Paducah Site and to evaluate the effectiveness of the outfall sampling program. Threshold values were not exceeded during 2016 for the surface water environmental surveillance monitoring (DOE 2017a).

In addition to the environmental surveillance surface water sampling locations, samples are taken at the fifteen KPDES-permitted outfalls. The Paducah Site received three notices of violation in 2015 for alleged violations related to the KPDES permit. In September of 2015, a beaver dam caused exceedance of total suspended solids for one sampling event at Outfall 001; Outfall 006 exceeded the pH permitted limit for one sampling event; and Outfall 017 exceeded the toxicity permitted limit for four sampling events. Corrective actions were implemented, including removal of the beaver dam and preparation of a toxicity reduction plan. Efforts to maintain and monitor water quality standards and address toxicity continue to be implemented at the Paducah Site (DOE 2016a). However, two exceedances for toxicity were recorded for Outfall 020 in 2016: one in October and one in December. As of the end of 2016, no notice of violation had been received for either of these events (DOE 2017a).

Sediment sampling was conducted at the Paducah Site in June 2016 to measure concentrations of radiological and nonradiological constituents. An additional sampling for PCBs occurred in December 2016 (a list of constituents and background concentrations can be found in the *2016 Paducah Site Annual Site Environmental Report for the Calendar Year 2016,* DOE 2017a). Overall, radiological concentrations in sediment are near background concentrations with the exception of two locations, both of which are within or just downstream of the DOE boundary. Overall, uranium activity is above background in Little Bayou Creek and Bayou Creek near and downstream of the Paducah Site. Other radionuclides, although present, are not significantly above background levels (DOE 2017a). PCBs were detected in sediment in 2016, but were within the acceptable risk range (DOE 2017a). Warning signs along the Bayou and Little Bayou Creeks are posted to warn members of the public about the possible risks posed by recreational contact with these waters, stream sediments, and fish caught in the creeks (DOE 2017a).

3.1.4.2 Groundwater

The local groundwater flow systems at the Paducah Site include the following, from deepest to shallowest (DOE 2017a):

- The Bedrock Aquifer is 335 to 350 feet below the ground surface. There is no known contamination associated with the Paducah Site in the bedrock aquifer.

- The McNairy Flow System is about 225 feet thick and is first encountered about 100 feet below the surface. Groundwater flow in the McNairy Flow System is to the north and northwest. DOE has found minor amounts of Paducah Site associated contamination, in the upper portions of the McNairy flow system. The interface between the McNairy Flow System and the Bedrock Aquifier may include a thin and discontinuous layer of chert gravel rubble (Tuscaloosa Formation) but this layer is not considered a confining layer (PPPO 2018).

- The Regional Gravel Aquifer (RGA) is the uppermost and primary aquifer in the area. It is 30 to 70 feet thick and flows northward toward the Ohio River. This aquifer has been the most affected by contamination from past Paducah Site operations.

- The Porters Creek Clay pinches out the Regional Gravel Aquifer in the southern part of the DOE-owned property and is overlain by Terrace Gravel and Eocene sands. DOE has found contamination from past Paducah Site activities in these sands and gravels in the industrial portions of the site.

- Upper Continental Recharge System (UCRS) consists mainly of clay silt with interbedded sand and gravel and generally recharges the underlying Regional Gravel Aquifer. DOE has found contamination from past Paducah Site activities in the upper continental recharge system in the industrial portions of the site.

Groundwater flow originates south of the Paducah Site within Eocene Sands and the Terrace Gravel. Groundwater within the Terrace Gravel discharges to local streams and recharges the RGA. Groundwater flow through the UCRS is predominantly downward and also recharges the RGA. From the Paducah Site, groundwater generally flows northward in the RGA toward the Ohio River, which is the local base level for the system. The groundwater in the McNairy flow system beneath the Paducah Site also flows northward towards the Ohio River (DOE 2017a) as does groundwater in the bedrock aquifer (PPPO 2018).

Monitoring and protection of groundwater resources at the Paducah Site are required by DOE Orders and Commonwealth of Kentucky regulations, and groundwater programs continue to remediate contamination in off-site plumes and on-site source areas as outlined in the *Groundwater Protection Plan for the Paducah Gaseous Diffusion Plant* (LATA 2015) and the *Environmental Monitoring Plan, Fiscal Year 2018, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (FRNP 2018). Data obtained from groundwater monitoring supports the decision-making process for the ultimate disposition of the contaminants. Groundwater monitoring serves to detect the nature and extent of contamination (i.e., types of contaminants and concentration of contaminants) and to determine the movement of groundwater near the Paducah Site (DOE 2017a).

Monitoring wells are used extensively at the Paducah Site to assess the effect of plant operations on groundwater quality. Over 200 monitoring wells and residential wells were sampled in 2016 in accordance with DOE Orders and federal, state, and local requirements (DOE 2017a). Groundwater monitoring activities at the Paducah Site include general environmental surveillance, current and inactive landfills, groundwater plume pump-and-treat operations, the C-400 Cleaning Building, Interim Remedial Action monitoring, and area residential wells (DOE 2017a). The primary contaminants in the RGA are trichloroethlyene (TCE) and technetium-99. Based on the 2014 results, the concentrations of technetium-99 in areas off DOE property do not exceed the technetium-99 maximum contaminant level (DOE 2015e). Known or potential sources of TCE and technetium-99 include former test areas, spills, leaks, buried waste, and leachate derived from contaminated scrap metal. Investigations of the source areas of TCE at the Paducah Site are ongoing with the main source of TCE contamination located near the C-400 Cleaning Building (DOE 2017a). Based on the results of monitoring, groundwater plume maps are created to depict the general footprint of the TCE and technetium-99 contamination in the RGA and convey the general magnitude and distribution of contamination within the plumes. The Paducah site groundwater plume maps are used to facilitate planning to optimize the site groundwater (DOE 2017a).

Historically, groundwater was the primary source of drinking water for residents and businesses in the vicinity of the Paducah Site. In areas near the Paducah Site where the groundwater either is known to be contaminated or has the potential to become contaminated in the future, DOE has provided water hookups to the West McCracken County Water District and pays water bills for affected residences and businesses. An annual educational mailer was developed in 2016 and was mailed to residents during the first quarter of 2016 and 2017 in an effort to ensure public awareness of the groundwater contamination. Residential wells have been capped, except for those that are used by DOE for monitoring (per license agreement between DOE and each resident), and all wells are locked (DOE 2017a).

3.1.5 Biotic Resources

3.1.5.1 Vegetation and Wildlife Habitats

Within the industrial area of the Paducah Site, buildings, roads, paved and graveled surfaces, and utility infrastructure cover large areas. The vegetation among the buildings consists mainly of maintained grassy areas and fields; shrubs are nearly absent and exist in only a few locations. The vegetation in the industrialized area outside the fence is a mixture of maintained grass fields, areas of second-growth forest, old fields, and wetlands. The vegetation in the area DOE licenses to Kentucky for the WKWMA, with the exception of a DOE-controlled landfill, has a high diversity of interspersed habitats including second-growth hardwood forest, riparian zones along Bayou Creek, palustrine wetlands, old fields, agricultural land, fencerows, and maintained grass fields. The Kentucky Department of Fish and Wildlife Resources (KDFWR) manages the WKWMA, including the DOE licensed land, primarily for early successional wildlife habitat. Common vegetation management practices include periodic mowing, field restoration, prescribed burning, discing, and tree and shrub control (physical removal or herbicide treatment) to maintain open areas and utility corridors (DOE 2015b).

Wildlife species indigenous to hardwood forests, scrub-shrub, and open grassland communities are present at the Paducah Site. Additionally, the Ohio River, which is 3 miles north of the Paducah Site, serves as a major flyway for migratory waterfowl (DOE 2017a). Common wildlife species of the WKWMA and undeveloped areas 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. Harvestable fish populations exist in Bayou Creek, especially near the mouth of the creek at the Ohio River. Harvestable fish populations do not exist in Little Bayou Creek (DOE 2016a). The abundance and diversity of aquatic organisms are generally lower near the Paducah Site outfalls than in upstream areas for both Little Bayou and Bayou Creeks (DOE 2004a). Warning signs along Bayou and Little Bayou Creeks are posted to warn members of the public about the possible risks posed by recreational contact with these waters, stream sediments, and fish caught in the creeks (DOE 2017a).

3.1.5.2 Wetlands

There are an estimated 400 acres (162 hectares) of wetlands characterized as forested wetlands, ponds, wet meadows, vernal pools, and wetlands converted to agriculture on the 3,556 acres (1,439 hectares) of the Paducah Site (DOE 2015b). Approximately 5 acres (2 hectares) of jurisdictional wetlands were identified in drainage ditches within the 750 acres (303 hectares) of the Paducah GDP. Palustrine forested wetlands occur extensively along the banks of Bayou and Little Bayou Creeks. A forested wetland dominated by tupelo trees in the WKWMA has been designated by the Kentucky Nature Preserves Commission and KDFWR as an area of ecological concern (DOE 2004a).

3.1.5.3 Threatened and Endangered Species

While there are potential habitats for endangered species on DOE property, none of the federally listed species has been found on the Paducah Site (DOE 2017a). Federally listed endangered and threatened species known to occur in the vicinity of the Paducah Site are identified in **Table 3-3**.

Table 3-3 Federally Listed Endangered and Threatened Species near the Paducah Site

Scientific Name	Common Name	Status
Mammals		
Myotis grisescens	Gray bat	Endangered
Myotis sodalis	Indiana bat	Endangered
Myotis septentrionalis	Northern long-eared bat	Threatened
Birds		
Sterna antillarum	Least tern	Endangered
Clams		
Pleurobema clava	Clubshell	Endangered
Cyprogenia stegaria	Fanshell	Endangered
Potamilus capax	Fat pocketbook	Endangered
Plethobasus cooperianus	Orangefoot pimpleback (pearlymussel)	Endangered
Lampsillis abrupta	Pink mucket (pearleymussel)	Endangered
Quadrula cylindrical cylindrica	Rabbitsfoot	Threatened (CH)
Obovaria retusa	Ring pink (mussel)	Endangered
Pleurobema plenum	Rough pigtoe	Endangered
Plethobasus cyphus	Sheepnose mussel	Endangered
Cumberlandia monodonta	Spectaclecase mussel	Endangered

Note: CH = critical habitat.
Source: DOE 2017a

The Indiana bat (federally listed endangered) has been found near the confluence of Bayou Creek and the Ohio River 3 miles (5 kilometers) north of the Paducah Site. 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 GDP and in adjacent wooded areas, but none has been observed on the site (DOE 2004a, 2017d). Unit RF 20 of the critical habitat designated for the Rabbitsfoot mussel (federally listed threatened) includes the portion of the Ohio River near the Paducah Site (USFWS 2015). No other critical habitat is in the vicinity of the Paducah Site (USFWS 2016).

The compass plant, listed by KDFWR as threatened, and cream wild indigo, listed by KDFWR 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 KDFWR as threatened, is known from early, but not recent, surveys of Bayou Creek and Little Bayou Creek (DOE 2004a).

3.1.6 Public and Occupational Safety and Health

3.1.6.1 Radiation Environment

DOE has calculated the radiation exposures of on-site workers and members of the off-site general public resulting from operations of the Paducah Site. In 2015, thehypothetical maximum radiation dose to an off-site member of the public as a result of on-site facility operations was estimated to be 4.5 millirem per year (DOE 2017a**)** with no latent cancer fatalities (LCFs[24]) expected (calculated value of 3×10^{-6}) (DOE 2017a), which is less than 2 percent of the average dose of 311 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for an individual in the United States (NCRP 2009). The DOE dose limit for the general public is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1. **Table 3-4** provides the contributions to the maximum individual dose by pathway. The hypothetical maximum dose was estimated by using the largest environmental media concentrations monitored at different off-site locations, emission data, and conservative exposure parameters.

The population dose is the sum of individual doses to the entire population within 50 miles (80 kilometers) of the Paducah Site. In 2015, the population dose from operations at the Paducah Site was 0.89 person-rem (DOE 2017a) with no LCFs expected (calculated value of 5×10^{-4}) which is approximately 5.4×10^{-4} percent of the total population dose (from natural background radiation) of 166,000 person-rem.

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[24] A latent cancer fatality (LCF) is a death from cancer resulting from and occurring sometime after exposure to ionizing radiation or other carcinogens. This DU Oxide SEIS focuses on LCFs as the primary means of evaluating health risk from radiation exposure. A risk factor of 0.0006 LCF per person-rem or rem is used, consistent with DOE guidance (DOE 2003).

Table 3-4 Sources of Maximum Individual Dose from Paducah Site Operations

Sources of Maximum Individual Dose	Dose (millirem per year)	LCFs
Airborne radionuclides[a]	1.3×10^{-4}	8×10^{-11}
Waterborne radionuclides (Little Bayou Creek)[b]	0.09	5×10^{-8}
Incidental ingestion of surface water[c]	0.19	1×10^{-7}
Incidental ingestion of sediments	0.062	4×10^{-8}
Direct radiation[d]	4.2	3×10^{-6}
Total	4.5	3×10^{-6}

Key: LCF = latent cancer fatality

[a] U.S. EPA limit for public dose from airborne radionuclides is 10 millirem per year (NESHAP, 40 CFR Part 61 subpart H)

[b] From sources (creeks and ditches) in the vicinity of the Paducah site.

[c] Drinking water is from the nearest (closest to the Paducah site) surface water intake for Cairo Il.

[d] The Paducah 2016 ASER presents a direct radiation dose of 4.2mrem for the maximally exposed individual (MEI). However, it indicates that the calculation is unrealistic as site security protocols do not allow members of the public in the areas required to receive such a dose.

Source: Table 4.7 of DOE 2017a

The radiation environment is also impacted by operation of the Honeywell Metropolis Works (a uranium conversion facility under NRC license in Metropolis, Illinois). This facility is located approximately 5 miles to the Northeast of the Paducah site on the Ohio River. Based on an environmental analysis performed for a license renewal (NRC 2006), calculations indicate that the emissions from this facility result in a maximum dose to an off-site member of the public of 0.57 millirem per year with the population dose estimated to be 3.81 person-rem per year.[25]

Of the approximately 1,200 workers at Paducah (PPPO 2018), nearly 47 percent received a measureable dose (a dose of 1 millirem or more) during 2016 (DOE 2017b). These workers were primarily workers handling DU cylinders. The total worker dose for 2016 was 6.2 person-rem with no LCFs expected (calculated value of 0.004). Considering all 1,200 workers, the average worker dose was 5.2 millirem. However, considering only the workers who received a measurable dose (559 workers), the average dose to these workers was 11 millirem **(**DOE 2017b). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017g) and maintained as low as reasonably achievable (ALARA).

3.1.6.2 Chemical Environment

The chemical environment is described by the nonradiological effect of uranium when inhaled or ingested. This health effect is expressed as a hazard quotient, a ratio of the estimated intake versus the level below which adverse effects are not expected. A hazard quotient of less than one means no adverse health effects are expected. The hazard quotient for various exposure pathways (environmental medium) for members of the general public under existing environmental conditions near the Paducah Site are presented in **Table 3-5**. Since the on-site activities addressed

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[25] The Honeywell Metropolis Works ceased operations in 2017 (PPPO 2018). Honeywell has indicated this shutdown is temporary due to reduced UF_6 demand. Operations are to resume once demand rebounds (Honeywell 2018).

in this DU Oxide SEIS at Paducah pertain primarily to the storage of DU oxide and handling of DU oxide containers for off-site shipment, only uranium is addressed in this table, as that is the element most relevant to this DU Oxide SEIS.

Table 3-5 Chemical Hazard Quotient for Uranium

Environmental Medium	Assumed Exposure Concentration	Estimated Chronic Intake (mg/kg-d)[g]	Reference Level [f] (mg/kg-d)	Hazard Quotient
Air[a]	NA	--	--	--
Soil[b]	17.5mg/g	$0.2.5\times10^{-4}$	3.0×10^{-3}	0.083
Surface Water[c]	0.42 mg/L	2.4×10^{-4}	3.0×10^{-3}	0.081
Sediment[d]	9.7 µg/g	$7.52.8\times10^{-6}$	3.0×10^{-3}	0.00092
Groundwater[e]	7.7 µg/L	2.2×10^{-4}	3.0×10^{-3}	0.07

Key: mg/g = milligrams per gram; µg/g = micrograms per gram; mg/L = milligrams per liter; ASER = annual site environmental report; NA = not available.

[a] Uranium emissions are approximately 120 grams per year (derived from Table 4.1 of DOE 2017a); chronic intake would be negligible.

[b] Concentration is the largest value for uranium in Table 4.5 of DOE 2017a

[c] Concentration is the largest value for uranium in Table 5.2 of DOE 2017a.

[d] Concentration derived from Table 4.9 of the 2015 Paducah ASER (DOE 2016a). Sediment concentrations were not analyzed in DOE 2017a.

[e] Concentration is the largest value for uranium in Table 6-2 of DOE 2017a.

[f] Reference levels are those included in DOE 2004a.

[g] Calculated based on an assumed inhalation/consumption rate (derived from DOE 2004a) for a representative person (weight of 70 kilograms)

Source: DOE 2017a

Safety and health requirements for DOE workers are governed by 10 CFR Part 851, which establishes requirements for a worker safety and health program to ensure that DOE workers have a safe work environment. Included are provisions to protect against hazardous chemicals. For worker protection from the toxic effects of uranium, DOE uses the Occupational Safety and Health Administration (OSHA) permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000, Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels.

3.1.7 Socioeconomics

The ROI for this socioeconomic analysis consists of six counties: Ballard, Carlisle, Graves, Marshall, and McCracken counties in Kentucky and Massac County in Illinois. The ROI is based on where socioeconomic impacts would be expected, if any were to occur, with a focus on McCracken County, where the majority of any impacts would be expected.

3.1.7.1 Population

In 2010, the population of the ROI was 141,585 people (Census 2010). Approximately 46.3 percent (65,565 people) of the total ROI resided in McCracken County. Between the 2010 U.S. Census and 2014 estimates, the total ROI population decreased by 94 people (approximately 0.02 percent). Over the same period, the population in Kentucky and Illinois grew at an average annual rate of 0.25 percent and 0.07 percent, respectively (see **Table 3-6)**.

Table 3-6 Population in the Paducah Region of Influence, Kentucky and Illinois in 2010 and 2014

Location	2010 Census	2014 ACS 5-Year Estimate	Average Annual Growth Rate (%) 2010-2014
McCracken County	65,565	65,545	-0.01
Ballard County	8,249	8,274	0.08
Carlisle County	5,104	5,031	-0.36
Graves County	37,121	37,451	0.22
Marshall County	10,117	10,042	-0.19
Massac County	15,429	15,148	-0.46
ROI Total	**141,585**	**141,491**	**-0.02**
Kentucky	4,339,367	4,383,272	0.25
Illinois	12,830,632	12,868,747	0.07

Key: ACS = American community survey; ROI = region of influence.
Sources: Census 2010, 2014a

3.1.7.2 Employment and Income

Paducah Site employment was approximately 1,200 as of January 2018 (PPPO 2018). In 2014, total employment in the ROI was 91,232 people, representing an increase of 1,117 (1.24 percent) jobs since 2010. Major industries by employment in the ROI include retail trade, government and government enterprises, and health care and social assistance. In 2014, the total employment in McCracken County was 47,118 people, representing an increase of 1,320 jobs (3 percent) since 2010. The major industries by employment in the county include health care and social assistance, retail trade, and government and government enterprises (BEA 2015a).

Unemployment in McCracken County decreased from 9.1 percent in 2010 to 5.9 percent in 2015 (BLS 2016a). Unemployment in the ROI was 6.1 percent in 2015 (see **Table 3-7**). McCracken County had the highest per capita personal income in the six-county ROI, at $42,532 in 2014 (BEA 2015b).

Table 3-7 Employment in the Paducah Region of Influence in 2015

Location	Total Employment	Unemployment Rate (%)
McCracken County	47,118	5.9
Ballard County	3,793	7.1
Carlisle County	2,321	5.8
Graves County	17,003	6.3
Marshall County	15,629	5.7
Massac County	5,368	7.4
ROI Total	**91,232**	**6.1**
Kentucky	2,437,101	5.4
Illinois	7,595,648	5.9

Sources: Census 2014b; BEA 2015a; BLS 2016a

3.1.7.3 Housing

In 2014, total housing units in the six-county ROI totaled 77,279 units (Census 2014c). Over 40 percent of the total housing units in the ROI were in McCracken County. Approximately 15 percent of the total housing units were vacant, while the remaining 85 percent were occupied (see **Table 3-8**).

Table 3-8 Housing in McCracken County and the Paducah Region of Influence in 2014

Location	Total Housing Units	Occupied Housing Units	Vacant Housing Units
McCracken County	31,242	27,409	3,833
Ballard County	3,888	3,279	609
Carlisle County	2,448	2,075	373
Graves County	16,766	14,284	2,482
Marshall County	15,842	12,426	3,416
Maasac County	7,093	6,013	1,080
ROI Total	**77,279**	**65,486**	**11,793**
Kentucky	1,938,836	1,702,235	236,601
Illinois	5,299,433	4,778,633	520,800

Source: Census 2014c

3.1.7.4 Community Resources

Emergency response services in the ROI include police, fire rescue, and emergency response. The Paducah Fire Department serves the city of Paducah and has 76 employees (City of Paducah 2016a, 2016b). The Paducah Police Department consists of 87 employees, which includes 9 civilians and 78 sworn officers (City of Paducah 2016a, 2016b). Lourdes Hospital and Baptist Health Paducah are the primary care facilities in the city of Paducah and McCracken County, with 359 beds and 379 beds, respectively (Lourdes 2016; Baptist Health Paducah 2016).

There are 13 schools in McCracken County, with a total enrollment of 6,923 students during the 2014–2015 school year (KDE 2016a). In 2015, there were 402 full-time equivalent (FTE) teachers in McCracken County, for a student-to-teacher ratio of approximately 17 to 1 (KDE 2016b).

3.1.8 Waste Management

A variety of wastes are generated at the Paducah Site as a result of differing activities, including management of DUF_6 cylinders in storage; conversion of DUF_6 to DU oxide and on-site storage of DU oxide cylinders pending their disposition; DD&D of excess facilities and structures; and environmental restoration of soil, groundwater, and surface water contamination. These wastes include LLW,[26] MLLW,[27] nonradioactive hazardous and toxic waste, solid nonhazardous waste, and wastewater. Current annual waste generation rates are summarized in **Table 3-9**.

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[26] Includes calcium fluoride generated during the oxide conversion process that may be disposed as low-activity LLW.

[27] Consisting of waste regulated for its radioactive content pursuant to the Atomic Energy Act of 1954, as amended, as well as for its chemical content pursuant to the RCRA, the TSCA, or other applicable statutes.

Table 3-10 shows the waste expected to be generated during DD&D of the Paducah Site over the period 2018 through 2065. Approximately 3,238,000 cubic yards (2,476,000 cubic meters) of lightly contaminated LLW could be disposed of in the OSWDF (PPPO 2018).

Table 3-9 Current Waste Generation Rates at Paducah

Waste Type		Annual Quantities
Solid LLW	Unusable empty DUF_6 cylinders[a]	29 cubic yards
	Debris	180 cubic yards
	Oversized debris	6.3 cubic yards
	Soil-like material	21 cubic yards
	Soil-like material with TSCA constituents	0.28 cubic yards
	Calcium fluoride[b]	24 metric tons (26 tons
Liquid LLW		690 gallons
MLLW	Debris	0.47 cubic yards
	Soil-like material	0.89 cubic yards
Liquid MLLW		59 gallons
Hazardous waste		5.5 cubic yards
Universal waste[c]		1.9 cubic yards
Solid nonhazardous waste		120 tons
Wastewater (not including sanitary wastewater)		1,200 gallons

Key: DUF_6 = depleted uranium hexafluoride; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TSCA = Toxic Substances Control Act.

[a] Emptied cylinders determined to be unusable for containment of DU oxide are disposed of as LLW.

[b] From the oxide conversion process. The calcium fluoride may be shipped off site for disposal as low-activity LLW (also called exempt LLW). Low-activity LLW is waste that contains so little radioactive material that it can be disposed of at a facility other than a LLW disposal facility licensed under 10 CFR Part 61 or compatible Agreement State regulation. Disposal of low-activity LLW is licensed under 10 CFR 20.2002 or compatible Agreement State regulation.

[c] Universal waste refers to a category of hazardous waste having streamlined management procedures.

Source: PPPO 2018

Note: To convert cubic yards to cubic meters, multiply by 0.76456; tons to metric tons, multiply by 0.90718; gallons to liters, multiply by 3.7854.

Table 3-10 Estimate of Waste Generated During Deactivation, Decontamination, and Demolition of the Paducah Site

Waste Type	Disposal Location	Total Quantity (cubic yards)[a]
LLW	Off site	9,559
LLW	OSWDF	1,619,065
TSCA-LLW	OSWDF	1,619,065
MLLW	Off site	70,708
RCRA	Off site	761
TSCA	Off site	356
Solid waste	On-site U Landfill	272,039
Total		**3,591,554**

Key: LLW = Low-level radioactive waste; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; RCRA = Resource, Conservation, and Recovery Act; and TSCA = Toxic Substance Control Act.

[a] Estimated to be generated over the period 2018 through 2065.

Source: PPPO 2018

Note: To convert cubic yards to cubic meters, multiply by 0.76456; tons to metric tons, multiply by 0.90718; gallons to liters, multiply by 3.7854.

Procedures for management of these wastes are summarized in **Table 3-11**.

Table 3-11 Current Procedures for Management of Wastes at the Paducah Site

Waste	Typical Content	Management Procedure[a]
Solid LLW	Refuse, sludge, or debris primarily containing uranium and technetium.	Temporary storage on-site pending shipment to off-site treatment and/or disposal facilities.
Solid and liquid MLLW	Similar materials as solid LLW but also containing RCRA hazardous components, such as lead, or toxic materials, such as PCBs.	Temporary on-site storage pending shipment to off-site permitted facilities for treatment and/or disposal. On-site storage capacity is 3,600 cubic yards (2,800 cubic meters).
Solid and liquid hazardous and toxic waste	Spent solvents, heavy-metal-contaminated waste and PCB-contaminated toxic waste.	Temporary on-site storage or on-site treatment pending shipment to off-site facilities for disposal. On-site capabilities include treatment units, tanks, container storage areas, and several additional 90-day storage areas.
Solid nonhazardous waste	Sanitary refuse, cafeteria waste, industrial waste, and construction and demolition debris.	Recycle or disposal off-site or in an on-site landfill permitted for disposal of 1 million cubic yards (764,000 cubic meters) of solid nonhazardous waste.
Wastewater	Nonradioactive sanitary and process-related wastewater streams, cooling water blowdown, and radioactive process-related liquid effluents	Nonradioactive wastewater is processed at on-site treatment facilities and discharged through eight permitted outfalls. The total capacity of the Paducah Site wastewater facilities is about 300 gallons (1,100 liters) per minute. Normal flow is between 200 and 300 gallons (800 to 1,100 liters) per minute (DOE 2012). Radioactive liquid waste is shipped off site for treatment and disposal.

Key: PCB = polychlorinated biphenyl; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; RCRA = Resource Conservation and Recovery Act.

[a] In addition, the Paducah Site has an active program to minimize the generation of solid LLW, MLLW, hazardous waste, and solid nonhazardous waste.

Source: DOE 2004a

3.1.9 Land Use and Aesthetics

3.1.9.1 Land Use

The Paducah Site is in a generally rural area of McCracken County, Kentucky, about 10 miles (16 kilometers) west of the City of Paducah and 3.5 miles (5.6 kilometers) south of the Ohio River (see Figure 2-1). The predominant regional land uses in the vicinity of the Paducah Site are agricultural, industrial, and recreational. The area immediately surrounding the site generally features a combination of pasture, row crops, and deciduous forest (DOE 2004a).

The 2012 agricultural census recorded 447 farms in McCracken County, covering more than 67,192 acres (27,192 hectares), approximately 42 percent of the county (USDA 2014a). Residential land use occurs throughout much of McCracken County; however, 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 Paducah Site lies, consists primarily of pasture/hay and row crops (DOE 2004a).

The Paducah Site encompasses an area of 3,556 acres (1,439 hectares) (DOE 2017a). Approximately 837 acres (339 hectares) of the site are within a fenced security area, 600 acres (243 hectares) are located outside the security fence, 133 acres (54 hectares) are in acquired easements, and the remaining 1,986 acres (803 hectares) are licensed to the Commonwealth of Kentucky as part of the WKWMA (DOE 2004a, 2017d). The fenced area contains the Paducah

GDP and the Conversion Facility. The former Paducah GDP includes about 115 buildings with a combined floor space of about 8.2 million square feet (0.76 million square meters) with many support facilities. The areas between buildings consist primarily of mowed grassy areas. The developed lands outside the security fence contain roads, parking lots, grassy areas, utility infrastructure, water impoundments, landfills, and burial grounds (DOE 2015b).

The industrial area of the Paducah Site is surrounded by the WKWMA, including a 1,986-acre (803-hectare) parcel conveyed by DOE to the Commonwealth of Kentucky for use in wildlife conservation and for recreational purposes (DOE 2004a). According to a 1953 agreement granting the land to KDFWR, DOE can use any or all of this WKWMA whenever the need arises (DOE 2004a). The WKWMA contains access roads and multiple rights-of-way for electrical transmission lines but is otherwise a mixture of grass meadows, forested areas, and areas of diverse vegetation (DOE 2015b). Public activities in the WKWMA include bow hunting for deer, bird dog and retriever trials, youth turkey hunting, horseback riding, hiking, biking, and firearms hunting for small game (DOE 2015b).

The Paducah Site is currently zoned for heavy industry; therefore, industrial use of the site would be compatible with existing McCracken County zoning (DOE 2015b).

3.1.9.2 Aesthetics

The Paducah Site is in a generally rural area of McCracken County, Kentucky. The area is characterized by gently rolling terrain in the upland areas to a relatively flat floodplain near the Ohio River. The dominant viewshed (an area visible to the human eye from a fixed vantage point) at the Paducah Site consists of buildings, a water tower, cylinder storage yards, transmission lines, and open and forested buffer areas. Numerous buildings within the Paducah Site viewshed are in various stages of deactivation and decommissioning (KCREE 2016). There are no designated scenic areas near the Paducah Site.

The developed areas and utility corridors (transmission lines and aboveground pipelines) of the Paducah Site are consistent with a Visual Resource Management Class IV designation. The remainder of the Paducah Site is consistent with a Visual Resource Management Class II or Class III designation. Management activities within Class II and Class III areas may be seen, but do not dominate the view; management activities in Class IV areas dominate the view and are the focus of viewer attention (DOI 1986).

3.1.10 Cultural Resources

Human occupation in the vicinity of the Paducah Site dates to at least 10,000 years before the Common Era (BCE), and possibly longer. Archaeological sites reflect occupations from the Archaic period (10,000 to 3000 BCE), the Woodland period (3000 BCE to 1000 Common Era [CE]) and Mississippian period (1000 CE to 1700 CE). Western Kentucky was part of the Chickasaw Nation when first encountered by Euro-Americans, and the Chicksaw remained in the area as late as 1827. However, the land was purchased from the Chickasaw through the Jackson Purchase, a treaty negotiated by Andrew Jackson and Isaac Shelby in 1818. In addition to the Chickasaw Nation, the Peoria Tribe of Indians of Oklahoma has land claims in McCracken

County. Euro-American settlements centered on farmsteads established in the 19th century, as reflected in associated cemeteries. Families included Baldry, Owen, and Carneal (DOE 2015b).

The federal government purchased part of the Baldry farm in 1942 and began construction of the Kentucky Ordnance Works. The Kentucky Ordnance Works operated until the end of World War II. In 1950, the Atomic Energy Commission acquired the Kentucky Ordnance Works for conversion to a gaseous diffusion plant (BJC 2006).

Although not all of the Paducah Site has been surveyed for archaeological resources, there have been a number of investigations, finding numerous archaeological sites outside the security fencing. The results of a 20-percent, stratified, random sample archaeological survey were used to develop a sensitivity analysis for the unsurveyed portion of Paducah. Although the area outside the security fence is outside the ROI for the action, previous archaeological surveys of sample areas identified 34 archaeological sites. Inside the security fence, all areas are considered to have a "low" to "very low" sensitivity index for the presence of archaeological resources. As a result of this analysis, and because of the heavily disturbed nature of the facility inside the security fencing, this portion of Paducah was not investigated; existing disturbance greatly reduces the likelihood of finding any cultural resources with intact integrity (DOE 2015b).

The architectural resources at Paducah have been inventoried, with the result that 101 historic properties were identified, contributing to a NRHP-eligible historic district inside the security fencing. Although some of the historic properties have been demolished, the district retains its eligibility under NRHP Criterion A[28] for its military significance during the Cold War and its role in the development of commercial nuclear power (DOE 2015b).

As described in Chapter 2, Section 2.1.3, of this DU Oxide SEIS, DU storage cylinders are stored at several storage yards within the security fence at the Paducah Site. None of these locations has been identified as historic resources, nor are they likely to contain previously undiscovered or unrecorded cultural resources. No traditional cultural resources have been identified at Paducah.

Status of Consultation

In the course of various projects (DOE 2004a, 2015b), DOE has consulted with the following Native American tribes:

- Absentee-Shawnee Tribe of Oklahoma
- Cherokee Nation
- The Chickasaw Nation of Oklahoma
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Miami Tribe of Oklahoma
- Peoria Indian Tribe of Oklahoma

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[28] "Criterion A" applies to cultural resources "that are associated with events that have made a significant contribution to the broad patterns of our history" (36 CFR 60.4).

- Quapaw Tribe of Indians
- Shawnee Nation, United Remnant Band
- Shawnee Tribe of Miami, Oklahoma
- United Keetoowah Band of Cherokee Indians

The Eastern Shawnee Tribe of Oklahoma and the Peoria Indian Tribe of Oklahoma responded that they had no concerns, but requested to be made aware of potential Native American Graves Protection and Repatriation Act issues should they arise. The Cherokee Nation responded by requesting that DOE conduct future coordination with the Eastern Band of Cherokee Indians. DOE did not receive responses from other tribes. No religious or sacred sites, burial sites, resources significant to Native Americans, or other Native American concerns have been identified at Paducah (DOE 2004a).

DOE also consulted with the following State Historic Preservation Offices (SHPO) when preparing NEPA documents for construction and operation of the conversion facility (DOE 2004a) and potential land and facilities transfers (DOE 2015b):

- Kentucky Heritage Council
- Ohio Historic Preservation Office
- Tennessee Historical Commission

The Ohio Historic Preservation Office did not respond to either consultation request. . Tennessee Historical Commission requested additional consultation for construction and operation of the conversion facility (DOE 2004a). The Kentucky Heritage Council and DOE agreed that DOE would follow the 2006 *Paducah Gaseous Diffusion Plant Cultural Resources Management Plan* (BJC 2006), consulting with the SHPO as appropriate under the plan, relative to potential land and facilities transfers (DOE 2015b).

In terms of the potential impacts to cultural resources, DOE determined that the actions evaluated in this DU Oxide SEIS do not differ appreciably from those evaluated in the 2004 EIS (DOE 2004a), which resulted in the execution of a Programmatic Agreement (DOE 2004a) and the preparation and implementation of the *Paducah Gaseous Diffusion Plant Cultural Resources Management Plan* (BJC 2006). Therefore, DOE determined that the consultations completed for the 2004 EIS satisfy DOE’s obligation under NHPA Section 106 and that no further consultations are needed.

3.1.11 Environmental Justice

In 1994, Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations (Environmental Justice)*, was issued to focus the attention of federal agencies on how their actions affect the human health and environmental conditions to which minority and low-income populations are exposed. This EO was also established to ensure that if there were disproportionately high and adverse human health or environmental effects from federal actions on these populations, these effects would be identified and addressed. The environmental justice analyses in this DU Oxide SEIS address the characteristics of race, ethnicity, and poverty status for populations residing in areas potentially affected by implementation of the alternatives presented in this SEIS.

In 1997, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks (Protection of Children)*, was issued to identify and address anticipated health or safety issues that affect children. The protection-of-children analyses in this DU Oxide SEIS address the distribution of population by age in areas potentially affected by implementation of the alternatives presented in this SEIS.

For the purpose of the environmental justice analysis, these populations are defined as follows:

Minority Populations – All persons identified by the U.S. Census Bureau to be of Hispanic or Latino origin, regardless of race, plus non-Hispanic persons who are Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or members of some other (i.e., nonwhite) race or two or more races.

Low-Income Populations – All persons who fall within the statistical poverty thresholds established by the U.S. Census Bureau. For the purposes of this analysis, low-income populations are defined as persons living below the poverty level. Starting with the 2010 Decennial Census, poverty data will be provided through the annual American Community Survey rather than as part of the Decennial Census.

Children – All persons identified by the U.S. Census Bureau to be under the age of 18 years.

Table 3-12 provides a summary of the percentage of minority and low-income populations within 50 miles (80 kilometers) of the Paducah Site. There are 181 census tracts within 50 miles (80 kilometers) of the Paducah Site, collectively defined as the ROI. To identify census tracts with disproportionately high minority populations, this DU Oxide SEIS uses the percentage of minorities in each state containing a given tract as the Community of Comparison (COC). 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. As shown in **Figure 3-1**, in 2014, of the 181 census tracts within 50 miles (80 kilometers) of the Paducah Site, 40 census tracts had minority populations in excess of state-specific thresholds; a total of 49,862 minority persons. Of the 181 census tracts within 50 miles of the Paducah Site, 98 census tracts had low-income populations in excess of state-specific thresholds; a total of 84,181 low-income persons (Census 2014d, 2014e).

Table 3-12 Environmental Justice Populations

Location	Minority		Low-Income[a]	
	Number	Percent	Number	Percent
United States	116,947,592	37.2	47,755,606	15.6
Kentucky	622,404	14.2	803,866	18.9
Illinois	4,780,117	37.1	1,810,470	14.4
Tennessee	1,612,415	25.0	121,344	17.8
Missouri	1,176,814	19.5	912,291	15.6

[a] Based on population for whom poverty status is determined[29] which may differ from the total population

Source: Census 2014a, 2014f

Table 3-13 provides a summary of the age distribution for the population in states containing a given census tract within 50 miles (80 kilometers) of the Paducah Site.

Table 3-13 Population Distribution by Age

Location	Total Population	Under 5 Years		Under 18 Years		Over 65 Years	
		Number	Percent	Number	Percent	Number	Percent
United States	314,107,084	19,973,711	6.4	73,777,658	23.5	43,177,961	13.7
Kentucky	4,383,272	277,776	6.3	1,018,350	23.2	614,496	14.0
Illinois	12,868,747	810,671	6.3	3,054,966	23.7	1,696,283	13.2
Tennessee	6,451,365	402,121	6.2	1,492,474	23.1	918,218	14.2
Missouri	6,028,076	379,273	6.3	1,406,494	23.3	882,552	14.6

Source: Census 2014a

Schools, childcare centers, parks, and hospitals represent areas where there would be high concentrations of children. There are two schools within a 5-mile (8-kilometer) radius of the Paducah Site: the ROE Safe School and the Metropolis Elementary School. Western Baptist Hospital and Lourdes Hospital are both located approximately 10 miles (16 kilometers) from the Paducah Site.

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[29] People whose poverty status cannot be determined includes people in college dormitories, military barracks, living situations without conventional housing, institutional group quarters, and unrelated invidivuals under age 15. However, these people may be included in the total population count; thus the total number of low-income individuals might differ if the percent of low-income individuals is taken from the total population.

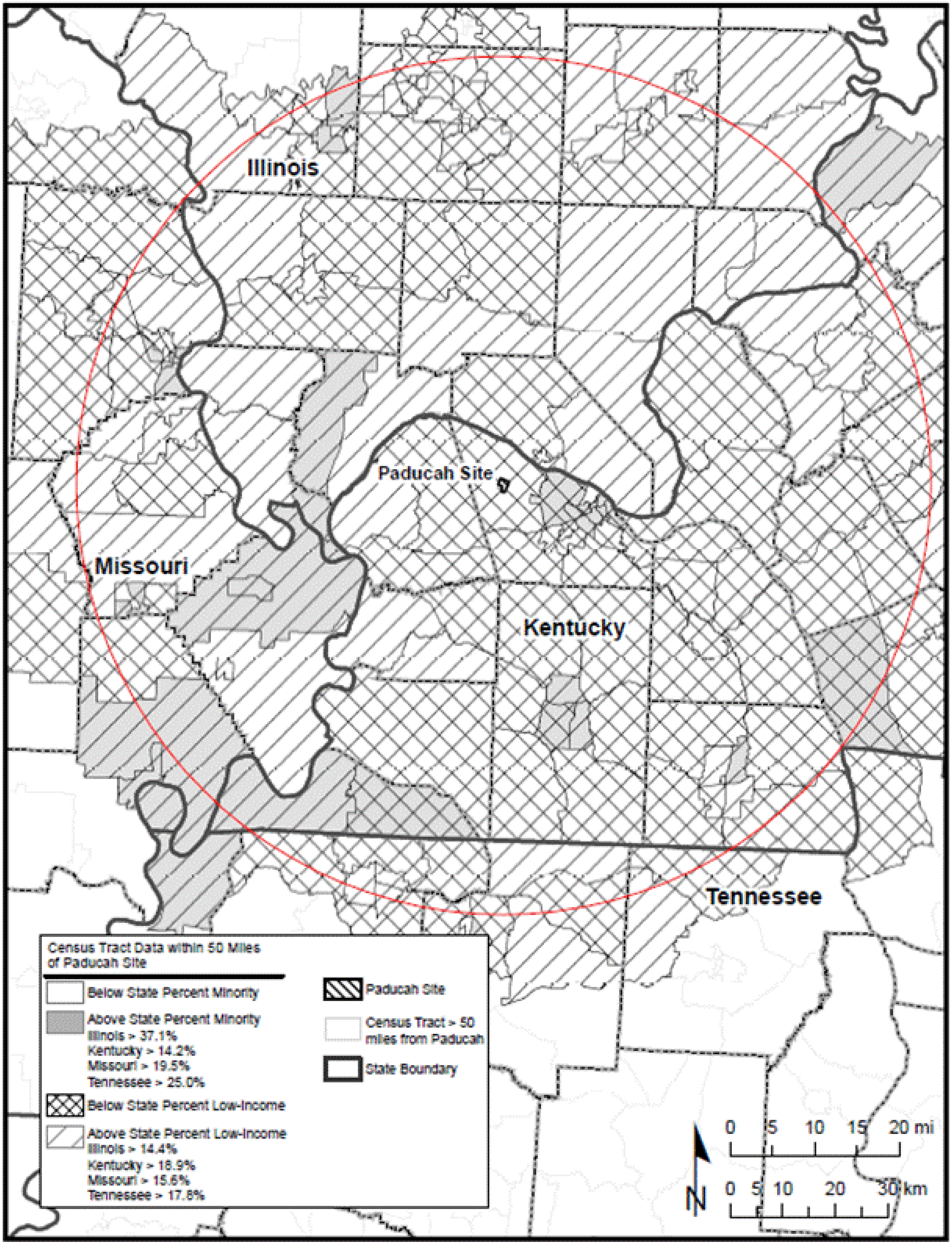

Figure 3-1 Environmental Justice Populations—Paducah Site (Source: Census 2014a–2014f)

3.2 PORTSMOUTH SITE

This section presents a brief description of the affected environment at the Portsmouth Site commensurate with the level of analysis required in this DU Oxide SEIS. Additional information on the affected environment at the Portsmouth Site (Portsmouth) is presented in the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site* (DOE 2004b) and the *Portsmouth Gaseous Diffusion Plant Annual Site Environmental Report – 2015, Piketon, Ohio* (DOE 2017c).

The Portsmouth Site is located in a rural area of Pike County, Ohio about 5 miles (8 kilometers) south of the town of Piketon, and approximately 22 miles (35 kilometers) north of the Ohio River and 2 miles (3 kilometers) east of the Scioto River (DOE 2017c) (see **Figure 2-2**). The two largest cities in the vicinity are Chillicothe, located 26 miles (42 kilometers) north of the Portsmouth Site, and Portsmouth, 22 miles (35 kilometers) south (DOE 2004b).

The Portsmouth Site encompasses 3,777 acres (1,529 hectares). The three former GDP process buildings, the Conversion Facility, and most of the remaining buildings and structures, are situated within the approximately 1,000-acre (405 hectare) industrialized area that lies within Perimeter Road. The industrialized area includes a 750-acre (304-hectare) controlled access area (see **Figure 2-6**). The Portsmouth Conversion Facility includes four major buildings with a combined floor space of about 87,693 square feet (8,147 square meters) (PPPO 2018). The portion of the DOE property outside of Perimeter Road, consisting of more than 2,500 acres (1,000 hectares), is used for a variety of purposes, including a water treatment plant, sediment ponds, sanitary and inert landfills, the On-site Waste Disposal Facility (OSWDF), cylinder storage yards, open fields, and forested buffer areas. Closed landfills and burial grounds account for approximately 101 acres (41 hectares) (DOE 2014).[30]

3.2.1 Site Infrastructure

3.2.1.1 Transportation

The Portsmouth Site has direct access to major highway and rail systems, a nearby regional airport, and barge terminals on the Ohio River. Use of the Ohio River barge terminals requires transportation by public road from Portsmouth (DOE 2004b).

Two of southern Ohio's major highway systems, U.S. Route 23 and State Route 32/124, provide access to Portsmouth. Both routes are four lanes with U.S. Route 23 traversing north-to-south and State Route 32 traversing east-to-west. The Portsmouth Site is 3.5 miles (5.6 kilometers) from the U.S. Route 23 and State Route 32/124 interchange. State Route 32/124/50 runs 185 miles (298 kilometers) east-to-west from Cincinnati through Piketon to Parkersburg, West Virginia (DOE

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[30] Centrus Energy Corp. (Centrus), formerly USEC, Inc., operated the American Centrifuge Plant, a small-scale demonstration centrifuge for uranium enrichment at Portsmouth starting 2006 (DOE 2017c). The American Centrifuge Plant is shut down (PPPO 2018). Because this is a relatively recent development, much of the affected environment information presented in Chapter 3 of this DU Oxide SEIS still reflects the impacts of operation of this facility. This will not have a substantive affect on the analysis or conclusions in this SEIS.

2004b). The local road network is in generally good condition (DOE 2014). Annual average daily traffic on U.S. Route 23 in proximity to the entrance to the Portsmouth Site is 14,490 vehicles; at the intersection of State Route 32 and U.S. Route 23, 7,700 vehicles (DOE 2014).

The main access road for Portsmouth is a four-lane interchange with U.S. Route 23. The main access road is accessible to the public and connects to Perimeter Road, which encircles the fenced portion of the Portsmouth Site. Smaller roads that intersect with Perimeter Road from four directions provide access to inner portions of Portsmouth. The buildings and facilities are serviced with a system of roads and streets, which generally follow a north-to-south grid. This system is in generally good condition because of road repaving projects (DOE 2014).

Two railroad carriers, CSX and Norfolk Southern, serve Pike County. Railroad track in the vicinity of Piketon allows a maximum train speed of 60 miles per hour (97 kilometers per hour) (DOE 2004b). A railroad system is located at the Portsmouth Site. The site railroad is connected to the CSX main rail system via a Norfolk Southern rail spur that enters the northwest portion of the site. Approximately 17 miles (27 kilometers) of track lie within the boundaries of Portsmouth; rail spurs lie in close proximity to the cylinder storage yards. However, only approximately one-third of the tracks are currently in service. The on-site railroad system is used infrequently (DOE 2004b).

The Portsmouth Site can be served indirectly by barge transportation on the Ohio River. However, use of the Ohio River barge terminals would require initial transportation of loads over public roads leading from the site to the barge terminal in the city of Portsmouth (DOE 2004b). All heavy-unit loading is done by mobile crane or barge-mounted crane at the open-air terminal. The Ohio River provides barge access to the Gulf of Mexico via the Mississippi River or the Tennessee-Tombigbee Waterway (DOE 2014).

Because of the relatively isolated location of Portsmouth, commercial air service is limited. The nearest airport is the Greater Portsmouth Regional Airport, located approximately 15 miles (24 kilometers) south of the site. The airport mostly serves private aircraft owners and business travelers. There are no regularly scheduled commercial flights; however, charter service is available (DOE 2014). Another nearby airport, the Pike County Airport, is located just north of Waverly. This facility is similar in size and makeup to the Greater Portsmouth Regional Airport. Three international airports are located within a 2-hour drive of Portsmouth: Cincinnati/Northern Kentucky International Airport, Dayton International Airport, and Port Columbus International Airport (DOE 2014).

3.2.1.2 Water

The Portsmouth Site has access to large, reliable supplies of water (DOE 2017d). The site is the largest industrial user of water in the vicinity and obtains its water supply from the on-site X-611 Water Treatment Facility, which draws water from two well fields located along the Scioto River. The well fields draw groundwater from the Scioto River buried aquifer and are located in the Scioto River alluvium within the Scioto River floodplain. Recharge of the aquifer occurs from river and stream flow as well as precipitation. The maximum potential production associated with the well fields is 13 million gallons per day (49 million liters per day). Nominal capacity is approximately 4 million gallons per day (15 million liters per day). Current sitewide usage is approximately 707 million gallons (2.7 billion liters) annually (DOE 2017d).

3.2.1.3 Electricity

The Ohio Valley Electric Corporation supplies electricity to the Portsmouth Site (DOE 2017d). Its combined generating capacity is comparable to the site design load of 2,260 megawatts. Electrical power from the Ohio Valley Electric Corporation external 345-kilovolt power grid flowed through switchyards to substations around the site where the electrical power was stepped down in voltage to 13.8 kilovolts for distribution to the process and other support buildings. The plant currently uses between 20 and 40 megawatts hourly (DOE 2017d).

3.2.1.4 Natural Gas

A natural gas main (6-inch-diameter pipe rated to carry natural gas at 350 to 400 pounds per square inch) was installed from the main line near Zahn's Corner to the East Access Road Reducing Station to support a hot water boiler system in the X-3002 building. Another line was installed for a natural gas boiler system that replaced the X-600 Steam Plant. Current sitewide usage is approximately 366,000 million standard cubic feet annually (DOE 2017d).

3.2.1.5 Steam

The X-690 Steam Plant was built in 2012 to provide a more reliable and cost-effective source of steam following the DD&D of the X-600 Steam Plant (DOE 2017d). The plant consists of the installation of two 42,000 pounds per hour natural gas-fired boilers and de-aerating feed tanks installed on a concrete pad located on the north side of the X-670 Dry Air Plant. The de-aerating feed tanks remove dissolved oxygen and other dissolved gases from the boiler feed water. Control system components and other auxiliary equipment for the boilers are located within the X-670 Dry Air Plant building. A 20,000-gallon, double-walled fuel oil tank, equipped with an electronic leak detection system, is mounted on a concrete pad just northeast of the boilers. The fuel oil is a contingency should the natural gas supply be disrupted. Current sitewide steam usage is approximately 235 million pounds annually (DOE 2017d).

3.2.2 Climate, Air Quality, and Noise

3.2.2.1 Climate

The Portsmouth Site is located in the humid continental climatic zone characterized by warm, humid summers and cold, humid winters (DOE 2017c). For the 1981 through 2010 period in Pike County, the annual average temperature was 54.8°F (12.7°C), with July the hottest month (average temperature of 87.0°F [30.6°C]) and January the coldest month (average temperature of 24.0°F [-4.44°C]). Annual precipitation averages about 40.9 inches (104 centimeters) primarily as rain. Precipitation is relatively evenly distributed throughout the year but is somewhat higher in spring and summer than in winter and fall. Snowfall in Portsmouth averages 9.0 inches (23 centimeters) per year, typically occurring from December to March (NWS 2016). The comfort index, which is based on humidity during the hot months, is 40 out of 100, where higher is more comfortable (Sperling 2016).

Wind data have been collected at an on-site meteorological tower. The data were collected at heights of 33, 98, and 197 feet (10, 30, and 60 meters) above the ground surface. An evaluation of data collected from 1995 through 2001 indicated that winds at the 33-foot (10-meter) level appear to be influenced by local topographical and/or vegetative features, while the wind data from the 98-foot (60-meter) level are believed to be more representative of actual prevailing wind direction and speed. About one third of the time, the wind blows from the south-southwest at an average speed of almost 6.5 miles per hour (10.5 kilometers per hour). Directional wind speed was highest from the south at approximately 8 miles per hour (13 kilometers per hour), while the lowest value was recorded in winds blowing from the east at 4 miles per hour (6 kilometers per hour) (DOE 2014).

Tornadoes are rare in the area surrounding the Portsmouth Site, and those that do occur are less destructive in this region than those occurring in other parts of the Midwest. From 1997 through 2017, only 8 tornadoes were reported in Pike County, Ohio (NCDC 2018). Most of those were relatively weak, registering, at most, F1 on the Fujita tornado scale (73 to 112 miles per hour average wind speed).

3.2.2.2 Air Quality

The Portsmouth Site is located in the Wilmington-Chillicothe-Logan Intrastate AQCR, which includes eight counties in Ohio. **Table 3-14** provides baseline annual emissions data obtained from EPA's 2011 NEI for Pike County and the Wilmington-Chillicothe-Logan AQCR (EPA 2018a). The data include emissions from point sources, area sources, and mobile sources. *Point sources* are stationary sources that can be identified by name and location. *Area sources* are stationary sources from which emissions are too low to track individually, such as a home or small office building, or a diffuse stationary source, such as wildfires or agricultural tilling. *Mobile sources* are any kind of vehicle or equipment with gasoline or diesel engine, an airplane, or a ship. Currently, Pike County is in attainment for all NAAQS criteria pollutants (EPA 2018b). The Ohio SAAQS for six criteria pollutants—SO_2, NO_2, CO, O_3, PM_{10} and $PM_{2.5}$, and Pb—are the same as the NAAQS (OAC 2016). Ozone, is not emitted directly into the air, but is created by chemical reactions between NO_x and VOCs (EPA 2017). Therefore, ozone is analyzed and reported as NO_x and VOCs throughout this document.

Table 3-14 Baseline Criteria Pollutant Emissions Inventory for Pike County and the Wilmington-Chillicothe-Logan Intrastate AQCR

Region	Criteria Pollutant Emissions (tons per year)					
	CO	NO_2	PM_{10}	$PM_{2.5}$	SO_2	VOC
Pike County	8,297	1,371	2,729	755	35	7,214
Wilmington-Chillicothe-Logan AQCR	70,303	13,768	30,082	7,658	18,694	51,552

Key: AQCR = air quality control region; CO = carbon monoxide; NO_2 = nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Source: EPA 2018a

For 2015, the following emissions of nonradiological air pollutants from the Portsmouth Site were reported as 11.03 tons (9.98 metric tons) of particulate matter, 1.96 tons (1.77 metric tons) of organic compounds, and 1.78 ton (1.61 metric ton) of nitrogen oxides. Emissions for 2015 are associated with the X-627 Groundwater Treatment Facility, X-330 Dry Air Plant Emergency Generator, and plant roads/parking areas.

The DUF_6 Conversion Facility emits only a small quantity of nonradiological air pollutants. Because of these small emissions, Ohio EPA requires a fee emissions report only once every two years. BWXT Conversion Services, the conversion facility operator at the time, reported less than 10 tons per year of specified nonradiological air pollutants for 2015 (DOE 2017c).

DOE operates under a Title V permit for operations that was issued by Ohio EPA in April 2014 (DOE 2017c). Title V Permit number P0109662 is a sitewide, federally enforceable operating permit that covers emissions of all regulated air pollutants at Portsmouth.

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. 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. Class I areas are areas of special national or regional natural, scenic, recreational, or historic value for which the PSD regulations provide special protection. Class I and Class II areas are subject to maximum limits on air quality degradation called air quality increments (often referred to as PSD increments). Class II area air quality increments are more stringent than NAAQS, though less stringent than in Class I areas. The nearest Class I PSD areas are Otter Creek Wilderness Area in West Virginia, about 177 miles (285 kilometers) east of Portsmouth; Dolly Sods Wilderness Area in West Virginia, about 193 miles (311 kilometers) east of the site; and Mammoth Cave National Park in Kentucky, about 200 miles (322 kilometers) southwest of the site. These Class I areas are not located downwind of prevailing winds at the Portsmouth Site.

As discussed in Section 3.1.2.2 of this DU Oxide SEIS, the “natural greenhouse effect” is the process by which part of the terrestrial infrared radiation is absorbed by gases in the atmosphere, thereby warming the Earth’s surface and atmosphere. This greenhouse effect and the Earth’s radiative balance are affected largely by water vapor, CO_2, and trace gases, all of which are absorbers of infrared radiation and commonly referred to as “greenhouse gases” (GHGs). Other trace gases include nitrous oxide, chlorofluorocarbons, methane, and sulfur hexafluoride. Currently EPA reporting for the NEI does not include GHGs. CO_2, methane, and nitrous oxide annual GHG emissions data for the Portsmouth Site, Pike County, and the Wilmington-Chillicothe-Logan Interstate AQCR are provided in **Table 3-15**.

Table 3-15 Baseline Greenhouse Gas Emissions Inventory for Pike County and the Wilmington-Chillicothe-Logan Intrastate AQCR

Region of Interest	Greenhouse Gas (tons per year)			
	CO_2	CH_4	N_2O	Total CO_2e[a]
Portsmouth Site	15,105	0.29	0.029	15,120
Pike County	263,674	39	14	268,870
Wilmington-Chillicothe-Logan AQCR	2,796,109	236	139	2,847,831

Key: AQCR = air quality control region; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent.

[a] CO_2e is the internationally recognized measure of GHGs which weights GHGs based on their Global Warming Potential and the chemical’s ability to impact global warming.

Source: DOE 2017c; EPA 2016d

3.2.2.3 Noise

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978; 42 U.S.C. §§ 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 Ohio and Pike County, where the Portsmouth Site is located, have no quantitative noise-limit regulations.

The EPA has recommended a maximum noise level of 55 dBA as the DNL to protect against outdoor activity interference and annoyance; 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 (EPA 1974). For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an average noise level over a 24-hour period [L_{eq}(24 h)] of 70 dBA or less.

The noise-producing activities within the Portsmouth Site are associated with processing and construction activities and local traffic, similar to those at any other typical industrial site. During Portsmouth 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 Portsmouth Site. In particular, train whistle noise, at a typical noise level of 95 to 115 dBA, is high at public grade crossings. Currently, rail traffic noise is not a factor in the local noise environment because of infrequent traffic (DOE 2004b).

The Portsmouth Site is in a rural setting, and no residences or other sensitive receptor locations (e.g., schools, hospitals) exist in the immediate vicinity of any noisy on-site operations. The nearest sensitive receptor is located about 1 mile (2 kilometers) from the Portsmouth Site. Ambient sound level measurements around the Portsmouth Site are not currently available; however, the ambient noise level around the site is expected to be relatively low, except for infrequent vehicular noise. In general, the background environment is typical of rural areas; DNL from the population density in Pike County is estimated to be about 40 dBA (EPA 1974).

3.2.3 Geology and Soil

3.2.3.1 Geology

The topography of the Portsmouth Site area consists of steep hills and narrow valleys, except where major rivers have formed broad floodplains. Just east of the Scioto River, the summits of the main ridges rise to an altitude of more than 1,160 feet (354 meters) above mean sea level, with relief of up to 490 feet (149 meters) from the bottom of the valleys (DOE 2017d).

The stratigraphic sequence found beneath the Portsmouth Site is as follows (from oldest to youngest): Ohio Shale, thinly bedded black shale that may contain oil; Bedford Shale, interbedded thin sandstone and shale; Berea Sandstone, has a larger sand content than the Bedford Shale but is otherwise similar; Sunbury Shale, black carbonaceous shale (this unit thins from east to west and may be completely absent in western portions of the site); Cuyahoga Shale, thinly laminated shale with interbedded sandstone and siltstone (absent beneath the industrial portion of the Portsmouth Site); Gallia Sand, silty to clayey, coarse to fine-grained sand with a pebble base; Minford Clay, interbedded silts and clays divided into two zones, an upper zone of clay, and a lower zone of silty clay. The Gallia Sand and the Minford Clay form the Teays Formation (DOE 2004b, 2014c).

Geologic studies conducted to determine the potential seismic hazard for Portsmouth have determined that only one fault is located within 25 miles (40 kilometers) of the site. This fault lies approximately 18 miles (29 kilometers) to the west of the facility. No seismicity has been recorded on this fault (DOE 2017d).

Based on data from the U.S. Geological Survey, 29 earthquakes occurred within 100 miles (161 kilometers) of the site between June 1974 and June 2016. The largest event occurred on July 27, 1980, with an epicenter approximately 8.7 miles (14 kilometers) north of Mount Sterling, Kentucky (approximately 74 miles [119 kilometers] southwest of the Portsmouth Site) and an estimated magnitude of 5.1. Only 2 of the 29 earthquakes had a magnitude greater than 4.0 (USGS 2016b).

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of Earth's gravity). Probabilistic peak (horizontal) ground acceleration (PGA) data from the U.S. Geological Survey were used to indicate seismic hazard. The PGA values cited are based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual occurrence probability of about 1 in 2,500. At the Portsmouth Site, the calculated PGA is in the range of 0.06 to 0.08 *g* (USGS 2014a, 2014b).

3.2.3.2 Soils

Soils within the industrialized portion of the plant have been heavily disturbed and have lost much of their original character. As such, they are classified as "Urban Land." Approximately 1,500 acres (600 hectares) of the Portsmouth Site consists of moderately drained soils of the Urban Land-Omulga silt loam complex. The Omulga soil at the site is a dark grayish brown silt loam about 10 inches (25 centimeters) thick. Beneath this layer is about 54 inches (137 centimeters) of yellowish-brown subsoil. This material is characterized by a friable silt loam, a silty clay fragipan (low-permeability layer), and, near the bottom, a friable silt loam. Other soils of Portsmouth include the Clifty and Wilbur silt loams, which occur in stream valleys. The uplands areas contain a mixture of Coolville, Blairton, Latham, Princeton, Shelocta, and Wyatt soils (DOE 2004b, 2014).

Soil samples are collected annually at 15 ambient air monitoring locations (on site, fence line, off site, and background locations) and analyzed for radionuclides. Soil samples are also collected and analyzed for radionuclides and chemicals in association with remediation activities (DOE 2017c). Soils at the Portsmouth Site have been contaminated by historical releases and practices. Contaminants include radionuclides (primarily uranium and technetium), metals, and organics. The only analytes exceeding screening levels are uranium-238, arsenic, chromium, and cobalt. Several organic compounds sporadically detected include TCE, PCBs, cis-1,2-dichloroethene, and PAHs (DOE 2014)

3.2.4 Water Resources

3.2.4.1 Surface Water

The Portsmouth Site is located within the Lower Scioto River watershed about 2 miles (3 kilometers) east of the confluence of the Scioto River and Big Beaver Creek. The largest stream on the site is Little Beaver Creek, which drains the northern portion of the site and discharges into Big Beaver Creek, which then discharges into the Scioto River. The next largest stream, Big Run Creek, drains the east-central and southern portions of the site and flows off site to the southwest where it joins the Scioto River, approximately 4 river miles (6 river kilometers) from the site. The West Drainage Ditch, which drains the west-central portion of the site, flows for 4 stream miles (6 stream kilometers) before discharging into the Scioto River. The Southwest Drainage Ditch (also known as the DOE Piketon Tributary), which drains the southwestern portion of the site, is a small, intermittent watercourse (DOE 2017d). Flooding is not a problem for the majority of the Portsmouth Site. The facilities on the Portsmouth Site are located at a nominal elevation of 670 feet (204 meters) above mean sea level, which is about 100 feet (30 meters) above the historical flood level for the Scioto River in the area. The highest recorded flood elevation of the Scioto River in the vicinity of the site is 570 feet (174 meters) above mean sea level, occurring in January 1913. The entire Portsmouth Site is located outside of the 100-year floodplain, with the exception of a small area in the northwest portion of the site that is associated with Little Beaver Creek (DOE 2017d). The cylinder storage yards are not within the 100-year floodplain.

Discharges of chemicals and other parameters that measure water quality are regulated by the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act. Water from Portsmouth is monitored at 23 NPDES-permitted locations. Water from the NPDES outfalls is discharged or eventually flows to the Scioto River. Transuranic radionuclides were not detected in any of the samples collected from NPDES external outfalls in 2015. Uranium discharges from external outfalls were estimated at 8.9 kilograms. Total radioactivity (technetium-99 and isotopic uranium) released from the outfalls was estimated at 0.059 curie. Discharge limitations at the NPDES monitoring locations were exceeded on seven occasions in 2015 with these exceedances attributed to concentrations of chlorine or other chemicals in cooling tower or sanitary sewage discharges (DOE 2017c). Historically, all of the NPDES permits have maintained very high compliance rates (DOE 2017d).

Data collected in 2014 are consistent with data collected in previous years and indicate that radionuclides, metals, and other chemicals released by Portsmouth Site operations have a minimal effect on human health and the environment (DOE 2016a). In 2015, samples of surface water were collected semiannually from 14 locations upstream and downstream from Portsmouth at locations on the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek and background locations on local streams approximately 10 miles north, south, east, and west of Portsmouth. Uranium and uranium isotopes were detected at most of the surface water sampling locations. Technetium-99 was detected in samples collected from Little Beaver Creek and Big Beaver Creek downstream from Portsmouth. These detected concentrations of radionuclides were less than 1 percent of the DOE-derived concentration standards for drinking water; surface water around Portsmouth is not used for drinking water (DOE 2017c).

In 2015, samples of sediment were collected annually at 17 monitoring locations, which include the 14 locations sampled for the surface water monitoring program and three on-site NPDES outfalls on the east and west sides of Portsmouth. Samples were analyzed for radionuclides and PCBs. Neptunium-237 and/or plutonium-239/240 were detected in sediment from Little Beaver Creek, on site near NPDES Outfall 001, and Big Beaver Creek. Technetium-99 was detected in sediment collected from Big Beaver Creek, Big Run Creek, on site near NPDES Outfalls 010 and 013, and downstream locations on Little Beaver Creek. Uranium and uranium isotopes were also detected at each of the sediment sampling locations, including upstream and background sampling locations (DOE 2017c). Technetium-99, uranium, and uranium isotopes detected in the 2015 samples have been detected at similar levels in previous sampling events from 2002 through 2014. These radionuclides would yield a dose of 0.035 millirem per year to a hypothetical individual exposed to the maximum concentrations of all radionuclides; well below the DOE standard of 100 millirem per year in DOE Order 458.1 (DOE 2017c). PCBs were detected in Little Beaver Creek, Big Beaver Creek, Big Run Creek, and on site in the West Drainage. None of the detections of PCBs in sediment around Portsmouth were above the risk-based screening level of 240 micrograms per kilogram (DOE 2017c).

3.2.4.2 Groundwater

Five hydrogeological units are important for groundwater flow and contaminant migration at the Portsmouth Site. These units are, in descending order, Minford Clay, Gallia Sand, Sunbury Shale, Berea Sandstone, and Bedford Shale. The upper two units form an aquifer in unconsolidated Quaternary deposits; the lower three units form a Mississippian bedrock aquifer. The hydraulic conductivities of all of the units are very low at the Portsmouth Site (DOE 2004b). Two water-bearing zones are present beneath the industrialized portion of the Portsmouth Site: the Gallia and Berea formations. The Gallia is the uppermost water-bearing zone and contains most of the groundwater contamination at the Portsmouth Site. The Berea is deeper than the Gallia and is usually separated from the Gallia by the Sunbury shale, which acts as a barrier to impede groundwater flow between the Gallia and Berea formations, although the Sunbury shale may be absent in western portions of the site (DOE 2017c).

The direction of groundwater flow beneath the Portsmouth Site is controlled by a complex interaction between the Gallia and Berea units and is also affected by the presence of storm sewer drains and by the reduction in recharge caused by the presence of buildings and paved areas. The direction of groundwater flow is generally to the south in the southern sections of the Portsmouth Site and to the north in the northern sections. Three main discharge areas exist for the groundwater system beneath the Portsmouth Site: Little Beaver Creek to the north and east, Big Run Creek to the south, and two unnamed drainages to the west (DOE 2004b).

Groundwater monitoring at the Portsmouth Site is required by a combination of state and federal regulations, legal agreements with the Ohio EPA and U.S. EPA, and DOE Orders. More than 400 monitoring wells are used to track the flow of groundwater and to identify and measure groundwater contaminants including VOCs, radionuclides, metals, and other parameters (DOE 2017c). The *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* describes the groundwater monitoring program for the Portsmouth Site (DOE 2017f).

Five groundwater contamination plumes have been identified at the Portsmouth Site. Groundwater contamination consists of VOCs (primarily TCE) and radionuclides such as technetium-99. Four groundwater treatment facilities are operated by the DOE Environmental Restoration Program to treat contaminated groundwater from the on-site groundwater plumes that are contaminated with industrial solvents. The groundwater treatment facilities remove TCE from the water so it can be safely discharged to Little Beaver Creek or the Scioto River in accordance with NPDES permits issued by Ohio EPA (DOE 2017c). In general, concentrations of contaminants detected within the groundwater plumes at Portsmouth were stable or decreasing in 2015. No VOCs were detected in any of the seven off-site monitoring wells that monitor the groundwater plume near the southern boundary of Portsmouth (DOE 2017c).

DOE has filed a deed notification at the Pike County Auditor's Office that restricts the use of groundwater beneath the Portsmouth Site. Groundwater directly beneath the Portsmouth Site is not used as a domestic, municipal, or industrial water supply, and contaminants in the groundwater do not affect the quality of the water in the Scioto River Valley buried aquifer (DOE 2017c).

Monitoring of four private residential drinking water sources is routinely performed at the Portsmouth Site to determine whether the site has had any impact on the quality of drinking water sources. The Portsmouth water supply is also sampled as part of this program. The Portsmouth Site is the largest industrial user of water in the area and obtains water from water supply well fields north or west of the site in the Scioto River Valley buried aquifer. Results of groundwater monitoring indicate that Portsmouth has not affected drinking water wells outside the site boundaries. (DOE 2017c)

3.2.5 Biotic Resources

3.2.5.1 Vegetation and Wildlife Habitat

The most common type of vegetation on the Portsmouth Site is managed grassland (making up approximately 30 percent of the total site area), oak-hickory forest (17 percent), old field (11 percent), and upland mixed hardwood forest (11 percent).[31] Oak-hickory forest occurs on well-drained upland areas, and old-field communities occur in disturbed areas. Riparian forest occurs in low, periodically flooded areas near streams. Within the area surrounded by Perimeter Road, the Portsmouth Site consists primarily of open grassland (including areas maintained as lawns) and developed areas consisting of buildings, paved areas, and storage yards (DOE 2017c).

Habitats on the Portsmouth Site support a relatively high diversity of terrestrial and aquatic wildlife species, including 27 mammal species, 114 bird species, 11 reptile species, and 6 amphibian species (DOE 2017d). Various species of reptiles and amphibians are associated with streams and other surface water on the site and migrating waterfowl use site retention ponds (DOE 2004b).

Little Beaver Creek fish communities are described as fair upstream and good to exceptional downstream of the Portsmouth Site. Little Beaver Creek has lower water levels upstream of the

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[31] Approximately half of this upland mixed hardwood forest was recently removed for construction of the OSWDF (DOE 2017d).

Portsmouth Site where stream flow is intermittent. Upstream macroinvertebrate communities are poor, while downstream communities range from poor to exceptional. The fish community in West Ditch is marginally good, while the macroinvertebrate community is fair (DOE 2004b).

3.2.5.2 Wetlands

The aquatic habitats on Portsmouth include the various holding ponds; streams that flow through the site and include Little Beaver Creek, Big Run Creek, the West Drainage Ditch; and the DOE Piketon Tributary, all of which discharge into the Scioto River. Little Beaver Creek, Big Run Creek, and the West Drainage Ditch are designated warm water habitats (DOE 2017d). Of these aquatic habitats, 34 acres (14 hectares) of wetlands, excluding retention ponds, occur on the Portsmouth Site; 41 (of the 45 total) wetlands meeting the U.S. Army Corps of Engineers criteria for jurisdictional wetlands. The jurisdictional wetlands primarily support emergent vegetation with palustrine forested wetlands occurring along Little Beaver Creek. The Ohio State Division of Natural Areas and Preserves has listed two wetland areas near the site as significant wetland communities: (1) a palustrine forested wetland, about 5 miles (8 kilometers) east of the site, and (2) Givens Marsh, a palustrine wetland with persistent emergent vegetation, about 2.5 miles (4 kilometers) northeast of the site (DOE 2004b).

3.2.5.3 Threatened and Endangered Species

Federally and state-listed endangered and threatened species known to occur in the vicinity of the Portsmouth Site are identified in **Table 3-16**.

Table 3-16 Federally and State-Listed Endangered, Threatened, and Special Concern Species near the Portsmouth Site

Scientific Name	Common Name	Status	
		Federal	State
Faunal Species			
Myotis sodalis	Indiana bat	Endangered	Endangered
Myotis septentrionalis	Northern long-eared bat	Threatened	Threatened
Opheodrys aestivus	Rough green snake	Not Listed	Species of Concern
Accipiter striatus	Sharp-shinned hawk	Not Listed	Species of Concern
Tyto alba	Barn owl	Not Listed	Threatened
Crotalus horridus	Timber rattlesnake	Species of Concern	Endangered
Floral Species			
Rhexia virginica	Virginia meadow-beauty	Not Listed	Potentially Threatened
Xyris difformis	Carolina yellow-eyed grass	Not Listed	Endangered
Juncus secundus	Lopsided rush	Not Listed	Potentially Threatened
Packera paupercula	Balsam groundsel	Not Listed	Threatened
Piptochaetium avenaceum	Blackseed speargrass	Not Listed	Endangered
Trifolium stoloniferum	Running buffalo clover	Endangered	Endangered

Source: DOE 2017d

Suitable habitat has been identified for the federal- and state-listed endangered Indiana bat (*Myotis sodalis*) and the federal-listed threatened northern long-eared bat (*Myotis septentrionalis*). Potential summer habitat for the Indiana bat was identified on the site. Mist net surveys were conducted on the Portsmouth site in May of 2011 and July and August of 2013; no Indiana bats were found. However nine northern long-eared bats were captured (and released) (DOE 2017d).

The sharp-shinned hawk and the rough green snake, both species of concern in Ohio, have been observed on the Portsmouth Site. Both of these species inhabit moist woods. The timber rattlesnake, listed by the State of Ohio as endangered, occurs in the vicinity of the Portsmouth Site but has not been found on the site. Habitat for the timber rattlesnake is found on and near high, dry ridges.

No occurrence of federal-listed endangered or threatened plant species have been documented on the Portsmouth Site. Of the state-listed plant species, only the Virginia meadow-beauty (listed as potentially threatened) has been identified on site, and the Carolina yellow-eyed grass (listed as endangered) has been tentatively identified on Portsmouth. Thirteen additional state-listed rare, threatened, and endangered plant species were preliminarily identified on the Portsmouth Site during a 2012 Ohio University habitat study. These plant species identifications did not meet the multi-level criteria (three-season survey) necessary to definitively identify the presence of a listed plant species (DOE 2017d).

3.2.6 Public and Occupational Safety and Health

3.2.6.1 Radiation Environment

DOE has calculated the radiation exposures of on-site workers and members of the off-site general public from operation of the Portsmouth Site. In 2014, the hypothetical maximum radiation dose to an off-site member of the public as a result of on-site facility operations was estimated to be 1.1 millirem per year (DOE 2017c) with no LCFs expected (calculated value of 7×10^{-7}), which is less than one percent of the average dose of 311 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for an individual in the United States (NCRP 2009). The calculation of this maximum dose limit assumes that the same representative person works near the Portsmouth Site and lives in the immediate vicinity of the Portsmouth Site. The DOE dose limit for the general public is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1. **Table 3-17** provides the contributions to the maximum individual dose by pathway. The hypothetical maximum dose was estimated by using the largest environmental media concentrations monitored at different off-site locations, emission data, and conservative exposure parameters.

Table 3-17 Sources of Maximum Individual Dose

Source of Dose	Dose (millirem per year)	LCFs
Airborne radionuclides[a]	0.037	2×10^{-8}
Waterborne radionuclides (Scioto River)[b]	0.0017	1×10^{-9}
External radiation[c]	0.96	6×10^{-7}
Radionuclides detected by environmental monitoring programs[d]	0.082	5×10^{-8}
Total	1.1	1×10^{-6}

Key: LCF = latent cancer fatality.

[a] EPA limit for public dose from airborne radionuclides is 10 millirem per year (NESHAP, 40 CFR Part 61, Subpart H).

[b] Dose calculated from measured radionuclide discharges from the plant outfalls and the annual flow rate of the Scioto River.

[c] From the off-site monitoring station resulting in the highest calculated dose.

[d] Includes all sources (e.g., sediment, soil, residential drinking water, biota) not specifically identified in the first three entries in this table.

Source: DOE 2017c (Table 4.1)

The population dose is the sum of individual doses to the entire population within 50 miles of the Portsmouth Site. In 2015, the population dose from operations at the Portsmouth Site was 0.224 person-rem (DOE 2017c) with no LCFs expected (calculated value of 1×10^{-4}), which is approximately 1.1×10^{-4} percent of the total population dose (from natural background radiation) of 210,000 person-rem.

Less than 2 percent of the 2,527 workers at Portsmouth received a measureable dose (a dose of 1 millirem or more) in 2016. These workers were primarily handling DU cylinders. The total worker dose for 2016 was 2.5 person-rem with no LCFs expected (calculated value of 0.002). Considering all 2,527 workers, the average worker dose was 0.99 millirem (DOE 2017b). However, considering only the workers who received a measurable dose (40 workers), the average dose to these workers was 63 millirem **(**DOE 2017b). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than a DOE administrative limit of 2,000 millirem per year (DOE 2017g) and maintained to achieve ALARA goals.

3.2.6.2 Chemical Environment

The chemical environment is described by the nonradiological effect of uranium when inhaled or ingested. This health effect is expressed as a hazard quotient, a ratio of the estimated intake versus the level below which adverse health effects are not expected. A hazard quotient of less than one means no adverse health effects are expected. The hazard quotient for various exposure pathways (environmental medium) for members of the general public under existing environmental conditions near the Portsmouth Site are presented in **Table 3-18**. Since the on-site activities addressed in this DU Oxide SEIS pertain only to the storage of DU oxide and not the DUF_6 conversion process nor the source material for that process, only uranium is addressed in this table, as that is the element most relevant to this SEIS.

Table 3-18 Chemical Hazard Quotient for Uranium

Environmental Medium	Assumed Exposure Concentration	Estimated Chronic Intake (mg/kg-d)[a]	Reference Level[b] (mg/kg-d)	Hazard Quotient
Air[c]	2.4×10^{-3}μg/m^3	2.1×10^{-6}	3.0×10^{-4}	6.9×10^{-3}
Soil[d]	3.49 μg/g	15.0×10^{-5}	3.0×10^{-3}	1.7×10^{-2}
Surface Water[e]	5.04 μg/L	2.9×10^{-6}	3.0×10^{-3}	9.6×10^{-4}
Sediment[f]	6.49 μg/g	1.9×10^{-6}	3.0×10^{-3}	6.2×10^{-4}
Groundwater[g]	35.6 μg/L	1.0×10^{-3}	3.0×10^{-3}	3.4×10^{-1}

Key: μg/m^3 = micrograms per cubic meter; μg/g = micrograms per gram; μg/L = micrograms per liter; mg/m^3 = milligrams per cubic meter.

[a] Calculated based on an assumed inhalation/consumption rate (derived from DOE 2017c) for a representative person (weight of 70kg)

[b] Air reference level derived from the OSHA permissible exposure limits (PELs) for soluble uranium compounds (0.05 mg/m^3) instead of the higher limit for insoluble uranium. The other environmental medium reference level is EPA's oral reference dose (RfD) from EPA Integrated Risk Information System for uranium.

[c] Concentration is the largest value for uranium in Table 2-10 of DOE (2017c).

[d] Concentration is the largest value for uranium in Table 2-16 of DOE (2017c).

[e] Concentration is the largest value for uranium in Table 2-14 of DOE (2017c).

[f] Concentration is the largest value for uranium in Table 2-15 of DOE (2017c).

[g] Concentration is the largest value for uranium in Table 4-9 of DOE (2017c).

Source: DOE 2017c

Safety and health requirements for DOE workers are governed by 10 CFR Part 851, which establishes requirements for a worker safety and health program to ensure that DOE workers have a safe work environment. Included are provisions to protect against hazardous chemicals. For worker protection from the toxic effects of uranium, DOE uses the OSHA permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000, Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels.

3.2.7 Socioeconomics

The ROI for this socioeconomic analysis consists of four counties: Jackson, Pike, Ross, and Scioto counties in Ohio. The ROI is based on where socioeconomic impacts would be expected, if any were to occur, with a focus on Pike County and Scioto County, where the majority of any impacts would be expected.

3.2.7.1 Population

In 2010, the population of the ROI was 219,497 people (Census 2010). Approximately 49.3 percent (108,208 people) of the total ROI resided in Pike County and Scioto County. Between the 2010 U.S. Census and 2014 estimates, the total four-county ROI population decreased by 1,969 people (approximately -0.23 percent annually). Over the same period, the population in Ohio grew at an average annual rate of 0.05 percent (see **Table 3-19)**.

Table 3-19 Population in the Portsmouth Region of Influence and Ohio in 2010 and 2014

Location	2010 Census	2014 Estimate	Average Annual Growth Rate (%) 2010–2014
Jackson County	33,225	32,952	-0.21
Pike County	28,709	28,504	-0.18
Ross County	78,064	77,552	-0.16
Scioto County	79,499	78,520	-0.31
ROI Total	**219,497**	**217,528**	**-0.23**
Ohio	11,536,504	11,560,380	0.05

Key: ROI = region of influence.
Sources: Census 2010, 2014a

3.2.7.2 Employment and Income

The number of personnel supporting Portsmouth was 2,612 non-DOE government personnel including 116 Centrus personnel as of January 2018 (PPPO 2018). In 2014, total employment in the ROI was 93,493, representing an increase of 1,673 (1.82 percent) jobs since 2010. Major industries by employment in the ROI include health care and social assistance, government and government enterprises, and retail trade. In 2014, total employment in Pike County was 12,785, representing a decrease of 282 jobs (2 percent) since 2010. The major industries by employment in the county include administrative and support and waste management, health care and social assistance, and government and government enterprises. In 2014, total employment in Scioto County was 31,016, representing a decrease of 373 jobs (1.2 percent) since 2010. The major industries in the county include health care and social assistance, government and government enterprises, and retail trade (BEA 2015a).

Unemployment in Pike County and Scioto County decreased between 2010 and 2015 from 14.8 percent to 7.4 percent in Pike County and from 13.3 percent to 7.7 percent in Scioto County (BLS 2016a). Unemployment in each county and the total ROI was greater than the unemployment rate in the state of Ohio during 2015 (see **Table 3-20**). Scioto County had the lowest per capita personal income in the four-county ROI with $31,627 in 2014 and Jackson County had the highest with $32,701. Pike County had a per capita personal income of $32,093. All counties had a lower per capita personal income compared to the state of Ohio with $42,236 in 2014 (BEA 2015c).

Table 3-20 Employment in the Portsmouth Region of Influence in 2015

Location	Total Employment	Unemployment Rate (%)
Jackson County	14,400	7.5
Pike County	12,785	7.4
Ross County	35,292	5.3
Scioto County	31,016	7.7
ROI Total	**93,493**	**6.7**
Ohio	6,753,002	4.9

Sources: Census 2014b; BEA 2015a; BLS 2016a

3.2.7.3 Housing

In 2014, housing units in the four-county ROI totaled 93,141 units (Census 2014c). More than 36 percent of the total housing units in the ROI were in Scioto County. Approximately 12 percent of the total housing units were vacant, while the remaining 88 percent were occupied (see **Table 3-21**).

Table 3-21 Housing in the Portsmouth Region of Influence in 2014

Location	Total Housing Units	Occupied Housing Units	Vacant Housing Units
Jackson County	14,574	13,204	1,370
Pike County	12,534	10,944	1,590
Ross County	31,933	28,209	3,724
Scioto County	34,100	29,558	4,542
ROI Total	**93,141**	**81,915**	**11,226**
Ohio	5,135,173	4,570,015	565,158

Key: ROI = Region of Influence
Source: Census 2014c

3.2.7.4 Community Resources

Emergency response services in the ROI include police, fire rescue, and emergency response. Law enforcement in the ROI consists of state, county, and local police departments. There are 16 officers in Pike County, 14 in Jackson County, 44 in Ross County, and 43 in Scioto County (DOE 2017d). The Portsmouth Fire Department serves the city of Portsmouth and Sciotoville and has 36 sworn officers and 6 emergency dispatchers (Portsmouth Ohio 2016a, 2016b). There is an on-site fire department on Portsmouth with the capabilities and equipment to contain most fires that would occur on site; however, the on-site fire department has a mutual assistance agreement with off-site fire departments for situations that are beyond the on-site fire department's capabilities (DOE 2017d).

Southern Ohio Medical Center (Portsmouth) and Adena Pike Medical Center (Waverly) are the primary care facilities with 222 beds and 25 beds, respectively (SOMC 2016; Adena 2016). Both medical centers operate an urgent care facility approximately 8 miles north of Portsmouth. In addition, there is an on-site medical center at Portsmouth. There is also a first aid room maintained by the X-1007 Fire Station (DOE 2017d).

There are 33 public school districts throughout the four-county ROI. During the 2013–2014 school year, there were 33,286 students enrolled throughout the 86 schools in the ROI (DOE 2017d). There are four school districts in Pike County with a total enrollment of 4,689 students and 271 full-time teachers during the 2014–2015 school year, for a student-to-teacher ratio of 17.3 to 1 (ODE 2016a, 2016b). There are ten school districts in Scioto County with a total enrollment of 11,530 students and 723 full-time teachers during the 2014–2015 school year, for a student-to-teacher ratio of 15.9 to 1 (ODE 2016a, 2016b).

3.2.8 Waste Management

A variety of wastes are generated at the Portsmouth Site as a result of differing activities including the management of DUF_6 cylinders in storage; conversion of DUF_6 to DU oxide with on-site storage of DU oxide cylinders pending their disposition; DD&D of excess facilities and structures; and environmental restoration of soil, groundwater, and surface-water contamination. These wastes include LLW,[32] MLLW,[33] nonradioactive hazardous and Toxic Substances Control Act (TSCA) waste, solid nonhazardous waste, and wastewater. Current annual generation rates for these wastes are summarized in **Table 3-22**.

Table 3-23 shows the waste expected to be generated during DD&D of the Portsmouth Site. Approximately 1,357,000 cubic yards (1,038,000 cubic meters) of waste is expected to be generated by DD&D (PPPO 2018). It is anticipated that the large majority of the lightly contaminated waste will be disposed of in the OSWDF. It is also anticipated that 107,000 cubic yards (81,800 cubic meters) of the waste will be sent off site for disposal, and another 110,000 cubic yards (84,100 cubic meters) of material may be a candidate for recycling and/or reuse. The OSWDF will have a capacity of 5 million cubic yards (3,823,000 cubic meters) to factor in uncertainties in the underlying assumptions of the original capacity calculations (DOE 2015g).

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[32] Includes calcium fluoride generated during the oxide conversion process that would be disposed as low-activity LLW.

[33] Consisting of waste regulated for its radioactive content pursuant to the Atomic Energy Act of 1954, as amended, as well as its chemical content pursuant to RCRA, TSCA, or other applicable statutes.

Table 3-22 Current Waste Generation Rates at Portsmouth

Waste Type		Annual Quantities
Solid LLW	Unusable empty DUF_6 cylinders[a]	22 cubic yards
	Debris	140 cubic yards
	Oversized debris	4.8 cubic yards
	Soil-like material	16 cubic yards
	Soil-like material with TSCA constituents	0.21 cubic yards
	Calcium fluoride[b]	18 metric tons/20 tons
Liquid LLW		510 gallons
MLLW	Debris	0.35 cubic yards
	Soil-like material	0.67 cubic yards
Liquid MLLW		44 gallons
Hazardous waste		4.1 cubic yards
Universal waste[c]		1.4 cubic yards
Solid nonhazardous waste		87 tons
Wastewater (not including sanitary wastewater)		920 gallons

Key: DUF_6 = depleted uranium hexafluoride; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TSCA = Toxic Substances Control Act.

[a] Emptied cylinders determined to be unusable for containment of DU oxide are disposed of as LLW.

[b] From the oxide conversion process. The calcium fluoride would be shipped off site for disposal as low-activity LLW (also called exempt LLW). Low-activity LLW is waste that contains so little radioactive material that it can be disposed of at a facility other than a LLW disposal facility licensed under 10 CFR Part 61 or compatible Agreement State regulation. Disposal of this waste is licensed under 10 CFR 20.2002 or compatible Agreement State regulation.

[c] Universal waste refers to a category of hazardous waste having streamlined management procedures.

Source: PPPO 2018

Note: To convert cubic yards to cubic meters, multiply by 0.76456; tons by metric tons, multiply by 0.90718; gallons to liters, multiply by 3.7854.

Table 3-23 Estimate of Waste Generated During Deactivation, Decontamination, and Demolition of the Portsmouth Site

Waste Type	Total Quantity[a]
Solid LLW	437,500
LLW - construction and demolition debris	786,800
LLW - TSCA	37,000
MLLW	100
RCRA	53,400
Construction and demolition debris	32,000
Solid Waste	10,200
Total	1,357,000

Key: LLW = Low-level radioactive waste; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; RCRA = Resource, Conservation and Recovery Act; and TSCA = Toxic Substance Control Act.

[a] This waste could be generated, depending upon funding, over a 10- to 12-year period (DOE 2014).

Source: PPPO 2018

Methods for management of these wastes are summarized in **Table 3-24**.

Table 3-24 Current Methods for Management of Wastes at the Portsmouth Site

Waste	Typical Content	Management Procedure[a]
Solid LLW	Refuse, sludge, or debris primarily containing uranium and technetium.	Temporary storage on-site pending shipment to off-site treatment and/or disposal facilities.[b]
Solid and liquid MLLW	Similar materials as solid low-level radioactive waste but also containing RCRA hazardous components such as lead, or toxic materials such as PCBs.	Temporary on-site storage pending shipment to off-site permitted facilities for treatment and/or disposal.[b]
Solid and liquid hazardous and toxic waste	Spent solvents, heavy-metal-contaminated waste and PCB-contaminated toxic waste.	Temporary on-site permitted storage pending shipment to off-site facilities for treatment and or storage disposition. Principal storage areas are the X-330 and X-345 RCRA storage areas. Several 90-day storage areas are also available.[b]
Solid nonhazardous waste	Sanitary refuse, cafeteria waste, industrial waste, disinfected medical waste, and construction and demolition debris.	Recycle or disposal in an off-site permitted nonhazardous waste landfill.[b]
Wastewater	Sanitary and process-related wastewater streams, cooling water blowdown, radioactive process-related liquid effluents, discharges from groundwater treatment systems, and storm water runoff from plant areas. Radioactive process-related liquid.	Nonradioactive wastewater is processed at several on-site treatment facilities and discharged through permitted outfalls. Treatment facilities include an activated sludge sewage treatment plant; facilities that apply waste-specific pretreatment technologies (e.g., pH adjustment, activated carbon adsorption, metals removal, denitrification, and ion absorption); and basins to facilitate solids settling, oil collection, and chlorine dissipation. The Portsmouth Site wastewater facilities have a capacity of about 5.3 million gallons (20 million liters) per day. Radioactive liquid is shipped off site for treatment and disposal.

Key: LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; PCB = polychlorinated biphenyl; RCRA = Resource Conservation and Recovery Act.

[a] In addition, the Portsmouth Site has an active program to minimize the generation of solid LLW, MLLW, hazardous waste, and solid nonhazardous waste.

[b] In the future, Portsmouth plans to dispose of waste from DD&D activities within an OSWDF, provided the waste meets the waste acceptance criteria for the OSWDF. Waste not meeting the OSWDF waste acceptance criteria will be transported off site for disposal (DOE 2015g).

Sources: DOE 2004b; PPPO 2018

3.2.9 Land Use and Aesthetics

3.2.9.1 Land Use

The Portsmouth Site is located in south-central Ohio, in the southern portion of rural Pike County, and encompasses an area of 3,777 acres (1,528 hectares). Land use in the general vicinity of the Portsmouth Site includes urban land, residential areas, private and commercial farms, light industries, and transportation corridors (highways and railroads) (DOE 2014). In Pike County the land use is approximately 66 percent forest, 23 percent cropland, and 8 percent pasture. The remaining 3 percent is classified as urban land, open water, and bare/mines areas (DOE 2014). The latter classification refers to largely unvegetated areas of nonurban land, some of which may be associated with mining. Two public recreational areas are located in the vicinity of the Portsmouth Site: Brush Creek State Forest (approximately 15 miles [24 kilometers] to the southwest), and Lake White State Park (approximately 6 miles [10 kilometers] to the north) (DOE 2014, 2017a).

In the immediate area surrounding the Portsmouth Site, land is used primarily for farms, pastures, forests, and rural residences; however, the dominant land use is farming. The 2012 agricultural census recorded 490 farms in Pike County, covering more than 97,446 acres (39,370 hectares), approximately 34 percent of the county (USDA 2014b).

Human settlement is sparse throughout most of Pike County; the largest communities (Piketon and Waverly) are located near the Scioto River, north of the Portsmouth Site; the village of Jasper is northwest of the site; and the village of Wakefield is south of the site (DOE 2004b).

Within the 3,777-acre (1,528-hectare) DOE land holdings at the Portsmouth Site, Perimeter Road surrounds a 1,300-acre (526-hectare) developed industrial use area, which includes the Conversion Facility and former Portsmouth GDP in a 750-acre (304-hectare) controlled access area. The Portsmouth Conversion Facility includes multiple buildings supporting the site mission, located in proximity to three large process buildings with a combined floor space of about 9,680,000 square feet (900,000 square meters) (DOE 2018a). The portion of the plant outside of Perimeter Road has approximately 2,500 acres (1,010 hectares) of land. Land uses outside of the central industrial area include a water treatment plant, holding ponds, sanitary and inert landfills, cylinder storage yards, parking areas, open fields, and forested buffer areas (DOE 2014).

Currently, DOE has two real property leases with the Southern Ohio Diversification Initiative (SODI) (DOE 2014). The first lease between DOE and SODI was signed in April 1998 for 7 acres (3 hectares) of land on the north side of the DOE property. This tract is used as a right-of-way for a railroad spur that connects to the existing DOE north rail spur. SODI subleases a portion of this property to the Glatfelter Corporation to allow access to the rail line for a wood-grading operation. In October 2000, a second lease between DOE and SODI was signed to allow concurrent SODI access to and use of the existing north rail spur (DOE 2014). In July 2018, DOE DOE transferred 80 acres of additional site property to SODI (DOE 2018b).

3.2.9.2 Aesthetics

The Portsmouth Site is located in a rural area of Pike County, Ohio. The area is characterized by gently rolling terrain. The dominant viewshed (an area visible to the human eye from a fixed vantage point) at the Portsmouth Site consists of buildings, cylinder storage yards, transmission lines, and open and forested buffer areas. Numerous buildings within the Portsmouth Site viewshed are in various stages of deactivation and decommissioning.

A visual impact study was conducted at the Portsmouth Site (DOE 2014). This study evaluated the visibility of various components of the Portsmouth Site from the surrounding community. In the immediate area surrounding the Portsmouth Site there are no environmentally sensitive areas, including areas of recreational, scenic, or aesthetic importance (DOE 2014).

The developed areas and utility corridors (transmission lines and aboveground pipelines) of the Portsmouth Site are consistent with a Visual Resource Management Class IV designation. The remainder of the site is consistent with a Visual Resource Management Class II or Class III designation. Management activities within Class II and Class III areas may be seen, but do not dominate the view; management activities in Class IV areas dominate the view and are the focus of viewer attention (DOI 1986).

3.2.10 Cultural Resources

Although southern Ohio has been home to humans from at least the Paleoindian period, prior to 11,000 BCE, there is very little evidence in the vicinity of the Portsmouth Site. More common are sites dating to the Archaic Period (11,000 BCE to 3000 BCE), followed by the Woodland Period (3000 BCE to 900 CE). The latter period is particularly notable for the mound complexes found throughout the region. Most recently, prior to Euro-American contact, the Fort Ancient culture period extended from 900 CE to 1600 CE. At the time of Euro-American contact, the Shawnee lived in southern Ohio, including the Scioto Valley. Euro-American settlements took hold in the early 1800s, consisting primarily of agricultural ventures (DOE 2004b; Miller et al. 2014).

The Atomic Energy Commission chose the Scioto Valley as the location for a gaseous uranium diffusion facility to work in concert with facilities at Paducah, Kentucky and Oak Ridge, Tennessee. With construction starting in 1952, the plant became operational in 1954 (DOE 2004b; Miller et al. 2014).

Portsmouth fulfilled its cultural resource inventory obligations under Section 110 of the National Historic Preservation Act through numerous cultural resources surveys and consultation with the Ohio SHPO between 1996 and 2013. As a result of these efforts, 117 archaeological resources, 196 architectural resources (buildings and structures), and 2 cemeteries were identified. Of the archaeological resources, three prehistoric sites and two historic era sites (the Holt Cemetery and Mount Gilead Church and Cemetery) are eligible for listing on the NRHP, and the rest are not NRHP-eligible (DOE 2017d). Additionally, based on the results of those surveys, it has been determined that all of the area within Perimeter Road was significantly disturbed during plant construction (DOE 2015b).

Thirty-three of the 196 Portsmouth buildings are considered historic properties, all of which are considered eligible for the NRHP based upon their relationship with the historic Cold War mission of Portsmouth (DOE 2017d). The final comprehensive mitigation measures are included in the *Final Record of Decision for the Site-Wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant* (DOE 2015g). None of the cylinder storage locations has been identified as historic resources. No traditional cultural resources have been identified at the Portsmouth Site.

Status of Consultation

For the 2004 EIS (DOE 2004b), DOE initiated Section 106 consultation with the following Native American tribes:

- Absentee Shawnee Tribe of Oklahoma
- Chickasaw Nation of Oklahoma
- Eastern Band of Cherokee Indians, Quallah Boundary
- Eastern Shawnee Tribe of Oklahoma
- Peoria Tribe of Oklahoma

- Seneca-Cayuga Tribe of Oklahoma
- Shawnee Nation, United Remnant Band
- Shawnee Tribe

The Eastern Shawnee Tribe of Oklahoma and Peoria Tribe of Oklahoma had no concerns and requested consultation in the event of any North American Graves Protection and Repatriation Act-related finds or issues. No other tribes responded. No religious or sacred sites, burial sites, resources significant to Native Americans, or other Native American concerns have been identified at the Portsmouth Site (DOE 2004b).

In 2009, DOE transmitted a letter, "Interest as a Consulting Party in NHPA Section 106 Consultation Process," to the following Native American tribes:

- Citizen Potawatomi Nation
- Delaware Nation
- Eastern Shawnee Tribe of Oklahoma
- Forest County Potawatomi Community
- Hannahville Indian Community Council
- Miami Tribe of Oklahoma
- Ottawa Tribe of Oklahoma
- Peoria Tribe of Indians of Oklahoma
- Pokagon Band of Potawatomi Indians
- Prairie Band of Potawatomi Nation
- Shawnee Tribe
- Turtle Mountain Band of Chippewa
- Wyandotte Tribe of Oklahoma

For the *Conveyance of Real Property at the Portsmouth Gaseous Diffusion Plant EA* (DOE 2017d) DOE initiated Section 106 consultation with the following Native American tribes:

- Shawnee Tribe of Oklahoma
- Eastern Shawnee Tribe of Oklahoma
- Seneca-Cayuga Tribe of Oklahoma
- Shawnee Nation, United Remnant Band
- Shawnee Tribe

At this time, the Portsmouth NHPA Officer is in contact with the following tribes:

- Absentee-Shawnee Tribe of Oklahoma
- Eastern Shawnee Tribe of Oklahoma
- Seneca-Cayuga Tribe of Oklahoma
- Shawnee Tribe

DOE also consulted with the following SHPOs on the 2004 Portsmouth EIS (DOE 2004b):

- Kentucky Heritage Council

- Ohio Historic Preservation Office
- Tennessee Historical Commission

The Ohio and Kentucky offices indicated, by not responding, that they had no concerns. Although the Tennessee Historical Commission had some concerns at the time of consultation for the 2004 action (DOE 2004b), no elements of the current project involve resources that are regulated by the State of Tennessee. DOE also consulted with the Ohio Historic Preservation Office for the *Coneyance of Real Property at the Portsmouth Gaseous Diffusion Plant EA* (DOE 2017d).

In terms of the potential impacts to cultural resources, DOE determined that the actions evaluated in this DU Oxide SEIS do not differ appreciably from those evaluated in the 2004 EIS (DOE 2004b). Therefore, DOE determined that the consultations completed for the 2004 EIS satisfy DOE’s obligation under NHPA Section 106 and that no further consultations are needed.

3.2.11 Environmental Justice

In 1994, EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations (Environmental Justice)*, was issued to focus the attention of federal agencies on how their actions affect the human health and environmental conditions to which minority and low-income populations are exposed. This EO was also established to ensure that if there were disproportionately high and adverse human health or environmental effects from federal actions on these populations, these effects would be identified and addressed. The environmental justice analyses in this DU Oxide SEIS address the characteristics of race, ethnicity, and poverty status for populations residing in areas potentially affected by implementation of the alternatives presented in this SEIS.

In 1997, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks (Protection of Children)*, was issued to identify and address anticipated health or safety issues that affect children. The protection-of-children analyses in this DU Oxide SEIS address the distribution of population by age in areas potentially affected by implementation of the alternatives presented in this SEIS.

For the purpose of the environmental justice analysis, these populations are defined as follows:

Minority Populations – All persons identified by the U.S. Census Bureau to be of Hispanic or Latino origin, regardless of race, plus non-Hispanic persons who are Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or members of some other (i.e., nonwhite) race or two or more races.

Low-Income Populations – All persons who fall within the statistical poverty thresholds established by the U.S. Census Bureau. For the purposes of this analysis, low-income populations are defined as persons living below the poverty level. Starting with the 2010 Decennial Census, poverty data will be provided through the annual American Community Survey rather than as part of the Decennial Census.

Children – All persons identified by the U.S. Census Bureau to be under the age of 18 years.

Table 3-25 provides a summary of the percentage of minority and low-income populations within 50 miles (80 kilometers) of the Portsmouth Site. The 225 census tracts within 50 miles of the Portsmouth Site are defined as the ROI. To identify census tracts with disproportionately high minority populations, this DU Oxide SEIS uses the percentage of minorities in each state containing a given tract as the COC. 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.

Table 3-25 Environmental Justice Populations

Location	Minority		Low-Income[a]	
	Number	Percent	Number	Percent
United States	116,947,592	37.2	47,755,606	15.6
Ohio	2,248,817	19.5	1,790,564	15.9
Kentucky	622,404	14.2	803,866	18.9
West Virginia	135,010	7.3	326,225	18.1

[a] Based on population for whom poverty status is determined[34] which may differ from the total population

Sources: Census 2014a, 2014f

Table 3-26 provides a summary of the age distribution for the population in states containing a given census tract within 50 miles (80 kilometers) of the Portsmouth Site.

Table 3-26 Population Distribution by Age

Location	Total Population	Under 5 Years		Under 18 Years		Over 65 Years	
		Number	Percent	Number	Percent	Number	Percent
United States	314,107,084	19,973,711	6.4	73,777,658	23.5	43,177,961	13.7
Ohio	11,560,380	700,088	6.1	2,673,661	23.1	1,704,599	14.7
Kentucky	4,383,272	277,776	6.3	1,018,350	23.2	614,496	14.0
West Virginia	1,853,881	103,044	5.6	383,727	20.7	311,625	16.8

Source: Census 2014a

Schools, childcare centers, parks, and hospitals represent areas where there would be high concentrations of children. There are three schools approximately 4 to 6 miles from the Portsmouth Site: Jasper Elementary School, Piketon Junior/Senior High School, and Zahn's Middle School. Adena Pike Medical Center and Southern Ohio Medical Center are located 5 miles and 17 miles (8 kilometers and 27 kilometers) from the Portsmouth Site, respectively.

As shown in **Figure 3-2**, in 2014, of the 225 census tracts within 50 miles (80 kilometers) of the Portsmouth Site, 17 census tracts had minority populations in excess of state-specific thresholds; a total of 11,555 minority persons. Of the 225 census tracts within 50 miles of the Portsmouth Site there were 147 census tracts with low-income populations in excess of state-specific thresholds; a total of 144,420 low-income persons (Census 2014d, 2014e).

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[34] People whose poverty status cannot be determined includes people in college dormitories, military barracks, living situations without conventional housing, institutional group quarters, and unrelated invidivuals under age 15. However, these people may be included in the total population count; thus the total number of low-income individuals might differ if the percent of low-income individuals is taken from the total population.

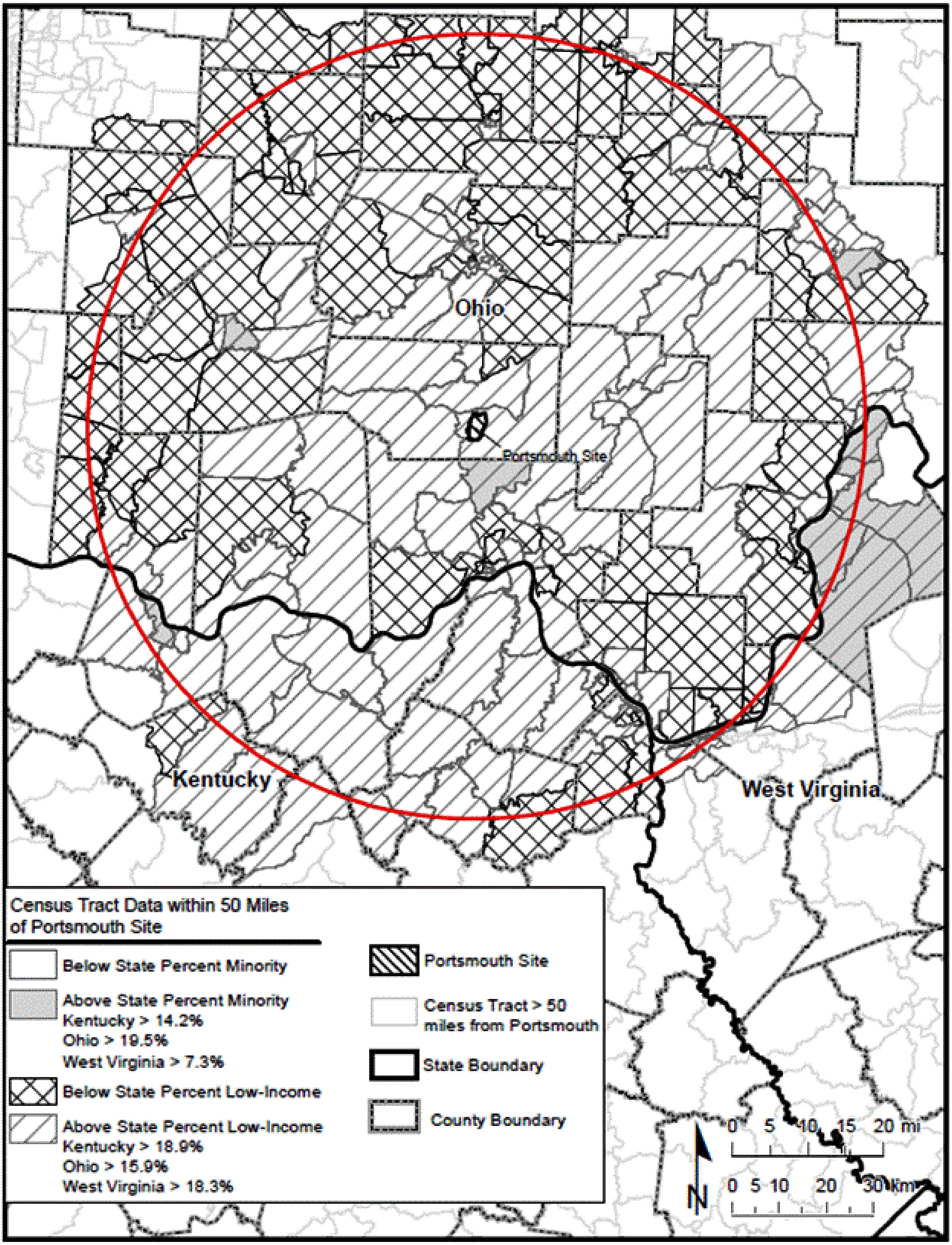

Figure 3-2 Environmental Justice Populations—Portsmouth Site (Source: Census 2014a–2014f)

3.3 ENERGY*SOLUTIONS*

The Energy*Solutions* site is located on a 640-acre (260-hectare) parcel of land in western Utah, in the northwestern portion of Tooele County, about 60 miles (100 kilometers) west of Salt Lake City, on the eastern edge of the Great Salt Lake Desert (ES 2016b) (**Figure 3-3**). Energy*Solutions* owns the property, with the exception of 100 acres (40.5 hectares) owned by DOE (ES 2016a).

Figure 3-3 Location of the Energy*Solutions* Site Near Clive, Utah

The Energy*Solutions* site is located in the Intermountain Plateau climatic zone, which is classified as a middle-latitude dry climate or steppe (ES 2016a). From 1992 to 2009, the average monthly temperatures at the site ranged from 80°F (26°C) in July to 28°F (-2.4°C) in December. Site data indicate that, from 1992 to 2004, the average annual rainfall was approximately 8.6 inches (22 centimeters) per year. On average, April has the highest amount of precipitation (1.3 inches [3.2 centimeters]), while August has the lowest (0.32 inches [0.8 centimeters]). Snowfall does occur during the winter months (Neptune 2015).

The Energy*Solutions* site is located in the Basin and Range Province of North America, which predominantly consists of block-faulted mountain ranges generally trending north to south. The soils primarily consist of sediments originating from Quaternary lacustrine Lake Bonneville deposits and Quaternary and Tertiary colluvial and alluvial materials eroded from adjacent mountains (ES 2016c).

The aquifer system below the Energy*Solutions* site consists of a shallow unconfined aquifer that extends through the upper 40 feet (12 meters) of lacustrine deposits and a confined aquifer that begins around 40 to 45 feet (12 to 14 meters) and continues through the valley fill (ES 2016c). Little or no precipitation reaches the upper unconfined aquifer as direct vertical infiltration due to low precipitation and high evapotranspiration rates. Most groundwater recharge occurs from infiltration at bedrock and alluvial fan deposits followed by lateral and vertical movement through the unconfined and confined aquifers (ES 2016c). The groundwater at the site is considered saline and contains several chemicals with concentrations above EPA's secondary drinking water standards. Therefore, the groundwater is not considered potable (ES 2016c).

In 2010, Tooele County had a total population of 58,218 people and a population density of 8.4 persons per square mile (3.2 persons per square kilometer) (Census 2015a). The closest resident to the Energy*Solutions* site is approximately 7 miles (11 kilometers) to the northeast (ES 2016c). As of October 2016, there were approximately 100 employees working on site (Shrum 2016c).

The Energy*Solutions* site can accept waste by truck and rail and has direct access to major highway and rail systems in the region. Vehicular access is provided by Interstate 80, Exit 49, and an all-weather road to the site that Energy*Solutions* maintains. Rail access is provided by a rail system owned and operated by the Union Pacific Railroad. Energy*Solutions* owns over 5 miles (8 kilometers) of track and operates two locomotives at the disposal site (ES 2016c).

The Energy*Solutions* site is licensed and permitted to dispose of Class A LLW as defined in the NRC's regulation at 10 CFR Part 61, MLLW,[35] and uranium mill tailings (defined in Section 11e.(2) of the Atomic Energy Act of 1954, as amended [42 U.S.C. § 2014] as a byproduct material)[36] (**Figure 3-4**). Waste disposal occurs in above-grade disposal units (embankments) using low-permeable clay as a liner on top of a foundation of compacted indigenous clay and soil. In addition,-high density polyethylene liners were installed in the MLLW disposal units (NDR 2016). Although most waste is emplaced in shallow (2-foot) "lifts," larger waste such as discarded equipment is disposed of using controlled low-strength material, a "flowable" grout material to reduce the presence of voids and air pockets (Shrum 2016b). Wastes having higher radiation levels are disposed of in concrete vaults with voids in the vaults filled with controlled low-strength material. Filled disposal units are covered with layers of clay, gravel, soil, and rock designed to promote evapotranspiration (NDR 2016). A summary of the treatment and disposal services provided, and waste disposal capacity, is provided in **Table 3-27**.

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[35] Consisting of waste regulated for its radioactive content pursuant to the Atomic Energy Act of 1954, as amended, as well as for its chemical content pursuant to RCRA, TSCA, or other applicable statutes.

[36] 11e.(2) byproduct material is defined as the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

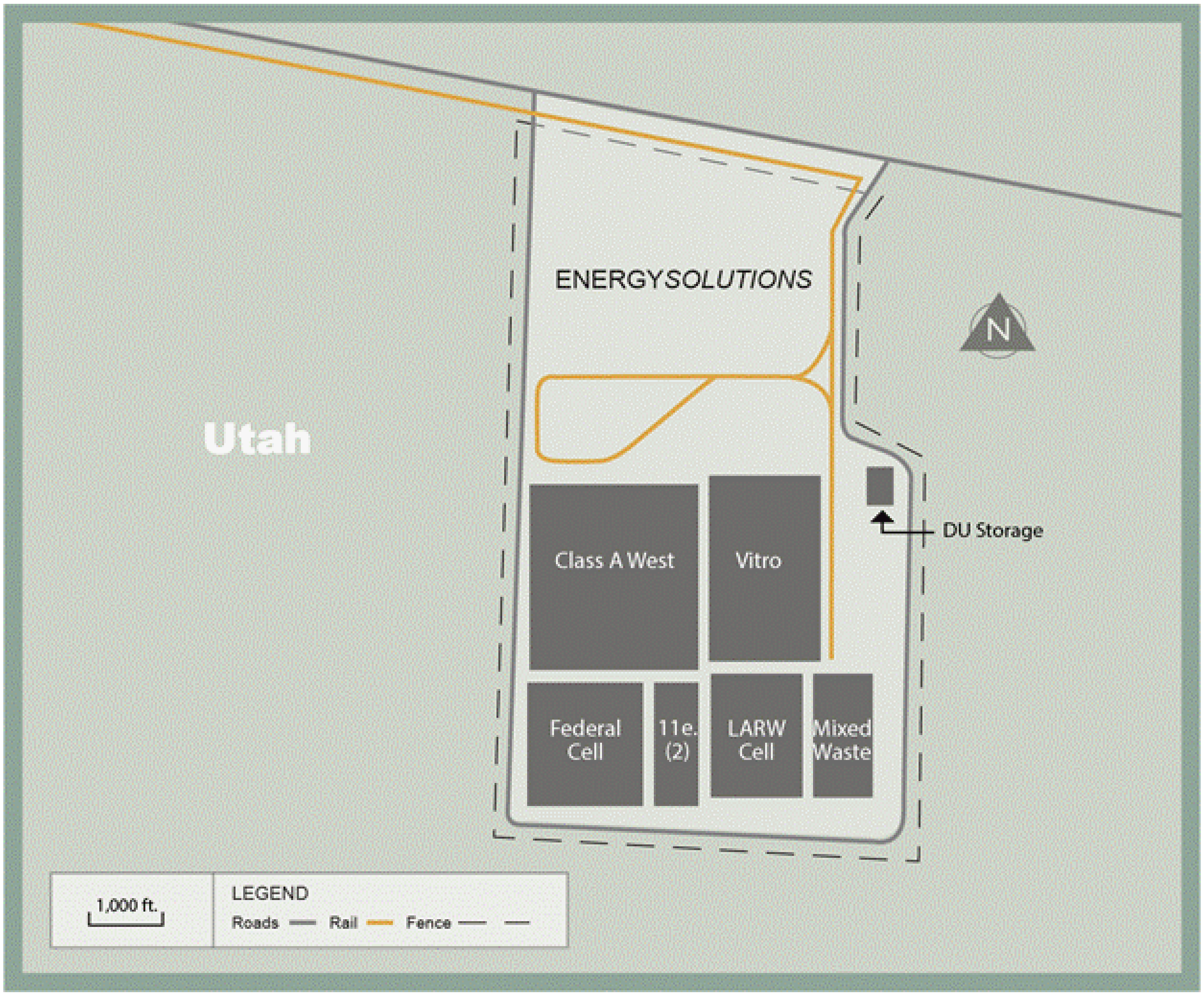

Figure 3-4 Energy*Solutions* Disposal Facilities (Source: ES 2015a)[37]

The disposal unit proposed by Energy*Solutions* to receive DU waste would be constructed separately from the disposal units for other wastes. The DU disposal unit would be located in the area labeled "Federal Cell" on Figure 3-4. This disposal unit has been partially constructed and would be completed following completion of the State regulatory review process for the proposed license amendment. The disposal unit is designed[38] to accept approximately 378,000 cubic yards (289,000 cubic meters) of DU (Shrum 2016a). The ultimate capacity of this disposal unit would depend on the quantities of DU waste that would be received from Paducah, Portsmouth, and other sources, and in accordance with any limits on waste acceptance imposed through the licensing and permitting process.

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[37] **Key:** 11e(2) = uranium processing byproduct waste; DU = depleted uranium; LARW = low-activity radioactive waste; Vitro = uranium mill tailings from the inactive Vitro Mill site located near Salt Lake City, Utah.

[38] The design of the disposal unit (designated the Federal Cell) has not been finalized and the final design features, including design capacity, are subject to change.

Table 3-27 Waste Management Services Provided at Energy*Solutions* Site

	Disposal Capacities		
		Disposal Capacity (cubic yards)	
Waste Types Accepted and Services	**Waste Type**	**Permitted**	**Remaining**
Accepts Class A LLW, Class A MLLW, 11e.(2) byproduct material, NORM waste, and NARM waste for disposal, and proposes to accept DU for disposal (a form of Class A LLW), principally in the form of DU oxide. Waste types include decommissioning debris, metal, soil and debris, PCBs, asbestos, and liquids. Treatment services include metal shredding, thermal desorption, oxidation/reduction, macro-encapsulation, chemical stabilization, mercury amalgamation, chemical stabilization, neutralization and deactivation, and debris spray washing. The facility can accept waste by truck and rail.	LLW	8,724,000	4,172,000 as of August 24, 2016
	DU	378,000 proposed	NA
	MLLW	1,353,000	358,000 as of August 24, 2016

Key: DU = depleted uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; NARM = naturally occurring and accelerator produced radioactive material; NORM = naturally occurring radioactive material; PCB = polychlorinated biphenyl.

Note: Capacities are rounded to the nearest thousand cubic yards.

Sources: ES 2015b, 2016a; Halstrom 2014; Shrum 2016a; PPPO 2018

In June 2010, the Utah Department of Environmental Quality (UDEQ) issued revised radioactive waste disposal regulations addressing disposal of DU at disposal facilities in Utah. These revised regulations require the preparation for review and approval of a performance assessment with a quantitative compliance period for comparison against regulatory dose limits for a minimum of 10,000 years, with additional qualitative analyses for the period of peak radiation dose. Energy*Solutions* then prepared a technical analysis to support a proposed license amendment to authorize disposal of DU at its Utah disposal facility and submitted the analysis and proposed amendment to UDEQ for review. Energy*Solutions* prepared several responses to UDEQ interrogatories with the final response submitted on April 2, 2018. The UDEQ review of the final responses is underway (ES 2018).

3.4 NATIONAL NUCLEAR SECURITY SITE

The NNSS is located on an 870,400-acre (352,200-hectare) parcel of land in southern Nevada, in the southern portion of Nye County, about 57 miles (92 kilometers) northwest of downtown Las Vegas (DOE 2013a; NNSS 2016) (**Figure 3-5**). The NNSS is surrounded by thousands of additional acres of land withdrawn from the public domain, creating an unpopulated area of nearly 6,500 square miles (16,830 square kilometers). The area around NNSS consists of sparsely vegetated basins or flats (Jackass Flats in the southwestern quadrant, Frenchman Flats in the southeastern quadrant, and Yucca Flats in the northwestern quadrant) and mountains separated by canyons (northeastern quadrant) (DOE 2013a).

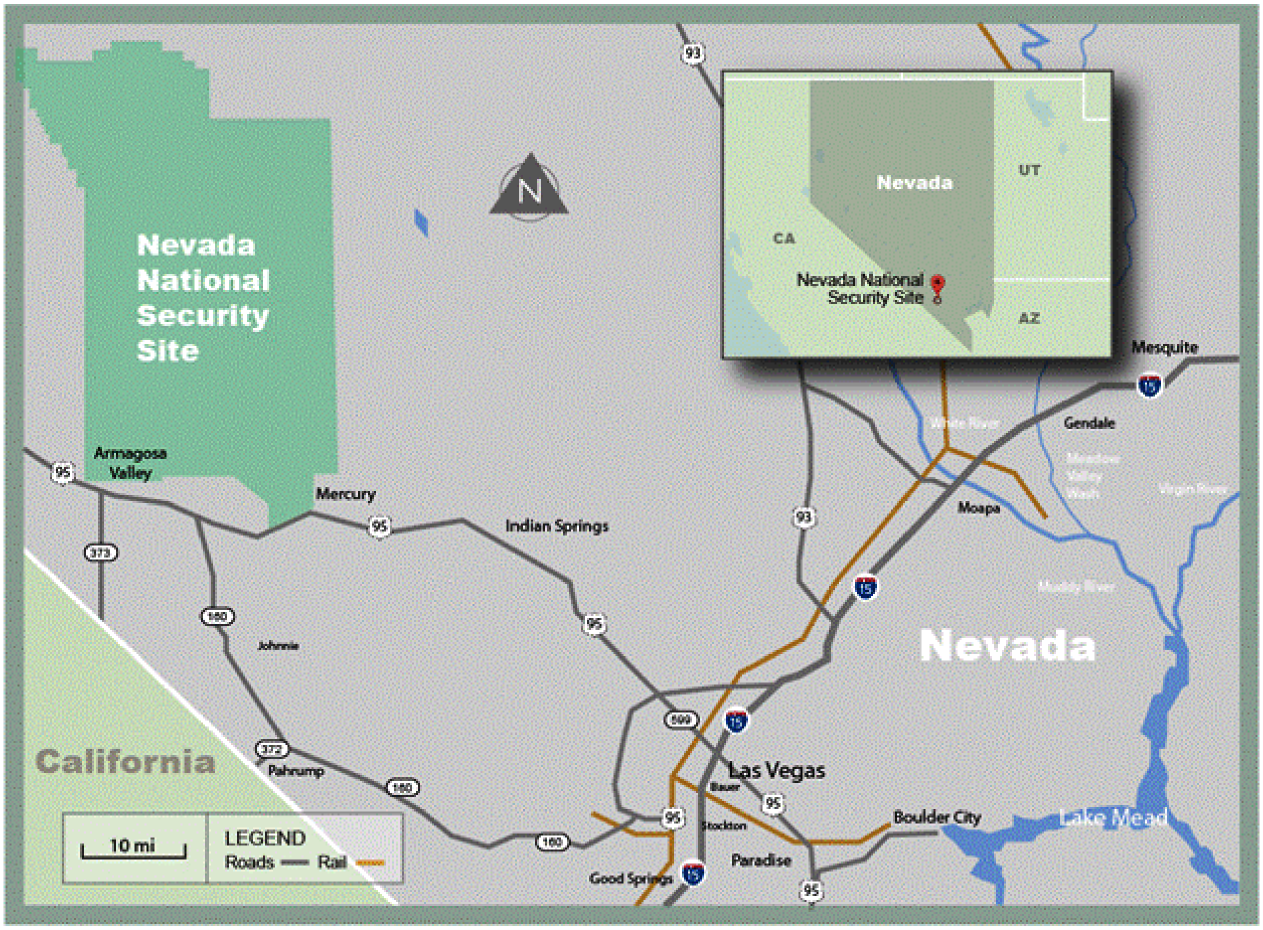

Figure 3-5 Nevada National Security Site Location

Most of the NNSS is located in the southwestern corner of the Great Basin Desert with a portion located in the Mojave Desert (southern third of the site). The NNSS is located in the rain shadow of the southern Sierra Nevada mountain range and has the general climatic characteristics of a mid-latitude desert area. From 1983 to 2002, average summer temperatures range from a maximum of 90 to 100°F (32 to 38°C) to a minimum of 55 to 70°F (13 to 21°C), while average winter temperatures range from a maximum of 50 to 60°F (10 to 16°C) to a minimum of 20 to 35°F (-6.7 to 1.7°C) (DOE 2013a). Annual average precipitation at the site varies from 5 inches (13 centimeters) to 13 inches (33 centimeters) depending on the elevation, with higher elevations receiving more precipitation. Precipitation falls most often during winter and early spring and during mid to late summer (DOE 2013a).

The region is characterized by complex stratigraphic and structural elements that combine Basin and Range faulted bedrock, Mesozoic thrust faults, volcanic uplands and calderas, and modern alluvial basins. These features overlay a basement complex of highly deformed Proterozoic- and Paleozoic-age sedimentary and metasedimentary rocks (DOE 2013a).

The NNSS is located within the Death Valley regional groundwater flow system, which encompasses approximately 16,000 square miles (41,400 square kilometers) of the Great Basin. The three primary hydrogeologic water-bearing units of the Death Valley regional groundwater flow system are grouped into three types of aquifers: basin-fill alluvium (alluvial aquifers), volcanic aquifers, and carbonate aquifers. Groundwater flow through these units is mainly controlled by faults and fractures with the flow system extending from the water table to a depth that may exceed 4,900 feet (1,490 meters) (DOE 2013a). The depth to groundwater at the NNSS varies from approximately 30 feet (9.1 meters) to more than 2,000 feet (610 meters). Most groundwater recharge occurs from precipitation and from interbasin underflow from upgradient areas. Groundwater is the only source of potable water at the NNSS and is withdrawn from deep wells installed in the alluvial, volcanic, and carbonate aquifers (DOE 2013a).

In 2010, Nye County had a total population of 43,945 people and a population density of 2.4 persons per square mile (0.93 persons per square kilometer) (Census 2015b). Because the land surrounding the NNSS is withdrawn from the public domain, there are no residents near the site. As of 2013, there were approximately 1,849 employees working at NNSS (DOE 2013a).

The NNSS can only accept waste by truck and has direct access to major highways in the region. The main entrance to the NNSS (Gate 100) is located on Mercury Highway, which originates at U.S. Route 95. There are other access points around the site; however, their use is restricted and they are usually barricaded. The NNSS has 640 miles (1,030 kilometers) of on-site roadways (340 miles [550 kilometers] of paved roads and 300 miles [480 kilometers] of unpaved roads) that are used to transport personnel and materials around the site (DOE 2013a).

NNSS is divided into numbered operational areas to facilitate management; communications; and distribution, use, and control of resources. Waste disposal currently occurs at the RWMC in Area 5, northwest of Frenchman Lake (**Figure 3-6**).[39] NNSS receives waste from DOE and DoD facilities throughout the United States; NNSS does not accept commercially generated waste (DOE 2013c). Operations at the Area 5 RWMC include LLW and MLLW examination, repackaging if necessary, and disposal; temporary hazardous and MLLW storage; treatment of some on-site generated MLLW before disposal; and temporary storage of in-state-generated TRU waste pending off-site shipment. The Area 5 RWMC covers about 740 acres (300 hectares) of land and is surrounded by a 1,000-foot- (300-meter-) wide buffer zone. The Area 5 RWMC includes several equipment storage yards, as well as structures that are used for offices, laboratories, utilities, and routine operations. The total area used to date for waste disposal, including operational disposal units, covers about 200 acres (80 hectares) (DOE 2013a).

LLW disposal at the Area 5 RWMC occurs in unlined pits while MLLW disposal occurs in lined pits permitted by the State of Nevada (DOE 2013c). A summary of the treatment and disposal services provided, and remaining waste disposal capacity, is provided as **Table 3-28**.

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[39] Another disposal area is located in Area 3 but is not accepting waste at this time. Currently, Area 3 is planned to open during 2018. As required, it would be used, subject to consultation with the State of Nevada, for disposal of wastes from environmental restoration and other activities at DOE/National Nuclear Security Administration sites within the state of Nevada.

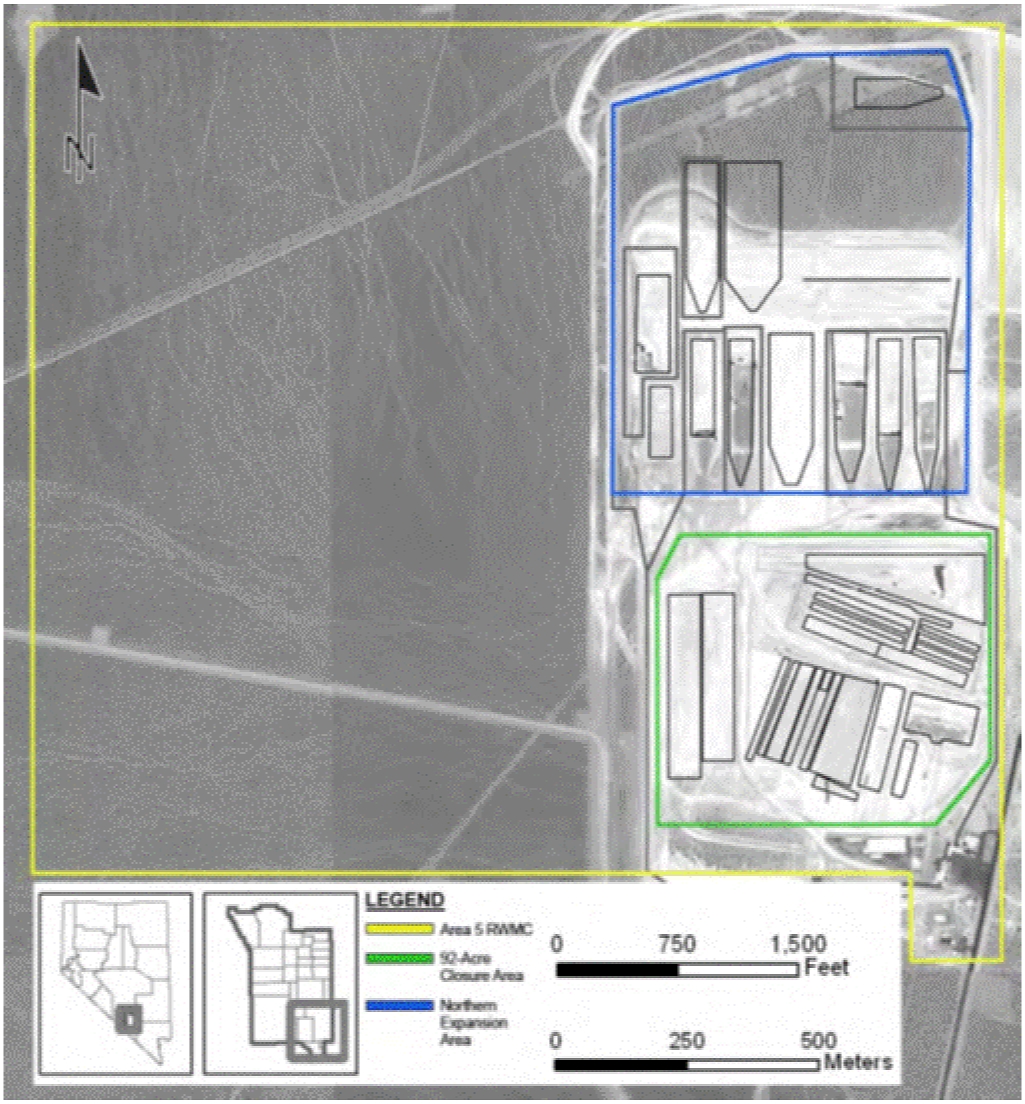

Figure 3-6 Nevada National Security Site Area 5 Radioactive Waste Management Complex (Source: DOE 2013a)

DOE has performed technical analyses (performance assessments) that address potential impacts far into the future and in support of disposal authorizations at NNSS by DOE pursuant to DOE Order 435.1. DOE Order 435.1 requires performance assessments that demonstrate compliance with prescribed radiation dose limits for a period of 1,000 years following disposal, along with sensitivity analyses that address peak doses that could occur beyond 1,000 years. In addition, DOE Order 435.1 requires analyses that demonstrate compliance with prescribed limits on the long-term gaseous release of radon-isotopes from LLW disposal facilities.[40] Approved analyses are

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[40] One of the principal concerns for disposal of large quantities of DU as waste is the long-term gaseous release of radon isotopes

summarized in the NNSS SWEIS (DOE 2013a). In 2012, DOE prepared an analysis addressing disposal of DU at NNSS (NSTec 2012). This analysis showed compliance with the DOE Order.

Table 3-28 Waste Management Services Provided at Nevada National Security Site

Waste Types Accepted and Services	Disposal Capacities	
	Waste Type	**Disposal Capacity (cubic yards)**
Accepts LLW and MLLW for disposal, including wastes containing or contaminated with asbestos or PCBs, from approved DOE waste generators. All MLLW must meet RCRA land disposal restrictions, prior to being shipped for disposal at NNSS. The NNSS RCRA permit does not include provisions for treatment of waste generated off-site. In DOE's December 30, 2014, ROD (79 FR 78421) for the NNSS SWEIS (DOE 2013a), DOE decided to pursue expanded waste management capabilities including storage of MLLW (received from on- and off-site [including out-of-state] generators) at the Area 5 RWMC pending treatment by micro- and macro-encapsulation (i.e., repackaging); and conduct sorting and segregation or bench-scale mercury amalgamation of MLLW, and/or disposal of this waste at the Area 5 RWMC, as appropriate. The facility can accept waste only by truck.	LLW	1,778,000[a]
	MLLW	148,000[a]

Key: LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; RCRA = Resource Conservation and Recovery Act; RWMC= Radioactive Waste Management Complex.

[a] In DOE's December 30, 2014, ROD (79 FR 78421) for the NNSS SWEIS (DOE 2013a), DOE decided to dispose of up to 1.78 million cubic yards (48 million cubic feet) of LLW and up to 148,000 cubic yards (4 million cubic feet) of MLLW at the NNSS Area 5 RWMC. As of April 2014, disposal units had been constructed providing about 237,000 cubic yards (6.4 million cubic feet) of disposal capacity.

Note: Capacities are rounded to the nearest thousand cubic yard.

Sources: DOE 2013a; Gordon 2014

3.5 WASTE CONTROL SPECIALISTS LLC

Waste Control Specialists LLC (WCS) owns a 14,000-acre (5,670-hectare) property in western Texas, in the northwestern portion of Andrews County, about 30 miles (50 kilometers) west of the City of Andrews on the border between Texas and New Mexico (**Figure 3-7**). The waste management facility encompasses 1,338 acres (541 hectares) of the WCS site (WCS 2016a, 2016b).

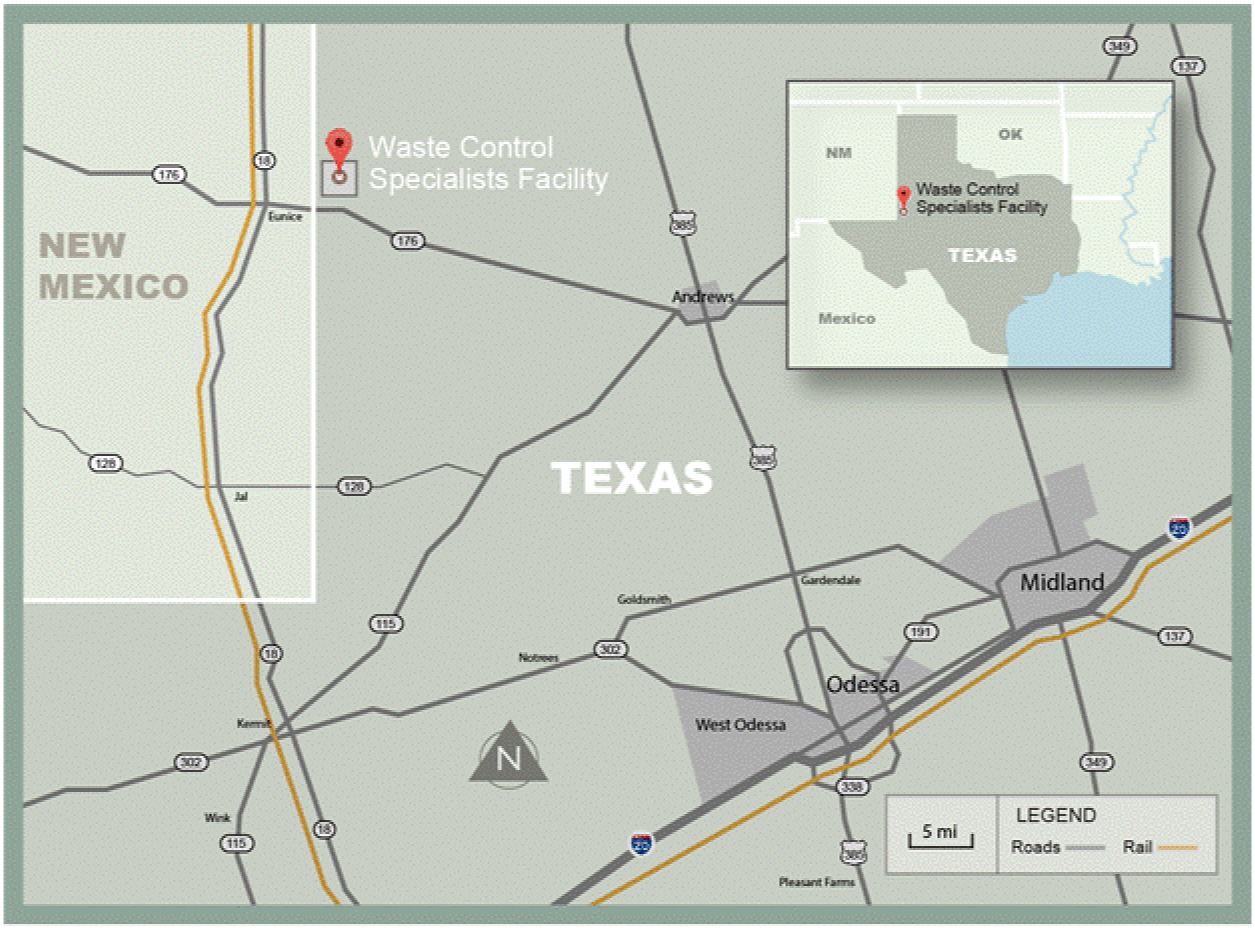

Figure 3-7 Waste Control Specialists Site Location

The WCS site is located in a semi-arid continental climate. From 1962 to 2010 in Andrews County, the annual average temperature was 63°F (17°C), with July the hottest month (average temperature of 81°F [27°C]) and January being the coldest month (average temperature of 44°F [6.7°C]) (WRCC 2016). The Western Regional Climate Center records indicate that the average annual precipitation is approximately 15 inches (38 centimeters), primarily as rain, with a low of 2.0 inches (5.1 centimeters) in 2011 and a maximum of 32 inches (82 centimeters) in 1941 (WRCC 2016, WCS 2016a). Precipitation is relatively evenly distributed throughout the year but is somewhat higher in spring and summer than in winter and fall. Snowfall in Andrews County averages 3.3 inches (8.4 centimeters) per year, typically occurring from November to February (WRCC 2016).

The WCS site is located on the southwestern edge of the Southern High Plains (DOE 2011) on a gently southeastward-sloping plain with a natural slope of approximately 8 to 10 feet (3.4 to 3.0 meters) per mile. Soils primarily consist of well-drained, fine sandy loam and fine sand underlain by gravelly loam and cemented material (WCS 2016a).

Groundwater occurs in two principal aquifer systems in the vicinity of the WCS site: the High Plains Aquifer and the Dockum Aquifer (DOE 2011). The High Plains Aquifer of west Texas, the principal aquifer in west Texas, consists of water bearing units within the Tertiary Ogallala

Formation and underlying Cretaceous rocks. The Ogallala Formation, if present, is not water bearing in the WCS-permitted area. The Cretaceous Antlers Formation has been identified in the subsurface immediately below the WCS site; however, it is unsaturated but for a few isolated perched lenses. The shallowest water-bearing zone is about 225 feet (69 meters) deep at the site. The nearest downgradient drinking water well is approximately 6.5 miles (10 kilometers) to the east of the site (WCS 2016a).

In 2010, Andrews County had a total population of 14,786 people and a population density of 9.9 persons per square mile (3.8 persons per square kilometer) (Census 2015c). The nearest population center is Eunice, New Mexico, located approximately 6 miles (10 kilometers) west of the WCS site (DOE 2011). Andrews, Texas, is located approximately 30 miles (50 kilometers) to the east of the site (WCS 2016a). As of 2015, there were approximately 204 employees working on site, with approximately 50 percent of the site employees living in Texas and 50 percent living in New Mexico (WCS 2015).

The WCS site can accept waste by truck and rail and has direct access to major highway and rail systems in the region. Vehicular access to the site is provided by Interstate 20 to Highway 176 from the east and by U.S. Highway 62 to Highway 176 from the west. Rail access to WCS is provided by a rail system that is owned and operated by the Texas-New Mexico Railroad (GE 2009). The Texas-New Mexico Railroad connects to the WCS rail system that travels around the perimeter of the site.

The WCS site is licensed and permitted by the State of Texas for disposal of LLW, MLLW, hazardous waste, and byproduct material (**Figure 3-8**). Disposal operations include the following (WCS 2016c):

- **Compact Waste Facility** – Licensed to dispose of LLW generated by State Compacts formed pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985.
- **Federal Waste Facility (FWF) –** Licensed and permitted to dispose of LLW and MLLW generated by the Federal Government.
- **Hazardous Waste Facility –** Permitted to dispose of hazardous waste as defined by the RCRA, toxic waste such as PCBs and asbestos as defined by TSCA, and exempted low-activity radioactive waste.[41]
- **Byproduct Disposal Facility –** Licensed to dispose of 11e(2) byproduct material.

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[41] Exempted low-activity radioactive waste contains less than 10 percent of the Class A limits as defined by the NRC in 10 CFR Part 61.

Figure 3-8 Waste Control Specialists LLC Waste Management Facilities (Source: WCS 2016d)

Waste disposal typically occurs in large disposal units with multilayer liner systems totaling about 7 feet (2 meters) thick and consisting of layers of clay, geosynthetic material, and concrete. The planned final covers for the disposal units would be up to 45 feet (14 meters) thick and consist of layers of concrete, clay, soil, sand, and rock, topped by an evapotranspiration layer. The depth to the waste would be at least 25 feet (7.6 meters) below the final ground surface (WCS 2016d, 2016e).

In addition, the WCS site is authorized to process and store a variety of wastes, as well as for the non-thermal treatment of radioactive and nonradioactive wastes. For example, WCS is capable of storing greater-than-Class C LLW, TRU waste, sealed sources, and byproduct material, and provides a variety of waste treatment services. A summary of the treatment, storage, and disposal services provided, and remaining waste disposal capacity, is provided as **Table 3-29**. DU oxide from Paducah and Portsmouth would be disposed of in the FWF.

Table 3-29 Waste Management Services Provided at Waste Control Specialists Site LLC

Waste Types Accepted and Services	Disposal Capacities		
	Waste Type	Disposal Capacity (cubic yards)	
		Permitted	Remaining
Accepts LLW, MLLW, hazardous waste and 11e(2) byproduct material for disposal. Treatment services include chemical oxidation/reduction, deactivation, micro- and macro-encapsulation, neutralization, stabilization, controlled reaction, stabilization, shredding, repackaging, and dewatering. Accepts LLW, TRU waste, sealed sources, byproduct material, and RCRA/TSCA waste for storage. The site can accept waste by truck and/or rail.	LLW and MLLW (in the FWF)	963,000	956,000 as of March 2018

Key: LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; RCRA = Resource Conservation and Recovery Act; TRU = transuranic; TSCA = Toxic Substances Control Act.

Note: Capacities are rounded to the nearest thousand cubic yards.

Sources: WCS 2014a, 2016d

As discussed in Section 3.1, in recent years, federal and state regulators have reviewed existing LLW disposal requirements for DU, which is classified as Class A LLW. The TCEQ required that WCS prepare a technical analysis specifically addressing the potential long-term impacts that could result from disposal of DU at WCS. In August 2014, informed by the required technical analysis (performance assessment) prepared by WCS which addressed the radiological impacts that could occur over a 1-million-year period following waste disposal, TCEQ approved an amendment to the LLW disposal license providing WCS authority to dispose of DU (WCS 2014b).

4. ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This chapter discusses the potential impacts on the environment, including impacts on workers and members of the general public, under the No Action Alternative for the long-term storage of DU oxide at Paducah and Portsmouth (Section 4.1) and the Action Alternatives for disposal of DU oxide at Energy*Solutions* near Clive, Utah (Section 4.2), NNSS in Nye County, Nevada (Section 4.3), and WCS near Andrews, Texas (Section 4.4). The alternatives are described in Chapter 2. This chapter also describes the potential cumulative impacts of the alternatives (Section 4.5), potential mitigation measures (Section 4.6), unavoidable adverse impacts of the alternatives (Section 4.7), irreversible and irretrievable commitments of resources (Section 4.8), the relationship between short-term use of the environment and long-term productivity (Section 4.9), and pollution prevention and waste minimization (Section 4.10).

The impacts assessment methodologies and assumptions are described in Chapter 4 and Appendix F of the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site* (Paducah EIS) (DOE 2004a), and the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site* (Portsmouth EIS) (DOE 2004b) (referred to collectively as the 2004 EISs). Changes from the 2004 EISs' impact assessment methodologies and assumptions are described in this chapter and related appendixes.

This DU Oxide SEIS does not reevaluate the impacts of storage of DUF_6 cylinders, conversion of DUF_6 to DU oxide, or the management and disposition of HF. These activities were evaluated in the 2004 EISs (DOE 2004a, 2004b) and decisions announced in the associated RODs (69 FR 44654; 69 FR 44649). The impacts of these activities are considered as part of potential cumulative impacts (Section 4.5).

4.1 NO ACTION ALTERNATIVE

As described in Chapter 2, Section 2.2.1 of this Draft DU Oxide SEIS, under the No Action Alternative, DU oxide would be stored at Paducah and Portsmouth and would not be disposed of as LLW. The empty and heel cylinders, CaF_2, and ancillary LLW and MLLW would be shipped to off-site disposal facilities.

4.1.1 Impacts at Paducah and Portsmouth

For purposes of analysis, the duration of the No Action Alternative at Paducah and Portsmouth is 100 years beginning with storage of the first DU oxide containers in 2011 and ending in 2110.[42]

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[42] Storage under the No Action Alternative could extend beyond the 100 years analyzed in this DU Oxide SEIS. Storage for longer than 100 years would not change the maximum reasonably foreseeable annual impacts of operations, but would extend the impacts described in this DU Oxide SEIS further out in time. The contributions attributable to those facilities to total life-cycle impacts, such as those for total worker and population dose and LCFs, and total waste generation, would increase in proportion to the extended period. These impacts can be

Based on the rate of conversion of DUF_6 to DU Oxide, and the current inventory of DUF_6, DOE believes that conversion activities will be completed and the last DU oxide produced, between 2044 and 2054 at Paducah and 2032 and 2042 at Portsmouth (PPPO 2018).

The long-term storage of DU oxide containers are considered under the No Action Alternative. Long-term storage includes monitoring and maintenance of the containers, and repair of any containers that are damaged or breached during the storage period.

4.1.1.1 Site Infrastructure

Impacts on infrastructure at Paducah and Portsmouth could occur from new construction or changes in operations. Under the No Action Alternative, there would be no new construction and no substantial change in DU container storage and maintenance activities at Paducah and Portsmouth, and therefore, no adverse impacts on site infrastructure. There would be adequate capacity to store all the DU oxide containers and therefore no adverse impacts on the storage infrastructure.

As shown in **Table 4-1**, the utility infrastructure needs for storage and maintenance of DU oxide containers under the No Action Alternative would be small when compared to current use and site capacity. Therefore, impacts on the utility infrastructure at both Paducah and Portsmouth would be minor.

Table 4-1 Infrastructure Comparison for the No Action Alternative

Resource	Paducah			Portsmouth		
	No Action Alternative[a]	Current Use[b]	Capacity[b]	No Action Alternative[a]	Current Use[c]	Capacity[c]
Electricity	0.167 MWh	7 to 12 MWh [d]	3,040 MW	0.167 MWh	20 to 40 MWh	2,260 MW
Water (mgd)	0.23	3.4	30 to 32 [e]	0.073	1.9	4 to 13
Natural gas (mcf/year)	Minimal	154,000	876,000 [f]	Minimal	366,000	NR
Steam (lbs/hour)	Minimal	100,000 [g]	135,000	Minimal	26,835 [h]	84,000

Key: gal = gallons; lbs = pounds; mcf = million cubic feet; mgd = million gallons per day; MW = megawatt; MWh = megawatt hours; NR = not reported.

[a] Usage estimates from PPPO 2018, unless otherwise noted.

[b] Paducah current use and capacity from Chapter 3, Section 3.1.1, unless otherwise noted.

[c] Portsmouth current use and capacity from Chapter 3, Section 3.2.1, unless otherwise noted.

[d] Soaurce: DOE 2012

[e] Peak withdrawal reported in DOE 2012.

[f] Annual natural gas capacity is calculated based on an hourly capacity of 100 mcf per hour.

[g] Current use of steam is identified as an estimate of demand.

[h] Use estimate is an extrapolation of hourly use based on reported annual use of 235 million pounds per year.

Note: To convert gallons to liters multiply by 3.785.

The container storage and maintenance activities and loading of wastes at Paducah and Portsmouth for transport to a disposal facility would consume minimal amounts of water and electricity.

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estimated from the analyses provided in this DU Oxide SEIS under the No Action Alternative by multiplying the additional years of operation by the annual impacts.

Support vehicles (i.e., cars and light trucks) at each site are expected to use 2,080 gallons per year (7,870 liters per year) of gasoline. Waste package handling is expected to use 15,600 gallons per year (59,050 liters per year) of diesel fuel at both Paducah and Portsmouth. Fuel consumed by support vehicles and container loading equipment would be supplied by off-site sources and would not adversely affect the infrastructure at Paducah or Portsmouth.

Table 4-2 presents a summary of the potential off-site shipments from the Paducah and Portsmouth Sites. This table does not include the small number of shipments of ancillary LLW and MLLW (one shipment per year from both Paducah and Portsmouth),but does include the option of shipping CaF_2 (converted from HF) off site for disposal. This table shows an annual maximum of 1,080 truck or 243 rail shipments from Paducah and 742 truck or 158 rail shipments from Portsmouth. Assuming 250 shipping days per year, this equates to 4 daily truck or 1 rail shipments from Paducah, and 3 truck or 1 rail shipments from Paducah per working day. Therefore, the loading of wastes and off-site shipments using either truck or rail, would not require new construction or changes in infrastructure at Paducah and Portsmouth, and would likely result in minor impacts on the transportation infrastructure at Paducah and Portsmouth.

Table 4-2 Summary of Off-Site Shipments Under the No Action Alternative

Location		Container Type and Estimated Number of Shipments[a]				Maximum Total Shipments	
		14,000 Intact Empty and Heel Cylinders[b]		CaF_2 in Bulk Bags Option[c]			
		Truck	Rail	Truck	Rail	Truck	Rail
Paducah	Total	4,240	140	32,400	8,100	36,700	8,250
	Annual	125	4	953	238	1,080	243
Portsmouth	Total	2,760	90	13,600	3,390	16,300	3,480
	Annual	125	4	616	154	742	158

[a] Estimates of annual truck, rail and total shipments are based on total number of shipments divided by the number of years of conversion facility operation, in this case, 34 years for Paducah and 22 years for Portsmouth. Use of the shorter timeframe for completion of conversion operatons would result in the most conservative estimate of annual impacts, as the total impacts would be spread across fewer years.

[b] The 14,000 empty and heel cylinders would be shipped intact, two per truck or six per rail gondola, 10 gondolas per train.

[c] The CaF_2 in bulk bags would be shipped one per truck or four per train.

Notes: Shipment numbers are derived from PPPO (2018) or calculated based on the assumptions described in the table notes.

4.1.1.2 Air Quality, Climate, and Noise

This DU Oxide SEIS generally follows the methodologies described in the 2004 EISs (DOE 2004a, 2004b) for the air quality and noise analysis. The 2004 EISs did not evaluate greenhouse gas (GHG) emissions and the effects of climate change. This DU Oxide SEIS evaluates potential climate change impacts in terms of context and intensity as defined in 40 CFR 1508.27. This requires the analysis of significance of the action with respect to the setting of the Proposed Action and the severity of the impact.

Impacts on air quality and climate change could occur from the combustion of fossil fuels associated with DU oxide storage and maintenance activities. These activities would involve no construction and little painting or other industrial processes requiring fossil fuel combustion or other emissions of criteria air pollutants or GHGs above those from normal daily operations. In addition, there would be no routine releases of hazardous air pollutants.

The vehicles and equipment used for loading of wastes at Paducah and Portsmouth for truck or rail transport to a disposal facility would emit air pollutants. Support vehicles (i.e., cars and light trucks) at each site are expected to use 2,080 gallons per year (7,870 liters per year) of gasoline. Waste package handling is expected to use 15,600 gallons per year (59,050 liters per year) of diesel fuel at both Paducah and Portsmouth. Annual emissions of criteria pollutants produced by consumption of this fuel would be similar to ongoing cylinder yard activities at Paducah and Portsmouth, and would result in minimal impacts on air quality.

Further, container storage and maintenance and waste loading activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, little painting, and little or no increase in other activities above normal daily operations that would contribute to the noise environment. Therefore, potential impacts on air quality, climate, and noise at both Paducah and Portsmouth would be minor.

In addition, container storage and maintenance and truck- and rail-loading activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be little or no increase above current daily operations that would contribute to the noise environment. Off-site shipments via rail could increase by one shipment per day per site, and truck shipments could increase by three or four per day (see Section 4.1.1.1). This increase is unlikely to be perceptible on public roadways and existing railways in comparison to existing traffic in the region around the sites and the millions of annual shipments already occurring on public highways (3.68 million trucks travelling 2.74 billion miles annually [ATA 2018]) and railways. Therefore, because the increase is small and would occur in areas, roads, and/or railways already used for these purposes, potential impacts on noise levels near Paducah and Portsmouth would be minor.

4.1.1.3 Geology and Soil

Impacts on geology and soils could occur from the disturbance or use of geologic and soil materials, and from contamination by radioactive or hazardous materials via air or water borne pathways. Container storage and maintenance and waste loading activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, no use of geologic and soils materials, and no routine releases of DU oxide or hazardous materials. Soil contaminated by the release of uranium oxide from a potential cylinder breach would be removed, packaged, and disposed of at an off-site radioactive waste disposal facility. In addition, the release of uranium from a potential cylinder breach was evaluated in the 2004 EISs and found to result in soil concentrations considerably below the U.S. Environmental Protection Agency (EPA) health-based value for residential exposure (DOE 2004a, 2004b). Therefore, potential impacts on geology and soils would be minor at both Paducah and Portsmouth.

4.1.1.4 Water Resources

Impacts on water resources could occur from changes in water use, surface water discharge, groundwater recharge, or impacts on surface water or groundwater quality due to contamination by radioactive or hazardous materials associated with long-term container storage and maintenance, waste loading, or a potential container breach. Under the No Action Alternative, container storage and maintenance and waste loading activities would occur within the industrialized areas of both Paducah and Portsmouth in areas outside the 100-year floodplain.

Primary impacts to floodplains in 2004 were expected to be related to construction of the conversion facilities. The ongoing operational, storage and maintenance, and transportation-related activities are not appreciably different than in 2004, and these activities had negligible impact, as shown in the 2004 EISs and *Floodplain/Wetland Assessment of the Effects of Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah Kentucky Site* (Floodplain/Wetland Assessment) (ANL 2004a). At that time, DOE determined that a floodplain assessment was not required for Portsmouth because the site was outside maximum historic flooding levels (see Chapter 3, Section 3.2.4 of this SEIS). Therefore, no additional floodplain assessment is necessary.

There would be no construction, no increases in water use and wastewater discharge, no change to groundwater recharge, and no routine releases of DU oxide or hazardous materials. As described in Section 4.1.1.1, Table 4-1, water usage under the No Action Alternative would be 0.23 million gallons per day (0.87 million liters per day) at Paducah and 0.073 million gallons per day (0.28 million liters per year) at Portsmouth. This is a small percentage of the daily water use of 3.4 million gallons (13 million liters) at Paducah and 1.9 million gallons (7.2 million liters) at Portsmouth. Therefore, potential impacts on water resources at both Paducah and Portsmouth would be minor.

Potential impacts on surface and groundwater quality as a result of a DU release associated with a potential container breach was evaluated in the 2004 EISs. For both Paducah and Portsmouth, impacts on surface water and groundwater quality from hypothetical releases of uranium would result in uranium concentrations below radiological benchmark levels (i.e., Safe Drinking Water Act maximum contaminant levels) (DOE 2004a, 2004b).

4.1.1.5 Biotic Resources

Impacts on biotic resources could occur from removal or degradation of vegetation, wildlife habitats, wetlands, and federal and state-listed species, and contamination by radioactive or hazardous materials via air or water borne pathways. Container storage and maintenance and waste loading activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction and no routine releases of DU oxide or hazardous materials. Container storage and maintenance and waste-loading activities would not disturb wetlands, sensitive habitats, or threatened, endangered, or sensitive species. Therefore, potential impacts on biotic resources would be minor at both Paducah and Portsmouth. Primary impacts to wetlands in 2004 were expected to be related to construction of the conversion facilities. The ongoing operational, storage and maintenance, and transportation-related activities are not appreciably different than in 2004, and these activities had negligible impact as shown in the 2004 EISs and the Paducah Floodplain/Wetland Assessment (ANL 2004a), and *Wetland Assessment of the Effects of Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site* (ANL 2004b). Therefore, no additional wetlands assessment is necessary.

Potential impacts on biotic resources due to a potential container breach were evaluated in the 2004 EISs. At both Paducah and Portsmouth, groundwater uranium concentrations from such a release could exceed ecological screening values for water. However, most plants and animals would not have direct access to the groundwater and contaminants in the groundwater discharging to a surface water body, such as a stream or river, are likely to be quickly diluted to negligible concentrations (DOE 2004a, 2004b).

4.1.1.6 Public and Occupational Safety and Health

Rem – A unit of radiation dose used to measure the biological effects of different types of radiation on humans. The dose in rem is estimated by a formula that accounts for the type of radiation, the total absorbed dose, and the tissues involved. One thousandth of a rem is a millirem.

Person-rem – A unit of collective radiation dose applied to a population or group of individuals. It is calculated as the sum of the estimated doses, in rem, received by each individual of the specified population. For example, if 1,000 people each received a dose of 1 millirem, the collective dose would be 1 person-rem (1,000 persons×0.001 rem).

Latent cancer fatalities (LCFs) – Deaths from cancer resulting from and occurring sometime after exposure to ionizing radiation or other carcinogens. This supplemental environmental impact statement focuses on LCFs as the primary means of evaluating health risk from radiation exposure. A risk factor of 0.0006 LCF per person-rem or rem is used, consistent with DOE guidance (DOE 2003b). The values reported for an LCF are (1) the increased risk of an MEI or other individual developing a fatal cancer, or (2) the number of LCFs projected to occur in an identified population. For a population, if the calculated LCF value is less than 0.5, the number of LCFs is reported as zero.

This section presents radiological impacts on workers and the public from normal operations and postulated accidents at Paducah and Portsmouth, as well as impacts from potential chemical exposures and accidents and intentional destructive acts. This DU Oxide SEIS generally follows the methodology described in the 2004 EISs (DOE 2004a, 2004b) with two primary differences. The 2004 EISs used risk factors of 0.0004 LCF per person-rem of exposure for workers and 0.0005 LCFs per person-rem of exposure for members of the general public. This DU Oxide SEIS uses a more conservative risk factor of 0.0006 LCF per person-rem for both workers and the public, consistent with current DOE guidance (DOE 2003). In addition, this DU Oxide SEIS uses updated population data from the 2010 Census.

Health risks are considered for involved and noninvolved workers, the off-site population, and a maximally exposed individual (MEI).[43] Workers and members of the public are protected from exposure to radioactive material and hazardous chemicals by facility design and administrative procedures. Major DOE design criteria include those in DOE Order 420.1C, Change 2 "*Facility Safety*," and DOE Order 430.1C, "*Real Property Asset Management*." DOE regulation 10 CFR Part 830, "*Nuclear Safety Management*," requires documented safety analyses and technical safety requirements that provide the safety basis and controls for facility design and operation. Other regulations and DOE directives include 10 CFR Part 820, "*Procedural Rules for DOE Nuclear Facilities*," DOE Order 458.1, Change 3 "*Radiation Protection of the Public and the Environment*," 10 CFR Part 835, "*Occupational*

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[43] An involved worker is directly or indirectly involved with operations at a facility who receives an occupational radiation exposure from direct radiation (i.e., neutron, x-ray, beta, or gamma) or from radionuclides released to the environment from normal operations. A noninvolved worker is a site worker outside of a facility who is unlikely to be subjected to direct radiation exposure, but could be exposed to emissions from that facility, particularly during postulated accidents. The off-site population comprises members of the general public living within 50 miles (80 kilometers) of a facility. The maximally exposed individual (MEI) is a hypothetical member of the public at a location of public access that would result in the highest exposure, which is assumed to be at the site boundary during normal operations and postulated accidents.

Radiation Protection," and 10 CFR Part 851, "*Worker Safety and Health Program*." See Chapter 5 for more information on health and safety requirements.

To protect the public from impacts from radiological exposure, DOE Order 458.1 imposes an annual individual dose limit to members of the public of 10 millirem from airborne pathways, 4 millirem from the drinking water pathway, and 100 millirem total from all pathways. Public doses from all pathways must be maintained to achieve ALARA goals. To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year and maintained to achieve ALARA goals (DOE 2017g).

Nonradiological public health impacts may occur primarily through inhalation of air containing hazardous chemicals released to the atmosphere; risks from other pathways such as ingestion of contaminated drinking water are generally lower. Impacts are minimized through design, construction, and administrative controls that limit hazardous chemical releases to the environment and achieve compliance with National Emissions Standards for Hazardous Air Pollutants and National Pollutant Discharge Elimination System requirements. The effectiveness of these controls is verified through the use of environmental monitoring information and inspection of mitigation measures.

Nonradiological impacts on workers at Paducah and Portsmouth could occur through exposure to hazardous materials by inhaling contaminants in the workplace atmosphere or by direct contact. Workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, materials substitution, and engineering and management controls. They are also protected by adherence to federal and state laws, DOE orders and regulations, and OSHA and EPA guidelines. Monitoring that reflects the frequency and quantity of chemicals used in the operational processes ensure that these standards are not exceeded. DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

Public Safety and Health Under Normal Operations

Containers of DU oxide emit very low levels of gamma and neutron radiation, resulting in a dose rate of about 2 millirem/hour at 30 centimeters (PPPO 2016). Public health impacts could result from the release of DU oxide due to container breaches. The uranium could be transported through the environment as an airborne release or as a groundwater or surface water release. As indicated in Chapter 2, Section 2.2.1, the numbers of DU oxide cylinder breaches have been estimated based on two scenarios. The more conservative "uncontrolled corrosion" scenario assumes that the historical rate of breaches would continue throughout the duration of the No Action Alternative. In the second "controlled corrosion" scenario, improved storage conditions are assumed to result in lowered breach rates. No new cylinder breaches have occurred at Paducah and Portsmouth since improved storage conditions have been implemented (PPPO 2018).

The 2004 Paducah EIS and the 2004 Portsmouth EIS (DOE 2004a, 2004b) estimated the public health impacts from the storage of DUF_6 at Paducah and Portsmouth. After conversion, any exposure to stored uranium would be from DU oxide. The chemical form of the uranium does not appreciably impact the radiological characteristics of the material. Therefore, the dose estimates from the 2004 EISs for DUF_6 were used in this DU Oxide SEIS to estimate the effects of exposure to DU oxide.

The 2004 Paducah EIS (DOE 2004a) estimated that if all DU annually assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.008 person-rem. When scaled for the increased number of cylinders being stored under the No Action Alternative, this results in an annual population dose of 0.01 person-rem.[44] For the 100 years of DU oxide storage assumed for the No Action Alternative, this population dose rate would correspond to a total population dose of 1.0 person-rem. This population dose would result in an estimated 0 (6×10^{-4}) LCF,[45] indicating that there is a very small likelihood, 1 chance in about 1,700, of an additional cancer fatality in the general population. For comparison, the average natural background radiation level in the United States is 310 millirem per year; this means that during the 100 years of DU oxide storage, the population within 50 miles of Paducah would receive a background dose of 16 million person-rem based on a population of 534,000 (DOE 2017c). The population dose associated with natural background radiation could result in an estimated 9,600 LCFs.

The 2004 Portsmouth EIS (DOE 2004b) estimated that if all DU annually assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.002 person-rem. For the 100 years of DU oxide storage assumed for the No Action Alternative, this population dose rate would correspond to a total population dose of 0.2 person-rem.[46] This population dose would not be expected to result in any LCFs in the general population. At a calculated value of 1×10^{-4} LCF, there would be 1 chance in 10,000 of an additional cancer fatality in the general population. For comparison, over the same period, the 677,000 people (DOE 2017c) living within 50 miles of Portsmouth would receive a background dose of 21 million person-rem. The population dose associated with natural background radiation could result in an estimated 12,600 LCFs.

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[44] The annual number of cylinder breaches assumed in this DU Oxide SEIS (Table 2-2) for Paducah is higher than that assumed in the 2004 EIS for storage of uranium hexafluoride (approximately 14 versus 11 breaches per year for the conservative case and 1.14 versus 0.9 breaches per year for the improved storage condition scenario). This scaling is required due to the larger number of cylinders assumed to be stored in this DU Oxide SEIS versus the 2004 Paducah EIS. Estimates for population doses at Paducah from the 2004 EIS (DOE 2004a) are scaled up by 25 percent to account for the greater number of breaches and corresponding increase in the amount of uranium released per year assumed in this DU Oxide SEIS.

[45] A latent cancer fatality (LCF) is a death from cancer resulting from and occurring sometime after exposure to ionizing radiation or other carcinogens. This DU Oxide SEIS focuses on LCFs as the primary means of evaluating health risk from radiation exposure. A risk factor of 0.0006 LCFs per person-rem or rem is used, consistent with DOE guidance (DOE 2003).

[46] The annual number of cylinder breaches assumed in this DU Oxide SEIS (Table 2-2) for Portsmouth is similar to that assumed in the 2004 EIS for the storage of uranium hexafluoride (approximately 1.9 per year for the conservative case and 0.4 per year for the improved storage condition scenario). This number of cylinders assumed to be stored in this DU Oxide SEIS is within 10 percent of that assumed in the 2004 Portsmouth EIS and the breach rates developed in the 2004 EISs are used in this DU Oxide SEIS. Therefore, no scaling of the estimates for population doses from the 2004 EIS (DOE 2004a) were performed for this DU Oxide SEIS.

The Paducah Annual Site Environmental Report for mentions that the effective dose potentially received by a member of the public passing through accessible portions of the Paducah Site would likely be 4.24 millirem/year in a scenario where areas of highest exposure are visited 80 hours/year" (DOE 2017c). Measurements at one of the locations used in developing this estimate of a direct radiation dose are from monitors located just outside the controlled (security fenced) area near the cylinder yards. The Paducah Annual Site Environmental Report also states "Because security protocols prohibited the public from gaining prolonged access to the Paducah Gaseous Diffusion Plant (GDP) boundary fence in CY 2016, the potential radiation doses calculated at or in close proximity to the fence are not realistic." However unrealistic, this estimate has been included to produce a conservative estimate of the MEI dose from cylinder storage. The MEI doses identified in the 2004 Paducah EIS (DOE 2004a) resulted from cylinder breaches and were approximately 0.1 millirem per year from airborne releases of uranium and less than 0.5 millirem per year from ingestion of contaminated water. Scaling for the increase in the annual cylinder breach rate (see footnote 43), the combined doses would correspond to an MEI dose of approximately 0.75 millirem per year from potential cylinder breaches. Assuming, conservatively, that the same individual receives all of the MEI doses, combining the direct radiation dose from the Annual Site Environmental Report and the 2004 EIS results in an MEI dose of less than 5.0 millirem per year. These doses are well below regulatory limits established by EPA and DOE for radiation exposure to a member of the public. EPA has set radiation dose limit to a member of the general public of 10 millirem per year from airborne sources (40 CFR Part 61). In DOE Order 458.1, DOE established a limit on the dose to a member of the public of 100 millirem per year from all sources combined. The 5.0 millirem per year dose to the MEI results in an incremental increase in an annual risk of an LCF for this individual of 3×10^{-6}, or 1 chance in about 330,000 of an LCF. Although it is extremely unlikely that the same individual would be the MEI every year over the 100 years of DU oxide storage, the total dose during this period would be 500 millirem. The likelihood of the individual receiving this MEI dose during that period and contracting an LCF is less than 1 chance in about 3,300 (calculated risk of 3×10^{-4} LCF).

The Portsmouth Annual Site Environmental Report for 2015 states that a member of the public that drives on Perimeter Road past the cylinder yards, on a daily basis, could receive a direct radiation dose from storage of DU in the cylinder yard (DOE 2017c). In 2015, this hypothetical individual received a dose of 0.77 millirem from direct radiation. The MEI doses identified in the 2004 Portsmouth EIS (DOE 2004b) resulted from cylinder breaches and were less than 0.1 millirem per year from airborne releases of uranium and less than 0.4 millirem per year from ingestion of contaminated water. Assuming the same individual receives all of the MEI doses, combining the direct radiation dose from the Annual Site Environmental Report and the 2004 EIS results in an MEI dose of less than 1.3 millirem per year. These doses are well below regulatory limits established by EPA and DOE for radiation exposure to a member of the public. This 1.3 millirem per year dose to the MEI results in an incremental increase in the annual risk of an LCF for this individual of 8×10^{-7}, or 1 chance in about 1.3 million of an LCF. Although it is extremely unlikely that the same individual would be the MEI every year over the 100 years of DU oxide storage, the total dose during this period would be 130 millirem. The likelihood of an LCF for this individual receiving this MEI dose during that period is less than 1 chance in 12,000 (calculated risk of 9×10^{-5} LCF).

The 2004 EISs (DOE 2004a, 2004b) also provide an estimate of the nonradiological impacts of uranium releases on the public. Both of the 2004 EISs estimated that the hazard index (HI) associated with airborne releases of uranium would be less than 0.1 and that for releases into the waters around Paducah and Portsmouth the HI would be less than 0.05. Therefore, no adverse impacts are expected from chemical exposure.

Hazard Index

The hazard index (HI) is the 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.

The hazard quotient is a comparison of the estimated intake level of a chemical with its adverse effects level. It is expressed as a ratio of estimated intake level to adverse effects level.

Data presented in the Paducah Annual Site Environmental Report for 2016 (DOE 2017c**)** suggests that the HI for water releases may be smaller than that presented in the 2004 Paducah EIS (DOE 2004a). This report indicates that groundwater is not used as a source of drinking water in the area downstream of Paducah; all well water systems have been replaced by city water. Assuming all of the uranium released from cylinder breaches would be released into surface water and not ultimately reach groundwater, the potential HI to an individual that uses Ohio River surface water as a source of drinking water would be less than 0.05.

Data presented in the Portsmouth Annual Site Environmental Report for 2015 (DOE 2017c**)** suggests that the HI for water releases may be smaller than that presented in the 2004 Portsmouth EIS (DOE 2004b). This report indicates that groundwater monitoring has not detected uranium above background levels in drinking (well) water in the area surrounding Portsmouth. Assuming all of the uranium released from cylinder breaches would be released into surface water and not ultimately reach groundwater, the potential HI to an individual that uses Scioto River surface water as a source of drinking water would be less than 0.05. For both Paducah and Portsmouth, the concentrations of uranium within the rivers, based on concentrations of less than 20 micrograms per liter in the tributaries to the rivers (DOE 2004a, 2004b), would be well below 30 micrograms per liter, the EPA maximum contaminant level for drinking water (EPA 2001).

Noncancer health effects from exposure to possible groundwater contamination are not expected; the estimated maximum HI for an individual assumed to use groundwater is less than 0.05 (DOE 2004a, 2004b).

Occupational Safety and Health Under Normal Operations

Workers would be exposed to low levels of gamma and neutron radiation while working in the DU oxide cylinder storage yards performing activities that include routine cylinder inspections, radiological monitoring and valve maintenance, and cylinder repair and relocations. At Paducah, a total of 16 workers would be required for these activities during the 100 year period evaluated for the No Action Alternative, while at Portsmouth, a total of 12 workers would be required (PPPO 2018).

The average annual dose to Paducah and Portsmouth cylinder yard workers, are provided in the DOE’s 2014 and 2016 Occupational Radiation Exposure Reports (DOE 2015h, 2017b). In 2014 the average dose (considering only those workers that received a measurable dose) was 74 millirem at Paducah[47] and in 2016 the average dose was 63 millirem at Portsmouth. These reported doses are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR 835, "*Occupational Radiation Protection*," and correspond to an annual risk of about 4×10^{-5} LCF. These workers performed duties similar to those expected of workers during the implementation of this alternative and these historical doses were used as estimates of cylinder yard worker doses for this analysis. Therefore, it is estimated that at Paducah the collective dose would be approximately 1.2 person-rem per year for the 16 cylinder yard workers, and would total 120 person-rem during the 100 years of DU oxide storage. No LCFs (calculated value of 0.07) would be expected from this exposure. Similarly, it is estimated that the collective dose for the 12 Portsmouth cylinder yard workers would be approximately 0.76 person-rem per year and total 76 person-rem during the 100 years of DU oxide storage. No LCFs (calculated value of 0.05) are expected to result from this exposure.

The 2004 Paducah and Portsmouth EISs (DOE 2004a, 2004b) calculated a maximum noninvolved worker dose of 0.15 millirem per year from storage of DUF_6. The dose, primarily from direct radiation, was estimated based on the uranium in the cylinders in the conversion facility and cylinder storage yards and the cylinders moved to and from the conversion facility. Because the amount of uranium that will be stored as an oxide would be similar to that previously being stored as DUF_6, the dose to the noninvolved worker would be similar for the storage and handling of DU oxide.

The 2004 Paducah and Portsmouth EISs (DOE 2004a, 2004b) also calculated a total worker dose for noninvolved workers. The collective noninvolved worker dose at both facilities was estimated to be 0.003 person-rem per year at Paducah and 0.001 person-rem per year at Portsmouth for workforces, which is somewhat different[48] than that predicted for each site during the storage of DU oxide; these doses, therefore, provide a reasonable estimate for the total noninvolved worker dose. During the 100 years of DU oxide storage, the total noninvolved worker dose would be 0.3 person-rem at Paducah and 0.1 person-rem at Portsmouth. No LCFs (calculated values are less than 0.0002 LCF at Paducah and 0.00006 LCF at Portsmouth) would be expected at either site.

For worker protection from the toxic effects of uranium, DOE uses the OSHA permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000, Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels. Adherence to these limits would result in no adverse health effects to workers at either site from the toxic effects of uranium exposure.

Nonradiological accidents also pose a risk to site workers. All on-site work would be performed in accordance with best management practices and in accordance with applicable OSHA

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[47] As noted in Chapter 3, in 2016 over 500 workers received a measurable dose at Paducah. The higher average dose calculated from the 2014 occupational exposure data (versus the 11-millirem value from the 2016 data) was used in this section because Paducah data for 2014 was deemed more representative of cylinder yard worker doses.

[48] The size of the workforces used in the 2004 EISs were 1,727 at Portsmouth and 1,799 at Paducah. In 2016 the size of the workforce at each site was 2,612 workers at Portsmouth and approximately 1,200 workers at Paducah (PPPO 2018). Noninvolved worker doses were not scaled due to these differences.

requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, "*Worker Safety and Health Program*." DOE Order 450.2, "*Integrated Safety Management,*" integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were based on the number of workers in the cylinder storage yard (16 at Paducah and 12 at Portsmouth) and national worker injury and fatality rates. During the assumed 100 years of DU oxide storage there would be no expected fatalities at either site based on an average worker fatality rate of 3.4 fatalities per 100,000 worker years (BLS 2014). In 2016, the national average across all industries for accidents resulting in lost worker days was 3.0 accidents per 100,000 worker-years (BLS 2016b). This accident rate results in an estimated 0.48 annual cylinder yard worker injury at both Paducah and 0.36 worker injury at Portsmouth. During the 100 years of assumed DU oxide storage, there could be a total of 48 worker injuries at both Paducah and 36 worker injuries at Portsmouth.

Public and Occupational Safety and Health Under Accident Conditions

The potential impacts of accidents associated with continued DU oxide container storage operations have been extensively examined in NEPA and safety analyses for the respective Sites, including the 1999 Final PEIS (DOE 1999), the 2004 EISs (DOE 2004a, 2004b), and the 2016 documented safety analyses (DSAs) for the cylinder storage yards for each site (BWXT 2016a, 2016b). The 2004 EISs and 2016 DSAs identified similar accidents and impacts from cylinder storage and maintenance activities. The accident analyses in these documents indicate that the physical hazards associated with handling large, heavy cylinders were such that workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. The potential for accidental injuries and deaths are similar to other industries that use heavy equipment or manipulate heavy objects.

DU oxide cylinders and drums would be stored for an assumed 100 years in the cylinder storage yards as described in Chapter 2, Section 2.1.3. DU oxide cylinders would be stored in the open, but DU oxide stored in 55-gallon (208-liter) drums would be protected from the elements by storing the drums in intermodal containers (BWXT 2016b).

Accidents could release radionuclides or chemicals to the environment, potentially affecting workers and members of the general public. If released to the atmosphere, DU oxide may become airborne as a function of particle size. Inhalation of fine uranium particles presents increased radiation hazards; uranium particles in the lungs may be a long-term cancer hazard. The lung is the critical organ (i.e., the part of the body most vulnerable to damage from the uranium) for insoluble respirable dusts or fines such as oxide powders; the more soluble uranium compounds are considered most toxic to the kidneys. Uranium dusts are also respiratory irritants, with coughing or shortness of breath as possible results of exposure.

In both the NEPA and safety documents, a range of operational and natural-phenomena-initiated accidents were considered, including cylinder handling equipment fires, fires involving cylinder(s) in a pool of fuel or oil, small vehicle or transport truck fires, tornadoes and high winds, seismic events, and small and large aircraft impacts followed by fires. The assessment considered accidents ranging from those that would be reasonably likely to occur (estimated 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).[49]

The previous NEPA analyses indicate that of all the operational accidents considered during handling and storage area operations, those involving DUF_6 cylinders would have the largest potential effects. These analyses indicated that accidents involving DUF_6 cylinders would present higher potential impacts on workers and the public than DU oxide cylinders because the DUF_6 cylinders were more likely to rupture when exposed to fire. In addition, if a cylinder ruptured, DUF_6 would undergo chemical reactions and release HF in addition to various uranium compounds, thus presenting additional chemical hazards when compared to a DU oxide release. The previous NEPA analyses indicated that impacts from handling and storage area accidents involving DUF_6 cylinders would bound the impacts from any accidents involving DU oxide containers. Therefore, specific analyses for accidents involving DU oxide containers in the storage areas were not performed in the previous NEPA analyses since the potential impacts were considered bounded by the impacts from potential accidents involving DUF_6 cylinders.

The hazards analyses in the Paducah and Portsmouth cylinder yard DSAs concluded that fire events at the storage yards could potentially involve several cylinders or drums containing DU oxide. However, the densified (i.e., packed) oxide powder in the cylinders or drums is not easily dispersible under fire conditions because the oxide is difficult to deagglomerate and DU oxide does not liquefy or vaporize and would not over-pressurize a container to the point of rupture. These events are not expected to result in significant radiological and chemical consequences (BWXT 2016b). In addition, the DSAs indicated that a non-fire related breach of a cylinder or drum containing DU oxide is not expected to have significant radiological or chemical consequences.

The hazards analyses in the Paducah and Portsmouth cylinder yard DSAs involving handling and storage of cylinders of DU oxide concluded that the hazards associated with DU oxide evaluated in the respective hazards analyses result in acceptable-risk events. No accident scenarios or mechanisms were identified that could result in the airborne dispersion of substantial quantities of DU oxide. All of the operational and natural phenomena initiated events identified in the hazard evaluation tables in the DSAs that involved DU oxide were found to have low unmitigated (without preventive or mitigative features) radiological and chemical consequences to facility (involved) or collocated (noninvolved) workers, and negligible radiological and chemical consequences to the public. As a result, no DU oxide events were evaluated in detail in the Paducah and Portsmouth cylinder storage yard DSAs; the DSAs instead concentrate on DUF_6 accidents as the bounding cylinder storage yard accidents (BWXT 2016b).

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[49] Container breaches as a result of corrosion are expected to occur and are analyzed as part of "Normal Operations."

The detailed technical basis for a hypothetical, worse-case, that is, more conservative than the NEPA standard of maximum reasonably foreseeable, accident within the conversion facility involving drums and cylinders of DU oxide is described in the DUF_6 Conversion Facility DSAs (BWXT 2016c, 2016d). The modeled release is a full hopper containing 20,000 kilograms (44,100 pounds) of DU oxide resulting from a broken discharge chute. The release is modeled as a free-fall spill of DU oxide powder from 3 meters (9.8 feet) with a total airborne respirable release fraction of 6×10^{-4}. Because the DU oxide powder is assumed to become suspended, a damage ratio of 0.5 is assigned and about 6.0 kilograms (13 pounds) is assumed to be released. This is extremely conservative for a spill of this size and bounds other release mechanisms.

A cylinder contains 9,000 to 12,000 kilograms (20,000 to 26,000 pounds) of DU oxide, and a bulk bag would contain about 11,000 kilograms (22,000 pounds) of DU oxide. No physical mechanisms were identified involving cylinders or bulk bags of DU oxide during handling or storage that would result in as high a fraction of the total amount of DU released as the hypothetical full hopper failure and a free-fall spill modeled for the conversion facilities. Therefore, the full hopper failure and a free-fall spill modeled for the conversion facilities was used as the bounding DU oxide accident.

The dose conversion factor for DU oxide (insoluble uranium) is approximately 0.083 rem per milligram. For an accident involving the contents of a DU oxide powder hopper (20 metric tons [22 tons] of DU oxide), the largest estimated dose for both Sites is approximately 6.5×10^{-3} rem for an off-site MEI and 1.3 rem for an on-site noninvolved worker at a distance of 100 meters (330 feet). These doses correspond to risks of 4×10^{-4} LCF and 8×10^{-4} LCF, respectively. For both Sites, uranium uptake is estimated to be 0.08 milligrams for an off-site individual and 15.4 milligrams for an on-site noninvolved worker at a distance of 100 meters (330 feet) (BWXT 2016c). The consequences of the modeled unmitigated release from a DU oxide powder hopper resulted in low consequences for both the off-site public and on-site noninvolved workers in terms of radiological dose and uranium uptake. No quantitative evaluation of dose consequences was performed for the facility worker; however, based on qualitative considerations, the hazard is assumed to be low. This is because the hazard from DU oxide is low and the worker would have to remain in the area for an extended time to receive a substantial exposure (BWXT 2016c).

Acute Exposure Guideline Levels (AEGLs)

Threshold values published by the National Research Council and National Academy of Sciences for use in chemical emergency planning, prevention, and response programs. AEGLs represent threshold exposure limits for the general population, including susceptible individuals. AEGL values are defined for varying degrees of severity of toxic effects, as follows:

AEGL-1 – The airborne level of concentration of a substance above which the exposed population could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects would not be disabling and would be transient and reversible upon cessation of exposure.

AEGL-2 – The airborne level of concentration of a substance above which the exposed population could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 – The airborne level of concentration of a substance above which the exposed population could experience life-threatening health effects or death.

Uptake by an off-site member of the public of 0.08 milligram of uranium would be less than 1 percent of Acute Exposure Guideline Level-1 (AEGL-1) (10 milligrams), which is considered acceptable for members of the public in a chemical accident. A noninvolved worker uptake of 15.4 milligrams is less than the 50 milligrams uranium AEGL-2 value considered acceptable to workers (BWXT 2016c).

The radiological and chemical impacts on non-involved workers and the public from this 6.0 kilograms (13 pounds) DU oxide airborne release are expected to bound any other credible storage yard accidents associated with DU oxide container handling operations at Paducah or Portsmouth.

Other accidents evaluated in the Paducah and Portsmouth EISs include a DU oxide drum spill in which a single DU oxide drum is damaged by a forklift and spills its contents onto the ground outside a storage facility. For that accident a release of 1.1 kilograms (2.4 pounds) was postulated (DOE 2004b).

Fires and other events at the DU oxide container staging area could potentially involve several cylinders or drums. However, the packed DU oxide powder in the cylinders or drums would not be easily dispersible under fire conditions because it would not vaporize and would be very difficult to deagglomerate. Thus, the full hopper failure and a free-fall spill accident bounds the potential consequences of events for DU oxide container storage.

The handling for disposal of CaF_2 is unlikely to present any substantial risks from an accident involving this material. CaF_2 is not a hazardous material and would likely contain very low level of radionuclides such that it could be handling and disposed of as a solid waste. Therefore, no credible accident scenarios were evaluated that would result in a substantial health risk.

A seismic-initiated earthquake was also evaluated in which a DU oxide storage building was damaged and 10 percent of the contents of the stored containers were breached, resulting in a spill of 61 kilograms (135 pounds) (DOE 2004b). Because the DU oxide will not be stored in a building, there would be no risk of damage to the cylinders from falling debris; thus, this storage building accident is not applicable. Severe, natural phenomena events, including earthquakes, do not have the potential to substantially damage stored DU oxide containers, and releases larger than the 6 kilograms (13 pounds) of DU oxide evaluated above would not be expected.

Public and Occupational Safety and Health—Intentional Destructive Act Scenarios

Because of the low hazard posed by DU oxide, the material would not be an attractive target for a terrorist attack or other intentional destructive acts. The releases caused by intentional destructive acts during the management of DU oxide were not expressly calculated in the site-specific EIS (DOE 2004b) and this DU Oxide SEIS. However, should an intentional destructive act occur, the consequences of the accident scenarios considered in the 2004 EISs and this DU Oxide SEIS would either bound or be comparable to the consequences from the act. As discussed in the 2004 EISs and this DU Oxide SEIS, releases for and the consequences from severe accidents involving the DU oxide were derived using highly conservative assumptions. Therefore, any releases caused by and the consequences from any potential intentional destructive events would either be bounded by or be comparable to the releases and consequences presented in this DU Oxide SEIS for severe accidents. However, because of the relatively low hazard posed by DU oxide, should an intentional destructive act occur, the consequences of the act are expected to be comparable to the consequences of the accidents described in the 2004 EISs and summarized in this DU Oxide SEIS.

4.1.1.7 Socioeconomics

The socioeconomic analysis covers the effects on population, employment, income, regional growth, housing, and community resources in the ROI of Paducah and Portsmouth. At Paducah, 16 workers would be required for DU oxide container storage and maintenance and waste loading activities, while at Portsmouth, 12 workers would be required (PPPO 2018). There would be no construction activities at Paducah or Portsmouth.

Table 4-3 compares the employment for DU oxide monitoring and maintenance to estimated future site employment at Paducah and Portsmouth. The employment associated with DU oxide container monitoring and maintenance and waste loading activities would be less than 2 percent of total site employment, and approximately 6 percent of conversion facility employment at each location. During the post-conversion period, employment for DU oxide container monitoring and maintenance and waste loading activities would likely constitute most of the remaining employees at Paducah and Portsmouth. This does not consider the possible extension of current activities or future activities that could locate at these Sites. In addition, management of large quantities of CaF_2 would only be required if DOE was unable to sell HF; in which case, staff assigned to manage HF could manage the CaF_2. Therefore, because of the small number of employees involved, no in-migration or out-migration is expected that would impact population, employment, income, regional growth, housing, or community services in the Paducah and Portsmouth ROIs.

Table 4-3 Comparison of Site Employment Against Employment for DU Oxide Container Management under the No Action Alternative

Site	Employment for DU Oxide Container Monitoring and Maintenance	Site Employment (Percent of Employment)	
		Estimated for Conversion Facility	Total Site
Paducah	12 to 16	250 (6)	1,200 (2)
Portsmouth	12	210 (6)	2,612 (<1)

Key: DU = depleted uranium.
Source: PPPO 2018

4.1.1.8 Waste Management

Storage and maintenance of DU oxide containers at Paducah and Portsmouth would annually generate small quantities of solid LLW (exclusive of empty and heel cylinders and CaF_2), and MLLW (**Table 4-4**). These annual waste quantities would represent small fractions of the same types of waste that are currently generated and managed during other site activities such as conversion of DUF_6 to DU oxide, environmental restoration, and building demolition.

Therefore, generation of waste during storage and maintenance of DU oxide containers would not impact waste management capabilities at Paducah or Portsmouth. All LLW and MLLW generated during storage and maintenance of DU oxide containers would be transported to off-site facilities for treatment and/or disposal.

In addition, some of the cylinders would not be usable for storage and potential future shipment of DU oxide or may be excess, and would be shipped off site for disposal as LLW. DOE estimates that 8,483 empty and heel cylinders would be generated at Paducah and 5,517 empty and heel cylinders would be generated at Portsmouth. Assuming each cylinder is 4 feet (1.2 meters) in diameter and 12 feet (3.7 meters) long, and no volume reduction occurs at either site, about 1,400 cubic yards (1,070 cubic meters) per year of empty and heel cylinders would be generated at Paducah and Portsmouth. In addition, if the HF cannot be recycled into commerce, CaF_2 would be generated. Although these empty and heel cylinders and CaF_2 would be very large percentages of current LLW generation, the site waste management infrastructure has been modified under the 2004 EISs and associated RODs to handle these volumes of wastes. Therefore, managing these waste would not adversely affect the waste management infrastructure. Nonhazardous waste (general trash) and sanitary wastewater would be generated at both Paducah and Portsmouth by the 16 and 12 employees involved in DU oxide container storage and maintenance activities, respectively (PPPO 2018). At both Portsmouth and Paducah, nonhazardous waste would be disposed of on site or sent to off-site permitted recycle or disposal facilities, while sanitary wastewater would be treated on-site (see Sections 3.1.8 and 3.2.8). Any nonhazardous waste or sanitary wastewater that would be generated would represent small fractions of the same types of waste generated by current site personnel and would be managed with no impacts on capacities at either site.

Table 4-4 Percent of Annual Waste Generation at Paducah and Portsmouth under the No Action Alternative

Waste Type	Paducah			Portsmouth		
	Waste Volume (cubic yards)[a]	Current Waste Generation[b]	Percent of Current Waste Generation	Waste Volume (cubic yards)[a]	Current Waste Generation[b]	Percent of Current Waste Generation[b]
LLW [c]	2.1	210	1.0	1.6	160	1.0
LLW – empty and heel cylinders[d]	1,400	NWS	NA	1,400	NWS	NA
LLW – CaF_2	4,600	NWS	NA	3,700	NWS	NA
MLLW	0.014	1.4	1.0	0.010	1.0	1.0

Key: LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; NWS = new waste stream.

[a] Source: PPPO 2018.

[b] Waste from current activities at Paducah is described in Section 3.1.8, while waste from current activities at Portsmouth is described in Section 3.2.8.

[c] The comparisons against current LLW generation rates are for LLW other than empty and heel cylinders.

[d] The listed volume of the empty and heel cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facilities or a separate waste treatment facility.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

4.1.1.9 Land Use and Aesthetics

Impacts on land resources, including land use and aesthetics could occur from new construction or changes in land use. DU oxide container storage and maintenance activities and waste loading would occur within the industrialized areas of Paducah and Portsmouth, and there would be no new construction and no change in land use. Therefore, potential impacts on land use and aesthetics would be minor at both Paducah and Portsmouth.

4.1.1.10 Cultural Resources

Impacts on cultural resources are not likely. The existing storage yards at Paducah and Portsmouth are located in previously disturbed areas that were graded during the original yard construction, and both are unlikely to contain cultural properties or resources listed on or eligible for listing on the NRHP (DOE 2015b; Miller et al. 2014). No new or expanded DU oxide container storage areas are proposed at either site. In the unlikely event of a container breach, pollutant emissions are not expected to be sufficient to cause impacts on cultural resources (see Section 4.1.1.2 of this DU Oxide SEIS).

Continued storage of DU oxide containers would mean maintaining the status quo for known historic properties at Paducah and Portsmouth. At either site there would be no effects on historic properties during long-term storage, monitoring and maintenance, repair of containers, and routine shipping of wastes off-site. In addition, there would be no impacts on religious or sacred sites, burial sites, or resources significant to Native Americans because none has been identified at these locations (DOE 2004a, 2004b). If any cultural resources are discovered during implementation of the alternatives evaluated in this DU Oxide SEIS, consultation with the appropriate SHPO and Tribal governments would be undertaken in accordance with law and applicable agreements (DOE 2004a, 2004b).

4.1.1.11 Environmental Justice

A determination of impacts that could disproportionately affect minority and low-income populations is based upon the identification of high and adverse impacts on the resource areas considered in this DU Oxide SEIS. As shown in Sections 3.1.11 and 3.2.11, there are a number of census tracts with a higher–than-state-average proportion of minority and low-income populations within 50 miles (80 km) of both Paducah and Portsmouth.

A review of the radiological impacts on the public from normal operations and postulated accidents at Paducah and Portsmouth, as well as impacts from potential chemical exposures and accidents (Section 4.1.1.6), indicates that all of the operational and natural-phenomena-initiated events identified in the hazard evaluation tables in the DSAs that involved DU oxide were found to have low unmitigated (without preventive or mitigative features) radiological and chemical consequences on involved and uninvolved workers, and negligible radiological and chemical consequences on the public.

Minimal impacts on the general public related to air quality, climate, noise, and water resources have been identified, including at the population and individual level. In addition, accidents were found to have negligible radiological and chemical consequences to the public. There would be no disproportionately high and adverse impacts on minority or low-income populations.

4.1.2 Transport of Radioactive Waste to Disposal Facilities

As described in Section 4.1.1.8, LLW and MLLW generated from storage and maintenance of DU oxide containers would be transported to off-site radioactive waste management facilities.

This DU Oxide SEIS generally follows the methodology described in the 2004 EISs (DOE 2004a, 2004b), with the following changes. The 2004 EISs used risk factors of 0.0004 LCF per person-rem of exposure for workers and 0.0005 LCF per person-rem of exposure for members of the general public. This DU Oxide SEIS uses a risk factor of 0.0006 LCF per person-rem, consistent with current DOE guidance (DOE 2003). In addition, this DU Oxide SEIS updated computer modeling software and uses updated population data from the 2010 Census. See Section 4.2.2 and Appendix B for more information on the transportation impact methodology and the related modeling software.

This section summarizes the potential impacts due to shipment of empty and heel cylinders, ancillary LLW and MLLW, and CaF_2 from Paducah in Kentucky and Portsmouth in Ohio to the disposal facilities under incident-free and accident conditions. Potential impacts for the empty and heel cylinders, ancillary LLW and MLLW, and CaF_2 shipments are presented on an annual basis, as identified in **Tables 4-5, 4-6,** and **4-7**. Footnotes in the tables describe how total impacts can be estimated. Because the annual numbers of expected ancillary LLW and MLLW shipments are small, this would make transport by rail inefficient. Therefore, only truck transport is analyzed. Because the quantities of empty and heel cylinder and CaF_2 would be larger than the ancillary LLW and MLLS shipments, both truck and rail shipment are analyzed.

Tables 4-5, 4-6 and **4-7** summarize the potential average annual impacts of transporting empty and heel cylinders, ancillary LLW and MLLW, and CaF_2 to a disposal facility (i.e., Energy*Solutions*, NNSS, or WCS). As indicated in these tables, no LCFs are expected, although traffic fatalities could result from transport of CaF_2 to a disposal facility over the duration of the entire shipping campaign.

Table 4-5 Annual Risks to Crew Members and the Public from Transporting 14,000 Empty and Heel Cylinders to a Radioactive Waste Disposal Facility

Destination	Number of Shipments	Total One-way Kilometers Traveled	Incident-Free[a]				Accident[a]	
			Crew		Population			
			Dose (person-rem)	LCFs [b]	Dose (person-rem)	LCFs [b]	Radiological Risk[b]	Nonrad Risk[b]
Truck Transport from Paducah								
Energy*Solutions*	125	321,300	0.004	2×10^{-6}	0.01	6×10^{-6}	3×10^{-9}	0.02
NNSS	125	400,900	0.005	3×10^{-6}	0.01	7×10^{-6}	2×10^{-9}	0.02
WCS	125	212,300	0.003	2×10^{-6}	0.007	4×10^{-6}	2×10^{-9}	0.02
Rail Transport from Paducah								
Energy*Solutions*	4	390,000	0.003	2×10^{-6}	0.003	3×10^{-6}	2×10^{-8}	0.003
NNSS	4	1,900,000	0.003	3×10^{-6}	0.005	3×10^{-6}	2×10^{-8}	0.003
WCS	4	280,000	0.003	1×10^{-6}	0.003	2×10^{-6}	3×10^{-8}	0.003
Truck Transport from Portsmouth								
Energy*Solutions*	125	205,600	0.003	2×10^{-6}	0.008	5×10^{-6}	2×10^{-9}	0.01
NNSS	125	303,700	0.004	2×10^{-6}	0.009	6×10^{-6}	2×10^{-9}	0.01
WCS	125	185,700	0.002	1×10^{-6}	0.006	3×10^{-6}	2×10^{-10}	0.01
Rail Transport from Portsmouth								
Energy*Solutions*	4	290,000	0.004	2×10^{-6}	0.005	3×10^{-6}	4×10^{-8}	0.004
NNSS	4	1,290,000	0.004	3×10^{-6}	0.009	5×10^{-6}	4×10^{-8}	0.005
WCS	4	270,000	0.004	2×10^{-6}	0.005	4×10^{-6}	5×10^{-8}	0.005

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; Nonrad = nonradiological; WCS = Waste Control Specialists.

[a] Total risks can be estimated by multiplying by the duration of the conversion period at each site (34 years for Paducah and 22 years for Portsmouth), the duration over which it is expected that the empty and heel cylinders would be shipped to the disposal facility.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles, multiply by 0.62137.

Table 4-6 Average Annual Risks to Crew Members and the Public from Transporting Other Ancillary LLW and MLLW to a Radioactive Waste Disposal Facility

			Incident-Free[a]				Accident[a]	
			Crew		Population			
Origin	Number of Shipments	Total One-way Kilometers Traveled	Dose (person-rem)	LCFs [b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck Transport from Paducah[c]								
Energy*Solutions*	1	2,600	$3x10^{-4}$	2×10^{-7}	2×10^{-4}	1×10^{-7}	7×10^{-14}	1×10^{-4}
NNSS	1	3,200	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	4×10^{-14}	1×10^{-4}
WCS	1	1,700	2×10^{-4}	1×10^{-7}	1×10^{-4}	9×10^{-8}	4×10^{-14}	1×10^{-4}
Truck Transport from Portsmouth[c]								
Energy*Solutions*	1	3,100	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	6×10^{-14}	1×10^{-4}
NNSS	1	3,700	4×10^{-4}	3×10^{-7}	3×10^{-4}	2×10^{-7}	5×10^{-14}	2×10^{-4}
WCS	1	2,300	3×10^{-4}	2×10^{-7}	2×10^{-4}	1×10^{-7}	8×10^{-14}	2×10^{-4}

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; Nonrad = nanradiological; WCS = Waste Control Specialists.

[a] Total risks can be estimated by multiplying by the duration of the No Action Alternative (100 years).

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because of the small amount of waste requiring shipment to the waste management facility, rail transport would be inefficient and was not considered.

Note: To convert kilometers to miles, multiply by 0.62137.

Table 4-7 Annual Population Transportation Risks for Shipment of Calcium Fluoride to a Radioactive Waste Disposal Facility under the Hydrogen Fluoride Neutralization Option

Origin	Paducah		Portsmouth	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Energy*Solutions*				
Number of shipments	954	238	369	154
Total distance (one-way [km])	2,459,706	639,735	1,134,727	509,545
Traffic fatalities (round trip)[a]	0.13	0.01	0.05	0.02
Nevada National Security Site				
Number of shipments	954	238	369	154
Total distance (one-way [km])[b]	3,059,265	1,129,500	1,374,500	828,682
Traffic fatalities (round trip)[a]	0.14	0.06	0.06	0.03
Waste Control Specialists				
Number of shipments	954	238	369	154
Total distance (one-way [km])	146,9647	478,500	841,455	454,136
Traffic fatalities (round trip)[a]	0.11	0.02	0.06	0.02

[a] Total risks can be estimated by multiplying by the duration of the conversion period at each site (34 years for Paducah and 22 years for Portsmouth), the duration over which it is expected that the CaF_2 would be shipped to the disposal facility.

[b] Because NNSS does not have a direct rail line connection, every rail transport requires four shipments of truck transport from an intermodal facility to NNSS. The cited distances are the sum of truck and rail transport distances.

Impacts from Incident-Free Transport of Radioactive Waste

The potential annual radiological impacts for transport crews and populations along the routes are shown in Tables 4-5, 4-6, and 4-7. The tables state the impacts from shipping all empty and heel cylinders, ancillary LLW and MLLW, and CaF_2 to a single disposal facility.

The annual transport of empty and heel cylinders would not result in any LCFs to crew members. The maximum calculated annual risk would be less than 5×10^{-6} LCF (refelects the sum of transports from Paducah and Portsmouth to NNSS), or 1 chance in 200,000 of a single LCF among the transportation crew.

The single annual truck shipment of ancillary LLW and MLLW from each site to any disposal facility would lead to a very low crew risk. The maximum calculated annual risk would be less than 5×10^{-7} (reflects the sum of transports from Paducah and Poprtsmouth to NNSS), or 1 chance in 2 million of a single LCF among the transportation crews. The calculated per-shipment risk to the crew is higher than for the empty and heel cylinders because the drums containing the ancillary LLW and MLLW are situated closer to the crew cabin than cylinders during truck transport.

The annual dose to the general population from transporting empty and heel cylinders would not result in an LCF. The maximum calculated annual risk would be 1×10^{-5} LCF (refelects the sum of transports from Paducah and Portsmouth to NNSS), or 1 chance in 100,000 of a single LCF in the exposed population.

The maximum calculated annual risk to the general population for transporting ancillary LLW and MLLW would be 4×10^{-7} (reflects the sum of transports from Paducah and Portsmouth to NNSS), or 1 chance in 2.5 million of a single LCF in the exposed population.

Impacts of Transportation Accidents Involving Radioactive Waste

As indicated in Tables 4-5, 4-6, and 4-7, truck transportation of empty and heel cylinders, ancillary LLW and MLLW, and CaF_2 is not expected to result in any LCFs although traffic fatalities could result from transport of CaF_2 to a disposal facility.

Vehicle Emissions

Under this alternative, ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 would be generated that would need to be shipped off site for disposal. These shipments of ancillary LLW and MLLW would be via truck due to the relatively small annual quantity of waste to be shipped. It is expected that there would be an annual average of 1 truck shipment from Paducah and 1 truck shipment from Portsmouth to transport LLW and MLLW, and 125 truck shipments for the 14,000 empty and heel cylinders at each site. Empty and heel cylinders could also be shipped via rail, and it is assumed that four annual shipments would take place under the rail option. Emissions were also calculated for the potential shipment of CaF_2 which would be shipped in 953 and 616 truck shipments from Paducah and Portsmouth, respectively, or via 238 or 154 annual rail shipments. Although shipments may go to various facilities, in order to bound the impacts, calculations are based on the longest potential shipping distance which would be to NNSS.

Truck Option

Table 4-8 presents the estimated annual criteria pollutant emissions associated with an annual maximum total of 1,078 semi-tractor trailer truck shipments from Paducah and 748 shipments from Portsmouth to NNSS. Analysis estimated approximately 2,000 miles (3,300 kilometers) per truck shipment from Paducah to NNSS and approximately 2,400 miles (3,800 kilometers) per shipment from Portsmouth to NNSS. Emissions were derived using the emission factors for heavy-duty diesel vehicles in the EPA's MOVES2014a. MOVES is the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator. It is used to create emission factors or emission inventories for both onroad motor vehicles and nonroad equipment (EPA 2015). Annual emissions of each criteria pollutant would be less than 28 tons (25 metric tons) for all shipments from Paducah and Portsmouth combined. These emissions are extremely small in comparison to the national emissions (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular Air Quality Control Region (AQCR).

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions in the regions (see Sections 3.1.2.2 and 3.2.2.2 of this DU Oxide SEIS), the emissions are not likely to contribute to any significant impact on air quality.

Table 4-8 Criteria Pollutant Emissions from No Action Alternative Truck Shipments

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_x**	**VOC**
LLW and MLLW	Paducah	0.17	0.48	0.02	0.02	0.00	0.05
	Portsmouth	0.14	0.41	0.01	0.01	0.00	0.04
	Total emissions	*0.31*	*0.88*	*0.03*	*0.03*	*0.00*	*0.09*
Empty and heel cylinders	Paducah	0.60	1.70	0.06	0.06	0.00	0.18
	Portsmouth	0.72	2.04	0.07	0.07	0.00	0.21
	Total emissions	*1.31*	*3.74*	*0.14*	*0.13*	*0.01*	*0.39*
CaF_2	Paducah	4.54	12.96	0.47	0.43	0.03	1.35
	Portsmouth	3.52	10.05	0.37	0.34	0.02	1.05
	Total emissions	*8.07*	*23.01*	*0.84*	*0.77*	*0.05*	*2.40*
Grand Total		**9.69**	**27.64**	**1.01**	**0.93**	**0.06**	**2.88**

Rail/Truck Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with waste shipments via the rail/truck option to NNSS (considered to be the bounding because of the greatest distance traveled). It was estimated that locomotives would travel approximately 2,000 miles (3,300 kilometers) per rail shipment from Paducah to Barstow, CA, and approximately 2,400 miles (3,800 kilometers) from Portsmouth to Barstow, CA. Because there is no direct rail access to NNSS, shipment via rail would travel to Barstow, CA, where they would be transported approximately 200 miles (330 kilometers) from Barstow to the NNSS facility. Emissions for the rail portion of the transport were calculated using emission factors for tier 2 line haul locomotives derived from the EPA's *Emission Factors for Locomotives* (EPA 2009). Emissions for the truck portion of the transport were calcualated as described in the "*Truck Option*" section above.

Table 4-9 shows the annual emissions associated with waste shipments via the rail/truck option to NNSS. Emissions of all criteria pollutants would be less than 151 tons (137 metric tons) annually for all shipments from Paducah and Portsmouth combined. Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR. However, because the emissions are so small in comparison to overall locomotive and vehicle transportation emissions, the emissions are not likely to contribute to any significant impact on air quality.

Table 4-9 Criteria Pollutant Emissions from Transportation via Railcar to Barstow, CA, and Truck to NNSS for the No Action Alternative

Material	Mode of Transport	Site	Criteria Pollutant Emissions (tons/year)					
			CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Truck	Paducah	0.02	0.05	0.00	0.00	0.00	0.00
		Portsmouth	0.01	0.03	0.00	0.00	0.00	0.00
		Total emissions	*0.03*	*0.08*	*0.00*	*0.00*	*0.00*	*0.01*
	Rail	Paducah	*0.09*	*0.34*	*0.01*	*0.01*	*0.01*	*0.02*
		Portsmouth	*0.11*	*0.41*	*0.01*	*0.01*	*0.01*	*0.02*
		Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
14,000 empty and heel cylinders	Truck	Paducah	0.06	0.17	0.01	0.01	0.00	0.02
		Portsmouth	0.06	0.17	0.01	0.01	0.00	0.02
		Total emissions	0.12	0.34	0.01	0.01	0.00	0.04
	Rail	Paducah	0.35	1.36	0.05	0.05	0.02	0.08
		Portsmouth	0.42	1.63	0.06	0.06	0.03	0.09
		Total emissions	*0.77*	*3.00*	*0.11*	*0.11*	*0.05*	*0.17*
CaF_2	Truck	Paducah	0.45	1.30	0.05	0.04	0.00	0.14
		Portsmouth	0.29	0.84	0.03	0.03	0.00	0.09
		Total emissions	*0.75*	*2.13*	*0.08*	*0.07*	*0.00*	*0.22*
	Rail	Paducah	20.95	81.03	2.95	2.86	1.48	4.48
		Portsmouth	16.27	62.92	2.29	2.22	1.15	3.48
		Total emissions	*37.22*	*143.95*	*5.23*	*5.08*	*2.63*	*7.96*
Grand Total (maximum shipments)			***39.06***	***150.17***	***5.46***	***5.29***	***2.70***	***8.43***

Greenhouse Gases

Table 4-10 shows the annual GHG emissions associated with waste shipments to NNSS. The total GHG emissions for the truck option would be 6,732 tons (6,107 metric tons) per year, which would be minimal in terms of the national annual GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018c). The total GHG emissions for the rail/truck option would be 20,113 tons (18,244 metric tons) per year. This amount would be minimal in terms of the national annual GHG emissions from combined truck and rail transportation, which total 512.7 million tons (465.1 million metric tons) annually (EPA 2018c).

Table 4-10 Annual GHG Emissions from Transport of Ancillary LLW and MLLW, Empty and Heel Cylinders, and CaF_2 to the Nevada National Security Site

Site	GHG Emissions (tons per year CO_2e)			
	Rail/Truck Option			Truck Option
	Rail	Truck	Total	
Paducah[a]	8,889	862	9,751	3,687
Portsmouth[a]	9,587	775	10,362	3,045
Grand Total	**18,476**	**1,636**	**20,113**	**6,732**
National Rail Emissions[b]	45,300,000			NA
National Truck Emissions[c]	467,400,000			467,400,000
Total National Rail/Truck Emissions	512,700,000			NA

Key: GHG = greenhouse gas; NA = not applicable.

[a] Source: PPPO 2018

[b] Source: CNR 2016

[c] Source: ATA 2018

4.1.3 Impacts at the Disposal Facilities

No DU oxide would be shipped from Paducah or Portsmouth for disposal at off-site waste management facilities under the No Action alternative. As described in Section 4.1.1.8, ancillary LLW and MLLW generated from storage and maintenance of DU oxide containers, empty and heel cylinders, and CaF_2, would be sent to Energy*Solutions*, NNSS, or WCS. All waste received at the evaluated facilities would be in compliance with waste acceptance criteria and in accordance with site licenses, permits, and other authorizations. **Table 4-11** compares the total waste generated to the capacities of each of the evaluated disposal facilities, assuming transport of all waste to each facility. The volumes of wastes generated under the No Action Alternative would be within the capacities of the facilities, even assuming all waste from a hypothetical 100 years of storage of DU oxide at both Paducah and Portsmouth was transported to a single facility. The impacts on any one disposal facility could be mitigated by sending the waste to more than one facility.

Table 4-11 Percent of Disposal Capacities at the Evaluated Disposal Facilities under the No Action Alternative

Waste	Waste Volume (cubic yards)[a]	Percent of Disposal Capacity		
		Energy*Solutions*[b]	NNSS[c]	WCS[d]
LLW[e]	370	0.0088	0.021	0.038
MLLW[e]	2.4	0.00066	0.0016	0.00025
Empty and heel cylinders[f]	78,300	1.9	4.4	8.2
CaF_2 in bulk bags	225,000	5.4	13	24

Key: FWF = Federal Waste Facility; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] Source: PPPO 2018.

[b] The disposal capacity for LLW and MLLW is assumed to be the remaining capacity in the Class A West Embankment 4.28 million cubic yards (3.27 million cubic meters) and the Mixed Waste disposal cell 354,000 cubic yards (271,000 cubic meters), respectively, as of August 27, 2015.

[c] The disposal capacity for LLW and MLLW at the Area 5 Radioactive Waste Management Complex is assumed to be 48 million cubic feet (1,778,000 cubic yards or 1.36 million cubic meters) and 4 million cubic feet (148,000 cubic yards or 113,000 cubic meters) in accordance with DOE's December 30, 2014, ROD (79 FR 78421) for the NNSS SWEIS (DOE 2013a).

[d] It is assumed that LLW, MLLW, and DU oxide waste would be disposed of in the FWF at WCS, which has a total capacity of about 963,000 cubic yards (736,000 cubic meters), of which about 7,550 cubic yards (5,780 cubic meters) had been used as of August 26, 2016.

[e] It is assumed for analysis that all waste from DU oxide storage and maintenance activities from Paducah and Portsmouth would be disposed of at each evaluated disposal facility. Waste volumes reflect totals from both Paducah and Portsmouth assuming on-site storage of DU oxide for 100 years.

[f] The listed volume of the empty and heel cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facility or separate waste treatment facility.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

The total volume of empty and heel cylinders was determined conservatively as discussed in Section 4.1.1.8 This results in a total LLW disposal volume of about 78,300 cubic yards (59,900 cubic meters), which would represent less than 10 percent of the disposal capacity at any evaluated disposal facility. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at Paducah or Portsmouth before shipping or after receipt at the disposal facility. Disposal operations would need to address the void space within the cylinders, which could include measures such as volume reduction at the disposal facility or at a separate waste treatment facility, filling the void volume within the cylinders with a material such as grout or sand, or by stabilizing the cylinders in place with grout or similar media.

The CaF_2 disposal option would only be instituted if HF could not be recycled into commerce. Although, the CaF_2 could likely be managed and disposed of as nonradioactive nonhazardous solid waste it was conservatively assumed to be low-activity LLW for this analysis. The total volume of CaF_2 in bulk bags results in a total disposal volume of about 225,000 cubic yards (172,000 cubic meters), which would represent less than 25 percent of the disposal capacity at any evaluated disposal facility. Assuming the bags were all shipped by truck from both Paducah and Portsmouth, over 250 working days per year at each site, the disposal site would receive an average of about six truckloads of CaF_2 per work day. Otherwise, assuming the same number of bulk bags was shipped by rail from both Paducah and Portsmouth, trains with DU oxide cylinders would arrive about one or two per work day. Assuming four CaF_2 bulk bags per railcar, and one railcar per train, each rail shipment would contain four bulk bags to be offloaded and transferred to the designated disposal unit. A train could easily accommodate additional railcars (each carrying four bags). Therefore, train deliveries could be reduced to an average of one or two per week.

Because MLLW contains constituents regulated under the RCRA, disposal of MLLW would be conditional at all sites on treatment to meet land disposal restrictions and other regulatory requirements. Because the Energy*Solutions* and WCS disposal sites both provide treatment capacity for many waste streams that contain RCRA-regulated constituents, DOE expects that the MLLW generated from DU oxide storage and maintenance could be transported directly to these sites for treatment and disposal. NNSS, however, does not currently provide waste treatment capacity for RCRA-regulated constituents in waste generated outside the State of Nevada, although limited treatment capacity for out-of-State MLLW may be available in the future. Therefore, some or all of any MLLW sent to NNSS for disposal could first require transport to a separate waste management facility with the treated residuals then being transported to NNSS. It is assumed that commercial capacity is available to perform treatment for these very small quantities of MLLW.

Receipt of waste is not expected to require modifications to disposal facility operations because of the relatively small number of annual waste deliveries to any evaluated facility.

4.2 DISPOSAL OF DEPLETED URANIUM OXIDE AND OTHER WASTES AT ENERGY*SOLUTIONS*

As described in Section 2.2.2.1, under the Energy*Solutions* Disposal Alternative, DU oxide would be disposed of at Energy*Solutions* near Clive, Utah. This section presents the estimated potential environmental impacts for this alternative including: (1) impacts from storage of DU oxide at Paducah and Portsmouth until shipment to Energy*Solutions* (Section 4.2.1); (2) impacts from transportation of the DU oxide and other radioactive waste to Energy*Solutions* (Section 4.2.2); and (3) impacts on the LLW and MLLW disposal capacities at Energy*Solutions* (Section 4.2.3).

4.2.1 Impacts at Paducah and Portsmouth

DU oxide would be stored at Paducah and Portsmouth until it is shipped to the Energy*Solutions* site for disposal. As described in Chapter 2, Section 2.4.1, in order to provide a conservative estimate of impacts, storage of DU oxide containers was analyzed for 76 years (44 years of storage plus 32 years of shipping) at Paducah and 47 years (32 years of storage plus 15 years of shipping) at Portsmouth under the Action Alternatives. This is a conservative assumption that over-estimates the impacts of storage at Paducah and Portsmouth because: 1) DU oxide would be generated over the duration of the storage period by conversion from DUF_6, and 2) DOE anticipates shipping at least a portion of the DU oxide off-site for disposal soon after it is generated and not storing it for a long period of time.

4.2.1.1 Site Infrastructure

Impacts on site infrastructure could occur from new construction. The impacts of storage and maintenance of DU oxide containers, and the loading of ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions*, would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.1). Therefore, there would be only minor impacts on site utility infrastructure. In addition, there would be adequate capacity to store all the DU oxide containers and therefore, no adverse impacts on the storage infrastructure.

The type of DU oxide disposal container will affect the numbers of shipments from Paducah and Portsmouth to the disposal site. If bulk bags are used, the empty and heel cylinders will need to be managed and disposed of as LLW. **Table 4-12** presents a summary of the potential off-site shipments of waste from the Paducah and Portsmouth Sites. This table shows an annual maximum of 2,520 truck or 657 rail shipments from Paducah and 2,265 truck or 472 rail shipments from Portsmouth. Assuming 250 shipping days per year, this equates to 10 daily truck or 3 rail shipments from Paducah and nine truck or two rail shipments from Paducah per work day. Therefore, the loading of the DU oxide containers and other wastes, and off-site shipment using either truck or rail, would not require new construction or changes in infrastructure at Paducah and Portsmouth, and would likely result in minor impacts on the transportation infrastructure at Paducah and Portsmouth.

Table 4-12 Summary of Off-Site Shipments for the Action Alternatives

Location		Container Type and Estimated Number of Shipments[a]							
						Bulk Bags with Empty Cylinders Option			
		DU Oxide in Cylinders[b]		14,000 Intact Empty and Heel Cylinders[c]		DU Oxide in Bulk Bags[d]		69,000 Intact Empty and Heel Cylinders (volume-reduced)[e]	
		Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
Paducah	Total	46,150	769	4,242	140	20,500	5,130	23,100 (4,620)	7,690 (2,310)
	Annual	1,440	24	125	4	603	151	679 (136)	226 (TBD)
Portsmouth	Total	22,850	380	2,759	90	9,070	2,270	11,400 (2,290)	3,800 (1,140)
	Annual	1.440	24	125	4	412	103	519 (104)	173 (TBD)

Location		Container Type and Estimated Number of Shipments[a]		Maximum Total Shipments[g]	
		CaF_2 in Bulk Bags Option[f]			
		Truck	Rail	Truck	Rail
Paducah	Total	32,420	8,105	82,800	21,100
	Annual	953	238	2,520	620
Portsmouth	Total	13,550	3,390	39,200	9,550
	Annual	616	154	2,270	434

[a] Annual shipments of DU oxide in cylinders were calculated based on a projected 32 years of shipments from Paducah and 15 years of shipments from Portsmouth. Estimates of annual truck and rail shipments for the DU oxide in bulk bags, empty and heel cylinders, and CaF_2 in bulk bags, is based on total number of shipments divided by the number of years of conversion facility operation, in this case, 34 years for Paducah and 22 years for Portsmouth.

[b] DU oxide cylinders would be shipped 1 per truck, or 6 per rail gondola, 10 gondolas per train.

[c] The 14,000 empty and heel cylinders would be shipped intact 2 per truck, or 6 per rail gondola, 10 gondolas per train.

[d] DU oxide in bulk bags would be shipped 2 per truck or 8 per train.

[e] Empty and heel cylinders remaining after DUF_6 conversion to DU oxide and transfer to bulk bags would be shipped intact 2 per truck or 6 per rail gondola, 10 gondolas per train, or volume-reduced and shipped 10 per cargo container, with 1 container per truck or 2 containers per train (DOE 2004a, 2004b).

[f] CaF_2 in bulk bags would be shipped 1 per truck or 4 per train.

[g] The maximum total shipments for truck transportation include DU oxide shipment in cylinders, 14,000 intact empty and heel cylinders, and CaF_2 in bulk bags. The maximum total shipments for rail transportation include DU oxide shipment in bulk bags, 14,000 intact empty and heel cylinders, 69,000 volume-reduced empty and heel cylinders, and CaF_2 in bulk bags.

Notes: Cylinder and transportation numbers are derived from PPPO (2018) or calculated based on the above table notes.

4.2.1.2 Air Quality, Climate, and Noise

Impacts on air quality, climate, and noise could occur from DU oxide container storage and maintenance activities. The impacts from storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.2).

Transfer of DU oxide cylinders from storage locations to a loading area for transportation would involve the use of standard equipment at Paducah and Portsmouth including Straddle Buggies and NCH-35 cylinder handlers. Support vehicles (i.e., cars and light trucks) at each site are expected to use 2,080 gallons per year (7,870 liters per year) of gasoline. Cylinder handling using Straddle Buggies and NCH 35 cylinder handlers is expected to use 15,600 gallons per year (59,050 liters per year) of diesel fuel at both Paducah and Portsmouth. These types of equipment are currently in use as part of conversion facility operations and there would be no substantial increase in activity above current levels. Emissions from diesel fuel combustion during container movement and loading activities would therefore be minimal, and would not represent or contribute to any exceedances of SAAQS or NAAQS. Likewise, GHG emissions (measured as CO_2e) would be minimal in the context of the over 1.3 million metric tons CO2e emitted annually from fossil fuel combustion in the industrial sector and would not be expected to contribute substantially to climate change. **Table 4-13** presents the operational emissions at Paducah and compares the emissions to those for McCracken County, Kentucky. **Table 4-14** presents the operational emissions at the Portsmouth Site and compares these emissions to those for Pike County, Ohio.

Table 4-13 Operational Emissions at Paducah under the Action Alternatives

Emission Source	Criteria Pollutant Emissions (tons per year)						
	CO	NO_2	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
NCH-35 cylinder handler	0.93	1.95	0.080	0.080	0.0024	0.25	240
McCracken County	13,217	15,200	2,464	826	30,162	6,378	497,850
Percentage of County emissions	0.007	0.01	0.003	0.01	8×10^{-6}	4×10^{-4}	0.05

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalents; NO_2 = nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Sources: EPA 2016d; PPPO 2018

Table 4-14 Operational Emissions at Portsmouth under the Action Alternatives

Emission Source	**Criteria Pollutant Emissions (tons per year)**						
	CO	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**	**CO_2e**
Straddle Buggies and NCH-35 cylinder handler	0.93	1.95	0.080	0.080	0.0024	0.25	240
Pike County	8,297	1,371	2,729	755	35	7,214	268,870
Percentage of County emissions	0.01	0.1	0.003	0.01	0.007	0.003	0.09

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalents; NO_2 = nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Sources: EPA 2016f; PPPO 2018

In addition, truck and rail loading activities would occur within the industrialized areas of Paducah and Portsmouth, and there would be little or no increase above current daily operations that would contribute to the noise environment. Off-site shipments via rail could increase by 2 or 3 shipments per day per site, and truck shipments could increase by 9 or 10 per day (see Section 4.2.1.1). This increase is unlikely to be perceptible on public roadways and existing railways in comparison to existing traffic in the region around the sites and the millions of annual shipments already occurring on public highways (3.68 million trucks travelling 2.74 billion miles annually [ATA 2018]) and railways. Therefore, because the increase is small and would occur in areas, roads, and/or railways already used for these purposes, potential impacts on noise levels near Paducah and Portsmouth would be minor.

4.2.1.3 Geology and Soil

Impacts on geology and soils could occur from the disturbance or use of geologic and soil materials, and from contamination by radioactive or hazardous materials via air or water borne pathways. The impacts from storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.3). The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.3).

Truck and rail loading of DU oxide containers would occur within the industrialized areas of Paducah and Portsmouth, and there would be no construction, no use of geologic and soils materials, and no routine releases of DU or other hazardous materials. Therefore, potential impacts on geology and soils would be minor at both Paducah and Portsmouth.

4.2.1.4 Water Resources

Impacts on water resources could occur from changes in water use, surface water discharge, groundwater recharge, or impacts on surface water or groundwater quality resulting from contamination by radioactive or hazardous materials associated with long-term container storage and maintenance or potential cylinder breach. The impacts of storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.4). The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.4).

Truck and rail loading of DU oxide containers would occur within the industrialized areas of Paducah and Portsmouth and use similar numbers of employees as the No Action Alternative. There would be no routine releases of DU oxide or hazardous materials. Container storage and maintenance and waste-loading activities would occur within the industrialized areas of both Paducah and Portsmouth in areas outside the 100-year floodplain. Therefore, any additional impacts on water resources over those described for the No Action Alternative would be minor. Primary impacts to floodplains in 2004 were expected to be related to construction of the conversion facilities. The ongoing operational, storage and maintenance, and transportation-related activities are not appreciably different than in 2004, and these activities had negligible impact as shown in the 2004 EISs and Paducah Floodplain/Wetland Assessment (ANL 2004a). At that time, DOE determined that a floodplain assessment was not required for Portsmouth because the site was outside maximum historic flooding levels (see Chapter 3, Section 3.2.4 of this SEIS). Therefore, no additional floodplain assessment is necessary.

4.2.1.5 Biotic Resources

Impacts on biotic resources could occur from removal or degradation of vegetation, wildlife habitats, wetlands, or federal and state-listed species; facility construction and operations; or contamination by radioactive or hazardous materials via air or water borne pathways. The impacts of storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.5). The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.5).

Truck and rail loading of DU oxide containers would occur within the industrialized areas of Paducah and Portsmouth and there would be no routine releases of DU oxide or hazardous materials. Container storage and maintenance and waste-loading activities would not disturb wetlands, sensitive habitat, or threatened, endangered, or special species. Therefore, any impacts on biotic resources would be minor at both Paducah and Portsmouth. Primary impacts to wetlands in 2004 were expected to be related to construction of the conversion facilities. The ongoing operational, storage and maintenance, and transportation-related activities are not appreciably different than in 2004, and these activities had negligible impact, as shown in the 2004 EISs and the Paducah Floodplain/Wetland Assessment (ANL 2004a) and Portsmouth Wetland Assessment (ANL 2004b). Therefore, no additional wetlands assessment is necessary.

4.2.1.6 Public and Occupational Safety and Health

Impacts on public and worker health at Paducah and Portsmouth would be similar to the impacts described in Section 4.1.1.6 for the No Action Alternative. As described in Section 4.2.1, the major difference would be that under the Energy*Solutions* Disposal Alternative, DU oxide containers would be stored for up to 76 years at Paducah and 47 years at Portsmouth rather than at least 100 years under the No Action Alternative. In addition, under the Energy*Solutions* Disposal Alternative, containers would be loaded on railcars and trucks for shipment to the Energy*Solutions* disposal facility.

Public Safety and Health Under Normal Operations

DU oxide containers emit very low levels of gamma and neutron radiation, resulting in a dose rate of about 2 millirem/hour at 30 centimeters (PPPO 2016). Public health impacts could result from the release of DU oxide due to container breaches. The uranium could be transported through the environment as an airborne release or as a groundwater or surface water release. As indicated in Chapter 2, Section 2.2.1, the numbers of DU oxide cylinder breaches were estimated based on two scenarios. The more conservative 'uncontrolled corrosion" scenario assumes that the historical rate of breaches would continue throughout the duration of this alternative. In the second "controlled corrosion" scenario, improved storage conditions are expected to result in lowered breach rates. No new cylinder breaches have occurred at Paducah and Portsmouth since improved storage conditions have been implemented (PPPO 2018).

The 2004 EISs (DOE 2004a, 2004b) estimated the public health impacts from storage of DUF_6 at Paducah and Portsmouth. After conversion, any exposure to stored uranium would be from DU oxide. The chemical form of the released uranium does not appreciably impact the radiological characteristics of the material. Therefore, the dose estimates from the 2004 EISs for DUF_6 were used in this DU Oxide SEIS to estimate the effects of exposure to DU oxide.

The 2004 Paducah EIS (DOE 2004a) estimated that if all DU annually assumed to be released in cylinder breaches were released to the atmosphere, the dose to the general public would be 0.008 person-rem. When scaled for the increased number of cylinders being stored under this alternative, this results in an annual population dose of 0.01 person-rem.[50] This annual population dose rate would result in a total population dose during 76 years of DU oxide storage of 0.76 person-rem. The population dose associated with DU oxide storage would not result in any expected LCFs. At a calculated value of 4×10^{-4} LCF, there would be a very small likelihood, 1 chance in about 2,700, of an additional cancer fatality in the general population. For comparison, the average natural background radiation level in the United States is 310 millirem per year; which means that during the 76 years of DU oxide storage, the population within 50 miles of Paducah would receive a background dose of 13 million person-rem, based on a population of 534,000 (DOE 2017c**)**. The population dose associated with natural background radiation could result in an estimated 7,600 LCFs.

The 2004 Portsmouth EIS (DOE 2004b) estimated that if all DU annually assumed to be released in cylinder breaches each year were released to the atmosphere, the dose to the general public would be 0.002 person-rem. This annual population dose rate would result in a total population dose during 47 years of DU oxide storage of 0.094 person-rem. The population dose associated

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[50] As with the No Action Alternative, estimates for population doses from the 2004 Paducah EIS (DOE 2004a) are scaled up by 25 percent, to a value of 0.01 person-rem per year, to account for the greater number of cylinders being stored and therefore the greater number of breaches and corresponding increases in the quantities of uranium released per year assumed in this DU Oxide SEIS compared to the 2004 Paducah EIS.

with DU oxide storage would not be expected to result in any LCFs. At a calculated value of 6×10^{-5} LCF, there would be a very small likelihood, 1 chance in about 18,000, of an additional cancer fatality in the general population. For comparison, over the same period, the 677,000 people (DOE 2017c**)** living within 50 miles of Portsmouth would receive a background dose of 9.9 million person-rem. The population dose associated with natural background radiation could result in an estimated 5,900 LCFs.

The Paducah Annual Site Environmental Report for 2016 mentions that the effective dose potentially received by a member of the public passing through accessible portions of the Paducah Site would likely receive 4.24 millirem per year received by a member of the public passing through accessible portions of the DOE Reservation would receive 4.24 millirem/year in a scenario where areas of highest exposure are visited 80 hours per year (DOE 2017c). Measurements at one of the locations used in developing this estimate of a direct radiation dose are from monitors located just outside the controlled (security fenced) area near the cylinder yards. The MEI doses identified in the 2004 Paducah EIS (DOE 2004a) were approximately 0.1 millirem per year from airborne releases of uranium and less than 0.5 millirem per year from ingestion of contaminated water. Scaling for the increase in the annual cylinder breach rate (see footnote 49), combined doses would correspond to an MEI dose of approximately 0.75 millirem per year from potential cylinder breaches. Assuming that the same individual receives all of the MEI doses, combining the direct radiation dose from the Annual Site Environmental Report and the 2004 Paducah EIS results in an MEI dose of less than 5.0 millirem per year. These doses are well below regulatory limits established by EPA and DOE for radiation exposure to a member of the public. EPA has set radiation dose limit to a member of the general public of 10 millirem per year from airborne sources (40 CFR Part 61). DOE has established a limit on the dose to a member of the public of 100 millirem per year from all sources combined (DOE Order 458.1). This less than 5.0 millirem per year dose to the MEI would result in an incremental increase in the risk of an LCF of 3×10^{-6} per year, or 1 chance in about 330,000 of an LCF. Assuming the same individual is the MEI for each year of DU oxide storage under this alternative, the MEI would receive a total dose of less than 380 millirem[51] over 76 years. The likelihood of this individual receiving the MEI dose during that period and contracting an LCF is less than 1 chance in about 4,400.

The Portsmouth Annual Site Environmental Report for 2015 states that a member of the public that drives on Perimeter Road past the cylinder storage yards could receive a direct dose from storage of DU in the cylinder yards (DOE 2017c). In 2015, this hypothetical individual would have received a dose of 0.77 millirem from direct radiation. The MEI doses identified in the 2004 Portsmouth EIS (DOE 2004b) resulted from cylinder breaches and were less than 0.1 millirem per year from airborne releases of uranium and less than 0.4 millirem per year from ingestion of contaminated water. Assuming the same individual receives all of the MEI doses, combining the direct radiation dose from the Annual Site Environmental Report and the 2004 Portsmouth EIS results in an MEI dose of less than 1.3 millirem per year. These doses are well below regulatory limits established by EPA and DOE for radiation exposure to a member of the public. This dose

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[51] In evaluating the total impacts for the duration of this alternative, no credit is taken for the reduction in DU oxide stored at Paducah or Portsmouth resulting from shipment of material to an off-site disposal facility. The timeframe considered includes the full storage period plus the shipment period, which is assumed to begin at the end of the maximum storage period.

to the MEI results in an incremental increase in the risk of an LCF for the MEI of 8×10^{-7}, or 1 chance in about 1.3 million for an LCF. Assuming the same individual is the MEI for each year of DU oxide storage, the MEI would receive a total dose of 61 millirem over 47 years, corresponding to a risk of 4×10^{-5} LCF. The likelihood of the individual receiving this MEI dose during that period and contracting an LCF is less than 1 chance in about 27,000.

The 2004 EISs (DOE 2004a, 2004b) also provide estimates of the nonradiological impacts of uranium releases on the public. Both of the 2004 EISs estimated that the HI associated with airborne releases of uranium would be less than 0.1 and that for releases into the waters around Paducah and Portsmouth the HI would be less than 0.05. Both HIs are less than 1, therefore, no adverse impacts are expected from chemical exposure.

Occupational Safety and Health Under Normal Operations

Workers would be exposed to low levels of gamma and neutron radiation while working in the cylinder storage yards and performing activities that include routine inspections, radiological monitoring and maintenance, and cylinder repair and relocations. At Paducah, 16 workers would be required for these activities. At Portsmouth, 12 workers would be required (PPPO 2018).

The average annual doses to Paducah and Portsmouth cylinder yard workers are provided in DOE's 2014 and 2016 Occupational Radiation Exposure Reports (DOE 2015h, 2017b). In 2014, the average dose (considering only those workers that received a measurable dose) was 74 millirem at Paducah, and in 2016 the average dose was 63 millirem at Portsmouth. These reported doses are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR 835, "*Occupational Radiation Protection*," and correspond to an annual risk of about 4×10^{-5} LCF. These workers performed duties similar to those expected of the cylinder yard workers during the implementation of this alternative. Therefore, it is estimated that at Paducah the collective worker dose for the 16 cylinder yard workers would be about 1.2 person-rem per year with a total dose of 90 person-rem for 76 years of DU oxide storage. No LCFs (calculated value of 0.05) would be expected from this exposure. Similarly, the collective worker dose for the 12 Portsmouth cylinder yard workers would be about 0.76 person-rem per year with a total dose of 36 person-rem for 47 years of DU oxide storage. No LCFs (calculated value of 0.02) would be expected from this exposure.

Worker exposure would also result from the handling of the DU oxide cylinders and empty and heel cylinders during loading operations at the site in preparation for shipment to the waste disposal site. For the DU oxide cylinders, it is assumed that the cylinders could be shipped either by rail (six cylinders per railcar) or by truck (one cylinder per truck). It would take four workers and a supervisor about four hours to load six cylinders onto a railcar (PPPO 2018). The same crew would take about a half-hour to load a single cylinder onto a truck. As noted in the transportation analysis the dose at 30 cm from the cylinder surface is about 2 millirem/hour which equates to less than 1 millirem/hour at 1 meter from the cylinder surface. Although it takes four hours to load six cylinders onto a railcar, the time spent in close proximity to the cylinder is limited. It is estimated that the worker dose associated with loading these six cylinders would be 2 millirem per person for a total of 0.01 person/rem for the 5 workers. Given the shorter time to load a single cylinder onto a truck, compared to a single cylinder onto a railcar, this dose should be bounding for this operation.

At Paducah, 46,150 DU oxide cylinders are to be shipped to a waste disposal facility. Given the dose rate per railcar provided above this results in a total worker dose of 77 person-rem. No LCFs (calculated value of 0.05) would be expected from this exposure. Over the 32 years of shipment operations, the average individual worker dose would be 480 millirem/yr which corresponds to an annual risk of about 3×10^{-4} LCF. At Portsmouth, 22,850 DU oxide cylinders are to be shipped to a waste disposal facility. Given the dose rate per railcar provided above this results in a total worker dose of 38 person-rem. No LCFs (calculated value of 0.02) would be expected from this exposure. Over the 15 years of shipment operations, the average individual worker dose would be 510 millirem/yr which corresponds to an annual risk of about 3×10^{-4} LCF.

There are also a number of empty and heel cylinders at both sites, 8,483 at Paducah and 5,517 at Portsmouth, that would need to be disposed. However, the surface dose for these cylinders is 0.01 millirem at 1 meter (see Appendix B of this DU Oxide SEIS), two orders of magnitude less than that for a loaded DU oxide cylinder. Assuming an equivalent reduction in the dose (0.1 millirem to a crew loading 6 bulk bags) loading these cylinders onto either railcars or trucks results in a total dose of less than 1 person-rem. Therefore, the total worker dose for loading operations would be dominated by the dose for loading DU oxide cylinders. **Table 4-15** provides a summary of the worker doses from the storage and loading operations.

Table 4-15 Disposal of Depleted Uranium Oxide Alternative - Worker Health Radiological Impacts

	Involved Worker					
	Average Worker			**Worker Population**		
	Annual	**Duration of Activity**		**Annual**	**Duration of Activity**	
Site	**Dose (mrem/yr)**	**Dose (rem)**	**Health Risk (LCF)**	**Dose (person-rem/yr)**	**Dose (person-rem)**	**Health Risk (LCF)**
Paducah						
Cylinder storage	74	3.7[a]	2×10^{-3}	1.2	90	0.05
Cylinder loading[b]	480	15	9×10^{-3}	2.4	77	0.05
Total[c]	**550**	**19**	**1×10^{-2}**	**3.6**	**170**	**0.10**
Portsmouth						
Cylinder storage	63	3.2[a]	2×10^{-3}	0.76	36	0.02
Cylinder loading[b]	510	7.6	5×10^{-3}	2.5	38	0.02
Total[c]	**570**	**11**	**7×10^{-3}**	**3.3**	**74**	**0.04**

Key: LCF = latent cancer fatality; mrem = millirem; yr = year.

[a] Due to the length of cylinder storage, individual worker exposure was limited to a 50 year exposure time.

[b] Average worker dose is based on the assumption that the same team performs all loading operations.

[c] Only for the years during shipping and assuming no reduction in storage impacts due to reduced quantities in storage from shipping. Total for the average worker assumes that different workers are involved in cylinder storage activities and cylinder loading.

The 2004 EISs (DOE 2004a, 2004b) calculated a maximum noninvolved worker dose of 0.15 millirem per year from storage of DUF_6. The dose, primarily from direct radiation, was estimated based on the uranium in the cylinders in the conversion facility and cylinder storage yards and the cylinders being moved to and from the conversion facility. Because the amount of uranium that will be stored as an oxide would be similar to that previously being stored as DUF_6, the dose to the noninvolved worker would be similar for the storage and handling of DU oxide.

The 2004 EISs (DOE 2004a, 2004b) also calculated a total worker dose for noninvolved workers. The collective noninvolved worker dose at the two Sites was estimated to be 0.003 person-rem per year at Paducah and 0.001 person-rem per year at Portsmouth for workforces that vary from those predicted in this DU Oxide SEIS during storage of DU oxide.[52] During the years of DU oxide storage, the total noninvolved worker dose would be 0.22 person-rem at Paducah and 0.047 person-rem at Portsmouth. No LCFs (calculated values are less than 1×10^{-4} LCF at Paducah and 3×10^{-5} LCF at Portsmouth) would be expected at either site for DU oxide storage and handling before shipment to Energy*Solutions*.

For worker protection from the toxic effects of uranium, DOE uses the OSHA permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000 Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels. Adherence to these limits would result in no adverse health effects to workers at either site from the toxic effects of uranium exposure.

Nonradiological accidents could also pose risks to site workers. All on-site work would be performed in accordance with best management practices, and in accordance with applicable OSHA requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, "*Worker Safety and Health Program*." DOE Order 450.2, "*Integrated Safety Management*," integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were determined on the basis of the number of workers in the cylinder yard (16 at Paducah and 12 at Portsmouth) and national worker injury and fatality rates. There would be no expected fatalities at either site based on an average worker fatality rate of 3.4 fatalities per 100,000 worker years (BLS 2014). In 2016, the national average across all industries for accidents resulting in lost worker days was 3.0 accidents per 100 worker-years (BLS 2016b). This accident rate results in an annual estimated 0.48 cylinder yard worker injury at Paducah and 0.36 cylinder yard worker injury at Portsmouth. During the evaluated 76 years of DU oxide storage at Paducah and 47 years of DU oxide storage at Portsmouth, this accident rate could result in 36 and 17 worker injuries, respectively.

Public and Occupational Safety and Health under the Bulk Bags Option

An option is being considered for the Action Alternative under which the DU oxide would be placed in bulk bags directly from the conversion process. These bulk bags would then be loaded onto trucks or railcars and shipped to a waste disposal facility and would not be placed in the cylinder yards for storage. Based on the amount of DU oxide that would be produced and the assumed capacity of the bulk bags; 41,016 bulk bags would be filled and shipped to the disposal facility from Paducah and 18,142 bulk bags would be filled and shipped from Portsmouth. In this

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[52] The size of the workforces used in the 2004 EISs were 1,799 at Paducah and 1,727 at Portsmouth. In 2016 the size of the workforce at each site was approximately 1,200 at Paducah and 2,527 at Portsmouth (DOE 2017b). Noninvolved worker doses were not scaled due to these differences.

option, the empty and heel cylinders (46,150 at Paducah and 22,850 at Portsmouth) would be volume-reduced and shipped off site as waste.

Public Health and Safety for the Bulk Bag Option

Under this option there would be little or no individual or population dose from the temporary storage and loading for shipment of DU oxide in bulk bags. Comparatively, there would be less DU oxide on site at any one time since the bags are filled, loaded, and shipped as the DU oxide is generated. This means there would be less material available as a source of direct radiation for any member of the public near the site boundary. The dose at 1 meter from the surface of the bulk bag is expected to be similar to that for a cylinder, less than 1 millirem/hour (PPPO 2018).

The primary source of the normal operations population dose from cylinder storage is the release of material during cylinder breaches. Because the bulk bags are on-site for a short period there would little to no likelihood of a breach of a bulk bag that would be considered a normal operational event. Any rupture of the bulk bags would be the result of an accident and not from normal wear during storage.

Occupational Safety and Health for the Bulk Bag Option

As with the public health and safety, there would be no worker exposure due to the temporary storage of bulk bags. Worker exposure would result from the handling of the DU oxide in bulk bags and empty and heel cylinders during loading operations at the site in preparation for shipment to the waste disposal site.

For the DU oxide bulk bags, it is assumed that the bulk bags could be shipped either by rail (eight bulk bags per railcar) or by truck (two bulk bags per truck). It is assumed that the information on the loading of cylinders is a reasonable approximation for the loading of bulk bags. It would take four workers and a supervisor about four hours to load six bulk bags onto a railcar (PPPO 2018). The same crew would take about a half-hour to load a single bulk bag onto a truck. The dose at 1 meter from the bulk bag is less than 1 millirem/hour (PPPO 2018), similar to the dose associated with a full cylinder. Although it takes four hours to load six bulk bags onto a railcar, the time spent in close proximity to the bulk bag is limited. It is estimated that the worker dose associated with loading these six bulk bags would be 2 millirem per person, for a total of 0.01 person/rem for the 5 workers. Given the shorter time to load a single bulk bag onto a truck, compared to a single bulk bag onto a railcar, this dose should be bounding for this operation.

At Paducah, 41,016 DU oxide bulk bags would be shipped to a waste disposal facility. Given the dose rate per railcar provided above this results in a total worker dose of 68 person-rem. No LCFs (calculated value of 0.04) would be expected from this exposure. Over the assumed 34 years of shipment operations, the average annual worker dose would be 2.1 person-rem/yr which corresponds to an annual risk of about 1.2×10^{-3} LCF. At Portsmouth, 18,142 DU oxide bulk bags are to be shipped to a waste disposal facility. Given the dose rate per railcar provided above this results in a total worker dose of 30 person-rem. No LCFs (calculated value of 0.02) would be expected from this exposure. Over the assumed 22 years of shipment operations, the average individual worker dose would be 1.4 person-rem/yr which corresponds to an annual risk of about 8.2×10^{-4} LCF.

The use of bulk bags results in the generation of a large number of empty and heel cylinders at both sites (46,150 at Paducah and 22,850 at Portsmouth) that would need to be disposed. These cylinders would be compacted and cut in half to reduce their length at the on-site volume-reduction reduction facility. The reduced size cylinder would then be loaded by overhead crane into a shipping container. Secondary containment would be provided for the intermodal container loadout. Operation of the volume-reduction facility was analyzed in the 2004 EISs and is not within the scope of this DU Oxide SEIS. None of these activities requires a worker to be in close proximity to the cylinders. In assessing the worker doses associated with this activity, the 2004 EISs, while identifying this activity as part of the conversion operations with the use of bulk bags, did not modify the worker doses associated with conversion operations. Based on that treatment of this activity and the fact that no worker needs to be in close proximity to the empty and heel cylinders during the activity, these worker impacts are assumed not to significantly contribute to worker dose.

Public and Occupational Safety and Health Related to Accident Scenarios

The impacts of accidents, should they occur, during storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.3). However, because the storage time is shorter, the probability of an accident is lower.

Truck and rail loading activities could result in an increased likelihood of container handling accidents as compared to the No Action Alternative. Although greater than the No Action Alternative, the accident likelihood would be similar to existing activities where DUF_6 containers are regularly moved into and DU oxide containers moved out of the conversion facility. See Section 4.1.1.6 of this DU Oxide SEIS for a discussion of accidents under existing conditions.

Public and Occupational Safety and Health—Intentional Destructive Acts

Because of the low hazard posed by DU oxide, the material would not be an attractive target for a terrorist attack or other intentional destructive acts. The potential impacts of intentional destructive acts during storage of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.6).

The impacts caused by potential intentional destructive acts during loading of DU oxide containers for transportation to Energy*Solutions* were not specifically calculated in the 2004 EISs (DOE 2004a, 2004b). However, because of the relatively low hazard posed by DU oxide, should an intentional destructive act occur, the consequences of the act are expected to be comparable to the consequences of the accidents described in the 2004 EISs and summarized in this DU Oxide SEIS.

4.2.1.7 Socioeconomics

The socioeconomic analysis covers the effects on population, employment, income, regional growth, housing and community resources in the ROI of Paducah and Portsmouth. The impacts of storage and maintenance of DU oxide containers, and the loading of waste for off-site disposal, at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.7).

DU oxide storage containers would be moved and loaded onto trucks or railcars for shipment to the disposal site. As shown in **Table** 4-16, employment for DU oxide container monitoring and maintenance is estimated at 16 full-time employees for Paducah and 12 full-time employees for Portsmouth. These employees would also perform the truck- and rail-loading duties. Disposal of DU oxide in bulk bags would likely be similar to disposal of DU oxide in cylinders since bulk bags would require fewer bags than DU oxide in cylinders (less labor) but would generate a greater number of empty and heel cylinders (more labor). In addition, management of large quantities of CaF_2 would only be required if the DOE was unable to sell HF; in which case, staff assigned to manage HF could manage CaF_2. Therefore, because of the small numbers of employees involved, no appreciable in-migration or out-migration is expected, and there would be no impacts on population and regional growth, housing, or community services in the Paducah and Portsmouth ROIs.

Table 4-16 Comparison of Site Employment to Employment for DU Oxide Container Management under the Action Alternatives

Site	Employment for DU Oxide Container Monitoring, Maintenance, and Shipping	Site Employment (Percent of Employment)	
		Estimated for Conversion Facility	Current Total Site
Paducah	16	250 (6)	1,200 (1)
Portsmouth	12	210 (6)	2,612 (0.5)

Key: DU = depleted uranium.
Source: PPPO 2018

4.2.1.8 Waste Management

The impacts from storage and maintenance of DU oxide cylinders at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.8). No impacts on waste management capabilities at Paducah or Portsmouth would be expected from generation of ancillary LLW and MLLW from storage and maintenance of DU oxide containers, or from generation of empty and heel cylinders or CaF_2.

Activities at Paducah and Portsmouth to load DU oxide cylinders onto trucks or railcars for transport to Energy*Solutions* would generate negligible quantities, if any, of LLW or MLLW. DOE expects the cylinders to be free from surface contamination. As part of the oxide conversion process, any contamination that may be present on the surfaces of the cylinders after loading with DU oxide would be removed before transfer of the cylinders to the storage yards. The small quantities of nonhazardous waste and sanitary wastewater would be similar to the quantities currently generated from cylinder surveillance and maintenance activities and would be managed as described in Section 4.1.1.8, with no additional impacts on waste management capabilities at Paducah or Portsmouth.

4.2.1.9 Land Use and Aesthetics

Adverse impacts on land use and aesthetics could occur from new construction or changes in land use. The impacts from storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.9). There would be no new construction and no changes in land use at Paducah and Portsmouth. The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.9).

As the DU oxide containers are shipped off site, the numbers of containers stored at Paducah and Portsmouth would be reduced. Over time, the storage yards would be emptied and the visual impact of the large numbers of storage containers would be reduced and finally eliminated. Because the storage pads would remain until a final disposition decision is made, the industrial character of the Sites would not change appreciably. Therefore, minimal impacts are expected on land use and aesthetics at Paducah or Portsmouth.

4.2.1.10 Cultural Resources

The impacts of storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.10). The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.10).

Impacts on cultural resources could occur if ground disturbance resulted in the discovery of previously unrecorded cultural resources that, once evaluated, were determined to be eligible for listing on the NRHP. This alternative does not include any ground disturbance at Paducah and Portsmouth. Therefore, handling wastes, including DU oxide containers, and shipping them off-site from Paducah and Portsmouth would be expected to have no effect on cultural resources at either site (DOE 2004a, 2004b).

4.2.1.11 Environmental Justice

A determination of impacts that could disproportionately affect minority and low-income populations is based upon the identification of high and adverse impacts on the resource areas considered in this DU Oxide SEIS. The impacts of storage and maintenance of DU oxide containers at Paducah and Portsmouth until shipment to Energy*Solutions* would be similar to those described for long-term storage under the No Action Alternative (Section 4.1.1.11). The impacts from loading ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 at Paducah and Portsmouth for shipment to Energy*Solutions* would be similar to those described under the No Action Alternative (Section 4.1.1.11).

In addition, DU oxide containers would be loaded onto trucks or railcars for shipment to the disposal site. As described in Section 4.2.1.6, there would be minimal impacts on the general public from normal operations. Therefore, there would be no disproportionate high and adverse impacts on minority and low-income populations from normal operations.

Potential adverse human health impacts associated with a truck or railcar loading accident could impact the health and safety of the general population surrounding the site. The results of the accident analysis (Section 4.2.1.6) identified that, although there would be an increased likelihood of container handling accidents, consequences would be expected to be minor and similar to those from current container handling operations. Therefore, disproportionate high and adverse impacts on minority or low-income populations near the Paducah and Portsmouth Sites are not expected.

Minimal impacts on the general public related to air quality, climate, noise, and water resources have been identified, including at the population and individual level. In addition, accidents were found to have negligible radiological and chemical consequences to the public. There would be no disproportionately high and adverse impacts on minority or low-income populations.

4.2.2 Transport of Depleted Uranium Oxide and Other Wastes to Energy*Solutions*

This section summarizes the potential impacts associated with the shipment of DU oxide and other wastes from Paducah in Kentucky and Portsmouth in Ohio, to Energy*Solutions* in Utah under incident-free and accident conditions. Details of the analysis methodology and analytical results are presented in Appendix B. Two options are considered: rail and truck. Under the truck option, one DU oxide cylinder would be transported per truck. Under the rail option, each train would consist of 10 railcars, each railcar containing six DU oxide cylinders. [53] It is expected that Paducah and Portsmouth would each annually make 24 train shipments or 1,440 truck shipments to Energy*Solutions*.

Empty and heel cylinders, ancillary LLW and MLLW, and CaF_2, would also be shipped to Energy*Solutions*. Under the rail option, empty or heel cylinders would be shipped 6 per railcar with 10 railcars per train, while under the truck option, 2 empty or heel cylinders would be shipped per truck. There would be a total of 140 rail shipments of empty and heel cylinders from Paducah and 90 rail shipments from Portsmouth, or 4,240 truck transports from Paducah and 2,760 truck shipments from Portsmouth. Each heel cylinder is assumed to contain between 10 to 23 kilograms (22 to 50 pounds) of residual DU. The ancillary LLW and MLLW is estimated to annually require one truck shipment each from Paducah and Portsmouth. Furthermore, consistent with the assumption in the 2004 conversion EISs, it is assume that for CaF_2, four bulk bags would be shipped per railcar, and one bulk bag would be shipped per truck. It is estimated that there would be 32,420 CaF_2 truck shipments or 8,150 rail shipments from Paducah and 13,550 truck shipments or 3,390 rail shipments from Portsmouth to Energy*Solutions*.

For incident-free transportation, the potential human health impacts from the radiation field surrounding the packages were estimated for transportation workers and populations along the

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[53] As described in Chapter 2, Section 2.1.2, small quantities of DU oxide may also be stored in 55-gallon drums. The DU oxide stored in these drums would result in fewer DU oxide cylinders or bulk bags being generated. Therefore, transportion of the drums is not specifically analyzed, but the impacts of transporting these drums would be encompassed by the transportion of DU oxide in cylinders or bulk bags.

route (off-traffic, or off-link[54]), people sharing the route (in-traffic or on-link [55]), and people at rest areas and stops along the route. The System for Analyzing the Radiological Impact of the Transportation of Radioactive Materials (RADTRAN) 6 computer program (SNL 2013) was used to estimate impacts on transportation workers and populations, as well as the impact to an MEI, who may be a worker or a member of the public (for example, a resident along the route, a person struck in traffic, a gasoline station attendee, or an inspector).

Potential human health impacts from transportation accidents were evaluated. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (accident frequency) multiplied by the accident consequences. The overall risk was obtained by summing individual risks from all accidents evaluated in this DU Oxide SEIS. The analysis of accident risks accounts for a spectrum of accidents ranging from high-probability accidents of low severity (a fender-bender) to hypothetical high-severity accidents that have a corresponding low probability of occurrence.

In addition to calculating the radiological risks that would result from all evaluated accidents that could occur during transportation of radioactive waste, DOE evaluated the radiological consequences of maximum reasonably foreseeable accidents with probabilities greater than 1×10^{-7} (1 chance in 10 million) per year. These latter consequences were determined for the atmospheric conditions that would likely prevail during accidents. This analysis used the Risks and Consequences of Radioactive Material Transport (RISKIND) computer program to estimate doses to individuals and populations (Yuan et al. 1995).

Incident-free radiological health impacts are expressed as additional LCFs. Radiological accident health impacts are also expressed as additional LCFs, and nonradiological accident risks are expressed in terms of additional immediate traffic fatalities. LCFs associated with radiological exposure are estimated by multiplying the occupational (worker) and public dose by a risk factor of 0.0006 (6×10^{-4}) LCF per rem or person-rem of exposure (DOE 2003). Impacts from transporting wastes were calculated assuming that the wastes are shipped by truck or by rail. All shipments would meet applicable DOT and NRC packaging and other transportation regulations (see Appendix B, Sections B.3.1 and B.3.2, of this DU Oxide SEIS).

In determining transportation risks, per-shipment risk factors were calculated for incident-free and accident conditions using the RADTRAN 6 computer program (SNL 2013) in conjunction with the Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003) to choose transportation routes in accordance with DOT regulations. The TRAGIS program provides population density estimates for rural, suburban, and urban areas along the routes based on the 2010 U.S. Census. The population density estimates were escalated to 2020 population density estimates using state-level 2000 and 2010 Census data and assuming population growth between 2000 and 2010 would continue through 2020. The ROI of this analysis is the affected population, including individuals living within 0.5 miles (0.8

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[54] All persons residing or working alongside of a transportation route (DOE 2002b; see Appendix B).

[55] Persons in all vehicles sharing the transportation route. This group includes persons traveling in the same or the opposite direction as the shipment, as well as persons in vehicles passing the shipment (DOE 2002b; see Appendix B).

kilometers) of each side of the road or rail line for incident-free operations and, for accident conditions, individuals living within 50 miles (80 kilometers) of the accident. The MEI is assumed to be a receptor located 100 meters (330 feet) directly downwind from the accident. Details of the analytical approach and the modeling parameter selections are provided in Appendix B.

Route-specific accident and fatality rates for commercial truck transports and rail shipments were used to determine the risk of traffic accident fatalities (Saricks and Tompkins 1999) after being adjusted for possible under-reporting (UMTRI 2003). The methodology for obtaining and using accident and fatality rates is provided in Appendix B, Section B.6.2.

It is estimated that transportation of DU oxide from Paducah via truck or rail would require about 32 years, based on transport of up to 1,440 cylinders per year. About 46,150 cylinders would be transported from Paducah containing 446,520 metric tons of DU oxide (PPPO 2018). The transportation of DU oxide from Portsmouth via truck or rail requires about 15 years, also based on transport of up to 1,440 cylinders per year. About 22,850 cylinders would be transported from Portsmouth containing 199,340 metric tons of DU oxide (PPPO 2018).

Table 4-17 summarizes the potential transportation impacts for disposal of DU oxide in cylinders at Energy*Solutions*. As indicated, all risk values are less than one, except for the nonradiological accident risk associated with truck or rail shipments. This means that no LCFs are expected during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of transports over 32 years.

Table 4-17 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Cylinders to Energy*Solutions*

Origin	Number of Shipments[a]	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population		Radiological Risk[b]	Nonrad Risk[b]
			Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]		
Truck								
Paducah	46,200	119,200,000	141	0.08	375	0.2	3×10^{-4}	6
Portsmouth	21,900	70,500,000	84	0.05	216	0.1	1×10^{-4}	3
Rail								
Paducah	770	2,100,000	61	0.04	82	0.05	2×10^{-3}	0.7
Portsmouth	380	1,200,000	38	0.02	52	0.03	1×10^{-3}	0.3

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Tables 4-18 and 4-19 summarize the potential transportation impacts for shipment of empty and heel cylinders and other LLW and MLLW to Energy*Solutions*. Table 4-18 shows the transportation impacts assuming the empty and heel cylinders are transported intact. As indicated in Tables 4-18, and 4-19, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail.

Table 4-18 Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to Energy*Solutions*

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk [b]
Truck								
Paducah	4,240	10,900,000	0.1	8×10^{-5}	0.3	2×10^{-4}	1×10^{-7}	0.6
Portsmouth	2,760	8,500,000	0.1	6×10^{-5}	0.3	2×10^{-4}	6×10^{-8}	0.4
Rail								
Paducah	140	390,000	0.1	7×10^{-5}	0.1	9×10^{-5}	8×10^{-7}	0.1
Portsmouth	290	290,000	0.09	5×10^{-5}	0.1	7×10^{-5}	7×10^{-7}	0.07

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Table 4-19 Annual Risks to Crew Members and the Public from Transporting Other Low-Level Radioactive Waste and Mixed Level Radioactive Waste to Energy*Solutions*

			Incident-Free[a]				Accident[a]	
			Crew		Population			
Origin	Number of Shipments	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck[c]								
Paducah	1	2,600	3×10^{-4}	2×10^{-7}	2×10^{-4}	1×10^{-7}	7×10^{-14}	1×10^{-4}
Portsmouth	1	3,100	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	6×10^{-14}	1×10^{-4}

Key: LCF = latent cancer fatality; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; Nonrad = nonradiological.

[a] Total risks can be estimated by multiplying by the maximum duration of the storage period for this alternative (76 years [44 + 32) for Paducah and 47 years (32 +15) for Portsmouth)

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because of the small amount of waste requiring shipment to the waste management facility, rail transport would be inefficient and was not considered.

DOE is also considering the option of transporting DU oxide using bulk bags consistent with the analysis presented in the 2004 EISs (DOE 2004a, 2004b). It is estimated that there would be 20,150 and 9,070 truck shipments and 5,130 and 2,270 rail shipments from Paducah and Portsmouth, respectively, using consistent assumptions as those used in the 2004 EISs. Therefore, because the amount of DU oxide evaluated in this DU Oxide SEIS is larger than that evaluated in the 2004 EISs, the bulk bag transportation risks presented in this SEIS are proportionally larger than those cited in the 2004 EISs. If the bulk bags are used, the empty and heel cylinders also need to be transported to the disposal sites. It is assumed that the cylinders would be volume-reduced and packaged 10 to a 20-foot intermodal container and transported one container per truck and two containers per railcar. The 2004 EISs also considered that about 10 percent of the cylinders could not be accepted at the Energy*Solutions*; therefore, these cylinders would be transported intact to NNSS. The 2004 EISs assumed that rail connections will be available at NNSS, therefore, no intermodal facility near the NNSS was used. The risks of transporting the volume-reduced cylinders are calculated using information from the 2004 EISs, and those for the intact cylinders are calculated using the same assumptions used in Table 4-28 in this DU Oxide SEIS. Note that the results presented for the impacts of transporting DU oxide in bulk bags and volume-reduced empty and heel cylinders are based on assumptions and information from the 2004 EISs regarding populations along the routes that are different from those considered for transporting DU oxides in cylinders to Energy*Solutions* and NNSS as analyzed in this DU Oxide SEIS. Nevertheless, the impacts from the 2004 EISs have been scaled where appropriate to provide information on potential impacts for the larger amount of DU oxide that would be shipped to Energy*Solutions* and NNSS under the alternatives evaluated in this DU Oxide SEIS.

Tables 4-20 and **4-21** summarize the potential transportation impacts for shipping DU oxide in bulk bags, and the empty and heel cylinders to the Energy*Solutions* site. As indicated in Tables 4-20 and 4-21, all radiological risk values are less than 1. This means that no LCFs are expected to occur during transport by truck or rail.

Table 4-20 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Bulk Bags to Energy*Solutions*

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah[c]	20,510	52,099,000	300	0.2	137	0.08	3×10^{-2}	2
Portsmouth[d]	9,070	26,515,000	154	0.09	72	0.04	2×10^{-2}	1
Rail								
Paducah[c]	5,130	13,759,000	700	0.4	26	0.02	7×10^{-3}	0.6
Portsmouth[d]	2,270	7,507,000	359	0.2	17	0.01	6×10^{-3}	0.5

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-21 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

Note: To convert kilometers to miles multiply by 0.62137.

Table 4-21 Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to Energy*Solutions*

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck (volume-reduced to Energy*Solutions*)								
Paducah[c]	4,920	12,497,000	73	4×10^{-2}	40	2×10^{-2}	3×10^{-4}	0.6
Portsmouth[d]	2,550	7,453,000	44	3×10^{-2}	24	1×10^{-2}	2×10^{-4}	0.3
Truck (10% intact to NNSS)[e]								
Paducah[c,e]	2,730	8,757,000	0.1	6×10^{-5}	0.3	2×10^{-4}	4×10^{-8}	0.4
Portsmouth[d,e]	1,420	5,299,000	0.06	4×10^{-5}	0.2	1×10^{-4}	3×10^{-8}	0.2
Rail (volume-reduced to Energy*Solutions*)								
Paducah[c]	2,460	6,600,000	185	1×10^{-1}	7	4×10^{-3}	6×10^{-5}	0.3
Portsmouth[d]	1,275	4,226,000	112	7×10^{-2}	5	3×10^{-3}	6×10^{-5}	0.3
Rail (10% intact to NNSS)[e]								
Paducah[c,e]	50	168,000	0.05	3×10^{-5}	0.06	3×10^{-5}	2×10^{-7}	0.04
Portsmouth[d,e]	20	80,000	0.02	1×10^{-5}	0.03	2×10^{-5}	1×10^{-7}	0.02

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-21 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] The intact cylinders represent transport of 10 percent of the total empty and heel cylinders, which are 83,000 (69,000 plus 14,000) to NNSS. The calculated doses and risks are based on the information provided in Table 4-28 of this DU Oxide SEIS, assuming that the intact cylinders are transported 2 per truck and 60 per train. These cylinders are transported to NNSS. In addition, for the volume-reduced packages, the 2004 EISs assume that direct rail connections will be available at NNSS.

Note: To convert kilometers to miles multiply by 0.62137.

Furthermore, the impacts from the transport of calcium fluoride (CaF_2) from neutralization of HF to a LLW disposal facility are also estimated. It is estimated that there would be 32,420 truck shipments or 8,105 rail shipments from Paducah and 13,550 truck shipments or 3,390 rail shipments from Portsmouth to Energy*Solutions*. Although conservatively considered LLW for purposes of disposal, the CaF_2 has such low levels of radiation, it would provide a neglibile dose to the crew and the public during transport. The estimated traffic fatalities from these shipments are summarized in **Table 4-22**.

Table 4-22 Total Population Transportation Risks for Shipment of CaF_2 to Energy*Solutions* under the Hydrogen Fluoride Neutralization Option

Origin	Paducah		Portsmouth	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	32,420	8,105	13,550	3,390
Total distance (one-way [km])	83,630,000	21,751,000	41,736,000	11,210,000
Traffic fatalities (round trip)	4.5	0.48	1.92	0.53

Impacts from Incident-Free Transport of Radioactive Waste

The potential radiological impacts for transport crews and populations along the routes are shown in Tables 4-17 through 4-22. The table includes the results of shipping all DU oxide and other radioactive waste to Energy*Solutions*. As shown in Tables 4-17 through 4-22, transportation of the DU oxide dominates the risks of transportation. Therefore, the impacts of shipping empty and heel cylinders and other LLW and MLLW to Energy*Solutions* are not discussed further.

Transport of DU oxide in bulk bags results in the maximum impact on the transportation crew compared to transport of DU oxide in cylinders. This difference is driven by the modeling assumptions in the 2004 conversion EISs. Under the Energy*Solutions* Disposal Alternative, transport of DU oxide would likely not result in any LCFs to crew members, as detailed in Table 4-20. For truck transport, the LCF risk over the duration of the project (assuming all DU oxide waste from both Paducah and Portsmouth was disposed of at Energy*Solutions*) would be 0.3, or 1 chance in 3 of developing a single LCF among the transportation crews. For rail transport, the calculated LCF risk over the duration of the project would be 0.6, or 1 chance in about 1.6 of a single LCF among the transportation crews.

Transport of DU oxide in cylinders results in the maximum impact on the general population compared to transport of DU oxide in bulk bags. This difference is driven by the higher population estimates along the routes, both on and off the roads. However, as detailed in Table 4-17, the dose to the general population would likely not result in an LCF. For truck transport of DU oxide, the calculated LCF risk over the duration of the project would be 0.35, or 1 chance in about 3 of a single LCF in the exposed population. For rail transport, the calculated LCF risk over the duration of the project would be 0.08, or 1 chance in about 12 of a single LCF in the exposed population.

The total radioactive dose received by an MEI (a resident along the route near Energy*Solutions*), hypothetically assumed to be exposed to every DU oxide truck shipment from both Paducah and Portsmouth would be about 2.14 millirem, resulting in an increased risk of developing a fatal cancer of 1×10^{-6}, or 1 chance in 780,000. Assuming that shipments would occur over 34 years, the average annual dose to this individual would be 0.063 millirem, which is 0.063 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents) and (2) maximum reasonably foreseeable accidents (accidents with radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year).

As indicated in Tables 4-17 through 4-19, considering all reasonably foreseeable accidents, transport of radioactive waste would likely result in no LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck and rail transportation options.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and maximum consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxide shipped under this alternative, the reasonably foreseeable transportation accident with the highest consequence would involve rail transport with the assumption of the breach of all six cylinders in a railcar in an urban area (see Appendix B, Table B-7). The maximum reasonably foreseeable probability of a rail accident involving transport of DU oxide to Energy*Solutions* would be up to 1.5×10^{-7} per year in an urban area, or approximately 1 chance in 7 million each year. The consequences of the rail transport accident, if it occurred, in terms of population and MEI dose would be about 47 person-rem and 0.039 rem, respectively. These doses would likely result in no (calculated value: 0.03 LCF) additional LCFs among the exposed population and a risk of 2×10^{-5} that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (calculated value: 4×10^{-9} LCF).

Vehicle Emissions

Transport of DU oxide and other radioactive wastes to the Energy*Solutions* site would result in emissions from trains or trucks. It is expected that Paducah and Portsmouth would each make two railcar shipments of DU oxide each month for an average of 24 railcar shipments annually from Paduchah and 25 from Portsmouth. For shipment by truck, it is expected that Paducah and Portsmouth would each ship approximately 1,440 truckloads per year. The empty and heel cylinders could be shipped via rail in 4 annual shipments or via truck in 125 annual shipments. Transport of CaF_2 via rail is assumed to be another 238 and 154 additional shipments annually from Paducah and Portsmouth, respectively. Shipment of CaF_2 via truck would result in an additional 953 and 616 shipments from Paducah and Portsmouth, annually.

The quantity of DU oxide in each truck or rail shipment would vary depending on whether cylinders or bulk bags are used. If bulk bags were to be used, the total number of truck shipments of DU oxide would decrease, but the number of empty and heel cylinders to be shipped for disposal would increase. The total number of rail shipments under the bulk bag shipment scenario would be more than the number of shipments utilizing DU oxide in cylinders. Therefore, the analysis below represents the most conservative scenario (i.e., the largest quantity of emissions), and all other potential shipping scenarios would generate lower levels of emissions of both criteria pollutants and GHGs.

Rail Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 railcar shipments annually from Paduchah and 25 from Portsmouth to Energy*Solutions* and an additional 238 and 154 shipments of CaF_2 from Paducah and Portsmouth, respectively. It was estimated that locomotives would travel approximately 1,600 miles (2,600 kilometers) per rail shipment from Paducah to Energy*Solutions* and approximately 1,900 miles (3,100 kilometers) from Portsmouth to Energy*Solutions.* Emissions were calculated using emission factors for tier 2 line haul locomotives derived from the EPA's *Emission Factors for Locomotives* (EPA 2009).

Emissions of all criteria pollutants would be less than 310 tons (280 metric tons) annually for all shipments of DU oxide, ancillary LLW and MLLW, empty and heel cylinders, and $CaF_{2,}$ from Paducah and Portsmouth combined (**Table 4-23**). Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR. However, because the emissions are so small in comparison to overall U.S. locomotive and vehicle transportation emissions, the emissions are not likely to contribute to any significant impact on air quality. Emissions could be decreased further by combining shipments for the rail option. That is, while it was assumed that DU oxide and CaF$_2$ in bulk bags would be shipped in one railcar per shipment, filling multiple cars per shipment would decrease the overall number of trips and, therefore, the quantity of annual emissions.

Table 4-23 Annual Criteria Pollutant Emissions from Transportation via Railcar to Energy*Solutions*

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO$_x$	PM$_{10}$	PM$_{2.5}$	SO$_x$	VOC
Ancillary LLW and MLLW	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
	Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
	Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Paducah	1.69	6.54	0.24	0.23	0.12	0.36
	Portsmouth	2.09	8.09	0.29	0.29	0.15	0.45
	Total emissions	*3.78*	*14.62*	*0.53*	*0.52*	*0.27*	*0.81*
14,000 empty and heel cylinders	Paducah	0.28	1.09	0.04	0.04	0.02	0.06
	Portsmouth	0.33	1.29	0.05	0.05	0.02	0.07
	Total emissions	*0.62*	*2.38*	*0.09*	*0.08*	*0.04*	*0.13*
DU oxide in bulk bags	Paducah	10.64	41.13	1.50	1.45	0.75	2.27
	Portsmouth	8.61	33.32	1.21	1.18	0.61	1.84
	Total emissions	*19.25*	*74.45*	*2.71*	*2.63*	*1.36*	*4.12*
69,000 empty and heel cylinders	Paducah	15.92	61.56	2.24	2.17	1.12	3.40
	Portsmouth	14.47	55.96	2.03	1.97	1.02	3.09
	Total emissions	*30.39*	*117.52*	*4.27*	*4.15*	*2.15*	*6.50*
CaF$_2$	Paducah	16.76	64.83	2.36	2.29	1.18	3.59
	Portsmouth	12.88	49.81	1.81	1.76	0.91	2.76
	Total emissions	*29.64*	*114.64*	*4.17*	*4.04*	*2.09*	*6.34*
Grand Total (DU Oxide in Cylinders)		**34.23**	**132.39**	**4.82**	**4.67**	**2.41**	**7.32**
Grand Total (DU Oxide in Bulk Bags)		**80.09**	**309.73**	**11.26**	**10.93**	**5.66**	**17.13**

Truck Option

Criteria pollutant emissions were calculated based on an estimated 1,440 shipments annually from each facility to Energy*Solutions* (see **Table 4-24)**. Analysis estimated approximately 1,600 miles (2,600 kilometers) per truck shipment from Paducah to Energy*Solutions* and approximately 1,900 miles (3,100 kilometers) per shipment from Portsmouth to Energy*Solutions* via truck. Emissions were derived using the emission factors for heavy-duty diesel vehicles in the EPA's MOVES2014a. MOVES is the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator. It is used to create emission factors or emission inventories for both onroad motor vehicles and nonroad equipment (EPA 2015).

Emissions of all criteria pollutants would be less than 58 tons (53 metric tons) annually for all shipments from Paducah and Portsmouth combined. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular Air Quality Control Region (AQCR).

Because the emissions are so small in comparison to overall U.S. vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table 4-24 Annual Criteria Pollutant Emissions from DU Oxide Transportation via Truck to Energy*Solutions*

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.17	0.48	0.02	0.02	0.00	0.05
	Portsmouth	0.14	0.41	0.01	0.01	0.00	0.04
	Total emissions	*0.31*	*0.88*	*0.03*	*0.03*	*0.00*	*0.09*
DU oxide (cylinders)	Paducah	5.50	15.69	0.57	0.53	0.04	1.64
	Portsmouth	6.90	19.68	0.72	0.66	0.04	2.05
	Total emissions	*12.40*	*35.37*	*1.29*	*1.19*	*0.08*	*3.69*
14,000 empty and heel cylinders	Paducah	0.48	1.36	0.05	0.05	0.00	0.14
	Portsmouth	0.57	1.62	0.06	0.05	0.00	0.17
	Total emissions	*1.04*	*2.98*	*0.11*	*0.10*	*0.01*	*0.31*
DU oxide (bulk bags)	Paducah	2.30	6.56	0.24	0.22	0.01	0.68
	Portsmouth	1.87	5.32	0.19	0.18	0.01	0.55
	Total emissions	*4.17*	*11.88*	*0.43*	*0.40*	*0.03*	*1.24*
69,000 empty and heel cylinders	Paducah	2.59	7.39	0.27	0.25	0.02	0.77
	Portsmouth	2.35	6.71	0.24	0.23	0.02	0.70
	Total emissions	*4.94*	*14.09*	*0.51*	*0.47*	*0.03*	*1.47*
CaF_2	Paducah	3.64	10.37	0.38	0.35	0.02	1.08
	Portsmouth	2.79	7.96	0.29	0.27	0.02	0.83
	Total emissions	*6.43*	*18.33*	*0.67*	*0.61*	*0.04*	*1.91*
Grand Total (DU Oxide in Cylinders)		**20.18**	**57.56**	**2.1**	**1.93**	**0.13**	**6**
Grand Total (DU Oxide in Bulk Bags)		**16.89**	**48.16**	**1.75**	**1.61**	**0.11**	**5.02**

Greenhouse Gases

Estimating approximately 1,600 miles (2,600 kilometers) per rail shipment from Paducah to Energy*Solutions*, approximately 7,111 tons (6,451 metric tons) of GHG emissions (measured as CO_2e) would be produced annually (CNR 2016) (see **Table 4-25**). Estimating approximately 1,900 miles (3,100 kilometers) per rail shipment from Portsmouth to Energy*Solutions*, approximately 7,590 tons (6,886 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for disposal of ancillary LLW and MLLW and empty and heel cylinders, and CaF_2 as discussed in Section 4.1.2 for the No Action Alternative, total annual GHG emissions from shipping DU oxide and other wastes to the disposal facilities by rail would be 14,701 tons (13,337 metric tons) which would be minimal in terms of the national GHG emissions from railway transportation which total 45.3 million tons (41.1 million metric tons) annually (EPA 2018c).

Table 4-25 Annual GHG Emissions from the Transport of DU Oxide to Energy*Solutions*

Site	GHG Emissions (CO_2e tons per year)	
	Rail Option[a]	**Truck Option**[a]
Paducah[b]	7,111	6,894
Portsmouth[b]	7,590	7,359
Total	**14,701**	**14,253**
National Rail Emissions[c]	45,300,000	NA
National Truck Emissions[c]	NA	467,400,000

Key: CO_2e = carbon dioxide equivalents; GHG = greenhouse gas; NA = not applicable.

[a] The rail and truck options both include emissions from truck shipment for disposal of LLW, MLLW, and empty and heel cylinders as discussed in Section 4.1.2 for the No Action Alternative.

[b] **Source:** CNR 2016

[c] **Source:** EPA 2018c

For shipment by truck, it is expected that estimating approximately 1,600 miles (2,600 kilometers) per truck shipment from Paducah to Energy*Solutions*, approximately 6,894 tons (6,254 metric tons) of GHG emissions would be produced annually (CNR 2016). Estimating approximately 1,900 miles (3,100 kilometers) per truck shipment from Portsmouth to Energy*Solutions*, approximately 7,359 tons (6,676 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for disposal of ancillary LLW and MLLW, and empty and heel cylinders, and CaF_2, as discussed in Section 4.1.2 for the No Action Alternative, total annual GHG emissions from shipping DU oxide and other wastes to the disposal facilities by truck would be 14,253 tons (12,930 metric tons) which would be minimal in terms of the national GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018c).

4.2.3 Impacts on Disposal Capacity at Energy*Solutions*

This section describes the impacts on the disposal capacity at Energy*Solutions*. Other potential environmental impacts of disposal at this site are not analyzed in this DU Oxide SEIS. As long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, it is assumed the impacts of disposal would be considered and found to be acceptable as part of the licensing and permitting process. Chapter 5, Section 5.4.3, briefly describes the licenses and permits held by Energy*Solutions*. Energy*Solutions*' operating licenses and permits are available for review at http://www.energysolutions.com/waste-management/facilities/clive-facility-details/.

The disposal of DU oxide, ancillary LLW and MLLW from storage and maintenance of DU oxide cylinders, empty and heel cylinders, and CaF_2 would not exceed Energy*Solutions*' disposal capacities, even if Energy*Solutions* received all DU oxide and other radioactive waste from both Paducah and Portsmouth.

Table 4-26 shows the waste volumes and percent of disposal capacity under the Disposal of Waste at Energy*Solutions* Alternative. DOE projects a total of 46,150 DU oxide cylinders from Paducah and 22,850 cylinders from Portsmouth, or a total of 69,000 cylinders. Assuming each cylinder has an envelope volume of about 5.59 cubic yards (4.28 cubic meters) (see Section 4.1.1.8), the volume of the DU oxide cylinders would total about 386,000 cubic yards (295,000 cubic meters). In addition, 205, 55-gallon (208 liter) drums containing DU oxide were generated at Portsmouth during 5 years of start-up operations and outages. Conservatively assuming 5 drums with oxide are generated each year at each site during the projected periods of oxide conversion, about 380 additional drums of DU oxide would be generated at both sites combined for a total of 585 drums. Assuming the volume of each drum is 0.27 cubic yards (0.21 cubic meters), the volume of the DU oxide drums would total about 158 cubic yards (122 cubic meters). This is within the rounding error for the DU oxide in cylinders and therefore the impact on site capacity is not discussed further.

U.S. Nuclear Regulatory Commission 10 CFR Part 61 Rulemaking

Chapter 5, Section 5.4.4, of this DU Oxide SEIS describes the status of U.S. Nuclear Regulatory Commission (NRC) 10 CFR Part 61 Rulemaking that may affect the commercial disposal of large quantities of DU oxide. Disposal of bulk DU oxide will only be allowed if it meets all applicable requirements of DOE, NRC, and the affected Agreement States.

There would be no impacts on disposal capacity at Energy*Solutions* from disposal of DU oxide because, as described in Chapter 3, Section 3.3, of this DU Oxide SEIS, the disposal unit that would receive the DU oxide would be separate from the other disposal units at the site and, would be designed to receive all DU oxide that may be sent from both Paducah and Portsmouth. In addition, if DU oxide were disposed of in bulk bags, it would result in a similar disposal volume as DU oxide in cylinders, and therefore similar impacts on the capacity of the disposal facility. The volume-reduced empty and heel cylinders generated as a result of disposal of DU oxide in bulk bags would generate an additional waste stream estimated at 38,600 cubic yards or 0.9 percent of disposal capacity at Energy*Solutions*.

As shown in Table 4-15, the small quantities of ancillary LLW and MLLW from storage and maintenance of DU oxide cylinders would represent only small fractions of the disposal capacities for LLW and MLLW at Energy*Solutions*. Disposal of empty and heel cylinders would represent about 1.9 percent of Energy*Solutions*' LLW disposal capacity. Disposal of CaF_2, if this option is exercised, would represent about 5.4 percent of Energy*Solutions*' LLW disposal capacity.

Table 4-26 Waste Volumes and Percent of Disposal Capacity under the Disposal of Waste at Energy*Solutions* Alternative

Waste			Waste Volume (cubic yards)[a]	Disposal Capacity (cubic yards)[b]	Percent of Disposal Capacity
LLW – DU oxide	In Cylinders[c]		386,000	NA	100
	Bulk Bag Option	In Bulk Bags	386,000	NA	100
		Volume-Reduced Empty and Heel Cylinders	38,600	4,170,000	0.9
LLW – empty and heel cylinders[d]			78,300	4,170,000	1.9
Ancillary LLW[e]			140	4,170,000	0.0034
Ancillary MLLW[e]			0.92	358,000	0.00026
LLA – CaF_2 option			225,000	4,170,000	5.4

Key: DU = depleted uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable.

[a] It is assumed for analysis that all waste generated at both Paducah and Portsmouth from the Proposed Action would be disposed of at Energy*Solutions* under this alternative. Waste volumes from DU oxide storage and maintenance were determined assuming these activities would last for 76 years (44 years of storage and 32 years of shipping) at Paducah and 47 years (32 years of storage and 15 years of shipping) at Portsmouth. Source: PPPO 2018.

[b] DU oxide would be disposed of in a separate disposal unit sized to receive all DU oxide waste. The disposal capacity for LLW and MLLW other than DU oxide is assumed, respectively, to be the remaining capacity in the Class A West Embankment (4.17 million cubic yards [3.25 million cubic meters]) and the Mixed Waste disposal cell (358,000 cubic yards [274,000 cubic meters]) as of August 24, 2016.

[c] Determined assuming 69,000 DU oxide cylinders each measuring 4 feet (1.2 meters) in diameter and 12 feet (3.7 meters) long; plus approximately 107 cubic yards (82 cubic meters) of DU oxide in drums.

[d] The listed volume of the empty and heel cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facilities or a separate waste treatment facility.

[e] It is assumed for analysis that all waste from storage and maintenance of DU oxide cylinders from both Paducah and Portsmouth would be disposed of in each evaluated disposal site. Waste volumes from oxide storage and maintenance were determined assuming these activities would last for 76 years (44 years of storage and 32 years of shipping) at Paducah and 47 years (32 years of storage and 15 years of shipping) at Portsmouth.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

DOE would coordinate shipment scheduling with Energy*Solutions* to ensure that appropriate personnel and equipment would be available to safely manage waste receipts. Energy*Solutions* routinely receives waste by both truck and rail transport. Assuming Energy*Solutions* received DU oxide cylinders from both Paducah and Portsmouth, the disposal facility could conservatively receive up to 2,880 cylinders in a year. Assuming the cylinders were all shipped by truck from both Paducah and Portsmouth, over 250 working days per year at each site, the disposal site would receive an average of about 12 truckloads of DU oxide cylinders per day. Otherwise, assuming the same number of cylinders was all shipped by rail from both Paducah and Portsmouth, trains with DU oxide cylinder would arrive about 4 times per month. Assuming 6 cylinders per railcar and 10 railcars per train, each rail shipment would contain 60 cylinders to be offloaded and transferred to the designated disposal unit.

DOE expects that Energy*Solutions* would have little difficulty in accommodating either shipment mode. DOE expects that an average of 12 trucks per day or 4 trainloads per month would be within the range of truck and rail shipments that routinely arrive at Energy*Solutions*, and the uniform nature of the DU oxide shipments in terms of container type and size, and waste content, enhances the efficiency of disposal operations.[56] The small quantity of DU oxide shipped in drums could be delivered in a few annual truck loads or with the rail shipments of DU oxide cylinders which would be easily managed at Energy*Solutions*.

Similarly, DOE expects that deliveries of empty and heel cylinders would be readily managed at Energy*Solutions*. Paducah would annually make an average of 125 truck deliveries of empty and heel cylinders to Energy*Solutions*, while Portsmouth would annually make an average of 125 truck deliveries. Assuming 250 working days per year at the disposal facilities, there would be an average of one delivery of empty and heel cylinders every work day from Paducah and Portsmouth. As discussed in Section 4.1.3, the projected volume of empty and heel cylinders could be reduced by volume reduction activities (e.g., compaction or shredding) at the disposal facility or a separate treatment facility. In addition, the void space within the cylinders would need to be addressed; this could be accomplished through volume reduction or other measures. Otherwise, assuming the same number of empty and heel cylinders was shipped by rail from both Paducah and Portsmouth, trains with the cylinders would arrive about 4 times per year. Assuming 6 empty and heel cylinders per railcar and 10 railcars per train, each rail shipment would contain 60 cylinders to be offloaded and transferred to the designated disposal unit.

Other volumes of radioactive wastes generated from storage and maintenance of DU oxide cylinders are very small and could be easily managed at Energy*Solutions*. The annual generation of LLW from these activities is about 2.1 cubic yards (1.7 cubic meters) at Paducah and 1.6 cubic yards (1.2 cubic meters) at Portsmouth. Assuming this waste would be shipped within 55-gallon drums with an average volume of 0.2 cubic meters per drum, LLW from Paducah could be shipped in nine 55-gallon drums while LLW from Portsmouth could be shipped in six 55-gallon drums. Only a single truckload would be required to ship the waste from Paducah to Energy*Solutions*, and another single truckload would be required to ship the waste from Portsmouth. Annual volumes of MLLW could be shipped in a single 55-gallon drum from Paducah and a single 55-gallon drum from Portsmouth.

If HF could not be sold and needed to be converted to CaF_2 and disposed, the CaF_2 would be packaged in bulk bags and sent to a disposal facility. Although the CaF_2 would likely have little or no radioactivity, in order to be conservative, it is considered LLW for this waste management analysis. Assuming Energy*Solutions* received CaF_2 in bulk bags from both Paducah and Portsmouth, the disposal facility could conservatively receive up to 45,971 CaF_2 bulk bags. Assuming the bags were all shipped by truck from both Paducah and Portsmouth, over 250 working days per year at each site, the disposal site would receive an average of about six

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[56] Shipments to LLW and MLLW disposal facilities are inspected upon arrival for compliance with acceptance criteria such as direct radiation levels, the presence of detectable removable contamination, waste content, and manifesting. Departing vehicles are also inspected to ensure compliance with transportation requirements including the presence of detectable removable contamination. A uniform waste stream such as DU oxide would require less time to perform these inspections than another waste stream containing – for example, a more variable range of isotopes. It may also require less time to inspect a rail shipment than it would if the same quantity of waste in the rail shipment was instead shipped in multiple truck loads. The uniform size and configuration of the DU oxide containers (i.e., cylinders) also promotes a more efficient and timely waste emplacement process compared to that required for shipments containing the same quantity of waste but in containers of a variety of sizes and configurations (e.g., drums, boxes, lift liners).

truckloads of CaF_2 per work day. Otherwise, assuming the same number of bulk bags was shipped by rail from both Paducah and Portsmouth, trains with DU oxide cylinders would arrive about one or two per work day. Assuming four CaF_2 bulk bags per railcar, and one railcar per train, each rail shipment would contain four bulk bags to be offloaded and transferred to the designated disposal unit. A train could easily accommodate additional railcars (each carrying four bags). Therefore, train deliveries could be reduced to an average of one or two per week.

4.3 DISPOSAL OF DEPLETED URANIUM OXIDE AND OTHER WASTES AT THE NEVADA NATIONAL SECURITY SITE

As described in Section 2.2.2.2, under the NNSS Disposal Alternative, DU oxide would be disposed of at NNSS in Nye County, Nevada. This section presents the estimated potential environmental impacts for this alternative including: (1) impacts from storage of DU oxide at Paducah and Portsmouth until shipment to NNSS (Section 4.3.1); (2) impacts from the transportation of DU oxide and other radioactive waste to NNSS (Section 4.3.2); and (3) impacts on the LLW and MLLW disposal capacities at NNSS (Section 4.3.3).

Many of the environmental impacts would be similar regardless of which disposal site (Energy*Solutions*, NNSS or WCS) receives the wastes from Paducah and Portsmouth. Therefore, some portions of the discussion of disposal of wastes at NNSS (Section 4.3) refers back to sections of the Energy*Solutions* discussion (Section 4.2) rather than repeating the same information.

4.3.1 Impacts at Paducah and Portsmouth

DU oxide would be stored at Paducah and Portsmouth until it is shipped to NNSS for disposal. The impacts of storage at Paducah and Portsmouth would be the same as those described in Section 4.2.1 for the Energy*Solutions* Disposal Alternative.

4.3.2 Transport of Depleted Uranium Oxide and other Wastes to the Nevada National Security Site

This section summarizes the potential impacts from shipment of DU oxide and other radioactive waste from Paducah in Kentucky and Portsmouth in Ohio, to NNSS in Nevada, under incident-free and accident conditions. Section 4.2.2 summarizes some of the general transportation assumptions. Details of the analysis methodology and analytical results are presented in Appendix B.

Because NNSS lacks a direct rail connection for waste delivery, truck transports were evaluated for shipments from an intermodal facility to NNSS. For purposes of analysis and consistent with the NNSS SWEIS (DOE 2013a), the intermodal facility is assumed to be the rail yard in Barstow, California.

Table 4-27 summarizes the potential transportation impacts for disposal of DU oxide at NNSS. As indicated in Table 4-15, all risk values are less than one, except for nonradiological accident risk associated with rail or truck shipments. This means that no LCFs are expected to occur during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of DU oxide and CaF_2 transports.

Table 4-27 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Cylinders to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	46,200	148,100,000	175	0.1	458	0.3	1×10^{-4}	6
Portsmouth	22,900	85,400,000	101	0.06	264	0.2	9×10^{-5}	4
Rail/Truck[c]								
Paducah, rail	770	2,600,000	73	0.04	89	0.05	1×10^{-3}	0.8
Paducah Barstow, truck	46,200	15,600,000	18	0.01	48	0.03	2×10^{-6}	0.3
Total	46,970	18,200,000	91	0.05	137	0.08	1×10^{-3}	1
Portsmouth, rail	380	1,500,000	45	0.03	56	0.03	1×10^{-5}	0.5
Portsmouth Barstow, truck	22,900	7,700,000	9	0.005	24	0.01	8×10^{-7}	0.1
Total	23,280	9,200,000	54	0.03	79	0.05	1×10^{-3}	0.7

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo will be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for NSSS under Rail/Truck section in this table. For transport of cylinders originating from Paducah, 46,000 truck transports are required between Barstow, California and NNSS, whereas for cylinders originating from Portsmouth 21,000 truck transports are required,.

Note: To convert kilometers to miles multiply by 0.62137.

Tables 4-28 and **4-29** summarize the potential transportation impacts for shipment of empty and heel cylinders and other LLW and MLLW to NNSS. Table 4-28 shows the transportation impacts assuming the empty and heel cylinders are transported intact. As indicated in Tables 4-28 and 4-29, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail under this alternative.

Table 4-28 Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	4,240	13,600,000	0.2	1×10^{-4}	0.4	3×10^{-4}	6×10^{-8}	0.6
Portsmouth	2,260	10,300,000	0.1	7×10^{-5}	0.3	2×10^{-4}	5×10^{-8}	0.5
Rail/Truck[c]								
Paducah, rail	140	470,000	0.1	8×10^{-5}	0.2	1×10^{-4}	6×10^{-7}	0.1

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Paducah Barstow, truck	4,240	1,430,000	0.02	1×10^{-5}	0.04	3×10^{-5}	7×10^{-10}	0.02
Total	4,380	1,900,000	0.1	9×10^{-5}	0.2	1×10^{-4}	6×10^{-7}	0.1
Portsmouth, rail	90	360,000	0.1	6×10^{-5}	0.1	8×10^{-5}	8×10^{-7}	0.1
Portsmouth Barstow, truck	2,760	930,000	0.01	7×10^{-6}	0.03	2×10^{-5}	4×10^{-10}	0.02
Total	2,850	1,290,000	0.1	7×10^{-5}	0.2	1×10^{-4}	8×10^{-7}	0.1

Key: LCF = latent cancer fatality, nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo will be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for the NSSS under Rail/Truck in this table. For transport of cylinders originating from Paducah, 4,240 truck transports between Barstow, California and NNSS are required, whereas for cylinders originating from Portsmouth 2,760 truck transports are required.

Note: To convert kilometers to miles multiply by 0.62137.

Table 4-29 Annual Risks to Crew Members and the Public from Transporting Other Low-Level Radioactive Waste and Mixed Level Radioactive Waste to the Nevada National Security Site

			Incident-Free[a]				Accident[a]	
			Crew		Population			
Origin	Number of Shipments	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck[c]								
Paducah	1	3,200	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	4×10^{-14}	1×10^{-4}
Portsmouth	1	3,700	5×10^{-4}	3×10^{-7}	3×10^{-4}	2×10^{-7}	5×10^{-14}	2×10^{-4}

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] Total risks can be estimated by multiplying by the maximum duration of the storage period for this alternative (76 years [44 + 32) for Paducah and 47 years (32 +15) for Portsmouth)

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because of the small amount of waste requiring shipment to the waste management facility, rail transport would be inefficient and was not considered.

Note: To convert kilometers to miles multiply by 0.62137.

DOE is also considering the option of transporting DU oxide using bulk bags consistent with the analysis presented in the 2004 EISs (DOE 2004a, 2004b). It is estimated that there would be 20,150 and 9,070 truck shipments and 5,130 and 2,270 rail shipments from Paducah and Portsmouth, respectively, using consistent assumptions as those used in the 2004 EISs. Therefore, because the amount of DU oxide evaluated in this DU Oxide SEIS is larger than that evaluated in the 2004 EISs, the bulk bag transportation risks presented in this SEIS are proportionally larger than those cited in the 2004 EISs. If the bulk bags are used, then, the empty and heel cylinders also need to be transported to the disposal sites. It is assumed that the cylinders would be volume-reduced and packaged 10 to a 20-foot intermodal container and transported one per truck and two per railcar. The conversion EISs also considered that about 10 percent of the cylinders could not be accepted at the Energy*Solutions*, therefore, these cylinders would be transported intact to NNSS. The 2004 EISs assumed that rail connections will be available at NNSS, therefore, no intermodal facility near the NNSS was used. The risks of transporting the volume-reduced cylinders are calculated the using information in the 2004 EISs, and those for the intact cylinders are calculated using the same assumptions used in Table 4-28, above. Note that the results presented for the impacts of transporting DU oxide in bulk bags and volume-reduced empty and heel cylinders are based on assumptions and information from the 2004 EISs regarding populations along the routes that are different from those considered for transporting DU oxides in cylinders to Energy*Solutions* and NNSS as analyzed in this DU Oxide SEIS. Nevertheless, the impacts from the 2004 EISs have been scaled where appropriate to provide information on potential impacts for the larger amount of DU oxide that would be shipped to Energy*Solutions* and NNSS under the alternatives evaluated in this DU Oxide SEIS.

Tables 4-30 and **4-31** summarize the potential transportation impacts for shipment DU-oxides in bulk bags, and the empty and heel cylinders to NNSS. As indicated in Tables 4-30 and 4-31, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail.

Table 4-30 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Bulk Bags to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah[c]	20,510	57,758,000	337	0.2	162	0.1	1×10^{-02}	3
Portsmouth[d]	9,070	30,493,000	185	0.1	84	0.05	1×10^{-02}	1
Rail								
Paducah[c]	5,130	17,596,000	837	0.5	27	0.02	7×10^{-03}	0.8
Portsmouth[d]	2,270	9,112,000	421	0.3	16	0.01	5×10^{-03}	0.5

Key: LCF = latent cancer fatality.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-22 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-27 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

Note: To convert kilometers to miles multiply by 0.62137.

Table 4-31 Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to the Nevada National Security Site

Origin	Number of Shipments[a]	One-way Kilometers Traveled	Incident-Free: Crew: Dose (person-rem)	Incident-Free: Crew: LCFs[b]	Incident-Free: Population: Dose (person-rem)	Incident-Free: Population: LCFs[b]	Accident: Radiological Risk[b]	Accident: Nonrad Risk[b]
Truck (volume-reduced)								
Paducah[c]	4,920	13,853,000	81	5×10^{-2}	45	3×10^{-2}	1×10^{-4}	0.6
Portsmouth[d]	2,550	8,574,000	52	3×10^{-2}	28	2×10^{-2}	1×10^{-4}	0.3
Truck (10% intact)[e]								
Paducah[c,e]	2,730	8,757,000	0.1	6×10^{-5}	0.3	2×10^{-4}	4×10^{-8}	0.4
Portsmouth[d,e]	1,420	5,299,000	0.06	4×10^{-5}	0.2	1×10^{-4}	3×10^{-8}	0.2
Rail (volume-reduced)								
Paducah[c]	2,460	8,435,000	225	1×10^{-1}	7	4×10^{-3}	6×10^{-5}	0.4
Portsmouth[d]	1,275	5,118,000	127	8×10^{-2}	5	3×10^{-3}	4×10^{-5}	0.3
Rail (10% intact)[e]								
Paducah[c,e]	50	168,000	0.05	3×10^{-5}	0.06	3×10^{-5}	2×10^{-7}	0.04
Portsmouth[d,e]	20	80,000	0.02	1×10^{-5}	0.03	2×10^{-5}	1×10^{-7}	0.02

Key: LCF = latent cancer fatality.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-22 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-27 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] The intact cylinders represent transport of 10 percent of the total empty and heel cylinders, which are 83,000 (69,000 plus 14,000). The calculated doses and risks are based on the information provided in Table 4-28 of this DU Oxide SEIS, assuming that the intact cylinders are transported two per truck and 60 per rail. In addition, For the size reduced packages, the 2004 EISs assumed that direct rail connections will be available at NNSS.

Note: To convert kilometers to miles multiply by 0.62137.

Furthermore, the impacts from the transport of CaF_2 from neutralization of HF to a LLW disposal facility are also estimated. It is estimated that there would be 32,420 truck shipments or 8,150 rail shipments from Paducah and 13,550 truck shipments or 3,390 rail shipments from Portsmouth to NNSS. Although conservatively considered LLW for purposes of disposal, CaF_2 has such low levels of radiation it would provide a negligible dose to the crew and the public turing transport. The estimated traffic fatalities from these shipments are summarized in **Table 4-32**.

Table 4-32 Total Population Transportation Risks for Shipment of CaF_2 to the Nevada National Security Site under the Hydrogen Fluoride Neutralization Option[a]

Origin	Paducah		Portsmouth	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	32,420	8,105	13,554	3,390
Total distance (one-way [km])[b]	104,015,000	38,403,000	50,555,000	18,231,000
Traffic fatalities (round trip)	4.8	1.96	2.25	0.55

[a] Although shipped to a LLW disposal facility, the CaF_2 would likely have little or no radioactivity; therefore, there would be negligible doses to the transportation crew and the public.

[b] Because NNSS does not have a direct rail line connection, every rail transport requires four shipments of truck transport from an intermodal facility to NNSS. The cited distances are the sum of truck and rail transport distances.

Impacts from Incident-Free Transport of Radioactive Waste

The potential radiological impacts on transport crews and populations along the routes are shown in Tables 4-27 through 4-32. The tables include the results of shipping all DU oxide and other wastes to NNSS. As shown in Tables 4-27 through 4-32, transportation of the DU oxide dominates the risks. Therefore, the impacts of shipping empty and heel cylinders and ancillary LLW and MLLW to NNSS are not discussed further. In addition, CaF_2 is not discussed further because this material would contain little or no radioactivity, and therefore would not result in work or public exposure.

Transport of DU oxide in bulk bags results in the maximum impact on the transportation crew compared to transport of DU oxide in cylinders. As detailed in Table 4-30, the transport of DU oxide in bulk bags could result in one LCF to crew members. For truck transport, the calculated LCF risk over the duration of the project would be 0.3, or 1 chance in about 3 of developing a single LCF among the transportation crew. For truck/rail transport, the calculated LCF risk over the duration of the project would be 0.8, or a chance of a single LCF among the transportation crews.

Transport of DU oxide in cylinders results in the maximum impact on the general population compared to transport of DU oxide in bulk bags. Under this Alternative, as detailed in Table 4-27, the dose to the general population likely would not result in an LCF. For truck transport of DU oxide in cylinders, the calculated LCF risk over the duration of the project would be 0.4, or 1 chance in 2.5 of a single LCF in the exposed population. For rail transport, the calculated LCF risk over the duration of the project would be 0.1, or 1 chance in 10 of a single LCF in the exposed population.

The total radioactive dose received by an MEI (a resident along the route near the NNSS), hypothetically assumed to be exposed to every DU oxide truck shipment over the duration of the project, would be about 2.14 millirem, resulting in an increased risk of developing an LCF of 1×10^{-6}, or 1 chance in 780,000. Assuming that shipments would occur over 34 years, the average annual dose to this individual would be 0.063 millirem, which is 0.063 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents) and (2) maximum reasonably foreseeable accidents (accidents with a radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year). As indicated in Tables 4-27 through 4-29 considering all reasonably foreseeable accidents, transport of radioactive waste would likely not result in any LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck and rail transportation options.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and maximum consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxide shipped under this alternative, the maximum reasonably foreseeable transportation accident with the highest consequence would involve truck transport in an urban area (see Appendix B, Table B-7). The maximum probability of this truck accident involving transport of DU oxide to NNSS would be 5.3×10^{-7} per year in an urban area, or approximately 1 chance in 1.8 million each year. The consequences of the truck transport accident, if it occurred, in terms of population and MEI dose would be about 7.7 person-rem and 0.0064 rem, respectively. These doses would likely result in no (calculated value of 0.005) additional LCFs among the exposed population and a risk of 4×10^{-6} that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (calculated value of 3×10^{-9}).

Vehicle Emissions

Transport of DU Oxide to NNSS would result in emissions from trains or trucks. It is expected that an average of 24 railcar shipments would occur annually from each of Paducah and Portsmouth. For shipment by truck only, it is expected that Paducah and Portsmouth would each ship up to 1,440 truckloads per year. The empty and heel cylinders could be shipped via rail in four annual shipments, or via truck in 125 annual shipments. Transport of CaF_2 via rail is assumed to be an additional 238 and 154 shipments annually from Paducah and Portsmouth, respectively. Shipment of CaF_2 via truck would result in an additional 953 and 616 shipments from Paducah and Portsmouth, annually.

The quantity of DU oxide in each truck or rail shipment would vary depending on whether cylinders or bulk bags are used. If bulk bags were to be used, the total number of truck shipments of DU oxide would decrease, but the number of empty and heel cylinders to be shipped for disposal would increase. The total number of rail shipments under the bulk bag shipment scenario would be more than the number of shipments utilizing DU oxide in cylinders,. Therefore, the analysis below represents the most conservative scenario (i.e., the largest quantity of emissions), and all other potential shipping scenarios would generate lower levels of emissions of both criteria pollutants and GHGs.

Rail/Truck Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 shipments via railcar annually from each site to NNSS. It was estimated that locomotives would travel approximately 2,000 miles (3,300 kilometers) per rail shipment from Paducah to Barstow, CA, and approximately 2,400 miles (3,800 kilometers) from Portsmouth to Barstow, CA. Emissions were calculated using emission factors for tier 2 line haul locomotives derived from the EPA's *Emission Factors for Locomotives* (EPA 2009).

Because there is no direct rail access to NNSS, shipments via rail would travel to Barstow, California, where they would be transported approximately 200 miles (330 kilometers) from Barstow to the NNSS facility. **Table 4-33** presents annual emissions associated with both the rail and truck portions of the shipments.

Emissions of all criteria pollutants would be less than 395 tons (358 metric tons) annually for all shipments from Paducah and Portsmouth combined. Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR. However, because the emissions are so small in comparison to overall locomotive and vehicle transportation emissions, the emissions are not likely to contribute to any significant impact on air quality. Emissions could be decreased further by combining shipments for the rail option. That is, while it was assumed that DU oxide and CaF_2 in bulk bags would be shipped in one railcar per shipment, filling multiple cars per shipment would decrease the overall number of trips and, therefore, the quantity of annual emissions.

Table 4-33 Criteria Pollutant Emissions from Transportation via Railcar to Barstow, CA, and Truck to NNSS[a]

Material	Mode of Transport	Site	Criteria Pollutant Emissions (tons/year)					
			CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Truck	Paducah	0.02	0.05	0.00	0.00	0.00	0.00
		Portsmouth	0.01	0.03	0.00	0.00	0.00	0.00
		Total emissions	*0.03*	*0.08*	*0.00*	*0.00*	*0.00*	*0.01*
	Rail	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
		Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
		Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Truck	Paducah	0.69	1.96	0.07	0.07	0.00	0.20
		Portsmouth	0.73	2.07	0.08	0.07	0.00	0.22
		Total emissions	*1.41*	*4.03*	*0.15*	*0.14*	*0.01*	*0.42*
	Rail	Paducah	2.11	8.17	0.30	0.29	0.15	0.45
		Portsmouth	2.64	10.21	0.37	0.36	0.19	0.56
		Total emissions	*4.75*	*18.39*	*0.67*	*0.65*	*0.34*	*1.02*
14,000 empty and heel cylinders	Truck	Paducah	0.06	0.17	0.01	0.01	0.00	0.02
		Portsmouth	0.06	0.17	0.01	0.01	0.00	0.02
		Total emissions	*0.12*	*0.34*	*0.01*	*0.01*	*0.00*	*0.04*
	Rail	Paducah	0.35	1.36	0.05	0.05	0.02	0.08
		Portsmouth	0.42	1.63	0.06	0.06	0.03	0.09
		Total emissions	*0.77*	*3.00*	*0.11*	*0.11*	*0.05*	*0.17*

Material	Mode of Transport	Site	Criteria Pollutant Emissions (tons/year)					
			CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
DU oxide in bulk bags	Truck	Paducah	0.29	0.82	0.03	0.03	0.00	0.09
		Portsmouth	0.20	0.56	0.02	0.02	0.00	0.06
		Total emissions	*0.48*	*1.38*	*0.05*	*0.05*	*0.00*	*0.14*
	Rail	Paducah	13.29	51.41	1.87	1.81	0.94	2.84
		Portsmouth	10.88	42.08	1.53	1.48	0.77	2.33
		Total emissions	*24.18*	*93.50*	*3.40*	*3.30*	*1.71*	*5.17*
69,000 empty and heel cylinders	Truck	Paducah	0.32	0.92	0.03	0.03	0.00	0.10
		Portsmouth	0.25	0.71	0.03	0.02	0.00	0.07
		Total emissions	*0.57*	*1.63*	*0.06*	*0.05*	*0.00*	*0.17*
	Rail	Paducah	19.90	76.95	2.80	2.71	1.41	4.26
		Portsmouth	18.28	70.68	2.57	2.49	1.29	3.91
		Total emissions	*38.18*	*147.63*	*5.37*	*5.21*	*2.70*	*8.17*
CaF_2	Truck	Paducah	0.45	1.30	0.05	0.04	0.00	0.14
		Portsmouth	0.29	0.84	0.03	0.03	0.00	0.09
		Total emissions	*0.75*	*2.13*	*0.08*	*0.07*	*0.00*	*0.22*
	Rail	Paducah	20.95	81.03	2.95	2.86	1.48	4.48
		Portsmouth	16.27	62.92	2.29	2.22	1.15	3.48
		Total emissions	*37.22*	*143.95*	*5.23*	*5.08*	*2.63*	*7.96*
Grand Total (DU Oxide in Cylinders)			***45.24***	***172.67***	***6.28***	***6.09***	***3.04***	***9.88***
Grand Total (DU Oxide in Bulk Bags)			***102.47***	***394.31***	***14.34***	***13.90***	***7.11***	***22.08***

[a] Because there is no direct rail access to NNSS, shipments via rail would travel to Barstow, California, where they would be transported approximately 200 miles (330 kilometers) from Barstow to the NNSS facility. The "Grand Total" emissions are the sum of truck and rail transport emission.

Truck Option

Criteria pollutant emissions were calculated based on an estimated 1,440 shipments annually from each facility to NNSS (**Table 4-34)**. Analysis estimated approximately 2,000 miles (3,300 kilometers) per truck shipment from Paducah NNSS and approximately 2,400 miles (3,800 kilometers) per shipment from Portsmouth to NNSS via truck. Emissions were derived using the emission factors for heavy-duty diesel vehicles in the EPA's MOVES2014a. MOVES is the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator. It is used to create emission factors or emission inventories for both onroad motor vehicles and nonroad equipment (EPA 2015).

Under the truck option, emissions of all criteria pollutants would be less than 72 tons (65 metric tons) annually for all shipments from Paducah and Portsmouth combined. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular Air Quality Control Region (AQCR).

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table 4-34 Criteria Pollutant Emissions Transportation via Truck to NNSS

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.17	0.48	0.02	0.02	0.00	0.05
	Portsmouth	0.14	0.41	0.01	0.01	0.00	0.04
	Total emissions	*0.31*	*0.88*	*0.03*	*0.03*	*0.00*	*0.09*
DU oxide (cylinders)	Paducah	6.88	19.61	0.72	0.66	0.04	2.04
	Portsmouth	8.72	24.86	0.91	0.83	0.06	2.59
	Total emissions	*15.59*	*44.47*	*1.62*	*1.49*	*0.10*	*4.63*
14,000 empty and heel cylinders	Paducah	0.60	1.70	0.06	0.06	0.00	0.18
	Portsmouth	0.72	2.04	0.07	0.07	0.00	0.21
	Total emissions	*1.31*	*3.74*	*0.14*	*0.13*	*0.01*	*0.39*
DU oxide (bulk bags)	Paducah	2.88	8.20	0.30	0.28	0.02	0.85
	Portsmouth	2.36	6.72	0.25	0.23	0.02	0.70
	Total emissions	*5.23*	*14.92*	*0.54*	*0.50*	*0.03*	*1.56*
69,000 empty and heel cylinders	Paducah	3.24	9.23	0.34	0.31	0.02	0.96
	Portsmouth	2.97	8.47	0.31	0.28	0.02	0.88
	Total emissions	*6.21*	*17.70*	*0.65*	*0.59*	*0.04*	*1.85*
CaF_2	Paducah	4.54	12.96	0.47	0.43	0.03	1.35
	Portsmouth	3.52	10.05	0.37	0.34	0.02	1.05
	Total emissions	*8.07*	*23.01*	*0.84*	*0.77*	*0.05*	*2.40*
Grand Total (DU Oxide in Cylinders)		**25.28**	**72.11**	**2.63**	**2.42**	**0.16**	**7.52**
Grand Total (DU Oxide in Bulk Bags)		**21.13**	**60.25**	**2.2**	**2.02**	**0.13**	**6.29**

Greenhouse Gases

Estimating approximately 2,000 miles (3,300 kilometers) per rail shipment from Paducah to Barstow, CA, approximately 8,889 tons (8,064 metric tons) of GHG emissions (measured as CO_2e) would be produced annually (CNR 2016) (**Table 4-35**). Estimating approximately 2,400 miles (3,800 kilometers) per rail shipment from Portsmouth to Barstow, California, approximately 9,587 tons (8,698 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for disposal of ancillary LLW and MLLW, empty and heel cylinders, and CaF_2, total annual GHG emissions from railcar shipments (18,476 tons [16,762 metric tons]) would be minimal in terms of the national GHG emissions from railway transportation, which total 43.5 million tons (41.1 million metric tons) annually (EPA 2018c).

Because there is no direct rail access to NNSS, shipments would be transferred at Barstow, California, to trucks (DOE 2013a). Estimating approximately 200 miles (330 kilometers) via truck from Barstow, CA, to NNSS, GHG emissions would be approximately 862 and 775 tons (782 and 703 metric tons) for shipments from Paducah and Portsmouth, respectively, or 1,636 total tons [1,484 metric tons] annually, which would be minimal in terms of the national annual GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018c). Thus, the total GHG emissions for the rail/truck option would be 9,751 and 10,362 tons (8,845 and 9,399 metric tons) per year from Paducah and Portsmouth, respectively. Therefore, the annual total for both sites would be 20,113 tons per year (18,244 metric tons per year). This amount would be minimal in terms of the national annual GHG emissions from combined truck and rail transportation, which total 512.7 million tons (465.1 million metric tons) annually (EPA 2018c).

Table 4-35 Annual GHG Emissions from the Transport of DU Oxide to the Nevada National Security Site

Site	GHG Emissions (tons per year CO_2e)			
	Rail/Truck Option			Truck Option
	Rail	Truck	Total	
Paducah[a]	8,889	862	9,751	8,618
Portsmouth[a]	9,587	775	10,362	9,295
Total	**18,476**	**1,636**	**20,113**	**17,913**
National Rail Emissions[b]	45,300,000			NA
National Truck Emissions[c]	467,400,000			467,400,000
Total National Rail/Truck Emissions	512,700,000			NA

Key: CO_2e = carbon dioxide equivalents; GHG = greenhouse gas; NA = not applicable.

[a] The rail/truck and truck options both include emissions from truck shipment for disposal of LLW, MLLW, and empty and heel cylinders as discussed in Section 4.1.2 for the No Action Alternative.

[b] Source: CNR 2016

[c] Source: EPA 2018c

For shipment by truck only, it is expected that estimating approximately 2,000 miles (3,300 kilometers) per truck shipment from Paducah to NNSS, approximately 8,618 tons (7,818 metric tons) of GHG emissions would be produced annually (CNR 2016). Estimating approximately 2,400 miles (3,800 kilometers) per truck shipment from Portsmouth to NNSS, approximately 9,295 tons (8,432 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for disposal of ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 as discussed in Section 4.1.2 for the No Action Alternative, total annual GHG emissions from truck shipments 17,913 tons [16,250 metric tons]) would be minimal in terms of the national GHG emissions from truck transportation, which are 467.4 million tons (424.0 million metric tons) annually (EPA 2018c).

4.3.3 Impacts on Disposal Capacity at the Nevada National Security Site

This section describes the impacts on the disposal capacity at NNSS. Other potential environmental impacts of disposal at NNSS are not analyzed in this DU Oxide SEIS. As long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, it is assumed that the impacts of disposal would have been considered and found to be acceptable as part of the performance assessment and authorization process. Chapter 5, Section 5.4.2, briefly describes applicable laws and regulations for disposal of waste at NNSS. Additional information on applicable laws and regulations, and the impacts of disposal of LLW at NNSS, are presented in the NNSS SWEIS (DOE 2013a).

As indicated in **Table 4-36**, the disposal of DU oxide, ancillary LLW and MLLW from storage and maintenance of DU oxide containers, empty and heel cylinders, and CaF_2, would not exceed the NNSS LLW disposal capacity, even if NNSS received all DU oxide and other waste from both Paducah and Portsmouth. The volumes of DU oxide, LLW and MLLW from storage and maintenance of DU oxide containers, empty and heel cylinders, and CaF_2 are the same as those stated in Section 4.2.3.

Table 4-36 Waste Volumes and Percent of Disposal Capacities under the Disposal of Waste at the Nevada National Security Site Alternative

Waste			Waste Volume (cubic yards)[a]	Disposal Capacity (cubic yards)[b]	Percent of Disposal Capacity[b]
LLW – DU oxide	In cylinders[c]		386,000 [c]	1,778,000	22
	Bulk Bag Option	In bulk bags	386,000	1,778,000	22
		Volume-reduced empty and heel cylinders	38,600	1,778,000	2.2
LLW – empty and heel cylinders			78,300 [d]	1,778,000	4.4
Ancillary LLW[e]			140	1,778,000	0.0080
Ancillary MLLW[e]			0.92	148,000	0.00062
LLW – CaF_2 option			225,000	1,778,000	13

Key: DU = depleted uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NNSS = Nevada National Security Site; RWMC = Radioactive Waste Management Complex.

[a] Source: PPPO 2018

[b] The disposal capacity for LLW and MLLW at the Area 5 Radioactive Waste Management Complex is assumed to be 48 million cubic feet (1.36 million cubic meters) and 4 million cubic feet (113,000 cubic meters) in accordance with DOE's December 30, 2014, ROD (79 FR 78421) for the NNSS SWEIS (DOE 2013a). It is assumed that DU oxide waste would be disposed of in the Area 5 LLW disposal units.

[c] Determined assuming 66,982 DU oxide cylinders each measuring 4 feet (1.2 meters) in diameter and 12 feet (3.7 meters) long; plus approximately 107 cubic yards (82 cubic meters) of DU oxide in drums.

[d] The listed volume of the empty and heel cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facilities or a separate waste treatment facility.

[e] It is assumed for analysis that all waste from storage and maintenance of DU oxide containers from both Paducah and Portsmouth would be disposed of at NNSS. Waste volumes from oxide storage and maintenance were determined assuming these activities would last for 76 years (44 years of storage and 32 years of shipping) at Paducah and 47 years (32 years of storage and 15 years of shipping) at Portsmouth.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

As shown in Table 4-20, the total volume of the DU oxide would represent about 22 percent of the LLW disposal capacity at the Area 5 Radioactive Waste Management Complex of 1.78 million cubic yards (1.36 million cubic meters) (as presented in DOE's December 30, 2014, ROD [79 FR 78421] for the NNSS SWEIS [DOE 2013a]). In addition, if DU oxide were disposed of in bulk bags, it would result in a similar disposal volume as DU oxide in cylinders, and therefore similar impacts on the capacity of the disposal facility. The volume-reduced empty and heel cylinders generated as a result of disposal of DU oxide in bulk bags would generate an additional waste stream estimated at 38,600 cubic yards or 2.2 percent of disposal capacity at NNSS.

Disposal at NNSS of empty and heel cylinders would represent about 4.4 percent of the NNSS LLW disposal capacity. The small quantities of ancillary LLW and MLLW from storage and maintenance of DU oxide cylinders would represent very small fractions of the NNSS LLW and MLLW disposal capacities. Disposal at NNSS of all CaF_2 would represent about 13 percent of the NNSS LLW disposal capacity. If all LLW associated with the Proposed Action were shipped to NNSS, it would represent about 39 percent of LLW disposal capacity.

DOE would coordinate with NNSS with respect to shipment scheduling to ensure that the appropriate personnel and equipment would be available to safely manage waste receipts. NNSS is capable of receiving waste only by truck shipment. Assuming NNSS received DU oxide cylinders from both Paducah and Portsmouth, the site could conservatively receive an average of 12 trucks per day, assuming all oxide was shipped from Paducah and Portsmouth by truck. This frequency of delivery could be addressed at NNSS under the current operational capability (equipment and personnel). Assuming the cylinders were delivered by rail to an intermodal location to be transferred to trucks for delivery to NNSS, it could require multiple days for all cylinders from a given rail shipment to be transported by truck from the intermodal location to NNSS. One of the features of the DU oxide shipments that would lead to efficient and timely disposal operations is their expected uniformity in terms of container shape, size, and waste content (see Section 4.2.3). Truck and rail shipments would be scheduled to ensure the proper mix of personnel and equipment.

Similar to the discussion in Section 4.2.3, DOE expects that deliveries of empty and heel cylinders would be readily managed at NNSS given its existing personnel and equipment configuration. There would be an average of one truck delivery of empty and heel cylinders every work day from Paducah and Portsmouth. As discussed in Section 4.1.3, the projected volume of empty and heel cylinders could be reduced by volume reduction activities (e.g., compaction or shredding) at the disposal facility or a separate treatment facility. In addition, the void space within the cylinders would need to be addressed; this could be accomplished through volume reduction or other measures. Otherwise, assuming the same number of empty and heel cylinders was shipped by rail from both Paducah and Portsmouth, trains with the cylinders would arrive about 4 times per year. Assuming 6 empty and heel cylinders per railcar and 10 railcars per train, each rail shipment would contain 60 cylinders to be offloaded and transferred by truck to the designated disposal unit.

Also similar to the discussion in Section 4.2.3, the projected volumes of wastes generated from storage and maintenance of DU oxide cylinders are very small and could be managed at NNSS given its existing personnel and equipment configuration. The annual generation rate of LLW from these activities from both Paducah and Portsmouth could be sent to NNSS in a total of two truckloads. Annual volumes of MLLW could be shipped in a single 55-gallon drum from Paducah and a single 55-gallon drum from Portsmouth.

Similar to the discussion in Section 4.2.3, if HF cannot be sold and needs to be converted to CaF_2 and sent to a disposal facility, there would be an average of six truck deliveries (one bag per truck) of CaF_2 every work day from Paducah and Portsmouth. This was based on the assumption that only one bag would be transported on each truck. Otherwise, assuming the same number of bulk bags was shipped by rail from both Paducah and Portsmouth, trains with DU oxide cylinders would arrive about one or two per day. Assuming 4 CaF_2 bulk bags per railcar, and one railcar per train, each rail shipment would contain four bulk bags to be offloaded and transferred by truck to the designated disposal unit. A train could easily accommodate additional railcars (each carrying four bags). Therefore, train deliveries could be reduced to an average of one or two per week.

4.4 DISPOSAL OF DEPLETED URANIUM OXIDE AND OTHER WASTES AT WASTE CONTROL SPECIALISTS

As described in Section 2.2.2.3, under the WCS Disposal Alternative, DU oxide and other wastes would be disposed of at WCS near Andrews, Texas. This section presents the estimated potential environmental impacts for this alternative including: (1) impacts from storage of DU oxide at Paducah and Portsmouth until shipment to WCS (Section 4.4.1); (2) impacts from transportation of DU oxide and other radioactive waste to WCS (Section 4.4.2); and (3) impacts on the LLW and MLLW disposal capacities at WCS (Section 4.4.3).

Many of the environmental impacts would be similar regardless of which disposal site (Energy*Solutions*, NNSS or WCS) receives the wastes from Paducah and Portsmouth. Therefore, some portions of the discussion of disposal of wastes at WCS (Section 4.4) refers back to sections of the Energy*Solutions* discussion (Section 4.2) rather than repeating the same information.

4.4.1 Impacts at Paducah and Portsmouth

DU oxide would be stored at Paducah and Portsmouth until it is shipped to WCS for disposal. The impacts of storage at Paducah and Portsmouth would be the same as the impacts described in Section 4.2.1 for the Disposal at Energy*Solutions* Alternative.

4.4.2 Transport of Depleted Uranium Oxide and other Wastes to Waste Control Specialists

This section summarizes the potential impacts associated with the shipment of DU oxide and other wastes from Paducah and Portsmouth to WCS under incident-free and accident conditions. Section 4.2.2 summarizes the general transportation assumptions. Details of the analysis methodology and analytical results are presented in Appendix B.

Table 4-37 summarizes the potential transportation impacts from disposal of DU oxide at WCS. As indicated in Table 4-20, all risk values are less than one, except for nonradiological accident risk associated with rail or truck shipments. This means that no LCFs would be expected during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of transports over 34 years.

Tables 4-38 and 4-39 summarize potential transportation impacts for shipment of empty and heel cylinders and other LLW and MLLW to WCS. Table 4-38 shows the transportation impacts assuming the empty and heel cylinders are transported intact. As indicated in Tables 4-38 and 4-39, all risk values are less than one. This means that no LCFs would be expected during transport by truck or rail.

Table 4-37 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Cylinders to Waste Control Specialists

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	46,200	78,300,000	93	0.06	243	0.1	1×10^{-4}	6
Portsmouth	22,900	52,300,000	63	0.04	160	0.1	1×10^{-4}	4
Rail								
Paducah	770	1,500,000	47	0.03	77	0.05	2×10^{-3}	0.7
Portsmouth	380	1,100,000	37	0.02	58	0.04	2×10^{-3}	0.4

Key: LCF = latent cancer fatality; nonrad = nonradiological; WCS= Waste Complex Specialists.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Table 4-38 Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to Waste Control Specialists

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	4,240	7,900,000	0.09	5×10^{-5}	0.2	1×10^{-4}	8×10^{-8}	0.5
Portsmouth	2,760	6,300,000	0.08	5×10^{-5}	0.2	1×10^{-4}	8×10^{-8}	0.4
Rail								
Paducah	140	280,000	0.09	5×10^{-5}	0.1	8×10^{-5}	8×10^{-7}	0.07
Portsmouth	90	270,000	0.04	5×10^{-5}	0.1	8×10^{-5}	9×10^{-7}	0.1

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Table 4-39 Annual Risks to Crew Members and the Public from Transporting Ancillary Low-Level Radioactive Waste and Mixed Level Radioactive Waste to Waste Control Specialists

			Incident-Free[a]				Accident[a]	
			Crew		Population			
Origin	Number of Shipments	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck[c]								
Paducah	1	1,700	2×10^{-4}	1×10^{-7}	1×10^{-4}	9×10^{-8}	4×10^{-14}	1×10^{-4}
Portsmouth	1	2,300	3×10^{-4}	2×10^{-7}	2×10^{-4}	1×10^{-7}	8×10^{-14}	2×10^{-4}

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] Total risks can be estimated by multiplying by the maximum duration of the storage period for this alternative (76 years [44 + 32) for Paducah and 47 years (32 +15) for Portsmouth)

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because of the small amount of waste requiring shipment to the waste management facility, rail transport would be inefficient and was not considered.

Note: To convert kilometers to miles multiply by 0.62137.

The WCS disposal option was not analyzed in the 2004 EISs. Therefore, no calculations based on the 2004 EISs could be performed for transportation of DU oxide in bulk bags (and the resulting 69,000 volume-reduced empty and heel cylinders) to WCS. Nevertheless, given that the estimated risks (in terms of crew and population doses) for transport of DU oxide in cylinders to WCS is shown to be less than or equal the transport to Energy*Solutions* and NNSS, the corresponding risks associated with transport of the DU oxide in bulk bags (and the resulting empty and heel cylinders) to WCS would also be expected to be less than those calculated for Energy*Solutions* and NNSS.

Furthermore, the impacts from the transport of CaF_2 from neutralization of HF to a LLW disposal facility are also estimated. It is estimated that there would be 32,420 truck shipments or 8,105 rail shipments from Paducah and 13,550 truck shipments or 3,390 rail shipments from Portsmouth to WCS. Although conservatively considered LLW for purposes of disposal, CaF_2 has such low levels of radiation it would provide a negligible dose to the crew and the public during transport. The estimated traffic fatalities from these shipments are summarized in **Table 4-40**.

Table 4-40 Total Population Transportation Risks for Shipment of CaF_2 to the Waste Control Specialists Site under the Hydrogen Fluoride Neutralization Option[a]

Origin	Paducah		Portsmouth	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	32,420	8,105	13,550	3,390
Total distance (one-way [km])[a]	49,968,000	16,269,000	30,949,000	9,991,000
Traffic fatalities (round trip)	3.66	0.77	2.70	0.45

Key: km = kilometer.

[a] Although shipped to a LLW disposal facility, the CaF_2 would likely have little or no radioactivity; therefore, there would be negligible doses to the transportation crew and the public.

Impacts from Incident-Free Transport of Radioactive Waste

The potential radiological impacts on transport crews and populations along the routes are shown in Tables 4-37 through 4-39. The tables include the results of shipping all DU oxide and other wastes to WCS. As shown in Tables 4-37 through 4-39, transportation of DU oxide dominates the risks. Therefore, the impacts of shipping empty and heel cylinders and ancillary LLW and MLLW to WCS are not discussed further. In addition, CaF_2 is not discussed further because this material would contain little or no radioactivity, and therefore would not result in work or public exposure.

Given that the estimated risks associated with transport of DU oxide in bulk bags to WCS would be expected to be less than those calculated for Energy*Solutions* and NNSS, transport of DU oxide in bulk bags is not expected to result in any LCFs to crew members. For truck transport, the calculated LCF risk over the duration of the project would be less than 0.1, or less than 1 chance in about 10 of a single LCF among the transportation crews. For rail transport, the calculated LCF risk over the duration of the project would be less than 0.05, or less than 1 chance in about 20 of a single LCF among the transportation crews.

The dose to the general population likely would not result in an LCF for transport of DU oxide in cylinders. As detailed in Table 4-37, for truck transport of DU oxide, the calculated LCF risk over the duration of the project would be 0.2, or 1 chance in 5 of a single LCF in the exposed population. For rail transport, the calculated LCF risk over the duration of the project would be 0.1, or 1 chance in about 10 of a single LCF in the exposed population.

The total radioactive dose received by an MEI (a resident along the route near WCS), hypothetically assumed to be exposed to every DU oxide truck shipment over the duration of the project, would be about 2.14 millirem, resulting in an increased risk of developing an LCF of 1×10^{-6}, or 1 chance in 780,000. Assuming that shipments would occur over 32 years, the average annual dose to this individual would be 0.063 millirem, which is 0.063 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents) and (2) maximum reasonably foreseeable accidents (accidents with radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year). As indicated in Tables 4-37 through 4-39, considering all reasonably foreseeable accidents, transport of radioactive waste would likely result in no LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck and rail transportation options.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxide shipped under this alternative, the maximum reasonably foreseeable transportation accident with the highest consequence would involve rail transport in an suburban area (see Appendix B, Table B-7). The probability of this rail accident involving transport of DU oxide to WCS would be 4.1×10^{-6} per year in an urban area, or 1 chance in 244,000 each year. The consequences of the truck transport accident, if it occurred, in terms of population and MEI dose would be about 11 person-rem and 0.0039 rem, respectively. These doses would likely result in no (calculated value of 0.007) additional LCFs among the exposed population and a risk of 2×10^{-5} that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (calculated value of 3×10^{-8}).

Vehicle Emissions

Transport of DU oxide to WCS would result in emissions from trains or trucks. It is expected that an average of 24 railcar shipments would occur annually from each of Paducah and Portsmouth. For shipment by truck, it is expected that Paducah and Portsmouth would each ship up to 1,440 truckloads per year. The empty and heel cylinders could be shipped via rail in four annual shipments, or via truck in 125 annual shipments. Transport of CaF_2 via rail is assumed to be an additional 238 and 154 shipments annually from Paducah and Portsmouth, respectively. Shipment of CaF_2 via truck would result in an additional 953 and 616 shipments from Paducah and Portsmouth, annually.

The quantity of DU oxide in each truck or rail shipment would vary depending on whether cylinders or bulk bags are used. If bulk bags were to be used, the total number of truck shipments of DU oxide would decrease, but the number of empty and heel cylinders to be shipped for disposal would increase. The total number of rail shipments under the bulk bag shipment scenario would be more than the number of shipments utilizing DU oxide in cylinders. Therefore, the analysis below represents the most conservative scenario (i.e., the largest quantity of emissions), and all other potential shipping scenarios would generate lower levels of emissions of both criteria pollutants and GHGs.

Rail Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 railcar shipments annually from Paducah and 25 from Portsmouth to WCS. It was estimated that locomotives would travel approximately 1,000 miles (1,700 kilometers) per rail shipment from Paducah to WCS and approximately 1,400 miles (2,300 kilometers) from Portsmouth to WCS. Emissions were calculated using emission factors for tier 2 line haul locomotives derived from the EPA's *Emission Factors for Locomotives* (EPA 2009). Emissions of all criteria pollutants would be less than 210 tons (190 metric tons) annually for all shipments from Paducah and Portsmouth combined (see **Table 4-41**). Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR.

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality. Emissions could be decreased further by combining shipments for the rail option. That is, while it was assumed that DU oxide and CaF_2 in bulk bags would be shipped in one railcar per shipment, filling multiple cars per shipment would decrease the overall number of trips and, therefore, the quantity of annual emissions.

Table 4-41 Criteria Pollutant Emissions from Transportation via Railcar to Waste Control Specialists

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
	Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
	Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Paducah	1.06	4.09	0.15	0.14	0.07	0.23
	Portsmouth	1.54	5.96	0.22	0.21	0.11	0.33
	Total emissions	*2.60*	*10.04*	*0.37*	*0.35*	*0.18*	*0.56*
14,000 empty and heel cylinders	Paducah	0.18	0.68	0.02	0.02	0.01	0.04
	Portsmouth	0.25	0.95	0.03	0.03	0.02	0.05
	Total emissions	*0.42*	*1.63*	*0.06*	*0.06*	*0.03*	*0.09*
DU oxide in bulk bags	Paducah	6.65	25.71	0.93	0.91	0.47	1.42
	Portsmouth	6.35	24.55	0.89	0.87	0.45	1.36
	Total emissions	*13.00*	*50.25*	*1.83*	*1.77*	*0.92*	*2.78*
69,000 empty and heel cylinders	Paducah	9.95	38.47	1.40	1.36	0.70	2.13
	Portsmouth	10.66	41.23	1.50	1.45	0.75	2.28
	Total emissions	*20.61*	*79.71*	*2.90*	*2.81*	*1.46*	*4.41*
CaF_2	Paducah	10.48	40.52	1.47	1.43	0.74	2.24
	Portsmouth	9.49	36.70	1.33	1.29	0.67	2.03
	Total emissions	*19.97*	*77.22*	*2.81*	*2.72*	*1.41*	*4.27*
Grand Total (DU Oxide in Cylinders)		**23.18**	**89.64**	**3.27**	**3.16**	**1.63**	**4.96**
Grand Total (DU Oxide in Cylinders)		**54.19**	**209.56**	**7.62**	**7.39**	**3.83**	**11.59**

Truck Option

Criteria pollutant emissions were calculated based on an estimated 1,440 shipments annually from each facility to WCS (see **Table 4-42)**. Analysis estimated approximately 1,000 miles (1,700 kilometers) per truck shipment from Paducah to WCS and approximately 1,400 miles (2,300 kilometers) per shipment from Portsmouth to WCS via truck. Emissions were derived using the emission factors for heavy-duty diesel vehicles in the EPA's MOVES2014a. MOVES is the EPA Motor Vehicle Emission Simulator. It is used to create emission factors or emission inventories for both onroad motor vehicles and nonroad equipment (EPA 2015).

Emissions of all criteria pollutants would be less than 40 tons (36 metric tons) annually for all shipments from Paducah and Portsmouth combined. These emissions are extremely minute in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular Air Quality Control Region (AQCR). However, because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table 4-42 Criteria Pollutant Emissions from Transportation via Truck to Waste Control Specialists

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.08	0.24	0.01	0.01	0.00	0.02
	Portsmouth	0.08	0.24	0.01	0.01	0.00	0.02
	Total emissions	*0.17*	*0.48*	*0.02*	*0.02*	*0.00*	*0.05*
DU oxide (cylinders)	Paducah	3.44	9.81	0.36	0.33	0.02	1.02
	Portsmouth	5.08	14.50	0.53	0.49	0.03	1.51
	Total emissions	*8.52*	*24.30*	*0.89*	*0.82*	*0.06*	*2.53*
14,000 empty and heel cylinders	Paducah	0.30	0.85	0.03	0.03	0.00	0.09
	Portsmouth	0.42	1.19	0.04	0.04	0.00	0.12
	Total emissions	*0.72*	*2.04*	*0.07*	*0.07*	*0.00*	*0.21*
DU oxide (bulk bags)	Paducah	1.44	4.10	0.15	0.14	0.01	0.43
	Portsmouth	1.38	3.92	0.14	0.13	0.01	0.41
	Total emissions	*2.81*	*8.02*	*0.29*	*0.27*	*0.02*	*0.84*
69,000 empty and heel cylinders	Paducah	1.62	4.62	0.17	0.15	0.01	0.48
	Portsmouth	1.73	4.94	0.18	0.17	0.01	0.51
	Total emissions	*3.35*	*9.56*	*0.35*	*0.32*	*0.02*	*1.00*
CaF_2	Paducah	2.27	6.48	0.24	0.22	0.01	0.68
	Portsmouth	2.06	5.86	0.21	0.20	0.01	0.61
	Total emissions	*4.33*	*12.34*	*0.45*	*0.41*	*0.03*	*1.29*
Grand Total (DU Oxide in Cylinders)		**13.74**	**39.16**	**1.43**	**1.32**	**0.09**	**4.08**
Grand Total (DU Oxide in Bulk Bags)		**11.38**	**32.44**	**1.18**	**1.09**	**0.07**	**3.39**

Greenhouse Gases

Estimating approximately 1,000 miles (1,700 kilometers) per rail shipment from Paducah to WCS, approximately 4,445 tons (4,032 metric tons) of GHG emissions (measured as CO_2e) would be produced annually (CNR 2016) (see **Table 4-43**). Estimating approximately 1,400 miles (2,300 kilometers) per rail shipment from Portsmouth to WCS, approximately 5,593 tons (5,074 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for

Table 4-43 Annual GHG Emissions from the Transport of DU Oxide to Waste Control Specialists

Site	GHG Emissions (tons per year CO_2e)	
	Rail Option	Truck Option
Paducah[a]	4,445	4,309
Portsmouth[b]	5,593	5,422
Total	**10,037**	**9,731**
National Rail Emissions[c]	45,300,000	NA
National Truck Emissions[c]	NA	467,400,000

Key: CO_2e = carbon dioxide equivalents; GHG = greenhouse gas; NA = not applicable.

[a] The rail and truck options both include emissions from truck shipment for disposal of LLW, MLLW, and empty and heel cylinders as discussed in Section 4.1.2 for the No Action Alternative.

[b] Source: CNR 2016

[c] Source: EPA 2018c

disposal of ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 as discussed in Section 4.1.2 for the No Action Alternative, total annual GHG emissions from railcar shipments (10,037 tons [9,106 metric tons]) would be minimal in terms of the national GHG emissions from railway transportation, which total 45.3 million tons (41.1 million metric tons) annually (EPA 2018c).

For shipment by truck, it is Estimating approximately 1,000 miles (1,700 kilometers) per truck shipment from Paducah to WCS, approximately 4,309 tons (3,909 metric tons) of GHG emissions would be produced annually (CNR 2016). Estimating approximately 1,400 miles (2,300 kilometers) per shipment from Portsmouth to WCS, approximately 5,422 tons (4,919 metric tons) of GHG emissions would be produced annually (CNR 2016). Including shipments for disposal of ancillary LLW and MLLW, empty and heel cylinders, and CaF_2 as discussed in Section 4.1.2 for the No Action Alternative, total annual GHG emissions from truck shipments (9,731 tons [8,828 metric tons]) would be minimal in terms of the national GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018c).

4.4.3 Impacts on Disposal Capacity at Waste Control Specialists

This section describes the impacts on the disposal capacity at WCS. Other potential environmental impacts of disposal at WCS are not analyzed in this DU Oxide SEIS. As long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, it is assumed that the impacts of disposal have been considered and found to be acceptable as part of the licensing and permitting process for the facility. Chapter 5, Section 5.4.3, briefly describes the licenses and permits held by WCS. WCS operating licenses and permits are available for review at http://www.wcstexas.com/facilities/licenses-permits/.

The disposal of DU oxide, ancillary LLW and MLLW from storage and maintenance of DU oxide cylinders, empty and heel cylinders, and CaF_2, would not exceed the disposal capacity for the WCS FWF, even if WCS received this waste from both Paducah and Portsmouth. The volumes of DU oxide, waste from storage and maintenance of DU oxide cylinders, empty and heel cylinders, and CaF_2, would be the same as those stated in Section 4.2.3.

Table 4-44 shows the waste volumes and percent of disposal capacity under the Disposal of Waste at Waste Control Specialists Alternative. As shown in Table 4-43, delivery of all DU oxide to WCS would represent about 40 percent of the disposal capacity of the FWF. In addition, if DU oxide were disposed of in bulk bags, it would result in a similar disposal volume as DU oxide in cylinders, and therefore similar impacts on the capacity of the disposal facility. The volume-reduced empty and heel cylinders generated as a result of disposal of DU oxide in bulk bags would generate an additional waste stream estimated at 38,600 cubic yards or 4 percent of disposal capacity at WCS.

Disposal of empty and heel cylinders would represent about 8.2 percent of the disposal capacity of the FWF. The small quantities of ancillary LLW and MLLW from storage and maintenance of DU oxide cylinders would represent only small fractions of the disposal capacity for the FWF. Disposal at WCS of all CaF_2 would represent about 24 percent of the LLW disposal capacity of the FWF. If all waste associated with the Proposed Action were shipped to WCS, it would represent about 72 percent of the LLW disposal capacity of the FWF.

Table 4-44 Waste Volumes and Percent of Disposal Capacities under the Disposal of Waste at Waste Control Specialists Alternative

Waste			Waste Volume (cubic yards)[a]	Disposal Capacity (cubic yards)[b]	Percent of Disposal Capacity
LLW – DU oxide	In cylinders[c]		386,000[c]	955,000	40
	Bulk Bag Option	In bulk bags	386,000	955,000	40
		Volume-reduced empty and heel cylinders	38,600	955,000	4
LLW – empty and heel cylinders			78,300[d]	955,000	8.2
Ancillary LLW[e]			140	955,000	0.015
Ancillary MLLW[e]			0.92	955,000	0.00010
CaF_2 option			225,000	955,000	24

Key: DU = depleted uranium; FWF = Federal Waste Facility; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste.

[a] Source: PPPO 2018.

[b] It is assumed that LLW, MLLW, and DU oxide waste would be disposed of in the FWF at WCS, which has a total capacity of about 963,000 cubic yards (736,000 cubic meters), of which about 7,550 cubic yards (5,780 cubic meters) had been used as of August 26, 2016.

[c] Determined assuming 69,000 DU oxide cylinders each measuring 4 feet (1.2 meters) in diameter and 12 feet (3.7 meters) long; plus approximately 107 cubic yards (82 cubic meters) of DU oxide in drums.

[d] The listed volume of the empty and heel cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facilities or a separate waste treatment facility.

[e] It is assumed for analysis that all waste from storage and maintenance of DU oxide cylinders from both Paducah and Portsmouth would be disposed of at WCS. Waste volumes from oxide storage and maintenance were determined assuming these activities would last for 76 years (44 years of storage and 32 years of shipping) at Paducah and 47 years (32 years of storage and 15 years of shipping)at Portsmouth.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Similar to the discussion for Energy*Solutions* (Section 4.2.3), DOE would coordinate shipment scheduling with WCS to ensure that the appropriate personnel and equipment are available to safely manage waste receipts. WCS routinely receives waste by both truck and rail delivery. Assuming WCS received DU oxide from both Paducah and Portsmouth, WCS could conservatively receive an average of 12 trucks per day, assuming all oxide was delivered by truck, or 4 trainloads a month, assuming all oxide was delivered by rail. DOE expects that WCS would have little difficulty in accommodating either shipment mode. DOE expects that an average of 12 trucks per day or 4 trainloads per month would be within the range of truck and rail shipments that routinely arrive at WCS. The small quantity of DU oxide shipped in drums could be delivered in a few annual truck loads or with the rail shipments of DU oxide cylinders which would be easily managed at WCS.

Similar to the discussion in Section 4.2.3, DOE expects that deliveries of empty and heel cylinders would be readily managed at WCS given its existing personnel and equipment configuration. There would be an average of one truck delivery of empty and heel cylinders every work day from Paducah and Portsmouth. As discussed in Section 4.1.3, the projected volume of empty and heel cylinders could be reduced by volume reduction activities (e.g., compaction or shredding) at the disposal facility or a separate treatment facility. In addition, the void space within the cylinders would need to be addressed; this could be accomplished through volume reduction or other measures. Otherwise, assuming the same number of empty and heel cylinders was shipped by rail from both Paducah and Portsmouth, trains with the cylinders would arrive about 4 times per year.

Assuming 6 empty and heel cylinders per railcar and 10 railcars per train, each rail shipment would contain 60 cylinders to be offloaded and transferred to the designated disposal unit.

As also discussed in Section 4.2.3, the projected volumes of waste from DU oxide storage and maintenance activities are very small and could be managed at WCS given its existing personnel and equipment configuration. The annual generation rate of LLW from these activities from both Paducah and Portsmouth could be sent to WCS in a total of two truckloads. Annual volumes of MLLW could be shipped in a single 55-gallon drum from Paducah and a single 55-gallon drum from Portsmouth.

Similar to the discussion in Section 4.2.3, if HF cannot be sold and needs to be converted to CaF_2 and sent to a disposal facility, there would be an average of six truck deliveries or one to two rail deliveries per day of CaF_2 from Paducah and Portsmouth. This was based on assumption that only one bag would be transported per truck and only four bags on each train. A train could easily accommodate additional railcars (each carrying four bags). Therefore, train deliveries could be easily reduced to an average of less than one per day.

4.5 CUMULATIVE IMPACTS

4.5.1 Issues and Assumptions

CEQ regulations define cumulative impacts as the effects on the environment that result from implementing the Proposed Action or any of its alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions (40 CFR 1508.7). Thus, the cumulative impacts of an action can be viewed as the total impact on a resource, ecosystem, or human community of that action and all other activities affecting that resource irrespective of the source. Noteworthy cumulative impacts can result from individually small, but collectively significant, effects of all actions.

Cumulative impacts were assessed by combining the effects of alternative activities evaluated in this DU Oxide SEIS with the effects of other past, present, and reasonably foreseeable actions in the ROI. These actions may occur at different times and locations and may not be truly additive. The effects were combined irrespective of the time and location of the impact, to envelop any uncertainties in the projected activities and their effects. This approach produces a conservative estimation of cumulative impacts for the activities considered.

As described in Chapter 4, Sections 4.1.1 and 4.2.1, the alternatives evaluated in this DU Oxide SEIS would cause little to no impacts on site infrastructure; air quality and noise; geology and soils; water, biotic, and cultural resources; socioeconomics; land use; aesthetics, and environmental justice, near Paducah and Portsmouth. Because the alternatives would produce little or no impacts on these resource areas, they would not substantially contribute to cumulative impacts. Thus, this section analyzes cumulative impacts on the remaining areas of public and occupational health and safety and waste management for the Paducah (Section 4.5.2) and Portsmouth (Section 4.5.3). In addition, nationwide cumulative impacts on transportation air quality and climate change are discussed in Section 4.5.4.

4.5.2 Paducah Site

DOE's mission involves the following ongoing activities at Paducah (DOE 2004a, 2017a):

- Continued management of DUF_6 cylinders,
- Operation of the DUF_6 to DU oxide Conversion Facility,
- Storage and management of cylinders containing DU oxide conversion product,
- Waste Management, and
- Decontamination, Decommissioning, and Demolition of facilities
- Environmental Remediation.

The affected environment information presented in Chapter 3 of this DU Oxide SEIS reflects the impacts of ongoing activities at Paducah. Reasonably foreseeable future activities that are being considered for Paducah include:

- Disposal of waste in an on-site disposal facility,
- Land and facilities transfers,
- Conversion of additional commercially generated DUF_6, and
- Construction of a laser enrichment facility.

4.5.2.1 Disposal of Waste in an On-Site Disposal Facility

DOE is addressing options for management of waste that will be generated from further cleanup of Paducah. Cleanup of Paducah is estimated to generate 3.6 million cubic yards (2.8 million cubic meters) of demolition debris, metals, soils, asbestos and other material (see Table 3-10 in Chapter 3). DOE is using the CERCLA process to make a decision on disposition of this waste. DOE is evaluating three alternatives: (1) No Action (no changes to current waste disposal practices); (2) Off-Site Disposal; and (3) On-Site Disposal. The On-Site Disposal Alternative includes on-site disposal in a CERCLA waste disposal facility (PPPO 2016). Sufficient information is not available on the environmental impacts of the various disposal alternatives to include in this cumulative impacts analysis.

4.5.2.2 Land and Facilities Transfers

In the *Paducah Gaseous Diffusion Plant Final Environmental Assessment for Potential Land and Facilities Transfers, McCracken County, Kentucky* (DOE 2015b), DOE evaluated the potential transfer of GDP property to one or more entities for uses that could be different from its current use. The Proposed Action would reduce the footprint of the Paducah Site, which would reduce the cost to maintain the site. In December 2015 DOE issued a Finding of No Significant Impact (FONSI) for the Proposed Action (DOE 2015i).

4.5.2.3 Conversion of Additional Commercially Generated DUF_6

As described in Chapter 1, Section 1.4, commercial uranium enrichment facilities may request that DOE disposition their DUF_6. Section 3113(a) of the USEC Privatization Act (42 U.S.C. §§ 2297h-11(a)) and Section 66 of the Atomic Energy Act of 1954 (as amended), requires DOE to accept commercial DUF_6 that has been determined to be LLW, for disposal upon request and reimbursement of cost by any generator licensed by NRC to operate a uranium enrichment facility.

To estimate the contribution to cumulative impacts from the potential management of commercial DUF_6 at Paducah, DOE has assumed that 150,000 metric tons (approximately 12,500 cylinders) of commercial DUF_6 would be managed. The detailed analysis of the impacts of the receipt, handling, conversion, storage, and disposal of commercial DUF_6 is presented in Appendix C of this SEIS. Where appropriate, the impacts of the management of commercial DUF_6 at Paducah are summarized in this cumulative impacts analysis.

4.5.2.4 Construction and Operation of a Laser Enrichment Facility

In November, 2016, DOE announced that GE-Hitachi Global Laser Enrichment is evaluating construction of a laser enrichment facility adjacent to the Paducah Site. DOE has agreed to sell DU to GE-Hitachi Global Laser Enrichment over a 40-year period which would be enriched at a proposed facility to produce uranium-235 to be used for production of fuel for commercial nuclear power reactors. GE-Hitachi Global Laser Enrichment would finance, construct, own and operate the Paducah Laser Enrichment Facility adjacent to Paducah. The facility would be a commercial uranium enrichment facility licensed by NRC. The construction and operation of the billion-dollar facility could bring approximately 800 to 1,200 jobs to the local community (PPPO 2016). Although, sufficient information is not available to determine the environmental impacts of this proposal, it would not be expected to exceed the impacts of historic operations at Paducah.

4.5.2.5 Other Off-Site Actions

Other actions occurring near Paducah that could contribute to current and future cumulative impacts include:

- Electrical power generation at the TVA's Shawnee Power Plant,
- Electrical power generation at the Electric Energy, Inc., power plant (Joppa Plant) in Joppa, Illinois,
- Conversion of uranium ore to UF_6 at the Honeywell International, Inc., uranium conversion plant in Metropolis, Illinois, and
- Development of the Ohio River Triple Rail Megasite.

The Tennessee Valley Authority (TVA) Shawnee Fossil Plant abuts the northeastern boundary of Paducah and has nine active generating units that burn about 9,600 tons (8,700 metric tons) of coal per day. The Shawnee Fossil Plant produces electricity by heating water in coal-fired boilers to produce steam that flows into a turbine that spins a generator to make electricity. The Shawnee Fossil Plant generates about 8 billion kilowatt-hours of electricity a year, enough to supply 540,000 homes (DOE 2015b). TVA has recently installed scrubbers and Selective Catalytic Reduction systems at two of the Shawnee Fossil Plant's units to control emissions (TVA 2018). These systems are expected to reduce emissions of NO_x and SO_2 by approximately 22 percent. On April 17, 2015, the EPA established national criteria and schedules for the management and closure of Coal Combustion Residuals (coal ash) facilities (80 FR 21302). The Shawnee Fossil Plant's approximately 200 acre (81 hectares) special waste landfill will be closed pursuant to these regulations (TVA 2016).

Electric Energy operates a six-unit coal-fired generating plant in Joppa, Illinois, (Joppa Plant) with a total generating capacity of 1,086 MW, and two gas turbines with a total capacity of approximately 74 MW. Eight miles (13 kilometers) of 161 kV transmission lines connect the Joppa Plant and Paducah (FERC 2013). The Joppa Plant is approximately 4.5 miles (7.2 kilometers) northwest of the nearest boundary of Paducah.

Honeywell's Metropolis Works converts uranium ore into UF_6. UF_6 is used to produce enriched uranium for use as fuel in nuclear power plants. The site is located on approximately 950 acres (384 hectares) of land in Massac County, Illinois. Plant operations are conducted in a fenced, restricted area covering approximately 59 acres (24 hectares) in the north-central portion of the site. The Metropolis Works operates under a license from NRC. The facility has the capacity to convert approximately 15,000 metric tons (16,500 tons) of uranium per year from ore concentrates into UF_6 (Enercon 2016). Honeywell's Metropolis Works employed 250 people (Honeywell 2016). As a result of a downward trend in the uranium fuel market, Honeywell temporarily idled production of the Metropolis Works in November 2017, while maintaining minimal operations to support a future restart should business conditions improve. Because of this, the company intended to reduce the full-time workforce at the plant by 170 positions (Honeywell 2018; PPPO 2018). However, for purposes of conservative cumulative impacts analysis, DOE has assumed that Honeywell's Metropolis Works will continue to operate. The Metropolis Works is approximately 2.5 miles (4 kilometers) northeast of the nearest boundary of Paducah.

Paducah Economic Development, which is the economic development agency for Paducah and McCracken County, has identified 1,112 acres (450 hectares) of previously undeveloped land adjacent and to the northeast of Paducah as a location for a future development called the Ohio River Triple Rail Megasite. The TVA Shawnee Fossil Plant lies to the west of this site. The proposed development would include industrial and commercial uses. As proposed, development activities would include construction of a rail spur and a barge dock. No details are available of specific proposals for development (DOE 2015b; PED 2018). Therefore, analysis of the impacts of this future action would be speculative.

4.5.2.6 Results

The results of the cumulative impacts analyses for Paducah are summarized in **Table 4-45**. The second and third data columns of the table summarize the results of the assessment of impacts of alternatives presented in Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS. The fourth and fifth data columns summarize the results of the impacts from the two scenarios for conversion of commercial DUF_6 that were evaluated and presented in Appendix C of this SEIS. The next column summarizes the impacts from other actions at Paducah and in the vicinity, particularly the impacts from DD&D of the conversion capabilities. The last two data columns identify the anticipated cumulative impacts of the alternatives when added to existing conditions and other reasonably foreseeable actions. For conservative analysis, the cumulative impacts for both the No Action and Action Alternatives include the impacts from conversion of commercial DUF_6 (that is, it is assumed that cumulative impacts for the Action Alternatives include the impacts from the commercial Conversion and Disposal Scenario, while the cumulative impacts for the No Action Alternative include the impacts from the commercial Conversion and Storage Scenario.

Table 4-45 Annual Cumulative Impacts at the Paducah Site

Impact Category	Existing Conditions[a]	DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[c]		Other Actions[d]	Cumulative Impacts[e]	
		Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative
Public and Occupational Safety and Health								
Worker dose[f] (person-rem/yr)	6.2	3.6	1.2	16	17	14.7[g]	40.5	39.1
Worker LCFs	0 (0.004)	0 (2×10^{-3})	0 (7×10^{-4})	0 (0.01)[j]	0 (0.01)[j]	0 (0.01)[g]	0 (0.01)	0 (0.01)
Public dose (person-rem/yr)	0.89	0.01	0.01	0.003	0.003	3.81[g]	4.7	4.7
Public LCFs	0 (0.0005)	0 (5×10^{-6})	0 (5×10^{-6})	0 (2×10^{-6})	0 (2×10^{-6})	0 (0.002)[g]	0 (0.003)	0 (0.003)
Off-site MEI dose (millirem/yr)	4.5	5.0	5.0	0.2	0.2	0.57[g]	6.1[h,i]	6.1[h,i]
Waste Management								
LLW (including empty and heel cylinders and CaF_2) (yd^3/yr)	210	6,790[j]	6,030[j]	5,960	5,540	92[k]	7,090[l]	6,330[l]
MLLW (yd^3/yr)	1.4	0.014	0.014	0.014	0.014	52[k]	54[l]	54[l]

Key: DD&D = decontamination, decommissioning, and demolition; DU = depleted uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; SEIS = supplemental environmental impact statement; yd^3 = cubic yard; yr = year.

[a] Based on information presented in Chapter 3, Section 3.1, of this DU Oxide SEIS.

[b] Based on results presented in Chapter 4, Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS.

[c] Impacts from the conversion of 150,000 metric tons (165,000 tons) of commercial DUF_6 and storage or disposal of the converted commercial DU oxide (see Appendix C of this DU Oxide SEIS).

[d] Includes impacts of other actions as described in Section 4.5.2 of this DU Oxide SEIS.

[e] Cumulative impacts equal the sum of the impacts of the management alternative and other past, present, and reasonably foreseeable future actions. The cumulative impacts of the Action Alternatives include the sum of existing conditions; DU Oxide SEIS alternatives – Action Alternatives; commercial conversion scenarios – Conversion and Disposal; and other actions. The cumulative impacts of the No Action Alternative include the sum of existing conditions; DU Oxide SEIS alternatives – No Action Alternative; commercial conversion scenarios – Conversion and Storage; and other actions. This is a conservative assumption because some site activities are counted twice and some will not occur concurrently. For example: (1) LLW and MLLW from existing conditions include wastes generated from conversion of DOE DUF_6 to DU oxide and (2) conversion of DOE DUF_6 to DU oxide may not occur in the same years that conversion of commercial DUF_6 to DU oxide would occur.

[f] Includes involved and noninvolved worker doses.

[g] Impacts from operation of the Honeywell Metropolis Works, a uranium conversion facility in Metropolis, Illinois (Enercon 2017; NRC 2006).

[h] The MEI doses occur at different locations for different facilities. Therefore, adding the MEI doses is a very conservative estimate of potential cumulative doses to an MEI.

[i] The off-site MEI dose reported in Section 3.1.6 of this SEIS for existing conditions and in Sectinos 4.1.1.6 and 4.2.1.6 for each of the alternatives includes the same direct radiation dose from cylinders stored in the cylinder yard (4.2 millirem per year). When calculating the cumulative MEIS dose, this direct exposure was only counted once.

[j] The increased generation of LLW during the alternatives primarily reflects the assumed increased generation of LLW in the form of empty and heel cylinders and CaF_2 (PPPO 2018). DU oxide is not considered in this estimate because it is a resource until shipped off site for disposal.

Impact Category	Existing Conditions[a]	DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[c]		Other Actions[d]	Cumulative Impacts[e]	
		Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative

[k] Reflects generation of LLW and MLLW from DD&D of the oxide conversion capability (DOE 2004a). Approximately 3.2 million cubic yards (2.5 million cubic meters) of lightly contaminated LLW, 70,708 cubic yards (54,060 cubic meters) of MLLW, and 356 cubic yards (272 cubic meters) of TSCA waste could be generated from future environmental restoration and DD&D activities over the period from 2018 through 2065 (see Table 3-10). DOE is currently evaluating the potential to dispose of 3.2 million cubic yards of lightly contaminated LLW in the OSWDF.

[l] The scenarios for conversion of commercial DUF_6 were not added to the cumulative annual impacts because the majority of these activities would not take place at the same time as the management of DOE DU oxide. Therefore, only the maximum values between the DU Oxide SEIS alternatives and the commercial conversion scenarios were used in the totals.

Sources: DOE 2004a; PPPO 2018

Human Health During Normal Operations

For the No Action and the Action Alternatives, impacts to human health and safety would be low. As shown in Table 4-44, the cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 millirem per year to the off-site MEI for both the No Action and Action Alternatives and below the limit of 25 millirem per year specified in 40 CFR 190 for uranium fuel cycle facilities. Doses to individual involved workers would be below the regulatory limit of 5,000 millirem per year (10 CFR Part 835) and less than an administrative limit of 2,000 millirem per year (DOE 2017g).

As described in Chapter 4, Sections 4.1.1 and 4.2.1, impacts associated with chemical exposure are expected to be very small under the No Action and Action Alternatives. Impacts from the cumulative exposure to chemicals are unlikely due to regulations that limit the release of hazardous chemicals, and the distances to other potential sources of these chemicals. The calculation of cumulative impacts is not possible because of the absence of necessary measures (chemical concentrations or hazard indices) for the other actions.

Human Health Under Accident Scenarios

For the No Action and the Action Alternatives, as well as the Conversion and Storage and Conversion and Disposal Scenarios, 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 [$0.01 * 0.01 = 0.0001$]). 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 result in no chemical effects and no LCFs (DOE 2004a).

Waste Management

Cumulative annual waste generation is presented in Table 4-45. As described in Section 3.1.8, Paducah would continue to generate a variety of wastes from ongoing activities. Radioactive wastes (primarily LLWs) would be generated from management of DUF_6 cylinders and other site activities including conversion of DUF_6 to DU oxide. As described in Sections 4.1.1.8 and 4.2.1.8, the alternatives evaluated in this DU Oxide SEIS would generate small quantities of ancillary LLW and MLLW, LLW in the form of empty and heel cylinders, and potentially LLW from conversion of HF to CaF_2. Additional ancillary LLW and MLLW, and CaF_2 would be generated if DOE converts 150,000 metric tons (165,000 tons) of commercial DUF_6 to DU oxide and then stores or disposes of the oxide. As addressed in Section 3.1.8, these wastes would be shipped to off-site facilities for treatment and/or disposal. After DUF_6 to DU oxide conversion activities are complete, the conversion capability would be deactivated, decontaminated, and demolished. These wastes would be treated and/or disposed of in authorized facilities that are operating at that time.

Paducah activities will continue to generate waste from environmental restoration and DD&D activities: in the future generation rates could exceed current levels. Remediation of Paducah is being conducted in accordance with the CERCLA process. Through this process, DOE has projected that environmental restoration and DD&D activities at Paducah will generate approximately 3.6 million cubic yards (2.752 million cubic meters) of demolition debris, metals, soils, asbestos, and other material (see Table 3-10 in Chapter 3). Much of this waste is expected to be classified as LLW. Alternatives for on- or off-site disposal of this waste are being considered in accordance with the CERCLA process (DOE 2016d).

The cumulative quantities of wastes generated from activities at Paducah would be managed using existing and new on-site and off-site capabilities and would not be expected to result in substantial cumulative impacts to the waste management infrastructure. See Section 4.5.4 for a discussion of cumulative impacts of waste disposal at Energy*Solutions*, NNSS, and WCS.

4.5.3 Portsmouth Site

Ongoing actions at Portsmouth include (DOE 2004b, 2016a):

- Continued management of DUF_6 cylinders,
- Operation of the DUF_6 to DU oxide Conversion Facility,
- Storage and management of cylinders containing DU oxide conversion product,
- Decontamination, Decommissioning, and Demolition,
- Waste management, and
- Environmental remediation, including operation of the OSWDF.

The affected environment information presented in Chapter 3 of this DU Oxide SEIS reflects the impacts of ongoing activities at Portsmouth. Centrus Energy Corp. (Centrus), formerly USEC, Inc., operated the American Centrifuge Plant, a small-scale demonstration centrifuge for uranium enrichment at Portsmouth since 2006 (DOE 2017c). In 2016, Centrus Energy announced that it would shut down the American Centrifuge Plant (Balusik 2016). More than 230 employees worked at the plant at the time the announcement was made (Balusik 2017). The American Centrifuge Plant is shut down (PPPO 2018). Because this is a relatively recent development, much of the affected environment information presented in Chapter 3 of this DU Oxide SEIS still reflects the impacts of operation of this facility. This will not have a substantive affect on the analysis or conclusions in this SEIS.

Reasonably foreseeable future activities that are being considered, for Portsmouth include (DOE 2004b):

- Disposal of waste in an on-site disposal facility,
- Land and facilities transfer, and
- Conversion of additional commercially generated DUF_6.

4.5.3.1 Disposal of Waste in an On-Site Disposal Facility

Approximately 1.36 million cubic yards (1.04 million cubic meters) of demolition waste will need a disposal pathway (see Table 3-23 in Chapter 3). The Portsmouth Site-wide Waste Disposition

ROD, approved in June 2015, identifies the selected alternative for disposing of waste expected to be produced from DD&D of Portsmouth (DOE 2015g). Under the selected alternative for the Portsmouth Sitewide Waste Disposition ROD (DOE 2015b), the majority of DD&D wastes would remain at Portsmouth in a state-of-the-art OSWDF designed to safely isolate the contaminants present in the waste and to prevent them from being released to the environment. It is anticipated that 107,000 cubic yards (81,800 cubic meters) of material may be a candidate for recycling and/or reuse. Any waste that cannot meet the waste acceptance criteria for the OSWDF would be sent off site for disposal. The on-site facility will be designed to have a total waste capacity of approximately 5 million cubic yards (3.8 million cubic meters). About 100 acres (40 hectares) will be dedicated to the OSWDF (DOE 2015g, 2017a; PPPO 2016). DOE has no plans to dispose of DU oxide in the OSWDF.

4.5.3.2 Land and Facilities Transfers

In the *Conveyance of Real Property at the Portsmouth Gaseous Diffusion Plant in Pike County, Ohio* (DOE 2017d), DOE evaluated the potential transfer of GDP property to one or more entities for uses that could be different from its current use. The Proposed Action would reduce the footprint of Portsmouth, which would reduce the cost to maintain the site. In June 2017 DOE issued a Finding of No Significant Impact (FONSI) for the Proposed Action (DOE 2017e).

4.5.3.3 Conversion of Additional Commercially Generated DUF6

As described in Section 4.5.2.4, DOE may dispose of 150,000 metric tons of commercial DUF_6. For purposes of analysis in this DU Oxide SEIS and as a conservative measure of impacts, DOE assumes that the entire mass of commercial DUF_6 could be managed at Paducah or Portsmouth. The detailed analysis of the impacts of the receipt, handling, conversion, storage, and disposal of commercial DUF_6 is presented in Appendix C of this SEIS. Where appropriate, the impacts of the management of commercial DUF_6 at Portsmouth are summarized in this cumulative impacts analysis.

4.5.3.4 Other Off-Site Actions

Other actions occurring near Portsmouth that could contribute to current and future cumulative impacts include new industrial park projects in the ROI: Sarah James Industrial Park and Gettles Industrial Park (Jackson County); Zahn's Corner and Pike County Manufacturing Center (Pike County); Gateway Industrial Park (Ross County); and Ohio River Industrial Park, Haverhill Industrial Park, and the 522 Site (Scioto County) (DOE 2014). Because of the distance and nature of the activities that could occur at these industrial parks, they are unlikely to contribute to cumulative impacts in this DU Oxide SEIS.

4.5.3.5 Results

The results of the cumulative impacts analyses for Portsmouth are summarized in **Table 4-46**. The second and third data columns of the table summarize the results of the assessment of impacts of alternatives presented in Sections 4.1.1and 4.2.1 of this DU Oxide SEIS. The fourth and fifth data columns summarize the results of the impacts from the two scenarios for conversion of commercial DUF_6 that were evaluated and presented in Appendix C of this SEIS. The next column summarizes the impacts from other actions at Portsmouth and in the vicinity, particularly the impacts from

DD&D of the conversion capability. The last two data columns identify the anticipated cumulative impacts of the alternatives when added to existing conditions and other reasonably foreseeable actions. For conservative analysis, the cumulative impacts for both the No Action and Action Alternatives include the impacts from conversion of commercial DUF_6 (that is, it is assumed that cumulative impacts for the Action Alternatives include the impacts from the commercial Conversion and Disposal Scenario while the cumulative impacts for the No Action Alternative include the impacts from the commercial Conversion and Storage Scenario.

Table 4-46 Annual Cumulative Impacts at the Portsmouth Site

Impact Category	Existing Conditions[a]	Impacts of DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[c]		Impacts of Other Actions[d]	Cumulative Impacts[e]	
		Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative
Public and Occupational Safety and Health								
Worker dose[f] (person-rem/yr)	2.5	3.8	0.76	13	13	No Data	19.3	16.3
Worker LCFs	0 (3×10^{-4})	0 (2.3×10^{-3})	0 (4.6×10^{-4})	0 (0.008)	0 (0.008)	No Data	0 (0.01)	0 (0.01)
Public dose (person-rem/yr)	0.22	0.002	0.002	2×10^{-3}	2×10^{-3}	No Data	0.22	0.22
Public LCFs	0 (1×10^{-4})	0 (1.2×10^{-6})	0 (1.2×10^{-6})	0 (9×10^{-7})	0 (9×10^{-7})	No Data	0 (1×10^{-4})	0 (1×10^{-4})
Off-site MEI dose (millirem/yr)	1.1	1.3	1.3	0.4	0.4	No Data	2.8[h]	2.8[h]
Waste Management								
LLW (including empty and heel cylinders and CaF_2) (yd^3/yr)	160	5,050[h]	4,470[h]	4,480	4,170	92[i]	5,300[i]	4,720[i]
MLLW (yd^3/yr)	1.0	0.010	0.010	0.010	0.010	52[i]	53[i]	53[i]

Key: DD&D = decontamination, decommissioning, and demolition; DU = depleted uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; MLLW = mixed low-level radioactive waste; OSWDF = On-Site Waste Disposal Facility; SEIS = supplemental environmental impact statement; yd^3 = cubic yard; yr = year.

[a] Based on information presented in Chapter 3, Section 3.2 of this DU Oxide SEIS.

[b] Based on results presented in Chapter 4, Sections 4.1.1 and 4.2.1 of this DU Oxide SEIS. No action impacts were considered over 100 years. Action Alternative impacts were considered for 22 or 32 years, whichever had the greatest impacts.

[c] Impacts from the conversion of 150,000 metric tons (165,000 tons) of commercial DUF_6 and storage or disposal of the converted commercial DU oxide (see Appendix C of this SEIS).

[d] Includes impacts of other actions as described in Section 4.5.3. The impacts of other future actions on public and occupational safety and health is unknown, but would be limited by compliance with applicable regulations.

[e] Cumulative impacts equal the sum of the impacts of the management alternative and other past, present, and reasonably foreseeable future actions. The cumulative impacts of the Action Alternatives include the sum of existing conditions; DU Oxide SEIS alternatives – Action Alternatives; commercial conversion scenarios – Conversion and Disposal; and other actions. The cumulative impacts of the No Action Alternative include the sum of existing conditions; DU Oxide SEIS alternatives – No Action Alternative; commercial conversion scenarios – Conversion and Storage; and other actions. This is a conservative assumption because some site activities are counted twice and some will not occur concurrently. For example: (1) LLW and MLLW from existing conditions include wastes generated from conversion of DOE DUF_6 to DU oxide and (2) conversion of DOE DUF_6 to DU oxide may not occur in the same years that conversion of commercial DUF_6 to DU oxide would occur.

[f] Includes involved worker and noninvolved worker doses.

[g] The MEI doses occur at different locations for different facilities operations. Therefore, adding the MEI doses is a very conservative estimate of potential cumulative doses to an MEI.

[h] The increased generation of LLW during the alternatives primarily reflects the assumed increased generation of LLW in the form of empty and heel cylinders and CaF_2 (PPPO 2018). DU oxide is not considered in this estimate because it is a resource until shipped off site for disposal.

Impact Category	Existing Conditions[a]	Impacts of DU Oxide SEIS Alternatives[b]		Commercial Conversion Scenarios[c]		Impacts of Other Actions[d]	Cumulative Impacts[e]	
		Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative

[i] Reflects generation of LLW and MLLW from DD&D of the oxide conversion capability (DOE 2004b). Approximately 1.26 million cubic yards (0.96 million cubic meters) of lightly contaminated LLW, and 100 cubic yards (76 cubic meters) of MLLW are estimated to be generated from future environmental restoration and DD&D activities (see Table 3-23). Approximately 1.14 million cubic yards (0.87 million cubic meters) of LLW are estimated to be disposed of in the OSWDF.

[j] The scenarios for conversion of commercial DUF_6 were not added to the cumulative annual impacts because the majority of these activities would not take place at the same time as the management of DOE DU oxide. Therefore, only the maximum values between the DU Oxide SEIS alternatives and the commercial conversion scenarios were used in the totals.

Sources: DOE 2004b; PPPO 2018

Human Health During Normal Operations

For the No Action and the Action Alternatives, impacts to human health and safety would be low. As shown in Table 4-46, the cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 millirem per year to the off-site MEI for both alternatives and below the limit of 25 millirem per year specified in 40 CFR 190 for uranium fuel cycle facilities. Doses to individual involved workers would be below the regulatory limit of 5,000 millirem per year (10 CFR Part 835) and less than an administrative limit of 2,000 millirem per year (DOE 2017g).

As described in Chapter 4, Sections 4.1.1 and 4.2.1, impacts associated with chemical exposure are expected to be very small under the No Action and Action Alternatives. Impacts from the cumulative exposure to chemicals are unlikely due to regulations that limit the release of hazardous chemicals, and the distances to other potential sources of these chemicals. The calculation of cumulative impacts is not possible because of the absence of necessary measures (chemical concentrations or hazard indices) for the other actions.

Human Health During Accident Scenarios

For the No Action and the 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 result in no chemical effects and no LCFs (DOE 2004b).

Waste Management

Cumulative annual waste generation is presented in Table 4-46. As described in Section 3.2.8, Portsmouth would continue to generate a variety of wastes from ongoing activities. Radioactive wastes (primarily LLW) would be generated from management of DUF_6 cylinders, and other site activities including conversion of DUF_6 to DU oxide. As addressed in Section 3.2.8, these wastes would be shipped to off-site facilities for treatment and/or disposal. As described in Sections 4.1.1.8 and 4.2.1.8, the alternatives evaluated in this DU Oxide SEIS would generate small quantities of ancillary LLW and MLLW, LLW in the form of empty and heel cylinders, and potentially CaF_2. Additional ancillary LLW and MLLW, and CaF_2 would be generated if DOE converts 150,000 metric tons (165,000 tons) of commercial DUF_6 to DU oxide and then stores or disposes of the oxide. After DUF_6 to DU oxide conversion activities are complete, the conversion capability would be deactivated, decontaminated, and demolished. These wastes would be treated and/or disposed of in authorized facilities that are operating at that time.

Portsmouth will continue to generate waste from environmental restoration and DD&D activities, and future generation rates could exceed current levels. In June 2015, DOE issued a ROD for management of a variety of wastes from environmental restoration and DD&D activities at Portsmouth. The ROD calls for disposal of mostly lighly contaminated LLW in a new on-site disposal cell and off-site disposal or recycle of some wastes (DOE 2015g). DOE estimates that a total of approximately 1.47 million cubic yards (1.12 million cubic meters) of waste would be generated, which would be reduced to approximately 1.35 million cubic yards (1.03 million cubic meters) after volume reduction of process gas equipment (DOE 2016d). Approximately 1.14 million cubic yards (0.87 million cubic meters) of LLW is estimated to be disposed of in the OSWDF. It is anticipated that 107,000 cubic yards (84,100 cubic meters) of material may be a candidate for recycling and/or reuse (DOE 2015g). This waste could be generated, depending upon funding, over a 10- to 12-year period (DOE 2014).

The cumulative quantities of wastes generated from activities at Portsmouth would be managed using existing and new on-site and off-site capabilities and would not be expected to result in substantial cumulative impacts on the waste management infrastructure. See Section 4.5.4 for a discussion of cumulative impacts of waste disposal at Energy*Solutions*, NNSS, and WCS.

4.5.4 Cumulative Impacts on Disposal Site Capacity

As described in **Table 4-47**, the cumulative impacts of disposal of DU oxide and other wastes would not exceed the capacities of any evaluated disposal facility, even if each facility received all DU oxide and other waste from both Paducah and Portsmouth. However, as discussed in Sections 4.5.2.1 and 4.5.3.1, about 3.6 million cubic yards (2.75 million cubic meters) of waste from environmental restoration and DD&D activities may be generated at Paducah as well as about 1.36 million cubic yards (1.04 million cubic meters) at Portsmouth. At this time, the total quantities of LLW and MLLW that would be generated from these activities and that could require off-site disposition is uncertain, but initial estimates indicate 9,559 cubic yards (7,308 cubic meters) of LLW and 70,708 cubic yards (54,061 cubic meters) of MLLW from Paducah and approximately 53,600 cubic yards (40,980 cubic meters) of additional LLW and MLLW from Portsmouth would be disposed of at off-site facilities, such as Energy*Solutions*, NNSS, and WCS. In the unlikely event that most of this future DD&D waste was LLW or MLLW that would require off-site disposition,[57] the total quantity of waste that could be disposed of at any single facility could challenge that facility's disposal capacity. Impacts on any facility's capacity could be reduced by distributing waste shipments to multiple disposal facilities, or by developing additional capacity at one or more disposal facilities.

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[57] Most of this DD&D waste would likely be lightly contaminated waste that would be disposed in the on-site disposal facility being developed at Portsmouth for this purpose.

Table 4-47 Cumulative Impacts on Radioactive Waste Disposal Capacity (cubic yards)

Waste	Facility Capacity[a]	Wastes Generated at Paducah and Portsmouth						Cumulative Total (Percent of Capacity in Parenthesis)[e]	
		Existing Operations[b]	DU Oxide SEIS Alternatives[c]		Commercial Conversion Scenarios		Other Actions[d]		
			Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative
Energy*Solutions*									
LLW – DU oxide	Dedicated cell	NA	386,000	0	69,900	0	NA	456,000 (100) [f]	0 (NA)
LLW – includes empty and heel cylinders	4,300,000	12,200	117,000	78,300	4,200	4,300	520	134,000 (3.1)	95,300 (2.2)
LLW – CaF_2	4,300,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (6.2)	264,000 (6.2)
MLLW	354,000	68	0.92	2.4	0.70	1.4	290	360 (0.10)	362 (0.10)
Nevada National Security Site									
LLW – DU oxide	1,800,000	NA	386,000	0	69,900	0	NA	456,000 (25)	0 (NA)
LLW – includes empty and heel cylinders	1,800,000	12,200	117,000	78,300	4,200	4,300	520	134,000 (7.4)	95,300 (5.3)
LLW – CaF_2	1,800,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (15)	264,000 (15)
MLLW	148,000	68	0.92	2.4	0.70	1.4	290	360 (0.24)	362 (0.24)
Waste Control Specialists									
LLW – DU oxide	955,000	NA	386,000	0	69,900	0	NA	456,000 (48)	0 (NA)
LLW – includes empty and heel cylinders	955,000	12,200	117,000	78,300	4,200	4,300	520	134,000 (14)	95,300 (10)
LLW – CaF_2	955,000	NA	225,000	225,000	39,300	39,300	NA	264,000 (28)	264,000 (28)
MLLW	955,000	68	0.92	2.4	0.70	1.4	290	360 (0.04)	362 (0.04)

Key: DOE = U.S. Department of Energy; DU = depleted uranium; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; SEIS = supplemental environmental impact statement.

Waste	Facility Capacity[a]	Wastes Generated at Paducah and Portsmouth						Cumulative Total (Percent of Capacity in Parenthesis)[e]	
		Existing Operations[b]	DU Oxide SEIS Alternatives[c]		Commercial Conversion Scenarios		Other Actions[d]		
			Action Alternatives	No Action Alternative	Conversion and Disposal	Conversion and Storage		Action Alternatives	No Action Alternative

[a] Based on information presented in Chapter 3, Sections 3.3, 3.4, and 3.5 of this DU Oxide SEIS.

[b] Based on current generation rates for LLW and MLLW as described in Chapter 3, Sections 3.1.8 and 3.2.8, except for empty and heel cylinders, for 44 and 32 years, respectively, for Paducah and Portsmouth. Current waste generation is due to on-site activities including DU oxide conversion and ongoing remediation and decontamination and decommissioning activities.

[c] Based on results presented in Chapter 4, Sections 4.1, 4.2, 4.3, and 4.4 of this DU Oxide SEIS. No Action Alternative impacts were considered over 100 years. Action Alternative impacts were considered for operations over 44 or 32 years, respectively, for Paducah and Portsmouth. Wastes include those from DU oxide management and from disposal as LLW of empty and heel cylinders.

[d] Reflects waste from decontamination and decommissioning of the oxide conversion capabilities at Paducah and Portsmouth (DOE 2004a, 2004b). Additional waste will be generated from future environmental restoration and DD&D activities at Paducah and Portsmouth. Initial estimates indicate 9,559 cubic yards (7,308 cubic meters) of additional LLW and 70,708 cubic yards (54,061 cubic meters) of MLLW from Paducah and approximately 53,600 cubic yards (40,980 cubic meters) of additional LLW and MLLW from Portsmouth would be disposed of at off-site facilities, such as Energy*Solutions*, NNSS, and WCS (see Section 4.5.4).

[e] Cumulative impacts equal the sum of the impacts of the alternative and other past, present, and reasonably foreseeable future actions. Volumes and projected impacts on waste disposal facility capacities reflect the assumption that each facility receives all LLW and MLLW from both Paducah and Portsmouth. The Action Alternatives were summed with waste from the Conversion and Disposal Scenario; the No Action Alternative was summed with waste from the Conversion and Storage Scenario.

[f] There would be no impacts on disposal capacity at Energy*Solutions* from disposal of DU oxide because, as described in Chapter 3, Section 3.3, of this DU Oxide SEIS, the disposal unit that would receive the DU oxide would be separate from the other disposal units at the site and, would be designed to receive all DU oxide that may be sent from both Paducah and Portsmouth.

Notes: To convert cubic yards to cubic meters, multiply by 0.76456.

4.5.5 Nationwide and Global Cumulative Impacts

This section evaluates cumulative impacts for nationwide radioactive material transportation and global climate change.

4.5.5.1 Nationwide Radioactive Material Transportation

As shown in **Table 4-48**, rail and truck shipments associated with the alternatives evaluated in this DU Oxide SEIS could result in maximum doses (and LCFs) to workers of 1,610 person-rem (1 LCF) (if bulk bag packagings are used), and to the public of 216 person-rem (0 [0.1] LCF) (if cylinder packagings are used), for rail transportation. Maximum doses (and LCFs) for truck transportation would be 655 person-rem (0 [0.4] LCF) to workers (if bulk bag packagings are used), and 722 person-rem (0 [0.4] LCF) to the public (if cylinder packagings are used). Based on the cumulative impacts analysis presented in Table 4-48 of the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015a) other past, present, and reasonably foreseeable radioactive material transport activities could result in population doses (and LCFs) for workers and the public of 423,000 person-rem (254 LCFs) and 436,800 person-rem (262 LCFs), respectively. Therefore, the impacts of transportation activities related to the actions evaluated in this DU Oxide SEIS would be very small in comparison and would not appreciably add to cumulative impacts.

Table 4-48 Cumulative Impacts of Transportation

Parameter	**Action Alternatives[a]**			**Commercial DUF_6 [c]**			**Other Actions[d]**	**Cumulative Impact[e]**
	Energy*Solutions*	**NNSS[b]**	**WCS**	**Energy*Solutions***	**NNSS[b]**	**WCS**		
Rail – Incident-free								
Crew Dose (person-rem)	1,356[f]	1,610[f]	84[g]	266[f]	310[f]	20[g]	421,000	423,000
Crew LCF	1 (0.8)	1 (1)	0 (0.05)	0 (0.2)	0 (0.2)	0 (0.01)	253	254
Population Dose (person-rem)	135 [g]	216 [g]	135[g]	29[g]	43[g]	32[g]	436,000	436,300
Population LCF	0 (0.08)	0 (0.1)	0 (0.08)	0 (0.02)	0 (0.03)	0 (0.02)	262	262
Rail – Accidents								
Traffic Fatalities	2[f]	2 [f] [g]	1.4[g]	0.4[f]	0.4[f,g]	0.3[g]	NA[h]	NA[h]
Truck – Incident-free								
Crew Dose (person-rem)	571[f]	655 [f]	155[g]	113[f]	135[f]	34[g]	421,000	421,700
Crew LCF	0 (0.3)	0 (0.4)	0 (0.09)	0 (0.07)	0 (0.08)	0 (0.02)	253	253
Population Dose (person-rem)	590[g]	722 [g]	403[g]	118 [g]	144 [g]	88[g]	436,000	436,800
Population LCF	0 (0.4)	0 (0.4)	0 (0.2)	0 (0.07)	0 (0.09)	0 (0.05)	262	262

Parameter	Action Alternatives[a]			Commercial DUF_6 [c]			Other Actions[d]	Cumulative Impact[e]
	Energy*Solutions*	NNSS[b]	WCS	Energy*Solutions*	NNSS[b]	WCS		
Truck – Accidents								
Traffic Fatalities	11[g]	11[g]	10[g]	2[g]	2[g]	2[g]	NA[h]	NA[h]

Key: LCF = latent cancer fatality; NA = not applicable; NNSS=Nevada National Security Site; WCS= Waste Control Specialists.

[a] Based on results presented in Chapter 4, Sections 4.2, 4.3, and 4.4 of this DU Oxide SEIS.

[b] Because NNSS lacks a direct rail connection for waste delivery, rail analyses include calculation of potential impacts associated with rail transportation between both Portsmouth and Paducah and an intermodal facility, as well as truck transports for shipments from the intermodal facility to NNSS. For purposes of analysis and consistent with NNSS SWEIS (DOE 2013a), the intermodal facility was assumed to be the rail yard in Barstow, California.

[c] The impacts of transportation of wastes related to DOE management and disposal of 150,000 metric tons of commercial DUF_6 are described in Appendix C, Section C.7.3. The maximum values for Paducah or Portsmouth are used for this table.

[d] Includes impacts of all other actions as described in the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015a). Includes information from the 2004 Paducah and Portsmouth conversion facility environmental impact statements (DOE 2004a, 2004b). These values are rounded to three significant figures.

[e] Cumulative impacts equal the sum of the impacts of the alternative and other past, present, and reasonably foreseeable future actions. The cumulative impacts represent the maximum values.

[f] These values correspond to the impacts of using bulk bags for DU oxide transportation. They include the impacts from transporting the DU oxides and the 83,000 (69,000+14,000) empty and heel cylinders. Because this analysis relies on the analyses in the 2004 EISs (DOE 2004a, 2004b), impacts were only calculated for transportation to Energy*Solutions* and NNSS: WCS was not evaluated in the 2004 EISs.

[g] These values correspond to impacts of using cylinders for DU oxide transportation. They include the impacts from transporting the DU oxide and the 14,000 empty and heel cylinders.

[h] Information on traffic fatalities for other actions was not estimated in the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015a). For general comparison, over 32,000 traffic fatalities occur annually in the United States (DOE 2015a).

4.5.5.2 Global Climate Change

The natural greenhouse effect is the process by which part of terrestrial radiation is absorbed by gases in the atmosphere, warming the Earth's surface and atmosphere. This greenhouse effect and the Earth's radiation balance are affected largely by water vapor, carbon dioxide, and trace gases, which absorb infrared radiation and are referred to as GHGs (DOE 2015a).

The Intergovernmental Panel on Climate Change (IPCC) identifies increases in atmospheric concentrations of certain gases as a cause of changes in the Earth's atmospheric energy balance and an influence on global climate. Warming of the global climate is referred to as global warming. Water vapor (approximately 1 percent of the atmosphere) is the most common and dominant GHG; only small amounts of water vapor are produced as the result of human activities. The principal GHGs resulting from human activities are carbon dioxide, methane, nitrous oxide, and halocarbons. Halocarbons include chlorofluorocarbons; hydrofluorocarbons, which are replacing chlorofluorocarbons as refrigerants; and perfluorocarbons, which are byproducts of aluminum smelting. Other gases of concern include sulfur hexafluoride, which is widely used in insulation for electrical equipment. These gases are released in different quantities and have different potencies in their contributions to global warming. EPA considers carbon dioxide, methane, nitrous oxide, and fluorinated gases (e.g., hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) as the primary GHGs as defined by EPA under Section 202(a) of the Clean Air Act (see Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 FR 66495, December 15, 2009).

Sources of anthropogenic carbon dioxide include combustion of fossil fuels such as natural gas, oil, gasoline, and coal. The IPCC estimates that carbon dioxide atmospheric levels have risen by more than 35 percent since the preindustrial period (beginning in 1750) as a result of human activities. Emissions of other GHGs have also risen (IPCC 2007). While annual U.S. GHG emissions have increased overall since 1990, U.S. GHG emissions have been decreasing since 2010 (EPA 2018c). Emissions of GHGs are stated in terms of equivalent emissions of carbon dioxide (CO_2e) based on their global warming potential.

The IPCC lists potential impacts from warming of the climate system, including expansion of seawater volume; decreases in mountain glaciers and snow cover resulting in sea-level rise; changes in arctic temperatures and ice; changes in precipitation, ocean salinity, and wind patterns; and changes in extreme weather (IPCC 2007).

The release of anthropogenic GHGs and their potential contribution to climate change are inherently cumulative phenomena. Cumulative impacts of the emission of carbon dioxide and other GHGs from the alternatives addressed in this DU Oxide SEIS, and other activities at Paducah and Portsmouth and throughout the region, would contribute to the changes related to global climate discussed above. As described in this chapter, the alternatives considered in this DU Oxide SEIS could produce various quantities of carbon dioxide from the activities under analysis. Specifically, the emission estimates for the alternatives account for mobile source emissions from waste shipments. Emissions from employee vehicles are not considered because there would be no new jobs associated with the Proposed Action, and the numbers of employees associated with the alternatives are minimal (i.e., 16 FTEs at Paducah and 12 FTEs at Portsmouth).

The GHGs emitted by the activities analyzed in this DU Oxide SEIS would add a small increment to emissions of these gases in the United States and the world. Overall GHG emissions in the United States during 2014 totaled about 7.57 billion tons (6.87 billion metric tons) of CO_2e (EPA 2016c). By way of comparison, the maximum annual CO_2e emissions under the DU Oxide SEIS alternatives would be approximately 20,113 tons (18,244 metric tons), an exceedingly small percentage of the United States' total emissions. Emissions from the Proposed Action could contribute in a small way to the climate change impacts described above. At present, there is no methodology that would allow DOE to estimate the specific impacts this increment of climate change would produce in the vicinity of a site or elsewhere.

The IPCC has concluded that emissions of GHGs and the impacts on global climate and the resulting environmental, economic, and social consequences could be significant (IPCC 2007). It has been projected that widespread impacts due to climate change in North America may include warmer and/or fewer cold days and nights; warmer and/or more hot days and nights; increased frequency and intensity of heat waves, heavy precipitation events, droughts, and tropical cyclones activity; and increased incidence and/or magnitude of extreme high sea level (IPCC 2013). Impacts of particular concern in the Midwestern United States could include continued warming in all seasons and an increase in the rate of warming. The increased frequency, duration, and intensity of droughts, flooding, heat waves, and other extreme weather events is likely. In the next few decades, longer growing seasons and rising carbon dioxide levels could increase yields of some crops, though those benefits could be offset by extreme weather events (Pryor et al. 2014). Of particular concern for both Paducah and Portsmouth is their proximity to the Ohio River which means that increases in extreme precipitation and/or flood events could impact the facilities. The increase in temperature could result in increased heat stress for people, decreased forest growth and crop productivity, long-term damage to infrastructure, decline in dissolved oxygen in surface waters, increases in fish kills and loss of aquatic species diversity, and decline in production of livestock. Changes in the distribution of native plants and animals may occur, threatened and endangered species may be lost, native species may be displaced by invasive species, and more frequent and intense wildfires may occur. Some of these effects may eventually necessitate adaptation of activities at Paducah and Portsmouth (Pryor et al. 2014).

4.6 MITIGATION

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of the National Environmental Policy Act (42 U.S.C. § 4321) require an EIS (likewise an SEIS) to include a discussion of appropriate mitigation measures (40 CFR 1502.14(f) and 16(h)). The term *mitigation* includes the following (40 CFR 1508.20):

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

In general, activities associated with this Proposed Action would follow standard practices such as Best Management Practices (BMPs) for minimizing impacts on environmental resources as required by regulations, permits, or guidelines. Standard practices that are protective of the air, water, land, and other natural and cultural resources affected by DOE operations would be implemented in accordance with an environmental management system established pursuant to DOE Order 436.1, *Departmental Sustainability*, which was prepared to incorporate the requirements of Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*.[58]

As described in Sections 4.1 through 4.5, the impacts of the alternatives evaluated in this DU Oxide SEIS are not expected to produce impacts that would require mitigation. Nevertheless, **Table 4-49** identifies general types of mitigation measures that could be used to further reduce impacts. These mitigation measures could be applied if practical and cost effective. Because transporting the DU oxide cylinders to a disposal site is the activity with the largest potential for impacts, a number of transportation mitigation measures are described in more detail below:

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[58] Section 16 of EO 13693, Planning for Federal Sustainability in the Next Decade, revokes Executive Order 13514.

- The impacts of combustion air emissions from transportation vehicles could be reduced by use of low-sulfur fuels. Noise could be minimized by ensuring vehicles are in optimal condition, and for trucks, by rules that discourage engine braking.

- Potential transportation impacts could be minimized by transporting DU oxide containers and other wastes only during periods of light traffic volume, providing vehicle escorts, avoiding high-population areas, avoiding high-accident areas, and providing additional training for drivers and emergency response personnel.

- Impacts on workers and the public from non-incident exposure during transportation could be minimized by adding additional radiation shielding.

- The consequences of an accident could be reduced by reducing the quantity of DU oxide transported in each shipment. This change would have adverse impacts by necessitating more shipments.

- In addition, although the probabilities of occurrence for high consequence transportation accidents are extremely low, emergency response plans and procedures are in place to minimize the impacts should a transportation accident occur.

Table 4-49 Potential Mitigating Measures

Mitigating Measure	Resource Area											
	Land Use	**Geology and Soils**	**Water Resources**	**Air Quality, Climate, and Noise**	**Biotic Resources**	**Human Health**	**Cultural Resources**	**Socioeconomics**	**Site Infrastructure**	**Waste Management**	**Transportation**	**Environmental Justice**
Use of low sulfur fuels				●	●	●						●
Dust suppression measures		●		●	●	●	●					●
Silencers/mufflers, rules discouraging truck engine braking, hearing protection programs				●		●	●					●
Water conservation practices			●		●				●	●		
Spill prevention and control measures		●	●		●	●	●			●		●
Personal protective equipment				●		●					●	
Confinement and shielding systems				●		●					●	
Emergency preparedness and response plans						●					●	●
Rad Con Program and ALARA						●					●	●
High-efficiency electric equipment/off-peak use									●			
Waste minimization				●		●				●	●	●
Public outreach and training						●						●
Scheduling								●	●		●	

4.7 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are those impacts that cannot be mitigated by choices associated with the alternatives evaluated in this DU Oxide SEIS. They are impacts that would be unavoidable, no matter which options were selected.

The DU oxide containers 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 containers to low levels of radiation. The radiation exposure of workers would be minimized, but some level of exposure would be unavoidable. As described in Sections 4.1 through 4.5, the radiation doses to workers are estimated to be well within public health standards and DOE guidance under all alternatives. Radiation exposures of workers would be monitored and kept to achieve ALARA goals.

Container monitoring and maintenance activities would also emit air pollutants, such as vehicle exhaust and dust (PM_{10}), and produce small amounts of LLW, TSCA waste, MLLW, and sanitary waste. Concentrations of air emissions during monitoring and maintenance activities are estimated to be within applicable standards and guidelines, and waste generation would not appreciably affect waste management operations at Paducah and Portsmouth.

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. 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.

4.8 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 DU Oxide SEIS 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 DU Oxide SEIS 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 SEIS: land, labor and materials, and energy.

4.8.1 Land

Land that is occupied by cylinder storage yards could ultimately be returned to another productive use if the areas underwent DD&D activities. When no longer needed, DOE could DD&D the storage yards. Appropriate CERCLA and/or NEPA reviews would be conducted before initiation of DD&D actions. After DD&D, the storage yards could be reused or removed. Examples of future use of these tracts of land, although beyond the scope of this DU Oxide SEIS, could include other industrial uses, and restoring them for unrestricted use. Therefore, the commitment of this land would not necessarily be irreversible However, the land used to dispose of DU oxide and other wastes is likely to be an irretrievable commitment because wastes in belowground disposal areas are not anticipated to be removed, the land could not be restored, and the site could not be used for other purposes.

4.8.2 Labor and Materials

Human resources (labor), once consumed, are irretrievable. The irreversible and irretrievable commitment of labor and material resources for the SEIS alternatives would include labor and materials consumed or reduced to unrecoverable forms of waste. **Table 4-50** shows the estimated consumption of labor and materials under the alternatives evaluated in this DU Oxide SEIS. Consumption of the labor shown in Table 4-50, although irreversible and irretrievable, would not constitute a major drain on local labor resources. Substantial quantities of steel would be used in the form of DU oxide containers and empty and heel cylinders that would be disposed of rather than being recycled. Consumption of steel, although irreversible and irretrievable, would not involve a resource in short supply in the United States. Only small quantities of materials are expected to be needed during container storage and maintenance, and during container loading for transport.

Table 4-50 Irreversible and Irretrievable Commitment of Resources

	No Action Alternative	Transport DU Oxide		
		to NNSS	to Energy*Solutions*	to WCS
Labor				
Full-time equivalent (person-years)[a]	2,800	1,780	1,780	1,780
Material				
Steel in disposed containers (tons)	18,200[b]	108,000	108,000	108,000
Energy				
Electricity (megawatt-hours)	33.4	20.5	20.5	20.5
Diesel fuel (gallons)[c]				
Rail Transportation	188,000,000	490,000,000	398,000,000	285,000,000
Truck Transportation	20,400,000	46,100,000	37,800,000	26,600,000
Gasoline (gallons)	416,000	256,000	256,000	256,000

Key: DU = depleted uranium; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] Does not include transportation workers.

[b] Assumes steel in the DU oxide cylinders would not be irreversibly committed until disposed.

[c] Includes diesel fuel for cylinder handling and loading equipment at Paducah and Portsmouth, and for truck or rail transportation vehicles for transportation to a disposal site, as applicable.

Source: Tables 4-1 and 4-2 and Section 4.2.1.1 of this SEIS

4.8.3 Energy

The irretrievable commitment of energy resources during DU oxide container storage, maintenance, handling, and transportation would include the consumption of electricity and fossil fuels (i.e., diesel fuel, gasoline) used for equipment operation, and transportation vehicles (see Table 4-50). Consumption of energy, although irreversible and irretrievable, would not constitute a permanent drain on local resources or involve any energy source in critically short supply in the United States.

4.9 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

The relationship between short-term uses of the environment and long-term productivity for key environmental resources is described in the following paragraphs. For this DU Oxide SEIS, *short-term* is considered the period of storage of DU oxide cylinders at Paducah and Portsmouth under the Action Alternatives, and the period of transportation of the DU oxide to the disposal facilities; that is, the time when most short-term (or temporary) environmental impacts would occur. *Long-term* is considered to be anything longer than *short-term*, including the 100 year period DU oxide would be stored at Paducah and Portsmouth under the No Action Alternative.

Under the alternatives evaluated in this DU Oxide SEIS, there would be no facility construction, and therefore, no impacts from construction. As described in Chapter 2, Section 2.1.3, storage of DU oxide on approximately 83 acres at Paducah and 23 acres at Portsmouth under the No Action Alternative, would result in the continued exclusion of terrestrial and aquatic habitats from natural productivity.

Under the Action Alternatives, DU oxide containers would be maintained in the storage yards until shipped off site for disposal. Therefore, the amount of DU oxide stored in the storage yards would be reduced over time and eventually eliminated as the last cylinders are shipped to a disposal site. When no longer needed, DOE could DD&D the storage yards. After DD&D, the storage yards could be reused or removed. If a decision is made to entirely remove the storage yards, the areas could be restored to long-term productivity as functioning habitat for plants and animals. If the storage yards are not entirely removed, the areas could be put to a productive industrial use.

As a result of the activities at the cylinder storage yards, air emissions and water discharges could introduce small amounts of radiological and chemical constituents to the environment. These emissions could result in additional environmental loading and human and biological exposure, but are not expected to impact DOE's ability to continue to comply with air and water quality or exposure standards (see Sections 4.1.1 and 4.2.1). Future cleanup of the storage yards would be expected to occur in accordance with CERCLA regulations. Decisions on the level of cleanup would be made as part of the CERCLA process. DOE expects that future cleanup of the storage yards, would leave behind minimal residual environmental contamination from previous air and water emissions and the storage yards could be returned to productive uses. Therefore, minor effects on long-term productivity are expected.

In addition, transportation workers and the public could be exposed to small doses of radiation during non-incident transportation of DU oxide and other wastes to a disposal site (see Sections 4.1.2, 4.2.2, 4.3.2, and 4.4.2). These impacts are not expected to impact long-term human health and the environment.

As described in Section 4.2.2, no LCFs would be expected from radiation exposure during a transportation accident, but fatalities could occur due to trauma during the accident. In the unlikely event of a transportation accident that releases DU oxide, environmental impacts could result and transportation workers and the public could be exposed to radiation and chemical hazards (see Section 4.2.2). Emergency response to such an accident would be swift and cleanup would occur in accordance with regulatory requirements. Under the scenario evaluated in Section 4.2.2, impacts from the accidental release of DU oxide would not be expected to impact long-term human health and the environment.

Water would be used to meet the needs of personnel maintaining the DU oxide cylinder storage yards (see Sections 4.1.1.1 and 4.1.1.4). After use and treatment, this water would be released through permitted outfalls into surface water streams. The withdrawal, use, and treatment of water are not likely to affect the long-term productivity of this resource.

In addition, labor and other resources would be committed to operation of the DU oxide cylinder storage yards and transport of the cylinders to the disposal site (see Section 4.8). These short-term uses of these resources are not expected to impact the long-term productivity of the environment.

Disposal of wastes would require space at a disposal facility (see Sections 4.1.2, 4.2.2, 4.3.2, and 4.4.2). The space required for waste disposal would impact the long-term productivity of the land areas comprising the disposal facility. As long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, it is assumed the impacts of disposal were considered and found to be acceptable as part of the licensing and permitting process.

4.10 POLLUTION PREVENTION AND WASTE MINIMIZATION

Activities described in this DU Oxide SEIS would be conducted in accordance with all applicable pollution prevention and waste minimization requirements. Pollution prevention is designed to reduce the 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 U.S.C. §§ 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*, and DOE Order 450.1, *Environmental Protection Program General Environmental Protection Program*, 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 waste, especially radioactive and hazardous waste. Waste minimization techniques include technology modifications, changes in input materials, product changes, and good operating practices. 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.

DOE already has aggressive pollution prevention and waste minimization programs in place and actively pursues substitution of nonhazardous materials for hazardous materials. Because of the limited scope of the activities evaluated in this DU Oxide SEIS, there are limited opportunities for implementation of additional pollution prevention and waste minimization measures. As described in Sections 4.1.1.2 and 4.1.1.4, there would be no routine releases of radioactive or hazardous materials to air or water from storage and maintenance activities at Paducah and

Portsmouth. Any releases from cylinder breaches would be contained and rapidly cleaned up. Therefore, there is little opportunity for implementation of additional pollution prevention measures.

As described in Section 4.1.1.8, a substantial quantity of empty and heel cylinders could be generated. Thorough decontamination of the cylinders to a level that would allow disposal as nonradioactive waste or allow recycling would generate a relatively large volume of wastewater and residues that would require treatment and disposal. In addition, decontamination would consume labor, energy, and other material resources. Therefore, disposal of empty and heel cylinders as LLW is more cost effective and potentially produces less impact than decontamination and recycling or disposal as nonhazardous waste. Crushing or shredding the cylinders could be implemented to reduce the volume of space that would be required at the disposal facility.

5. APPLICABLE STATUTORY REQUIREMENTS AND REGULATORY STANDARDS

5.1 OVERVIEW

This chapter provides a summary of the statutory requirements and regulatory standards that are potentially applicable to the storage, shipment, and disposal activities addressed in this DU Oxide SEIS. These requirements and standards originate from a number of sources. Federal and state statutes define broad environmental and safety programs and provide authorization to agencies to carry out the mandated programs. More specific requirements are established through regulations at the federal and state level. DOE has established additional regulations and management directives (DOE Orders) that are applicable to DOE activities, facilities, and contractors. Regulations often include requirements for permits and consultations, which provide for in-depth, facility-specific oversight of the activities proposed.

Federal, state and local requirements applicable to the activities addressed in this DU Oxide SEIS may differ based on the alternatives considered. These potential differences are related to federal and state agencies' authority and jurisdiction for regulating certain activities. The agencies involved, and the corresponding requirements, while similar, may be different between federally owned sites and commercially owned sites.

This distinction in agency regulatory oversight is important in this DU Oxide SEIS, as the alternatives described in Chapter 2 involve both federally owned sites as well as commercially owned sites. As described in Chapter 2, the No Action Alternative would result in continued storage of depleted uranium (DU) oxide at both Paducah and Portsmouth Sites (Paducah and Portsmouth). In one of the Action Alternatives, disposal of DU oxide would occur at the Nevada National Security Site (NNSS). Paducah, Portsmouth, and NNSS are federally owned. Different requirements apply to the two commercial sites being considered under the other two Action Alternatives, Energy*Solutions* near Clive, Utah, and Waste Control Specialists LLC (WCS) near Andrews, Texas.

This chapter summarizes the environmental and health and safety requirements for the storage, transportation and disposal activities considered in this DU Oxide SEIS, and distinguishes among the regulatory requirements at each facility of interest where appropriate.

5.2 DU OXIDE STORAGE

As described in Chapter 2, Section 2.2.1, under the No Action Alternative, DU oxide would continue to be stored at Paducah and Portsmouth. The Atomic Energy Act of 1954, as amended (AEA) (42 U.S.C. § 2011 et seq.), provides the basic statutory framework for DOE's use and management of radioactive materials. DOE has issued a series of orders to establish a system of standards and requirements to ensure safe operation of DOE 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 and its contractors to comply with relevant worker protection standards and regulations (e.g., 29 CFR Part 1910, "*Occupational Safety and Health Standards*"), and impose additional radiation and chemical exposure standards developed by DOE (DOE Order 440.1B Change 2). 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. DOE facilities are required 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.

Storage activities would be conducted pursuant to numerous other federal and state regulations, DOE Orders, and site management plans. These regulatory requirements may require a variety of permits, licenses, and other consents to be obtained. **Table 5-1** provides a summary list of potentially applicable permitting, reporting, and compliance requirements for activities at Paducah and Portsmouth. The status of each is indicated on the basis of currently available information. However, because DU oxide production and storage are in progress, and DOE has not made a decision to transport and dispose of the DU oxide, additional requirements may apply; alternatively, some requirements may not be applicable.

5.3 WASTE TRANSPORTATION

Under the Action Alternatives, DU oxide and other radioactive wastes would be transported from Paducah and Portsmouth to a LLW disposal facility. Transport of radioactive materials is regulated by DOT (49 CFR Part 171 through 180) and the NRC (10 CFR Part 71). Table 5-1 provides a summary of potentially applicable requirements for transporting DU oxide and other radioactive wastes. A more detailed discussion of these regulations is presented in DOT's *Radioactive Material Regulations Review* (RAMREG-12-2008) (DOT 2008).

DOT regulates hazardous materials transportation in interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of transport, such as routing, handling and storage incident to transport, and vehicle and driver requirements to minimize transportation impacts. Other DOT regulations specify the maximum dose rate from radioactive material shipments. DOT also regulates the labeling, classification, and marking of radioactive material packaging. NRC transportation and packaging regulations are found in 10 CFR Part 71; manifesting requirements for disposal at LLW disposal facilities are found in 10 CFR Part 20.

The regulatory requirements for packaging and transporting radioactive materials are designed to achieve the following four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation by imposing specific limitations on the allowable radiation levels.
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria).
- Prevent nuclear criticality (an unplanned nuclear chain reaction that could occur as a result of concentrating too much fissile material in one place).
- Provide physical protection against theft and sabotage during transit.

The DOT and NRC performance based requirements for the packaging of radioactive materials promotes safety from radiological exposure during transportation. Packaging represents the primary barrier between the radioactive material being transported and the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transportation conditions. DU oxide shipped in the 48 inch diameter cylinders, bulk bags, and 55 gallon drums are expected to meet Industrial Packaging (IP-1) requirements. The type of packaging to be used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B. Specific requirements for these packages are detailed in 49 CFR Part 173, Subpart I. All packagings are designed to ensure that they can be handled safely. Packages must protect and retain their contents during incident-free transportation conditions. Excepted packagings are limited to the transport of materials that have extremely low levels of radioactivity and very low external radiation. Industrial packagings are used to transport materials that present a limited hazard to the public and the environment because of their low concentration of radioactive materials. There are 3 types of Industrial Packagings, IP-1, IP-2, and IP-3, with IP-3 being subject to the most rigorous requirements. Type A packagings, typically 55-gallon drums or standard waste boxes, are commonly used to transport radioactive materials with higher concentrations or amounts of radioactivity than Excepted or Industrial packaging. Type A packagings must maintain sufficient shielding to limit radiation exposure to handling personnel because of the higher radioactivity of their contents. Type B packagings are used to transport material with the highest radioactivity levels.

In addition, DOE Orders apply to transportation of radioactive materials. DOE Order 460.2A, “Departmental Materials Transportation and Packaging Management,” states that DOE operations shall be conducted in compliance with all applicable international, federal, state, local, and tribal laws, rules, and regulations governing materials transportation that are consistent with federal regulations, unless exemptions are approved in accordance with DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*.

DOE Order 460.1D establishes safety requirements for the proper packaging and transportation of off-site shipments, and on-site transfers of hazardous materials, including radioactive materials. Off-site refers to any area within or outside a DOE site to which the public has free and uncontrolled access; on-site refers to any area within the boundaries of a DOE site or facility to which access is controlled. Transport of LLW that occurs entirely on DOE property to which public access is controlled at all times through the use of gates and guards, is subject to applicable DOE directives and transportation safety requirements set forth in 10 CFR Part 830, Subpart B, and Order 460.1D. DOE transport of LLW off site for disposal, over highways to which the public has access, would also be subject to applicable DOT and NRC requirements.

5.4 WASTE DISPOSAL

5.4.1 Low-Level Radioactive Waste Disposal Overview

Under the Atomic Energy Act of 1954, as amended (AEA) (42 U.S.C. § 2011 et seq.), both DOE and NRC are authorized to regulate the disposal of LLW. DOE regulates LLW management and disposal at DOE sites, and NRC regulates (at a federal level) LLW management and disposal at commercial sites. In addition, Section 274 of the AEA enables NRC to delegate certain regulatory responsibilities (e.g., low-level radioactive waste disposal) to state regulatory agencies (see below).

DOE Order 435.1, *Radioactive Waste Management*, and DOE's associated *Radioactive Waste Manual* (DOE M 435.1-1) ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety, and the environment. DOE radioactive waste management activities are required to be systematically planned, documented, executed, and evaluated.

Technical analyses (performance assessments) supporting LLW disposal authorizations at NNSS pursuant to DOE Order 435.1 are summarized in the NNSS SWEIS (DOE 2013a). In 2012, DOE approved an updated performance assessment to address disposal of DU at NNSS (NSTec 2012). DOE Order 435.1 requires performance assessments that demonstrate compliance with prescribed radiation dose limits for a period of 1,000 years following disposal, along with sensitivity analyses that address peak doses that could occur beyond 1,000 years. In addition, DOE Order 435.1 requires analyses that demonstrate compliance with prescribed limits on the long-term gaseous release of radon-isotopes from LLW disposal facilities.[59] See Chapter 9 of the NNSS SWEIS (DOE 2013a), for more information on laws, regulations and permits applicable to waste disposal at NNSS.

Federal regulatory authority over LLW disposal at commercial sites resides with NRC. Through its Agreement State Program, the NRC may delegate authority to states to regulate certain radioactive materials activities within their respective borders. Under the Agreement State Program, NRC has delegated most of its authority to license and regulate byproduct, source, and certain quantities of special nuclear materials to Utah and Texas including the authority to license and regulate LLW disposal facilities.

NRC operating licenses administered through the regulations in 10 CFR Part 61 establish the procedures, criteria, terms, and conditions for land disposal of LLW containing byproduct, source, and special nuclear material. These regulations, or compatible regulations for Agreement States, apply to LLW managed in commercial facilities, regardless of the generator. As a LLW generator, DOE would be required to meet the waste acceptance criteria of the disposal facilities licensed under this regulation or compatible Agreement State regulations.

Energy*Solutions*, at Clive, Utah is licensed by the State of Utah to accept Class A LLW from generators through the United States. Energy*Solutions'* operating licenses and permits are available for review at https://customerportal.energysolutions.com/Content/ViewContent?ContentId=3991e385-ec8d-4416-8512-e98a081a7127 .

Waste Control Specialists LLC, near Andrews, Texas (WCS) is licensed by the State of Texas to accept Class A, B, and C LLW from states (WCS Compact Waste Facility) comprising the Texas

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[59] One of the principal concerns for disposal of large quantities of depleted uranium as waste is the long-term gaseous release of radon isotopes.

Compact (Texas and Vermont), and the Federal Government (WCS Federal Waste Facility). Out-of-compact waste generators may also access WCS (Compact Waste Facility) for Class A, B, and C LLW disposal. WCS facility operating licenses and permits are available for review at http://www.wcstexas.com/facilities/licenses-permits/.

5.4.2 Status of 10 CFR Part 61 Rulemaking

This DU Oxide SEIS evaluates DU oxide and other wastes disposed of as LLW at Energy*Solutions* near Clive, Utah; NNSS; or WCS near Andrews, Texas. Energy*Solutions* and WCS are licensed to dispose of LLW pursuant to state regulations compatible with NRC regulations in 10 CFR Part 61, while NNSS is authorized by DOE to dispose of LLW pursuant to DOE Order 435.1. The licenses and disposal authorizations include facility construction and operational requirements, and waste acceptance criteria, which are derived from required technical analyses to assure that potential releases to the environment and radiation doses received by the public over very long periods of time following waste disposal (e.g., potentially thousands of years) would not exceed the limits prescribed in DOE Order 435.1 or state regulations compatible with 10 CFR Part 61.

Because of the potential for disposition of DU from conversion of DUF_6 at DOE facilities, and additional volumes of DU waste from uranium enrichment activities, federal and state regulators and DOE have reviewed existing LLW disposal requirements for DU. A 2008 NRC technical analysis concluded that the safe disposal of DU was dependent on the geological, hydrological, and climate characteristics of the proposed site, and recommended site-specific technical analyses (performance assessments) to evaluate disposal of this material (NRC 2008).

In April 2010, the UDEQ issued revised radioactive waste disposal regulations addressing disposal of DU at disposal facilities in Utah. These revised regulations require additional technical analyses with a quantitative compliance period for comparison against regulatory dose limits for a minimum of 10,000 years, with additional qualitative analyses for the period of peak radiation dose. Energy*Solutions* prepared a technical analysis to support a proposed license amendment to authorize disposal of DU at its Utah disposal facility and submitted the analysis and proposed amendment to UDEQ for review (ES 2011). The UDEQ review is underway.

In August 2014, informed by a technical analysis prepared by WCS, which addressed the radiological impacts that could occur over a 1-million-year period following waste disposal, the TCEQ approved an amendment to the LLW disposal license for the WCS facility to authorize disposal of DU (WCS 2014).

On March 26, 2015 (80 FR 16082), NRC proposed to amend its regulations governing disposal of LLW, 10 CFR Part 61, to require new and revised site-specific technical analyses to address the disposal of unique waste streams such as significant quantities of DU. The technical analyses would address potential radiological impacts over three periods following waste disposal: the first 1,000 years; years 1,000 to 10,000; and the period after 10,000 years. On the same day NRC also issued draft guidance (NUREG-2175, *Guidance for Conducting Technical Analyses for 10 CFR Part 61*) for conducting the technical analyses required under the Part 61 regulations, including the analyses required under the proposed amendments (NRC 2015). NRC requested public comment on both the proposed amendments and the draft guidance document.[60] Subsequently, NRC published on October 17, 2017 (82 FR 48284) a supplemental proposed rule change for public comment. The proposed rule change would change the compliance period to 1,000 years, independent of radionuclide content. NRC staff are working on the revisions.

After the Part 61 amendments go into effect after being issued in final form, Agreement State regulators would have three years to promulgate compatible regulations. Because Utah and Texas are both Agreement States, the operators of the Energy*Solutions* facility in Utah and the WCS facility in Texas would prepare analyses for state regulatory approval in compliance with the compatible state regulations. It is expected that these analyses would be in the form of as-needed updates to the existing analyses. Informed by these analyses, the regulators would issue license amendments, as needed, to receive and dispose of the waste including any revisions to facility construction and operational requirements, and waste acceptance criteria, which may be needed to comply with amended regulatory requirements.

As described in Chapter 2, Section 2.2.1, under the No Action Alternative, DU oxide would continue to be stored at Paducah and Portsmouth. The AEA provides the basic statutory framework for DOE's use and management of radioactive materials. DOE has issued a series of orders to establish a system of standards and requirements to ensure safe operation of DOE 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 and its contractors to comply with relevant worker protection standards and regulations (e.g., 29 CFR Part 1910, "*Occupational Safety and Health Standards*"), and impose additional radiation and chemical exposure standards developed by DOE (DOE Order 440.1B Change 2). 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. DOE facilities are required 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.

Storage activities would be conducted pursuant to numerous other federal and state regulations, DOE Orders, and site management plans. These regulatory requirements may require a variety of permits, licenses, and other consents to be obtained. Table 5-1 provides a summary list of potentially applicable permitting, reporting, and compliance requirements for activities at Paducah and Portsmouth. The status of each is indicated on the basis of currently available information. However, because DU oxide production and storage are in progress, and DOE has not made a decision to transport and dispose of the DU oxide, additional requirements may apply; alternatively, some requirements may not be applicable.

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[60] On August 27, 2015 (80 FR 51964), NRC extended the public comment period for the proposed rule revisions and the draft guidance until September 21, 2015.

Table 5-1 Potentially Applicable Permitting, Reporting, and Compliance Requirements for Activities at the Paducah and Portsmouth Sites

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Water Resources Protection			
Kentucky Pollutant Discharge Elimination System (KPDES) Permit – Industrial Facility Storm Water: Required before making point source storm water discharges into waters of the state from an industrial site.	KDEP	Clean Water Act (CWA) (33 U.S.C. § 1251 et seq.); 40 CFR Part 122; 401 KAR 5:055 and 5:060	Storm water runoff would be discharged from the DU oxide storage yards at Paducah through an existing outfall covered by KPDES Permit Number KY0004049 and KY0102083. Paducah has a required Storm Water Pollution Prevention Plan
National Pollutant Discharge Elimination System (NPDES) Permit – Industrial Facility Storm Water: Required before making point source storm water discharges into waters of the state from an industrial site.	OEPA	CWA (33 U.S.C. § 1251 et seq.); 40 CFR Part 122; OAC-3745-33-02, 3745-38-02, and 3745-38-06	Storm water runoff would be discharged from the DU oxide storage yards at Portsmouth through existing outfalls covered by NPDES Permit Numbers 0IO00000*ND and 0IS00034*BD. Portsmouth has a required Storm Water Pollution Prevention Plan
Groundwater Protection Plan: Required for conducting specified activities that may result in the pollution of groundwater.	KDEP	40 1 KAR 5:037	A groundwater protection plan has been developed and implemented for the Paducah Site.
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; OEPA	RCRA, as amended (42 U.S.C. § 6901 et seq.), Subtitle C; 401 KAR 32:010; OAC 3745-52-12	The Paducah Conversion Facility and Portsmouth Conversion Facility are small quantity generators (Paducah ID Number: KYR000051128; and Portsmouth ID Number: OHR000158121). Small quantity generator status also applies to activities for DU oxide management.

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
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; OEPA	RCRA, as amended (42 U.S.C. § 6901 et seq.), Subtitle C; 401 KAR 38:010, Section 4; OAC 3745-50-40	The Paducah Site currently holds Paducah Hazardous Waste Facility Permit number KY8-890-008-982. The Portsmouth Site currently holds Portsmouth Hazardous Waste Permit number 04-66-0680. Hazardous waste permits do not apply to DU oxide because DU oxide is not a hazardous waste. Aside from minor neutralization, the Paducah and Portsmouth Conversion Facilities perform no hazardous waste treatment on site. Any ancillary hazardous waste generated by DU oxide management would be disposed of off site.
Notification of PCB Waste Activity	EPA	TSCA, as amended (15 U.S.C. § 2601 et seq.); 40 CFR Part 761	The Portsmouth Site has an agreement with EPA Region 5 (no requirement/agreement for Paducah). EPA is notified annually of PCB related activities (e.g., PCB containers coming in and going out of Portsmouth, sampling and analysis, PCB paint removal/clean-up activities, and disposal). Conversion of cylinders coated with PCB containing paints requires notification in advance of placing the cylinders in the autoclaves.
Emergency Planning and Response			
List of Material Safety Data Sheets (MSDS): Submission of a list of MSDSs 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; Kentucky Emergency Response Commission; Ohio State Emergency Response Commission	Emergency Planning and Community Right-to-Know Act of 1986, Section 311 (42 U.S.C. § 11021); 40 CFR 370.20; OAC 3750-30-15	Lists of MSDSs have been submitted for Paducah and Portsmouth. The lists are updated as needed.

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
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; Ohio SERC; local fire department	EPCRA, Section 312 (42 U.S.C. § 11022); 40 CFR 370.25; 106 KAR 1:081; OAC 3750-30-01	DOE tenants at both Paducah and Portsmouth have submitted sitewide Annual Hazardous Chemical Inventory Reports. No hazardous chemicals would be stored in the DU oxide storage yards at either Paducah or Portsmouth.
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 U.S.C. § 11023); 40 CFR Part 372	A TRI report is annually prepared at Paducah and Portsmouth and submitted to EPA. The report includes the quantities of DUF_6 processed, HF generated, emissions, hazardous chemicals transferred/dispositioned, on-site/off-site disposal, material recycled, and DU oxide in storage.
Transport 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.	DOT	Hazardous Materials Transportation Act (HMTA), as amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 and other acts (49 U.S.C. § 5101 et seq.); 49 CFR 107.608(b)	The Paducah and Portsmouth Sites have obtained DOT Hazardous Materials Registrations.
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 U.S.C. § 5101 et seq.); Atomic Energy Act (AEA), as amended (42 U.S.C. § 2011 et seq.); 49 CFR Parts 172, 173, 174, 177, and 397	DOE will comply with DOT packaging, labeling, and routing requirements for shipments of radioactive materials.

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
Biotic Resources			
Threatened and Endangered Species Consultation: Required between the responsible federal agencies and affected states to ensure that a 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; KDFWR; Ohio Department of Natural Resources	Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.); KRS 150.183, 150.990, and 146.600–619; ORC 1531.25-26 and 1531.99	No species listed at the federal or state level as endangered or Threatened, or the critical habitat of such a species, has been identified at Paducah or Portsmouth that would be affected by alternatives evaluated relative to the Proposed Action in this DU Oxide SEIS. See Chapter 3, Sections 3.1.5 and 3.2.5, for more information.
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); Ohio SHPO	National Historic Preservation Act of 1966, as amended (16 U.S.C. § 470 et seq.); Archaeological and Historical Preservation Act of 1974 (16 U.S.C. §§ 469–469c-2); Antiquities Act of 1906 (16 U.S.C. § 431et seq.); Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. §§ 470aa–mm)	DOE has coordinated with the Advisory Council on Historic Preservation and the Kentucky and Ohio SHPOs. For Paducah, a programmatic agreement (PA) calling for a complete cultural resource survey of Paducah, as well as the associated Cultural Resource Management Plan (CRMP), was developed and is in place. Surveys have been conducted at Portsmouth and many historic sites were identified, including some with potential NRHP eligibility, although none is located within the cylinder storage areas. See Chapter 3, Section 3.1.10 and 3.2.10, for more information.
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	Religious Freedom Act of 1978 (42 U.S.C. §§ 1996 and 1996a); Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001 et seq.); National Historic Preservation Act of 1966, as amended (16 U.S.C. § 470f); 36 CFR Part 800, Subpart B; 43 CFR Part 10	DOE has conducted government-to-government consultations with Native American tribes in the area of Paducah and Portsmouth as part of preparing the 2004 EISs. No religious or sacred sites, burial sites, or resources significant to Native Americans have been identified to date. If religious or sacred sites, burial sites, or resources significant to Native Americans are identified, the appropriate Native American tribe(s) would be consulted. See Chapter 3, Section 3.1.10 and 3.2.10, for more information.

License, Permit, or Other Consent	Responsible Agency	Authority	Relevance and Status
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 U.S.C. § 4321 et seq.); 40 CFR Parts 1500–1508; 10 CFR Part 1021	The requirements of NEPA are satisfied for this Proposed Action by publication of this DU Oxide SEIS.

Key: AEA = Atomic Energy Act of 1954, as amended; CaF_2 = calcium fluoride; CFR = Code of Federal Regulations; CRMP = Cultural Resources Management Plan; CWA = Clean Water Act; DOE = U.S. Department of Energy; DOT = U.S. Department of Transportation; DU = depleted uranium; DUF_6 = depleted uranium hexafluoride; EIS = Environmental Impact Statement; EPA = U.S. Environmental Protection Agency; EPCRA = Emergency Planning and Community Right-to-Know Act; HF = hydrogen fluoride; HMTA = Hazardous Material Transportation Act; KAR = Kentucky Administrative Regulations; KDEP = Kentucky Department of Environmental Protection; KPDES = Kentucky Pollutant Discharge Elimination System; kg = kilogram; KRS = Kentucky Revised Statutes; lb = pound; LEPC = Local Emergency Planning Commission; LLW = low level radioactive waste; MSDS = Material Safety Data Sheet; NEPA = National Environmental Policy Act; NPDES = National Pollutant Discharge Elimination System; NRHP = National Register of Historic Places; OAC = Ohio Administrative Code; OEPA = Ohio Environmental Protection Agency; ORC = Ohio Revised Codes; PA = Programmatic Agreement; PCB = polychlorinated biphenyl; RCRA = Resource Conservation and Recovery Act; SEIS = supplemental environmental impact statement; SERC = State Emergency Response Commission; SHPO = State historic preservation officer; TRI = Toxic Release Inventory; SIC = Standard Industrial Classification; TSCA = Toxic Substances Control Act; U.S.C. = U.S. Code

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8. GLOSSARY

aquifer—A body of rock or sediment that is capable of transmitting groundwater and yielding usable quantities of water to wells or springs.

aquitard—A less-permeable, or impermeable, geologic unit in a stratigraphic sequence. Aquitards separate aquifers.

as low as reasonably achievable (ALARA)—An approach to radiation protection to manage and control worker and public exposures (both individual and collective) and releases of radioactive material to the environment to as far below applicable limits as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit, but a process for minimizing doses to as far below limits as is practicable.

background radiation—Radiation from (1) cosmic sources; (2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material); and (3) global fallout as it exists in the environment (e.g., from the testing of nuclear explosive devices).

beyond-design-basis accident—This term is used as a technical way to discuss accident sequences that are possible but were not fully considered in the design process because they were judged to be too unlikely. (In that sense, they are considered beyond the scope of design-basis accidents [e.g., fire, earthquake, spill, explosion] that a nuclear facility must be designed and built to withstand.) As the regulatory process strives to be as thorough as possible, "beyond-design-basis" accident sequences are analyzed to fully understand the capability of a design. These accidents are typically very low-probability, but high-consequence events. (See *design-basis accident*.)

criticality—The condition in which a system undergoes a sustained nuclear chain reaction.

decay (radioactive)—The decrease in the amount of any radioactive material with the passage of time, due to spontaneous nuclear disintegration (i.e., emission from atomic nuclei of charged particles, photons, or both).

depleted uranium—Uranium with a content of the fissile isotope uranium-235 of less than 0.7 percent (by weight) found in natural uranium, so that it contains more uranium-238 than natural uranium.

depleted uranium oxide—The oxidized form of depleted uranium primarily in the form of UO_2 or U_3O_8. The U_3O_8 form of depleted uranium oxide is the most stable form.

design-basis—For nuclear facilities, information that identifies the specific functions to be performed by a structure, system, or component and the specific values (or ranges of values) chosen for controlling parameters for reference bounds for design. These values may be (1) restraints derived from generally accepted, state-of-the-art practices for achieving functional goals; (2) requirements derived from analysis (based on calculation or experiment) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals; or (3) requirements derived from federal safety objectives, principles, goals, or requirements.

design-basis accident—An accident postulated for the purpose of establishing functional and performance requirements for safety structures, systems, and components. (See *beyond-design-basis accident*.)

documented safety analysis (DSA)—A report that systematically identifies potential hazards within a nuclear facility, describes and analyzes the adequacy of measures to eliminate or control identified hazards, and analyzes potential accidents and their associated risks. Safety analysis reports are used to ensure that a nuclear facility can be constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations. Safety analysis reports (or documented safety analyses per 10 CFR Part 830) are required for U.S. Department of Energy (DOE) nuclear facilities and as a part of applications for U.S. Nuclear Regulatory Commission (NRC) licenses. The NRC regulations or DOE orders and technical standards that apply to the facility type provide specific requirements for the content of safety analysis reports. (See *nuclear facility*.)

dose—A generic term meaning absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or committed equivalent dose. For ionizing radiation, the energy imparted to matter by ionizing radiation per unit mass of the irradiated material (e.g., biological tissue). The units of absorbed dose are the rad and the gray. In many publications, the rem is used as an approximation of the rad.

effective dose equivalent—The dose value obtained by multiplying the dose equivalents received by specified tissues or organs of the body by the appropriate weighting factors applicable to the tissues or organs irradiated, and then summing all of the resulting products. It includes the dose from radiation sources internal and external to the body. The effective dose equivalent is expressed in units of rem or sieverts.

enriched uranium—Uranium whose content of the fissile isotope uranium-235 is greater than the 0.7 percent (by weight) found in natural uranium. (See *highly enriched uranium* and *low-enriched uranium*.)

environmental impact statement (EIS)—The detailed written statement that is required by section 102(2)(C) of NEPA for a proposed major federal action significantly affecting the quality of the human environment.

environmental justice—The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations. (See *minority population* and *low-income population*.)

fissile material—Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning; namely, any material fissionable by low-energy (i.e., thermal or slow) neutrons. Fissile materials include uranium-233 and -235, and plutonium-239 and -241.

fugitive emissions—(1) Emissions that do not pass through a stack, vent, chimney, or similar opening where they could be captured by a control device, or (2) any air pollutant emitted to the atmosphere other than from a stack. Sources of fugitive emissions include pumps; valves; flanges; seals; area sources such as ponds, lagoons, landfills, and piles of stored material (such as coal); and road construction areas or other areas where earthwork is occurring.

half-life (radiological)—Time in which one-half of the atoms of a particular radionuclide disintegrate into another nuclear form. Half-lives for specific radionuclides vary from millionths of a second to billions of years.

hazard index—The hazard index (HI) is the 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. The hazard quotient is a comparison of the estimated intake level of a chemical with its adverse effects level. It is expressed as a ratio of estimated intake level to adverse effects level.

hazardous material—A material, as defined by 49 CFR 171.8, that the Department of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous air pollutants—Air pollutants not covered by ambient air quality standards, but that may present a threat of adverse human health or environmental effects. Those specifically listed in 40 CFR 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, hazardous air pollutants are any of the 189 pollutants listed in or pursuant to Section 112(b) of the Clean Air Act.

ionizing radiation—Particles (alpha, beta, neutrons, and other subatomic particles) or photons (i.e., gamma, x-rays) emitted from the nucleus of unstable atoms as a result of radioactive decay. Such radiation is capable of displacing electrons from atoms or molecules in the target material (such as biological tissues), thereby producing ions.

isotope—Any of two or more variations of an element in which the nuclei have the same number of protons (and thus the same atomic number), but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties; e.g., carbon-12 and -13 are stable; carbon-14 is radioactive.

low-level radioactive waste (LLW)—Radioactive waste that is not high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in Section 11e.(2), (3), or (4) of the Atomic Energy Act of 1954, as amended.

maximally exposed individual (MEI)—A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (i.e., inhalation, ingestion, direct exposure, resuspension).

natural phenomena hazard—A category of events (e.g., earthquake, severe wind, tornado, flood, and lightning) that must be considered in the U.S. Department of Energy facility design, construction, and operations, as specified in DOE Order 420.1C.

nuclear criticality—See *criticality*.

person-rem—A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group. One person-rem equals 0.01 person-sieverts.

rad—A unit of radiation-absorbed dose (e.g., in body tissue). One rad is equal to an absorbed dose of 0.01 joules per kilogram.

radiation—See ionizing radiation.

radioactivity—Defined as a *process*: The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.

—Defined as a *property*: The property of unstable nuclei in certain atoms to spontaneously emit ionizing radiation during nuclear transformations.

radionuclide—A radioactive element characterized according to its atomic mass and atomic number. Radionuclides can be manmade or naturally occurring, have a long half-life, and have potentially mutagenic, teratogenic, or carcinogenic effects on the human body.

radon—A colorless, odorless, naturally occurring, radioactive, inert, gaseous element formed by radioactive decay of radium atoms. The atomic number is 86.

region of influence (ROI)—The physical area that bounds the environmental, sociological, economic, or cultural features of interest for the purpose of analysis.

roentgen—A unit of exposure to ionizing x-ray or gamma radiation equal to or producing 1 electrostatic unit of charge per cubic centimeter of air. It is approximately equal to 1 rad.

roentgen equivalent man (rem)—A unit of dose equivalent. The dose equivalent in rem equals the absorbed dose in rad in tissue multiplied by the appropriate quality factor and possibly other modifying factors. Rem refers to the dosage of ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma ray exposure. One rem equals 0.01 sieverts.

security—An integrated system of activities, systems, programs, facilities, and policies for the protection of Restricted Data and other classified information or matter, nuclear materials, nuclear weapons and nuclear weapons components, and/or U.S. Department of Energy or contractor facilities, property, and equipment.

shielding—Any material or obstruction (e.g., bulkhead, wall, or other structure) that absorbs radiation, and thus tends to protect personnel or materials from the effects of ionizing radiation.

stabilize—To convert a compound, mixture, or solution to a nonreactive form.

supplemental environmental impact statement—A supplemental environmental impact statement is required when an agency makes substantial changes in the Proposed Action relevant to environmental concerns, or when there are significant new circumstances or information relevant to environmental concerns bearing on the Proposed Action, and is optional when an agency otherwise determines to supplement an EIS. (40 CFR 1502.9(c)). See environmental impact statement.

transuranic waste—Waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste; (B) waste that the U.S. Department of Energy has determined, with the concurrence of the U.S. Environmental Protection Agency, does not need the degree of isolation called for by 40 CFR Part 191; or (C) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

uranium—A radioactive, metallic element with the atomic number 92. Uranium has 14 known isotopes, of which uranium-238 is the most abundant in nature. Uranium-235 is commonly used as a fuel for nuclear fission, and uranium-238 is transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.

9. INDEX

APPENDICES

APPENDIX A

RELEVANT FEDERAL REGISTER NOTICES

APPENDIX A: RELEVANT FEDERAL REGISTER NOTICES

64 FR 43358, *Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Tuesday, August 10, 1999

69 FR 44654, *Record of Decision for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site*, U.S. Department of Energy, Tuesday, July 27, 2004.

69 FR 44649, *Record of Decision for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site*, U.S. Department of Energy, Tuesday, July 27, 2004.

72 FR 15869, *Notice of Availability of a Draft Supplement Analysis for Disposal of Depleted Uranium Oxide Conversion Product Generated From DOE'S Inventory of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Tuesday, April 3, 2007.

81 FR 58921, *Notice of Intent To Prepare a Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated From DOE's Inventory of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Friday, August 26, 2016, with associated *Correction*, published in 81 FR 61674 on Wednesday, September 7, 2016.

64 FR 43358, *Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Tuesday, August 10, 1999.

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FOR FURTHER INFORMATION CONTACT: For information on the alternative strategies for the long-term management and use of depleted UF_6, contact Scott Harlow at the address listed above. For general information on the DOE NEPA process, please contact: Carol Borgstrom, Director, Office of NEPA Policy and Assistance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, D.C. 20585, (202) 586–4600 or 1–800–472–2756.

SUPPLEMENTARY INFORMATION:

I. Background

Depleted UF_6 results from the process of making uranium suitable for use as fuel for nuclear power plants or for military applications. The use of uranium in these applications requires increasing the proportion of the uranium-235 isotope found in natural uranium through an isotopic separation process called uranium enrichment. Gaseous diffusion is the enrichment process currently used in the United States. The depleted UF_6 that is produced as a result of enrichment typically contains 0.2 percent to 0.4 percent uranium-235 and is stored as a solid in large metal cylinders at the gaseous diffusion facilities.

Large-scale uranium enrichment in the United States began as part of atomic bomb development during World War II. Uranium enrichment activities were subsequently continued under the U.S. Atomic Energy Commission and its successor agencies including DOE. The K–25 Plant (now called the East Tennessee Technology Park) at Oak Ridge, Tennessee, was the first of the three gaseous diffusion plants constructed to produce enriched uranium. The U.S. program to enrich uranium was conducted first to support U.S. national security activities and later (by the late 1960s) to provide enriched uranium-235 for fuel for commercial nuclear power plants in the United States and abroad. The K–25 plant ceased operation in 1985, but uranium enrichment continues at both the Paducah Site in Kentucky and the Portsmouth Site in Ohio. These two plants are now operated by USEC Inc. (formerly known as the United States Enrichment Corporation), created by law in 1993 to privatize the uranium enrichment program. Depleted UF_6 is stored as a solid at all three sites in steel cylinders. Each cylinder holds approximately 9 to 12 metric tons of material. The cylinders usually are stacked two layers high in outdoor areas called "yards."

DOE maintains an active cylinder management program to improve storage conditions in the cylinder yards, to monitor cylinder integrity by conducting routine inspections for breaches (leaks), and to perform cylinder maintenance and repairs as needed. The results of these management activities ensure that cylinders are stored with minimum risks to workers, members of the general public, and the environment at the sites. Because storage began in the early 1950s and the cylinders are stored outdoors, many of the cylinders now show evidence of external corrosion. Eight cylinders out of the 46,422 that were filled by DOE or its predecessor agencies have developed leaks. Because the depleted UF_6 is a solid at outdoor ambient temperatures and pressures, it is not readily released from a cylinder following a breach.

DOE has an integrated program plan that has been in place since December 1994 to ensure the safe management of these cylinders. Under this program plan, if alternative uses for the depleted uranium were not found to be feasible by approximately the year 2010, DOE would take steps to convert the depleted UF_6 to triuranium octaoxide (U_3O_8) beginning in the year 2020. U_3O_8 would be more chemically stable than the depleted UF_6 and would be safely stored pending a determination that all or a portion of the depleted uranium was no longer needed. At that point, the U_3O_8 would be disposed of as low-level waste (LLW). This program plan was based on reserving depleted UF_6 for future defense needs and for other potential productive and economically viable purposes including possible reenrichment in an atomic vapor laser isotope separation plant, conversion to depleted uranium metal for fabricating antitank weapons, and use as fuel in advanced liquid metal nuclear reactors. Since the time when that program plan was put into place, several developments have occurred prompting the need for its revision. These developments include the passage and implementation of the Energy Policy Act of 1992 that assigned responsibility for uranium enrichment to the United States Enrichment Corporation. Also, the demand for antitank weapons has diminished, and the advanced liquid metal nuclear reactor program has been canceled. In addition, stakeholders near the current cylinder storage sites have expressed concern about the environmental, safety, health, and regulatory issues associated with the continued storage of the depleted UF_6 inventory. The selection of a new management strategy constituted a major Federal action and required preparation of a PEIS.

The Final Plan for the Conversion of Depleted Uranium Hexafluoride (herein referred to as the "Plan") submitted to Congress in July 1999 was prepared in accordance with Public Law 105–204, which required the Department to prepare and submit a plan to construct conversion facilities at both the Paducah and Portsmouth gaseous diffusion plants. The Plan was also consistent with the preferred alternative of the Final PEIS, to begin conversion of the depleted UF_6 inventory to depleted uranium oxide, depleted uranium metal, or a combination of both. The Department currently expects that conversion to depleted uranium metal would be performed only if uses become available. At this time, the Department does not believe that long-term storage as depleted uranium metal and disposal as depleted uranium metal are reasonable alternatives; however, the Department remains open to exploring these options further. DOE plans to use the resources and expertise of the private sector to convert the depleted UF_6 inventory. The Department has proceeded to implement its procurement strategy to award one or more contracts for the design, construction, operation, and decontamination and decommissioning of conversion facilities and support functions. The draft request for proposals for this procurement, scheduled to be issued in the summer of 1999, will be based on responses received from the Department's request for expressions of interest issued March 4, 1999, input from Congress and stakeholders, the draft Plan, and the Final PEIS.

Work on the PEIS began in 1994 with a request for recommendations for management strategies for depleted UF_6 published in the **Federal Register** designed to solicit ideas from industry and the general public for the management and use of depleted UF_6. The responses were evaluated and those that appeared reasonable provided the basis for the alternatives that were subsequently assessed in the PEIS. The technologies that were suggested were described in The Technology Assessment Report for the Long-Term Management of Depleted Uranium Hexafluoride (UCRL–AR–120372) and The Engineering Analysis Report for the Long-Term Management of Depleted Uranium Hexafluoride (UCRL–AR–124080). The costs associated with the alternatives analyzed in the PEIS are provided in the Cost Analysis Report for the Long-Term Management of Depleted

Uranium Hexafluoride (UCRL–AR–127650). Public scoping meetings for the PEIS were held in Portsmouth, Ohio; Paducah, Kentucky; and Oak Ridge, Tennessee. The Draft PEIS was issued in December 1997. Public hearings on the Draft PEIS were held in Portsmouth, Ohio; Paducah, Kentucky; Oak Ridge, Tennessee; and Washington, D.C. Based on the comments received, a revised version of the document was produced that included a revision of the preferred alternative. The Final PEIS was mailed to interested parties and was made available to the public using the World Wide Web on April 16, 1999.

II. Purpose and Need for the Agency Action

The purpose of the PEIS was to reexamine DOE's long-term management strategy for depleted UF_6 and alternatives to that strategy. DOE needs to take this action to respond to economic, environmental, and legal developments. The PEIS examined the environmental consequences of alternative strategies for long-term storage, use, and disposal of the entire inventory as well as the no-action alternative.

III. Alternatives Analyzed in Detail

DOE evaluated the following alternative strategies for the long-term management and use of depleted UF_6.

No Action. Under this alternative, depleted UF_6 cylinder storage was assumed to continue at the three current storage sites indefinitely. Potential environmental impacts were estimated through the year 2039. The activities assumed to occur at the sites under the no-action alternative include a comprehensive cylinder monitoring and maintenance program with routine cylinder inspections, ultrasonic thickness testing of cylinders, radiological surveys, cylinder painting to prevent corrosion, cylinder yard surveillance and maintenance, construction of four new or improved cylinder yards at Paducah and one at K–25, and relocation of some cylinders at Paducah and K–25 to the new or improved yards. Cylinders were assumed to be painted every ten years, which is consistent with current plans.

Long-Term Storage as Depleted UF_6. This alternative includes long-term storage at a single location and could involve storage of cylinders in newly constructed yards, buildings, or an underground mine. The location of such a long-term storage facility could be at a site other than a current storage site. Continued storage of depleted UF_6 cylinders at the three current storage sites, with existing cylinder management of the entire inventory, would occur through 2008, and the inventory would decrease through 2034 as cylinders are being consolidated at a long-term storage facility. Cylinders would be prepared for shipment at the three current storage sites with transportation of cylinders to a long-term storage facility by truck or rail. The long-term storage facility would include yards, buildings, or an underground mine. Transportation and disposal of any waste created from the activities listed above would occur under this alternative.

Long-Term Storage as Uranium Oxide. Under this alternative, the depleted UF_6 would be converted from depleted UF_6 to depleted uranium oxide prior to placement in long-term storage. Storage in a retrievable form in a facility designed for indefinite, low-maintenance operation would preserve access to the depleted uranium. Storage in the form of an oxide would be advantageous in view of long-term stability and the material preferred for use or disposal at a later date. Conversion of the depleted UF_6 to depleted uranium oxide was assumed to take place in a newly constructed stand-alone plant dedicated to the conversion process. Two forms of uranium oxide, U_3O_8 and uranium dioxide (UO_2), were considered. Both oxide forms have low solubility in water and are relatively stable over a wide range of environmental conditions. Two representative conversion technologies were assessed for conversion to U_3O_8 and three for conversion to UO_2. In addition to producing depleted uranium oxide, conversion would result in the production of considerable quantities of hydrogen fluoride (HF) as a byproduct. HF could be converted to anhydrous hydrogen fluoride (AHF), a commercially valuable chemical. AHF is toxic to humans if exposed at high enough concentrations. HF is typically stored and transported as a liquid, and inventories produced from the conversion process potentially could be sold for use. Alternatively, HF could be neutralized by the addition of lime to form a solid fluoride salt, CaF_2, which is much less toxic than HF. CaF_2 potentially could be sold for commercial use or could be disposed of either in a landfill or LLW disposal facility depending on the uranium concentration and the applicable regulations at the time of disposal. Following conversion, the depleted uranium oxide was assumed to be stored in drums in buildings, below ground vaults, or an underground mine. The storage facilities would be designed to protect the stored material from natural forces/degradation by environmental forces. Once placed in storage, the drums would require only routine monitoring and maintenance activities.

Use as Uranium Oxide. Under this alternative, depleted UF_6 would first be converted to depleted uranium oxide (UO_2 or U_3O_8). For assessment purposes, conversion to depleted UO_2 was assumed. There is a variety of current and potential uses for depleted uranium oxide including use as radiation shielding, use in dense materials applications other than shielding, use in light water reactor fuel cycles, and use in advanced reactor fuel cycles. Radiation shielding was selected as the representative use option for detailed analysis in the PEIS. A conversion facility would be required to convert UF_6 to depleted uranium oxide. The conversion facility would also produce either AHF or CaF_2 as a byproduct. These materials would be used or disposed as discussed above.

Use as Uranium Metal. In this alternative, depleted UF_6 would first be converted to depleted uranium metal. Similar to use as depleted uranium oxide, the depleted uranium metal was assumed to be used as the primary shielding material in casks designed to contain spent nuclear fuel or high-level waste. The depleted uranium metal would be enclosed between the stainless steel shells making up the body of the casks. A conversion facility would be required to convert depleted UF_6 to depleted uranium metal. The conversion facility would also produce either AHF or CaF_2 as a byproduct. These materials would be used or disposed as discussed above. In addition, some metal conversion technologies would also produce large quantities of magnesium fluoride as a byproduct. The magnesium fluoride would be disposed of either in a sanitary landfill or LLW disposal facility depending upon the uranium concentration and applicable disposal regulations at the time. The manufacture of depleted uranium metal casks was assumed to take place at a stand-alone industrial plant dedicated to the cask manufacturing process. The plant would be capable of receiving depleted uranium metal from a conversion facility, manufacturing casks, and storing the casks until shipment by rail to a user such as a nuclear power plant or DOE facility.

Disposal. Under the disposal alternative, depleted UF_6 would be chemically converted to a more stable depleted uranium oxide form and disposed of below ground as LLW.

Compared with long-term storage, disposal is considered to be permanent with no intent to retrieve the material for future use. Prior to disposal, conversion of depleted UF_6 was assumed to take place at a newly constructed stand-alone plant dedicated to the conversion process. This activity would be identical to that described under the long-term storage as oxide alternative. Potential impacts were evaluated for both UO_2 and U_3O_8. The conversion facility would convert depleted UF_6 to depleted uranium oxide and would produce either AHF or CaF_2 as a byproduct. These materials would be used or disposed as discussed above. Several disposal options were considered including disposal in shallow earthen structures, below ground vaults, and an underground mine. In addition, two physical waste forms were considered, ungrouted waste and grouted waste.

Grouted waste refers to the solid material obtained by mixing the depleted uranium oxide with cement and repackaging it in drums. Grouting is intended to increase structural strength and stability of the waste and to reduce the solubility of the waste in water. However, because cement would be added to the depleted uranium oxide, grouting would increase the total volume requiring disposal. Grouting of waste was assumed to occur at the disposal facility.

DOE's Preferred Alternative. DOE's preferred alternative for the long-term management and use of depleted UF_6 is to begin conversion of the depleted UF_6 inventory, as soon as possible, to depleted uranium oxide, depleted uranium metal, or a combination of both. The conversion products, such as fluorine, would be used as much as possible, and the remaining products would be stored for future uses or disposal. The Department currently expects that conversion to depleted uranium metal would be performed only if uses become available. At this time, the Department does not believe that long-term storage as depleted uranium metal and disposal as depleted uranium metal are reasonable alternatives; however, the Department remains open to exploring these options further. DOE's preferred alternative in the Draft PEIS was to begin to convert the depleted UF_6 inventory to uranium oxide or depleted uranium metal only as uses for the material became available. Several reviewers expressed a desire for DOE to start conversion as soon as possible. After consideration of the comments, DOE revised the preferred alternative in the Final PEIS to call for the prompt conversion of the material to depleted uranium oxide, depleted uranium metal, or a combination of both and long-term storage of that portion of the depleted uranium oxide that cannot be put to immediate use. Any proposal to proceed with the location, construction, and operation of a facility or facilities will involve additional review under NEPA and will be subject to availability of funding. DOE expects that in the future, uses would be found for some portion of the converted material. The value of depleted uranium and HF or CaF_2 for use is based on their unique qualities, the size of the inventory, and the history of uses already implemented. DOE plans to continue its support for the development of Government applications for depleted uranium products and to continue the safe management of its depleted uranium inventory as long as such inventory remains in storage prior to total conversion.

IV. Alternatives Dismissed From Detailed Consideration

Storage and Disposal as Depleted Uranium Metal. Conversion of depleted UF_6 to depleted uranium metal for long-term storage and conversion to depleted uranium metal for disposal were not analyzed in depth as reasonable alternatives in the Final PEIS. These alternatives were rejected because of higher conversion cost for some processes used to convert UF_6 to metal, the lower chemical stability of uranium metal as opposed to uranium oxide thus requiring different considerations for handling and storage, and uncertainty over the suitability of depleted uranium metal as a final disposal form. At this time, the Department does not believe that long-term storage as depleted uranium metal and disposal as depleted uranium metal are reasonable alternatives; however, the Department remains open to exploring these options further.

Storage and Disposal as Depleted Uranium Tetrafluoride (UF_4). Long-term storage as depleted UF_4 and disposal as depleted UF_4 were also not analyzed in depth as reasonable alternatives in the Final PEIS. Although more stable than UF_6, UF_4 has no identified direct use, offers no obvious advantage in required storage space, and is less stable than oxide forms. Further, as a disposal form, UF_4 is soluble in water.

V. Summary of Environmental Impacts

The PEIS analyses indicated that the areas of potential adverse environmental impacts include human health and safety impacts, impacts to ground water, air quality, and waste management under certain conditions. In addition, the Final PEIS identified net positive socioeconomic impacts in terms of employment and income for all alternatives. The most important potential impacts in these areas are summarized in the following paragraphs (detailed discussions are provided in the Final PEIS). For all alternatives, potential impacts in other areas, including ecological resources, resource requirements, land use, cultural resources, and environmental justice, it was determined to be low to negligible or entirely dependent on the actual sites where the alternatives would be implemented that are, as yet, unidentified.

Human Health and Safety. Potential impacts to the health and safety of workers and members of the public are possible during construction activities, during normal facility operations, in the long-term if ground water contamination occurs, from facility accidents, and from transportation. During normal facility operations, under all alternatives, impacts to human health and safety would be limited to involved workers (persons directly involved in the handling of radioactive or hazardous materials). Involved workers could be exposed to low-level radiation emitted by depleted uranium during the normal course of their work activities. The overall radiation exposure of workers was estimated to result in one cancer fatality under the no-action alternative, from one to two cancer fatalities under the long-term storage as UF_6 and the two use alternatives, and up to three cancer fatalities under the disposal and preferred alternatives. For all alternatives, except the disposal as oxide alternative, these exposures were estimated to be within applicable public health standards and regulations.

For the disposal as oxide alternative, if the disposal facility were located in a "wet" environment (typical of the Eastern United States), the estimated dose from the use of groundwater at 1,000 years after the assumed failure of the facility would be about 100 mrem/year, which would exceed the regulatory dose limit of 25 mrem/year specified in 10 CFR Part 61 and DOE Order 5820.2A for the disposal of LLW. In a "dry" environment typical of the Western United States, the analysis indicated that disposal would not exceed regulatory limits for over 1,000 years in the future even if the facility leaked.

Under all alternatives, workers (including involved and noninvolved) could be injured or killed from on-the-job accidents unrelated to radiation or chemical exposure. Using statistics from similar activities, under the no-action alternative, it was estimated that zero fatalities and about 180 injuries might occur over the period from 1999 through 2039. Under all other alternatives, it was estimated that from one to five fatalities and from 310 to 4,100 injuries might occur over the same period.

Accidents are possible that could release radiation or chemicals to the environment potentially causing adverse health effects among workers and members of the public under all alternatives. Accidents involving cylinders are possible under all alternatives and could have severe consequences (depending on the amount of DUF_6 released) that would be primarily limited to on-site workers even under the worst conditions. During a severe cylinder accident, it was estimated that up to three fatalities from HF exposure would occur among noninvolved workers, with the additional possibility of fatalities among those directly involved in the accident. However, because the probability of such accidents occurring is low, they would not be expected to occur during the operational periods considered in the Final PEIS.

Low probability accidents involving chemicals at a conversion facility were estimated to have potential consequences that are much greater than accidents involving cylinders. Such accidents would be possible under the long-term storage as oxide, use as oxide, use as metal, disposal, and preferred alternatives because they would require conversion of UF_6 to another chemical form with rupture of tanks containing AHF or ammonia estimated to have the largest potential consequences. Such accidents are expected to occur with a frequency of less than once in one million per year of operation. If such a severe event were to occur, it was estimated that up to 30 fatalities among the public and four fatalities among noninvolved workers would be possible. Although the consequences of cylinder and chemical accidents could be severe, these types of accidents are expected to be extremely rare. The maximum calculated risk for these accidents would be zero fatalities and irreversible adverse health effects expected for noninvolved workers and the public combined and one adverse effect (mild and temporary effects such as temporary decrease in kidney function or respiratory irritation) expected for the general public.

Transportation activities could also potentially result in adverse health and safety impacts. Although specific sites for some of the management activities (conversion, for example) have not been identified, the Final PEIS analyzed the potential impacts associated with shipping UF_6 cylinders to alternative locations using representative shipment lengths and routes. The primary impacts from transportation are related to accidents. The total number of traffic fatalities was estimated on the basis of national traffic statistics for shipments by both truck and rail modes for all alternatives. If shipments were predominantly by truck, it was estimated that zero fatalities would be expected for the no-action alternative, approximately two fatalities for the long-term storage as depleted UF_6 alternative, and up to four fatalities for each of the other alternatives. Shipment by rail would result in similar, but slightly smaller, impacts. Severe transportation accidents could also cause a release of radioactive material or chemicals from a shipment that could have adverse health effects. All alternatives, other than no action and long-term storage as UF_6, could involve the transportation of relatively large quantities of chemicals such as ammonia and AHF because conversion would be required. Severe accidents involving these materials could result in releases that caused fatalities with HF posing the largest potential hazard. For example, if a severe accident involving a railcar containing HF occurred in an urban area under unfavorable weather conditions, it was estimated that up to 30,000 people would experience irreversible adverse effects (such as lung damage) and 300 fatalities could occur. However, because of the low probability of such accidents, the maximum calculated risk for these accidents would be zero fatalities. If HF were to be neutralized to CaF_2 at the conversion facility, the risks associated with its transportation would be eliminated.

Ground Water Quality. For operations under all alternatives, uranium concentrations in ground water at the three current storage sites would remain below guidelines throughout the project duration if cylinder maintenance and painting activities are performed as expected. Ground water impacts are possible under the disposal alternative if the disposal facility were located in a "wet" environment. In a dry environmental setting, ground water impacts for the severe situation would be unlikely for at least 1,000 years.

Air Quality. Under all alternatives, impacts to air quality from construction and facility operations would be within existing regulatory standards and guidelines. Under the no-action alternative, however, if cylinder maintenance and painting do not reduce cylinder corrosion rates, it is possible that cylinder breaches could result in HF air concentrations greater than the regulatory standard level at the K–25 storage site around the year 2020; HF concentrations at the Paducah and Portsmouth Sites were estimated to remain within applicable standards or guidelines.

Waste Management. Under all alternatives requiring conversion, there is the potential that significant amounts of fluorine-containing wastes could be generated. If the HF produced from conversion were not used, CaF_2 generated from the neutralization of HF might have to be disposed of as low-level radioactive waste.

Socioeconomics. Positive socioeconomic impacts would occur under all alternatives. The no-action alternative would create about 140 direct jobs and generate about $6.1 million in direct income per operational year. The storage as UF_6 alternative would create about 610 to 1,200 direct jobs and generate about $35 to $65 million in direct income per year. The other alternatives (long-term storage as oxide, use as oxide, use as metal, disposal, and preferred alternatives) would have more beneficial socioeconomic impacts, creating about 970 to 1,600, 1,250 to 1,600, 1,260 to 1,600, 900 to 2,100, and 1,600 to 1,840 direct jobs per year, respectively, and generating about $55 to $85 million, $79 to $93 million, $79 to $93 million, $55 to $120 million, and $89 to $110 million in direct income per year, respectively. Continued cylinder storage under all alternatives would result in negligible impacts on regional growth and housing.

Cumulative Impacts. The continued cylinder storage and cylinder preparation components of the depleted UF_6 management alternatives would result in environmental impacts that would be expected to be relatively minor. The estimated cumulative doses to members of the general public at all three sites would be below levels expected to result in a single cancer fatality over the life of the project, and the annual dose to the off-site maximally exposed individual would be considerably below the Environmental Protection Agency (EPA) maximum standard of 10 mrem/year from the air pathway. The cumulative collective dose to workers at the three sites would result in one to three additional cancer fatalities over the duration of the program. Cumulative demands for water, wastewater treatment, and power would be well within existing capacities at all three sites. Relatively small amounts of additional land would be needed for depleted UF_6 management at the three current storage sites. The cumulative impacts of conversion, long-term storage, and disposal activities could not be determined because specific sites and technologies have not been designated for these options. Further analyses of cumulative impacts would be performed as required by NEPA regulations for any technology or siting proposals that would involve these facilities.

VI. Environmentally Preferred Alternative

Overall, the potential for adverse environmental impacts tends to be the smallest for the no-action and long-term storage alternatives primarily because they do not require construction and operation of conversion facilities or significant transportation operations. Although the potential impacts tend to be small for all alternatives, differences do exist among the alternatives. The presence of a conversion facility results in the potential for both facility and transportation accidents involving hazardous chemicals that could have severe consequences. However, it must be recognized that the probability of such accidents is low, and accident prevention and mitigative measures are well established for these types of industrial activities. In addition, beneficial socioeconomic impacts tend to be smallest for the no-action and long-term storage as UF_6 alternatives and greatest for those alternatives involving conversion. Finally, the differences in impacts among the alternatives tend to be small when considering the uncertainties related to the actual processes and technologies that will be used and the fact that actual sites have not been identified. In general, because of the relatively small risks that would result under all alternatives and the absence of any clear basis for discerning an environmental preference, DOE concludes that no single alternative analyzed in depth in the Final PEIS is clearly environmentally preferable compared to the other alternatives.

VII. Mitigation

Specific mitigation measures may need to be developed as part of the design of the particular conversion facilities. Such measures would be addressed during the preparation of project-specific NEPA reviews.

VIII. Comments on Final PEIS

The Final PEIS was mailed to stakeholders in mid-April 1999, and the EPA issued a notice of availability in the April 23, 1999, **Federal Register**. In addition, DOE issued a notice of availability in the April 29, 1999, **Federal Register**. The entire document was also made available on the World Wide Web. Comments were received by five reviewers, and at the same time, about two dozen responses to the aforementioned expression of interest were received. The following is a summary of the comments received by reviewers of the Final PEIS:

- *Comments related to the preferred alternative.* One reviewer, BNFL Inc., reiterated their previous comments that DOE should have analyzed in depth, the environmental impacts of conversion of the depleted UF_6 to depleted uranium metal for long-term storage and disposal. DOE addressed these comments in volume 3 of the Final PEIS and earlier in this ROD. At this time, the Department does not believe that long-term storage as depleted uranium metal and disposal as depleted uranium metal are reasonable alternatives; however, the Department remains open to exploring these options further. Should the Department be persuaded that it is reasonable to convert the depleted UF_6 to depleted uranium metal for long-term storage or disposal, these alternatives would be analyzed in detail in future NEPA reviews, as necessary.
- *General comments.* The U.S. Environmental Protection Agency commented that the Department has adequately addressed its concerns on this project and suggested that DOE use a single location for a conversion pilot plant as it conducts its further planning and environmental analysis. The Kentucky Heritage Council recommended that any previously undisturbed areas impacted by the proposed project be surveyed by a professional archaeologist. Should the Department decide to construct a conversion facility in the State of Kentucky, the decision to conduct the requested survey would be addressed at that time. The Kentucky Department for Environmental Conservation, Division of Water, affirmed that the concerns they raised on the Draft PEIS have been addressed in the Final PEIS. The Kentucky Department for Environmental Conservation, Division of Waste Management, reiterated the concerns that were raised in their April 23, 1998, letter regarding the Draft PEIS. These comments were addressed in volume 3 of the Final PEIS. The Kentucky Department for Environmental Conservation, Underground Storage Tank Branch, is currently waiting for closure reports and documentation for several tanks from the Paducah Site. This comment was forwarded to the site for appropriate action. Finally, should the Department decide to construct a conversion facility in the State of Kentucky, the Department would address the issue of using on-site landfills for disposal of waste generated by such a facility at that time.

IX. Other Factors

Public Law 105–204. In accordance with this law, the Secretary of Energy submitted to Congress a plan for the construction of plants at Paducah, Kentucky, and Portsmouth, Ohio, to convert its large inventory of depleted uranium hexafluoride. These proposed activities would be subject to review under NEPA. The preferred alternative is consistent with this legislation.

Cost. As part of the analysis done to develop a long-term management plan, the comparative costs associated with representative technologies for each of the alternatives were calculated. The Cost Analysis Report provided life-cycle cost estimates for each of the alternatives and estimates the primary capital and operating costs for each alternative reflecting all development, construction, operating, and decontamination and decommissioning costs as well as potential offsetting revenues from the sale of recycled materials. The costs are estimated at a preconceptual design level. Depending on the technology and the option selected for disposal, conversion, long-term storage, and cylinder preparation, there was a wide variation in the cost of various alternatives. In general, the no-action alternative was the least costly, while the disposal and use as metal alternatives were the most costly.

Atomic Vapor Laser Isotope Separation (AVLIS). USEC Inc. announced on June 9, 1999, that it would suspend AVLIS technology development activities. The Final PEIS had identified that the AVLIS process could potentially be used to re-enrich depleted UF_6. USEC Inc. has announced that it will move forward with evaluating potentially more economical technology options, such as the Silex laser enrichment process and gas centrifuge technology.

X. Decision

DOE has decided that it will select the preferred alternative from the Final PEIS. This decision includes the following actions:

- DOE will take the necessary steps to promptly convert the depleted UF_6 inventory to depleted uranium oxide, depleted uranium metal, or a combination of both. Conversion to depleted uranium metal would occur only when uses for the converted material are identified.

- The depleted uranium oxide will be used as much as possible and the remaining depleted uranium oxide will be stored for potential future uses or disposal, as necessary.
- Any proposal to proceed with the location, construction, and operation of a facility or facilities for conversion of the depleted UF_6 to a form other than depleted UF_6 will involve additional NEPA review (i.e., project-specific EIS).
- The proposed facilities to be constructed to support this conversion decision would be built consistent with the plan submitted as required by Public Law 105–204.
- DOE anticipates that approximately 4,700 cylinders containing depleted UF_6 that are located at the East Tennessee Technology Park at Oak Ridge would be shipped to a conversion facility.
- Depleted UF_6 will be available for use until all of it has been converted to another form.

XI. Conclusion

DOE believes conversion of the depleted UF_6 inventory to depleted uranium oxide as soon as possible is the prudent and proper decision. Several factors, including increased chemical stability, socioeconomic benefits associated with the conversion, and public and congressional desire to move forward with conversion, have contributed to this decision. Conversion to depleted uranium metal would be performed only when uses for the converted material are identified. At this time, the Department does not believe that long-term storage as depleted uranium metal and disposal as depleted uranium metal are reasonable alternatives; however, the Department remains open to exploring these options further. DOE will continue to safely maintain the depleted UF_6 cylinders while moving forward to implement the decisions set forth in this ROD.

Issued in Washington, D.C. this second day of August, 1999.

Bill Richardson,
Secretary of Energy.

[FR Doc. 99–20471 Filed 8–9–99; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Request for Information on Potential Studies in the Russian Federation of Low Dose-Rate Radiation Health Effects

AGENCY: Office of Environment, Safety and Health, DOE.

ACTION: Request for information.

SUMMARY: The U.S. Department of Energy (DOE), announces a request for information (RFI) on potential studies in the Russian Federation of low dose-rate radiation health effects. Specifically, DOE is interested in receiving information on new ideas for epidemiologic, dosimetric/biodosimetric, and/or molecular epidemiologic studies that would: (1) Build upon collaborative research already conducted on workers and populations in the Southern Urals; or (2) utilize information on other similar cohorts in the Russian Federation. Information submitted in response to this RFI will be used to define the scope of a Request for Applications (RFA) that may be issued in late calendar year 1999.

DATES: The deadline for receipt of submissions is October 5, 1999.

ADDRESSES: U.S. Department of Energy, Office of International Health Programs, EH–63/270CC, 19901 Germantown Road, Germantown, Maryland 20874–1290

FOR FURTHER INFORMATION CONTACT: Requests for further information on this announcement may be directed to Elizabeth White, Office of International Health Programs (EH–63), U.S. Department of Energy, telephone: (301) 903–7582; facsimile: (301) 903–1413; electronic mail: elizabeth.white@eh.doe.gov. Responses may be submitted, preferably by electronic mail or facsimile, to Ms. White.

SUPPLEMENTARY INFORMATION:

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I. Purpose

The Office of International Health Programs, Office of Environment, Safety and Health, in partnership with ministries of the Russian Federation, funds epidemiologic studies of cohorts of workers and populations to evaluate the health consequences (cancer and other diseases) of exposure to low dose-rate ionizing radiation. These ongoing studies are coordinated through the Joint Coordinating Committee for Radiation Effects Research (JCCRER). Section II (''Background'') provides a description of the JCCRER and Section III (''Description of Ongoing Projects'') sets forth a description of the populations currently being studied in the Russian Federation under the auspices of the JCCRER.

The purpose of this Notice is to encourage the submission of information on potential radiation health effects research. The Office of International Health Programs is interested in ideas for new epidemiologic, dosimetric/biodosimetric, and/or molecular epidemiologic studies that would: (1) Build upon low dose-rate radiation health effects research already conducted under the auspices of the JCCRER in the Southern Urals. In particular, DOE is looking for ideas for new projects involving the worker and population cohorts (See Section II) affected by radiation emitted from the Mayak Production Association; or (2) use other similar epidemiologic and dosimetric databases in the Russian Federation to further elucidate the health effects of chronic low dose-rate radiation exposure. In particular, we are interested in learning about other cohorts or potential cohorts of radiation-exposed workers and populations, and the potential scientific studies that could be developed for these cohorts.

DOE, with the help of its standing Scientific Review Group, will review the information submitted in response to this RFI for use in defining the scope of an RFA that may be issued in late calendar year 1999. DOE anticipates that approximately $1,000,000 may be available in fiscal year 2000 to initiate new feasibility projects.

II. Background

The JCCRER is a bilateral Government committee representing agencies from the United States and ministries from the Russian Federation. It was established to implement the Agreement on Cooperation in Research on Radiation Effects for the Purpose of Minimizing the Consequences of Radioactive Contamination on Health and the Environment signed on January 1, 1994, by U.S. Secretary of State Warren Christopher and Russian Foreign Minister Andrey Kozyrev to support and facilitate joint cooperative research.

Radiation research conducted jointly with the Russian Federation provides a unique opportunity to learn more about possible risks to groups of people from lengthy exposure to radiation. This could include people receiving exposure from uranium mining, operations of nuclear facilities, transport and disposal of radioactive materials, the testing and dismantling of nuclear weapons, radiation accidents, and grossly contaminated sites or facilities.

Currently, the JCCRER and DOE are focusing on population and worker studies in the Southern Urals region of

69 FR 44654, *Record of Decision for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site*, U.S. Department of Energy, Tuesday, July 27, 2004.

accordance with the comprehensive set of DOE requirements and applicable regulatory requirements that have been established to protect public health and the environment. These requirements encompass a wide variety of areas, including radiation protection, facility design criteria, fire protection, emergency preparedness and response, and operational safety requirements.

- Cylinder management activities will be conducted in accordance with applicable DOE safety and environmental requirements, including the Cylinder Management Plan.
- Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility will be controlled by the best available practices, as necessary, to comply with the established standards for PM_{10} and $PM_{2.5}$.
- During construction, impacts to water quality and soil will be minimized through implementing storm water management, sediment and erosion controls, and good construction practices consistent with the Soil, Erosion, and Sediment Control Plan and Construction Management Plan.
- If live trees with exfoliating bark are encountered on construction areas, they will be saved if possible to avoid destroying potential habitat for the Indiana bat.

Issued in Washington, DC, this 20th day of July, 2004.

Paul M. Golan,

Principal Deputy Assistant Secretary for Environmental Management.

[FR Doc. 04–17048 Filed 7–26–04; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, KY, Site

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) prepared a Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky, Site (FEIS) (DOE/EIS–0359). The FEIS Notice of Availability was published by the U.S. Environmental Protection Agency (EPA) in the **Federal Register** (69 FR 34161) on June 18, 2004. In the FEIS, DOE considered the potential environmental impacts from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed depleted uranium hexafluoride (DUF_6) conversion facility at three alternative locations within the Paducah site, including transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the aqueous hydrogen fluoride (HF) produced as a conversion co-product; and neutralization of aqueous HF to calcium fluoride (CAF_2) and its sale or disposal in the event that the aqueous HF product is not sold. An option of shipping the East Tennessee Technology Park (ETTP) cylinders to the Paducah site has also been considered, as has an option of expanding operations by increasing efficiency or extending the period of operation. A similar EIS was issued concurrently for construction and operation of a DUF_6 conversion facility at DOE's Portsmouth, Ohio, site (DOE/EIS–0360).

DOE has decided to construct and operate the conversion facility in the south-central portion of the Paducah site, the preferred alternative identified in the FEIS as Location A. Groundbreaking for construction of the facility will commence on or before July 31, 2004, as anticipated by Public Law (Pub. L.) 107–206. The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits, as appropriate.

ADDRESSES: The FEIS and this Record of Decision (ROD) are available on the DOE National Environmental Policy Act (NEPA) Web site at *http://www.eh.doe.gov/nepa* and on the Depleted UF_6 Management Information Network Web site at *http://web.ead.anl.gov/uranium*. Copies of the FEIS and this ROD may be requested by e-mail at *Pad_DUF6@anl.gov*, by toll-free telephone at 1–866–530–0944, by toll-free fax at 1–866–530–0943, or by contacting Gary S. Hartman, Oak Ridge Operations Office, U.S. Department of Energy, SE–30–1, P.O. Box 2001, Oak Ridge, Tennessee 37831.

FOR FURTHER INFORMATION CONTACT: For information on the conversion facility construction and operation, contact Gary Hartman at the address listed above. For general information on the DOE NEPA process, contact Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION:

I. Background

The United States has produced DUF_6 since the early 1950s as part of the process of enriching natural uranium for both civilian and military applications. Production took place at three gaseous diffusion plants (GDPs), first at the K–25 site (now called ETTP) at Oak Ridge, Tennessee, and subsequently at Paducah, Kentucky, and Portsmouth, Ohio. The K–25 plant ceased enrichment operations in 1985, and the Portsmouth plant ceased enrichment operations in 2001. The Paducah GDP continues to operate.

Approximately 440,000 t (484,000 tons) of DUF_6 is presently stored at Paducah in about 36,200 cylinders. The majority of the cylinders weigh approximately 12 t (14 tons) each, are 48 inches (1.2 m) in diameter, and are stored on outside pads. DOE has been looking at alternatives for managing this inventory. 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) or are empty. [The non-DUF_6 cylinders would not be processed in the conversion facility.]

As a first step, DOE evaluated potential broad management options for its DUF_6 inventory in 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) issued in April 1999. In the PEIS Record of Decision (64 FR 43358, August 10, 1999), DOE decided to promptly convert the DUF_6 inventory to a more stable uranium oxide form and 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, DOE would convert DUF_6 to depleted uranium metal, but only if uses for metal were available. DOE did not select specific sites for the conversion facilities but reserved that decision for subsequent NEPA review. Today's Record of Decision announces the outcome of that site-specific NEPA review. DOE is also issuing today a separate but related ROD announcing the siting of a DUF_6 conversion facility at Portsmouth, Ohio.

Congress enacted two laws that directly addressed DOE's management of its DUF_6 inventory. The first law, Public Law 105–204, signed by the President in July 1998, required the Secretary of Energy to prepare a plan to commence construction of, no later than January 31, 2004, and to operate an on-site facility at each of the GDPs at

additional NEPA analysis for public review and comment.

The following alternatives were considered but not analyzed in detail in the FEIS: Use of Commercial Conversion Capacity, Sites Other Than Paducah, Alternative Conversion Processes, Long-Term Storage and Disposal Alternatives, Transportation Modes Other Than Truck and Rail, and One Conversion Plant Alternative.

IV. Summary of Environmental Impacts

The FEIS evaluated potential impacts from the range of alternatives described above. The impact areas included human health and safety, air quality, noise, water and soil, socioeconomics, ecological resources, waste management, resource requirements, land use, cultural resources, environmental justice, and cumulative impacts. In general, the impacts are low for both the no action and the proposed action alternatives. Among the three alternative locations considered at the Paducah site for the conversion facility, there are no major differences in impacts that would make one location clearly environmentally preferable. The discussion below summarizes the results of the FEIS impact analyses, highlighting the differences among the alternatives.

Human Health and Safety—Normal Operations and Transportation. Under all 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. UDS would confirm, prior to conversion or at the initiation of the conversion operations, that polychlorinated biphenyl (PCB) releases to the workplace from the paint coating of some cylinders manufactured prior to 1978 would be within applicable Occupational Safety and Health Administration (OSHA) limits. Transportation by rail would tend to cause fewer impacts than by truck primarily because of exhaust emissions from the trucks and the higher number of shipments for trucks than for rail. The option of converting the aqueous HF to CaF_2 and transporting the CaF_2 to a disposal facility would result in increased shipments. The impacts associated with transportation of uranium oxide product to a disposal facility in the western United States by truck would be about the same if bulk bags are used or two filled cylinders are loaded onto a truck. If only one cylinder is loaded onto a truck, the impacts would be higher because of the increased number of shipments.

Human Health and Safety—Accidents. DOE has extensive experience in safely storing, handling, and transporting cylinders containing UF_6 (depleted, normal, or enriched). In addition, the chemicals used or generated at the conversion facility are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for their storage and transportation.

Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting both the workers and members of the general public. It is also possible that, similar to other industrial facilities, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. Similarly, during transportation of materials, both crew members and members of the public may be injured or killed as a result of traffic accidents.

Three kinds of accidents have the largest possible consequences: (1) Those involving the DUF_6 cylinders during storage and handling under all alternatives, (2) those involving chemicals used or generated by the conversion process at the conversion site (in particular NH_3 and aqueous HF) under the action alternatives, and (3) those occurring during transportation of chemicals and cylinders under the action alternatives. The severity of the consequences from such accidents would depend on weather conditions at the time of the accident, and, in the case of the transportation accidents, the location of the accident, and could be significant. However, those accidents would have a low estimated probability of occurring, making the risk low. (Risk is determined by multiplying the consequences by the probability of occurrence).

In comparing truck versus rail transportation, even though the consequences of rail accidents are generally higher (because of the larger cargo load per railcar than per truck), the accident probabilities tend to be lower for railcars than for trucks. As a result, the risks of accidents would be about the same under either option.

Under the no action alternative, the risks associated with cylinder storage and handling would continue to exist as long as the cylinders are there. However, under the action alternatives, the risks associated with both the cylinder accidents and the chemical accidents would decline over time and disappear at the completion of the project.

Air Quality and Noise. Under the action alternatives, the total (modeled plus background value) concentrations due to emissions of most criteria pollutants—such as sulfur dioxide, nitrogen oxides, and carbon monoxide—would be well within applicable air quality standards. For construction, the primary concern would be particulate matter (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 boundaries would be close to or above the standards because of the high background concentrations. Accordingly, construction activities would be conducted so as to minimize further impacts on ambient air quality.

Water and Soil. During construction of the conversion facility, concentrations of any potential contaminants in soil, surface water, or groundwater would be kept well within applicable standards or guidelines by implementing storm water management, sediment and erosion controls, and good construction practices. During operations, no impacts would be expected because no contaminated liquid effluents are anticipated.

Socioeconomics. Under the action alternatives, construction and operation of the conversion facility would create more jobs and personal income in the vicinity of the Paducah site than would be possible under the no action alternative. The number of jobs would be approximately 190 direct and 290 total during construction, and 160 direct and 330 total during operations.

Ecology. For the action alternatives, the total area disturbed during conversion facility construction would be up to 45 acres (18 ha). Although vegetation communities in the disturbed area would be impacted by a loss of habitat, impacts could be minimized (*e.g.*, by appropriate placement of the facility within each location), and negligible long-term impacts to vegetation and wildlife are expected at all locations. Impacts to wetlands could be minimized, depending on where exactly the facility was placed within each location and by maintaining a buffer near adjacent wetlands during 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, potential impacts to forested areas could be avoided if temporary construction areas were placed in previously disturbed locations. During construction, trees with exfoliating bark (such as shagbark hickory or dead trees with loose bark) that can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer would be saved if possible.

Waste Management. Under the action alternatives, 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. If the aqueous HF were 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. 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.

The U_3O_8 produced during conversion would amount to about 80% of Paducah's annual projected LLW volume.

Option of Shipping ETTP Cylinders to Paducah. The cylinders at ETTP would require preparation for shipment by either truck or rail. Three cylinder preparation options were considered for the shipment of noncompliant cylinders: cylinder overpacks, shipping "as-is" under a U.S. Department of Transportation (DOT) exemption, and use of a cylinder transfer facility (there are no current plans to build such a facility at ETTP). The operational impacts (*e.g.*, storage, handling, and maintenance of cylinders) from any of the options would be small and limited primarily to external radiation exposure of involved workers. The annual impacts from conversion operations at Paducah would remain the same, however the conversion period would be approximately 3 years longer. If a decision was made to construct and operate a transfer facility at ETTP in the future, additional NEPA review would be conducted.

Conversion Product Sale and Use. The conversion of the DUF_6 inventory produces products having some potential for reuse. These products include aqueous HF and CaF_2, which are commonly used as commercial materials. DOE is currently pursuing the establishment of authorization limits (allowable concentration limits of uranium) in these products to be able to free-release them to commercial users. In addition, there is a small potential for reuse of the depleted uranium oxide product.

D&D Activities. D&D impacts would be primarily from external radiation to involved workers and would be a small fraction of allowable doses. Wastes generated during D&D operations would be disposed of in an appropriate disposal facility and would result in low impacts in comparison with projected site annual generation volumes.

Cumulative Impacts. The FEIS analyses indicated that no significant cumulative impacts at the Paducah site and its vicinity would be anticipated due to the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions.

Option of Expanding Conversion Facility Operations. The throughput of the Paducah facility could be increased by making process efficiency improvements. Such an increase would not be expected to significantly change the overall environmental impacts when compared with those of the current plant design.

The conversion facility operations could be extended to process any additional DUF_6 for which DOE might assume responsibility by operating the facility longer than the currently anticipated 25 years. 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. 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 unchanged.

V. Environmentally Preferred Alternative

In general, the FEIS shows greater impacts for the no action alternative than for the proposed action of constructing and operating the conversion facility mainly because of the relatively higher radiation exposures of the workers from the cylinder management operations and cylinder yards and because the cylinders and associated risk would remain if no action occurred. However, considering the uncertainties in the impact estimates and the magnitude of the impacts, the differences are not considered to be significant. The no action alternative has the potential for groundwater contamination with uranium over the long-term; this adverse impact is not anticipated under the proposed action alternatives. Beneficial socioeconomic impacts would be higher for the action alternatives than for the no action alternative.

The impacts associated with transportation of materials among sites would be comparable whether the transportation is by truck or rail.

With all alternatives, there is the potential for some high-consequence accidents to occur. The risks associated with such accidents can only be completely eliminated when the conversion of the DUF_6 inventory has been completed.

Although there are some differences in impacts among the three alternative locations for the conversion facility, these differences are small and well within the uncertainties associated with the methods used to estimate impacts. In general, because of the relatively small risks that would result under all alternatives and the absence of any clear basis for discerning an environmental preference, DOE concludes that no single alternative analyzed in depth in the FEIS is clearly environmentally preferable compared to the other alternatives.

VI. Comments on Final EIS

The Final EIS was mailed to stakeholders in early June 2004, and the EPA issued a Notice of Availability in the **Federal Register** on June 18, 2004. The entire document was also made available on the World Wide Web. Two comment letters were received on the DUF_6 Conversion Facility Final EISs. The State of Nevada indicated that it had no comments on the Final EISs and that the proposal was not in conflict with state plans, goals, or objectives. The U.S. Environmental Protection Agency, Region 5 in Chicago, stated that the Portsmouth Final EIS adequately address its concerns, and that it concurs with the Preferred Alternative and has no further concerns.

Decision

I. Bases for the Decision

DOE considered potential environmental impacts as identified in the FEIS (including the information contained in the classified appendix); cost; applicable regulatory requirements; Congressional direction as included in Public Law 105–204 and 107–206; agreements among DOE and the States of Ohio, Tennessee, and Kentucky concerning the management of DUF_6 currently stored at the Portsmouth, ETTP, and Paducah sites, respectively; and public comments in arriving at its decision. In deciding among the three alternative locations at the Paducah site for the conversion facility, DOE considered environmental factors, site preparation requirements affecting construction, availability of utilities, proximity to cylinder storage areas, and potential impacts to current or planned site operations. DOE has determined that Location A is the best alternative. DOE believes that the decision identified below best meets its programmatic goals and is consistent with all the regulatory requirements and public laws.

II. Decision

DOE has decided to implement the actions described in the preferred alternative from the FEIS at Location A. This decision includes the following actions:

- DOE will construct and operate the conversion facility at Location A within the Paducah site. Construction will commence on or before July 31, 2004, as intended by Congress in Public Law 107–206.
- All shipments to and from the conversion site, including any potential shipments of non-DUF_6 cylinders currently stored at ETTP to Paducah, will be conducted by either truck or rail, as appropriate. Cylinders will be shipped in a manner that is consistent with DOT regulations for the transportation of UF_6 cylinders.
- Current cylinder management activities (handling, inspection, monitoring, and maintenance) will continue, consistent with the Cylinder Project Management Plan for Depleted Uranium Hexafluoride, effective October 2003, which cover actions needed to meet safety and environmental requirements, until conversion could be accomplished.
- The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits as appropriate. If necessary, CaF_2 will be produced and reused, pending approval of authorized release limits, or disposed of as appropriate.
- The depleted U_3O_8 conversion product will be reused to the extent possible or packaged for disposal in emptied cylinders at an appropriate disposal facility. 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.

III. Mitigation

On the basis of the analyses conducted for the FEIS, the DOE will adopt all practicable measures, which are described below, to avoid or minimize adverse environmental impacts that may result from constructing and operating a conversion facility at Location A. These measures are either explicitly part of the alternative or are already performed as part of routine operations.

- The conversion facility will be designed, constructed, and operated in accordance with the comprehensive set of DOE requirements and applicable regulatory requirements that have been established to protect public health and the environment. These requirements encompass a wide variety of areas, including radiation protection, facility design criteria, fire protection, emergency preparedness and response, and operational safety requirements.
- Temporary impacts on air quality from fugitive dust emissions during reconstruction of cylinder yards or construction of any new facility will be controlled by the best available practices, as necessary, to comply with the established standards for PM_{10} and $PM_{2.5}$.
- During construction, impacts to water quality and soil will be minimized through implementing storm water management, sediment and erosion controls, and good construction practices consistent with the Soil, Erosion, and Sediment Control Plan and Construction Management Plan.
- If live trees with exfoliating bark are encountered on construction areas, they will be saved if possible to avoid destroying potential habitat for the Indiana bat.

Issued in Washington, DC this 20th day of July 2004.

Paul M. Golan,

Principal Deputy Assistant Secretary for Environmental Management.

[FR Doc. 04–17050 Filed 7–26–04; 8:45 am]

BILLING CODE 6450–01–U

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. CP04–368–000]

El Paso Natural Gas Company; Notice of Request for Authorization

July 2, 2004.

Take notice that on June 25, 2004, El Paso Natural Gas Company (El Paso), P.O. Box 1087, Colorado Springs, Colorado 80904, filed in Docket No. CP04–368–000, a request pursuant to section 157.216(b) and 157.208(b) of the Commission's Regulations (18 CFR 157.214) to abandon, by removal, its 7.1 mile 10¾ inch diameter Nevada Loop Line (Line No. 2112), and replace two segments of its 16 inch diameter Nevada Loop Line (Line No. 2121), totaling 17.2 miles, located in Mohave County, Arizona, all as more fully set forth in the application on file with the Commission and open for public review.

Any questions regarding this application should be directed to Robert T. Tomlinson, Director, Regulatory Affairs, El Paso Natural Gas Company, P.O. Box 1087, Colorado Springs, Colorado, 80944, at (719) 520–3788.

This filing is available for review at the Commission or may be viewed on the Commission's Web site at *http://www.ferc.gov* using the "eLibrary" link. Enter the docket number excluding the last three digits in the docket number field to access the document. For assistance, please contact FERC Online Support at *FERCOnlineSupport@ferc.gov* or call toll-free at (866) 208–3676, or for TTY, contact (202) 502–8659. Protests, comments and interventions may be filed electronically via the Internet in lieu of paper; see, 18 CFR 385.2001(a)(1)(iii) and the instructions on the Commission's Web site under the "e-Filing" link. The Commission strongly encourages interveners to file electronically.

Any person or the Commission's staff may, within 45 days after issuance of the instant notice by the Commission, file pursuant to Rule 214 of the Commission's Procedural Rules (18 CFR 385.214) a motion to intervene or notice of intervention and pursuant to section 157.205 of the Regulations under the Natural Gas Act (18 CFR 157.205) a protest to the request. If no protest is filed within the time allowed therefore, the proposed activity shall be deemed to be authorized effective the day after the time allowed for filing a protest. If a protest is filed and not withdrawn within 30 days after the time allowed for filing a protest, the instant request

69 FR 44649, *Record of Decision for Construction and Operation of Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site*, U.S. Department of Energy, Tuesday, July 27, 2004.

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halseypj@oro.doe.gov or check the Web site at *www.oakridge.doe.gov/em/ssab.*

SUPPLEMENTARY INFORMATION:

Purpose of the Board: The purpose of the Board is to make recommendations to DOE in the areas of environmental restoration, waste management, and related activities.

Tentative Agenda

8 a.m.—Introductions, overview of meeting agenda and logistics (Dave Mosby)
8:15 a.m.—Past year evaluation—Board and stakeholder survey results, what worked, what can be improved (Facilitator)
9:50 a.m.—Break
10:05 a.m.—Past year evaluation continued
10:45 a.m.—Summaries and Q&A on the most important issues to DOE, TN Department of Environment & Conservation, and EPA (Facilitator)
11:30 a.m.—Lunch
12:30 p.m.—Environmental Management Committee (Luther Gibson)

- Accomplishments and impacts
- Review FY 2004 Work Plan
- Identify issues for FY 2005
- Assignment of new issues/issues managers

1:30 p.m.—Stewardship Committee (Ben Adams)

- Accomplishments and impacts
- Review FY 2004 Work Plan
- Identify issues for FY 2005
- Assignment of new issues/issues managers

2:30 p.m.—Break
2:45 p.m.—Public Outreach Committee (Committee Chair)

- Accomplishments and impacts
- Review FY 2004 Work Plan
- Identify issues for FY 2005

3:15 p.m.—Board Finance Committee (Kerry Trammell)

- Accomplishments and impacts
- Review FY 2004 Work Plan
- Identify issues for FY 2005

3:45 p.m.—Convene Board meeting to elect officers and conduct other business as needed

- Public Comment Period

4:45 p.m.—Set date for next retreat and adjourn

Public Participation: The meeting is open to the public. Written statements may be filed with the Committee either before or after the meeting. Individuals who wish to make oral statements pertaining to agenda items should contact Pat Halsey at the address or telephone number listed above. Requests must be received five days prior to the meeting and reasonable provision will be made to include the presentation in the agenda. The Deputy Designated Federal Officer is empowered to conduct the meeting in a fashion that will facilitate the orderly conduct of business. Each individual wishing to make public comment will be provided a maximum of five minutes to present their comments. This **Federal Register** notice is being published less than 15 days prior to the meeting due to programmatic issues that had to be resolved prior to the meeting date.

Minutes: Minutes of this meeting will be available for public review and copying at the Department of Energy's Information Center at 475 Oak Ridge Turnpike, Oak Ridge, TN between 8 a.m. and 5 p.m. Monday through Friday, or by writing to Pat Halsey, Department of Energy Oak Ridge Operations Office, P.O. Box 2001, EM–90, Oak Ridge, TN 37831, or by calling her at (865) 576–4025.

Issued at Washington, DC, on July 20, 2004.

Rachel M. Samuel,

Deputy Advisory Committee Management Officer.

[FR Doc. 04–17049 Filed 7–26–04; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, OH, Site

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) prepared a *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio, Site* (FEIS) (DOE/EIS–0360). The FEIS Notice of Availability was published by the U.S. Environmental Protection Agency (EPA) in the **Federal Register** (69 FR 34161) on June 18, 2004. In the FEIS, DOE considered the potential environmental impacts from the construction, operation, maintenance, and decontamination and decommissioning (D&D) of the proposed depleted uranium hexafluoride (DUF_6) conversion facility at three alternative locations within the Portsmouth site, including transportation of cylinders (DUF_6, normal and enriched UF_6, and empty) currently stored at the East Tennessee Technology Park (ETTP) near Oak Ridge, Tennessee, to Portsmouth; construction of a new cylinder storage yard at Portsmouth (if required) for the ETTP cylinders; transportation of depleted uranium conversion products and waste materials to a disposal facility; transportation and sale of the aqueous hydrogen fluoride (HF) produced as a conversion co-product; and neutralization of aqueous HF to calcium fluoride (CaF_2) and its sale or disposal in the event that the aqueous HF product is not sold. An option of shipping the ETTP cylinders to the Paducah, Kentucky, site has also been considered, as has an option of expanding operations by increasing throughput (through efficiency improvements or by adding a fourth conversion line) or by extending the period of operation. A similar EIS was issued concurrently for construction and operation of a DUF_6 conversion facility at DOE's Paducah site (DOE/EIS–0359).

DOE has decided to construct and operate the conversion facility in the west-central portion of the Portsmouth site, the preferred alternative identified in the FEIS as Location A. Groundbreaking for construction of the facility will commence on or before July 31, 2004, as anticipated by Public Law (Pub. L.) 107–206. Cylinders currently stored at the ETTP site will be shipped to Portsmouth; a new cylinder yard will be constructed, if necessary, based on the availability of storage yard space when the cylinders are received. The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits, as appropriate.

ADDRESSES: The FEIS and this Record of Decision (ROD) are available on the DOE National Environmental Policy Act (NEPA) Web site at *http://www.eh.doe.gov/nepa* and on the Depleted UF_6 Management Information Network Web site at *http://web.ead.anl.gov/uranium.* Copies of the FEIS and this ROD may be requested by e-mail at *Ports_DUF6@anl.gov,* by toll-free telephone at 1–866–530–0944, by toll-free fax at 1–866–530–0943, or by contacting Gary S. Hartman, Oak Ridge Operations Office, U.S. Department of Energy, SE–30–1, P.O. Box 2001, Oak Ridge, Tennessee 37831.

FOR FURTHER INFORMATION CONTACT: For information on the conversion facility construction and operation, contact Gary Hartman at the address listed above. For general information on the DOE NEPA process, contact Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION:

I. Background

The United States has produced DUF_6 since the early 1950s as part of the process of enriching natural uranium for both civilian and military applications. Production took place at three gaseous diffusion plants (GDPs), first at the K–25 site (now called ETTP) at Oak Ridge, Tennessee, and subsequently at Paducah, Kentucky, and Portsmouth, Ohio. The K–25 plant ceased enrichment operations in 1985, and the Portsmouth plant ceased enrichment operations in 2001. The Paducah GDP continues to operate.

Approximately 250,000 t (275,000 tons) of DUF_6 is presently stored in about 16,000 cylinders at Portsmouth and about 4,800 cylinders at ETTP. The majority of the cylinders weigh approximately 12 t (14 tons) each, are 48 inches (1.2 m) in diameter, and are stored on outside pads. DOE has been looking at alternatives for managing this inventory. Also in storage are 3,200 cylinders at Portsmouth and 1,100 cylinders at ETTP that contain enriched UF_6 or normal UF_6 (collectively called "non-DUF_6" cylinders) or are empty. [The non-DUF_6 cylinders would not be processed in the conversion facility.] The Portsmouth FEIS considers the shipment of all ETTP cylinders to Portsmouth, as well as the management of both the Portsmouth and ETTP non-DUF_6 cylinders at Portsmouth.

As a first step, DOE evaluated potential broad management options for its DUF_6 inventory in 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) issued in April 1999. In the PEIS Record of Decision (64 FR 43358, August 10, 1999), DOE decided to promptly convert the DUF_6 inventory to a more stable uranium oxide form and 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, DOE would convert DUF_6 to depleted uranium metal, but only if uses for metal were available. DOE did not select specific sites for the conversion facilities but reserved that decision for subsequent NEPA review. Today's Record of Decision announces the outcome of that site-specific NEPA review. DOE is also issuing today a separate but related ROD announcing the siting of a DUF_6 conversion facility at Paducah, Kentucky.

Congress enacted two laws that directly addressed DOE's management of its DUF_6 inventory. The first law, Pub. L. 105–204, signed by the President in July 1998, required the Secretary of Energy to prepare a plan to commence construction of, no later than January 31, 2004, and to operate an on-site facility at each of the GDPs at Paducah, Kentucky, and Portsmouth, Ohio, to treat and recycle DUF_6, consistent with NEPA. The second law, Pub. L. 107–206, signed by the President on August 2, 2002, required that no later than 30 days after enactment, DOE must award a contract for the scope of work described in its Request for Proposals (RFP) issued in October 2000 for the design, construction, and operation of a DUF_6 conversion facility at each of the Department's Paducah, Kentucky, and Portsmouth, Ohio, gaseous diffusion sites. It also stipulated that the contract require groundbreaking for construction to occur no later than July 31, 2004, at both sites.

In response to these laws, DOE issued the *Final Plan for the Conversion of Depleted Uranium Hexafluoride as Required by Public Law 105–204* in July 1999, and awarded a contract to Uranium Disposition Services (UDS) for construction and operation of two conversion facilities on August 29, 2002, consistent with NEPA.

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: One at Portsmouth and one at Paducah. Following the enactment of Pub. L. 107–206, DOE 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 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 that ended on February 2, 2004. DOE considered these comments and prepared two FEISs. The Notice of Availability for the two FEISs was published by the EPA in the **Federal Register** (69 FR 34161) on June 18, 2004.

II. Purpose and Need for Agency Action

DOE needs to convert its inventory of DUF_6 to more stable chemical form(s) 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) Pub. 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.

III. Alternatives

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 Portsmouth and ETTP indefinitely.

Action Alternatives. The proposed action evaluated in the FEIS is to construct and operate a conversion facility at the Portsmouth site for conversion of the Portsmouth and ETTP DUF_6 inventories into depleted uranium oxide (primarily triuranium octaoxide [U_3O_8]) and other conversion products. The FEIS review is based on the conceptual conversion facility design proposed by the selected contractor, UDS. The UDS dry conversion process 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 from anhydrous ammonia (NH_3). The depleted U_3O_8 powder is collected and packaged for disposition in bulk bags (large-capacity, strong, flexible bags) or the emptied cylinders to the extent practicable. Equipment would also be installed to collect the aqueous HF (also called HF acid) co-product and process it into HF at concentrations suitable for commercial resale. A backup HF acid neutralization system would convert up to 100% of the HF acid to CaF_2 for sale or disposal in the future, if necessary. The conversion products would be transported to a disposal facility or to users by truck or rail. The conversion facility will be designed with three parallel processing lines to convert 13,500 t (15,000 tons) of DUF_6 per year, requiring 18 years to convert the Portsmouth and ETTP inventories.

Three alternative locations within the site were evaluated, Locations A (preferred), B, and C. The proposed action includes the transportation of the cylinders currently stored at the ETTP site to Portsmouth. In addition, an option of transporting the ETTP cylinders to Paducah was considered, as was an option of expanding conversion facility operations.

Alternative Location A (Preferred Alternative). Location A is the preferred location identified in the FEIS for the conversion facility and is located in the west-central portion of the site, encompassing 26 acres (10 ha). This location has three existing structures that were formerly used to store containerized lithium hydroxide monohydrate. The site was rough graded, and storm water ditch systems were installed. This location was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

Alternative Location B. Location B is in the southwestern portion of the site and encompasses approximately 50 acres (20 ha). The site has two existing structures built as part of the gas centrifuge enrichment project that was begun in the early 1980s and was terminated in 1985. 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 U.S. Nuclear Regulatory Commission (NRC) in February 2004. The lead facility would be located in the existing gas centrifuge buildings within Location B. In addition, USEC announced in January 2004 that it planned to site its American Centrifuge Facility at Portsmouth, although it did not identify an exact location. Therefore, Location B might not be available for construction of the conversion facility.

Alternative Location C. Location C is in the southeastern portion of the site and has an area of about 78 acres (31 ha). This location consists of a level to very gently rolling grass field. It was graded during the construction of the Portsmouth site and has been maintained as grass fields since then.

Under the action alternatives, DOE evaluated the impacts from packaging, handling, and transporting depleted uranium oxide conversion product (primarily U_3O_8) from the conversion facility to a low-level waste (LLW) disposal facility that would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized to receive the conversion products by DOE (in conformance with DOE orders), or licensed by 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 an LLW disposal facility has been deferred to the disposal site's site-specific NEPA or licensing documents. While the FEIS presents the impacts from transporting the DUF_6 conversion products to both the Envirocare of Utah, Inc., facility and the Nevada Test Site (NTS), DOE plans to decide the specific disposal location(s) for the depleted U_3O_8 conversion product after additional NEPA review, as necessary. 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 its specific disposal decision and will provide any additional NEPA analysis for public review and comment.

The following alternatives were considered but not analyzed in detail in the FEIS: Use of Commercial Conversion Capacity, Sites Other Than Portsmouth, Alternative Conversion Processes, Long-Term Storage and Disposal Alternatives, Transportation Modes Other Than Truck and Rail, and One Conversion Plant Alternative.

IV. Summary of Environmental Impacts

The FEIS evaluated potential impacts from the range of alternatives described above. The impact areas included human health and safety, air quality, noise, water and soil, socioeconomics, ecological resources, waste management, resource requirements, land use, cultural resources, environmental justice, and cumulative impacts. In general, the impacts are low for both the no action and the proposed action alternatives. Among the three alternative locations considered at the Portsmouth site for the conversion facility, there are no major differences in impacts that would make one location clearly environmentally preferable. The discussion below summarizes the results of the FEIS impact analyses, highlighting the differences among the alternatives.

Human Health and Safety—Normal Operations and Transportation. Under all 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. UDS would confirm, prior to conversion or at the initiation of the conversion operations, that polychlorinated biphenyl (PCB) releases to the workplace from the paint coating of some cylinders manufactured prior to 1978 would be within applicable Occupational Safety and Health Administration (OSHA) limits. Transportation by rail would tend to cause fewer impacts than by truck primarily because of exhaust emissions from the trucks and the higher number of shipments for trucks than for rail. The option of converting the aqueous HF to CaF_2 and transporting the CaF_2 to a disposal facility would result in increased shipments. The impacts associated with transportation of uranium oxide product to a disposal facility in the western United States by truck would be about the same if bulk bags are used or two filled cylinders are loaded onto a truck. If only one cylinder is loaded onto a truck, the impacts would be higher because of the increased number of shipments.

Human Health and Safety—Accidents. DOE has extensive experience in safely storing, handling, and transporting cylinders containing UF_6 (depleted, normal, or enriched). In addition, the chemicals used or generated at the conversion facility are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for their storage and transportation.

Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting both the workers and members of the general public. It is also possible that, similar to other industrial facilities, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. Similarly, during transportation of materials, both crew members and members of the public may be injured or killed as a result of traffic accidents.

Three kinds of accidents have the largest possible consequences: (1) Those involving the DUF_6 cylinders during storage and handling under all alternatives, (2) those involving chemicals used or generated by the conversion process at the conversion site (in particular NH_3 and aqueous HF) under the action alternatives, and (3) those occurring during transportation of chemicals and cylinders under the action alternatives. The severity of the consequences from such accidents would depend on weather conditions at the time of the accident, and, in the case of the transportation accidents, the location of the accident, and could be significant. However, those accidents would have a low estimated probability of occurring, making the risk low. (Risk is determined by multiplying the consequences by the probability of occurrence).

Under the no action alternative, the risks associated with cylinder storage and handling would continue to exist as long as the cylinders are there. However, under the action alternatives, the risks associated with both the cylinder accidents and the chemical accidents would decline over time and disappear at the completion of the conversion project.

In comparing truck versus rail transportation, even though the consequences of rail accidents are generally higher (because of the larger cargo load per railcar than per truck), the accident probabilities tend to be lower for railcars than for trucks. As a result, the risks of accidents would be about the same under either option.

Air Quality and Noise. Under the action alternatives, the total (modeled plus background value) concentrations due to emissions of most criteria pollutants—such as sulfur dioxide, nitrogen oxides, and carbon monoxide—would be well within applicable air quality standards. For construction, the primary concern would be particulate matter (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 boundaries would be close to or above the standards because of the high background concentrations. On the basis of maximum background values from 5 years of monitoring at the nearest monitoring station, exceedance of the annual $PM_{2.5}$ standard would be unavoidable because the background concentration already exceeds the standard. Construction activities would be conducted so as to minimize further impacts on ambient air quality.

Water and Soil. During construction of the conversion facility, concentrations of any potential contaminants in soil, surface water, or groundwater would be kept well within applicable standards or guidelines by implementing storm water management, sediment and erosion controls, and good construction practices. During operations, no impacts would be expected because no contaminated liquid effluents are anticipated.

Socioeconomics. Under the action alternatives, construction and operation of the conversion facility would create more jobs and personal income in the vicinity of the Portsmouth site than would be possible under the no action alternative. The number of jobs would be approximately 190 direct and 280 total during construction, and 160 direct and 320 total during operations.

Ecology. For the action alternatives, the total area disturbed during conversion facility construction would be up to 65 acres (26 ha). Although vegetation communities in the disturbed area would be impacted by a loss of habitat, impacts could be minimized (*e.g.*, by appropriate placement of the facility within each location), and negligible long-term impacts to vegetation and wildlife are expected at all locations. Impacts to wetlands could be minimized, depending on where exactly the facility was placed within each location and by maintaining a buffer near adjacent wetlands during construction. During construction, trees with exfoliating bark (such as shagbark hickory or dead trees with loose bark) that can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer would be saved if possible.

Waste Management. Under the action alternatives, waste generated during construction and operations would have negligible impacts on the Portsmouth site waste management operations, with the exception of possible impacts from disposal of CaF_2. If the aqueous HF were 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. 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.

The U_3O_8 produced during conversion would amount to about 5% of Portsmouth's annual projected LLW volume.

Cylinder Preparation at ETTP. The cylinders at ETTP will require preparation for shipment by either truck or rail. Three cylinder preparation options were considered for the shipment of noncompliant cylinders: cylinder overpacks, shipping "as-is" under a U.S. Department of Transportation (DOT) exemption, and use of a cylinder transfer facility (there are no current plans to build such a facility at ETTP). The operational impacts (*e.g.*, storage, handling, and maintenance of cylinders) from any of the options would be small and limited primarily to external radiation exposure of involved workers. If a decision was made to construct and operate a transfer facility at ETTP in the future, additional NEPA review would be conducted.

Conversion Product Sale and Use. The conversion of the DUF_6 inventory produces products having some potential for reuse. These products include aqueous HF and CaF_2, which are commonly used as commercial materials. DOE is currently pursuing the establishment of authorization limits (allowable concentration limits of uranium) in these products to be able to free-release them to commercial users. In addition, there is a small potential for reuse of the depleted uranium oxide product.

D&D Activities. D&D impacts would be primarily from external radiation to involved workers and would be a small fraction of allowable doses. Wastes generated during D&D operations would be disposed of in an appropriate disposal facility and would result in low impacts in comparison with projected site annual generation volumes.

Cumulative Impacts. The FEIS analyses indicated that no significant cumulative impacts at either the Portsmouth or the ETTP site and its vicinity would be anticipated due to the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions.

Option of Expanding Conversion Facility Operations. The throughput of the Portsmouth facility could be increased either by making process efficiency improvements or by adding an additional (fourth) process line. The addition of a fourth process line at the Portsmouth facility would require the installation of additional plant equipment and would result in a nominal 33% increase in throughput compared with the current base design. This throughput increase would reduce the time necessary to convert the Portsmouth and ETTP DUF_6 inventories by about 5 years. The construction impacts presented in the FEIS would be the same if a fourth line was added, because the analyses in the FEIS used a footprint sized to accommodate four process lines. In general, a 33% increase in throughput would not result in significantly greater environmental impacts during operations than with three parallel lines. Although annual impacts in certain areas might increase up to 33% (proportional to the throughput increase), the estimated annual impacts during operations would remain well within applicable guidelines and regulations, with collective and cumulative impacts being quite low.

The conversion facility operations could be extended to process any additional DUF_6 for which DOE might assume responsibility by operating the facility longer than the currently anticipated 18 years. 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. If operations were extended beyond 18 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 unchanged.

V. Environmentally Preferred Alternative

In general, the FEIS shows greater impacts for the no action alternative than for the proposed action of constructing and operating the conversion facility mainly because of the relatively higher radiation exposures of the workers from the cylinder management operations and cylinder yards and because the cylinders and associated risk would remain if no action occurred. However, considering the uncertainties in the impact estimates and the magnitude of the impacts, the differences are not considered to be significant. The no action alternative has the potential for groundwater contamination with uranium over the long-term; this adverse impact is not anticipated under the proposed action alternatives. Beneficial socioeconomic impacts would be higher for the action alternatives than for the no action alternative.

The impacts associated with transportation of materials among sites would be comparable whether the transportation is by truck or rail.

With all alternatives, there is the potential for some high-consequence accidents to occur. The risks associated with such accidents can only be completely eliminated when the conversion of the DUF_6 inventory has been completed.

Although there are some differences in impacts among the three alternative locations for the conversion facility, these differences are small and well within the uncertainties associated with the methods used to estimate impacts. In general, because of the relatively small risks that would result under all alternatives and the absence of any clear basis for discerning an environmental preference, DOE concludes that no single alternative analyzed in depth in the FEIS is clearly environmentally preferable compared to the other alternatives.

VI. Comments on Final EIS

The Final EIS was mailed to stakeholders in early June 2004, and the EPA issued a Notice of Availability in the **Federal Register** on June 18, 2004. The entire document was also made available on the World Wide Web. Two comment letters were received on the DUF_6 Conversion Facility Final EISs. The State of Nevada indicated that it had no comments on the Final EISs and that the proposal was not in conflict with state plans, goals, or objectives. The U.S. Environmental Protection Agency, Region 5 in Chicago, stated that the Portsmouth Final EIS adequately address its concerns, and that it concurs with the Preferred Alternative and has no further concerns.

Decision

I. Bases for the Decision

DOE considered potential environmental impacts as identified in the FEIS (including the information contained in the classified appendix); cost; applicable regulatory requirements; Congressional direction as included in Pub. L. 105–204 and Pub. L. 107–206; agreements among DOE and the States of Ohio, Tennessee, and Kentucky concerning the management of DUF_6 currently stored at the Portsmouth, ETTP, and Paducah sites, respectively; and public comments in arriving at its decision. In deciding among the three alternative locations at the Portsmouth site for the conversion facility, DOE considered environmental factors, site preparation requirements affecting construction, availability of utilities, proximity to cylinder storage areas, and potential impacts to current or planned site operations. DOE has determined that Location A is the best alternative. DOE believes that the decision identified below best meets its programmatic goals and is consistent with all the regulatory requirements and public laws.

II. Decision

DOE has decided to implement the actions described in the preferred alternative from the FEIS at Location A. This decision includes the following actions:

- DOE will construct and operate the conversion facility at Location A within the Portsmouth site. Construction will commence on or before July 31, 2004, as intended by Congress in Pub. L. 107–206.
- DUF_6 cylinders currently stored at ETTP will be shipped to Portsmouth for conversion; a new cylinder yard will be constructed, if necessary, based on the availability of storage yard space when the cylinders are received.
- All shipments to and from the sites, including the shipment of UF_6 cylinders (DUF_6 and non-DUF_6) currently stored at ETTP to Portsmouth, will be conducted by either truck or rail, as appropriate. Cylinders will be shipped in a manner that is consistent with DOT regulations for the transportation of UF_6 cylinders.
- Although efficiency improvements can be accomplished, which would increase the conversion facility's throughput and decrease the operational period, DOE has decided not to add the fourth processing line to the conversion facility at this time.
- Current cylinder management activities (handling, inspection, monitoring, and maintenance) will continue, consistent with the Depleted Uranium Hexafluoride Management Plan included in the Ohio EPA Director's final findings and orders effective February 1998 and March 2004, which cover actions needed to meet safety and environmental requirements, until conversion could be accomplished.
- The aqueous HF produced during conversion will be sold for use, pending approval of authorized release limits as appropriate. If necessary, CaF_2 will be produced and reused, pending approval of authorized release limits, or disposed of as appropriate.
- The depleted U_3O_8 conversion product will be reused to the extent possible or packaged for disposal in emptied cylinders at an appropriate disposal facility. 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.

III. Mitigation

On the basis of the analyses conducted for the FEIS, the DOE will adopt all practicable measures, which are described below, to avoid or minimize adverse environmental impacts that may result from constructing and operating a conversion facility at Location A. These measures are either explicitly part of the alternative or are already performed as part of routine operations.

- The conversion facility will be designed, constructed, and operated in

72 FR 15869, *Notice of Availability of a Draft Supplement Analysis for Disposal of Depleted Uranium Oxide Conversion Product Generated From DOE'S Inventory of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Tuesday, April 3, 2007.

Federal Register / Vol. 72, No. 63 / Tuesday, April 3, 2007 / Notices 15869

DEPARTMENT OF EDUCATION

The Historically Black Colleges and Universities Capital Financing Advisory Board

AGENCY: The Historically Black Colleges and Universities Capital Financing Board, Department of Education.

ACTION: Notice of an open meeting.

SUMMARY: This notice sets forth the schedule and proposed agenda of an upcoming open meeting of the Historically Black Colleges and Universities Capital Financing Advisory Board. The notice also describes the functions of the Board. Notice of this meeting is required by Section 10(a)(2) of the Federal Advisory Committee Act and is intended to notify the public of their opportunity to attend.

DATES: Friday, April 20, 2007.

Time: 10 a.m.–2 p.m.

ADDRESSES: Xavier University, University Center Building, 1 Drexel Drive, New Orleans, Louisiana 70125.

FOR FURTHER INFORMATION CONTACT: Don E. Watson, Executive Director, Historically Black College and University Capital Financing Program, 1990 K Street, NW., Washington, DC 20006; *telephone:* (202) 219–7037; *fax:* (202) 502–7677; e-mail: *donald.watson@ed.gov.*

Individuals who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FRS) at 1–800–877–8339, Monday through Friday between the hours of 8 a.m. and 8 p.m., Eastern Standard Time.

SUPPLEMENTARY INFORMATION: The Historically Black College and University Capital Financing Advisory Board (Board) is authorized by Title III, Part D, Section 347 of the Higher Education Act of 1965, as amended in 1998 (20 U.S.C. 1066f). The Board is established within the Department of Education to provide advice and counsel to the Secretary and the designated bonding authority as to the most effective and efficient means of implementing construction financing on historically black college and university campuses and to advise Congress regarding the progress made in implementing the program. Specifically, the Board will provide advice as to the capital needs of Historically Black Colleges and Universities, how those needs can be met through the program, and what additional steps might be taken to improve the operation and implementation of the construction financing program.

The purpose of this meeting is to review current program activities, provide guidance for 2007 activities, and to make recommendations to the Secretary on the current capital needs of Historically Black Colleges and Universities.

Individuals who will need accommodations for a disability in order to attend the meeting (e.g., interpreting services, assistance listening devices, or materials in alternative format) should notify Don Watson at 202 219–7037, no later than April 5, 2007. We will attempt to meet requests for accommodations after this date but cannot guarantee their availability. The meeting site is accessible to individuals with disabilities.

An opportunity for public comment is available on Friday, April 20, 2007 between 12:15 p.m.–12:45 p.m. Those members of the public interested in submitting written comments may do so by submitting them to the attention of Don E. Watson, 1990 K Street, NW., Washington, DC, by Friday, April 13, 2007.

Records are kept of all Board proceedings and are available for public inspection at the Office of the Historically Black College and University Capital Financing Advisory Board (Board), 1990 K Street, NW., Washington, DC 20006, from the hours of 9 a.m. to 5 p.m., Eastern Standard Time Monday through Friday (EST).

Electronic Access to This Document: You may view this document, as well as all other documents of this Department published in the **Federal Register**, in text or Adobe Portable Document Format (PDF) on the Internet at the following site: *http://www.ed.gov/news/federegister.*

To use PDF you must have Adobe Acrobat Reader, which is available free at this site. If you have questions about using PDF, call the U.S. Government Printing Office (GPO), toll free at 1–888–293–6498; or in the Washington, DC, area at (202) 512–1530.

Note: The official version of this document is the document published in the **Federal Register**. Free Internet access to the official edition of the **Federal Register** and the Code of Federal Regulations is available on GPO Access at: *http://www.gpoaccess.gov/nara/index.html.*

James F. Manning,

Delegated the Authority of Assistant Secretary for Postsecondary Education.

[FR Doc. E7–6090 Filed 4–2–07; 8:45 am]

BILLING CODE 4000–01–P

DEPARTMENT OF ENERGY

Notice of Availability of a Draft Supplement Analysis for Disposal of Depleted Uranium Oxide Conversion Product Generated From Doe's Inventory of Depleted Uranium Hexafluoride

AGENCY: Department of Energy.

ACTION: Notice of availability of a draft supplement analysis.

SUMMARY: DOE has prepared a Draft Supplement Analysis (SA) pursuant to DOE regulations implementing the National Environmental Policy Act (NEPA), 10 CFR 1021.314. The draft SA addresses DOE's proposal to dispose of the depleted uranium oxide conversion product at either the DOE-owned low-level radioactive waste disposal facility at the Nevada Test Site (NTS) or at EnergySolutions LLC, a commercial low-level waste disposal facility in Clive, Utah (EnergySolutions; formerly known as Envirocare of Utah, Inc.).

In April 1999, the U.S. Department of Energy (DOE) published a Programmatic Environmental Impact Statement (PEIS) for management of its Depleted Uranium Hexafluoride (DUF_6) inventory. The PEIS included a generic assessment of the disposal of depleted uranium oxide conversion product (as U_3O_8 or UO_2) and concluded that disposal of either product in shallow earthen structures, vaults, or mines would adequately protect human health and the environment over the time period considered, as long as the disposal facility is located in a dry environment and appropriately engineered (e.g., the cover material is maintained). Subsequently, DOE prepared site-specific final Environmental Impact Statements (EISs) for construction and operation of DUF_6 conversion facilities at the DOE's Paducah, Kentucky, and Portsmouth, Ohio, sites in the Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky Site, DOE/EIS–0359, and the Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio Site, DOE/EIS–0360. DOE published its Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky Site, and Record of Decision for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio Site (RODs) on July 27, 2004 (69 FR 44649 and 69 FR 44654).

In each site-specific ROD, DOE announced its decision to implement the actions described as the preferred alternative in the corresponding conversion facility EIS, which included the following actions:

- DOE will construct and operate a conversion facility at Location A within each of the Paducah and Portsmouth sites.
- All shipments to and from the conversion facility sites, including any potential shipments of non-DUF$_6$ cylinders currently stored at the East Tennessee Technology Park (ETTP), will be conducted by either truck or rail, as appropriate. Cylinders will be shipped in a manner that is consistent with U.S. Department of Transportation (DOT) regulations for the shipment of UF$_6$ cylinders.
- Current cylinder management activities (handling, inspection, monitoring, and maintenance) will continue, consistent with Cylinder Project Management Plan for Depleted Uranium Hexafluoride, effective October 2003, which covers actions needed to meet safety and environmental requirements, until conversion can be accomplished.
- The aqueous hydrofluoric acid (HF) produced during conversion will be sold for use. If necessary, calcium fluoride (CaF$_2$) will be produced and reused, or disposed of as appropriate.
- The depleted uranium oxide conversion product will be reused to the extent possible or packaged in emptied cylinders for disposal at an appropriate disposal facility. DOE plans to decide the specific disposal location(s) for the depleted uranium oxide 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.

The conversion facility RODs did not declare a decision regarding the location for disposal of depleted uranium oxide conversion product. The reason DOE did not make its disposal decision at the time it issued the RODs for construction and operation of the two DUF6 conversion facilities is that it discovered that it had, through an oversight, not served copies of the draft and final site-specific EISs (DOE 2004a, b) to the States of Utah, home of EnergySolutions, and Nevada, home of NTS, as required in 40 CFR 1502.19. As a result, each ROD states DOE's intention to decide the specific disposal location(s) for the depleted uranium oxide conversion product after additional appropriate NEPA review.

This draft SA addresses the additional appropriate NEPA review committed to in the earlier RODs. The draft SA identifies no significant new circumstances or information relevant to environmental concerns that bear on DOE's decisions on disposal locations or the impacts of those decisions. Based on the draft SA that is the subject of this Notice, DOE believes that a supplemental EIS is not needed to support amending the conversion facility RODs to decide the disposal location for the depleted uranium oxide conversion product. The depleted uranium oxide conversion product may be disposed either at the EnergySolutions low-level waste disposal facility or at the NTS low-level waste disposal facility. DOE plans to issue amended RODs under the conversion facility EISs no sooner than 45 days from the publication of this Notice.

DATES: DOE will consider all public comments on this matter submitted by May 18, 2007.

ADDRESSES: Comments should be submitted electronically via the Web at *http://web.ead.anl.gov/uranium/* or by regular mail. Written comments can be mailed to: DU Disposal Supplement Analysis Comment, Argonne National Laboratory, Building 900, Mail Stop 3, 9700 S. Cass Avenue, Argonne, IL 60439.

FOR FURTHER INFORMATION CONTACT: Copies of the Supplement Analysis for Disposal of Depleted Uranium Oxide Conversion Product Generated From DOE's Inventory of Depleted Uranium Hexafluoride (DOE/EIS–0359/0360–SA–001) is available on the Depleted UF$_6$ Management Information Network at: *http://web.ead.anl.gov/uranium/*, and on DOE's NEPA Web site at *http://www.eh.doe.gov/nepa/whatsnew.html.* To request printed copies of this document, please write: DU Disposal Supplement Analysis Comment, Argonne National Laboratory, Building 900, Mail Stop 3, 9700 S. Cass Avenue, Argonne, IL 60439.

For further information on DOE's NEPA process, contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Compliance, GC–20, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, *Telephone:* 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: Uranium Disposition Services, LLC (UDS) began construction of the DUF$_6$ conversion facilities at Paducah, Kentucky and Portsmouth, Ohio in July 2004. The main products from the conversion of DOE's inventory of DUF$_6$ will be depleted uranium oxide conversion product and aqueous hydrogen fluoride (HF). The quantities of depleted uranium oxide conversion product produced annually will be approximately 10,800 metric tons (t) (11,800 tons) at Portsmouth and 14,300 t (15,800 tons) at Paducah. UDS is planning to sell the HF product to a commercial user.

In addition to depleted uranium oxide conversion product, two other products from the conversion process require disposal: (1) Emptied DUF$_6$ cylinders and (2) a relatively small quantity of CaF$_2$ (approximately 18 t [20 tons] at Portsmouth and 24 t [26 tons] at Paducah annually). UDS is planning to use the emptied cylinders as disposal containers for the depleted uranium oxide conversion product. Therefore, the emptied cylinders would become part of the depleted uranium oxide waste stream. Any cylinders not used as disposal containers would be disposed of as low-level waste at an appropriate facility in compliance with applicable regulations. The small quantity of CaF$_2$ would be disposed with the unused depleted uranium oxide. Therefore, the unused depleted uranium oxide, most of the emptied cylinders, and the small quantity of CaF$_2$ would be sent to the same disposal facility.

The PEIS considered the environmental impacts of six alternative strategies for long-term management of DOE's DUF$_6$ inventory. The alternative strategies included: (1) Options for continued storage of DUF$_6$ in cylinders at the three sites where it was stored (Paducah, KY, Portsmouth, OH, and ETTP in Oak Ridge, TN); (2) long-term storage as DUF$_6$ at a consolidated site; (3) conversion of the DUF$_6$ to an oxide followed by long-term storage; (4) conversion to an oxide or depleted uranium metal followed by use; (5) conversion to an oxide followed by disposal; and (6) no action. The analyses of the long-term storage and disposal alternatives included the transportation of the depleted uranium oxide to generic storage or disposal sites located 155 mi (250 km), 620 mi (1,000 km), or 3,100 mi (5,000 km) from the conversion facilities. DOE analyzed the impacts of depleted uranium conversion product disposal using generic assumptions about disposal site characteristics, rather than actual characteristics for any particular disposal site. A technical support document for the PEIS investigated the feasibility of depleted uranium disposal at six low-level waste disposal facilities based on waste acceptance criteria, available capacity, and disposal cost (*Depleted Uranium Storage and Disposal Trade Study:* Summary Report, ORNL/TM–2000/10). This document and subsequent follow-up studies have verified that the only currently operating dry-environment, low-level waste disposal facilities that are feasible for disposal of the depleted uranium oxide conversion product are the NTS and EnergySolutions facilities.

Like the PEIS, site-specific EISs for each conversion facility assumed that depleted uranium oxide would be classified as low-level waste. This assumption is consistent with a recent ruling by the U.S. Nuclear Regulatory Commission (NRC) in the licensing proceeding for a commercial uranium enrichment facility (NRC 2005a,b,c,d and 2006a,b). The site-specific EISs stated that the disposal facility (or facilities) 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 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).

DOE is now proposing to amend the site-specific RODs to decide that the depleted uranium oxide conversion product may be disposed of at either the NTS or the EnergySolutions low-level waste disposal facilities. Accordingly, DOE has prepared the draft SA that is the subject of this Notice. All other aspects of the depleted DUF_6 conversion program remain as previously described in the site-specific EISs and RODs.

The draft SA identifies no significant new circumstances or information relevant to environmental concerns that bear on DOE's decisions on disposal locations or the impacts of those decisions. Since issuance of the two site-specific DUF_6 conversion facility final EISs, the following circumstances have changed. In May 2006, a contract was signed with Solvay Fluorides, a commercial vendor, for purchase of the HF co-product. On June 2, 2006, the NRC issued an order that determined that the Envirocare (now EnergySolutions) site near Clive, Utah, appears to be suitable for near-term disposal of depleted uranium. The transportation campaign has been slightly modified to include more cylinders per railcar with fewer shipments per year. Impacts from the modified campaign for both operations and accident scenarios are projected to be about the same as those presented in the site-specific EISs.

DOE believes, based on the analysis in the draft SA, that disposal at either NTS or EnergySolutions low-level waste disposal facilities are reasonable alternatives. Regarding the alternative of disposal at the EnergySolutions facility, DOE believes that adequate NEPA documentation exists to support disposal of any unused depleted uranium oxide conversion product as well as for emptied DUF_6 cylinders that would be used for disposal containers and the small quantity of CaF_2 that would be generated during the conversion process. With respect to NTS low-level waste facility, the draft SA analyses show that there is adequate NEPA coverage for all actions leading up to delivery at the NTS and that site-specific NEPA coverage at the NTS is adequate for disposal of up to 60,000 m^3 of unused depleted uranium oxide conversion product. Furthermore, upcoming reviews of the NTS site-wide EIS will evaluate disposal of additional uranium oxide conversion product volumes at NTS. Accordingly, DOE believes that a supplemental EIS (or an environmental assessment) is not needed to support amending the site-specific RODs to address disposal of the depleted uranium oxide conversion product.

DOE plans to issue amended RODs under the conversion facility EISs no sooner than 30 days after issuance of the final SA. DOE will consider all public comments on the draft SA submitted by May 18, 2007.

Issued in Washington, DC, March 27, 2007.

Mark W. Frei,

Deputy Assistant Secretary for Program Planning and Budget.

[FR Doc. E7–6039 Filed 4–2–07; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Extension of Time to Submit Scoping Comments on the Programmatic Environmental Impact Statement for the Global Nuclear Energy Partnership

AGENCY: Office of Nuclear Energy, U.S. Department of Energy.

ACTION: Notice of extension of time to submit scoping comments.

SUMMARY: In response to public requests, the Department of Energy (DOE) announces an extension of time to submit comments on the proposed scope, alternatives, and environmental issues to be analyzed in the Programmatic Environmental Impact Statement for the Global Nuclear Energy Partnership (GNEP PEIS). This date has been extended to June 4, 2007, thereby giving an additional 61 days to provide comments.

ADDRESSES: Please direct comments, suggestions, or relevant information on the GNEP PEIS to: Mr. Timothy A. Frazier, GNEP PEIS Document Manager, Office of Nuclear Energy, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585–0119; Telephone: 866–645–7803, Fax: 866–645–7807, e-mail to: *GNEP-PEIS@nuclear.energy.gov*. Please mark envelopes, faxes, and e-mails: "GNEP PEIS Comments." Additional information on GNEP may be found at *http://www.gnep.energy.gov*.

FOR FURTHER INFORMATION CONTACT: For general information on DOE's National Environmental Policy Act (NEPA) process, please contact: Ms. Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, GC–20, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585–0103, 202–586–4600, or by leaving a message at 1–800–472–2756. Additional information regarding DOE's NEPA activities is available on the DOE NEPA Web site at *http://www.eh.doe.gov/nepa*. This notice is available at *http://www.eh.doe.gov/nepa* and *http://www.gnep.energy.gov*.

SUPPLEMENTARY INFORMATION: On January 4, 2007, DOE published a Notice of Intent (NOI) (72 FR 331) to prepare the GNEP PEIS pursuant to the National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 *et seq.*, and the Council on Environmental Quality's (CEQ's) and DOE's regulations implementing NEPA, 40 CFR parts 1500–1508 and 10 CFR part 1021, respectively. With the publication of the NOI, DOE began the PEIS scoping period and invited Federal, state, and local governments, Native American Tribes, industry, other organizations, and the public to provide comments on the proposed scope, alternatives, and environmental issues to be analyzed in the GNEP PEIS. In response to public requests, DOE is now extending the time for submittal of scoping comments an additional 61 days from April 4, 2007, to June 4, 2007. DOE will consider all comments received during the scoping period in preparing the GNEP PEIS. Late comments will be considered to the extent practicable.

81 FR 58921, *Notice of Intent To Prepare a Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated From DOE's Inventory of Depleted Uranium Hexafluoride*, U.S. Department of Energy, Friday, August 26, 2016, with associated *Correction*, published in 81 FR 61674 on Wednesday, September 7, 2016.

Federal Register / Vol. 81, No. 166 / Friday, August 26, 2016 / Notices **58921**

operation of SURTASS LFA sonar and implementation of mitigation and monitoring measures. The Draft SEIS/SOEIS evaluates the environmental impacts associated with two action alternatives and a No-Action Alternative. The primary difference between the action alternatives is that the Navy's preferred alternative reduces the annual permitted allowance of LFA sonar transmissions from 432 hours (Alternative 1) to 255 hours (Alternative 2) per ship. The Draft SEIS/SOEIS and associated analyses will also be used to support consultations associated with required regulatory permits and authorizations effective in 2017.

The Draft SEIS/SOEIS was distributed to appropriate federal, state, and local agencies and organizations, Native Alaskan and Native Tribal governments and organizations, and other interested parties. The Draft SEIS/SOEIS is available for public viewing and downloading at the following project Web site: *http://www.surtass-lfa-eis.com*. Compact disc copies of the Draft SEIS/SOEIS are available upon request from: SURTASS LFA Sonar SEIS/SOEIS Program Manager, 4350 Fairfax Drive, Suite 600, Arlington, VA 22203–1632, Email: *eisteam@surtass-lfa-eis.com*. Compact discs of the Draft SEIS/OEIS are available for public review at the following public libraries:

1. Jacksonville Public Library, 303 N. Laura Street, Jacksonville, FL 32202;
2. Camden County Public Library, 1410 Hwy 40 E, Kingsland, GA 31548;
3. Ben May Main Library, 701 Government Street, Mobile, AL 36602;
4. Meridian-Lauderdale County Public Library, 2517 7th Street, Meridian, MS 39301;
5. New Orleans Public Library, 219 Loyola Avenue, New Orleans, LA 70112;
6. Houston Public Library, 500 McKinney Street, Houston, TX 77002;
7. New Hanover County Public Library, 201 Chestnut Street, Wilmington, NC 28401;
8. Anne Arundel County Public Library, 1410 West Street, Annapolis, MD 21401;
9. Charleston County Public Library, 68 Calhoun Street, Charleston, SC 29401;
10. Mary D. Pretlow Anchor Branch Library, 111 W. Ocean View Avenue, Norfolk, VA 23503;
11. Portland Public Library, 5 Monument Square, Portland, ME 04101;
12. Providence Public Library, 150 Empire Street, Providence, RI 02903;
13. Boston Public Library, 700 Boylston Street, Boston, MA 02116;
14. The Seattle Public Library, 1000 Fourth Avenue, Seattle, WA 98104;
15. Los Angeles Public Library, 630 W. 5th Street, Los Angeles, CA 90071;
16. San Francisco Public Library, 100 Larkin Street, San Francisco, CA 94102;
17. Oregon State University, 250 Winter Street NE., Salem, OR 97301;
18. Alaska Resources Library and Information Services, 3211 Providence Drive, Anchorage, AK 99508;
19. Hawaii State Library, 478 South King Street, Honolulu, HI 96813;
20. Nieves M. Flores Memorial Public Library, 254 Martyr Street, Hagåtña, Guam 96910; and
21. The Feleti Barstow Public Library, Pago Pago, American Samoa, 96799.

Written comments on the Draft SEIS/SOEIS can be submitted by mail: SURTASS LFA Sonar SEIS/SOEIS Program Manager, 4350 Fairfax Drive, Suite 600, Arlington, VA 22203–1632, or by Email: *eisteam@surtass-lfa-eis.com*. All written comments must be postmarked by October 11, 2016 to ensure that they become part of the official record. All timely comments will be addressed in the Final SEIS/SOEIS. No public hearings or meetings will be held.

Dated: August 18, 2016.

C. Pan,

Lieutenant, Judge Advocate General's Corps, U.S. Navy, Alternate Federal Register Liaison Officer.

[FR Doc. 2016–20500 Filed 8–25–16; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated From DOE's Inventory of Depleted Uranium Hexafluoride

AGENCY: U.S. Department of Energy.

ACTION: Notice of intent.

SUMMARY: The U.S. Department of Energy (DOE) announces its intention to prepare a Supplemental Environmental Impact Statement (SEIS) for its proposal to disposition depleted uranium oxide (DUO_X) conversion product from its depleted uranium hexafluoride (DUF_6) conversion facilities at the Paducah, Kentucky, and Portsmouth, Ohio, sites at up to three offsite low-level waste disposal facilities. The *Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride* (DOE/EIS–0359–S1; DOE/EIS–0360–S1) will analyze potential environmental impacts from the proposed action to identify a final disposition location or locations for the DUO_X conversion product from both operating DUF_6 conversion facilities.

The proposed scope of the draft SEIS includes an analysis of potential environmental impacts from activities associated with the transportation to and disposition of depleted uranium oxide at three proposed disposition location alternatives: the DOE-owned low-level radioactive waste disposal facility at the Nevada National Security Site (NNSS) in Nye County, Nevada; the Energy*Solutions*, LLC (formerly known as Envirocare of Utah, Inc.) low-level waste disposal facility in Clive, Utah; and the newly identified location at the Waste Control Specialists, LLC (WCS) low-level waste disposal facility in Andrews, Texas.

ADDRESSES: Questions concerning the project or requests to be placed on the document distribution list can be sent to: Ms. Jaffet Ferrer-Torres, National Environmental Policy Act (NEPA) Document Manager, Office of Environmental Management, U.S. Department of Energy, EM–4.22, 1000 Independence Avenue SW., Washington, DC 20585; or to *DUF6_NEPA@em.doe.gov*. Additional information regarding the SEIS is available at: *http://www.energy.gov/em/disposition-uranium-oxide-conversion-depleted-uranium-hexafluoride*.

FOR FURTHER INFORMATION CONTACT: For further information on DOE's DUF_6 long-term management and disposal program, please contact Ms. Jaffet Ferrer-Torres, U.S. Department of Energy at the above **ADDRESSES**.

For information on DOE's NEPA process, please contact Ms. Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585–0103; Telephone: (202) 586–4600, or leave a message at (800) 472–2756; or email at *askNEPA@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

Background

The use of uranium as fuel for nuclear power plants or for military applications requires increasing the proportion of the uranium-235 isotope found in natural uranium. Industrial uranium enrichment in the United States began as part of atomic bomb development during World War II. Uranium enrichment for both civilian and military uses was continued by the U.S. Atomic Energy Commission and its successor agencies, including DOE. Uranium enrichment by gaseous diffusion was carried out at three locations: the Paducah Site in Kentucky, the Portsmouth Site in Ohio, and the East Tennessee Technology Park in Oak Ridge, Tennessee.

DUF_6 results from the uranium enrichment process. The DUF_6 that remains after enrichment typically contains 0.2 percent to 0.4 percent uranium-235 and has been stored as a solid in large metal cylinders at the gaseous diffusion uranium enrichment facilities. The DUF_6 must be converted into a more stable form for disposal. The conversion process results in DUO_X and aqueous hydrogen fluoride[1] (HF). DOE's existing inventory has over 760,000 metric tons (MT) (1 MT = 1,000 kilograms, approximately 2,205 pounds) of DUF_6. Approximately 54,000 MT, or 7% of this total, has already been converted at the end of calendar year 2015. DUF_6 is stored as a solid in steel cylinders that each hold approximately 10 to 14 MT of material. These cylinders are stacked two layers high in outdoor areas known as "yards." The Paducah Site has approximately 44,000 DUF_6 cylinders, and the Portsmouth Site has approximately 19,000 DUF_6 cylinders, for a total of about 63,000 cylinders. All DUF_6 cylinders produced at facilities in Tennessee were previously transported to the Portsmouth Site. Operating at planned capacity, the conversion plants would produce approximately 10,800 MT (11,900 tons) of DUO_X annually at Portsmouth and 14,300 MT (15,800 tons) of DUO_X annually at Paducah. The duration to convert the inventory of DUF_6 to DUO_X is expected to be 18 years for the Portsmouth DUF_6 inventory and 25 years for Paducah's larger DUF_6 inventory.

Relationship to Existing NEPA Analyses

This SEIS represents the third phase of an environmental review process being used to evaluate and implement the DUF_6 long-term management program. As a first step and pursuant to Council on Environmental Quality (CEQ) and DOE NEPA implementing regulations at 40 CFR parts 1500–1508 and 10 CFR part 1021, respectively, DOE evaluated potential broad management options for its DUF_6 inventory in the *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride (DUF_6 PEIS)* (DOE/EIS–0269) issued in April 1999 (64 FR 19999; April 23, 1999). In the DUF_6 PEIS 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 and 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. DOE did not select specific sites for the conversion facilities or disposal at that time, but reserved that decision for subsequent NEPA review.

In June 2004, DOE issued two EISs for construction and operation of DUF_6 conversion facilities and other actions at its Paducah, Kentucky and Portsmouth, Ohio sites (69 FR 34161; June 18, 2004). Both the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Paducah, Kentucky Site (*DOE/EIS–0359*)* and the *Final Environmental Impact Statement for Construction and Operation of a Depleted Uranium Hexafluoride Conversion Facility at the Portsmouth, Ohio Site* (DOE/EIS–0360) were prepared as a second phase of the environmental review process to evaluate and implement DOE's DUF_6 long-term management program. These EISs evaluated the potential environmental impacts of transportation and disposition of depleted uranium oxide at two potential off-site locations: at the DOE-owned low-level radioactive waste disposal facility at the Nevada Test Site (now known as NNSS), and at Envirocare of Utah, Inc. (now known as Energy*Solutions*, LLC), a commercial low-level waste disposal facility in Clive, Utah. RODs were published for both of these EISs on July 27, 2004 (69 FR 44649, 69 FR 44654). However, DOE deferred a decision on the transportation and disposition of the conversion product and committed to addressing that action at a later date.

In 2007, DOE prepared a draft Supplement Analysis (SA), in accordance with DOE NEPA implementing regulations at 10 CFR 1021.314, in order to determine whether there were substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns that require preparation of a Supplemental EIS to decide disposition locations committed to in the 2004 RODs. DOE made the *Draft Supplement Analysis for Location(s) to Dispose of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride* (DOE/EIS–0359–SA–1 and DOE/EIS–0360–SA–1) publicly available on April 3, 2007 (72 FR 15869). The comments received associated with the scope of the draft SA suggested consideration of WCS's Andrews, Texas, site as a reasonable alternative, which will be considered in this SEIS. DOE determined that more time was needed to allow for resolution of regulatory questions at the disposal sites and did not issue a final SA.

In August 2014, the WCS facility near Andrews, Texas, was granted a license amendment by the Nuclear Regulatory Commission that would allow disposal of bulk uranium. As a result, DOE assumes, for purposes of planning, that WCS may be a new reasonable alternative as a disposal site for depleted uranium oxide conversion product. After due consideration of the existing DOE NEPA analyses summarized above, and any changes in the disposition activities currently being considered, DOE determined in March 2016 that a Supplemental EIS is warranted given that there are substantial changes to the proposal (in this case, a new alternative disposal site is under consideration), or potentially significant new circumstances or information relevant to environmental concerns given the time lapse since the 2004 EISs.

Purpose and Need for Agency Action

The purpose and need for this action is to dispose of DUO_x that results from converting DOE's DUF_6 inventory to a more stable chemical form. This need follows directly from the decisions presented in the 2004 RODs for construction and operation of DUF_6 conversion facilities and other NEPA actions at its Paducah, Kentucky and Portsmouth, Ohio sites, that deferred DOE's decision related to the transportation to and disposal of depleted uranium oxide at potential off-site facilities.

Alternatives Considered

The proposed scope of the draft SEIS includes an analysis of the potential impacts from three action alternatives and the No Action alternative (in accordance with 40 CFR 1502.14). Under the No Action alternative, transportation to and disposal of the conversion product at an offsite low-level waste disposal facility would not occur and refilled cylinders of DUO_x conversion product would remain at the DUF_6 conversion facility sites at DOE's Paducah and Portsmouth sites. The SEIS will also analyze and compare the potential impacts from three action alternatives that include transportation to and disposal of DUO_x at three proposed alternative locations, including government-owned and privately-owned facilities: (1) The DOE-owned Area 5 waste disposal facility at the NNSS; (2) the Energy*Solutions* LLC, low-level waste disposal facility in Clive, Utah; and (3) the newly identified location at the WCS federal low-level

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[1] The HF produced during conversion will be recycled into commercial product.

waste disposal facility in Andrews, Texas.

The SEIS analysis will include a review of available environmental data and information; comparative analyses of potential environmental and human health and safety impacts of DUO_x disposal at the three alternative locations (including updated information for the two offsite disposal locations previously identified and studied in the 2004 EISs); analyses of the potential environmental impacts of transporting DUO_x by rail or truck to each alternative site; and an evaluation of the No Action alternative.

Identification of Environmental Issues

The SEIS will examine potential public health and safety effects and environmental impacts from the proposed action. This notice is intended to inform agencies and the public of DOE's proposal. Although the following is not intended to be all inclusive or to imply any predetermination of impacts, these general categories of impacts will be considered in the SEIS: Land use; geology, soils, and geologic hazards, including seismicity; water resources (surface water and groundwater); biological resources; protected, threatened and endangered species, including species of special concern; human health and safety (both routine operations and potential accidents); air quality; noise; cultural and historic resources; waste management; environmental justice; and socioeconomics.

Public Participation in the SEIS Process

A public scoping process is optional for DOE Supplemental EISs (10 CFR 1021.311(f)), and there will be none for this project. However, DOE will provide opportunities for public review and comment, including public hearings, on the draft SEIS.

SEIS Preparation and Schedule

DOE expects to issue the draft SEIS in 2016.

Issued at Washington, DC, on August 19, 2016.

Frank Marcinowski,

Acting Assistant Secretary for Environmental Management.

[FR Doc. 2016–20501 Filed 8–25–16; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. ER16–2119–000]

Hartree Partners, LP; Supplemental Notice That Initial Market-Based Rate Filing Includes Request for Blanket Section 204 Authorization

This is a supplemental notice in the above-referenced proceeding of Hartree Partners, LP's application for market-based rate authority, with an accompanying rate tariff, noting that such application includes a request for blanket authorization, under 18 CFR part 34, of future issuances of securities and assumptions of liability.

Any person desiring to intervene or to protest should file with the Federal Energy Regulatory Commission, 888 First Street NE., Washington, DC 20426, in accordance with Rules 211 and 214 of the Commission's Rules of Practice and Procedure (18 CFR 385.211 and 385.214). Anyone filing a motion to intervene or protest must serve a copy of that document on the Applicant.

Notice is hereby given that the deadline for filing protests with regard to the applicant's request for blanket authorization, under 18 CFR part 34, of future issuances of securities and assumptions of liability, is September 8, 2016.

The Commission encourages electronic submission of protests and interventions in lieu of paper, using the FERC Online links at *http://www.ferc.gov*. To facilitate electronic service, persons with Internet access who will eFile a document and/or be listed as a contact for an intervenor must create and validate an eRegistration account using the eRegistration link. Select the eFiling link to log on and submit the intervention or protests.

Persons unable to file electronically should submit an original and 5 copies of the intervention or protest to the Federal Energy Regulatory Commission, 888 First Street NE., Washington, DC 20426.

The filings in the above-referenced proceeding are accessible in the Commission's eLibrary system by clicking on the appropriate link in the above list. They are also available for electronic review in the Commission's Public Reference Room in Washington, DC. There is an eSubscription link on the Web site that enables subscribers to receive email notification when a document is added to a subscribed docket(s). For assistance with any FERC Online service, please email *FERCOnlineSupport@ferc.gov* or call (866) 208–3676 (toll free). For TTY, call (202) 502–8659.

Dated: August 19, 2016.

Kimberly D. Bose,

Secretary.

[FR Doc. 2016–20435 Filed 8–25–16; 8:45 am]

BILLING CODE 6717–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

Combined Notice of Filings #1

Take notice that the Commission received the following electric corporate filings:

Docket Numbers: EC16–117–000.
Applicants: Northern States Power Company, a Wisconsin corporation.
Description: Second Supplement to May 10, 2016 Application of Northern States Power Company, a Wisconsin corporation for Authorization under FPA Section 203 to Acquire Jurisdictional Assets.
Filed Date: 8/16/16.
Accession Number: 20160816–5184.
Comments Due: 5 p.m. ET 9/6/16.

Docket Numbers: EC16–168–000.
Applicants: NRG Renew LLC, Four Brothers Holdings, LLC, Granite Mountain Renewables, LLC, Iron Springs Renewables, LLC.
Description: Joint Application for Approval Under Section 203 of the Federal Power Act and Request for Expedited Action of NRG Renew LLC, et al.
Filed Date: 8/18/16.
Accession Number: 20160818–5339.
Comments Due: 5 p.m. ET 9/8/16.

Take notice that the Commission received the following exempt wholesale generator filings:

Docket Numbers: EG16–136–000.
Applicants: Boulder Solar II, LLC.
Description: Notice of Self-Certification of Exempt Wholesale Generator Status of Boulder Solar II, LLC.
Filed Date: 8/19/16.
Accession Number: 20160819–5125.
Comments Due: 5 p.m. ET 9/9/16.

Take notice that the Commission received the following electric rate filings:

Docket Numbers: ER10–2980–007; ER10–2983–007.
Applicants: Castleton Power, LLC, Castleton Energy Services, LLC.
Description: Notice of Non-Material Change in Status of Castleton Power, LLC, et al.
Filed Date: 8/19/16.

and Development (OECD) and developed by participating countries with the support of the OECD. U.S. participated in the PIAAC Main Study data collection in 2012, conducted a national supplement in 2014, and in this submission requests to conduct the PIAAC 2017 National Supplement data collection from February to September 2017 with a nationally representative sample of 3,800 adults ages 16–74, in a new sample of 80 primary sampling units (PSUs).

Dated: August 31, 2016.

Kate Mullan,

Acting Director, Information Collection Clearance Division, Office of the Chief Privacy Officer, Office of Management.

[FR Doc. 2016–21378 Filed 9–6–16; 8:45 am]

BILLING CODE 4000–01–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated From DOE's Inventory of Depleted Uranium Hexafluoride; Correction

AGENCY: U.S. Department of Energy.

ACTION: Notice of intent; correction.

SUMMARY: The Department of the Energy (DOE) published a document in the **Federal Register** (81 FR 58921) on August 26, 2016, announcing a Notice of Intent to Prepare a Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride. The document contained an error regarding the agency that granted the amendment to the Waste Control Specialists facility near Andrews, Texas, to allow disposal of depleted uranium. This document corrects that error.

FOR FURTHER INFORMATION CONTACT: For further information on DOE's DUF_6 long-term management and disposal program, please contact Ms. Jaffet Ferrer-Torres, National Environmental Policy Act (NEPA) Document Manager, Office of Environmental Management, U.S. Department of Energy, EM–4.22, 1000 Independence Avenue SW., Washington, DC 20585.

Correction

In the **Federal Register** (81 FR 58921) of August 26, 2016, FR Doc. 2016–20501, on page 58922, third column, first paragraph, the first sentence is corrected to read: "In August 2014, the WCS facility near Andrews, Texas, was granted a license amendment by the Texas Commission on Environmental Quality that would allow disposal of large quantities of depleted uranium."

Issued in Washington, DC, on August 31, 2016.

Mark Senderling,

Acting Associate Principal Deputy Assistant Secretary for Regulatory and Policy Affairs.

[FR Doc. 2016–21428 Filed 9–6–16; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Project No. 14329–002]

Columbia Basin Hydropower; Notice of Intent To File License Application, Filing of Pre-Application Document, Approving Use of the Traditional Licensing Process

a. *Type of Filing:* Notice of Intent to File License Application and Request to Use the Traditional Licensing Process.

b. *Project No.:* 14329–002.

c. *Date Filed:* June 27, 2016.

d. *Submitted By:* Columbia Basin Hydropower.

e. *Name of Project:* Banks Lake Pumped Storage Project.

f. *Location:* On Banks Lake and Franklin D. Roosevelt Lake, in Grant and Douglas Counties, Washington. The project occupies about 65 acres of United States lands administered by Bureau of Reclamation.

g. *Filed Pursuant to:* 18 CFR 5.3 of the Commission's regulations.

h. Potential *Applicant Contact:* Tim Culbertson, Columbia Basin Hydropower, P.O. Box 219, Ephrata, WA 98823; (509) 754–2227; email: *TCulbertson@cbhydropower.org.*

i. *FERC Contact:* Karen Sughrue at (202) 502–8556; or email at *karen.sughrue@ferc.gov.*

j. Columbia Basin Hydropower filed its request to use the Traditional Licensing Process on June 27, 2016. Columbia Basin Hydropower provided public notice of its request on August 4, 2016. In a letter dated August 31, 2016, the Director of the Division of Hydropower Licensing approved Columbia Basin Hydropower's request to use the Traditional Licensing Process.

k. With this notice, we are initiating informal consultation with the U.S. Fish and Wildlife Service and/or NOAA Fisheries under section 7 of the Endangered Species Act and the joint agency regulations thereunder at 50 CFR, part 402; and NOAA Fisheries under section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations at 50 CFR 600.920. We are also initiating consultation with the Washington State Historic Preservation Officer, as required by section 106, National Historic Preservation Act, and the implementing regulations of the Advisory Council on Historic Preservation at 36 CFR 800.2.

l. With this notice, we are designating Columbia Basin Hydropower as the Commission's non-federal representative for carrying out informal consultation pursuant to section 7 of the Endangered Species Act and section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act; and consultation pursuant to section 106 of the National Historic Preservation Act.

m. Columbia Basin Hydropower filed a Pre-Application Document (PAD; including a proposed process plan and schedule) with the Commission, pursuant to 18 CFR 5.6 of the Commission's regulations.

n. A copy of the PAD is available for review at the Commission in the Public Reference Room or may be viewed on the Commission's Web site (*http://www.ferc.gov*), using the "eLibrary" link. Enter the docket number, excluding the last three digits in the docket number field to access the document. For assistance, contact FERC Online Support at *FERCONlineSupport@ferc.gov*, (866) 208–3676 (toll free), or (202) 502–8659 (TTY). A copy is also available for inspection and reproduction at the address in paragraph h.

o. Register online at *http://www.ferc.gov/docs-filing/esubscription.asp* to be notified via email of new filing and issuances related to this or other pending projects. For assistance, contact FERC Online Support.

Dated: August 31, 2016.

Kimberly D. Bose,

Secretary.

[FR Doc. 2016–21420 Filed 9–6–16; 8:45 am]

BILLING CODE 6717–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. ER16–2509–000]

Rutherford Farm, LLC; Supplemental Notice That Initial Market-Based Rate Filing Includes Request for Blanket Section 204 Authorization

This is a supplemental notice in the above-referenced proceeding Rutherford Farm, LLC's application for market-

APPENDIX B

EVALUATION OF THE HUMAN HEALTH EFFECTS OF TRANSPORTATION

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LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ALARA	as low as reasonably achievable
CFR	*Code of Federal Regulations*
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
Draft DU Oxide SEIS	*Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride*
DUF_6	DU hexafluoride
HF	hydrogen fluoride
LCF	latent cancer fatality
LLW	low-level radioactive waste
LSA	low specific activity waste
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
Modal Study	*Shipping Container Response to Severe Highway and Railway Accident Conditions*
mrem	millirem
NNSS	Nevada National Security Site
NRC	U.S. Nuclear Regulatory Commission
RADTRAN	Radioactive Material Transportation Risk Assessment
Reexamination Study	*Reexamination of Spent Fuel Shipping Risk Estimates*,
rem	roentgen equivalent man
RISKIND	Risks and Consequences of Radioactive Material Transport
TRAGIS	Transportation Routing Analysis Geographic Information System
WCS	Waste Control Specialists LLC

APPENDIX B: EVALUATION OF THE HUMAN HEALTH EFFECTS OF TRANSPORTATION

B.1 INTRODUCTION

Transportation of any commodity involves a risk to transport crew members and members of the public. This risk results from transportation-related accidents. Transport of certain materials, such as hazardous or radioactive materials or waste, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the alternatives, this appendix to the *Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride (Draft DU Oxide SEIS)* assesses the human health risks associated with the transportation of radioactive waste on public railways and highways.

This appendix provides an overview of the approach used to assess the human health risks that could result from transportation. The topics in this appendix include the scope of the assessment, packaging, determination of potential transportation routes, analytical methods used for the risk assessment (for example, computer models), and important assumptions. In addition, to aid in understanding and interpreting the results, specific areas of uncertainty are described with an emphasis on how those uncertainties may affect comparisons of the alternatives.

The risk assessment results are presented in this appendix in terms of "per-shipment" risk factors, as well as the total risks for a given alternative. Per-shipment risk factors provide an estimate of the risk from a single shipment. The total risks for a given alternative are estimated by multiplying the expected number of shipments by the appropriate per-shipment risk factors.

B.2 SCOPE OF ASSESSMENT

The scope of the transportation risk assessment, including transportation activities; potential radiological and nonradiological impacts; transportation modes; and receptors, is described in this section. Additional details of the assessment are provided in the remaining sections of this appendix.

B.2.1 Transportation-Related Activities

The transportation risk assessment estimates the human health risks related to transportation for each alternative. This includes incident-free risks from being in the vicinity of a shipment during transport or at stops, as well as accident risks. It also considers the potential effects of Intentional Destructive Acts, such as acts of sabotage or terrorism.

B.2.2 Radiological Impacts

For each alternative, radiological risks (that is, those risks that result from the radioactive nature of the materials) were assessed for incident-free (normal) transportation conditions and accidents. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people, or from an accident where there is no release of radioactive material but there is external radiation exposure, albeit very small, to the unbreached containers.

Radiological impacts are calculated in terms of radiation dose and associated health effects in the exposed populations. The radiation dose calculated is the total effective dose equivalent (see Title 10 of the *Code of Federal Regulations* [10 CFR] Part 20), which is the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. Radiation doses are presented in units of roentgen equivalent man (rem) or millirem (mrem) (one-thousandth of a rem) for individuals and person-rem for populations. The impacts are further expressed as health risks in terms of latent cancer fatalities (LCFs) in exposed individuals and populations using dose-to-risk conversion factors recommended by the Interagency Steering Committee on Radiation Standards (DOE 2003). A health risk conversion factor of 0.0006 LCF per rem or person-rem of exposure is used for both the public and workers (DOE 2003).

B.2.3 Nonradiological Impacts

In addition to radiological risks posed by transportation activities, vehicle-related risks are assessed from nonradiological causes (that is, causes related to the transport vehicles, not the radioactive cargo). Nonradiological transportation risks, which would be incurred for shipments of any commodity, are assessed for accidents involving transportation of radioactive waste (DU oxides and other low level wastes [i.e., emptied cylinders]). Nonradiological accident risk refers to the potential occurrence of transportation accidents that result in fatalities unrelated to the characteristics (for example, radioactive nature) of the cargo. For this analysis, state-specific fatality rate data along the routes for truck and rail transports were used to determine the nonradiological risks (i.e., traffic fatalities) associated with transportation.

Nonradiological risks during incident-free transportation conditions could also be caused by potential exposure to increased vehicle exhaust emissions. As explained in Section B.6.2 of this appendix, the health effects of these emissions were not explicitly considered, but to add context, Chapter 4, Sections 4.1.2, 4.2.2, 4.3.2, and 4.4.2 of this DU Oxide SEIS compare the transportation emissions from the Action Alternatives to total regional transportation emissions.

B.2.4 Transportation Modes

Two options were evaluated for delivery of DU oxide and other radioactive wastes (i.e., ancillary low-level radioactive waste [LLW] and mixed LLW [MLLW] and empty and heel cylinders) to off-site disposal sites: truck and rail/truck, as appropriate. The following waste disposal sites were evaluated under the truck and rail options:

- Energy*Solutions* near Clive, Utah,
- Nevada National Security Site (NNSS) in Nye County, Nevada, and
- Waste Control Specialists LLC (WCS) near Andrews, Texas.

For rail shipment to NNSS, the DU oxide containers would be transferred to trucks from the railcars at an intermodal facility, which was assumed to be located at Barstow, California, and then delivered to NNSS by truck.

B.2.5 Receptors

Radiation-related transportation risks were calculated and are presented separately for workers and members of the general public. The workers considered are truck crew members involved in transportation and inspection of the packages. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit. For incident-free operation, the affected population includes individuals living within 805 meters (0.5 miles) of each side of the road. Several scenarios were also evaluated for impacts on hypothetical maximally exposed individuals (MEIs). For example, an MEI could be a resident living near the highway who is exposed to all shipments transported on the road. Refer to Section B.6.3 for a description of the MEI scenarios that were analyzed. For accident conditions, the affected population includes individuals residing within 80 kilometers (50 miles) of the accident, and the MEI would be an individual located 330 feet (100 meters) directly downwind from the accident (NRC 1977). The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the impact on the affected population was used as the primary means of comparing impacts among the alternatives.

B.3 PACKAGING AND TRANSPORTATION REGULATIONS

This section provides a high-level summary of radioactive materials packaging and transportation regulations. Regulations pertaining to the transportation of radioactive materials are published by the U.S. Department of Transportation (DOT) (49 CFR Parts 106, 107, and 171–178) and U.S. Nuclear Regulatory Commission (NRC) (10 CFR Parts 20, 61, and 71). Interested readers are encouraged to visit the cited resources for current specifics or to review DOT's *Radioactive Material Regulations Review* (RAMREG-12-2008) (DOT 2008) for a comprehensive discussion of radioactive material regulations.

B.3.1 Radiological Packaging Regulations

The primary regulatory approach to promote safety from radiological exposure is the specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and radiation exposure to the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. For analyses of radioactive waste transports in this DU Oxide SEIS, two basic types of packaging were used: Industrial, and Type A. Specific requirements for these packages are detailed in 49 CFR Part 173, Subpart I. All packages are designed to protect and retain their content under normal conditions.

In this DU Oxide SEIS, because of low specific activity of the waste, industrial packaging is used to transport materials that, because of their low concentration of radioactive materials, present a limited hazard to the public and the environment. Industrial packaging is a subset of Type A packaging. Type A packaging is designed to protect and retain its contents under normal transport conditions. Packaging requirements are an important consideration for transportation risk assessment.

Radioactive materials shipped in Type A containers, or packagings, are subject to specific radioactivity limits identified as A1 and A2 values in 49 CFR 173.435. In addition, external radiation limits, as prescribed in 49 CFR 173.441, must be met. If the material qualifies as low specific activity, as defined in 10 CFR Part 71 and 49 CFR Part 173, it may be shipped in a shipping container such as Industrial or Type A Packaging (49 CFR 173.427); see also RAMREG-12-2008 (DOT 2008).

Type A packaging is designed to retain its radioactive contents in normal transport. Under normal conditions, a Type A package must withstand the following:

- Operating temperatures ranging from -40 to 70 degrees Celsius (-40 to 158 degrees Fahrenheit);
- External pressures ranging from 0.25 to 1.4 kilograms per square centimeter (3.5 to 20 pounds per square inch);
- Normal vibration experienced during transportation;
- Simulated rainfall of 5 centimeters (2 inches) per hour (for 1 hour);
- Free fall from 0.3 to 1.2 meters (1 to 4 feet), depending on the package weight;
- Water immersion tests;
- Impact of a 6-kilogram (13-pound) steel cylinder with rounded ends dropped from 1 meter (3.3 feet) onto the most vulnerable surface; and
- A compressive load of five times the mass of the gross weight of the package for 24 hours, or the equivalent of 13 kilopascals (1.9 pounds per square inch), multiplied by the vertically projected area of the package for 24 hours.

B.3.2 Transportation Regulations

The regulatory requirements for packaging and transporting radioactive materials are designed to achieve the following four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation by specific limitations on the allowable radiation levels;
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria);
- Prevent nuclear criticality (an unplanned nuclear chain reaction that could occur as a result of concentrating too much fissile material in one place); and

- Provide physical protection against theft and sabotage during transit.

DOT regulates the transportation of hazardous materials in interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of transport such as routing, handling and storage, and vehicle and driver requirements. DOT also regulates the labeling, classification, and marking of radioactive material packagings.

NRC regulates the packaging and transportation of radioactive material for its licensees, including commercial shippers of radioactive materials. In addition, under an agreement with DOT, NRC sets the standards for packages containing fissile materials and Type B packagings.

The U.S. Department of Energy (DOE), through its management directives, orders, and contractual agreements, ensures the protection of public health and safety by imposing standards on its transportation activities equivalent to those of DOT and NRC. According to 49 CFR 173.7(d), packagings made by or under the direction of DOE may be used for transporting Class 7 materials (radioactive materials) when the packages are evaluated, approved, and certified by DOE against packaging standards equivalent to those specified in 10 CFR Part 71.

DOT also has additional requirements that help reduce transportation impacts. Some requirements affect drivers, packaging, labeling, marking, and placarding. Others specifying the maximum dose rate from radioactive material shipments help reduce incident-free transportation doses.

B.4 EMERGENCY RESPONSE

The U.S. Department of Homeland Security (DHS) is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with, Federal Government agencies that have emergency response functions in the event of a transportation incident. In the event a transportation incident involving a radioactive waste occurs, guidelines for response actions are outlined in the *National Response Framework* (DHS 2014).

The Federal Emergency Management Agency, an organization within DHS, coordinates federal and state participation in developing emergency response plans and is responsible for the development and the maintenance of the *Nuclear/Radiological Incident Annex* (DHS 2008) to the *National Response Framework* (DHS 2014). The *Nuclear/Radiological Incident Annex* to the *National Response Framework* describes the policies, situations, concepts of operations, and responsibilities of the federal departments and agencies governing the immediate response and short-term recovery activities for incidents involving release of radioactive materials to address the consequences of the event.

DHS has the authority to activate Nuclear Incident Response Teams, which include DOE Radiological Assistance Program teams that can be dispatched from regional DOE offices in response to a radiological incident. These teams provide first-responder radiological assistance to protect the health and safety of the general public, responders, and the environment and to assist in the detection, identification and analysis, and response to events involving radiological or nuclear material. Deployed teams provide traditional field monitoring and assessment support, as well as a search capability.

DOE uses DOE Order 151.1C, *Comprehensive Emergency Management System* (DOE 2005), as a basis to establish a comprehensive emergency management program that provides detailed, hazard-specific planning and preparedness measures to minimize the health impacts of accidents involving loss of control over radioactive material or toxic chemicals. DOE provides technical assistance to other federal agencies and to state and local governments. Contractors are responsible for maintaining emergency plans and response procedures for all facilities, operations, and activities under their jurisdiction and for implementing those plans and procedures during emergencies. Contractor and state and local government plans are fully coordinated and integrated. In addition, DOE established the Transportation Emergency Preparedness Program to ensure its operating contractors and state, tribal, and local emergency responders are prepared to respond promptly, efficiently, and effectively to accidents involving DOE shipments of radioactive material. This program is a component of the overall emergency management system established by DOE Order 151.1C.

In the event of a radiological release from a shipment along a route, local emergency response personnel would be the first to arrive at the accident scene. It is expected that response actions would be taken in the context of the *Nuclear/Radiological Incident Annex* (DHS 2008). Based on their initial assessment at the scene, training, and available equipment, first responders would involve state and federal resources as necessary. First responders and/or state and federal responders would initiate actions in accordance with the DOT *Emergency Response Guidebook* (DOT 2012) to isolate the incident and perform actions necessary to protect human health and the environment (such as evacuations or other means to reduce or prevent impacts on the public). Cleanup actions are the responsibility of the carrier. DOE would partner with the carrier, shipper, and applicable state and local jurisdictions to ensure cleanup actions meet regulatory requirements.

To mitigate the possibility of an accident, DOE issued DOE Manual 460.2-1A, *Radioactive Material Transportation Practices Manual for Use with DOE Order 460.2A* (DOE 2008a). As specified in this manual, carriers are expected to exercise due caution and care in dispatching shipments. According to the manual, the carrier determines the acceptability of weather and road conditions, whether a shipment should be held before departure, and when actions should be taken while *en route*. The manual emphasizes that shipments should not be dispatched if severe weather or bad road conditions make travel hazardous. Current weather conditions, the weather forecast, and road conditions at the point of origin and along the entire route would be considered before dispatching a shipment.

B.5 METHODOLOGY

The transportation risk assessment is based on the alternatives described in Chapter 2 of this DU Oxide SEIS. **Figure B-1** summarizes the transportation risk assessment methodology. After the DU Oxide SEIS alternatives were identified and the requirements of the shipping campaign were understood, data were collected on material characteristics and accident parameters.

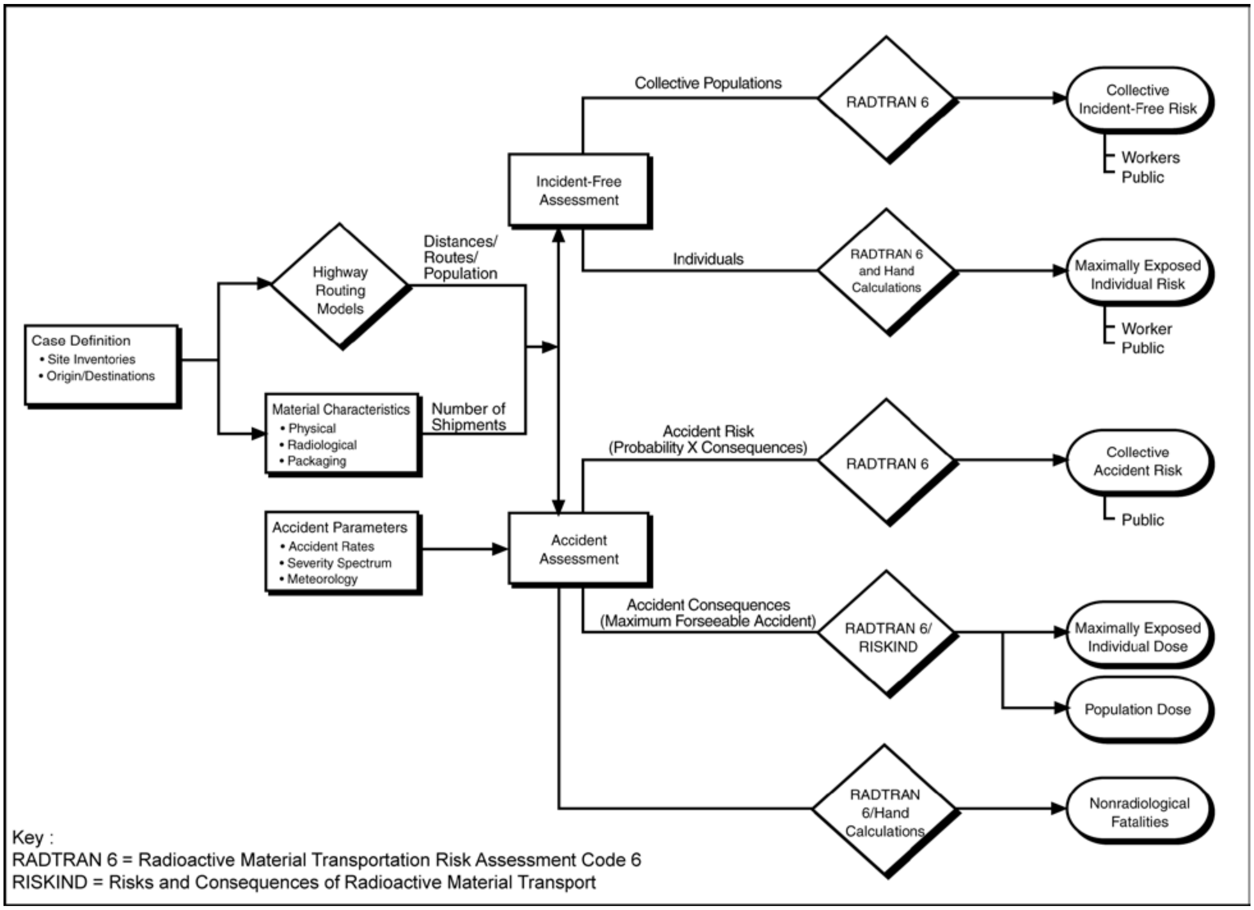

Figure B-1 Transportation Risk Assessment

Potential transportation impacts calculated for this SEIS are presented in two parts: impacts from incident-free or routine transportation and impacts from transportation accidents. Impacts from transportation accidents are further divided into nonradiological and radiological impacts. Nonradiological impacts could result from transportation accidents in terms of traffic fatalities. Radiological impacts of incident-free transportation include impacts on members of the public and crew from radiation emanating from materials in the shipment. Radiological impacts from accident conditions consider all reasonably foreseeable scenarios that could damage transportation packages, leading to releases of radioactive materials to the environment.

Impacts from transportation accidents are expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonably foreseeable accident conditions. This analysis also considers hypothetical maximum reasonably foreseeable transportation accidents with the highest consequences under each alternative. Hypothetical transportation accident conditions ranging from low-speed "fender-bender" collisions to high-speed collisions with or without fires were analyzed. Accident frequencies and consequences were evaluated using a method developed by NRC and described in the *Final Environmental Impact Statement on the Transportation of Radioactive Materials by Air and Other Modes*, NUREG-0170 (*Radioactive Material Transportation Study*) (NRC 1977); *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829 (Modal Study) (NRC 1987); and *Reexamination of Spent Fuel Shipping Risk*

Estimates, NUREG/CR-6672 (Reexamination Study) (NRC 2000). Radiological accident risk is expressed in terms of additional LCFs, and nonradiological accident risk is expressed in terms of additional traffic fatalities. Incident-free risk is also expressed in terms of additional LCFs.

Transportation-related risks were calculated and are presented separately for workers and members of the general public. The workers considered were the truck crew members transporting the radioactive materials and the inspectors. The general public included all persons who could be exposed to a shipment while it is moving or stopped during transit.

The first step in the ground transportation analysis was to determine the distances and populations along the routes. The Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003) was used to identify routes and the associated distances and populations for purposes of analysis. The TRAGIS computer program is a geographic information system-based transportation analysis computer program used to identify the highway, and rail routes for transporting radioactive materials within the United States that were used in the analysis. Both the road and rail network are 1:100,000-scale databases, which were developed from the U.S. Geological Survey digital line graphs and the U.S. Bureau of the Census Topological Integrated Geographic Encoding and Referencing System. The population densities along each route were derived from 2000 U.S. Census Bureau data (Johnson and Michelhaugh 2003). The features in TRAGIS allow users to determine routes for shipment of radioactive materials that conform to DOT regulations, as specified in 49 CFR Part 397. State-level U.S. Census data for 2010 (Census 2010) were used in relation to the 2000 Census data to project the population densities to 2020 levels

The information from TRAGIS, along with the properties of the material being shipped and route-specific accident frequencies, was entered into the Radioactive Material Transportation Risk Assessment (RADTRAN) 6.02 computer code (SNL 2013) to calculate incident-free transport and accident risks on a per-shipment basis. The risks under each alternative were determined by summing the products of per-shipment risks for each waste type by the corresponding number of shipments.

The RADTRAN 6.02 computer code (SNL 2013) was used for incident-free and accident risk assessments to estimate the impacts on populations, as well as for incident-free assessments associated with MEIs. RADTRAN 6.02 was developed by Sandia National Laboratories to calculate radiological risks associated with the transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge.

The RADTRAN 6.02 (SNL 2013) population risk calculations included both the consequences and probabilities of potential exposure events. For incident-free transportation, the probability of exposure is assumed to be 1 and the exposure pathway is direct radiation emanating from the transportation packages. The RADTRAN 6.02 code accident consequence analyses included the following exposure pathways: cloud shine, ground shine, direct radiation (from loss of shielding), inhalation (from dispersed materials), and resuspension (inhalation of resuspended materials) (SNL 2013). The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk was used as the primary means of comparing the various alternatives.

The Risks and Consequences of Radioactive Material Transport (RISKIND) computer code (Yuan et al. 1995) was used to estimate the doses to MEIs and populations for the worst-case maximum reasonably foreseeable transportation accident. The RISKIND computer code was developed for DOE's Office of Civilian Radioactive Waste Management to estimate potential radiological consequences and health risks to individuals and the collective population from exposures associated with the transportation of spent nuclear fuel; however, this code is also applicable to transportation of other types of cargo, as the code can model complex atmospheric dispersion and estimate radiation doses to MEIs near the accident. Use of the RISKIND computer code as implemented in this DU Oxide SEIS is consistent with direction provided in *A Resource Handbook on DOE Transportation Risk Assessment* (DOE 2002b).

The RISKIND calculations were conducted to supplement the collective risk results calculated using RADTRAN 6.02 (SNL 2013). Whereas the collective risk results provide a measure of the overall risks of each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups if a postulated accident were to take place. Essentially, the RISKIND analyses are meant to address "what if" questions, such as "what if I live next to a site access road?" or "what if an accident happens near my town?"

B.5.1 Transportation Routes

To assess incident-free and transportation accident radiological impacts, route characteristics were determined for the following off-site shipments that would occur as part of routine operations:

- LLW from the Paducah Site, Kentucky to Energy*Solutions* near Clive, Utah; NNSS, Nevada; and WCS, near Andrews, Texas; and
- LLW from the Portsmouth Site, Ohio; to Energy*Solutions* near Clive, Utah; NNSS, Nevada; and WCS, near Andrews, Texas.

Off-Site Route Characteristics

Route characteristics that are important to the radiological risk assessment include the total shipment distance and population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Route characteristics for routes analyzed in this DU Oxide SEIS are summarized in **Table B-1**. Rural, suburban, and urban areas were characterized according to the following breakdown (Johnson and Michelhaugh 2003):

- Rural population densities range from 0 to 54 persons per square kilometer (0 to 140 persons per square mile);
- Suburban population densities range from 55 to 1,284 persons per square kilometer (140 to 3,326 persons per square mile); and
- Urban population densities include all population densities greater than 1,284 persons per square kilometer (3,326 persons per square mile).

The affected population for route characterization and incident-free dose calculation includes all persons living within 805 meters (0.5 miles) of each side of the transportation route.

Table B-1 Off-Site Transport Truck/Rail Route Characteristics

Origin	Destination	Nominal Distance (kilometers)	Distance Traveled in Zones (kilometers)			Population Density in Zone[a] (number per square kilometers)			Number of Affected Persons[b]
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck									
Paducah, KY	NNSS, NV	3,208	2,600	549	60	12	341	1882	528,550
	Energy*Solutions*, UT	2,580	2,038	477	65	14	470	1,819	594,191
	WCS, TX	1,695	1,313	353	29	16	398	1,825	343,020
Portsmouth, OH	NNSS, NV	3731	2,970	686	74	13	357	1988	688,430
	Energy*Solutions*, UT	3,080	2,313	715	52	15	329	1,842	584,480
	WCS, TX	2,284	1,495	738	51	21	384	1,857	656,906
Barstow, CA	NNSS, NV[c]	337	3167	21	1.0	4	216	1,900	12,230
Rail									
Paducah, KY	Barstow, CA[c]	3,389	2872	467	50	8.0	411	2,531	546,675
	Energy*Solutions*, UT	2,763	2,256	440	67	9	456	2,434	613,427
	WCS, TX	2,007	1,408	550	50	14	444	2,859	648,848
Portsmouth, OH	Barstow, CA[c]	4,029	3,192	707	130	8.9	445	3,141	1,202,036
	Energy*Solutions*, UT	3,243	2,298	772	173	12	455	2,044	1,170,781
	WCS, TX	2,947	1,776	1,034	137	17	482	2,369	1,364,154

Key: CA = California; KY = Kentucky, NNSS = Nevada National Security Site; NV = Nevada; OH = Ohio, TX = Texas, UT = Utah.

[a] Population densities were projected to 2020 using state-level data from the 2010 U.S. Census (Census 2010) and assuming state population growth rates from 2000 to 2010 continue to 2020.

[b] For off-site shipments, the estimated number of persons residing within 0.5 mile along the transportation route, projected to 2020.

[c] Because NNSS does not have a rail yard, truck transport from a nearby rail yard would be required.

Note: Because all numbers are rounded to nearest digit, total distance may be different from some of individual segments.

The analyzed rail and truck routes for off-site shipments of radioactive waste from Paducah and Portsmouth sites to disposal sites are shown in **Figures B-2** and **B-3**.

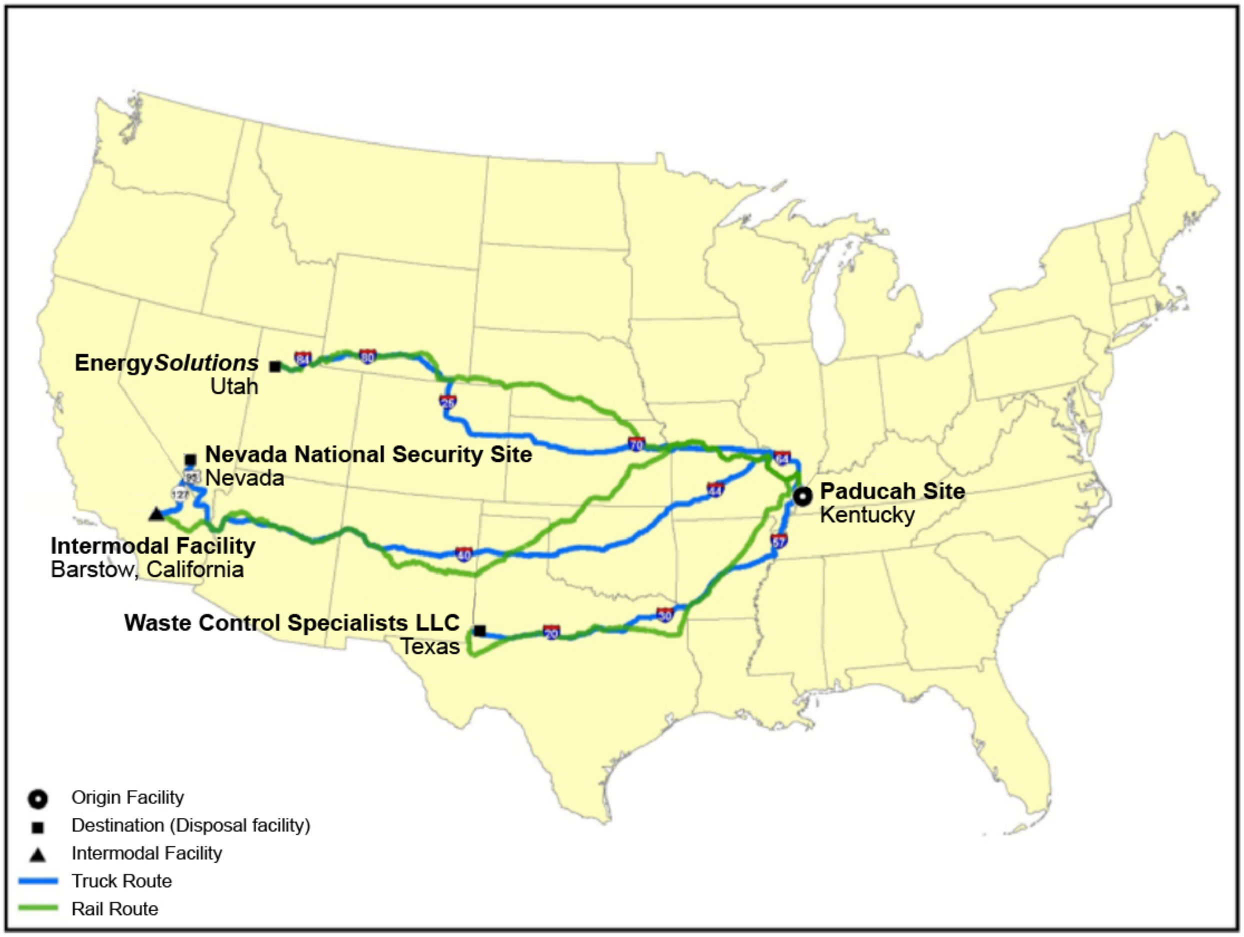

Figure B-2 Analyzed National Rail and Truck Routes from the Paducah Site to the Disposal Sites

Figure B-3 Analyzed National Rail and Truck Routes from the Portsmouth Site to the Disposal Sites

B.5.2 LLW Waste Shipments

Transportation of all LLW was assumed to occur in certified or certified-equivalent packaging on exclusive-use vehicles. Use of legal-weight, heavy combination trucks was assumed for highway transportation. Type A packages (in this DU Oxide SEIS, industrial packages) would be transported on common flatbed or covered trailers.

For transportation by truck, the maximum payload weight was considered to be about 48,000 pounds (21,770 kilograms), based on the federal gross vehicle weight limit of 80,000 pounds (36,288 kilograms) (23 CFR 658.17). While there are large numbers of multi-trailer combinations (known as longer combination vehicles) with gross weights in excess of the federal limit in operation on rural roads and turnpikes in some states (DOT 2000), for evaluation purposes, the load limit for the legal truck was based on the federal gross vehicle weight. The width restriction is about 102 inches (2.59 meters) (23 CFR 658.15). Length restrictions vary by state, but were assumed for purposes of analysis to be no more than 48 feet (14.6 meters).

The LLW that would be transported under the alternatives in this DU Oxide SEIS are mainly DU oxide in the repurposed and qualified DU hexafluoride (DUF_6) cylinders (a low specific activity

[LSA] waste) or in bulk bags. [62] Other containers such as intermodal or cargo containers could be used for transporting the non-conforming DUF_6 cylinders, if they are volume-reduced. **Table B-2** lists the types of containers assumed for the analysis, along with their volumes and the number of containers in a shipment. A shipment is defined as the amount of LLW transported on a single truck.

Table B-2 LLW Type and Associated Container Characteristics[a]

Waste Type	Container	Container Volume (cubic feet)[b]	Container Mass (pounds)[c]	Shipment Description
DU Oxide LLW (LSA)	48G	139	30,600	1 per truck; 6 per railcar
DU Oxide LLW (LSA)	48X	108.9	25,530	1 per truck; 6 per railcar
DU Oxide LLW (LSA)	48Y	142.9	32,760	1 per truck; 6 per railcar
Volume-Reduced Empty and Heel Cylinders (LLW/LSA)	intermodal container	690	60,000	1 per truck; 2 per railcar
DU Oxide LLW (LSA)	bulk bag	266	24,000	2 per truk; 8 per railcar
CaF_2 (LSA)	bulk Bag	266	26,500	1 per truck; 4 per railcar
Misc. MLLW or LLW (LSA)	55-gallon drums	7.35	600	80 per truck, 160 per railcar
Intact Empty and Heel Cylinders (LLW/LSA)	see cylinders 48X/Y/G	See cylinders 48X/Y/G	NA[d]	2 per truck; 6 per railcar

Key: LLW = low-level radioactive waste; LSA = low specific activity waste; MLLW = mixed low-level radioactive waste

[a] Containers and transport packages identified in this table were used to determine the transportation impacts for purposes of analysis.

[b] Container interior minimum volume for the 48X/Y/G and exterior volume for the intermodal container.

[c] Filled container maximum mass. Container mass includes the mass of the container shell, its internal packaging, and the materials within.

[d] Generally trucks are weight limited and railcars are space limited, but the weight of the empty and heel cylinders in not the limiting factor for transportation. Therefore, a truck could carry 2 empty or heel cylinders and the weight capacity would not be exceeded.

Source: LLNL1997; MHF 2015

In general, the number of shipping containers per truck and per rail are based on the current practice and the proposed approach by the Portsmouth/Paducah Project Office (PPPO 2016), limited by the

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[62] As described in Chapter 2, Section 2.1.2 of this DU Oxide SEIS, small quantities of DU oxide may also be stored in 55-gallon drums. The DU oxide stored in these drums would result in fewer DU oxide cylinders or bulk bags being generated. Therefore, transportion of the drums is not specifically analyzed, but the impacts of transportion of these drums would be encompassed by the transport of DU oxide in cylinders or bulk bags.

dimensions and weight of the shipping containers, the Transport Index,[63] and the transport vehicle dimensions and weight limits.

It was assumed that the LLW transported to a disposal site (for example, NNSS) would meet the disposal facility's waste acceptance criteria. Under all Action Alternatives, DU oxides and empty and heel cylinders (i.e., cylinders that are considered deficient for transporting radioactive wastes) are transported to a disposal site. It is expected that a total of about 69,000 DU oxides cylinders and about 14,000 empty and heel cylinders would be transported from both Paducah and Portsmouth to a disposal site. On the average, each cylinder would contain 10 metric tons (about 22,000 pounds) of DU oxides. It is assumed that all empty and heel cylinders contain about 23 kilograms (50 pounds) DUF_6 that has been neutralized using potassium hydroxide. In addition, there is a very small amount of LLW and MLLW that is generated annually.

As indicated in Section B.2.4, two transportation options are considered: rail and truck. Under the truck option, one DU oxide cylinder is transported per truck. Under the rail option, each train would consist of 10 railcars, each containing six DU oxide cylinders. It is expected that there would be a maximum of 24 train shipments or 1,440 truck shipments per year from each conversion site (i.e., Paducah or Portsmouth) to a disposal site. Two empty or heel cylinders are transported per truck. The LLW and MLLW is transported only by truck using 55-gallon (208-liter) drums because of the small amount of waste generated and the small number of shipments required (one truck shipment per year from each conversion site).

B.5.3 Radionuclide Inventories

Radionuclide inventories are used to determine accident risks associated with a hypothetical release of a portion of the radioactive cargo. To simplify the analysis and provide conservatism, the compositions of the DU oxide were assumed to be the maximum concentrations of each radionuclide per radioisotope. **Table B-3** shows the radionuclide concentrations in curies per one metric ton of depleted uranium oxide.

Table B-3 Depleted Uranium Oxide Radionuclide Concentrations

Radionuclides	Curies per Metric ton of DU Oxide
Main Nuclides	
Thorium-234	2.84×10^{-1}
Uranium-234	5.27×10^{-2}
Uranium-235	4.58×10^{-3}
Uranium-238	2.84×10^{-1}
Impurities	
Americium-241	3.75×10^{-6}
Technitium-99	2.29×10^{-4}
Neptunium-237	3.13×10^{-6}

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[63] The Transport Index is a dimensionless number (rounded up to the next tenth) that is placed on the label of a package to designate the degree of control to be exercised by the carrier. Its value is equivalent to the maximum radiation level in millirem per hour at 1 meter from the package (10 CFR 71.4 and 49 CFR 173.403).

Radionuclides	Curies per Metric ton of DU Oxide
Plutonium-238	1.74×10^{-6}
Plutonium-239	2.26×10-6

Source: PPPO 2016; LLNL 1997

B.6 INCIDENT-FREE TRANSPORTATION RISKS

B.6.1 Radiological Risk

During incident-free transportation of radioactive materials, a radiological dose results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers, their length of time of exposure, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crew members and the general population during incident-free transportation. For truck shipments, the crew members were the drivers of the shipment vehicles. The general population analyzed included persons residing within 805 meters (0.5 miles) of the truck route (off-link), persons sharing the road (on-link), and persons at stops. Exposures to workers loading and unloading shipments at Paducah or Portsmouth were not included in this analysis, but were subsumed within occupational exposures for site workers (see Chapter 4, of this DU Oxide SEIS). Exposures to inspectors were evaluated and are presented separately, as discussed in Section B.6.3.

Collective doses for the crew and general population were calculated using the RADTRAN 6.02 computer code (SNL 2013). The radioactive material shipments were assigned an external dose rate based on their radiological characteristics. The waste container dose rate at 1 meter (3.3 feet) from its surface, or its Transport Index, depends on the distribution and quantities of the radionuclides, the waste density, the shielding provided by the packaging, and the self-shielding provided by the waste mixture. If a waste container had a high external dose rate that could exceed a Transportation Index of 10, it would be categorized as an exclusive-use shipment and would have further transport and dose rate limitations. All exclusive-use shipments must meet a regulatory limit of 10 millirem per hour at 2 meters (6.6 feet) from the outer lateral surface of the transport vehicle (10 CFR 71.47 and 49 CFR 173.441).

Based on the radionuclide concentrations shown in Table B-3, a dose rate of 1 millirem per hour at 1 meter (3.3 feet) was assigned to packages containing DU oxides. This is a conservative dose rate assumption based on a maximum dose rate of 2-millirem per hour, at a 30-centimeter (1-foot) distance from the surface of the DU oxide cylinder (PPPO 2016). Because of the low radioactive contents in the empty and heel cylinders and in the shipment of LLW and MLLW, a dose rate of 0.01 millirem per hour at 1-meter (3.3-foot) from the transporter was assumed.

To calculate the collective dose, a unit risk factor was developed to estimate the impact of transporting a single shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors were combined with routing information, such as shipment distances in various population density zones, to determine the risk for a single shipment (a shipment risk factor) between a given origin and destination. Unit risk factors were developed on the basis of travel on interstate highways and freeways, as required by 49 CFR Parts 171 to 178, for highway-route-controlled quantities of radioactive material within rural, suburban, and urban population zones by using RADTRAN 6.02 (SNL 2013) and its default data. In addition, it was assumed that, for 10 percent of the time, travel through suburban and urban zones would encounter rush-hour conditions, leading to lower average speed and higher traffic density.

The radiological risks from transporting the waste were estimated in terms of the numbers of LCFs among the crew and the exposed population. A health risk conversion factor of 0.0006 LCF per rem or person-rem of exposure was used for both the public and workers (DOE 2003).

B.6.2 Nonradiological Risk

Nonradiological risk (vehicle-related health risk) resulting from incident-free transport of radioactive materials may be associated with the generation of air pollutants by the transport vehicles used during shipment. The vehicle-related health risk under incident-free transport conditions is the excess latent mortality resulting from inhalation of vehicle emissions. The estimation of hypothetical fatalities from exposure to vehicle emissions was deleted from RADTRAN 5 (Neuhauser, Kanipe, and Weiner 2000) and its recent revisions, because of the extreme uncertainties known to be associated with particulate inhalation models. Therefore, no risk factors were assigned to the vehicle emissions analyzed in this DU Oxide SEIS. Chapter 4, Sections 4.1.2, 4.2.2, 4.3.2, and 4.4.2 analyze the air quality impacts related to vehicle emissions under each alternative.

B.6.3 Maximally Exposed Individual Exposure Scenarios

Maximum individual doses for routine off-site transportation were estimated for transportation workers, as well as for members of the general population.

For truck shipments, four hypothetical scenarios were evaluated to determine the MEI in the general population. These scenarios are as follows (DOE 2002a):

- A resident living 30 meters (98 feet) from the highway used to transport the shipping containers;
- A person caught in traffic and located 1.2 meters (4 feet) from the surface of the shipping containers for 60 minutes;
- A person at a rest stop or gas station 20 meters (66 feet) from the shipping containers for 60 minutes; and
- A service station worker at a distance of 16 meters (52 feet) from the shipping container for 50 minutes.

Hypothetical MEI doses were accumulated over a single year for all transportation shipments. However, for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated on a per event basis. Because a potentially large number of trucks would leave the Paducah or Portsmouth Sites over a year’s time, it is possible that an individual could be exposed to multiple shipments. The MEI dose for an individual stuck in traffic next to a shipping container would equal the single event exposure dose (shown in Table B-6 in Section B.8 below) multiplied by the number of exposure events. For example, if an individual were stuck in traffic next to a shipping container for 1 hour 10 times (total exposure duration of 10 hours), the MEI dose would be 24 millirem (2.4 millirem per hour per stop × 10 hours).

The transportation worker would be a truck or rail crew member who could be a DOE employee or a driver for a commercial carrier. In addition to complying with DOT requirements, a DOE employee would also need to comply with 10 CFR Part 835, which limits worker radiation doses to 5 rem per year; however, DOE's goal is to maintain radiological exposure as low as reasonably achievable (ALARA). DOE has therefore established an Administrative Control Level of 2 rem per year (DOE 2017). A commercial truck driver who has been trained as a radiation worker is subject to Occupational Safety and Health Administration regulations, which limit the whole body dose to 5 rem per year (29 CFR 1910.1096(b)), and the DOT requirement of 2 millirem per hour in the truck cab (49 CFR 173.411). Commercial truck drivers who have been trained as radiation workers would have the same administrative dose limit as DOE employees; therefore, for purposes of analysis, a maximally exposed driver would not be expected to exceed the DOE Administrative Control Level of 2 rem per year (DOE 2017). For a truck driver who is not trained as a radiation worker, the maximum annual dose is limited to 100 millirem (10 CFR 20.1301).

Other workers would include inspectors who would inspect the truck and its cargo along the route. An inspector was assumed to be at a distance of 1 meter (3.3 feet) from the cargo for a duration of 1 hour per event.

The following two hypothetical scenarios were also evaluated for railcar shipments (DOE 2002a):

- A rail yard worker working at a distance of 10 meters (33 feet) from the shipping container for 2 hours;
- A resident living 200 meters (650 feet) from a rail stop during classification and inspection for 20 hours.

The maximally exposed transportation worker (excluding drivers) for both truck and rail shipments would be an individual inspecting the cargo at a distance of 1 meter from the shipping container for 1 hour.

B.7 TRANSPORTATION ACCIDENT RISKS

B.7.1 Methodology

The off-site transportation accident analysis considered the impacts of accidents during the transportation of materials. Under accident conditions, impacts on human health and the environment could result from the release and dispersal of radioactive material. Transportation accident impacts were assessed using an accident analysis methodology developed by NRC. This section provides an overview of the methodology; detailed descriptions of are found in the *Radioactive Material Transportation Study*, NUREG-0170 (NRC 1977); Modal Study, NUREG/CR-4829 (NRC 1987); and Reexamination Study, NUREG/CR-6672 (NRC 2000).

Accidents that could potentially breach the shipping container were represented by a spectrum of accident severities and radioactive release conditions. Historically, most transportation accidents involving radioactive materials have resulted in little or no release of radioactive material from the shipping container. Consequently, the analysis of accident risks evaluated accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a correspondingly low probability of occurrence. The accident analysis calculated the probabilities and consequences from this spectrum of accidents.

To provide a reasonable assessment of radioactive waste transportation accident impacts, two types of analysis were performed. First, an accident risk assessment was performed that takes into account the probabilities and consequences of a spectrum of potential accident severities using methodologies developed by NRC (NRC 1977, 1987, 2000). For the spectrum of accidents considered in the analysis, the RADTRAN 6.02 code (SNL 2013) sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as “dose risk,” to the population within 50 miles, which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts on individuals and populations should an accident occur, maximum radiological consequences were calculated in an urban or suburban population zone for an accidental release with a likelihood of occurrence greater than 1 chance in 10 million per year using the RISKIND computer program (Yuan et al. 1995).

For accidents in which a waste container remains undamaged, population and individual radiation exposures from the waste package were evaluated for the time needed to recover the container and resume shipment. The collective dose over all segments of the transportation routes was evaluated for an affected population to a distance of 805 meters (0.5 mile) from the accident location. This approach is consistent with that used in incident-free transport public dose calculations, which considers those individuals within a distance of 805 meters from the route (NRC 1977). When the package remains undamaged, people would receive a dose only from external radiation from the package. In general, the external dose to individuals in this population would be inversely proportional to the square of the distance of the affected individuals from the accident. Any additional dose to those residing beyond 805 meters from the accident would be negligible. The dose to an individual (first responder) was assumed to be equal to that of the inspector dose.

B.7.2 Accident Rates

Whenever material is shipped, the possibility exists that a traffic accident could result in vehicular damage, injury, or a fatality. An accident fatality is the death of a person who is killed instantly or dies within 30 days due to injuries sustained in the accident. Even when drivers are trained in defensive driving and take great care, there is a risk of a traffic accident.

To calculate accident risks, vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*, (Saricks and Tompkins 1999) and updated, as discussed below. Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with the accident involvement representing the numerator of the fraction and vehicular activity (total travel distance in truck kilometers) its denominator. Accident rates were generally determined for a multi-year period. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate.

No reduction in accident or fatality rates was assumed, even though radioactive material carrier drivers are better trained and utilize well-maintained equipment. Saricks and Kvitek (1994) points out that shippers and carriers of radioactive material generally have a higher-than-average awareness of transportation risk and prepare cargoes and drivers for such shipments accordingly. This preparation should have the twofold effect of reducing component and equipment failure and mitigating the contribution of human error to accident causation.

A review of truck accidents and fatalities by the Federal Carrier Safety Administration indicated that state-level accidents and fatalities were underreported (UMTRI 2003). For the years 1994 through 1996, which formed the bases for the analysis in the Saricks and Tompkins report, the review identified that accidents were underreported by about 39 percent and fatalities were underreported by about 36 percent. Therefore, the state-level truck accident and fatality rates in the Saricks and Tompkins report were increased by factors of 1.64 and 1.57, respectively, to account for the underreporting in the analyses for this DU Oxide SEIS.

For truck transportation, the calculated accident rates were specifically for heavy combination trucks involved in interstate commerce. Heavy combination trucks typically used for radioactive material shipments are rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other. Truck accident rates were computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers, from 1994 to 1996 (Saricks and Tompkins 1999; adjusted for underreporting using UMTRI 2003).

For off-site transport of radioactive waste, a weighted average accident and fatality rate was calculated based on the state-level distances travelled and their associated accident and fatality rates. The accident and fatality values selected were the state-level accident and fatality rates provided in the Saricks and Tompkins report (Saricks and Tompkins 1999); adjusted for underreporting using UMTRI 2003. The rates in the Saricks and Tompkins report are cited in terms of accident and fatality per car-kilometer and railcar-kilometer traveled. For DU oxide in cylinders and intact empty and heel cylinder transport by rail, the accident and fatality rate was based on 10 railcars per train (PPPO 2016), and for the disposal at NNSS an additional 60 truck shipments of DU oxides or 30 truck shipments of empty and heel cylinders from an intermodal facility (considered to be Barstow, California), because there is no direct rail access to NNSS. The selected accident and fatality rates used in this DU Oxide SEIS are limited to the rates in those states where truck and rail shipments would travel while transporting wastes from Portsmouth or Paducah to the evaluated disposal sites. For trucks, the selected state-level rates are those associated with total accidents and fatalities on interstate highways and primary roads.

B.7.3 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in the *Radioactive Material Transportation Study* (NRC 1977) for radioactive waste in general. The *Radioactive Material Transportation Study* (NRC 1977) was used to estimate conditional probabilities associated with accidents involving transportation of radioactive materials. The *Radioactive Material Transportation Study* (NRC 1977) analysis was primarily performed using best engineering judgments and presumptions concerning cask response.

As discussed earlier, the accident consequence assessment considered the potential impacts of severe transportation accidents. In terms of risk, the severity of an accident must be viewed in terms of potential radiological consequences, which are directly proportional to the fraction of the radioactive material within a cask that is released to the environment during the accident. Although accident severity regions span the entire range of mechanical and thermal accident loads, they are grouped into accident categories that can be characterized by a single set of release fractions and, therefore, can be considered together in the accident consequence assessment. The accident category severity fraction is the sum of all conditional probabilities in that accident category.

In this DU Oxide SEIS, consistent with the analysis approach used in the 2004 EISs (DOE 2004a, 2004b), the severity categories and the conditional probabilities are based on the data in the *Radioactive Material Transportation Study* (NRC 1977). Furthermore, radiological consequences are calculated by assigning package release fractions to each accident severity category. The release fraction is defined as the fraction of the material in a package that could be released from the package as the result of an accident of a given severity. Release fractions take into account all mechanisms necessary to cause release of material from a damaged package to the environment. The release fractions used are those reported in NUREG-0170 (NRC 1997) for both LSA drums and NRC Type A packages. It is assumed that for the higher severity categories all materials within the cylinders involved in an accident would be released and 1 percent of these materials would be aerosolized in all accidents with 5 percent of the aerosolized particles being in the respirable size range (NRC 1977; DOE 2002b). These assumptions are driven by the nature of the DU oxide which is a powder-like material.

For the accident risk assessment, the RADTRAN 6.02 computer code (SNL 2013) sums the product of the consequences and probabilities over all accident categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem.

B.7.4 Atmospheric Conditions

Because it is impossible to predict the specific location of an off-site transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. On the basis of observations from National Weather Service surface meteorological stations at over 177 locations in the United States, on an annual average, neutral conditions (Pasquill Stability Classes C and D) occur 58.5 percent of the time, and stable (Pasquill Stability Classes E, F, and G) and unstable (Pasquill Stability Classes A and B) conditions occur 33.5 percent and 8 percent of the time, respectively (DOE 2002a). The neutral weather conditions predominate in each season, but most frequently in the winter (nearly 60 percent of the observations).

Neutral weather conditions in Pasquill Stability Class D compose the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate wind speeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low wind speeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. The atmospheric condition used in RADTRAN 6.02 (SNL 2013) is an average weather condition that corresponds to a combination of Pasquill Stability Classes D and E.

The accident consequences for the maximum reasonably foreseeable accident (an accident with a likelihood of occurrence greater than 1 in 10 million per year) were assessed for both stable (Class F with a wind speed of 1 meter per second, or 2.2 miles per hour) and neutral (Class D with a wind speed of 4 meters per second or about 9 miles per hour) atmospheric conditions. The population dose was evaluated under neutral atmospheric conditions, and the MEI dose under stable atmospheric conditions. The MEI dose would represent an accident under weather conditions that result in a conservative dose (that is, a stable weather condition with minimum diffusion and dilution). The population dose would represent an average weather condition.

B.7.5 Intentional Destructive Acts – Acts of Sabotage or Terrorism

In response to the terrorist attacks of September 11, 2001, DOE continually assesses its measures in place to minimize the risk or potential consequences of radiological sabotage. While it is not possible to determine terrorists' motives and targets with certainty, DOE considers the threat of terrorist attack to be real and makes all efforts to reduce any vulnerability to this threat.

The impacts of intentional destructive acts are presented here to provide perspective on the risks that the transportation of the DU oxide could pose should such an act occur. The consequences of an intentional destructive acts involving radioactive and hazardous material depend on the material's packaging, chemical composition, radioactive and physical properties, accessibility, quantity, and ease of dispersion, as well as on the surrounding environment, including the number of people who are close to the event. An intentional destructive acts could occur during loading of the railcars or trucks and transportation activities under any of the alternatives.

The DU oxide is transported as a low specific activity waste. The low-activity nature of the uranium poses little risk, in general, to human health and the environment, even under accident conditions, as discussed in Tables B-4 through B-6 of this appendix. The impacts of an intentional destructive acts could be represented by the impacts of any of the reasonably foreseeable accidents presented in Table B-7 in Section B.8 below. These accidents represent the situations that would result in the highest amount of released materials without considering the accidents' probability. All accident cases (in both urban and suburban areas) indicate a small consequence and risk to the public and individuals—the highest dose from a release of all materials in one railcar without any prevention would be about 47 person-rem to the population in the urban area (with a risk of a latent fatal cancer [LCF] of 0.03) and an MEI dose of 6.4 millirem (with an LCF risk of 4×10^{-6}).

B.8 RISK ANALYSIS RESULTS

Per-shipment risk factors have been calculated for the collective populations of exposed persons and for the transport crew for all anticipated routes and shipment configurations. Radiological risks are presented in per-shipment doses for each unique route, material, and container combination. Per-shipment radiological risk factors for incident-free transportation and accident conditions are presented in **Table B-4**, for the DU oxides and in **Tables B-4a** for the empty and heel cylinders and LLW and MLLW. These factors have been adjusted to reflect the projected population in 2020. For incident-free transportation, both dose and LCF risk factors are provided for the crew and exposed population. The radiological risks would result from potential exposure of people to external radiation emanating from the packaged waste. The exposed population includes the off-link public (people living along the route), on-link public (pedestrian and car occupants along the route), and public at rest and fuel stops. LCF risk factors were calculated by multiplying the accident dose risks by a health risk conversion factor of 0.0006 cancer fatalities per person-rem of exposure (DOE 2003).

For transportation accidents, the risk factors are given for radiological impacts in terms of potential LCFs in the exposed population; for nonradiological impacts, the risk factors are given in terms of number of traffic fatalities. LCFs represent the number of additional latent fatal cancers expected among the exposed population in the event of an accident. Under accident conditions, the population would be exposed to radiation from released radioactivity if the package were breached and would receive an external radiation dose if the package were not breached. For accidents with no release, the analysis conservatively assumed that it would take about 12 hours to remove the package and/or vehicle from the accident area (DOE 2002a). The nonradiological risk factors are non-occupational traffic fatalities resulting from transportation accidents.

As stated in Section B.7.3, the accident dose is called the “dose risk” because the values incorporate the spectrum of accident severity probabilities and associated consequences (for example, dose). The accident dose risks would be very low because the accident severity probabilities (that is, the likelihood of accidents leading to confinement breach of a package or shipping cask and release of its contents) would be small, and the content and form of the wastes (that is, solids) are such that a breach would lead to a semi-dispersible and noncombustible release. Because RADTRAN 6.02 (SNL 2013) assumes a homogeneous population within a 80-kilometer (50-mile) radius along the transportation route, it likely overestimates the actual doses because this assumption theoretically places people directly adjacent to the route, where the highest doses would be present.

As indicated in Table B-4 (and B-4a), all per-shipment risk factors would be less than one. This means that no LCFs or traffic fatalities are expected to occur during each transport. For example, in Table B-4, the risk factors to truck crews and populations from transporting one shipment of DU oxide from Paducah to NNSS in a cylinder by truck are given as 2.3×10^{-6} and 6.2×10^{-6} LCF, respectively. These risk factors can also be interpreted to mean that during a single shipment of DU oxide LLW, there is a chance of about 1 in 435,000 that an additional latent fatal cancer could be experienced among the exposed workers from exposure to radiation, and a chance of about 1 in 161,000 that an additional latent fatal cancer could be experienced among the exposed population residing along the transport route. These chances are essentially equivalent to zero risk. It should be noted that the maximum dose rate allowed by regulation in the truck cab is less than or equal to 2 millirem per hour.

Table B-5 shows the risks of transporting DU oxide LLW to each disposal site under each alternative using truck and/or rail transport methods. **Table B-5a** shows the risks for transporting empty and heel cylinders to each disposal site under each alternative. The risks were calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the project and, for radiological doses, by the health risk conversion factors. Table B-5 indicates that the disposal at NNSS would have a higher radiological risk to the population during incident-free transport than the other alternatives because this Alternative is farthest from Paducah and Portsmouth, passes near the largest population, and additional truck transports from an intermodal facility to NNSS are required for the rail transport option.

Table B-4 Risk Factors per Shipment of Depleted Uranium Oxide Cylinders[a]

				Incident-Free				Accident	
				Crew		Population			
Origin	**Destination**	**Transportation Method**	**One-way Kilometers Traveled**	**Dose (person-rem)**	**LCFs[b]**	**Dose (person-rem)**	**LCFs[b]**	**Radiological Risk[b]**	**Nonradiological Risk (traffic fatalities)[b]**
Truck									
Paducah	*EnergySolutions*	Truck	2,578	3.05E-03	1.83E-06	8.11E-03	4.86E-06	5E-09	1E-04
	NNSS	Truck	3,208	3.78E-03	2.27E-06	9.92E-03	5.95E-06	3E-09	1E-04
	WCS	Truck	1,695	2.01E-03	1.20E-06	5.25E-03	3.15E-06	3E-09	1E-04
Portsmouth	*EnergySolutions*	Truck	3,080	3.65E-03	2.19E-06	9.43E-03	5.66E-06	5E-09	1E-04
	NNSS	Truck	3,731	4.41E-03	2.64E-06	1.15E-02	6.93E-06	4E-09	2E-04
	WCS	Truck	2,284	2.73E-03	1.64E-06	7.01E-03	4.20E-06	6E-09	2E-04
Rail/Truck									
Paducah	Energy*Solutions*	Rail	2,763	7.94E-02	4.76E-05	1.07E-01	6.42E-05	3E-06	6E-04
	WCS	Rail	2,007	6.12E-02	3.67E-05	9.99E-02	5.99E-05	4E-06	1E-03
	NNSS[c]	Rail	3,389	9.50E-02	5.70E-05	1.15E-01	6.93E-05	2E-06	1E-03
		Truck[c]	337	3.94E-04	2.36E-07	1.04E-03	6.24E-07	3E-11	6E-06
		TOTAL[d]	23,626	1.19E-01	5.84E-05	1.78E-01	1.07E-04	2E-06	1E-03
Portsmouth	Energy*Solutions*	Rail	3,243	1.01E-01	6.07E-05	1.38E-01	8.29E-05	4E-06	9E-04
	WCS	Rail	2,947	9.61E-02	5.76E-05	1.54E-01	9.23E-05	5E-06	1E-03
	NNSS[c]	Rail	4,029	1.18E-01	7.09E-05	1.46E-01	8.77E-05	4E-06	1E-03
		Truck[c]	337	3.94E-04	2.36E-07	1.04E-03	6.24E-07	3E-11	6E-06
		TOTAL[d]	24,266	1.42E-01	8.51E-05	2.09E-01	1.25E-04	4E-06	2E-03

Key: LCF = latent cancer fatality; LSA = low specific activity waste; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] All shipments would contain LLW (LSA). 1E-07 means 1×10^{-7} or 0.0000001.

[b] Risk is expressed in terms of LCFs, except for the nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because NNSS does not have a rail yard, the waste would be transported from a nearby rail yard (Barstow, CA) to NNSS via truck.

[d] Each rail shipment to NNSS would require the transport of 60 cylinders (or 60 truck shipments) from an intermodal facility in Barstow, CA.

Note: To convert kilometers to miles, multiply kilometers by 0.6215.

Table B-4a Risk Factors per Shipment of Empty and Heel Cylinders and LLW and MLLW Drums[a]

Origin	Destination	Transportation Method	One-way Kilometers Traveled	Incident-Free				Accident	
				Crew		Population		Radiological Risk[b]	Nonradiological Risk (traffic fatalities)[b]
				Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]		
Truck- Empty and Heel Cylinders									
Paducah	*EnergySolutions*	Truck	2,578	3.05E-05	1.83E-08	8.11E-05	4.86E-08	3E-11	1E-04
	NNSS	Truck	3,208	3.78E-05	2.27E-08	9.92E-05	5.95E-08	1E-11	1E-04
	WCS	Truck	1,695	2.01E-05	1.20E-08	5.25E-05	3.15E-08	1E-11	1E-04
Portsmouth	*EnergySolutions*	Truck	3,080	3.65E-05	2.19E-08	9.43E-05	5.66E-08	2E-11	1E-04
	NNSS	Truck	3,731	4.41E-05	2.64E-08	1.15E-04	6.93E-08	2E-11	2E-04
	WCS	Truck	2,284	2.73E-05	1.64E-08	7.01E-05	4.20E-08	3E-11	2E-04
Rail/Truck- Empty and Heel Cylinders									
Paducah	Energy*Solutions*	Rail	2,763	7.94E-04	4.76E-07	1.07E-03	6.42E-07	57E-09	6E-04
	WCS	Rail	2,007	6.12E-04	3.67E-07	9.99E-04	5.99E-07	8E-09	7E-04
	NNSS[c]	Rail	3,389	9.50E-04	5.70E-07	1.15E-03	6.93E-07	4E-09	8E-04
		Truck[c]	337	3.94E-06	2.36E-09	1.04E-05	6.24E-09	2E-13	6E-06
		TOTAL[d]	13.507	1.07E-03	6.41E-07	1.47E-03	8.80E-07	4E-09	9E-04
Portsmouth	Energy*Solutions*	Rail	3,243	1.01E-03	6.07E-07	1.38E-03	8.29E-07	1E-08	9E-04
	WCS	Rail	2,947	9.61E-04	5.76E-07	1.54E-03	9.23E-07	1E-08	1E-03
	NNSS[c]	Rail	4,029	1.18E-03	7.09E-07	1.46E-03	8.77E-07	8E-09	1E-03
		Truck[c]	337	3.94E-06	2.36E-09	1.04E-05	6.24E-09	2E-13	6E-06
		TOTAL[d]	14,147	1.30E-03	7.80E-07	1.77E-03	1.06E-06	9E-09	2E-03
Truck- LLW and MLLW Drums									
Paducah	*EnergySolutions*	Truck	2,578	3.10E-04	1.86E-07	2.26E-04	1.35E-07	7E-14	1E-04
	NNSS	Truck	3,208	3.85E-04	2.31E-07	2.78E-04	1.67E-07	4E-14	1E-04
	WCS	Truck	1,695	2.04E-04	1.23E-07	1.43E-04	8.60E-08	4E-14	1E-04
Portsmouth	*EnergySolutions*	Truck	3,080	3.72E-04	2.23E-07	2.52E-04	1.51E-07	6E-14	1E-04
	NNSS	Truck	3,731	4.49E-04	2.69E-07	3.21E-04	1.93E-07	5E-14	2E-04
	WCS	Truck	2,284	2.78E-04	1.67E-07	1.74E-04	1.04E-07	8E-14	2E-04

Key: LCF = latent cancer fatality; LSA = low specific activity waste; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] All empty and heel cylinder shipments would be LLW (LSA). 1E-07 means 1×10^{-7} or 0.0000001.

[b] Risk is expressed in terms of LCFs, except for the nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because NNSS does not have a rail yard, the waste would be transported from a nearby rail yard (Barstow, CA) to NNSS via truck.

[d] Each rail shipment to NNSS would require the transport of 60 cylinders (or 30 truck shipments) from an intermodal facility in Barstow, CA.

Note: To convert kilometers to miles, multiply kilometers by 0.6215.

Table B-5 Total Risks to Crew Members and Populations from Transporting Depleted Uranium Oxide Cylinders under Each Disposal Alternative

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonradiological Risk[b]
Energy*Solutions* Disposal Alternative								
Truck								
Paducah	46,200	119,000,000	141	0.08	374	0.2	3×10^{-4}	6
Portsmouth	22,900	70,400,000	83	0.05	215	0.1	1×10^{-4}	3
Rail								
Paducah	770	2,100,000	61	0.04	82	0.05	2×10^{-3}	0.5
Portsmouth	380	1,200,000	38	0.02	52	0.03	2×10^{-3}	0.3
NNSS Disposal Alternative								
Truck								
Paducah	46,200	148,100,000	175	0.1	458	0.3	1×10^{-4}	6
Portsmouth	22,900	85,300,000	101	0.06	264	0.2	9×10^{-5}	4
Rail/Truck[a]								
Paducah	46,970	18,200,000	91	0.05	137	0.08	1×10^{-3}	1
Portsmouth	23,280	9,200,000	54	0.03	79	0.05	1×10^{-3}	0.7
WCS Disposal Alternative								
Truck								
Paducah	46,200	78,200,000	93	0.06	242	0.1	1×10^{-4}	6
Portsmouth	22,900	52,200,000	62	0.04	160	0.1	1×10^{-4}	4
Rail								
Paducah	770	1,500,000	47	0.03	77	0.05	2×10^{-3}	0.7
Portsmouth	380	1,100,000	37	0.02	58	0.04	2×10^{-3}	0.5

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000. Under the Truck Option, the number of shipments would be those sent directly to the disposal facilities. Under the Rail Option, the same number of rail shipments would leave either Paducah or Portsmouth under all disposal site alternatives, but because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo would be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for the NNSS under "Rail/Truck" in this table.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles, multiply kilometers by 0.6215.

Table B-5a Total Risks to Crew Members and Populations from Transporting Empty and Heel Cylinders under Each Disposal Alternative

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonradiological Risk[b]
Energy*Solutions* Disposal Alternative								
Truck								
Paducah	4,240	10,900,000	0.1	8×10^{-5}	0.3	2×10^{-4}	1×10^{-7}	0.6
Portsmouth	2,760	8,500,000	0.1	6×10^{-5}	0.3	2×10^{-4}	6×10^{-8}	0.4
Rail								
Paducah	140	390,000	0.1	7×10^{-5}	0.1	9×10^{-5}	7×10^{-7}	0.09
Portsmouth	90	290,000	0.09	5×10^{-5}	0.1	7×10^{-5}	9×10^{-7}	0.08
NNSS Disposal Alternative								
Truck								
Paducah	4,240	13,600,000	0.2	1×10^{-4}	0.4	3×10^{-4}	6×10^{-8}	0.6
Portsmouth	2,760	10,300,000	0.1	7×10^{-5}	0.3	2×10^{-4}	5×10^{-8}	0.5
Rail/Truck [a]								
Paducah	4,380	1,900,000	0.1	9×10^{-5}	0.2	1×10^{-4}	6×10^{-7}	0.1
Portsmouth	2,850	1,290,000	0.1	7×10^{-5}	0.2	1×10^{-4}	8×10^{-7}	0.1
WCS Disposal Alternative								
Truck								
Paducah	4,240	7,200,000	0.09	5×10^{-5}	0.2	1×10^{-4}	6×10^{-8}	0.5
Portsmouth	2,760	6,300,000	0.08	5×10^{-5}	0.2	1×10^{-4}	8×10^{-8}	0.4
Rail								
Paducah	140	280,000	0.09	5×10^{-5}	0.1	8×10^{-5}	1×10^{-6}	0.1
Portsmouth	90	270,000	0.09	5×10^{-5}	0.1	8×10^{-5}	1×10^{-6}	0.1

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000. Under the Truck Option, the number of shipments would be those sent directly to the disposal facilities. Under the Rail Option, the same number of rail shipments would leave either Paducah or Portsmouth under all disposal site alternatives, but because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo will be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for NNSS under "Rail/Truck" in this table.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles, multiply kilometers by 0.6215.

Nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks, with an estimate of up to 12 fatalities for the duration of the analysis. Considering the transportation activities analyzed in this DU Oxide SEIS are assumed to occur over a 34-year period and the average number of traffic fatalities in the United States is about 33,000 per year (DOT 2011) or 1,122,000 fatalities over 34 years, the additional traffic fatality risk under all alternatives would be very small. See Section B.8 for further discussion of accident fatality rates.

DOE is also considering the option of transport of DU oxide to the disposal facility using bulk bags consistent with the analysis presented in the 2004 EISs (DOE 2004a, 2004b). It is estimated that there would be 20,150 and 9,070 truck shipments and 5,130 and 2,270 rail shipments from Paducah and Portsmouth, respectively, using consistent assumptions as those used in the 2004 EISs. Because the amount of DU oxide evaluated in this SEIS is larger than that evaluated in the 2004 EISs, the bulk bag transportation risks presented in this SEIS are proportionally larger than those cited in the 2004 EISs. If the bulk bags are used, then, the empty and heel cylinders also need to be transported to the disposal sites. It is assumed that the cylinders would be volume-reduced and packaged 10 in a 20-ft intermodal container and transported one container per truck and two containers per train. The 2004 EISs also considered that about 10 percent of the cylinders could not be accepted at the Energy*Solution*, therefore, these cylinders would be transported intact to NNSS. The 2004 EISs assume that rail connections will be available at NNSS; therefore, no intermodal facility near the NNSS was used. The risks of transporting the volume-reduced cylinders are calculated using information from the 2004 EISs, and those for the intact cylinders are calculated using the same assumptions used in Table 5-A in this DU Oxide SEIS. Note that the results presented for the impacts of transporting DU oxide in bulk bags and volume-reduced empty and heel cylinders are based on assumptions and information from the 2004 EISs regarding populations along the routes that are different from those considered for transporting DU oxides in cylinders to Energy*Solutions* and NNSS as analyzed in this DU Oxide SEIS. Nevertheless, the impacts from the 2004 EISs have been scaled where appropriate to provide information on potential impacts for the larger amount of DU oxide that would be shipped to Energy*Solutions* and NNSS under the alternatives evaluated in this DU Oxide SEIS.

In addition, if DOE is unable to sell the hydrogen fluoride (HF), the HF could be convereted to CaF_2 for disposal as LLW. Approximately 25,262 bulk bags of CaF_2 at Paducah and 13,559 bulk bags at Portsmouth were analyzed in the 2004 EISs (DOE 2004a, 2004b), while 32,417 bulk bags of CaF_2 at Paducah and 13,554 bulk bags of CaF_2 at Portsmouth would be expected under the quantitites analyzed in this DU Oxide SEIS.

Table B-5b shows the risks of transporting DU oxide in bulk bags to Energy*Solutions* and NNSS under each alternative using truck and/or rail transport methods. **Table B-5c** shows the risks for transporting empty and heel cylinders to Energy*Solutions* and NNSS under each alternative. The risks were calculated by multiplying the calculated per-shipment factors for similar impacts presented in the 2004 EISs (DOE 2004a, 2004b) by the number of shipments over the duration of the project and, for radiological doses, by the health risk conversion factors. Table B-5b indicates that disposal at NNSS would have a higher radiological risk to the population during incident-free transportation than the other alternatives because this location results in the farthest transportation distances, passes near the largest population, and additional truck transports from an intermodal facility to NNSS are required for the rail transport option.

Table B-5b Total Risks to Crew Members and Populations from Transporting Depleted Uranium Oxide in Bulk Bags under Each Disposal Alternative

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonradiological Risk[b]
Energy*Solutions* Disposal Alternative								
Truck								
Paducah[c]	20,510	52,099,000	300	0.2	137	0.08	3×10^{-2}	2
Portsmouth[d]	9,070	26,515,000	154	0.09	72	0.04	2×10^{-2}	1
Rail								
Paducah[c]	5,130	13,759,000	700	0.4	26	0.02	7×10^{-3}	0.6
Portsmouth[d]	2,270	7,507,000	359	0.2	17	0.01	6×10^{-3}	0.5
NNSS Disposal Alternative								
Truck								
Paducah[c]	20,510	57,758,000	337	0.2	162	0.1	1×10^{-2}	3
Portsmouth[d]	9,070	30,493,000	185	0.1	84	0.05	1×10^{-2}	1
Rail[e]								
Paducah[c]	5,130	17,596,000	837	0.5	27	0.02	7×10^{-3}	0.8
Portsmouth [d]	2,270	9,112,000	421	0.3	16	0.01	5×10^{-3}	0.5
WCS Disposal Alternative								
No analyses was performed in 2004 Conversion EISs for transport of DU oxide in bulk bag to WCS, therefore, no proportionality analyses can be performed for this alternative. The risk risk in terms of crew or population dose from transporting DU oxide in bulk bags to WCS would be less than or equal to those calculated for Energy*Solutions* or NSSS, based on the results of the analysis of transport of DU oxide in cylinders (see Table B-5).								

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; WCS = Waste Control Specialists.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Tables 5.2-21 (for Energy*Solutions*) and 5.2-22 (for NNSS) of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 (for Energy*Solutions*) and 5.2-27 (for NNSS) of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] The 2004 EISs considered rail connections will be available, therefore, there will be no intermodal facility as that considered in this SEIS. Hence, there will be no additional truck transports in this calculation.

Note: To convert kilometers to miles, multiply the kilometer numbers by 0.6215.

Table B-5c Total Risks to Crew Members and Populations from Transporting Empty and Heel Cylinders Under Each Disposal Alternative

Origin	Number of Shipments[a]	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population		Radiological Risk[b]	Nonradiological Risk[b]
			Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]		
Energy*Solutions* Disposal Alternative								
Truck (volume-reduced packaging)								
Paducah[c]	4,970	12,497,000	73	4×10^{-2}	40	2×10^{-2}	3×10^{-4}	0.6
Portsmouth[d]	2,550	7,453,000	44	3×10^{-2}	24	1×10^{-2}	2×10^{-4}	0.3
Rail (volume-reduced packaging)								
Paducah[c]	2,460	6,600,000	185	1×10^{-1}	7	4×10^{-3}	6×10^{-5}	0.3
Portsmouth[d]	1,275	4,216,000	112	7×10^{-2}	5	3×10^{-3}	6×10^{-5}	0.3
NNSS Disposal Alternative								
Truck (volume-reduced packaging)								
Paducah[c]	4,970	13,853,000	81	5×10^{-2}	45	3×10^{-2}	1×10^{-4}	0.6
Portsmouth[d]	2,550	8,574,000	52	3×10^{-2}	28	2×10^{-2}	1×10^{-4}	0.3
Rail[e] (volume-reduced packaging)								
Paducah[c]	2,460	8,435,000	225	1×10^{-1}	7	4×10^{-3}	6×10^{-5}	0.4
Portsmouth[d]	1,275	5,118,000	127	8×10^{-2}	5	3×10^{-3}	4×10^{-5}	0.3
Disposal at NNSS[f]								
Truck (intact cylinders)[f]								
Paducah[c]	2,730	8,885,000	0.1	6×10^{-5}	0.3	2×10^{-4}	1×10^{-7}	0.4
Portsmouth[d]	1,420	5,351,000	0.06	4×10^{-5}	0.2	1×10^{-4}	4×10^{-8}	0.2
Rail[e] (intact cylinders)[f]								
Paducah[c]	50	168,000	0.05	3×10^{-5}	0.06	3×10^{-5}	2×10^{-7}	0.04
Portsmouth[d]	20	80,000	0.02	1×10^{-5}	0.03	2×10^{-5}	1×10^{-7}	0.02
WCS Disposal Alternative								
No analyses was performed in 2004 Conversion EISs for transport of volume-reduced empty or heel cylinders to WCS, therefore, no proportionality analyses can be performed for this alternative. The risk in terms of crew or population dose from transporting the volume-reduced empty and heel cylinders to WCS would be less than or equal to those calculated for Energy*Solutions* or NSSS, based on the results of the transport of DU oxide in cylinders (see Table B-5).								

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCFs[b]	Dose (person-rem)	LCFs[b]	Radiological Risk[b]	Nonradiological Risk[b]

Key: LCF = latent cancer fatality; NNSS = Nevada National Security Site; WCS= Waste Control Specialists.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Tables 5.2-21 (for Energy*Solutions*) and 5.2-22 (for NNSS) of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 (for Energy*Solutions*) and 5.2-27 (for NNSS) of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] Conversion EISs considered rail connections will be available, therefore, there will be no intermodal facility as that considered in this SEIS. Hence, there will be no additional truck transports in this calculation.

[f] The intact cylinders represent transport of 10 percent of the total empty and heel cylinders, which are 83,000 (69,000 plus 14,000). The calculated doses and risks are based on the information provided in Table 5A of this DU Oxide SEIS, assuming that the intact cylinders are transported two per truck and 60 per rail. These cylinders are transported to NNSS, when the disposal facility is other than NNSS. In addition, For the volume-reduced packages, the 2004 EISs assumed that direct rail connections will be available at NNSS.

Note: To convert kilometers to miles, multiply the kilometer numbers by 0.6215.

Nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks, with an estimate of up to 4 fatalities for the duration of the analysis. Considering the transportation activities analyzed in this DU Oxide SEIS are assumed to occur over a 32-year period and the average number of traffic fatalities in the United States is about 33,000 per year (DOT 2011), the additional traffic fatality risk under all alternatives would be very small.

The risks to various exposed individuals under incident-free transportation conditions were estimated for the hypothetical exposure scenarios identified in Section B.6.3. The maximum estimated doses to workers and the public MEIs are presented in **Table B-6**, considering all shipment types. Doses are presented on a per-event basis (rem per event, per exposure, or per shipment), because it is generally unlikely that the same person would be exposed to all shipments. For those individuals that could have multiple exposures, the cumulative dose was calculated.

Table B-6 Estimated Dose to Maximally Exposed Individuals under Incident-Free Transportation Conditions

Receptor	Dose to Maximally Exposed Individual
Workers	
Crew member (truck/rail driver)	2 rem per year[a]
Inspector	2.9×10^{-3} rem per event per hour of inspection
Rail yard worker	1.1×10^{-3} rem per event
Public	
Resident (along the truck route)	3.1×10^{-8} rem per event
Resident (along the rail route)	1.1×10^{-7} rem per event
Person in traffic congestion	2.4×10^{-3} rem per event per one hour stop
Resident near rail yard during classification	1.5×10^{-5} rem per event
Person at a rest stop/gas station	2.0×10^{-5} rem per event per hour of stop
Gas station attendant	2.6×10^{-5} rem per event

Key: rem = roentgen equivalent man.

[a] In addition to complying with DOT requirements, a DOE employee would also need to comply with 10 CFR Part 835, which limits worker radiation doses to 5 rem per year; however, DOE's goal is to maintain radiological exposure to achieve ALARA goals. DOE has therefore established the Administrative Control Level of 2 rem per year (DOE 2017). Based on the number of shipments, the total crew dose per shipment to two drivers in Table B-4, and the number of commercial trucks per day (about 6),[64] a commercial driver dose would not exceed this administrative control limit. Therefore, the administrative control limit is reflected in this table (Table B-6) for the maximally exposed truck crew member.

The maximum dose to a crew member, as shown in Table B-6, was based on the assumption that the same individual would be responsible for driving multiple shipments until the administrative limit is reached. Note that the potential exists for larger individual exposures under one-time events of a longer duration. For example, the maximum dose to a person stuck in traffic next to a shipment of DU oxide LLW for 1 hour was calculated to be 2.4×10^{-3} rem (2.4 millirem). This was generally considered a one-time event for that individual, although this individual may encounter another exposure of a similar or longer duration in his or her lifetime. An inspector inspecting the

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[64] The maximum number of truck shipments originates from Paducah with an average number of shipments per year of 1,440, which leads to an average of about six truck shipments per day.

conveyance and its cargo would be exposed to a maximum dose rate of 2.9×10^{-3} rem (or 2.9 millirem) per hour if the inspector stood within 1 meter of the cargo for the duration of the inspection.

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The total dose to this resident was calculated by assuming all shipments pass his or her home. The total dose also was calculated assuming that the resident was present for every shipment and was unshielded at a distance of about 30 meters (98 feet) from the route. Therefore, the total dose depends on the number of shipments passing a particular point and is independent of the actual route being considered. Assuming the maximum resident dose provided in Table B-6 for all radioactive shipments, the maximum dose to this resident on a truck route, if all the materials were shipped via this route, would be, about 1.4×10^{-3} rem (1.4 millirem) for the estimated 46,150 truck transports from Paducah over 34 years, and about 7.1×10^{-4} rem (0.71 millirem) for the estimated 22,850 truck transports from Portsmouth over 22 years. A resident living along a rail route, if exposed to all rail shipments, would receive a dose of about 8.6×10^{-5} rem (0.086 millirem) for the estimated 770 rail shipments from Paducah, and 4.2×10^{-5} for the estimated 380 rail shipments from Portsmouth. The doses from transporting the empty and heel cylinders and ancillary LLW and MLLW would be a factor of 100 less, and therefore an insignificant contribution when compared to the doses from DU oxide shipments. CaF_2 would contain little or no radionuclide contamination and therefore transportation of CaF_2 would result in little or no dose.

The accident risk assessment and the impacts shown in Table B-5 take into account the entire spectrum of potential accidents, from minor accidents (i.e., fender-benders) to extremely severe accidents (i.e., high-speed collisions). To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequence assessment was performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence greater than 1 chance in 10 million per year.

The following assumptions were used to estimate the consequences of maximum reasonably foreseeable off-site transportation accidents:

- The accident is the most severe with the highest release fraction (high-impact and high-temperature fire accident [highest severity category]).
- The individual is 100 meters (330 feet) downwind from a ground release accident.
- The individual is exposed to airborne contamination for 2 hours and ground contamination for 24 hours, with no interdiction or cleanup. A stable weather condition (Pasquill Stability Class F) with a wind speed of 1 meter per second (2.2 miles per hour) was assumed.
- The population was assumed to have a uniform density to a radius of 80 kilometers (50 miles) and be exposed to the entire plume passage and 7 days of ground exposure, without interdiction and cleanup. A neutral weather condition (Pasquill Stability Class D) with a wind speed of 4 meters per second (8.8 miles per hour) also was assumed. Because

the consequence would be proportional to the population density, the accident was assumed to occur in an urban[65] area with the highest density (see Table B-1).

Table B-7 provides the estimated dose and risk to an individual and population from maximum reasonably foreseeable truck and rail transportation accidents with the highest consequences under each alternative. Only those accidents with a probability greater than 1×10^{-7} (1 chance in 10 million) per year were analyzed. The accident was assumed to be a severe impact in conjunction with a long fire. The highest consequences for the maximum reasonably foreseeable accident, based on population dose, would be from accidents occurring in an urban area via all rail routes, as part of the transport to the Energy*Solutions* site, and via truck routes as part of the transport to NNSS.

Table B-7 Estimated Dose to the Population and to Maximally Exposed Individuals under the Maximum Reasonably Foreseeable Accident

Transport Mode	Material or Waste in the Accident With the Highest Consequences	Applicable Alternatives	Maximum Likelihood of the Accident (per year)	Population Zone	Population[a]		MEI[b]	
					Dose (person -rem)	LCFs	Dose (rem)	Increased Probability of a Fatal Cancer
Truck transport to disposal site[c]	LLW(DU Oxide)	All	5.3×10^{-7}	Urban	7.7	5×10^{-3}	6.4×10^{3}	4×10^{-6}
Rail transport to disposal site[d]	LLW(DU Oxide)	All	1.5×10^{-7}	Urban	47.3	3×10^{-2}	3.9×10^{2}	2×10^{-5}
Truck transport to disposal sit [d]	LLW(DU Oxide)	All	3.8×10^{-5}	Suburban	2	1×10^{-3}	6.4×10^{3}	4×10^{-6}
Rail transport to disposal site[e]	LLW(DU Oxide)	All	4.1×10^{-6}	Suburban	11	7×10^{-3}	3.9×10^{2}	2×10^{-5}

Key: DU = depleted uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual.

[a] The population extends at a uniform density to a radius of 50 miles. The weather condition was assumed to be Pasquill Stability Class D, with a wind speed of 8.8 miles per hour.

[b] The MEI was assumed to be at a distance downwind from the accident that would maximize exposure and to be exposed to the entire plume of the radioactive release. The weather condition was assumed to be Pasquill Stability Class F, with a wind speed of 2.2 miles per hour.

[c] The maximum dose and frequency would occur for transports to NNSS.

[d] The maximum dose and frequency would occur for transports to Energy*Solutions*.

[e] The maximum dose and frequency would occur for transports to WCS.

B.9 LONG-TERM IMPACTS OF RADIOACTIVE MATERIAL TRANSPORTATION

The *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015a) analyzed the cumulative impacts of the transportation of radioactive material, consisting of impacts of historical shipments of radioactive waste and used nuclear fuel, reasonably foreseeable actions that include transportation of radioactive material, and general radioactive material transportation that was not related to a particular action. The collective dose to the general population and workers was the measure used to quantify cumulative transportation impacts. This

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[65] If the likelihood of an accident in an urban area is less than 1 chance in 10 million per year, then the accident was evaluated for a suburban area.

measure of impact was chosen because it may be directly related to the LCFs using a cancer risk coefficient. **Table B-8** provides an updated summary of the total worker and general population collective doses from various transportation activities involving the shipment of radioactive materials. The table shows that the potential impacts of transportation related to this DU Oxide SEIS would be small compared with the overall transportation impacts.

The total collective worker dose from all types of shipments that are not associated with this DU Oxide SEIS (historical, reasonably foreseeable actions; and general transportation) was estimated to be about 423,000 person-rem (potentially resulting in 253 LCFs) for the period from 1943 through 2073 (131 years) (DOE 2015a). Note the potential doses from transport of radioactive materials associated with the alternatives evaluated in this DU Oxide SEIS would be very small and would be insignificant compared to the dose from other nuclear material shipments. The total general population collective dose was estimated to be about 437,000 person-rem (potentially resulting in 262 LCFs). The majority of the collective dose for workers and the general population would be due to the general transportation of radioactive material (see Table B-8). Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of LLW to commercial disposal facilities.

Table B-8 Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2073)

Category	Collective Worker Dose (person-rem)	Collective General Population Dose (person-rem)
Transportation Impacts in this DU Oxide SEIS[a]	155 to 655[b] 84 to 1,610[c]	403 to722[b] 135 to 216[c]
Transportation Impacts from Appendix C of this DU Oxide SEIS, Impacts of the Management of Commercially Generated DUF_6	25 to 135[b] 13 to 310[c]	66 to 144 21 to 43
Subtotal	180 to 790[b] 97 to 1,920[c]	469 to 866[b] 156 to 259[c]
Other Nuclear Material Shipments[e]		
Past, Present, and Reasonably Foreseeable DOE Actions	31,400	36,900
Past, Present, and Reasonably Foreseeable non-DOE Actions	5,380	61,300
General Radioactive Material Transport (1943 to 2073)	384,000	338,000
Total Collective Dose (up to 2073)[f]	**423,000**	**437,000**
Total Latent Cancer Fatalities[g]	**253**	**262**

Key: DOE = Department of Energy; SEIS = supplemental environmental impact statement.

[a] Range of values from Table B-5, reflecting the sum impact values from Paducah and Portsmouth to each disposal site.

[b] Transport by truck.

[c] Transport by truck/rail.

[d] This is the maximum amongst the three disposal alternatives

[e] From the Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement (DOE 2015a); this reference provides the details of all contributing actions.

[f] Total includes the maximum values from the DU Oxide SEIS alternatives. Total may not equal the sum of the contributions due to rounding. Rounded to nearest 1,000.

[g] Total LCFs were calculated assuming 0.0006 LCF per rem of exposure (DOE 2003).

The total number of potential LCFs (among the workers and the general population) estimated to result from radioactive material transportation over the period between 1943 and 2073 would be about 515 (262 from workers and 253 from the general population) (DOE 2015a). These potential

LCFs averaged over 131 years would lead to about 4 LCFs per year. Over this same period (131 years), about 75 million people would die from cancer, based on the average annual number of cancer deaths in the United States of about 573,000, with no more than a 3 percent fluctuation in the number of cancer fatalities in any given year (CDC 2009 through 2016). The transportation-related LCFs would be 0.0003 percent of the total number of cancer deaths; therefore, this number is indistinguishable from the natural fluctuation in the total annual death rate from cancer.

B.10 CONCLUSIONS

Based on the results presented in the previous sections, the following conclusions have been reached (see Tables B-4 to B-7):

- For all alternatives, it is unlikely that transportation of radioactive waste would cause an additional fatality as a result of radiation exposure, either from incident-free transport or postulated transportation accidents.

- The highest risk to the public due to incident-free transportation would occur for DU oxide transport in cylinders by truck under the NNSS Disposal Alternative (722 person-rem, 0.4 LCF) because it is the farthest site among the disposal sites and passes through the largest population (see Table B-5).

- The highest risk to the crew due to incident-free transportation would occur for DU oxide transport in bulk bags by rail under the NNSS Disposal Alternative (744 person-rem, 1 LCF) because it is the farthest site among the disposal sites (see Table B-5).

- The nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present greater risks (up to 12 potential fatalities) than the radiological accident risks. For comparison, in the United States in 2012, there were over 4,100 fatalities due to crashes involving large trucks (DOT 2014) and over 32,000 traffic fatalities due to all vehicular crashes (DOT 2012). The incremental increase in risk to the general population from shipments from both Paducah and Portsmouth would therefore be very small and would not substantially contribute to cumulative impacts.

B.11 UNCERTAINTY AND CONSERVATISM IN ESTIMATED IMPACTS

The sequence of analyses performed to generate the estimates of radiological risk for transportation includes: (1) determination of the inventory and characteristics, (2) estimation of shipment requirements, (3) determination of route characteristics, (4) calculation of radiation doses to exposed individuals (including estimating environmental transport and uptake of radionuclides), and (5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models; in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns caused simply by the future nature of the actions being analyzed); and in the calculations themselves (for example, approximate algorithms used within the computer codes).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design is accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The reality and conservatism of the assumptions are addressed. Where practical, the parameters that most significantly affect the risk assessment results are identified.

B.11.1 Uncertainties in Material Inventory and Characterization

The inventories and the physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential numbers of shipments under all alternatives were primarily based on the projected dimensions of package contents, the strength of the radiation field, and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

Uncertainties in the inventory and characterization are reflected in the transportation risk results. If the inventory is overestimated (or underestimated), the resulting transportation risk estimates also will be overestimated (or underestimated) by roughly the same factor. However, the same inventory estimates were used to analyze the transportation impacts of each of the alternatives. Therefore, for comparative purposes, the observed differences in transportation risks among the alternatives, as given in Table B-5, are believed to represent unbiased, reasonably accurate estimates from current information in terms of relative risk comparisons.

B.11.2 Uncertainties in Containers, Shipment Capacities, and Number of Shipments

The transportation requirement for each alternative was based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks. Representative shipment capacities were defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities, such that the projected number of shipments and, consequently, the total transportation risk, would change. However, although the predicted transportation risks may increase or decrease accordingly, the relative differences in risks among alternatives would remain about the same.

B.11.3 Uncertainties in Route Determination

Analyzed routes were determined between Paducah and Portsmouth, and the disposal sites evaluated in this DU Oxide SEIS. The routes were determined to be consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the ones that are analyzed with regard to distances and total populations along the routes. Moreover, because materials could be transported over an extended time starting in the future, the highway infrastructure and the demographics along the routes could change. These effects were not accounted for in the transportation assessment; however, such changes are not expected to significantly affect the relative comparisons of risk among the alternatives considered in this DU Oxide SEIS.

B.11.4 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce a further uncertainty. Estimating the accuracy or absolute uncertainty of the risk assessment results is generally difficult. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN 6.02 (SNL 2013), or any computer code of this type, is the availability of data for certain input parameters. Populations (off-link and on-link) along the transportation routes, shipment surface dose rates, and the locations of individuals residing near the routes are among the most uncertain data in dose calculations. In preparing these data, one makes assumptions that the off-link population is uniformly distributed; the on-link population is proportional to the traffic density, with an assumed occupancy of two persons per car; the shipment surface dose rate is the maximum allowed dose rate; and a potential exists for an individual to be residing at the edge of the highway. Clearly, not all assumptions are accurate. For example, the off-link population is mostly heterogeneous, and the on-link traffic density varies widely within a geographic zone (urban, suburban, or rural). Finally, added to this complexity are the assumptions regarding the expected distance between the public and the shipment at a traffic stop, rest stop, or traffic jam, and the afforded shielding.

Uncertainties associated with the computational models were reduced by using state-of-the-art computer codes that have undergone extensive review. Because many uncertainties are recognized, but difficult to quantify, assumptions were made at each step of the risk assessment process that were intended to produce conservative results (that is, to overestimate the calculated dose and radiological risk). Because parameters and assumptions were applied consistently to all alternatives, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

B.11.5 Uncertainties in Traffic Fatality Rates

Vehicle accident and fatality rates were taken from Saricks and Tompkins 1999, as updated using UMTRI 2003. Truck and rail accident rates were computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers, and the Federal Railroad Administration from 1994 to 1996. The statistics are provided in terms of unit car-kilometers for each state, as well as national average and mean values. In this analysis, route-specific (origin-destination) rates were used.

Finally, it should be emphasized that the analysis was based on accident data for the years 1994 through 1996. While these data are considered to be the best available data, future accident and fatality rates may change due to vehicle and highway improvements. More-recent DOT national accident and fatality statistics for large trucks and buses indicate lower accident and fatality rates for recent years (DOT 2009) compared to those of 1994 through 1996 and earlier statistical data.

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APPENDIX C

IMPACTS OF THE MANAGEMENT OF COMMERCIALLY GENERATED DEPLETED URANIUM HEXAFLUORIDE

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ACRONYMS

AQCR	Air Quality Control Region
AQI	Air Quality Index
CaF_2	calcium fluoride
CO_2e	carbon dioxide equivalent
DU	depleted uranium
DUF_6	depleted uranium hexafluoride
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planing Guideline
FR	Federal Register
GHG	greenhouse gas
HF	hydrogen fluoride
HI	hazard index
LCF	latent cancer fatality
LLW	low-level radioactive waste
mg	milligram
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NH_3	anhydrous ammonia
NNSS	Nevada National Security Site
NRC	U.S. Nuclear Regulatory Commission
$PM_{2.5}$	particulate matter with a diameter of less than or equal to 2.5 microns
ppm	parts per million
ROI	region of influence
SAAQS	State Ambient Air Quality Standards
U.S.C.	*United States Codes*
WCS	Waste Control Specialists

APPENDIX C: IMPACTS OF THE MANAGEMENT OF COMMERCIALLY GENERATED DEPLETED URANIUM HEXAFLUORIDE

C.1 INTRODUCTION

Commercial uranium enrichment facilities may request that DOE dispose of their depleted uranium hexafluoride (DUF_6). Section 3113(a) of the United States Enrichment Corporation Privatization Act (Title 42 of the *United States Code* Section [U.S.C. §] 7h-11[a]) and Section 66 of the Atomic Energy Act of 1954 (as amended) (42 U.S.C. § 2011 et seq.), requires DOE to accept low-level radioactive waste (LLW), including commercial DUF_6 determined to be LLW, for disposal upon request and reimbursement of the cost by any generator licensed by the U.S. Nuclear Regulatory Commission (NRC) to operate a uranium enrichment facility. Therefore, this appendix analyzes the environmental impacts of the reasonably foreseeable receipt, conversion, storage, handling, and disposal of commercial DUF_6 from uranium enrichment facility licensees.

C.2 BACKGROUND AND ASSUMPTIONS

As described in Chapter 1, Section 1.1, of this DU Oxide SEIS, at its peak, Paducah stored approximately 560,000 metric tons of DOE DUF_6 (46,000 DUF_6 cylinders), and Portsmouth stored approximately 250,000 metric tons of DOE DUF_6 (21,000 DUF6 cylinders). This appendix analyzes the management of an additional 150,000 metric tons (approximately 12,500 cylinders[66]) of commercial DUF_6. For purposes of analysis in this DU Oxide SEIS and as a conservative measure of impacts, DOE has assumed that the entire mass of commercial DUF_6 (150,000 metric tons) could be managed at Paducah or Portsmouth.

Consistent with the decision to convert DOE DUF_6 to DU oxide (69 FR 44654; 69 FR 44649, July 27, 2004), DOE is assuming the commercial material would be converted to DU oxide at Paducah or Portsmouth. Based on the conversion rates of DUF_6 to DU oxide of 18,000 metric tons per year at Paducah, and 13,500 metric tons per year at Portsmouth (PPPO 2018), the conversion of 150,000 metric tons of commercial material could add 8 years to the conversion operations at Paducah, or 11 years to the conversion operations at Portsmouth.

As described in Chapter 2 of this DU Oxide SEIS, DOE has evaluated a No Action Alternative and three Action Alternatives for management of DOE DU oxide. As described in Chapter 2, Section 2.2.1, under the No Action Alternative, the DOE DU oxide containers would remain in storage at the Paducah and Portsmouth Sites (Paducah and Portsmouth) indefinitely.[67] As

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[66] Assuming 12-metric ton cylinders are used.

[67] For analysis purposes in this DU Oxide SEIS, the potential impacts of storage are evaluated for 100 years beginning with storage of the first DOE DU oxide cylinders in 2011 and ending in 2110. Based on the rate of conversion of DUF_6 to DU oxide, DOE estimates that conversion activities will be completed and the last DOE DU oxide cylinders produced between 2044 and 2054 at Paducah, and between 2032 and 2042 at Portsmouth. Storage under the No Action Alternative could extend beyond the 100 years analyzed in this DU Oxide SEIS. Storage for longer than 100 years would not change the maximum annual impacts of operations but would extend the impacts described in this SEIS further out in time. The contributions attributable to those facilities to total life-cycle impacts, such as those for total worker and population dose and latent cancer fatalities (LCFs), and total waste

described in Chapter 2, Section 2.2.2, under the Action Alternatives, the DOE DU oxide containers would be shipped to one or more of three disposal facilities and therefore would not remain in storage indefinitely. In order to be consistent with the alternatives for storage and disposal of the DOE DU oxide, this appendix analyzes two scenarios for the commercial DUF_6: (1) Conversion and Storage and (2) Conversion and Disposal. Under the Conversion and Storage Scenario, the commercial DUF_6 would be converted to DU oxide and stored for 100 years. Under the Conversion and Disposal Scenario, the commercial DUF_6 would be converted to DU oxide and shipped off site for disposal.

DOE expects that the impacts of conversion of a given amount of commercial DUF_6 would be the same as the impacts of conversion of the same amount of DOE DUF_6. Therefore, the annual impacts for DUF_6 to DU oxide conversion that are presented in the 2004 EISs, would be expected to be the same for commercial material.

The estimated cylinder breach rates shown in Table 2-2 were used to calculate the number of cylinders that could be breached under the various corrosion scenarios and storage periods. For "uncontrolled corrosion," DOE has assumed that historic cylinder breach rates described in Chapter 2, Section 2.2.1, would apply to the approximately 12,500 cylinders that could come from managing the commercial DUF_6. The results of these estimates are presented in **Table C-1** and are used in the impact analyses presented in this appendix. Because storage conditions have improved dramatically as a result of cylinder yard upgrades and restacking activities, it is expected

Table C-1 Estimate of Potential Cylinder Breaches During Storage of Commercial DUF_6/DU Oxide

Site	Number of Cylinders	Scenario	Storage Period (years)[a]	Number of Breaches[b]	
				Controlled Corrosion	Uncontrolled Corrosion
Paducah	12,500	Conversion and Storage	100	31[b]	383 [b]
		Conversion and Disposal	84	26	322
Portsmouth	12,500	Conversion and Storage	100	31[b]	144[b]
		Conversion and Disposal	58	18	83

Note: This table is based on information from Chapter 2, Tables 2-1 and 2-2, of this DU Oxide SEIS.

[a] Conservatively assumes that all 12,500 cylinders are stored for the entire analysis period. In order to produce a conservative estimate of the number of cylinder breaches, the maximum storage period was analyzed for the conversion and disposal scenario (i.e., 84 years at Paducah and 58 years at Portsmouth). The maximum storage period for Paducah includes the storage of DU oxide containers for the 44 years of conversion facility operation, plus 32 years to ship all the DOE DU oxide containers to the disposal facility, plus 8 years to ship all the commercial DU oxide containers to the disposal facility. The maximum storage period for Portsmouth includes the storage of DU oxide containers for the 32 years of conversion facility operation, plus 15 years to ship all the DOE DU oxide containers to the disposal facility, plus 11 years to ship all the commercial DU oxide containers to the disposal facility.

[b] Annual rates can be estimated by dividing the total number of cylinder breaches by the duration of the storage period in years.

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generation, would increase in proportion to the extended period. These impacts can be estimated from the analyses provided in this DU Oxide SEIS under the No Action Alternative by multiplying the additional years of operation by the annual impacts.

that these breach estimates based on historical corrosion rates provide a worst case for estimating the potential impacts from cylinder storage. "Controlled corrosion" assumes that the planned cylinder maintenance program and improved storage conditions would maintain the cylinders in a protected condition.

As described in Chapter 2, Section 2.2.2 of this DU Oxide SEIS, under the Action Alternatives, a total of 1,440 DU oxide cylinders would be transported in 24 rail shipments annually from each site to the disposal facilities. At this rate, it would take approximately 9 years to transport all the commercial DU oxide cylinders by rail from Paducah or Portsmouth. Because truck shipments would be made by legal-weight semitrailer trucks, it is expected that only one cylinder of DU oxide would be loaded on each truck. Assuming 1,440 truck shipments were made each year from each site, it would take approximately 9 years to transport all the DU oxide cylinders from Paducah or Portsmouth to the disposal facilities.

Assuming 5 percent of the commercial DUF_6 cylinders were not able to be reused (PPPO 2018), another 11 rail shipments would be needed from Paducah or Portsmouth to transport the 625 unusable empty and heel cylinders to the disposal site. These shipments would require approximately 6 months at Paducah or Portsmouth if they all occurred one after the other. Unusable empty and heel cylinders would weigh much less than the DU oxide cylinders, so each truck could carry two cylinders. Assuming 5 percent of the commercial DUF_6 cylinders were not able to be reused (PPPO 2018), another 313 truck shipments would be needed from Paducah or Portsmouth. Unusable empty and heel cylinders are assumed to be shipped during the 8 year duration of conversion operations at Paducah, or 11 years of conversion operations at Portsmouth.

As an option, this DU Oxide SEIS also evaluates the transport and disposal of DU oxide in bulk bags versus cylinders. It is estimated that approximately 10,986 bulk bags of DU oxide would be needed at Paducah or Portsmouth to dispose of the commercial DU oxide. It is assumed that 8 bulk bags would be shipped per railcar with 2 shipped per truck. This results in 1,373 rail and 5,493 truck shipments. In addition, under this option, 12,500 empty and heel cylinders would need to be volume-reduced and loaded on trucks for shipment to the disposal facilities. It is assumed that 10 volume-reduced cylinders would be transported in an intermodal shipping container, 2 containers per train or 1 container per truck. This results in 625 rail and 1,250 truck shipments. Bulk bags and volume-reduced cylinders are assumed to be shipped during the 8 year duration of conversion operations at Paducah, or 11 years of conversion operations at Portsmouth.

Likewise, approximately 8,084 bulk bags of CaF_2 at Paducah or Portsmouth would be expected, for the quantities of commercial DUF_6 analyzed in this DU Oxide SEIS, if the uranyl fluoride (HF) could not be sold and needed to be converted and disposed of as CaF_2. It is assumed that four bulk bag would be shipped per train with one shipped per truck. This results in 2,021 rail and 8,084 truck shipments. CaF_2 in bulk bags is assumed to be shipped during the 8 year duration of conversion operations at Paducah, or 11 years of conversion operations at Portsmouth.

This appendix considers the impact of management of the commercial DUF_6 and DU oxide for all the resource areas evaluated in Chapter 4 of this DU Oxide SEIS. Conversion of the DUF_6 to DU oxide in the existing facilities at Paducah or Portsmouth would not be expected to disturb any land areas. In addition, the commercial DUF_6 and DU oxide could be stored in a number of locations at Paducah or Portsmouth. DOE expects that existing storage pads in the industrialized portions of the sites would be used (PPPO 2018). Therefore, it is unlikely that there would be impacts on Geology and Soil, Land Use and Aesthetics, and Cultural Resources and these resource areas are not analyzed further.

The impacts of the receipt, conversion, storage, handling and disposal of 150,000 metric tons of commercial DUF_6 are evaluated below for Site Infrastructure; Air Quality, Climate, and Noise; Water Resources; Biotic Resources; Public and Occupational Safety and Health; Socioeconomics; Waste Management; Environmental Justice; and Resource Use. Impacts are evaluated for the Conversion and Storage and Conversion and Disposal Scenarios. The contributions to cumulative impacts of the management of commercial DUF_6 are considered in Chapter 4, Section 4.5.

The impacts of transportation of the DUF_6 cylinders from the commercial uranium enrichment facility to Paducah or Portsmouth is the responsibility of the commercial facility licensee and would be included in licensing documents and NEPA documents prepared by the licensee and the NRC. Therefore, these impacts are not included in this appendix but are considered in Chapter 4, Section 4.5.5.1 (Cumulative Impacts), of this DU Oxide SEIS.

C.3 SITE INFRASTRUCTURE

Impacts on site infrastructure could occur from DUF_6 cylinder storage, conversion of DUF_6 to DU oxide, DU oxide container storage, and loading DU oxide containers and other wastes for off-site disposal.

The management of the additional commercial DU would be conducted using the existing systems currently being used to store DUF_6 cylinders, convert DUF_6 to DU oxide, and store the DU oxide containers. The storage of the 12,500 cylinders associated with the commercial DUF_6 would likely be conducted alongside of existing cylinder storage at either Paducah or Portsmouth. There could be adequate storage capacity at both Paducah and Portsmouth to accommodate these additional cylinders pending shipment of DOE DU oxide off site (for beneficial reuse or disposal). Otherwise, additional cylinder yard storage could be required to accommodate the additional commercial cylinders. If additional storage space is needed, additional NEPA documentation would be prepared.

To the extent that the addition of these cylinders requires a long-term commitment of these storage areas, the inclusion of these cylinders in the site storage inventory could limit the availability of this space for other future uses. During the conversion process, this space commitment would be for a term of approximately 8 years at Paducah and 11 years at Portsmouth. During long-term storage, the storage space associated with these additional cylinders would not be available for other uses.

DOE expects that the impacts of conversion and management of a given amount of commercial DUF_6 would be the same as the impacts of conversion and management of the same amount of existing DOE DUF_6. Therefore, the primary impacts would be the extension of utility use for approximately 8 years at Paducah or 11 years at Portsmouth during operation of the conversion facility, and utility use during long-term storage of the DU oxide containers.

Table C-2 compares the estimated utility use for operation of the conversion facility with utility infrastructure capacity and current use at Paducah and Portsmouth. Both of the 2004 EISs concluded that no strategic or critical resources would be consumed and that the expected utility requirements would be well within the supply capacities at the sites (DOE 2004a, 2004b). Substantial infrastructure changes have occurred at both sites since the completion of the 2004 EISs, including the commissioning of five new natural gas-fueled boilers at Paducah in 2015 (DOE 2017a), and a similar natural gas-fueled steam plant commissioned at Portsmouth in 2012 (DOE 2017b). Although the electric and natural gas consumption patterns have changed at both sites since the 2004 EISs were completed, current consumption is still well within capacity.

Table C-2 Comparison of Utility Use for Conversion of Commercial DUF$_6$ with Site Utility Capacity and Current Use

	Conversion (DOE 2004a, 2004b)		Utility System	
Utility	**Average Use[a]**	**Peak Demand[b]**	**Capacity**	**Current Use[c]**
Paducah				
Electricity[d]	4.3 MWh[e]	7.1 MWh	3,040 MW	12 MWh[f]
Natural Gas[d]	44,000 mcf/yr[g]	190 scfm[h]	876,000 mcf/yr[i]	154,000 mcf
Process water	1.0×10^{5} gal/day[j]	215 gal/min	2.8×10^{7} gal/day[k]	3.4×10^{6} gal/day[l]
Potable water	8.2×10^{3} gal/day[m]	350 gal/min	8.6×10^{6} gal/day	6×10^{5} gal/day[l]
Steam	NR	NR	135,000 pounds/hour	100,000 pounds/hour[n]
Portsmouth				
Electricity[o]	3.6 MWh[p]	6.2 MWh	2,260 MW	20 to 40 MWh[q]
Natural Gas[o]	40,000 mcf/yr	180 scfm	NR[r]	366,000 mcf/yr
Process water	8.2×10^{4} gal/day[s]	215 gal/min	1.3×10^{7} gal/day[t]	1.9×10^{6} gal/day[u]
Potable water	8.2×10^{3} gal/day[v]	350 gal/min	1.8×10^{6} gal/day[w]	NR[x]
Steam	NR	NR	84,000 pounds/hour	26,800 pounds/hour [x]

Key: gal = gallon; mcf = 1000 cubic feet; mgd = million gallons per day; min = minute; MW = megawatt; MWH = megawatts per hour; NR = not reported; psia = standard atmospheric pressure; SCF = standard cubic feet measured at 14.7 psia and 60°F (17°C); scfm = standard cubic feet per minute.

Notes:

[a] Average use is a projected value based on design and planned operations (DOE 2004a, 2004b)

[b] Peak demand identified as maximum rate expected in any hour.

[c] 2017 average values are based on consumption measurements (DOE 2017a; PPPO 2018).

[d] The Paducah 2004 EIS notes that the operations at that time relied on electric heating, with a conversion to natural gas being planned (DOE 2004a). That conversion was completed in 2015 with the commissioning of five new natural gas boilers, resulting in a substantial reduction in site electric demand and consumption and a corresponding increase in natural gas demand in consumption (DOE 2017a).

[e] Paducah historic electric use calculated based on the reported 37,269 MWh/yr (DOE 2004a) assuming 8,760 hours per year.

[f] Estimated average electrical power demand for 2017 (PPPO 2018)

[g] Paducah natural gas annual average calculated based on reported annual average of 4.4×10^{7} SCF (DOE 2004a), which is represented as 44,000 mcf.

[h] DOE 2004a, Table 5.2-19.

[I] Paducah natural gas capacity identified as 100 mcf per hour (PPPO 2018). At 8,760 hours per year, total annual capacity identified as 876,000 mcf.

[j] Paducah projected daily process water demand calculated based on estimated 37×10^{6} gal/yr reported in the 2004 EIS (2004a).

[k] Paducah water withdrawal capacity is limited by a KDOW permit to 30 mgd (DOE 2017a).

[l] Paducah water consumption is estimated based on reported total withdrawal of up to 4 mgd, with 15% diversion for potable water use (PPPO 2018).

[m] Paducah projected daily potable water demand calculated based on estimated 3×10^{6} gal/yr reported in the 2004 EIS (DOE 2004a).

[n] Paducah current use of steam is an estimate of demand (PPPO 2018).

Utility	Conversion (DOE 2004a, 2004b)		Utility System	
	Average Use[a]	**Peak Demand[b]**	**Capacity**	**Current Use[c]**

[o] The 2004 Portsmouth EIS notes that the operations at that time relied on electric heating, with a conversion to natural gas being planned (DOE 2004b). That conversion occurred in 2012 with the commissioning of the new steam plant resulting in a substantial reduction in site electric use and a corresponding increase in natural gas consumption (DOE 2017b).

[p] Portsmouth electrical use calculated based on reported 31,840 MWh/yr (DOE 2004b) assuming 8,760 hours per year.

[q] Portsmouth electrical usage based on reported range of 20 to 40 megawatts per hour (DOE 2017a).

[r] Portsmouth natural gas capacity provided as a factor of pipe size (6 inch diameter) and pressure (350 to 400 pounds/square inch). Current capacity not disclosed.

[s] Portsmouth projected daily process water demand calculated based on estimated 30×10^6 gal/yr reported in the 2004 EIS (DOE 2004b).

[t] Portsmouth 2017 maximum water capacity is reported as 13×10^6 mgd (DOE 2017a).

[u] Portsmouth 2017 use estimated based upon reported approximate 707 million gallons of annual usage, or 1.94 million gallons per day (DOE 2017a).

[v] Portsmouth projected daily potable water demand calculated based on estimated 3×10^6 gal/yr reported in the 2004 EIS (DOE 2004b).

[w] Portsmouth recently upgraded its potable water system, providing a treatment capacity of approximately 1.8 mgd; current usage not reported.

[x] Portsmouth steam use estimate based on extrapolation of hourly use based on reported annual use of 235 million pounds per year and 8,760 hours per year.

Sources: DOE 2004a, 2004b; 2017a, 2017d; PPPO 2018

Impacts on infrastructure at Paducah or Portsmouth could occur from long-term storage of the DU oxide containers. As shown in Table C-3, infrastructure needs for long-term storage would be small when compared to current use and site capacity. Therefore, impacts on infrastructure at Paducah or Portsmouth would be minor. In addition, the potential impacts of storage of DU oxide containers was considered in the 2004 EISs which found that no strategic or critical resources would be consumed and that the expected requirements would be within the supply capacities at the Sites (DOE 2004a, 2004b).

Table C-3 Comparison of Utility Use for Long-Term Storage of Commercial DUF6 with Site Utility Capacity and Current Use

Resource	Paducah[a]			Portsmouth[b]		
	Long-Term Storage[c]	Utility System		Long-Term Storage[c]	Utility System	
		Capacity	Current Use		Capacity	Current Use
Electricity	0.167 MWh	3,040 MW	12 MW	0.167 MWh	2,260 MW	20 to 40 MWh
Water (mgd)	0.23	28	3.4	0.073	13	1.9
Natural gas (mcf/year)	Minimal	876,000	154,000	Minimal	NR	366,000
Steam (lbs/hr)	Minimal	135,000	100,000	Minimal	84,000	26,800

Key: gal = gallons; hr = hour; lbs = pounds; M = million; mcf = million cubic feet; mgd = million gallons per day; MW = megawatt; MWh = Megawatt hours; NR = not reported.

[a] Paducah capacity and current use from Chapter 3, Section 3.1.1, unless otherwise noted.

[b] Portsmouth capacity and current use from Chapter 3, Section 3.2.1, unless otherwise noted.

[c] Usage estimates from Chapter 4, Table 4-1 of this DU Oxide SEIS.

Note: To convert gallons to liters multiply by 3.785.

The impacts on the utility infrastructure of loading wastes for off-site shipment would be similar to those described under the DU Oxide SEIS No Action Alternative (Chapter 4, Section 4.1.1.1). Truck and rail loading activities would consume minimal amounts of water and electricity. Cylinder handling using Straddle Buggies and NCH-35 cylinder handlers is expected to use 15,600 gallons per year (59,050 liters per year) of diesel fuel at Paducah or Portsmouth

(PPPO 2018). Support vehicles (i.e., cars and light trucks) are expected to use 2,080 gallons per year (7,870 liters per year) of gasoline at each site (PPPO 2018). Fuel consumed by container loading equipment and support vehicles would be supplied by off-site sources and would not adversely affect the infrastructure at Paducah or Portsmouth. The primary impacts would be the extension of these activities for approximately 9 years at Paducah or Portsmouth during shipping of the DU oxide to off-site disposal sites. Therefore, the potential impacts on the utility infrastructure at Paducah or Portsmouth are expected to be minor.

The impacts on the transportation infrastructure of loading the DU oxide containers and other wastes for off-site shipment would be similar to those described under the DU Oxide SEIS No Action Alternative (Chapter 4, Section 4.1.1.1). The loading of the DU oxide containers, empty and heel cylinders, and CaF_2 in bulk bags and off-site shipment using either truck or rail would not require new construction or changes in infrastructure at either Paducah or Portsmouth. Therefore, the potential impacts on the transportation infrastructure at Paducah or Portsmouth would be minor.

Therefore, impacts on the utility and transportation infrastructure associated with the potential management of commercial DUF6 at either Paducah or Portsmouth under the Conversion and Storage scenario would be expected to be minor and well within the available capacities.

Secondary impacts might arise associated with the requirement that site operations associated with storage, conversion and management would need to be extended for the noted time periods. To the extent that the time periods associated with the introduction of the commercial DUF_6 requires a commitment of key equipment (e.g., boilers) or facilities beyond the planned design life, there may be an increase in repair, maintenance and replacement costs for such key equipment and facilities so as to extend their operational life. Such key equipment and facilities would need to be serviced and operational for an additional 8 years at Paducah or 11 years at Portsmouth to support the conversion process.

Conversion and Disposal Scenario: The impacts on site infrastructure from DUF_6 cylinder handling, conversion of DUF_6 to DU oxide, and storage of DU oxide containers, under the Conversion and Disposal scenario, would be similar to that described above for the Conversion and Storage Scenario. The impacts of storage would be less for the Conversion and Disposal scenario because the DU oxide containers would be shipped to a disposal facility or facilities and not be stored indefinitely.

The impacts on the utility infrastructure of loading the DU oxide containers and other wastes for off-site shipment would be similar to those described under the DU Oxide SEIS disposal alternatives (Chapter 4, Section 4.2.1.1). Truck and rail loading activities would consume minimal amounts of water and electricity. Cylinder handling using Straddle Buggies and NCH-35 cylinder handlers is expected to use 15,600 gallons per year (59,050 liters per year) of diesel fuel at Paducah or Portsmouth (PPPO 2018). Support vehicles (i.e., cars and light trucks) are expected to use 2,080 gallons per year (7,870 liters per year) of gasoline at each site (PPPO 2018). Fuel consumed by container loading equipment and support vehicles would be supplied by off-site sources and would not adversely affect the infrastructure at Paducah or Portsmouth. The primary impacts would be the extension of these activities for approximately 9 years at Paducah or Portsmouth during shipping of the DU oxide to off-site disposal sites. Therefore, the potential impacts on the utility infrastructure at Paducah or Portsmouth are expected to be minor.

The impacts on the transportation infrastructure of loading the DU oxide containers and other wastes for off-site shipment would be similar to those described under the DU Oxide SEIS disposal alternatives (Chapter 4, Section 4.2.1.1). The loading of the DU oxide containers, unusable cylinders, and CaF_2 in bulk bags and off-site shipment using either truck or rail would not require new construction or changes in infrastructure at either Paducah or Portsmouth. Therefore, the potential impacts on the transportation infrastructure at Paducah or Portsmouth would be minor.

C.4 AIR QUALITY, CLIMATE, AND NOISE

Impacts on air quality, climate, and noise could occur from DUF_6 cylinder storage, DUF_6 conversion to DU oxide, DU oxide container storage, and routine maintenance activities.

Conversion and Storage Scenario: Because there would be no expansion of the facilities or substantial changes in activities, the impacts associated with conversion of DUF_6 to DU oxide on an annual basis would be essentially the same as analyzed in the 2004 EISs (DOE 2004a, 2004b). As discussed in the 2004 EISs, annual air emissions from conversion operations at both Paducah and Portsmouth would not exceed the respective National Ambient Air Quality Standards (NAAQS) or State Ambient Air Quality Standards (SAAQS) for all criteria pollutants (DOE 2004a, 2004b)

Operations at Paducah would emit low concentrations of criteria pollutants. Criteria pollutant emissions would all be lower than 0.3 percent of NAAQS or SAAQS. If required during long-term storage, 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 any painting that would be performed were estimated to be less than 1.2 percent 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 (DOE 2004a, 2004b).

At the Portsmouth site, except for annual average particulate matter with a diameter of less than or equal to 2.5 microns ($PM_{2.5}$), total concentrations of criteria pollutants would be well below their respective standards. Total maximum estimated concentrations of criteria pollutants, except $PM_{2.5}$, would be less than 64 percent of NAAQS and SAAQS. Predicted total concentrations of 24-hour and annual average $PM_{2.5}$ would be near or above their respective standards, respectively; however, their concentration increments associated with site operations would account for only about 2.8 percent of the standards (DOE 2004a, 2004b). While the 2004 EIS predicted that the annual average $PM_{2.5}$ concentration at most statewide monitoring stations could either approach or exceed the standard, ambient air concentrations have not exceeded the NAAQS in the 13 years since publication of that document (EPA 2018). Further, the nearest $PM_{2.5}$ ambient concentration monitoring sites (located in Adams, Lawrence, and Franklin Counties) all report an Air Quality Index (AQI) in the “Good” range (Ohio EPA 2018). AQI is measured on a scale from 0 to 500.

The higher the AQI value, the greater the level of air pollution and potential health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality (AirNow 2016).

Conversion of commercial DUF_6 under either of the scenarios would be essentially the same as discussed in the 2004 EISs. Although the 2004 EISs did not analyze greenhouse gas (GHG) emissions, the conversion process itself does not produce GHGs in meaningful concentrations. No active emission points at the Paducah Site require nonradiological air monitoring. The aging steam plant boilers that required emission monitoring no longer are used as of May 2015, and have been replaced with new efficient natural gas fired package boilers. The new boilers do not require emission monitoring, and GHG emissions were not reported (DOE 2017a). However, the primary sources of operational GHG emissions are the boilers, the conversion building stack, and a backup generator. Because the boilers use relatively clean-burning natural gas, the backup generator is infrequently used, and the primary chemical emissions of concern from the HF stack are fluorides, GHG emissions from conversion operations at Paducah would be low, especially in comparison to national emissions levels. In 2015, Portsmouth reported emissions of 13,703 metric tons of carbon dioxide, 0.26 metric ton of methane, and 0.026 metric ton of nitrous oxide for a grand total of 13,716 metric tons (15,120 tons) carbon dioxide equivalents (CO_2e). These emissions primarily result from combustion of natural gas used at the X-690 Boilers (DOE 2017a). GHG emissions from DUF_6 conversion operations at Paducah or Portsmouth would be minimal in the region and national context and not likely to substantially contribute to climate change.

The impacts of storage and maintenance of commercial DU oxide containers at Paducah or Portsmouth until shipped off site for disposal would be similar to those described for long-term storage under the No Action Alternative (Chapter 4, Section 4.1.1.2) of this DU Oxide SEIS. Impacts on air quality and climate change could occur from the combustion of fossil fuels associated with DU oxide storage and maintenance activities. These activities would not involve any construction or other industrial processes requiring fossil fuel combustion or other emissions of criteria air pollutants or GHGs above those from normal daily operations. The only potential increase would be if the option to ship CaF_2 off-site for disposal is exercised. However, that increase in emissions would be minimal in perspective of national annual emissions from either truck or rail transport. Therefore, potential impacts on air quality and climate change due to emissions from Paducah or Portsmouth would be minor.

Conversion and storage operations are ongoing activities at Paducah and Portsmouth and therefore, the continuation of these activities for management of commercial DUF_6 is unlikely to change current noise levels. The 2004 EISs estimated noise impacts from cylinder handling and conversion facility operation. The 2004 EISs estimated that somewhat increased noise levels at the site could result from industrial activities such as cooling towers, heavy equipment use, and traffic. However, it is expected that the noise levels at off-site residences near Paducah would not increase noticeably. At Portsmouth, the noise levels at the nearest residence would be somewhat higher than the ambient background level, but would be barely distinguishable from the background level, depending on the time of the day. In conclusion, noise levels generated by cylinder handling and conversion plant operations would have minor impacts on the residence located nearest to the proposed facility and would be well below the EPA guideline limits for residential areas (DOE 2004a, 2004b). Also, as described in Chapter 4, Section 4.1.1.2, of this DU Oxide SEIS, DU oxide container storage and maintenance activities would occur within the industrialized areas of Paducah or Portsmouth, and there would be no construction, painting, or other increase in activities above normal daily operations that would contribute to the noise environment. Off-site shipments via rail would increase by a few shipments per week per site and truck shipments would increase by less than 3 per day. This increase in activity is unlikely to contribute to changes in the noise environment that would be perceptible along public roadways and existing railways in comparison to the shipments already occurring.

Conversion and Disposal Scenario: The impacts on air quality, climate and noise from DUF_6 cylinder handling, conversion of DUF_6 to DU oxide, and storage of DU oxide containers, under the Conversion and Disposal scenario, would be similar to that described above for the Conversion and Storage Scenario.

The quantity of DU oxide in each truck or rail shipment would vary depending on whether cylinders or bulk bags are used. If bulk bags were to be used, the total number of truck shipments of DU oxide would decrease, but the number of empty and heel cylinders to be shipped for disposal would increase. The total number of rail shipments under the bulk bag shipment scenario would be more than the number of shipments utilizing DU oxide in cylinders,. Therefore, the analysis below represents the most conservative scenario (i.e., the largest quantity of emissions), and all other potential shipping scenarios would generate lower levels of emissions of both criteria pollutants and GHGs.

Transfer of DU oxide containers from the storage locations to a loading area for transportation to the disposal sites would involve the use of Straddle Buggies and NCH-35 cylinder handlers. These types of equipment are currently in use as part of the conversion facility operations. **Table C-4** presents the operational emissions at the Paducah Site and compares the emissions to those for McCracken County, Kentucky. **Table C-5** presents the operational emissions at the Portsmouth Site and compares the emissions to those for Pike County, Ohio. Emissions from diesel fuel combustion during container movement and loading activities would therefore be minimal, and would not contribute to any exceedances of SAAQS or NAAQS. Likewise, GHG emissions (measured as CO_2e) would be minimal in the context of the over 1.3 million metric tons CO_2e emitted annually from fossil fuel combustion in the industrial sector and would not be expected to contribute substantially to climate change (EPA 2018).

Table C-4 Criteria Pollutant Emissions from Cylinder-Loading Activities at the Paducah Site

	Criteria Pollutant Emissions (tons per year)						
	CO	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**	**CO_2e**
Straddle Buggies and NCH-35	0.93	1.9508	0.0796	0.0796	0.0024	0.2464	239.08
McCracken County	13,217	15,200	2,464	826.2854015	30,162	6,378	497,850
Percentage of County Emissions	0.01%	0.01%	0.00%	0.01%	0.00%	0.00%	0.05%

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalents; NO_2 =nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.
Source: EPA 2016d, 2018

Table C-5 Criteria Pollutant Emissions from Cylinder-Loading Activities at the Portsmouth Site

	Criteria Pollutant Emissions (tons per year)						
	CO	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**	**CO_2e**
Straddle Buggies and NCH-35	0.93	1.9508	0.0796	0.0796	0.0024	0.2464	239.08
Pike County	8,297	1,371	2,729	755.3689	35	7,214	268,870
Percentage of County Emissions	0.01%	0.14%	0.00%	0.01%	0.01%	0.00%	0.09%

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalents; NO_2 = nitrogen dioxide; PM_{10} and $PM_{2.5}$ = particulate matter with a diameter of less than or equal to 10 microns and 2.5 microns, respectively; SO_2 = sulfur dioxide; VOC = volatile organic compounds.

Source: EPA2016d, 2018

In addition to the emissions discussed above, the Conversion and Disposal scenario would include air emissions associated with transportation of the DU oxide containers to a commercial disposal site. Air emissions from shipping of commercial DU oxide by truck or rail to one or more of the disposal sites would be similar to those discussed in Chapter 4, Sections 4.2.2, 4.3.2, and 4.4.2 of this DU Oxide SEIS.

Nevertheless, emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 35 semi-tractor trailer truck shipments from Paducah or 25 shipments from Portsmouth to NNSS containing ancillary LLW and MLLW, empty and heel cylinders, and CaF_2. Although shipments may go to various facilities, in order to bound the impacts, calculations are based on the longest potential shipping distance which would be to NNSS. Annual emissions of all criteria pollutants would be less than 6,800 tons (6,200 metric tons) for all shipments from Paducah or Portsmouth. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). **Table C-6** presents estimated annual GHG emissions from transportation of ancillary LLW and MLLW, empty heel cylinders, and CaF_2 to NNSS.

Table C-6 Annual GHG Emissions from Transportation of LLW, MLLW, and Empty and Heel Cylinders and Calcium Fluoride to the Nevada National Security Site

	GHG Emissions (tons per year CO_2e)			
	Rail/Truck Option			**Truck Option**
Site	**Rail**	**Truck**	**Total**	
Paducah[a]	8,889	862	9,751	3,687
Portsmouth[a]	9,587	775	10,362	3,045
Grand Total	**18,476**	**1,636**	**20,113**	**6,732**
National Rail Emissions[b]	45, 300,000			NA
National Truck Emissions[c]	467,400,000			467,400,000
Total National Rail/Truck Emissions	512,700,000			NA

[a] Source: PPPO 2018
[b] Source CNR 2016
[c] Source ATA 2018

As presented in Table C-6, GHG emissions from rail transport would not be likely to exceed approximately 20,200 tons (18,300 metric tons) annually. Again, this quantity would be miniscule in comparison to the national GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018).

In addition to the low noise levels discussed under the Conversion and Storage scenario, truck and rail loading activities would occur within the industrialized areas of Paducah or Portsmouth, and there would be little or no increase above current normal daily operations that would contribute to adverse noise impacts at or beyond the site boundary. Therefore, potential impacts on noise levels near Paducah or Portsmouth from truck and rail loading activities are expected to be minor. Off-site shipments via rail would increase by approximately 1 shipment per day per site and truck shipments would increase by less than 5 per day. This increase in activity is unlikely to contribute to changes in the noise environment that would be perceptible along public roadways and existing railways in comparison to the shipments already occurring.

Transportation to Energy*Solutions*

Rail Option

Emissions associated with transportation of DU oxide via rail to Energy*Solutions* were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 shipments of DU oxide, 1 to 2 shipments of ancillary LLW and MLLW, unusable cylinders, and 184 to 253 shipments of CaF_2 from either site to Energy*Solution*s. It was estimated that locomotives would travel approximately 1,600 miles (2,600 kilometers) per rail shipment from Paducah to Energy*Solutions* or approximately 1,900 miles (3,100 kilometers) from Portsmouth to Energy*Solutions.* Emissions were calculated using emission factors for tier 2 line haul locomotives derived from the EPA's *Emission Factors for Locomotives* (EPA 2009).

Emissions of all criteria pollutants would be less than 310 tons 280 (metric tons) annually for all waste shipments from Paducah or Portsmouth (see **Table C-7).** Emissions would be spread across a large area, so it is not useful to compare to National Emissions Inventory (NEI) baseline emissions for any particular Air Quality Control Region (AQCR). However, because the emissions are so small in comparison to overall locomotive and vehicle transportation emissions, the emissions are not likely to contribute to any significant impact on air quality.

Table C-7 Criteria Pollutant Emissions from Transportation of Wastes via Railcar to Energy*Solutions*

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
	Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
	Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Paducah	1.69	6.54	0.24	0.23	0.12	0.36
	Portsmouth	2.09	8.09	0.29	0.29	0.15	0.45
	Total emissions	*3.78*	*14.62*	*0.53*	*0.52*	*0.27*	*0.81*
14,000 empty and heel cylinders	Paducah	0.28	1.09	0.04	0.04	0.02	0.06
	Portsmouth	0.33	1.29	0.05	0.05	0.02	0.07
	Total emissions	*0.62*	*2.38*	*0.09*	*0.08*	*0.04*	*0.13*

Material	**Site**	**Criteria Pollutant Emissions (tons/year)**					
		CO	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_x**	**VOC**
DU oxide in bulk bags	Paducah	10.64	41.13	1.50	1.45	0.75	2.27
	Portsmouth	8.61	33.32	1.21	1.18	0.61	1.84
	Total emissions	*19.25*	*74.45*	*2.71*	*2.63*	*1.36*	*4.12*
69,000 empty and heel cylinders	Paducah	15.92	61.56	2.24	2.17	1.12	3.40
	Portsmouth	14.47	55.96	2.03	1.97	1.02	3.09
	Total emissions	*30.39*	*117.52*	*4.27*	*4.15*	*2.15*	*6.50*
CaF_2	Paducah	16.76	64.83	2.36	2.29	1.18	3.59
	Portsmouth	12.88	49.81	1.81	1.76	0.91	2.76
	Total emissions	*29.64*	*114.64*	*4.17*	*4.04*	*2.09*	*6.34*
Grand Total (DU Oxide in Cylinders)		**34.23**	**132.39**	**4.82**	**4.67**	**2.41**	**7.32**
Grand Total (DU Oxide in Bulk Bags)		**80.09**	**309.74**	**11.27**	**10.93**	**5.65**	**17.13**

Truck Option

Criteria pollutant emissions from shipment via truck to Energy*Solutions* were calculated based on an estimated 1,440 shipments of DU oxide from either site, 28 to 39 shipments of ancillary LLW and MLLW, empty and heel cylinders, and 734 to 1,010 shipments of CaF_2 annually from Paducah or Portsmouth to Energy*Solutions* (see **Table C-8).** The analysis is based on approximately 1,600 miles (2,600 kilometers) per truck shipment from Paducah to Energy*Solutions* or approximately 1,900 miles (3,100 kilometers) per shipment from Portsmouth to Energy*Solutions* via truck. Emissions were derived using the emission factors for heavy-duty diesel vehicles in the EPA's MOVES2014a. MOVES is the EPA Motor Vehicle Emission Simulator. It is used to create emission factors or emission inventories for both on road motor vehicles and nonroad equipment (EPA 2015).

Emissions of all criteria pollutants would be less than 58 tons annually for all waste shipments from Paducah or Portsmouth. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR.

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table C-8 Criteria Pollutant Emissions from DU Oxide Transportation via Truck to Energy*Solutions*

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_x**	**VOC**
Ancillary LLW and MLLW	Paducah	0.17	0.48	0.02	0.02	0.00	0.05
	Portsmouth	0.14	0.41	0.01	0.01	0.00	0.04
	Total emissions	*0.31*	*0.88*	*0.03*	*0.03*	*0.00*	*0.09*
DU oxide (cylinders)	Paducah	5.50	15.69	0.57	0.53	0.04	1.64
	Portsmouth	6.90	19.68	0.72	0.66	0.04	2.05
	Total emissions	*12.40*	*35.37*	*1.29*	*1.19*	*0.08*	*3.69*
14,000 empty and heel cylinders	Paducah	0.48	1.36	0.05	0.05	0.00	0.14
	Portsmouth	0.57	1.62	0.06	0.05	0.00	0.17
	Total emissions	*1.04*	*2.98*	*0.11*	*0.10*	*0.01*	*0.31*
DU oxide (bulk bags)	Paducah	2.30	6.56	0.24	0.22	0.01	0.68
	Portsmouth	1.87	5.32	0.19	0.18	0.01	0.55
	Total emissions	*4.17*	*11.88*	*0.43*	*0.40*	*0.03*	*1.24*
69,000 empty and heel cylinders	Paducah	2.59	7.39	0.27	0.25	0.02	0.77
	Portsmouth	2.35	6.71	0.24	0.23	0.02	0.70
	Total emissions	*4.94*	*14.09*	*0.51*	*0.47*	*0.03*	*1.47*
CaF_2	Paducah	3.64	10.37	0.38	0.35	0.02	1.08
	Portsmouth	2.79	7.96	0.29	0.27	0.02	0.83
	Total emissions	*6.43*	*18.33*	*0.67*	*0.61*	*0.04*	*1.91*
Grand Total (DU Oxide in Cylinders)		**20.18**	**57.56**	**2.1**	**1.93**	**0.13**	**6**
Grand Total (DU Oxide in Bulk Bags)		**16.89**	**48.16**	**1.75**	**1.61**	**0.11**	**5.02**

Greenhouse Gases

Annual GHG emissions from railcar shipments of DU oxide, ancillary LLW and MLLW, unusable cylinders, and CaF_2 would be 7,111 tons (6,451 metric tons) or 7,590 tons (6,886 metric tons) from Paducah and Portsmouth, respectively, and would be minimal in terms of the national GHG emissions from railway transportation, which total 45.3 million tons (41.1 million metric tons) annually (EPA 2018). Total annual GHG emissions from truck shipments would be 6,894 tons (6,254 metric tons) or 7,359 tons (6,674 metric tons) from Paducah and Portsmouth, respectively, and would be minimal in terms of the national GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018).

Transportation to the National Nuclear Security Site

Rail/Truck Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 shipments via railcar annually from either site to NNSS. It was estimated that locomotives would travel approximately 2,000 miles (3,300 kilometers) per rail shipment from Paducah to Barstow, CA, or approximately 2,400 miles (3,800 kilometers) from Portsmouth to Barstow, CA.

Because there is no direct rail access to NNSS, shipment via rail would travel to Barstow, CA, where they would be transported approximately 200 miles (330 kilometers) from Barstow to the NNSS facility. **Table C-9** presents annual emissions associated with 24 shipments via truck from Barstow to the NNSS facility.

Emissions of all criteria pollutants would be less than 395 tons (358 metric tons) annually for all shipments from Paducah or Portsmouth. Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR. However, because the emissions are so small in comparison to overall locomotive and vehicle transportation emissions, the emissions are not likely to contribute to any significant impact on air quality.

Table C-9 Criteria Pollutant Emissions from Transportation of Wastes via Railcar to Barstow, CA, and Truck to NNSS

Material	Mode of Transport	Site	Criteria Pollutant Emissions (tons/year)					
			CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Truck	Paducah	0.02	0.05	0.00	0.00	0.00	0.00
		Portsmouth	0.01	0.03	0.00	0.00	0.00	0.00
		Total emissions	*0.03*	*0.08*	*0.00*	*0.00*	*0.00*	*0.01*
	Rail	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
		Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
		Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Truck	Paducah	0.69	1.96	0.07	0.07	0.00	0.20
		Portsmouth	0.73	2.07	0.08	0.07	0.00	0.22
		Total emissions	*1.41*	*4.03*	*0.15*	*0.14*	*0.01*	*0.42*
	Rail	Paducah	2.11	8.17	0.30	0.29	0.15	0.45
		Portsmouth	2.64	10.21	0.37	0.36	0.19	0.56
		Total emissions	*4.75*	*18.39*	*0.67*	*0.65*	*0.34*	*1.02*
14,000 empty and heel cylinders	Truck	Paducah	0.06	0.17	0.01	0.01	0.00	0.02
		Portsmouth	0.06	0.17	0.01	0.01	0.00	0.02
		Total emissions	*0.12*	*0.34*	*0.01*	*0.01*	*0.00*	*0.04*
	Rail	Paducah	0.35	1.36	0.05	0.05	0.02	0.08
		Portsmouth	0.42	1.63	0.06	0.06	0.03	0.09
		Total emissions	*0.77*	*3.00*	*0.11*	*0.11*	*0.05*	*0.17*
DU oxide in bulk bags	Truck	Paducah	0.29	0.82	0.03	0.03	0.00	0.09
		Portsmouth	0.20	0.56	0.02	0.02	0.00	0.06
		Total emissions	*0.48*	*1.38*	*0.05*	*0.05*	*0.00*	*0.14*
	Rail	Paducah	13.29	51.41	1.87	1.81	0.94	2.84
		Portsmouth	10.88	42.08	1.53	1.48	0.77	2.33
		Total emissions	*24.18*	*93.50*	*3.40*	*3.30*	*1.71*	*5.17*
69,000 empty and heel cylinders	Truck	Paducah	0.32	0.92	0.03	0.03	0.00	0.10
		Portsmouth	0.25	0.71	0.03	0.02	0.00	0.07
		Total emissions	*0.57*	*1.63*	*0.06*	*0.05*	*0.00*	*0.17*
	Rail	Paducah	19.90	76.95	2.80	2.71	1.41	4.26
		Portsmouth	18.28	70.68	2.57	2.49	1.29	3.91
		Total emissions	*38.18*	*147.63*	*5.37*	*5.21*	*2.70*	*8.17*

Material	Mode of Transport	Site	Criteria Pollutant Emissions (tons/year)					
			CO	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_x**	**VOC**
CaF_2	Truck	Paducah	0.45	1.30	0.05	0.04	0.00	0.14
		Portsmouth	0.29	0.84	0.03	0.03	0.00	0.09
		Total emissions	*0.75*	*2.13*	*0.08*	*0.07*	*0.00*	*0.22*
	Rail	Paducah	20.95	81.03	2.95	2.86	1.48	4.48
		Portsmouth	16.27	62.92	2.29	2.22	1.15	3.48
		Total emissions	*37.22*	*143.95*	*5.23*	*5.08*	*2.63*	*7.96*
Grand Total (DU Oxide in Cylinders)			***45.24***	***172.67***	***6.28***	***6.09***	***3.04***	***9.88***
Grand Total (DU Oxide in Bulk Bags)			***102.49***	***394.39***	***14.34***	***13.91***	***7.1***	***22.09***

Truck Option

Criteria pollutant emissions were calculated based on an estimated 1,440 shipments of DU oxide from either site, 35 and 25 shipments of ancillary LLW and MLLW, empty and heel cylinders, and 1,000 and 850 shipments of CaF_2 annually from Paducah and Portsmouth, respectively, to NNSS (**Table C-10)**. The analysis is based on approximately 2,000 miles (3,300 kilometers) per truck shipment from Paducah NNSS or approximately 2,400 miles (3,800 kilometers) per shipment from Portsmouth to NNSS via truck.

Under the truck option, emissions of all criteria pollutants would be less than 73 tons (66 metric tons) annually for all shipments from Paducah or Portsmouth. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR.

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table C-10 Criteria Pollutant Emissions Transportation via Truck to NNSS

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**SOx**	**VOC**
Ancillary LLW and MLLW	Paducah	0.17	0.48	0.02	0.02	0.00	0.05
	Portsmouth	0.14	0.41	0.01	0.01	0.00	0.04
	Total emissions	*0.31*	*0.88*	*0.03*	*0.03*	*0.00*	*0.09*
DU oxide (cylinders)	Paducah	6.88	19.61	0.72	0.66	0.04	2.04
	Portsmouth	8.72	24.86	0.91	0.83	0.06	2.59
	Total emissions	*15.59*	*44.47*	*1.62*	*1.49*	*0.10*	*4.63*
14,000 empty and heel cylinders	Paducah	0.60	1.70	0.06	0.06	0.00	0.18
	Portsmouth	0.72	2.04	0.07	0.07	0.00	0.21
	Total emissions	*1.31*	*3.74*	*0.14*	*0.13*	*0.01*	*0.39*

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NOx	PM_{10}	$PM_{2.5}$	SOx	VOC
DU oxide (bulk bags)	Paducah	2.88	8.20	0.30	0.28	0.02	0.85
	Portsmouth	2.36	6.72	0.25	0.23	0.02	0.70
	Total emissions	*5.23*	*14.92*	*0.54*	*0.50*	*0.03*	*1.56*
69,000 empty and heel cylinders	Paducah	3.24	9.23	0.34	0.31	0.02	0.96
	Portsmouth	2.97	8.47	0.31	0.28	0.02	0.88
	Total emissions	*6.21*	*17.70*	*0.65*	*0.59*	*0.04*	*1.85*
CaF_2	Paducah	4.54	12.96	0.47	0.43	0.03	1.35
	Portsmouth	3.52	10.05	0.37	0.34	0.02	1.05
	Total emissions	*8.07*	*23.01*	*0.84*	*0.77*	*0.05*	*2.40*
Grand Total (DU Oxide in Cylinders)		**25.28**	**72.1**	**2.63**	**2.42**	**0.16**	**7.51**
Grand Total (DU Oxide in Bulk Bags)		**21.13**	**60.25**	**2.2**	**2.02**	**0.13**	**6.29**

Greenhouse Gases

Total annual GHG emissions for shipments of DU oxide, LLW, MLLW, and unusable cylinders, and CaF_2 via rail to Barstow, California, and truck from Barstow to NNSS, would be 20,113 tons per year (18,244 metric tons per year). This amount would be minimal in terms of the national annual GHG emissions from combined truck and rail transportation, which total 512.7 million tons (465.1 million metric tons) annually (EPA 2018). Total annual GHG emissions for shipments of DU oxide, ancillary LLW and MLLW, unusable cylinders, and CaF_2 via truck to NNSS (17,913 tons [16,250 metric tons]) would be minimal in terms of the national GHG emissions from truck transportation, which are 467.4 million tons (424.0 million metric tons) annually (EPA 2018).

Transportation to Waste Control Specialists

Rail Option

Emissions were calculated to provide an estimate of the annual criteria pollutant emissions associated with 24 shipments of DU oxide, 1 to 2 shipments of LLW, MLLW and unusable cylinders, and 24 shipments of CaF_2, from either site to WCS. It was estimated that locomotives would travel approximately 1,000 miles (1,700 kilometers) per rail shipment from Paducah to WCS or approximately 1,400 miles (2,300 kilometers) from Portsmouth to WCS.

Emissions of all criteria pollutants would be less than 210 tons (190 metric tons) annually for all wastes shipments from Paducah or Portsmouth (**Table C-11)**. Emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR.

Both McCracken and Pike Counties are currently classified as being in attainment for all criteria pollutants, so the General Conformity rule is not applicable. However, it is worth noting that none of the criteria pollutant emissions would exceed the *de minimis* thresholds set by the rule. Because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table C-11 Criteria Pollutant Emissions from Transportation of Wastes via Railcar to Waste Control Specialists

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.09	0.34	0.01	0.01	0.01	0.02
	Portsmouth	0.11	0.41	0.01	0.01	0.01	0.02
	Total emissions	*0.19*	*0.75*	*0.03*	*0.03*	*0.01*	*0.04*
DU oxide in cylinders	Paducah	1.06	4.09	0.15	0.14	0.07	0.23
	Portsmouth	1.54	5.96	0.22	0.21	0.11	0.33
	Total emissions	*2.60*	*10.04*	*0.37*	*0.35*	*0.18*	*0.56*
14,000 empty and heel cylinders	Paducah	0.18	0.68	0.02	0.02	0.01	0.04
	Portsmouth	0.25	0.95	0.03	0.03	0.02	0.05
	Total emissions	*0.42*	*1.63*	*0.06*	*0.06*	*0.03*	*0.09*
DU oxide in bulk bags	Paducah	6.65	25.71	0.93	0.91	0.47	1.42
	Portsmouth	6.35	24.55	0.89	0.87	0.45	1.36
	Total emissions	*13.00*	*50.25*	*1.83*	*1.77*	*0.92*	*2.78*
69,000 empty and heel cylinders	Paducah	9.95	38.47	1.40	1.36	0.70	2.13
	Portsmouth	10.66	41.23	1.50	1.45	0.75	2.28
	Total emissions	*20.61*	*79.71*	*2.90*	*2.81*	*1.46*	*4.41*
CaF_2	Paducah	10.48	40.52	1.47	1.43	0.74	2.24
	Portsmouth	9.49	36.70	1.33	1.29	0.67	2.03
	Total emissions	*19.97*	*77.22*	*2.81*	*2.72*	*1.41*	*4.27*
Grand Total (DU Oxide in Cylinders)		**23.18**	**89.64**	**3.27**	**3.16**	**1.63**	**4.96**
Grand Total (DU Oxide in Bulk Bags)		**54.19**	**209.56**	**7.63**	**7.39**	**3.83**	**11.59**

Truck Option

Criteria pollutant emissions were calculated based on an estimated 1,440 shipments of DU oxide from either site, 35 and 25 shipments of ancillary LLW and MLLW, empty and heel cylinders, and 1,000 and 850 shipments of CaF_2 annually from Paducah and Portsmouth, respectively, to to WCS (**Table C-12**). The analysis is based on approximately 1,000 miles (1,700 kilometers) per truck shipment from Paducah to Energy*Solutions* or approximately 1,400 miles (2,300 kilometers) per shipment from Portsmouth to Energy*Solutions* via truck.

Emissions of all criteria pollutants would be less than 40 tons (36 metric tons) annually for all shipments from Paducah or Portsmouth. These emissions are extremely small in comparison to the national emissions associated with approximately 3.68 million trucks in operation transporting some 2.74 billion miles annually (ATA 2018). Further, these emissions would be spread across a large area, so it is not useful to compare to NEI baseline emissions for any particular AQCR. However, because the emissions are so small in comparison to overall vehicle emissions on both urban and rural highways and roads, the emissions are not likely to contribute to any significant impact on air quality.

Table C-12 Criteria Pollutant Emissions from Transportation via Truck to Waste Control Specialists

Material	Site	Criteria Pollutant Emissions (tons/year)					
		CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Ancillary LLW and MLLW	Paducah	0.08	0.24	0.01	0.01	0.00	0.02
	Portsmouth	0.08	0.24	0.01	0.01	0.00	0.02
	Total emissions	*0.17*	*0.48*	*0.02*	*0.02*	*0.00*	*0.05*
DU oxide (cylinders)	Paducah	3.44	9.81	0.36	0.33	0.02	1.02
	Portsmouth	5.08	14.50	0.53	0.49	0.03	1.51
	Total emissions	*8.52*	*24.30*	*0.89*	*0.82*	*0.06*	*2.53*
14,000 empty and heel cylinders	Paducah	0.30	0.85	0.03	0.03	0.00	0.09
	Portsmouth	0.42	1.19	0.04	0.04	0.00	0.12
	Total emissions	*0.72*	*2.04*	*0.07*	*0.07*	*0.00*	*0.21*
DU oxide (bulk bags)	Paducah	1.44	4.10	0.15	0.14	0.01	0.43
	Portsmouth	1.38	3.92	0.14	0.13	0.01	0.41
	Total emissions	*2.81*	*8.02*	*0.29*	*0.27*	*0.02*	*0.84*
69,000 empty and heel cylinders	Paducah	1.62	4.62	0.17	0.15	0.01	0.48
	Portsmouth	1.73	4.94	0.18	0.17	0.01	0.51
	Total emissions	*3.35*	*9.56*	*0.35*	*0.32*	*0.02*	*1.00*
CaF_2	Paducah	2.27	6.48	0.24	0.22	0.01	0.68
	Portsmouth	2.06	5.86	0.21	0.20	0.01	0.61
	Total emissions	*4.33*	*12.34*	*0.45*	*0.41*	*0.03*	*1.29*
Grand Total (DU Oxide in Cylinders)		**13.74**	**39.16**	**1.43**	**1.32**	**0.09**	**4.08**
Grand Total (DU Oxide in Bulk Bags)		**11.38**	**32.44**	**1.18**	**1.09**	**0.07**	**3.39**

Greenhouse Gases

Total annual GHG emissions from railcar shipments for disposal of DU oxide, ancillary LLW and MLLW, unusable cylinders, and CaF_2 (10,037 tons [9,106 metric tons]) would be minimal in terms of the national GHG emissions from railway transportation, which total 45.3 million tons (41.1 million metric tons) annually (EPA 2018). Total annual GHG emissions from truck shipments for disposal of DU oxide, ancillary LLW and MLLW, unusable cylinders, and CaF_2 (9,731 tons [8,828 metric tons]) would be minimal in terms of the national GHG emissions from truck transportation, which total 467.4 million tons (424.0 million metric tons) annually (EPA 2018).

C.5 WATER RESOURCES

Impacts on water resources could occur from changes in water use, surface water discharge, groundwater recharge, or impacts on surface water or groundwater quality as a result of contamination by radioactive or hazardous materials associated with storage of DUF_6 containers, conversion of DUF_6 to DU oxide, storage of DU oxide containers, and potential container breach.

Conversion and Storage: Under the Conversion and Storage scenario, storage of DUF_6 containers, conversion of DUF_6 to DU oxide, and storage of DU oxide containers would occur within the industrialized areas of either Paducah or Portsmouth in areas outside the 100-year floodplain. There would be no construction, no change to groundwater recharge, and no routine releases of DU or hazardous materials. The impacts of conversion of DUF_6 to DU oxide were evaluated in the 2004 EISs (DOE 2004a, 2004b). The relevant information for water resources impacts from the 2004 EISs is summarized in Section C.3, Site Infrastructure; Section C.9, Waste Management; and this section.

As described in Section C.3, Tables C-2 and C-3, water usage for the Conversion and Storage scenario would be a very small percentage of the existing daily water use at Paducah or Portsmouth. All of the water needed at Paducah would be withdrawn from the Ohio River. The water needed would be a very small percentage of the average flow in the Ohio River. Impacts of this withdrawal would be negligible. Because all water used at Paducah would be obtained from the Ohio River there would be no impacts on groundwater levels and flow (DOE 2004a).

All of the water needed at Portsmouth would be withdrawn from groundwater resources. As shown in Section C.3, Tables C-2 and C-3, groundwater use would represent a very small percent of current water use. Impacts from this rate of groundwater use would be very small (DOE 2004b). Because all of the water used at Portsmouth would be obtained from groundwater wells, there would be no impacts on surface water levels and flow (DOE 2004b).

As described in Section C.9, Table C-28, wastewater generation for the Conversion and Storage scenario would be small percentages of the existing daily wastewater generation at Paducah or Portsmouth. This water would not contain any radionuclides and would be treated and released in accordance with National Pollutant Discharge Elimination System (NPDES) or state equivalent permits. At Paducah, the small quantities of wastewater released to the receiving water (Bayou Creek) after treatment would not have a measurable impact (DOE 2004a). At Portsmouth, the small quantities of wastewater released after treatment would produce negligible impacts on Little Beaver Creek, Big River Creek, and the Scioto River (DOE 2004b). Because there would be no direct discharges to groundwater, there would be no impacts on groundwater quality (DOE 2004a).

Potential impacts on surface and groundwater quality as a result of a release associated with a potential container breach was evaluated in the 2004 EISs. For both sites, the impacts on surface water and groundwater quality from hypothetical releases of uranium would result in uranium concentrations below radiological benchmark levels (i.e., Safe Drinking Water Act maximum contaminant levels) (DOE 2004a, 2004b).

Conversion and Disposal: The impacts of storage of DUF_6 containers, conversion of DUF_6 to DU oxide, and storage of DU oxide containers at Paducah or Portsmouth until shipped to a disposal site would be similar to those described under the Conversion and Storage scenario. The impacts of storage would be less for the Conversion and Disposal scenario because the DU oxide containers would be shipped to a disposal facility or facilities and not be stored indefinitely.

Under the disposal scenario, truck and rail loading activities would occur within the industrialized areas of Paducah or Portsmouth, would not occur in the 100-year floodplain, and there would be no routine releases of DU or hazardous materials. Therefore, any impacts on water resources are expected to be minor.

C.6 BIOTIC RESOURCES

Impacts on biotic resources could occur from removal or degradation of vegetation, wildlife habitats, wetlands, and federal and state-listed species; facility operations; or contamination by radioactive or hazardous materials via air or water borne pathways.

Conversion and Storage: A portion of the emissions released from the process stack of the conversion facility could become deposited on the surrounding soils. 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 on vegetation along nearby streams would not occur. Therefore, DOE concluded that the toxic effects on vegetation from uranium uptake from conversion of the quantities of DUF_6 addressed in the 2004 EISs would be expected to be negligible (DOE 2004a, 2004b). This appendix addresses the conversion and disposition of an additional amount of commercial DUF_6 that would be added to the DOE inventory of DUF_6. The additional inventory's cumulative toxic effects on vegetation from uranium uptake would be expected to be below concentrations known to produce toxic effects.

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 percent due to inhalation) of 3.9×10^{-5} mrem/yr at Paducah and 2.07×10^{-5} mrem/yr at Portsmouth. Noninvolved worker doses at both sites are similar to the doses to the general public. The non-involved worker MEI dose from conversion operations was less than 1×10^{-5} millirem per year at Paducah (DOE 2004a) and less than 5.5×10^{-5} millirem per year at Portsmouth (DOE 2004b). DOE guidelines limit an absorbed dose to terrestrial plants and aquatic animals to less than 1 rad/d, and to terrestrial animals to less than 0.1 rad/d (DOE 2002). Therefore, impacts on vegetation and 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 ug/m^3 at Paducah and 0.0028 ug/m^3 at Portsmouth. Toxic effect levels of chronic inhalation of HF are many orders of magnitude greater than expected concentrations. Therefore, toxic effects to wildlife from HF emissions would be expected to be negligible (DOE 2004a, 2004b).

Noise generated by the operation of a conversion facility and disturbance from human presence would likely result in a minor disturbance to wildlife in the vicinity (DOE 2004a, 2004b). Movement of railcars along the new rail line southwest of the conversion facility at the Paducah facility might potentially cause the adjacent mature deciduous forest habitat to be unsuitable for some species (DOE 2004a).

Liquid process effluents would not be discharged to surface waters during the operation of the conversion facility. In addition, surface water level changes would be negligible. Therefore, except for potential local indirect impacts near the facility, impacts on 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 (DOE 2004a, 2004b).

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 are regulated under the existing NPDES or state permits for industrial facility storm water discharge. The streams near the conversion facility and cylinder storage yards currently receive runoff and associated contaminants from various roadways and storage yards, and their biotic communities are likely indicative of developed areas (DOE 2004a, 2004b).

Direct impacts on federal- or state-listed species during operation of a conversion facility are not expected. The wooded areas near the industrialized areas of Paducah and Portsmouth have 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 trucks and railcars might decrease the quality of the adjacent forest habitat for use by Indiana bats. However, Indiana bats that might currently be using habitat near Paducah and Portsmouth 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 (DOE 2004a, 2004b).

In addition, noise from railcar movement along the rail lines entering and exiting Paducah or Portsmouth may result in a disturbance to Indiana bats that may use this habitat. Indiana bats have been observed to tolerate increased noise levels. Consequently, disturbances from rail traffic are not expected to result in loss of suitability of these habitat areas (DOE 2004a).

Under the Conversion and Storage scenario, container storage and maintenance activities would occur within the industrialized areas of Paducah or Portsmouth, would not disturb wetlands, sensitive habitat, or threatened, endangered, or sensitive species, and there would be no construction and no routine releases of DU or other hazardous materials. Therefore, potential impacts on biotic resources are expected to be minor.

Potential impacts on biotic resources as a result of an accidental release associated with a potential container breach were evaluated in the 2004 EISs. For either site, groundwater uranium concentrations could exceed the ecological screening value for surface water. However, contaminants in groundwater discharging to a surface water body, such as a local stream, would be quickly diluted to negligible concentrations (DOE 2004a, 2004b).

Conversion and Disposal: The impacts of storage of DUF_6 containers, conversion of DUF_6 to DU oxide, and storage of DU oxide containers at Paducah or Portsmouth until shipped to a disposal site would be similar to those described under the Conversion and Storage scenario. The impacts of storage would be less for the Conversion and Disposal scenario because the DU oxide containers would be shipped to a disposal facility or facilities and not be stored indefinitely.

Under the disposal scenario, truck and rail loading activities would occur within the industrialized areas of Paducah or Portsmouth and there would be no routine releases of DU or hazardous materials. Truck- and rail-loading activities would not disturb wetlands, sensitive habitat, or threatened, endangered, or sensitive species, and there would be no construction and no routine releases of DU or other hazardous materials. Therefore, any impacts on biotic resources are expected to be minor.

C.7 PUBLIC AND OCCUPATIONAL SAFETY AND HEALTH

This section presents radiological impacts on workers and the public from normal operations and postulated accidents at Paducah or Portsmouth, as well as impacts from potential chemical exposures and accidents and intentional destructive acts. Chapter 4, Section 4.1.1.6, of this DU Oxide SEIS, provides additional background information on the definition of terms, safety requirements, and analysis of health risks from chemical and radiological exposure.

C.7.1 Normal Operations

This section provides public and occupational health and safety impacts for the commercial DUF_6 Conversion and Storage Scenario and Conversion and Disposal Scenario. The activities addressed for both scenarios are the conversion process, cylinder yard operations associated with the conversion process, and long term storage of DU oxide cylinders. Radiological and chemical impacts are assessed for normal operations.

C.7.1.1 Conversion and Storage Scenario

Impacts on public and worker health at Paducah or Portsmouth under the Conversion and Storage Scenario considered impacts from conversion facility operation as well as cylinder yard activities during conversion (cylinder movements between the conversion facility and the cylinder storage yard) and during cylinder storage. Conversion of the commercial DUF_6 would require 8 years of conversion operations at Paducah or 11 years at Portsmouth. Under the Conversion and Storage Scenario cylinders of DU oxide are assumed to be stored for 100 years at either Paducah or Portsmouth.[68]

Public Safety and Health

The 2004 EISs (DOE 2004a, 2004b) estimated the public health impacts from the conversion of DUF_6 to DU oxide and from the storage of DUF_6 at Paducah and Portsmouth. After conversion, any exposure to stored uranium would be from DU oxide. The chemical form of the released uranium does not appreciably impact the radiological characteristics of the material. Therefore, the dose estimates from the 2004 EISs for DUF_6 were used in this DU Oxide SEIS to estimate the effects of exposure to DU oxide. In addition, information from both sites' annual site

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[68] The impacts presented for Paducah assume that all 150,000 tons of commercial DUF_6 are converted and stored at Paducah. The impacts presented for Portsmouth make a similar assumption.

environmental reports (DOE 2017b, 2017c) were used to augment the analysis of public health and safety.

Conversion of Commercial DUF_6

The 2004 EISs (DOE 2004a, 2004b) estimated the public health impacts from the conversion of DUF_6 to DU oxide at Paducah and Portsmouth. Potential impacts were assessed for both conversion operations and the cylinder yard operations associated with conversion (e.g., cylinder movement). However, only the conversion operations had the potential for impacts on the public. Annual impacts were provided for an off-site maximally exposed individual (MEI) and for the total population. Both of these EISs used census data from the 2000 U.S. Census. Populations have not changed significantly in the areas around the two sites; the population around Paducah has increased by about 14,000 persons or 3 percent (from 520,000 to 534,000 in 2016 [DOE 2017b]) and that around Portsmouth has increased by about 7,000 persons or 1 percent (from 570,000 to 577,000 in 2015 [DOE 2017c]). These small population changes would have an insignificant impact on the results of the analysis and are not considered further in this analysis.

The 2004 Paducah EIS calculated an MEI dose of less than 3.9×10^{-5} millirem per year and a population dose of 4.7×10^{-5} person-rem per year of conversion operations (DOE 2004a). That analysis used the same throughput (20,000 tons [18,000 metric tons]) that is being assumed for the conversion of the commercial DUF_6. For the eight-year conversion period for the commercial DUF_6, the total dose for the MEI (assuming the same person is the MEI for each year of operations) would be less than 3.1×10^{-4} millirem and the total population dose would be 3.8×10^{-4} person-rem. The MEI cancer risk would be essentially zero (2×10^{-10}) and no additional latent cancer fatalities[69] (LCFs) would be expected within the general population (2×10^{-7}).

The 2004 Portsmouth EIS calculated an MEI dose of less than 2.1×10^{-5} millirem per year and a population dose of 6.2×10^{-5} person-rem per year of conversion operations (DOE 2004b). That analysis used the same throughput (15,000 tons [13,500 metric tons]) that is being assumed for the conversion of the commercial DUF_6 (PPPO 2016a). For the 11-year conversion period for the commercial DUF_6, the total dose for the MEI (assuming the same person is the MEI for each year of operations) would be less than 2.3×10^{-4} millirem and the total population dose would be 6.8×10^{-4} person-rem. The MEI cancer risk would be essentially zero (1×10^{-10}) and no additional LCFs would be expected within the general population (4×10^{-7}).

Conversion to DU oxide would result in very low levels of exposure to hazardous chemicals. No adverse health effects to 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 a hazard index of 1.4×10^{-4} and 4.1×10^{-5} for the general public MEIs at Paducah or Portsmouth, respectively (DOE 2004a, 2004b). These hazard indices for the conversion process are significantly 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.

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[69] This DU Oxide SEIS uses a risk factor of 0.0006 LCF per person-rem, consistent with current DOE guidance (DOE 2003a).

Storage of Cylinders Containing Commercial DU

The 2004 EISs (DOE 2004a, 2004b) estimated the public health impacts from the storage of DUF_6 at Paducah and Portsmouth. After conversion, any exposure to stored uranium would be from DU oxide. The chemical form of the uranium does not appreciably impact the radiological characteristics of the material. Therefore, the dose estimates from the 2004 EISs for DUF_6 were used in this DU Oxide SEIS to estimate the effects of exposure to DU oxide.

The 2004 Paducah EIS (DOE 2004a) estimated that if all DU assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.008 person-rem per year. This dose is based on the storage of 36,191 cylinders and a breach rate associated with the uncontrolled corrosion breach rate.[70] The number of expected breaches for the 12,500 cylinders containing commercial DU would be 35 percent of the number used in the 2004 Paducah EIS for the storage of 36,191 cylinders. Scaling from the 2004 Paducah EIS results in an estimated dose of 0.003 person-rem per year.

For the 100 years of DU storage assumed for the Conversion and Storage Scenario, this population dose rate would correspond to a total population dose of 0.28 person-rem. This population dose would result in an estimated 0 (2×10^{-4}) LCF, indicating that there is a very small likelihood, about 1 in 6,000, of any additional cancer fatalities in the general population associated with DU oxide storage at Paducah. For comparison, the average natural background radiation level in the United States is 310 millirem per year; this means that during the 100 years of DU oxide storage, the population within 50 miles of Paducah would receive a background dose of 16 million person-rem based on a population of 534,000 (DOE 2017b). The population dose associated with natural background radiation could result in an estimated 9,600 LCFs.

The 2004 Portsmouth EIS (DOE 2004b) estimated that if all the DU assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.002 person-rem per year. This dose is based on the storage of 16,109 cylinders and the uncontrolled corrosion breach rate. The number of expected breaches for the 12,500 cylinders containing commercial DU would be 77 percent of the number used in the 2004 Portsmouth EIS for the storage of 16,109 cylinders. Scaling from the 2004 Portsmouth EIS results in an estimated dose of 0.002 person-rem per year. For the 100 years of DU oxide storage assumed for the Conversion and Storage Scenario, this population dose rate would correspond to a total population dose of 0.16 person-rem. This population dose would result in an estimated zero (9×10^{-5}) LCF, indicating that there is a very small likelihood, about 1 in 10,000 of any additional cancer fatalities in the general population associated with DU oxide storage at Portsmouth. For comparison, over the same period, the 677,000 people (DOE 2017c) living within 50 miles of Portsmouth would receive a background dose of 21 million person-rem. The population dose associated with natural background radiation could result in an estimated 12,600 LCFs.

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[70] The uncontrolled corrosion breach rate was used to maintain consistency between the 2004 EISs and the alternatives analysis in this DU Oxide SEIS.

The 2004 EISs calculated impacts on an MEI in the general population. At Paducah this MEI dose is approximately 0.1 millirem per year from airborne releases of uranium and less than 0.5 millirem per year from the ingestion of contaminated water (DOE 2004a); at Portsmouth it is less than 0.1 millirem per year from airborne releases of uranium and less than 0.4 millirem per year from the ingestion of contaminated water (DOE 2004b). In addition, the Annual Site Environmental Reports for both sites identify an MEI dose that results from direct radiation exposure to an individual that passes the site in close proximity to the cylinder storage yards. Since the commercial cylinders are to be stored within or directly adjacent to the existing cylinder storage yards, the addition of these cylinders should not significantly impact this direct radiation dose at either site. Therefore, the only incremental impact of storage of the commercial cylinders would be from the anticipated cylinder breaches. Scaling the MEI dose resulting from potential cylinder breaches to reflect the incremental number of cylinders from commercial DUF_6 at each site results in MEI doses of less than 0.2 millirem per year at Paducah (scaling factor of 0.35) and less than 0.4 millirem per year at Portsmouth (scaling factor of 0.77).

At Paducah, this dose to the MEI results in an incremental increase in the risk of a fatal cancer for this individual of 1×10^{-7}, less than a 1 in 8 million chance. Although it is extremely unlikely that the same individual would be the MEI every year over the 100 years of DU oxide storage, the likelihood of the individual receiving this MEI dose during that period and contracting a fatal cancer is less than 1 in 80,000.

At Portsmouth, this dose to the MEI results in an incremental increase in the risk of a fatal cancer for this individual of 2×10^{-7}, less than a 1 in 4 million chance. Although it is unlikely that the same individual would be the MEI every year over the 100 years of DU oxide storage, the likelihood of the individual receiving this MEI dose during that period and contracting a fatal cancer is approximately 1 in 40,000.

The 2004 EISs (DOE 2004a, 2004b) also provide an estimate of the nonradiological impacts of uranium releases on the public. Both of the 2004 EISs estimated that the hazard index (HI) associated with airborne releases of uranium would be less than 0.1 and that for releases into the waters around the sites the hazard index would be less than 0.05. Therefore, no adverse impacts are expected from chemical exposure.

Summary

Table C-13 provides a summary of the combined public radiological health impacts for the Conversion and Storage Scenario. Both MEI and total population impacts are dominated by cylinder storage impacts. All individual doses are well below regulatory limits for radiation exposure to a member of the public established by both the EPA and DOE. The EPA has set a radiation dose limit to a member of the general public of 10 millirem per year from airborne sources (40 CFR Part 61). DOE has established a limit on the dose to a member of the public of 100 millirem per year from all sources combined (DOE Order 458.1). Impacts from all operations are not expected to result in any health effects (i.e., LCFs), and the risks to individuals and the population are both less than 1 in 500,000 for each year of operation.

Table C-13 Conversion and Storage Scenario - Public Health Radiological Impacts

Site	Scenario	MEI			
		Annual		**Duration of Activity**	
		Dose (millirem/yr)	**Health Risk (LCF)**	**Dose (rem)**	**Health Risk (LCF)**
Paducah	Conversion	3.9×10^{-5}	(a)	3.1×10^{-7}	2×10^{-10}
	Cylinder Storage	0.2	1×10^{-7}	0.02	1×10^{-5}
	Total	**0.2**	**1×10^{-7}**	**0.02**	**1×10^{-5}**
Portsmouth	Conversion	2.1×10^{-5}	(a)	2.3×10^{-7}	1×10^{-10}
	Cylinder Storage	0.4	2×10^{-7}	0.04	2×10^{-5}
	Total	**0.4**	**2×10^{-7}**	**0.04**	**2×10^{-5}**

Site	Scenario	Population			
		Annual		**Duration of Activity**	
		Dose (Person-rem/yr)	**Health Risk (LCF)**	**Dose (Person-rem)**	**Health Risk (LCF)**
Paducah	Conversion	4.7×10^{-5}	3×10^{-8}	3.8×10^{-4}	2×10^{-7}
	Cylinder Storage	3×10^{-3}	2×10^{-6}	0.28	2×10^{-4}
	Total	**3×10^{-3}**	**2×10^{-6}**	**0.28**	**2×10^{-4}**
Portsmouth	Conversion	6.2×10^{-5}	4×10^{-8}	6.8×10^{-4}	4×10^{-7}
	Cylinder Storage	2×10^{-3}	9×10^{-7}	0.16	9×10^{-5}
	Total	**2×10^{-3}**	**9×10^{-7}**	**0.16**	**9×10^{-5}**

Key: LCF = latent cancer fatality; yr = year.

[a] Health risks are effectively zero.

Occupational Safety and Health

During normal operation of the conversion facility, conversion workers (involved workers) would be exposed to external radiation from the handling of DU. Impacts on the remainder of the site workers (noninvolved workers) would result from trace amounts of uranium compounds released to the environment. Cylinder storage yard workers would be exposed to low levels of gamma and neutron radiation while working in the yards performing activities that include routine inspections, ultrasonic inspections, radiological monitoring and valve maintenance, and container repair and relocations. The numbers of noninvolved workers assumed in this analysis is the same as the numbers used in the analyses presented in Chapter 4, Sections 4.2.1.6 and 4.2.2.6, of this DU Oxide SEIS. However the number of involved workers for cylinder storage has been scaled by the number of cylinders in this analysis compared to that in the Chapter 4 analyses. At Paducah the analysis in Chapter 4 used 16 cylinder yard workers for the 46,150 cylinders being stored for those alternatives; for Portsmouth 12 cylinder yard workers for 22,850 cylinders was used (PPPO 2018). The storage of commercial cylinders involves 12,500 cylinders. By scaling the workforce, the equivalent of 4 cylinder yard workers would be required to manage the commercial cylinders at Paducah or 6 cylinder yard workers at Portsmouth.

Conversion of Commercial DUF_6

The 2004 EISs (DOE 2004a, 2004b) estimated the worker health impacts for both involved and noninvolved workers, from the conversion of DUF_6 to DU oxide at Paducah and Portsmouth. Potential impacts were assessed for both conversion operations and the cylinder yard operations associated with conversion (e.g., cylinder movement). Annual impacts were provided for an average worker, the total worker population, a maximally exposed noninvolved worker, and for the total noninvolved worker population. This analysis for the conversion of commercial DUF_6

assumes the same annual throughput (20,000 tons [18,000 metric tons] at Paducah and 15,000 tons [13,500 metric tons at Portsmouth) and the same number of involved workers (142 at Paducah and 135 at Portsmouth) as the analyses in the 2004 EISs (DOE 2004a, 2004b). However the noninvolved worker numbers have changed at both sites; Paducah now has 1,200 workers (down from 1,900) and Portsmouth has 2,612 workers (up from 1,800) (DOE 2004a, 2004b; PPPO 2018).

The 2004 Paducah EIS calculated a conversion worker average dose of 75 millirem per year and a conversion worker population dose of 10.7 person-rem per year of conversion operations. (DOE 2004a). For the eight-year conversion period for the commercial DUF_6, the total dose for the average conversion worker would be 0.60 rem and the total worker population dose would be 86 person-rem. The average conversion worker cancer risk would 4×10^{-4} and no additional LCFs (0.05) would be expected within the conversion worker population. Annual doses for workers involved in cylinder yard operations were 690 millirem per year to the average cylinder yard worker and 5.5 person-rem to the total cylinder yard workforce. For the eight-year conversion period for the commercial DUF_6, the total dose for the average cylinder yard worker would be 5.5 rem and the total worker population dose would be 44 person-rem. The average cylinder yard worker cancer risk would be 3×10^{-3} and no additional LCFs (0.03) would be expected within the conversion worker population. Combined, the total workforce cumulative dose would be 130 person-rem resulting in no additional LCFs (0.08).

The 2004 Paducah EIS (2004a) also calculated the dose to the noninvolved workforce. The noninvolved worker MEI dose from conversion operations (there was no contribution from cylinder yard operations) was less than 1×10^{-5} millirem per year. With the smaller workforce at Paducah now, compared to the workforce used in the 2004 EIS, the noninvolved worker population dose (1.9×10^{-5} per the 2004 EIS) would be 1.2×10^{-5} person-rem per year. These two dose estimates result in essentially zero health risk to the noninvolved MEI worker and zero LCFs among the noninvolved worker population.

The 2004 Portsmouth EIS calculated a conversion worker average dose of 75 millirem per year and a conversion worker population dose of 10.1 person-rem per year of conversion operations (DOE 2004b). For the 11-year conversion period for the commercial DUF_6, the total dose for the average conversion worker would be 0.83 rem and the total worker population dose would be 110 person-rem. The average conversion worker cancer risk would 5×10^{-4} and no additional LCFs (0.07) would be expected within the conversion worker population. Annual doses for workers involved in cylinder yard operations were 600 millirem per year to the average cylinder yard worker and 3.0 person-rem per year to the total cylinder yard workforce. For the 11-year conversion period for the commercial DUF_6, the total dose for the average cylinder yard worker would be 6.6 rem and the total worker population dose would be 33 person-rem. The average cylinder yard worker cancer risk would 4×10^{-3} and no additional LCFs (0.02) would be expected within the conversion worker population. Combined the total workforce cumulative dose would be 130 person-rem resulting in no additional LCFs (0.09).

The 2004 Portsmouth EIS (2004b) also calculated the dose to the noninvolved workforce. The noninvolved worker MEI dose from conversion operations (there was no contribution from cylinder yard operations) was less than 5.5×10^{-5} millirem per year. With the larger workforce at Portsmouth now, compared to the workforce used in the 2004 EIS, the noninvolved worker population dose ($< 9.9 \times 10^{-6}$ person-rem per year per the 2004 EIS) would be $<1.4 \times 10^{-5}$ person-rem per year. These two dose estimates result in essentially zero health risk to the noninvolved MEI worker and zero LCFs among the noninvolved worker population.

Conversion to DU oxide would result in very low levels of exposure to hazardous chemicals. Impacts on 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. (DOE 2004a, 2004b)

No adverse health effects to noninvolved workers are expected during normal operations. Human health impacts resulting from exposure to hazardous chemicals during normal operations of the conversion facilities are estimated as a hazard index of 1.3×10^{-6} and 3.8×10^{-7} for the noninvolved worker at Paducah or Portsmouth, respectively (DOE 2004a, 2004b). The hazard indices for the conversion process would be significantly 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.

Storage of Cylinders Containing Commercial DU

At Paducah the equivalent of 4 workers would be involved in cylinder storage yard activities associated with storage of 12,500 cylinders containing commercial DUF_6 for the remainder of the duration of storage after the 8 years of conversion operation (an additional 92 years of cylinder storage at Paducah). At Portsmouth, the equivalent of 6 workers would be required for the 89 year duration (the 100-year duration of the project minus the 11 years of conversion operation) of DU oxide storage (PPPO 2018).

The average annual doses to Paducah and Portsmouth cylinder yard workers are provided in the DOE’s 2014 and 2016 Occupational Radiation Exposure Reports (DOE 2015, 2017d). In 2014 the average dose was 74 millirem at Paducah and in 2016 the average dose was 63 millirem at Portsmouth. These reported exposures are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR 835, “*Occupational Radiation Protection*.” These workers performed duties similar to what would be expected of the workers during the implementation of this scenario. Therefore, it is estimated that, at Paducah, the total worker dose for the 4 cylinder yard workers would be approximately 0.30 person-rem per year, and would total 27 person-rem for the 92 years of DU oxide storage after conversion assumed for the Conversion and Storage Scenario. No LCFs (0.02) are expected from this exposure. Similarly, it is estimated that the total worker dose for the 6 Portsmouth cylinder yard workers would be approximately 0.38 person-rem per year and 34 person-rem for the 89 years of DU oxide storage after conversion associated with the Conversion and Storage Scenario. No LCFs (0.02) are expected to result from this exposure.

The 2004 EISs (DOE 2004a, 2004b) calculated a maximum noninvolved worker dose of 0.15 millirem per year from storage of DUF_6. The noninvolved worker dose was calculated at 100 meters (328 feet) from the storage yards for airborne releases. The dose was estimated based on the uranium in the cylinders in the conversion facility and cylinder storage yards and those moved to and from the conversion facility. Since the amount of uranium that will be stored as an oxide would be similar to that previously being stored as DUF_6, the dose to the noninvolved worker would be similar for the storage and handling of DU oxide.

The 2004 EISs (DOE 2004a, 2004b) also calculated a total worker dose for noninvolved workers. The total noninvolved worker dose at the facilities were estimated to be 0.003 person-rem per year at Paducah and 0.001 person-rem per year at Portsmouth for workforces that vary from those predicted for each site during the storage of DU oxide. However the differences in the number of workers do not significantly affect the workforce doses for the total noninvolved worker dose. No LCFs (less than 0.0002 at Paducah and 0.00006 at Portsmouth) would be expected at either site for the 100 years of DU oxide storage assumed for the Conversion and Storage Scenario.

For worker protection from the toxic effects of uranium, DOE uses the OSHA permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000, Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels. Adherence to these limits would result in no adverse health effects to workers at either site from the toxic effects of uranium exposure.

Industrial accidents also pose a risk to site workers. All on-site work would be performed in accordance with good management practices and in accordance with applicable OSHA requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, *Worker Safety and Health Program*. DOE Order 450.2 *Integrated Safety Management* integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were based on the number of workers in the cylinder storage yard (4 at Paducah or 6 at Portsmouth) and national worker injury and fatality rates. During the 100 years of the Conversion and Storage Scenario there would be no anticipated fatalities at either site based on an average worker fatality rate of 3.4 fatalities per 100,000 worker years (BLS 2014). Accidents resulting in lost worker days occur at a rate of 3.0 per 100 worker years (the national average across all industries in 2016 (BLS 2016). This rate results in an estimated 0.12 cylinder yard worker injuries per year during conversion and 0.12 cylinder yard worker injuries per year once conversion operations cease at Paducah and 0.18 cylinder yard worker injuries per year at Portsmouth. During the 100 years of the Conversion and Storage Scenario, this could result in 12 worker injuries at Paducah and 18 worker injuries at Portsmouth.

Summary

Table C-14 provides a summary of the combined worker radiological health impacts for the Conversion and Storage Scenario. Due to the 100-year length of the cylinder storage activity, no single worker would receive the average dose for the full duration of cylinder storage. However, a cumulative average worker dose has been calculated assuming the same worker received the average dose from working in the cylinder yard for 50 years.

Involved worker impacts result primarily from the conversion operations, despite the longer period of time associated with cylinder storage. Cylinder operations (cylinder movement) associated with conversion operations result in annual MEI doses nearly an order of magnitude higher than those associated with conversion or cylinder storage. In all cases, the average worker doses are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR Part 835, "Occupational Radiation Protection." No LCFs would be expected within the worker populations from any of the activities.

Noninvolved worker annual and total impacts, both to the MEI and total worker population, are orders of magnitude lower than the impacts on the involved workers. No health effects (LCFs) are expected within the noninvolved worker population.

Table C-14 Conversion and Storage Scenario - Worker Health Radiological Impacts

	Involved Worker					
	Average Worker			**Worker Population**		
	Annual	**Duration of Activity[a]**		**Annual**	**Duration of Activity**	
Site	**Dose (mrem/yr)**	**Dose (rem)**	**Health Risk (LCF)**	**Dose (person-rem/yr)**	**Dose (person-rem)**	**Health Risk (LCF)**
Paducah						
Conversion	75	0.60	4×10^{-4}	10.7	86	0.05
Cylinder Operations	690	5.5	3×10^{-3}	5.5	44	0.03
Cylinder Storage	74	3.7	2×10^{-3}	0.89	27	0.02
Total[b]	**690**	**5.5**	**3×10^{-3}**	**17**	**160**	**0.10**
Portsmouth						
Conversion	75	0.83	5×10^{-4}	10.1	110	0.07
Cylinder Operations	600	6.6	4×10^{-3}	3.0	33	0.02
Cylinder Storage	63	3.2	2×10^{-3}	0.38	34	0.02
Total[b]	**600**	**6.6**	**4×10^{-3}**	**13**	**180**	**0.11**
	Noninvolved Worker					
	MEI Worker			**Worker Population**		
	Annual	**Duration of Activity**		**Annual**	**Duration of Activity**	
Site	**Dose (mrem/yr)**	**Dose (rem)**	**Health Risk (LCF)**	**Dose (person-rem/yr)**	**Dose (person-rem)**	**Health Risk (LCF)**
Paducah						
Conversion	1.0×10^{-5}	1×10^{-7}	(c)	1.2×10^{-5}	9.6×10^{-5}	(c)
Cylinder Storage	0.15	8×10^{-3}	5×10^{-6}	3×10^{-3}	0.3	2×10^{-4}
Total[b]	**0.15**	**8×10^{-3}**	**5×10^{-6}**	**3×10^{-3}**	**0.3**	**2×10^{-4}**
Portsmouth						
Conversion	5.5×10^{-5}	6×10^{-7}	(c)	1.4×10^{-5}	1.5×10^{-4}	(c)
Cylinder Storage	0.15	8×10^{-3}	5×10^{-6}	1×10^{-3}	0.1	6×10^{-5}
Total[b]	**0.15**	**8×10^{-3}**	**5×10^{-6}**	**1×10^{-3}**	**0.1**	**6×10^{-5}**

Key: LCF = latent cancer fatality; MEI = maximally exposed individual; mrem = millirem; yr = year.

[a] For the average worker, the exposure time is assumed to be 50 years for cylinder storage, not the full duration of cylinder storage.

[b] Numbers may not sum due to rounding.

[c] Health risks are effectively zero.

C.7.1.2 Conversion and Disposal Scenario

Impacts on public and worker health at Paducah or Portsmouth under all three Conversion and Disposal Scenarios would be similar to the impacts described in Section C.7.1 for the Conversion and Storage Scenario. The major difference would be that under the Conversion and Disposal Scenario, cylinders would be stored at Paducah for up to 62 years (53 years of storage and 9 years to ship to a disposal facility) and at Portsmouth for up to 52 years (43 years of storage and 9 years to ship to a disposal facility) rather than the 100 years under the Conversion and Storage Scenario.

Public Safety and Health

The 2004 EISs (DOE 2004a, 2004b) estimated the public health impacts from the conversion of DUF_6 to DU oxide and from the storage of DUF_6 at Paducah and Portsmouth. After conversion, any exposure to stored uranium would be from DU oxide. The chemical form of the released uranium does not appreciably impact the radiological characteristics of the material. Therefore, the dose estimates from the 2004 EISs for DUF_6 were used in this DU Oxide SEIS to estimate the effects of exposure to DU oxide. In addition, information from both sites' annual site environmental reports (DOE 2017b) were used to augment the analysis of public health and safety.

Conversion of Commercial DUF_6

Impacts from the conversion of the commercial DUF_6 would be the same under any of the Conversion and Disposal Scenarios as they would be under the Conversion and Storage Scenario.

Storage of Cylinders Containing Commercial DU

The 2004 Paducah EIS (DOE 2004a) estimated that if all DU assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.008 person-rem per year. These impacts were scaled using the same ratios as used for the Conversion and Storage Scenario. This results in an estimated dose of 0.003 person-rem per year at Paducah. For the 62 years of DU storage and shipment assumed for the Conversion and Disposal Scenario, this population dose rate would correspond to a total population dose of 0.18 person-rem. This population dose would result in an estimated zero (1×10^{-4}) LCF, indicating a very small likelihood, about 1 in 9,000, of additional cancer fatalities in the general population associated with commercial DU oxide storage at Paducah. For comparison, the average natural background radiation level in the United States is 310 millirem per year; this means that during the 62 years of commercial DU oxide storage, the population within 50 miles of Paducah would receive a background dose of 10 million person-rem based on a population of 534,000 (DOE 2017b). The population dose associated with natural background radiation could result in an estimated 6,100 LCFs.

The 2004 Portsmouth EIS (DOE 2004b) estimated that if all DU assumed to be released in cylinder breaches each year were released to the atmosphere (a very conservative assumption), the dose to the general public would be 0.002 person-rem per year. These impacts were scaled using the same ratios as used for the Conversion and Storage Scenario. This results in an estimated dose of less than 0.002 person-rem per year at Portsmouth. For the 52 years of commercial DU oxide storage and shipment assumed for the Conversion and Disposal Scenario, this population dose rate would correspond to a total population dose of 0.081 person-rem. This population dose would result in an estimated zero (5×10^{-5}) LCF, indicating a very small likelihood, about 1 in 25,000, of any additional cancer fatalities in the general population associated with commercial DU oxide storage at Portsmouth. For comparison, over the same period, the 677,000 people (DOE 2017c) living within 50 miles of Portsmouth would receive a background dose of 11.0 million person-rem. The population dose associated with natural background radiation could result in an estimated 6,500 LCFs.

The 2004 EISs calculated impacts on an MEI in the general population. At Paducah this MEI dose is approximately 0.1 millirem per year from airborne releases of uranium and less than 0.5 millirem per year from the ingestion of contaminated water (DOE 2004a); at Portsmouth it is less than 0.1 millirem per year from airborne releases of uranium and less than 0.4 millirem per year from the ingestion of contaminated water (DOE 2004b). In addition, the Annual Site Environmental Reports for both sites identify an MEI dose that results from direct radiation exposure to an individual that passes the site in close proximity to the cylinder storage yards. Since the commercial cylinders are to be stored within the existing cylinder yards and other appropriate available areas, and the dose drops off very quickly with distance from the cylinders, the addition of these cylinders should not significantly impact this direct radiation dose at either site. Therefore, the only incremental impact of storage of the commercial cylinders would be from the anticipated cylinder breaches. Scaling the MEI dose to reflect the reduced number of cylinders at each site results in MEI doses of less than 0.2 millirem per year at Paducah (scaling factor of 0.35) and less than 0.4 millirem per year at Portsmouth (scaling factor of 0.77).

At Paducah, this dose to the MEI results in an incremental increase in the risk of a fatal cancer for this individual of 1×10^{-7}, less than a 1 in 8 million chance. Although it is unlikely that the same individual would be the MEI every year over the 62 years of DU oxide storage and shipment, the likelihood of the individual receiving this MEI dose during that period and contracting a fatal cancer is less than 1 in 140,000.

At Portsmouth, this dose to the MEI results in an incremental increase in the risk of a fatal cancer for this individual of 2×10^{-7}, less than a 1 in 4 million chance. Although it is unlikely that the same individual would be the MEI every year over the 52 years of DU oxide storage and shipment, the likelihood of the individual receiving this MEI dose during that period and contracting a fatal cancer is approximately 1 in 80,000.

The 2004 EISs (DOE 2004a, 2004b) also provide an estimate of the nonradiological impacts of uranium releases on the public. Both of the 2004 EISs estimated that the HI associated with airborne releases of uranium would be less than 0.1 and that for releases into the waters around the sites the hazard index would be less than 0.05. Therefore, no adverse impacts are expected from chemical exposure.

Summary

Table C-15 provides a summary of the combined public health radiological impacts for the Conversion and Disposal Scenario. Both MEI and total population impacts are dominated by cylinder storage impacts. All individual doses are well below regulatory limits for radiation exposure to a member of the public established by both the EPA and DOE. The EPA has set a radiation dose limit to a member of the general public of 10 millirem per year from airborne sources (40 CFR Part 61). DOE has established a limit on the dose to a member of the public of 100 millirem per year from all sources combined (DOE Order 458.1). Impacts from all operations are not expected to result in any health effects (LCFs), and the risks to individuals and the population are both less than 1 in 1,000,000 for each year of operation.

Table C-15 Conversion and Disposal Scenario - Public Health Radiological Impacts

Site	Scenario	MEI			
		Annual		Duration of Activity	
		Dose (millirem/yr)	Health Risk (LCF)	Dose (rem)	Health Risk (LCF)
Paducah	Conversion	3.9×10^{-5}	(a)	3.1×10^{-7}	2×10^{-10}
	Cylinder Storage	0.2	1×10^{-7}	0.012	7×10^{-6}
	Total	**0.2**	$\mathbf{1\times10^{-7}}$	**0.012**	$\mathbf{7\times10^{-6}}$
Portsmouth	Conversion	2.1×10^{-5}	(a)	2.3×10^{-7}	1×10^{-10}
	Cylinder Storage	0.4	2×10^{-7}	0.02	1×10^{-5}
	Total	**0.4**	$\mathbf{2\times10^{-7}}$	**0.02**	$\mathbf{1\times10^{-5}}$

Site	Scenario	Population			
		Annual		Duration of Activity	
		Dose (Person-rem/yr)	Health Risk (LCF)	Dose (Person-rem)	Health Risk (LCF)
Paducah	Conversion	4.7×10^{-5}	3×10^{-8}	3.8×10^{-4}	2×10^{-7}
	Cylinder Storage	3×10^{-3}	2×10^{-6}	0.18	1×10^{-4}
	Total	$\mathbf{3\times10^{-3}}$	$\mathbf{2\times10^{-6}}$	**0.18**	$\mathbf{1\times10^{-4}}$
Portsmouth	Conversion	6.2×10^{-5}	4×10^{-8}	6.8×10^{-4}	4×10^{-7}
	Cylinder Storage	2×10^{-3}	9×10^{-7}	0.081	5×10^{-5}
	Total	$\mathbf{2\times10^{-3}}$	$\mathbf{9\times10^{-7}}$	**0.081**	$\mathbf{5\times10^{-5}}$

Key: LCF = latent cancer fatality; yr = year.

[a] Health risks are essentially zero.

Occupational Safety and Health

During normal operation of the conversion facility, conversion workers (involved workers) would be exposed to external radiation from the handling of DU materials. Impacts on the remainder of the site workers (noninvolved workers) would result from trace amounts of uranium compounds released to the environment. Cylinder storage yard workers would be exposed to low levels of gamma and neutron radiation while working in the yards performing activities that include routine inspections, ultrasonic inspections, radiological monitoring and valve maintenance, and container repair and relocations. The numbers of workers (involved and noninvolved) assumed in this analysis are the same as the numbers used in the 2004 EISs and in the analyses presented in Chapter 4, Sections 4.2.1.6 and 4.2.2.6, of this DU Oxide SEIS.

Conversion of Commercial DUF$_6$

Impacts from the conversion of the commercial DUF$_6$ would be the same under any of the Conversion and Disposal Scenarios as they would under the Conversion and Storage Scenario.

Storage of Cylinders Containing Commercial DU

At Paducah the equivalent of 4 workers would be involved in these activities. At Portsmouth, the equivalent of 6 workers would be required. The average annual dose to Paducah and Portsmouth cylinder yard workers, are provided in the DOE’s 2014 and 2016 Occupational Radiation Exposure Reports (DOE 2017d). In 2016 the average dose was 74 millirem at Paducah and in 2014 the average dose was 63 millirem at Portsmouth. These reported exposures are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR 835, “*Occupational Radiation*

Protection." These workers performed duties similar to what would be expected of the cylinder yard workers during the implementation of this scenario. Therefore, it is estimated that at Paducah the total worker dose for the 4 cylinder yard workers would be approximately 0.30 person-rem per year and 16 person-rem for the 53 years (61 years minus the 8 years of conversion operations) of DU oxide storage associated with the Conversion and Disposal Scenario. No LCFs (0.009) would be expected to result from this exposure. Similarly, it is estimated that the total worker dose for the 6 Portsmouth cylinder yard workers would be approximately 0.38 person-rem per year and 15 person-rem for the 41 years (52 years minus the 11 years of conversion operations) of DU oxide storage associated with the Conversion and Disposal Scenario. No LCFs (0.009) are expected to result from this exposure.

Worker exposure would also result from the handling of the DU oxide cylinders and unusable cylinders during loading operations at the site in preparation for shipment to the waste disposal site. For the DU oxide cylinders, it is assumed that the cylinders could be shipped either by rail (six cylinders per railcar) or by truck (one cylinder per truck). It would take four workers and a supervisor about four hours to load six cylinders onto a railcar (PPPO 2018). The same crew would take about a half-hour to load a single cylinder onto a truck. As noted in the transportation analysis the dose at 30 cm from the cylinder surface is about 2 millirem/hour which equates to less than 1 millirem/hour at 1 meter from the cylinder surface. Although it takes four hours to load six cylinders onto a railcar, the time spent in close proximity to the cylinder is limited. It is estimated that the worker dose associated with loading these six cylinders would be 2 millirem per person, for a total of 0.01 person/rem for the 5 workers. This would result in a worker dose of 21 person-rem for the 12,500 DU oxide cylinders generated from commercial DUF_6. Over the 9 years of shipping operations, the average total annual worker dose would be 2.3 person-rem/yr, 0.46 person-rem to the average worker. Given the shorter time to load a single cylinder onto a truck, compared to loading a single cylinder onto a railcar, the impacts of loading railcars should bound the impacts of loading trucks.

The 2004 EISs (DOE 2004a, 2004b) calculated a maximum noninvolved worker dose of 0.15 millirem per year from storage of DUF_6. The dose was estimated based on the uranium in the cylinders in the conversion facility and cylinder storage yards and those moved to and from the conversion facility. Since the amount of uranium that will be stored as an oxide would be similar to that previously being stored as DUF_6, the dose to the noninvolved worker would be similar for the storage and handling of DU oxide.

The 2004 EISs (DOE 2004a, 2004b) also calculated a total worker dose for noninvolved workers. The total noninvolved worker doses at the facilities were estimated to be 0.003 person-rem per year at Paducah and 0.001 person-rem per year at Portsmouth for workforces that vary from those predicted for each site during the storage of DU oxide. The difference in work force populations does not significantly impact the estimated noninvolved worker population dose. No LCFs (less than 0.00009 at Paducah and 0.00003 at Portsmouth) would be expected at either site for DU oxide storage and handling before shipment to a disposal site.

For worker protection from the toxic effects of uranium, DOE uses the OSHA permissible exposure levels for workplace exposure to uranium of 0.25 milligram per cubic meter for insoluble and 0.05 milligram per cubic meter for soluble uranium (29 CFR 1910.1000, Table Z-1). Under the requirements of DOE's worker protection program, site worker exposures to airborne uranium are maintained below these levels. Adherence to these limits would result in no adverse health effects to workers at either site from the toxic effects of uranium exposure.

Industrial accidents also pose a risk to site workers. All on-site work would be performed in accordance with good management practices, and in accordance with applicable OSHA requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, *Worker Safety and Health Program*. DOE Order 450.2 *Integrated Safety Management* integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were determined on the basis of the number of workers in the cylinder yard (four at Paducah and six at Portsmouth) and national worker injury and fatality rates. Under the Conversion and Disposal Scenario there would be no anticipated fatalities at either site based on an average worker fatality rate of 3.4 fatalities per 100,000 worker years (BLS 2014). Accidents resulting in lost worker days occur at a rate of 3.0 per 100 worker years (the national average across all industries in 2016) (BLS 2016b). This rate results in an estimated 0.12 cylinder yard worker injuries per year at Paducah and 0.18 cylinder yard worker injuries per year at Portsmouth. Under the Conversion and Disposal Scenario this could result in seven worker injuries at Paducah and nine worker injuries at Portsmouth.

Summary

Table C-16 provides a summary of the combined worker radiological health impacts for the Conversion and Disposal Scenario. Due to the length of the cylinder storage activity, 52 or 43 years at Paducah or Portsmouth, respectively, it is unlikely that any one worker would be subject to the average dose for the entire duration of cylinder storage. However, the average worker dose for the duration of cylinder storage has been calculated.

Involved worker impacts result primarily from the conversion operations, despite the longer period of time associated with cylinder storage. Cylinder operations (cylinder movement) associated with conversion operations result in annual MEI doses nearly an order of magnitude higher than those associated with conversion or cylinder storage. In all cases, the average worker doses are well below the worker exposure limit of 5,000 millirem per year as required by 10 CFR Part 835, “Occupational Radiation Protection.” No LCFs would be expected within the worker populations from any of the activities.

Noninvolved worker annual and total impacts, both to the MEI and total worker population, are orders of magnitude lower than the impacts on the involved workers. No health effects (LCFs) are expected within the noninvolved worker population.

Table C-16 Conversion and Disposal Scenario—Worker Health Radiological Impacts

	Involved Worker					
	Average Worker			**Worker Population**		
	Annual	**Duration of Activity**		**Annual**	**Duration of Activity**	
Site	**Dose (mrem/yr)**	**Dose (rem)**	**Health Risk (LCF)**	**Dose (person-rem/yr)**	**Dose (person-rem)**	**Health Risk (LCF)**
Paducah						
Conversion	75	0.6	4×10^{-4}	10.7	86	0.05
Cylinder Operations	690	5.5	3×10^{-3}	5.5	44	0.03
Cylinder Storage	74	3.9	2×10^{-3}	0.30	16	0.009
Cylinder Shipment	460	4.2	3×10^{-3}	2.3	21	0.01
Total[a]	**690**	**5.5**	$\mathbf{3\times10^{-3}}$	**16 [c]**	**170**	**0.1**
Portsmouth						
Conversion	75	0.83	5×10^{-4}	10.1	110	0.07
Cylinder Operations	600	6.6	4×10^{-3}	3.0	33	0.02
Cylinder Storage	63	2.6	2×10^{-3}	0.38	15	0.009
Cylinder Shipment	460	4.2	3×10^{-3}	2.3	21	0.01
Total[a]	**600**	**6.6**	$\mathbf{4\times10^{-3}}$	**13[c]**	**180**	**0.1**

	Noninvolved Worker					
	MEI Worker			**Worker Population**		
	Annual	**Duration of Activity**		**Annual**	**Duration of Activity**	
Site	**Dose (mrem/yr)**	**Dose (rem)**	**Health Risk (LCF)**	**Dose (person-rem/yr)**	**Dose (person-rem)**	**Health Risk (LCF)**
Paducah						
Conversion	1.0×10^{-5}	1×10^{-7}	(b)	1.2×10^{-5}	9.6×10^{-5}	(b)
Cylinder Storage and Shipment	0.15	8×10^{-3}	5×10^{-6}	3×10^{-3}	0.2	1×10^{-4}
Total[a]	**0.15**	$\mathbf{8\times10^{-3}}$	$\mathbf{5\times10^{-6}}$	$\mathbf{3\times10^{-3}}$	**0.2**	$\mathbf{1\times10^{-4}}$
Portsmouth						
Conversion	5.5×10^{-5}	6×10^{-7}	(b)	1.4×10^{-5}	1.5×10^{-4}	(b)
Cylinder Storage and Shipment	0.15	6×10^{-3}	4×10^{-6}	1×10^{-3}	0.04	2×10^{-5}
Total[a]	**0.15**	$\mathbf{6\times10^{-3}}$	$\mathbf{4\times10^{-6}}$	$\mathbf{1\times10^{-3}}$	**0.04**	$\mathbf{2\times10^{-5}}$

Key: LCF = latent cancer fatality; yr = year.

[a] Numbers may not sum due to rounding. Conversion and cylinder operations do not occur concurrently with cylinder storage and shipment

[b] Health risks are effectively zero.

C.7.1.3 Conversion and Disposal Bulk Bag Scenario

An option is being considered under the Conversion and Disposal scenario, where the DU oxide produced from commercial DUF$_6$ would be placed directly in bulk bags. These bulk bags would then be loaded onto trucks or railcars and shipped to a waste disposal facility and would not be placed in the cylinder yards for storage. Based on the amount of DU oxide that would be produced and the assumed capacity of the bulk bags; approximately 10,990 bulk bags would be filled and shipped at Paducah or Portsmouth. In this option, the 12,500 empty and heel cylinders would be volume-reduced and shipped off site as waste.

Public Health and Safety for the Bulk Bag Option

Conversion operations would result in the same population and individual doses as identified for conversion operaitons in the previous section (see Table C-15).

Under this option there would be no long-term storage of DU oxide and therefore no individual or population dose from the long-term storage of DU oxide. Comparatively, there would be less DU oxide on site at any one time since the bags are filled, loaded, and shipped as the DU oxide is generated. This means there would be less material available as a source of direct radiation for any member of the public near the site boundary. (The dose at 1 meter from the surface of the bulk bag is expected to be similar to that for a cylinder, less than 1 millirem/hour) (PPPO 2018). The annual individual and population dose associated with the truck or railcar loading of DU oxide bulk bags and empty and heel cylinders would be similar to that described in Chapter 4, Section 4.2.1.6, under the option for DU oxide disposal in bulk bags.

The primary source of the normal operations population dose from cylinder storage is the release of material during cylinder breaches. Because the bulk bags are on-site for a short period there would little to no likelihood of a breach of a bulk bag that would be considered a normal operational event. Any rupture of the bulk bags would be the result of an accident and not from normal wear or corrosion.

Occupational Safety and Health for the Bulk Bag Option

As with the public health and safety, there would be no worker exposure due to the storage of bulk bags.

Worker doses from the conversion process would be the same as identified in the previous section (see Table C-16). Additionally, worker exposure would result from the handling of the DU oxide in bulk bags and empty and heel cylinders during loading operations at the site in preparation for shipment to the waste disposal site.

For the DU oxide bulk bags, it is assumed that the bulk bags could be shipped either by rail (eight bulk bags per railcar; 10 railcars per train) or by truck (two bulk bags per truck). It is assumed that the information on the loading of cylinders is a reasonable approximation for the loading of bulk bags. It would take four workers and a supervisor about four hours to load six bulk bags onto a railcar (PPPO 2018). The same crew would take about a half-hour to load a single bulk bag onto a truck. The dose at 1 meter from the bulk bag is less than 1 millirem/hour (PPPO 2018), similar to the dose associated with a full cylinder. Although it takes four hours to load six bulk bags onto a railcar, the time spent in close proximity to the bulk bag is limited. It is estimated that the worker dose associated with loading these six bulk bags would be 2 millirem per person, for a total of 0.01 person/rem for the 5 workers. Given the shorter time to load a single bulk bag onto a truck, compared to a single bulk bag onto a railcar, the impacts of loading railcars should bound the impacts of loading trucks.

The 10,990 DU oxide bulk bags are to be shipped to a waste disposal facility. Given the dose rate per railcar provided above, this results in a total worker dose of 18 person-rem. No LCFs (calculated value of 0.01) would be expected from this exposure. Over the 8 years of shipment operations at Paducah and the 11 years at Portsmouth, the average individual worker dose would be 2.3 person-rem/yr which corresponds to an annual risk of about 0.001 LCF at Paducah or 1.6 person-rem/yr which corresponds to an annual risk of about 0.001 LCF at Portsmouth.

The use of bulk bags would result in the generation of 12,500 empty and heel cylinders at either site that would need to be disposed. These cylinders would be compacted and cut in half to reduce their length in a cylinder dispostion facility. The reduced size cylinder would then be loaded by overhead crane into a shipping container. Secondary containment would be provided for the intermodal container loadout. None of these activities requires a worker to be in close proximity to the cylinders. Therefore, worker doses from this activity are not expected to significantly alter the worker doses estimated for the conversion process.

C.7.2 Accidents

Accident risks to the public and worker health at Paducah or Portsmouth under the Conversion and Storage Scenario considered impacts from conversion facility operation as well as cylinder storage yard activities during conversion (cylinder movements between the conversion facility and the cylinder storage yard) and during cylinder storage. Conversion of the commercial DUF_6 would require 8 years of conversion operations at Paducah and 11 years at Portsmouth. Under the Conversion and Storage Scenario, cylinders of DU oxide would be stored for up to 100 years at either Paducah or Portsmouth. Under the Conversion and Disposal Scenario DU oxide containers would be stored for up to 53 years at Paducah and 43 years at Portsmouth rather than the 100 years under the Conversion and Storage Scenario.

The potential impacts of accidents associated with the management of the commercial DUF_6 and DU oxide have been extensively examined in NEPA and safety analyses for Paducah and Portsmouth, including the 2004 EISs (DOE 2004a, 2004b), the 1999 Final PEIS (DOE 1999), and the 2016 documented safety analyses for the cylinder storage yards for each site (BWXT 2006a, 2006b). The characteristics and processes for the conversion, management and storage of the commercial DUF_6 and DU oxide are similar to those for DOE DUF_6 and DU oxide evaluated in the site NEPA and safety documents, so the accident scenarios and consequences are expected to be similar. The additional materials processed, stored, and shipped would increase the amounts of material stored, extend the operational periods for the facilities and extend the timeframe during which the accident hazards exist.

Both the 2004 EISs and 2016 safety analyses identified similar accidents and impacts from conversion of DUF_6 and from cylinder storage yard and DU oxide management and storage activities. The accident analyses in these documents indicate that the physical hazards associated with handling large, heavy cylinders were such that workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. The potential for accidental injuries and deaths are similar to other industries that use heavy equipment or manipulate heavy objects.

Under both the Conversion and Storage and the Conversion and Disposal scenarios, containers of commercial DUF_6 and DU oxide would be stored and handled for many years. The accident analyses indicated that it is possible that accidents could release radiation or chemicals to the environment, potentially affecting both the workers and members of the general public. In both the NEPA and safety documents, a range of operational and natural-phenomena initiated accidents were considered, including cylinder handling equipment fires, fires involving cylinder(s) in a pool of fuel or oil, small vehicle or transport truck fires, tornado and high wind, seismic events, train accident with derailment and subsequent fires, and small and large aircraft impacts followed by fires. The NEPA and safety documents considered accidents ranging from those that would be reasonably likely to occur (expected 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).

These analyses indicate that of all the operational accidents considered, those involving DUF_6 cylinders would have the largest potential effects. Among extremely unlikely natural phenomena accidents, a severe seismic event that causes widespread failure of the DU oxide storage containers resulted in the highest radiological impacts. A seismic-initiated earthquake was evaluated evaluated in the 2004 EISs in which a DU oxide storage building was damaged and 10 percent of the contents of the stored containers were breached, resulting in a spill of 61 kilograms (135 pounds) (DOE 2004a, 2004b). Because the DU oxide will not be stored in a building, there would be no risk of damage to the cylinders from falling debris; thus, this storage building accident is not applicable. Severe, natural phenomena events, including earthquakes, do not have the potential to substantially damage stored DU oxide containers, and releases larger than the 6 kilograms (13 pounds) of DU oxide evaluated above would not be expected.

Under both the Conversion and Storage and the Conversion and Disposal scenarios, the probability is low that accidents involving DUF_6 cylinders would occur while in storage. 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 uranyl fluoride, a soluble solid in the form of small particles. The uranyl fluoride 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 as the DUF_6 is converted and the number of DUF_6 cylinders in storage decreases.

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 ammonia (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 on involved workers under accident conditions would likely be dominated by physical forces from the accident itself. For these reasons, the impacts on involved workers during accidents are not quantified in this DU Oxide SEIS. However, it is recognized that injuries and fatalities among involved workers would be possible if an accident did occur.

The impacts from accidental chemical releases for this DU Oxide SEIS were estimated by determining the numbers of people downwind who might experience *adverse* effects and *irreversible adverse* effects. These terms have very specific health meaning and are defined as:

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 accident analyses reported in the 2004 EISs (DOE 2004a, 2004b) concluded that for accidents involving cylinders that might happen at least once in 100 years (i.e., likely accidents), 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. If this type of accident occurred, up to 10 noninvolved workers at Paducah or 70 noninvolved workers at Portsmouth 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 up to 3 noninvolved workers at Paducah or Portsmouth would experience potential irreversible adverse effects that are permanent in nature (such as lung damage or kidney damage); no fatalities are 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 (DOE 2004a, 2004b).

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. **Table C-17** summarizes the estimated consequences of chemical exposures from extremely unlikely cylinder accidents at Paducah or Portsmouth. 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 DUF_6 cylinder(s) in a fire. If this type of accident occurred, it is estimated that up to 2,000 members of the general public at Paducah (or 680 at Portsmouth) and up to 910 noninvolved workers at Paducah (or 1,000 at Portsmouth) might experience a*dverse* chemical effects from HF and uranium exposure (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function) (DOE 2004b). At Paducah, 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 to nearby off-site populations (i.e., the concentrations that would occur would be higher at points farther from the release than at closer locations) (DOE 2004a). For the similar accident at Portsmouth, there are more adverse effects off-site due to the differences in population distributions between Paducah and Portsmouth.

The postulated cylinder accident that would result in the largest number of persons with *irreversible adverse* health effects is a corroded DUF_6 cylinder spill under wet conditions, with the DUF_6 being released into a pool of standing water. This accident is considered extremely unlikely, 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 at Paducah or Portsmouth, and up to 300 noninvolved workers at Paducah or 110 noninvolved workers at Portsmouth, might experience *irreversible adverse* effects (such as lung damage or kidney damage). No fatalities are expected among members of the general public; there would be a potential for 3 fatalities at Paducah or 1 at Portsmouth among noninvolved workers from chemical effects. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers (1 chance in 170 at Paducah' 1 chance in 100 at Portsmouth) or the general public (1 chance in 70 at Paducah; 1 chance in 30 at Portsmouth) (DOE 2004a, 2004b).

The number of persons actually experiencing *adverse* or *irreversible adverse* effects from DUF_6 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 exposure level is equivalent to the Emergency Response Planing Guideline (ERPG)-2 value for HF (DOE 1999). ERPG-2 levels are defined as "the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action". 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 (DOE 2004a, 2004b).

Similarly, the guideline intake level of 30 milligrams (mg) used to estimate the potential for irreversible adverse effects from the intake of uranium in this DU Oxide SEIS 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 DUF_6 have occurred that have caused diagnosable irreversible adverse effects among workers (DOE 2004a, 2004b). In previous accidental exposure incidents involving liquid DUF_6 in gaseous diffusion plants, some worker fatalities occurred immediately after the accident as a result of inhalation of HF generated from the DUF_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 (DOE 2004a, 2004b).

Table C-17 Estimated Consequences of Extremely Unlikely Chemical Exposures for DUF_6 Cylinder Accidents at the Paducah and Portsmouth Sites

Accident Scenario[a]	Potential Effect[b]	Consequence[c] (number of persons effected)	
		Paducah	**Portsmouth**
Impact to the General Public			
Rupture of cylinders – fire	Adverse effects	3–2,000	4–680
Corroded cylinder spill, wet conditions – water pool	Irreversible adverse effects	0–1	0–1
Corroded cylinder spill, wet conditions – water pool	Potential fatalities	0	0
Impacts on Noninvolved Workers[d]			
Rupture of cylinders – fire	Adverse effects	4–910	160–1,100
Corroded cylinder spill, wet conditions – water pool	Irreversible adverse effects	1–300	0–110
Corroded cylinder spill, wet conditions – water pool	Potential fatalities	0–3	0–1

Key: m/s = meters per second; mph = miles per hour.

[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 Paducah and Portsmouth are given in the 2004 EISs (DOE 2004 a, 2004b) and the supporting analyses by Hartmann (1999a, 1999b)

[b] 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 percent of the predicted potential irreversible adverse effects would result in fatalities (see text).

[c] The consequence is expressed as the number of individuals with a predicted exposure level sufficient to cause the corresponding health endpoint as reported in the 2004 EISs. Changes in the general population distrubutions since the analyzes were performed for the 2004 EISs are not expected to result in meaningful changes to the potential impacts identified. 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 the 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.

[d] 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.

Sources: DOE 2004a, 2004b, Tables 5.1-2

Under both the Conversion and Storage and the Conversion and Disposal scenarios, low-probability accidents involving chemicals at the conversion facility could have large potential consequences for noninvolved workers and members of the general public. These accidents were evaluated in detail in the 2004 EISs (DOE 2004a, 2004b). At either 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 is produced as a co-product of converting DUF_6.

The largest impacts identified in the 2004 EISs for the conversion operations would be caused by an HF storage tank rupture; a corroded DUF_6 cylinder spill under wet conditions (i.e., rain and formation of a water pool); an NH_3 tank rupture; and the rupture of several DUF_6 cylinders in a fire. Accidents involving stack emissions would have smaller impacts compared with accidents involving releases at ground level because of the relatively larger dilution and smaller release rates (due to filtration) involved with the stack emissions. The conversion accident estimated to have the largest potential consequences is an accident involving the rupture of tanks containing either 70 percent HF or NH_3. Such an accident could be caused by a large earthquake and would be expected to occur with a frequency of less than once in 1 million years of operations.

The Summary and Section 5.2 results in the 2004 EISs (DOE 2004a, 2004b) indicate that if an aqueous HF or NH_3 tank ruptured at the conversion facility, a maximum of up to about 6,700 members of the general public near Paducah (DOE 2004a, page S-35) or 2,300 members of the general public near Portsmouth (DOE 2004b, page S-37) 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 near Paducah or 210 people near Portsmouth might experience irreversible adverse effects (such as lung damage or kidney damage), with the potential for about 7 fatalities at Paducah or 4 fatalities at Portsmouth. With regard to noninvolved workers, up to about 1,600 at Paducah or 1,400 at Portsmouth might experience adverse effects (mild and temporary) as a result of chemical exposures. A maximum of about 1,600 noninvolved workers at Paducah or 1,400 noninvolved workers at Portsmouth might experience irreversible adverse effects, with the potential for about 30 fatalities at either location (DOE 2004a, 2004b).

Although such high-consequence accidents at the conversion facility are possible, they are expected to be extremely rare. The risk over the life of these facilities (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 mitigation measures for HF and NH_3 storage tanks (DOE 2004a, 2004b). These include storage tank siting principles, design recommendations, spill detection measures, and containment measures that were implemented during construction of the conversion facilities.

In the 2004 EISs, the highest consequence radiological accident at the conversion facility is estimated to be a design-basis earthquake damaging the DU oxide storage building and breaching 10 percent of the stored containers (DOE 2004a, 2004b). Because there are no plans to store the commercial DU oxide in a building, there would be no risk of damage to the cylinders from falling debris; thus, this storage building accident is not applicable for the Conversion and Storage and the Conversion and Disposal scenarios.

In the 2004 EISs, the accident scenario at the conversion facility with the second-highest radiological impacts was the extremely unlikely scenario caused by a tornado strike (DOE 2004a, 2004b). This accident would be possible but extremely unlikely under both the Conversion and Storage and the Conversion and Disposal scenarios. In this accident, it is assumed that a windblown missile from a tornado would pierce a single DU oxide container in storage. In this hypothetical accident, if bulk bags were used to transport and dispose of the DU oxide, approximately 1,200 pounds (550 kilograms) of DU oxide 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 at either Paducah or Portsmouth. The collective doses would be up to 230 person-rem at Paducah or 130 person-rem at Portsmouth to the worker population and up to 35 person rem at Paducah or 17 person-rem at Portsmouth to the general population. If cylinders are being used as DU oxide containers, rather than bulk bags, the doses would be approximately half of the above results.

Accident analyses in the 2004 EISs (DOE 2004a, 2004b) concluded that 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 40 rem for Paducah or 30 rem for Portsmouth. This dose would 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). Occurrence by the annual probability of occurrence by the number of years of operations) would be less than 1.

Summary

Accident risks to the public and worker at Paducah or Portsmouth under the Conversion and Disposal Scenario would be similar to those under the Conversion and Storage Scenario. The major difference would be that under the Conversion and Disposal Scenario cylinders would be stored for up to 53 years at Paducah and 43 years at Portsmouth rather than the 100 years under the Conversion and Storage Scenario. Other than the differences in storage time for the DU oxide cylinders, the accident scenarios, potential releases, and impacts on the public associated with DUF_6 cylinder handling, conversion to oxide, and DU oxide container storage would be very similar. For purposes of this DU Oxide SEIS, any differences in accident risks and impacts between the scenarios at Paducah and Portsmouth would be small.

Because of the low hazard posed by DU oxide, the material would not be an attractive target for a terrorist attack or other intentional destructive acts. The releases caused by intentional destructive acts during the management of DU oxide were not expressly calculated in the 2004 EISs (DOE 2004a, 2004b) and this DU Oxide SEIS. However, should an intentional destructive act occur, the consequences of the accident scenarios considered in the 2004 EISs and this DU Oxide SEIS would either bound or be comparable to the consequences from the act. As discussed in the 2004 EISs and this DU Oxide SEIS, releases for and the consequences from severe accidents involving the DU oxide were derived using highly conservative assumptions. Therefore any releases caused by and the consequences from any potential intentional events would either be bounded by or be comparable to the releases and consequences presented in this DU Oxide SEIS for severe accidents.

C.7.3 Transportation of Commercial DU Oxide and Other Wastes

As described in Section C.2 of this appendix, an additional 150,000 metric tons (approximately 12,500 cylinders[71]) of commercial DUF_6 will undergo conversion at Paducah or Portsmouth and will require storage or disposal. For purposes of analysis in this DU Oxide SEIS, and as a cons ervative measure of impacts, DOE has assumed that the entire mass of commercial DUF_6 would be managed at each facility. Therefore, this section provides the potential impacts associated with the shipment of DU oxide and other wastes from Paducah in Kentucky or Portsmouth in Ohio, to the Nevada National Security Site (NNSS) in Nevada; Energy*Solutions* in Utah; or Waste Control Specialists (WCS) in Texas. Details of the transportation analysis methodology and related waste characteristics assumptions are presented in Appendix B of this DU Oxide SEIS, and are not repeated here.

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[71] Assuming 12 metric ton cylinders are used.

Consistent with the analysis presented in Appendix B, two transport options: rail and truck are analyzed. Assuming that the same number of cylinders would be transported annually by either truck or rail, it is estimated that transportation of DU oxide from Paducah or Portsmouth to the disposal facilities would take about 9 years. Under the truck option, one DU oxide cylinder would be transported per truck. Under the rail option, each train would consist of 10 railcars, each containing six DU oxide cylinders. It is expected that there would be 24 train shipments or 1,440 truck shipments per year from either site (i.e., Paducah or Portsmouth).

Unusable cylinders (and ancillary LLW and MLLW) would also be shipped for disposal. Under the rail option each train would consist of 10 railcars, each containing six unusable cylinders. Under the truck option, two unusable cylinders would be transported per truck. It is expected that there would be a total of 11 rail shipments from Paducah or Portsmouth, or 313 truck transports from Paducah and or Portsmouth. Each empty cylinder is expected to contain between 10 to 23 kilograms (22 to 50 pounds) of residual DU. The LLW and MLLW shipments are estimated to be about one truck shipment from Paducah or Portsmouth, annually.

C.7.3.1 Transportation of DU Oxide and Other Wastes to Energy*Solutions*

This section summarizes the potential impacts associated with the shipment of DU oxide and other wastes between Paducah or Portsmouth, to Energy*Solutions* under incident-free and accident conditions. **Table C-18** summarizes the potential transportation impacts for disposal of DU oxide at Energy*Solutions*. As indicated in this table, all risk values are less than one, except for nonradiological accident risk associated with truck shipments. This means that no LCFs are expected to occur during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of transports over 9 years.

Table C-18 Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide to Energy*Solutions*

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	12,500	32,200,000	38	0.02	101	0.06	7×10^{-5}	2
Portsmouth	12,500	38,500,000	46	0.03	118	0.07	6×10^{-5}	2
Rail								
Paducah	208	600,000	17	0.01	22	0.01	5×10^{-4}	0.1
Portsmouth	208	700,000	21	0.01	29	0.02	9×10^{-4}	0.2

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Tables C-19 and C-20 summarize the potential transportation impacts for shipment of unusable cylinders and other LLW and MLLW to Energy*Solutions*. Table C-19 shows the transportation impacts assuming the unusable empty and heel cylinders are transported intact. The risk associated with cylinder size reductions are estimated based on the analysis in the 2004 EISs.

As indicated in these tables, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail. Transport of LLW and MLLW to Energy*Solutions* would be about 1 truck shipment annually. The impacts of this transport would be similar to those provided in Table B-4a in Appendix B of this DU Oxide SEIS.

Table C-19 Total Risks to Crew Members and the Public from Transporting Unusable Cylinders to Energy*Solutions*

Origin	Number of Shipments[a]	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	313	800,000	0.01	6×10^{-6}	0.03	2×10^{-5}	8×10^{-9}	0.04
Portsmouth	313	1,000,000	0.01	1×10^{-6}	0.03	2×10^{-5}	7×10^{-9}	0.04
Rail								
Paducah	11	30,000	0.009	5×10^{-6}	0.01	7×10^{-6}	6×10^{-8}	0.007
Portsmouth	11	36,000	0.01	7×10^{-6}	0.02	9×10^{-6}	1×10^{-7}	0.01

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Table C-20 Annual Risks to Crew Members and Public from Transporting other Low-Level Radioactive Waste and Mixed Level Radioactive Waste to Energy*Solutions*

Origin	Number of Shipments	One-way Kilometers Traveled	Incident-Free[a]				Accident[a]	
			Crew		Population			
			Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck[c]								
Paducah	1	2,600	3×10^{-4}	2×10^{-7}	2×10^{-4}	1×10^{-7}	7×10^{-14}	1×10^{-4}
Portsmouth	1	3,100	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	6×10^{-14}	1×10^{-4}

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] Total risks can be estimated by multiplying by the maximum duration of the storage period for this alternative (52 years [44 + 8] for Paducah and 43 years [32 +11] for Portsmouth).

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Because of the small amount of waste requiring shipment to the waste management facility, rail transport would be inefficient and was not considered.

DOE is also considering the option of transport of DU oxide using bulk bags consistent with the analysis presented in the 2004 EISs (DOE 2004a, 2004b). If this option is considered, it was estimated that there would be 5,490 truck shipments or 1,370 rail shipments of bulk bags from

Paducah, or Portsmouth site, using consistent assumptions as those used in the 2004 EISs. Therefore, the bulk bag transportation risks presented in this appendix are proportionally calculated using the risks cited in the 2004 EISs. If the bulk bags are used, then, the empty and heel cylinders also need to be transported to the disposal sites. It is assumed that the cylinders would be volume-reduced and packaged 10 in 20-ft intermodal containers and transported one per truck and two per train. The 2004 EISs also considered that about 10 percent of the cylinders could not be accepted at the Energy*Solutions*, therefore, these cylinders would be transported intact to NNSS. The 2004 EISs assumed that rail connections will be available at NNSS, therefore, no intermodal facility near the NNSS was used. The risks of transporting the volume-reduced cylinders are calculated using information in the 2004 EISs; those for the intact cylinders are calculated using the same assumptions used in Table C-19.

Tables C-18a and C-19a summarize the potential transportation impacts for shipping DU oxides in bulk bags and the empty and heel cylinders to the Energy*Solutions* site. As indicated in these tables, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail.

Table C-18a Total Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Bulk Bags to Energy*Solutions*

			Incident-Free				**Accident**	
			Crew		**Population**			
Origin	**Number of Shipments**[a]	**One-way Kilometers Traveled**	**Dose (person-rem)**	**LCF**[b]	**Dose (person-rem)**	**LCF**[b]	**Radiological Risk**[b]	**Nonrad Risk**[b]
Truck								
Paducah[c]	5,490	13,946,000	80	0.05	37	0.02	7×10^{-3}	0.7
Portsmouth[d]	5,490	16,049,000	93	0.06	43	0.03	1×10^{-2}	0.7
Rail								
Paducah[c]	1,370	3,674,000	187	0.1	7	0.004	2×10^{-3}	0.2
Portsmouth[d]	1,370	4,531,000	217	0.1	11	0.006	3×10^{-3}	0.3

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-21 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

Note: To convert kilometers to miles multiply by 0.62137.

Table C-19a Total Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to Energy*Solutions*

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck (volume-reduced)								
Paducah[c]	1,125	2,857,000	17	1×10^{-02}	9	5×10^{-3}	6×10^{-5}	0.1
Portsmouth[d]	1,125	3,288,000	20	1×10^{-2}	11	6×10^{-3}	8×10^{-5}	0.1
Truck (intact)[e]								
Paducah[c,e]	625	2,005,000	0.02	1×10^{-5}	0.06	4×10^{-5}	8×10^{-9}	0.09
Portsmouth[d,e]	625	2,332,000	0.03	2×10^{-5}	0.07	4×10^{-5}	1×10^{-8}	0.1
Rail (volume-reduced)								
Paducah[c]	563	1,511,000	42	3×10^{-2}	2	9×10^{-4}	1×10^{-5}	0.07
Portsmouth[d]	563	1,862,000	49	3×10^{-2}	2	1×10^{-3}	3×10^{-5}	0.10
Rail (intact)[e]								
Paducah[c,e]	21	71,000	0.02	1×10^{-5}	0.02	1×10^{-5}	8×10^{-8}	0.02
Portsmouth[d,e]	21	84,000	0.02	1×10^{-5}	0.03	2×10^{-5}	2×10^{-7}	0.03

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-21 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-26 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] The intact cylinders represent transport of 10 percent of the total empty and heel cylinders, which are 12,000. The calculated doses and risks are based on the information provided in Table 4-28 of this DU Oxide SEIS, assuming that the intact cylinders are transported two per truck and 60 per rail. These cylinders are transported to NNSS, when the disposal facility is other than NNSS. In addition, For the volume-reduced packages, the 2004 EISs assumed that direct rail connections will be available at NNSS.

Note: To convert kilometers to miles multiply by 0.62137.

Furthermore, the impacts from the transport of CaF$_2$ from neutralization of hydrogen fluoride, as a nonradioactive, nonhazardous waste, to a disposal facility is also estimated. It is estimated that there would be about 8,090 truck shipments or 2,020 rail shipments from Paducah or Portsmouth to Energy*Solutions*. The estimated traffic fatalities from these shipments are summarized in **Table C-20a**.

Table C-20a Collective Population Transportation Risks for Shipment of Calcium Fluoride to Energy*Solutions* for the Hydrogen Fluoride Neutralization Option

Origin	**Paducah**		**Portsmouth**	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	8,080	2,020	8,080	2,020
Total Distance (one-way [km])	20,843,000	5,421,000	24,887,000	6,679,700
Traffic fatalities (round trip)	1.12	0.12	1.15	0.32

Key: km = kilometer.

Impacts from Incident-Free Transportation of Radioactive Waste

The potential radiological impacts for transport crews and populations along the routes are shown in Tables C-18, C-19, and C-20. These tables include the results of shipping all DU oxide and other radioactive wastes to Energy*Solutions*. As shown in these tables, transportation of the DU oxide dominates the risks. Therefore, the impacts of shipping unusable cylinders and other LLW and MLLW to Energy*Solutions* are not discussed further.

Under the Energy*Solutions* disposal option, transport of DU oxide would not result in any LCFs to crew members. For truck transport, the maximum calculated LCF risk over the duration of the project (assuming all DU oxide waste was disposed of at Energy*Solutions*) would be 0.06, or 1 chance in 16 of developing a single LCF among the transportation crews. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.1, or 1 chance in 10 of a single LCF among the transportation crews. Transportation of DU oxide in bulk bags results in the maximum impact on the transportation crew versus transportation of DU oxide in cylinders.

Under this option, the dose to the general population likely would not result in an LCF. For truck transport of DU oxide, the maximum calculated LCF risk over the duration of the project would be 0.07, or 1 chance in 15 of a single LCF in the exposed population. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.02, or 1 chance in 50 of a single LCF in the exposed population. Transportation of DU oxide in cylinders results in the maximum impact on the general population versus transportation of DU oxide in bulk bags.

The total radioactive dose received by an MEI (a resident along the route near Energy*Solutions*), hypothetically assumed to be exposed to every DU oxide truck shipment over the duration of the project, would be about 0.39 millirem, resulting in an increased risk of developing a fatal cancer of 2.3×10^{-4}, or 1 chance in 4,300,000. Assuming that shipments would occur over 9 years, the average annual dose to this individual would be 0.04 millirem, which is .04 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents), and (2) maximum reasonably foreseeable accidents (accidents with radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year). As indicated in Table C-18, considering all reasonably foreseeable accidents, transport of radioactive waste would likely not result in any

LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck transportation option.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and maximum consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxides shipped under this scenario, the maximum reasonably foreseeable transportation accident with the highest consequence/risk would involve rail transport with the assumption of the breach of all six cylinders in a railcar in an urban area (see Appendix B, Table B-7). The maximum reasonably foreseeable probability of a rail accident involving transport of DU oxide to Energy*Solutions* would be up to 1.5×10^{-7} per year in an urban area, or approximately 1 chance in 7 million each year. The consequences of the rail transport accident, if it occurred, in terms of population and MEI dose would be about 47.3 person-rem and 0.039 rem, respectively. These doses would likely result in 0 (0.028) additional LCF among the exposed population and a 2×10^{-5} risk that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (4.5×10^{-9}).

C.7.3.2 Transportation of Depleted Uranium Oxide and other Wastes to the Nevada National Security Site

This section summarizes the potential impacts associated with the shipment of DU oxide and other wastes from Paducah or Portsmouth to NNSS under incident-free and accident conditions. Because NNSS lacks a direct rail connection for waste delivery, truck transports were evaluated for shipments from an intermodal facility to NNSS. For purposes of analysis and consistent with the *Final Environmental Impact Statement for Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (DOE 2013), the intermodal facility was assumed to be the rail yard at Barstow, California.

Table C-21 summarizes the potential transportation impacts for disposal of DU oxide at NNSS. As indicated in this table, all risk values are less than one, except for nonradiological accident risk associated with truck shipments. This means that no LCFs are expected to occur during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of transports over 9 years.

Table C-21 Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah	12,500	40,100,000	47	0.03	124	0.07	4×10^{-5}	2
Portsmouth	12,500	46,600,000	55	0.03	144	0.09	5×10^{-5}	2
Rail/Truck[c]								
Paducah, Rail	208	700,000	20	0.01	24	0.01	4×10^{-4}	0.2

Origin	Number of Shipments[a]	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck	12,500	4,200,000	5	0.003	13	0.008	4×10^{-7}	0.07
Total	12,710	4,900,000	25	0.01	37	0.02	4×10^{-4}	0.3
Portsmouth, Rail	208	800,000	25	0.02	30	0.02	7×10^{-4}	0.3
Truck	12,500	4,200,000	5	0.003	13	0.008	4×10^{-7}	0.07
Total	12,710	5,000,000	29	0.02	43	0.03	7×10^{-4}	0.4

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] Under the Rail Option, the same number of rail shipments would leave either Paducah or Portsmouth, but because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo will be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for the NSSS under "Rail/Truck" in this table. For transport from Paducah or Portsmouth, 12,500 truck transports would be required.

Note: To convert kilometers to miles multiply by 0.62137.

Tables C-22 and C-23 summarize the potential transportation impacts for shipment of unusable cylinders and other LLW and MLLW to NNSS. Table C-22 shows the transportation impacts assuming the unusable cylinders are transported intact. The risk associated with cylinder size reductions are estimated based on the analysis in the 2004 EISs.

As indicated in these tables, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail. Transport of other LLW and MLLW to NNSS would be about 1 truck shipment annually.

Table C-22 Risks to Crew Members and the Public from Transporting Unusable Cylinders to the Nevada National Security Site

Origin	Number of Shipments	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	LCF[a]	Dose (person-rem)	LCF[a]	Radiological Risk[a]	Nonrad Risk[a]
Truck								
Paducah	313	1,000,000	0.01	7×10^{-6}	0.03	2×10^{-5}	4×10^{-9}	0.04
Portsmouth	313	1,200,000	0.01	8×10^{-6}	0.04	2×10^{-5}	6×10^{-9}	0.05
Rail/Truck[b]								
Paducah, Rail	11	37,000	0.01	6×10^{-6}	0.01	8×10^{-6}	4×10^{-8}	0.008
Truck	313	110,000	0.001	7×10^{-7}	0.003	2×10^{-6}	5×10^{-1}	0.002
Total	323	147,000	0.01	7×10^{-6}	0.02	1×10^{-5}	4×10^{-8}	0.01
Portsmouth, Rail	11	44,000	0.01	8×10^{-6}	0.02	1×10^{-5}	9×10^{-8}	0.02
Truck	313	110,000	0.001	7×10^{-7}	0.003	2×10^{-6}	5×10^{-11}	0.002
Total	323	154,000	0.01	9×10^{-6}	0.02	1×10^{-5}	9×10^{-8}	0.02

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident

dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[b] Under the Rail Option, the same number of rail shipments would leave either Paducah or Portsmouth, but because NNSS does not have a rail connection, rail shipments would be shipped to an intermodal facility (which was assumed for analysis to be at Barstow, California) and then the cargo will be transported by truck to NNSS. Impacts from these additional shipments were included in the tabulated results for the NSSS under "Rail/Truck" in this table. For transport from Paducah or Portsmouth, 313 truck transports would be required.

Note: To convert kilometers to miles multiply by 0.62137.

Table C-23 Annual Risks to Crew Members and Public from Transporting other LLW and MLLW to Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments	One-way Kilometers Traveled	Dose (person-rem)	LCF[a]	Dose (person-rem)	LCF[a]	Radiological Risk[a]	Nonrad Risk[a]
Truck								
Paducah	1	3,200	4×10^{-4}	2×10^{-7}	3×10^{-4}	2×10^{-7}	4×10^{-14}	1×10^{-4}
Portsmouth	1	3,700	4×10^{-4}	3×10^{-7}	3×10^{-4}	2×10^{-7}	5×10^{-14}	2×10^{-4}

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

DOE is also considering the option of transport of DU oxide using bulk bags consistent with the analysis presented in the 2004 EISs (DOE 2004a, 2004b). If this option is considered, it was estimated that there would be 5,490 truck shipments and 1,370 rail shipments of bulk bags from Paducah, or Portsmouth, using consistent assumptions as those used in the 2004 EISs. Therefore, the bulk bag transportation risks presented in this DU Oxide SEIS are proportionally calculated using the risks cited in the 2004 EISs. If bulk bags are used, then the empty and heel cylinders also need to be transported to the disposal sites. It is assumed that the cylinders would be volume-reduced and packaged 10 in 20-ft intermodal containers and transported one per truck and two per railcar. The 2004 EISs also considered that about 10 percent of the cylinders could would be transported intact to NNSS. The 2004 EISs assumed that rail connections will be available at NNSS, therefore, no intermodal facility near NNSS was used. The risks of transporting the volume-reduced cylinders are calculated the using information in the 2004 EISs, and those for the intact cylinders are calculated using the same assumptions used in Table C-19.

Tables C-21a and **C-22a** summarize the potential transportation impacts for shipment DU-oxides in bulk bags, and the empty and heel cylinders to NNSS. As indicated in these tables, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail.

Table C-21a Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide in Bulk Bags to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck								
Paducah[c]	5,490	15,460,000	90	0.05	43	0.03	3×10^{-03}	0.7
Portsmouth[d]	5,490	18,457,000	112	0.07	51	0.03	7×10^{-03}	0.7
Rail								
Paducah[c]	1,370	4,699,000	224	0.1	7	0.004	2×10^{-03}	0.2
Portsmouth[d]	1,370	5,499,000	254	0.2	10	0.006	3×10^{-03}	0.3

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000, and to the nearest 5 when less than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-22 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[d] The calculated doses and risks are based on the information provided in Table 5.2-27 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

Note: To convert kilometers to miles multiply by 0.62137.

Table C-22a Risks to Crew Members and the Public from Transporting Empty and Heel Cylinders to the Nevada National Security Site

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]
Truck (volume-reduced)								
Paducah[c]	1,125	3,168,000	18	1×10^{-2}	10	6×10^{-3}	3×10^{-5}	0.1
Portsmouth[d]	1,125	3,783,000	23	1×10^{-2}	12	7×10^{-3}	6×10^{-05}	0.1
Truck (intact)[e]								
Paducah[c,e]	6,25	2,005,000	0.02	1×10^{-5}	0.06	4×10^{-5}	8×10^{-9}	0.09
Portsmouth[d,e]	625	2,332,000	0.03	2×10^{-5}	0.07	4×10^{-5}	1×10^{-8}	0.1
Rail (volume-reduced)								
Paducah[c]	563	1,931,000	52	3×10^{-2}	2	1×10^{-3}	1×10^{-5}	0.08
Portsmouth[d]	563	2,260,000	56	3×10^{-2}	2	1×10^{-3}	2×10^{-5}	0.1
Rail (intact)[e]								
Paducah[c,e]	21	71,000	0.02	1×10^{-5}	0.02	1×10^{-5}	8×10^{-8}	0.02
Portsmouth[d,e]	21	84,000	0.02	1×10^{-5}	0.03	2×10^{-5}	2×10^{-7}	0.03

Key: LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1000, and to the nearest 5 when less than 1000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

[c] The calculated doses and risks are based on the information provided in Table 5.2-22 of the 2004 Paducah EIS (DOE 2004a). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

			Incident-Free				Accident	
			Crew		Population			
Origin	Number of Shipments[a]	One-way Kilometers Traveled	Dose (person-rem)	LCF[b]	Dose (person-rem)	LCF[b]	Radiological Risk[b]	Nonrad Risk[b]

[d] The calculated doses and risks are based on the information provided in Table 5.2-27 of the 2004 Portsmouth EIS (DOE 2004b). The incident-free LCFs are calculated using the LCF risk factor of 0.0006 for both the workers and population. The nonradiological risks (traffic fatalities) are based on the round trip transports.

[e] The intact cylinders represent transport of 10 percent of the total empty and heel cylinders, which are 83,000 (69,000 plus 14,000). The calculated doses and risks are based on the information provided in Table 4-28 of this DU Oxide SEIS, assuming that the intact cylinders are transported two per truck and 60 per rail. In addition, For the volume-reduced packages, the 2004 EISs assumed that direct rail connections will be available at NNSS.

Note: To convert kilometers to miles multiply by 0.62137.

Furthermore, the impacts from the transport of calcium fluoride (CaF_2) from neutralization of hydrogen fluoride, as a nonradioactive, nonhazardous waste, to a disposal facility is also estimated. It is estimated that there would be about 8,090 truck shipments or 2,020 rail shipments from Paducah or Portsmouth to NNSS. The estimated traffic fatalities from these shipments are summarized in **Table C-23a**.

Table C-23a Collective Population Transportation Risks for Shipment of Calcium Fluoride to the Nevada National Security Site for the Hydrogen Fluoride Neutralization Option

Origin	Paducah		Portsmouth	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	8,080	2,020	8,080	2,020
Total Distance (one-way [km])[a]	25,923,000	9,571,000	30,146,000	10,863000
Traffic fatalities (round trip)	1.19	0.49	1.34	0.33

Key: km = kilometer.

[a] Because NNSS does not have a direct rail line connection, every rail transport requires four shipments of truck transport from an intermodal facility to NNSS. The cited distances are the sum of truck and rail transport distances.

Impacts from Incident-Free Transportation of Radioactive Waste

The potential radiological impacts for transport crews and populations along the routes are shown in Tables C-21, C-22, and C-23. These tables include the results of shipping all DU oxide and other wastes to NNSS. As shown in these tables, transportation of the DU oxide dominates the risks. Therefore, the impacts of shipping unusable cylinders and ancillary LLW and MLLW to NNSS are not discussed further.

Under this option, transport of DU oxide would not result in any LCFs to crew members. For truck transport, the maximum calculated LCF risk over the duration of the project (assuming all DU oxide waste was disposed of at NNSS) would be 0.07, or about 1 chance in 14 of developing a single LCF among the transportation crews. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.2, or about 1 chance in 5 of a single LCF among the transportation crews. Transportation of DU oxide in bulk bags results in the maximum impact on the transportation crew versus transportation of DU oxide in cylinders.

Under this option, the dose to the general population likely would not result in an LCF. For truck transport of DU oxide, the maximum calculated LCF risk over the duration of the project would be 0.09, or about 1 chance in 11 of a single LCF in the exposed population. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.03, or about 1 chance in 33 of a single LCF in the exposed population. Transportation of DU oxide in cylinders results in the maximum impact on the general population.

The total radioactive dose received by an MEI (a resident along the route near NNSS), hypothetically assumed to be exposed to every DU oxide truck shipment over the duration of the project, would be about 0.39 millirem, resulting in an increased risk of developing a fatal cancer of 2.3×10^{-4}, or 1 chance in 4,300,000. Assuming that shipments would occur over 9 years, the average annual dose to this individual would be 0.04 millirem, which is .04 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents), and (2) maximum reasonably foreseeable accidents (accidents with radioactive release probabilities greater than 1×10^{-7} [about 1 chance in 10 million] per year). As indicated in Table C-21, considering all reasonably foreseeable accidents, transport of radioactive waste would likely not result in any LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck transportation option.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and maximum consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxides shipped under this option, the maximum reasonably foreseeable transportation accident with the highest consequence/risk would involve truck transport in an urban area (see Appendix B, Table B-7). The maximum reasonably foreseeable probability of a truck accident involving transport of DU oxide to NNSS would be up to 5.3×10^{-7} per year in an urban area, or approximately 1 chance in 1.9 million each year. The consequences of the truck transport accident, if it occurred, in terms of population and MEI dose would be about 7.7 person-rem and 0.0064 rem, respectively. These doses would likely result in no (0.005) additional LCFs among the exposed population and a 4×10^{-6} risk that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (3×10^{-9}).

C.7.3.3 Transportation of DU Oxide and Other Wastes to Waste Control Specialists

This section summarizes the potential impacts associated with the shipment of DU oxide and other wastes between Paducah or Portsmouth to WCS under incident-free and accident conditions. **Table C-24** summarizes the potential transportation impacts for disposal of DU oxide at WCS. As indicated in this table, all risk values are less than one, except for nonradiological accident risk associated with truck shipments. This means that no LCFs are expected to occur during transport by truck or rail, but a small number of traffic fatalities could result from nonradiological accidents. This is the result of the large number of transports over 9 years.

Table C-24 Risks to Crew Members and the Public from Transporting Depleted Uranium Oxide to Waste Control Specialists

			Incident-Free				Accident	
			Crew		Population			
Origin	**Number of Shipments**[a]	**One-way Kilometers Traveled**	**Dose (person-rem)**	**LCFs**[b]	**Dose (person-rem)**	**LCFs**[b]	**Radiological Risk**[b]	**Nonrad Risk**[b]
Truck								
Paducah	12,500	21,200,000	25	0.02	66	0.04	4×10^{-5}	2
Portsmouth	12,500	28,600,000	34	0.02	88	0.05	7×10^{-5}	2
Rail								
Paducah	208	400,000	13	0.008	21	0.01	7×10^{-4}	0.2
Portsmouth	208	600,000	20	0.01	32	0.02	1×10^{-3}	0.3

LCF = latent cancer fatality; Nonrad = nonradiological.

[a] The number of shipments were rounded to the nearest ten when greater than 1,000.

[b] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Tables C-25 and C-26 summarize the potential transportation impacts for shipment of unusable cylinders and other LLW and MLLW to WCS. As indicated in these tables, all risk values are less than one. This means that no LCFs are expected to occur during transport by truck or rail. Transport of LLW and MLLW to WCS would be about 1 truck shipment annually.

Table C-25 Risks to Crew Members and the Public from Transporting Unusable Cylinders to Waste Control Specialists

			Incident-Free				Accident	
			Crew		Population			
Origin	**Number of Shipments**	**One-way Kilometers Traveled**	**Dose (person-rem)**	**LCFs**[a]	**Dose (person-rem)**	**LCFs**[a]	**Radiological Risk**[a]	**Nonrad Risk**[a]
Truck								
Paducah	313	500,000	0.006	4×10^{-6}	0.02	1×10^{-5}	5×10^{-9}	0.04
Portsmouth	313	700,000	0.009	5×10^{-6}	0.02	1×10^{-5}	9×10^{-9}	0.05
Rail								
Paducah	11	22,000	0.007	4×10^{-6}	0.01	7×10^{-6}	8×10^{-8}	0.008
Portsmouth	11	32,000	0.01	6×10^{-6}	0.02	1×10^{-5}	1×10^{-7}	0.01

LCF = latent cancer fatality; Nonrad = nonradiological.

[a] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

Note: To convert kilometers to miles multiply by 0.62137.

Table C-26 Annual Risks to Crew Members and Public from Transporting other LLW and MLLW to Waste Control Specialists

			Incident-Free				Accident	
			Crew		Population			
Origin	**Number of Shipments**	**One-way Kilometers Traveled**	**Dose (person-rem)**	**LCFs[a]**	**Dose (person-rem)**	**LCFs[a]**	**Radiological Risk[a]**	**Nonrad Risk[a]**
Truck								
Paducah	1	1,700	2×10^{-4}	1×10^{-7}	1×10^{-4}	9×10^{-8}	4×10^{-14}	1×10^{-4}
Portsmouth	1	2,300	3×10^{-4}	2×10^{-7}	2×10^{-4}	1×10^{-7}	8×10^{-14}	2×10^{-4}

Key: LCF = latent cancer fatality; nonrad = nonradiological.

[a] Risk is expressed in terms of LCFs, except for nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel, while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003). The values were rounded to one non-zero digit.

The WCS disposal option was not analyzed in the 2004 EISs. Therefore, a qualitative comparison was done to bound impacts related to transportation of DU oxide in bulk bags (along with the resulting empty and heel cylinders) to WCS. Given that the estimated risks (in terms of doses to the crew and the population) for transport of DU oxide in cylinders to WCS is shown in this DU Oxide SEIS to be less than or equal to transport to Energy*Solutions* and NNSS, the corresponding risks associated with transport of the DU oxide in bulk bags (along with the resulting empty and heel cylinders) to WCS would be expected to be less than or equal to those calculated for Energy*Solutions* and NNSS.

Furthermore, the impacts from the transport of calcium fluoride (CaF_2) from neutralization of hydrogen fluoride, to a LLW disposal facility is also estimated. It is estimated that there would be about 8,090 truck shipments or 2,020 rail shipments from Paducah or Portsmouth to NNSS. The estimated traffic fatalities from these shipments are summarized in Table C-26a.

Table C-26a Collective Population Transportation Risks for Shipment of Calcium Fluoride to the Waste Control Specialists Site for the Hydrohgen Fluoride Neutralization Option

Origin	**Paducah**		**Portsmouth**	
Mode of Transport	**Truck**	**Rail**	**Truck**	**Rail**
Number of shipments	8,080	2,020	8,080	2,020
Total Distance (one-way [km])[a]	12,454,000	4,055,000	18,455,000	5,953,000
Traffic fatalities (round trip)	0.91	0.19	1.29	0.27

Impacts from Incident-Free Transportation of Radioactive Waste

As shown in Tables C-24, C-25, and C-26, transportation of the DU oxide dominates the risks. Therefore, the impacts of shipping unusable cylinders and other LLW and MLLW to the WCS facility are not discussed further.

Under this option, transport of DU oxide would not result in any LCFs to crew members. For truck transport, the maximum calculated LCF risk over the duration of the project (assuming all DU oxide waste was disposed of at WCS) would be 0.02, or 1 chance in 50 of a single LCF among the transportation crews. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.01, or 1 chance in 100 of a single LCF among the transportation crews.

Under this option, the dose to the general population likely would not result in an LCF. For truck transport of DU oxide, the maximum calculated LCF risk over the duration of the project would be 0.05, or 1 chance in 20 of a single LCF in the exposed population. For rail transport, the maximum calculated LCF risk over the duration of the project would be 0.02, or 1 chance in 50 of a single LCF in the exposed population.

The total radioactive dose received by an MEI (a resident along the route near WCS), hypothetically assumed to be exposed to every DU oxide truck shipment over the duration of the project, would be about 0.39 millirem, resulting in an increased risk of developing a fatal cancer of 2.3×10^{-4}, or 1 chance in 4,300,000. Assuming that shipments would occur over 9 years, the average annual dose to this individual would be 0.04 millirem, which is .04 percent of DOE's limit in DOE Order 458.1 of 100 millirem a year, for exposure to a member of the public.

Impacts of Transportation Accidents Involving Radioactive Waste

Two sets of analyses were performed to evaluate potential radiological transportation accident impacts: (1) all reasonably foreseeable accidents (total transportation accidents), and (2) maximum reasonably foreseeable accidents (accidents with radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year). As indicated in Table C-24, considering all reasonably foreseeable accidents, transport of radioactive waste would likely not result in any LCFs, but there could be nonradiological fatalities due to traffic accidents under the truck transportation option.

For maximum reasonably foreseeable accidents, transportation accident probabilities were calculated for all route segments (that is, rural, suburban, and urban), and maximum consequences were determined for those shipment routes with a likelihood-of-release frequency exceeding 1 chance in 10 million per year. For DU oxides shipped under this option, the maximum reasonably foreseeable transportation accident with the highest consequence/risk would involve rail transport with the assumption of the breach of all six cylinders in a railcar in an urban area (see Appendix B, Table B-7). The maximum reasonably foreseeable probability of a rail accident involving transport of DU oxide to WCS would be up to 4.1×10^{-6} per year in an urban area, or approximately 1 chance in 244,000 each year. The consequences of the rail transport accident, if it occurred, in terms of population and MEI dose would be about 11 person-rem and 0.039 rem, respectively. These doses would likely result in 0 (0.007) additional LCFs among the exposed population and 2×10^{-5} risk that the MEI would develop an LCF. When the annual frequency of the accident occurring is taken into account, the increased risk of a single LCF in the exposed population would be negligible (3×10^{-8}).

C.8 SOCIOECONOMICS

The socioeconomic analysis covers the effects on population, employment, income, regional growth, housing, and community resources in the region of influence (ROI) of Paducah and Portsmouth.

C.8.1 Conversion and Storage

The socioeconomic impacts from operating the conversion facilities were evaluated in the 2004 EISs (DOE 2004a, DOE 2004b). As stated in Section C.2 of this DU Oxide SEIS, annual impacts for DUF_6 to DU oxide conversion that are presented in the 2004 EISs, would be expected to be the same for commercial material. During operation of the conversion facility at Paducah, 160 direct jobs and 170 indirect jobs were expected to be created. At the beginning of operations, an estimated 220 new residents were estimated to migrate into the area and require 80 housing units. In addition, 2 new public service employees (one general and one teacher in McCracken County) were estimated to be required to support the incoming population. During conversion operations, an estimated $13 million in personal income was estimated to be generated annually in the ROI (DOE 2004a). Any socioeconomic impacts associated with the operational impacts evaluated in the 2004 EIS (DOE 2004a) would have occurred and would be expected to continue at that level. Thus, there would be no new direct or indirect jobs or incoming population or new public service positions during conversion of 150,000 MT of commercial DUF_6. Existing employment, annual personal income generated, and annual public finances generated during conversion operations would extend for the additional 8 years it would take to convert the commercial DUF_6 to DU oxide at Paducah.

Similar to the socioeconomic impacts of conversion operations at Paducah, operation of the conversion facility at Portsmouth, was estimated to require 160 direct jobs and 160 indirect jobs. At the beginning of operations, an estimated 220 new residents were estimated to migrate into the area and require 80 housing units. In addition, 4 new public service employees were estimated to be required to support the incoming population. During conversion operations, an estimated $13 million in personal income was estimated to be generated annually in the ROI (DOE 2004a). Any socioeconomic impacts associated with the operational impacts evaluated in the 2004 EIS (DOE 2004b) would have occurred and would be expected to continue at that level. Thus, there would be no new direct or indirect jobs or incoming population or new public service positions during conversion of 150,000 MT of commercial DUF_6. Existing employment, annual personal income generated, and annual public finances generated during conversion operations would extend for the additional 11 years it would take to convert the commercial DUF_6 to DU oxide at Portsmouth.

DU oxide container storage and maintenance activities, and loading of wastes for off-site shipment at Paducah, while 12 workers would be required at Portsmouth (PPPO 2018). This employment represents approximately 1 percent in the 2018 total employment of 1,200 at Paducah or 0.5 percent of the 2018 total employment of 2,612 at Portsmouth (PPPO 2018). Additional management of large quantities of CaF_2 would only be required if DOE was unable to sell HF; in which case, staff assigned to manage HF could manage CaF_2. Therefore, because of the small number of employees involved, no in-migration or out-migration is expected that would impact population, employment, income, regional growth, housing, or community services in the Paducah or Portsmouth ROIs as a result of management of the commercial DU oxide material.

Post conversion employment at both sites would be expected to decline to 6 employees. Assuming that there would be no job replacements within the ROI, a total loss of 10 employees at Paducah and 6 employees at Portsmouth could result in an out-migration of people. Based on the U.S. Census information in Sections 3.1.7 and 3.2.7, an out-migration would represent a 0.01 percent decline in the total ROI population at Paducah and 0.003 percent decline at Portsmouth.

Employment in both areas would decline by 0.01 percent. In addition, the number of houses available for sale or rent would increase slightly while demand for public services would decline; The socioeconomic impacts of the out-migration of 10 employees within the Paducah ROI and 6 employees within the Portsmouth ROI would be relatively small.

Potential socioeconomic impacts associated with conversion and storage under the Conversion and Disposal scenario would be similar to those impacts under the Conversion and Storage scenario.

C.8.2 Conversion and Disposal

Under the Conversion and Disposal scenario, DU oxide storage containers and other wastes would need to be moved and loaded onto trucks or railcars for shipment to the disposal site. Similar to the Conversion and Storage scenario, employment for DU oxide container monitoring and maintenance, and loading of wastes for off-site shipment, is estimated at 16 full-time employees for Paducah and 12 full-time employees for Portsmouth. Loading of DU oxide in bulk bags for off-site shipment to disposal would likely be similar to loading of DU oxide in cylinders since bulk bags would require fewer bags than DU oxide in cylinders (less labor) but would generate a greater number of empty and heel cylinders (more labor). Therefore, because of the small number of employees involved, no in-migration or out-migration is expected under this scenario and no impact on population and regional growth, housing, or community services in the Paducah or Portsmouth ROIs during loading of wastes for off-site shipment to disposal.

C.9 WASTE MANAGEMENT

Impacts on the waste management infrastructure could occur at Paducah or Portsmouth from DUF_6 cylinder storage, conversion of DUF_6 to DU oxide, DU oxide container storage, and loading DU oxide containers for off-site disposal. Impact on the capacity of one or more off-site disposal facilities could occur from disposal of DU oxide and other wastes.

C.9.1 Paducah or Portsmouth

DUF_6 conversion operations at Paducah or Portsmouth would annually generate DU oxide that would be contained within cylinders that had been emptied of DUF_6, or alternatively, disposed of in bulk bags). The DU oxide cylinders would be stored indefinitely (assumed to be 100 years for purposes of analysis) at the sites under the Conversion and Storage Scenario but disposed of off site as LLW under the Conversion and Disposal Scenario. Bulk bags would not be used under the Conversion and Storage scenario, because they are not intended for long-term storage of DU oxide. In any event, DU oxide is not discussed further in this section because it is not consider to be waste until shipped off site for disposal.

In addition to DU oxide, under both scenarios the same types of waste would be generated at either of the two facilities. **Table C-27** summarizes the annual and total radioactive waste volumes projected at Paducah or Portsmouth for conversion operations and for storage and maintenance of oxide cylinders, as well as the percentages that the annual waste quantities would represent compared to current waste generation rates.

It is assumed that some of the cylinders that had been emptied of DUF_6 would be determined to be unusable as containers for DU oxide. It is assumed that the DU oxide and unusable cylinders would be managed as LLW. As with Chapter 4, Section 4.1.1.8, of this DU Oxide SEIS, it was conservatively assumed that 5 percent of the DUF_6 cylinders received from commercial sources would be unusable as DU oxide containers and would be disposed of as LLW. Under this assumption, unusable cylinders would be generated at a rate of 75 cylinders per year at Paducah or about 56 cylinders per year at Portsmouth. The same envelope volume is assumed for the unusable cylinders as for the DU oxide cylinders.

The LLW volumes include CaF_2, which, for this appendix, is conservatively assumed to be managed as radioactive waste. Total volumes were estimated based on the total periods of conversion operations, assumed to be approximately 8 years at Paducah or 11 years at Portsmouth (see Section C.1).

Table C-27 Annual and Total Radioactive Waste Generation at Paducah or Portsmouth

		Paducah		Portsmouth		Total Waste Volume (cubic yards)	
Waste	**Activity**	**Annual Waste Volume (cubic yards)**	**Percent of Current Waste Generation[a]**	**Annual Waste Volume (cubic yards)**	**Percent of Current Waste Generation[a]**	**Paducah**	**Portsmouth**
Conversion and Storage Scenario							
Unusable cylinders[b]	DUF_6 Conversion	420	NWS	310	NWS	3,500	3,500
LLW		75	36	56	36	620	620
CaF_2		4,910	NWS	3,570	NWS	39,300	39,300
LLW[c]	DU oxide storage and maintenance	2.1	1.0	1.6	1.0	210	160
MLLW		0.014	1.0	0.010	1.0	1.4	1.0
Conversion and Disposal Scenario							
Unusable cylinders[b]	DUF_6 Conversion	420	NWS	315	NWS	3,500	3,500
LLW		75	36	56	36	620	620
CaF_2		4,910	NWS	3,570	NWS	39,300	39,300
LLW[c]	DU oxide storage and maintenance	2.1	1.0	1.6	1.0	160	68
MLLW		0.014	1.0	0.010	1.0	0.70	0.44

Key: DU = depleted uranium; DUF_6 = depleted uranium hexafluoride; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; NWS = new waste stream.

[a] Waste from current activities at Paducah is described in Chapter 3, Section 3.1.8, of this DU Oxide SEIS, while waste from current activities at Portsmouth is described in Section 3.2.8.

[b] The listed volume of the unusable cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facilities or a separate waste treatment facility.

[d] The comparison is against current LLW generation rates other than DU oxide and unusable cylinders which are addressed separately in this table.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Finally, storage and maintenance of DU oxide cylinders at Paducah or Portsmouth would annually generate solid LLW, including LLW containing constituents such as polychlorinated biphenyls, which are regulated under the Toxic Substances Control Act and MLLW. Annual volumes are assumed to be the same as those for storage of DU oxide cylinders generated from conversion of DOE DUF_6 (see Chapter 4, Section 4.1.1.8, of the DU Oxide SEIS). Total volumes are estimated for the Conversion and Storage and Conversion and Disposal Scenarios based on the assumed DU oxide storage years, which are listed in Table C-1.

As indicated, the bulk of the radioactive waste would be generated as part of the conversion process with only minor quantities generated from storage and maintenance of DU oxide cylinders. For analysis, it is assumed that the oxide generation rate would be in accordance with the nominal conversion rates for Paducah and Portsmouth (current conversion rates are smaller). Assuming these nominal conversion rates and the above conservative assumptions about the annual volume of unusable cylinders to be generated, the annual volume of unusable cylinders produced would be much larger than current actual LLW generation rates. LLW volumes from DUF_6 conversion would be a fraction of current generation rates for either site as a whole, while LLW and MLLW volumes from storage and maintenance of DU oxide cylinders would represent a negligible percentage of current waste generation rates for either site as a whole.

Although the unusable cylinders and CaF_2 would be very large percentages of current LLW generation, the site waste management infrastructure was modified to handle these volumes of wastes. Therefore, managing these waste would not adversely affect the waste management infrastructure. DOE does not expect operational difficulties at Paducah or Portsmouth in managing the projected radioactive waste quantities. Although the projected volume of unusable cylinders is much larger than the current rate at either Paducah or Portsmouth, assuming the maximum generation rate of unusable cylinders (75 per year at Paducah), this rate would represent only 6 to 7 unusable cylinders being generated each month. Assuming truck delivery of the unusable cylinders to off-site facilities and two cylinders per truck load, only 3 to 4 off-site shipments would be required per month. Shipment of the CaF_2 to off-site disposal facilities, would require 3 to 4 truck shipments or approximately 1 rail shipment per day. These off-site shipment rates would not represent a management problem at Paducah or Portsmouth. Therefore, generation of waste during DUF_6 conversion and storage of DU oxide cylinders would not impact radioactive waste management capabilities at either Paducah or Portsmouth.

All oxide and other radioactive waste would be sent to off-site radioactive waste disposal facilities. Management of this waste at these facilities is addressed below in the "Radioactive Waste Disposition" subsection.

Conversion of DUF_6 would also generate hazardous waste, nonhazardous waste, and liquid sanitary waste as summarized in **Table C-28.** The indicated waste quantities would be the same for both the Conversion and Storage and Conversion and Disposal Scenarios. For hazardous waste and nonhazardous waste, a comparison of annual rates is made against current generation rates. For liquid sanitary waste, a comparison of annual rates is made against the treatment capacities of the on-site wastewater treatment systems. Much smaller quantities of nonhazardous waste and liquid sanitary waste would also be generated as part of DU oxide container storage and maintenance operations.

Table C-28 Nonradioactive Waste Generation from Commercial Depleted Uranium Hexafluoride Conversion at Paducah or Portsmouth

	Paducah		Portsmouth		Total Waste Volume (cubic yards)[c]	
Waste	**Annual Waste Volume (cubic yards)[a]**	**Percent of Current Annual Waste Generation[b]**	**Annual Waste Volume (cubic yards)[a]**	**Percent of Current Annual Waste Generation[b]**	**Paducah**	**Portsmouth**
Hazardous waste	7.2	97	5.4	97	60	60
Nonhazardous waste	240	300	190	320	2,000	2,100
Liquid sanitary waste (liters)	5.50×10^6	0.23	5.50×10^6	0.075	4.6×10^7	6.1×10^7

[a] Annual waste volumes for liquid sanitary waste are in units of liters.
[b] Waste from current activities at Paducah is described in Chapter 3, Section 3.1.8, of this DU Oxide SEIS, while waste from current activities at Portsmouth is described in Section 3.2.8.
[c] Total waste volumes assuming 8 and 11 years of conversion facility operation for Paducah and Portsmouth, respectively.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; liters to gallons, multiply by 0.26418.

At either Portsmouth or Paducah, nonhazardous waste would be disposed of on site or sent to off-site permitted recycle or disposal facilities; hazardous waste would be sent to off-site treatment and disposal facilities, and sanitary wastewater would be treated in on-site facilities (see Sections 3.1.8 and 3.2.8). The projected waste quantities would not represent a management problem at Paducah or Portsmouth. Because hazardous waste generation rates would be comparable to existing rates, no concerns are expected in on-site management or in off-site waste management capacities. Multiple off-site hazardous waste facilities exist within Kentucky and Ohio and neighboring states.[72] Nonhazardous waste generation rates would be larger than current rates but again, no management concerns are expected. In addition to an on-site disposal capacity that may be used at Portsmouth, there are multiple nonhazardous waste recycle and disposal facilities within Kentucky and Ohio;[73] thus, no concerns are expected with respect to off-site disposal capacities.

C.9.2 Radioactive Waste Disposition

This section describes the potential impacts on the disposal capacities and operations at Energy*Solutions*, NNSS, and WCS. Other potential environmental impacts of disposal at each site are not analyzed in this DU Oxide SEIS. Consistent with common practice, as long as the waste to be disposed of is within the authorized capacity and waste acceptance criteria of the disposal facility, the impacts of disposal have already been considered and found to be acceptable. It is expected that disposal of the oxide and other radioactive wastes identified in this appendix would be licensed or authorized[74] in accordance with a regulatory determination of safety by means of

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[72] For example, 22 commercial facilities in Ohio provide hazardous waste services, including one hazardous waste landfill (Ohio EPA 2018a); twelve commercial facilities provide hazardous waste services in Kentucky, although none operate a hazardous waste landfill (Fisher 2018).
[73] For example, there are 43 permitted municipal solid waste facilities in Ohio (Ohio EPA 2018b), and 31 in Kentucky (KEEC 2018)
[74] Or permitted in the case of constituents within the waste regulated under other statutes than the Atomic Energy Act of 1954, as amended.

analyses and long-term performance assessments. Chapter 5, Section 5.4.3, of this DU Oxide SEIS, describes the licenses and permits held by the Energy*Solutions* site. Energy*Solutions*' operating licenses and permits are available for review at http://www.energysolutions.com/waste-management/facilities/clive-facility-details/.

Section 5.4.2 of this DU Oxide SEIS describes applicable laws and regulations for disposal of waste at NNSS. Additional information on applicable laws and regulations, and the impacts of disposal of LLW at NNSS, is presented in the *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (DOE 2013). Section 5.4.3 of this DU Oxide SEIS describes the licenses and permits held by WCS. WCS operating licenses and permits are available for review at http://www.wcstexas.com/facilities/licenses-permits/.

Table C-29 presents the total volumes of LLW and MLLW (including oxide and unusable cylinders) that are projected from conversion of 150,000 metric tons of commercial DUF_6. In addition, the table estimates the percentages of the disposal capacities represented by these volumes for the three LLW and MLLW disposal facilities addressed in this DU Oxide SEIS: Energy*Solutions*, NNSS, and WCS. The percentages of disposal capacities are determined assuming that all LLW and MLLW from the conversion process would be disposed of at each of the three facilities. The percentages for any individual facility would be reduced by sending the waste to more than one facility.

Table C-29 Percentages of Disposal Capacities at Energy*Solutions*, Nevada National Security Site, and Waste Control Specialists

Waste	Volume (cubic yards)	Percent of Disposal Capacity		
		Energy*Solutions*[a]	Nevada National Security Site[b]	Waste Control Specialists[c]
Conversion and Storage Scenario				
DU oxide	NA	NA	NA	NA
Unusable cylinders[d]	3,500	0.084	0.20	0.37
LLW[e,f]	830	0.020	0.047	0.087
MLLW	1.4	3.8×10^{-4}	9.1×10^{-4}	1.4×10^{-4}
CaF_2	39,300	0.9	2.2	4.1
Conversion and Disposal Scenario				
DU oxide	69,900	100	3.9	7.3
Unusable cylinders[d]	3,500	0.084	0.20	0.37
LLW[e,f]	730	0.018	0.041	0.076
MLLW	0.70	2.0×10^{-4}	4.8×10^{-4}	7.4×10^{-5}
CaF_2	39,300	0.9	2.2	4.1

Key: DU = depleted uranium; FWF = Federal Waste Facility; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NA = not applicable; WCS = Waste Control Specialists.

[a] The disposal capacity for LLW and MLLW other than DU oxide is assumed, respectively, to be the remaining capacity in the Class A West Embankment (4.17 million cubic yards [3.25 million cubic meters]) and the Mixed Waste disposal cell (358,000 cubic yards [274,000 cubic meters]) as of August 24, 2016. DU oxide would be disposed of in a separate dedicated disposal unit sized to receive all DU oxide.

[b] The disposal capacity for LLW and MLLW at the Area 5 Radioactive Waste Management Complex is assumed to be 48 million cubic feet (1.36 million cubic meters) and 4 million cubic feet (113,000 cubic meters) in accordance with DOE's December 30, 2014, Record of Decision (79 FR 78421) for the *Final Site-Wide Environmental Impact Statement for the*

Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE 2013). It is assumed that DU oxide would be disposed of in the Area 5 LLW disposal units.

[c] It is assumed that LLW, MLLW, and DU oxide would be disposed of in the FWF at WCS with a total capacity of about 963,000 cubic yards (736,000 cubic meters), of which about 7,550 cubic yards (5,780 cubic meters) had been used as of August 26, 2016.

[d] The listed volume of the unusable cylinders is the envelope volume of the cylinders. Waste volumes may be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facility or a separate waste treatment facility.

[e] Includes all LLW projected from DUF_6 conversion and storage and maintenance of DU oxide cylinders except for DU oxide and unusable cylinders. Both these waste streams are considered separately.

[f] Total LLW volumes from storage and maintenance of DU oxide cylinders are slightly different for these activities at Paducah compared to comparable activities at Portsmouth. The larger LLW volumes from either Paducah or Portsmouth are shown in this table.

The disposal of DU oxide, unusable cylinders, ancillary LLW and MLLW, and CaF_2 would not exceed the disposal capacities at any of the evaluated facilities, even if each facility received all waste from Paducah or Portsmouth. DU oxide would not be disposed of under the Conversion and Storage Scenario. Under the Conversion and Oxide Disposal Scenario, disposal of DU oxide at Energy*Solutions* would not exceed the disposal capacity. This is because the disposal unit that would receive the DU oxide is a dedicated disposal unit that would be designed and sized to receive all DU oxide that may be sent from Paducah and Portsmouth. Disposal of DU oxide under this scenario at NNSS or WCS would represent less than 10 percent of the disposal capacities at either facility. Disposal of unusable cylinders and other LLW would represent less than 1 percent of the capacity at any evaluated facility, while disposal of MLLW would represent only tiny fractions of the disposal capacities at any evaluated facility.

As noted above, the listed volume of the unusable cylinders is the envelope volume of the cylinders. Cylinder waste volumes would be significantly reduced if the cylinders were volume-reduced (e.g., compacted or shredded) at the disposal facility or a separate waste treatment facility. In addition, disposal operations at any of the evaluated facilities would need to address the void spaces within the cylinders, which could include measures such as volume reduction, filling the void volume within the cylinders with a material such as grout or sand, or by stabilizing the cylinders in place with grout or similar media.

DOE would coordinate the proposed shipment scheduling with any facility receiving the waste to ensure that appropriate personnel and equipment are available to safely manage waste receipts. Energy*Solutions* and WCS routinely receive waste by both truck and rail. Assuming either Energy*Solutions* or WCS received DU oxide cylinders from Paducah or Portsmouth, either disposal facility could conservatively receive up to 2,880 cylinders in a year. Assuming the cylinders are all shipped by truck and that there are 250 working days per year at Paducah or Portsmouth and the disposal sites, Energy*Solutions* or WCS would receive an average of about 12 truckloads of DU oxide cylinders per day. Otherwise, assuming the same number of cylinders was shipped by rail from Paducah or Portsmouth, trains with DU oxide cylinders would arrive about 4 times per month. Assuming 6 cylinders per railcar and 10 railcars per train, each rail shipment would contain 60 cylinders to be offloaded and transferred to the designated disposal unit.

DOE expects that neither Energy*Solutions* nor WCS would have difficulty in accommodating either delivery mode. DOE expects that an average of 12 trucks per day or 4 trainloads per month would be within the range of truck and rail shipments that routinely arrive at Energy*Solutions* or

WCS, and the uniform nature of the DU oxide shipments in terms of container type and size, and waste content, enhances the efficiency of disposal operations.[75]

Projected volumes of other radioactive wastes are much smaller and could be easily managed at Energy*Solutions* or WCS. Unusable cylinders would represent the largest volumes, but could be readily managed at either disposal facility. Unusable cylinders would annually average approximately 38 truck deliveries from Paducah or about 28 truck deliveries from Portsmouth (assuming two cylinders per truck). Assuming 250 working days per year at the disposal facilities, there would be an average of one truck delivery of unusable cylinders every seven working days from Paducah or one truck delivery every nine working days from Portsmouth. The largest annual quantity of LLW (not including DU oxide and unusable cylinders) considering either scenario (about 77 cubic yards) would be generated at Paducah. This annual volume of waste could be hypothetically disposed of in approximately 290, 55-gallon drums. Assuming that delivery to either disposal facility would be by truck and each truck could carry 60 drums, there would be approximately 5 truck shipments per year. The projected annual volume of MLLW from either Paducah or Portsmouth could be hypothetically delivered in a single 55-gallon drum, so receipt of MLLW would not represent a management concern at either facility.

Alternatively, shipments of unusable cylinders and other wastes could be made by rail delivery to Energy*Solutions* or WCS. Delivery of these cylinders and wastes would require only a few train shipments per year, which would not be expected to represent any management concerns at either facility.

NNSS is capable of receiving waste only by truck shipment. Assuming NNSS received DU oxide from Paducah or Portsmouth at a rate of 12 trucks per day, this frequency of delivery could be addressed at NNSS under the current operational capability (equipment and personnel). Assuming the cylinders were delivered by rail to an intermodal location to be transferred to trucks for delivery to NNSS, it could require multiple days for all cylinders from each rail shipment to be transported from the intermodal location to NNSS. As discussed above, one of the features of the DU oxide shipments that would lead to efficient and timely disposal operations is their expected uniformity in terms of container shape, size, and waste content. Truck and rail shipments would be scheduled to ensure the proper mix of personnel and equipment.

Similar to the discussion for Energy*Solutions* and WCS, the projected volumes of unusable cylinders or other wastes are smaller than the oxide volumes and could be managed at NNSS given its existing personnel and equipment configuration. As discussed above, delivery of unusable

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[75] Shipments to LLW and MLLW disposal facilities are inspected upon arrival for compliance with acceptance criteria such as direct radiation levels, the presence of detectable removable contamination, waste content, and manifesting. Departing vehicles are also inspected to ensure compliance with transportation requirements including the presence of detectable removable contamination. A uniform waste stream such as DU oxide would require less time to perform these inspections than another waste stream containing, for example, a more variable range of isotopes. It also requires less time to inspect a rail shipment than it would if the same quantity of waste in the rail shipment was instead shipped in multiple truck loads. The uniform size and configuration of the great majority of the DU oxide containers (i.e., cylinders) also promotes a more efficient and timely waste emplacement process compared to that required for shipments containing the same quantity of waste but in containers of a variety of sizes and configurations (e.g., drums, boxes, lift liners).

cylinders would annually average 1 truck delivery every 7 working days from Paducah or 1 truck delivery every 9 working days from Portsmouth. As discussed above, annual deliveries of other LLW and MLLW would not represent a management concern at NNSS.

C.10 ENVIRONMENTAL JUSTICE

A determination of impacts that could disproportionately affect minority and low-income populations is based upon the impacts on the resource areas considered in this appendix.

C.10.1 Conversion and Storage

As shown in Chapter 3, Sections 3.1.11 and 3.2.11, of this DU Oxide SEIS, there are a number of census tracts with a higher proportion of minority and low-income populations within 50 miles (80 kilometers) of both Paducah and Portsmouth. However, as described in this appendix, under normal conditions there would be no high and adverse impacts anticipated on other resource areas that would disproportionately impact minority and low-income populations under the Conversion and Storage scenario.

Potential adverse human health impacts associated with an accident could impact the health and safety of the general population surrounding the site. For all youth and elderly populations, disproportionate impact is inherent. The extent to which youth and the elderly will be impacted is disproportionate due to their inherent vulnerabilities. Thus, potential accidental releases of hazardous materials have the potential to disproportionately impact children (under 18 years) and the elderly (65 and older). Operational and natural phenomena initiated events identified in the hazard evaluation tables in the documented safety analyses that involved DU oxide were found to have “negligible” radiological and chemical consequences to the public. In addition, as described in Section C.7.3, truck or rail transportation of DU oxide, unusable cylinders, CaF_2, and ancillary LLW and MLLW to off-site disposal facilities is not expected to result in any LCFs although a number of nonradiological fatalities due to traffic accidents could occur. The location of potential transportation accidents and the types of persons affected cannot be projected and reliably predicted and thus, there would be no reason to expect that minority and low-income populations would be affected disproportionately by high and adverse impacts. Therefore, disproportionate high and adverse impacts on minority or low-income populations are not expected under this scenario.

C.10.2 Conversion and Disposal

The impacts of storage of DUF_6 containers, conversion of DUF_6 to DU Oxide, storage of DU oxide containers, and loading of wastes for off-site disposal at Paducah or Portsmouth would be similar to those described for the Conversion and Storage scenario and there would be no high and adverse impacts anticipated to other resource areas that would disproportionately impact minority and low-income populations.

During disposal of the DU Oxide under this scenario, truck and rail loading activities would occur within the industrialized areas of Paducah or Portsmouth. For all youth and elderly populations, disproportionate impact is inherent. The extent to which youth and the elderly will be impacted is disproportionate due to their inherent vulnerabilities. However, the potential impacts associated with the shipment of DU oxide and other wastes from Paducah or Portsmouth to the disposal sites (see Section C.7.3) is not expected to result in any LCFs although a number of nonradiological fatalities due to traffic accidents could occur. In addition, the locations of potential transportation accidents and the types of persons affected cannot be projected and reliably predicted and thus, there would be no reason to expect that minority and low-income populations would be affected disproportionately by high and adverse impacts. Therefore, disproportionate high and adverse impacts on minority or low-income populations are not expected during transportation of wastes to disposal sites under this scenario.

C.11 RESOURCE USE

Resources would be used during commercial DUF_6 cylinder storage, conversion of DUF_6 to DU oxide, DU oxide container storage, loading DU oxide containers for off-site disposal, and disposal of DU oxide and other wastes. The major commitments of natural and man-made resources related to the scenarios for management of commercial DUF_6 are discussed below. Three major resource categories would be committed: land, labor and materials, and energy.

C.11.1 Land

When no longer needed, DOE could decontaminate the conversion facilities and the storage yards. After decontamination, the conversion facilities and the storage yards could be reused for another productive use. If a productive use for the facilities is not found, they could be demolished and removed. Appropriate CERCLA and/or NEPA reviews would be conducted before initiation of DD&D and removal actions. Examples of future use of these tracts of land, although beyond the scope of this DU Oxide SEIS, could include other industrial uses, and restoring them for unrestricted use. Therefore, the commitment of this land resource would not necessarily be irreversible. However, the land used to dispose of DU oxide and other wastes is likely to be irretrievable because wastes in belowground disposal areas are not anticipated to be removed, the land could not be restored, and the site could not be used for other purposes.

C.11.2 Labor and Materials

Human resources (labor) would be expended during commercial DU management activities. The commitment of labor and material resources for management of commercial DUF_6 would include labor and materials consumed or reduced to unrecoverable forms of waste. **Table C-30** shows the estimated consumption of labor and materials under the commercial DUF_6 management scenarios evaluated in this DU Oxide SEIS. Consumption of the labor and materials would not constitute a major drain on local resources. Substantial steel would be used in the form of unusable cylinders and DU oxide disposal containers. Substantial quantities of other materials would be used during the conversion of DUF_6 to DU oxide. Consumption of steel and other materials, although irreversible and irretrievable, would not involve a resource in short supply in the United States.

C.11.3 Energy

The commitment of energy resources during commercial DUF_6 management would include the consumption of electricity and fossil fuels (i.e., diesel fuel, gasoline) used for equipment operation and transportation vehicles (see Table C-30). Consumption of energy would not constitute a permanent drain on local resources or involve any energy source in critically short supply in the United States.

Table C-30 Resource Use for Management of Commercial DUF_6

	Paducah		**Portsmouth**	
	Conversion and Storage Scenario	**Conversion and Disposal Scenario**	**Conversion and Storage Scenario**	**Conversion and Disposal Scenario**
Labor				
Full-time equivalent (person-years)	1,710	1,540	2,480	2,130
Material				
Steel (in disposal containers and unusable cylinders) (tons)	814	17,100	814	17,100
Lime (tons)	152	152	154	154
Ammonia (tons)	5,360	5,360	5,610	5,610
Potassium hydroxide (tons)	64	64	66	66
Nitrogen (tons)	80,000	80,000	85,800	85,800
Energy				
Electricity (megawatt-hours)	298,000	298,000	342,000	342,000
Gasoline (gallons)	55,700	34,500	125,000	64,900
Diesel fuel (gallons)[a]				
Max for rail transportation	185,000	3,540,000	271,000	4,380,000
Max for truck transportation		9,200,000		10,900,000
Natural gas (scf)	1.85×10^{14}	1.85×10^{14}	2.31×10^{14}	2.31×10^{14}

Key: Max = maximum; scf = standard cubic feet.

[a] Includes diesel fuel for conversion, cylinder handling and loading equipment, and for truck or rail transportation vehicles for transportation to a disposal site. Disposal at the Nevada National Security Site (NNSS) resulted in the maximum fuel use and therefore the values for NNSS were used in this table.

C.12 REFERENCES

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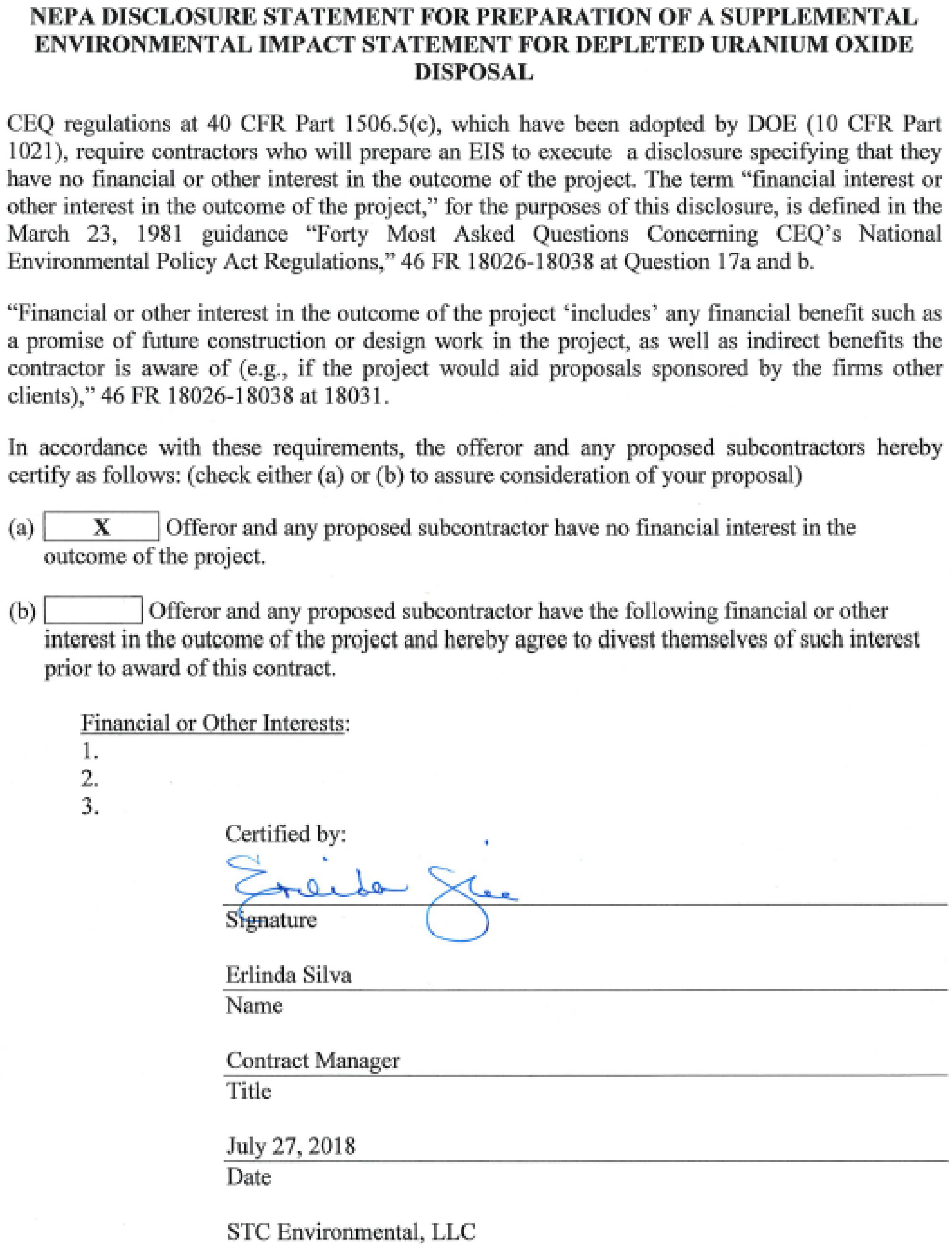
APPENDIX D

CONTRACTOR DISCLOSURE STATEMENTS

APPENDIX D: CONTRACTOR DISCLOSURE STATEMENTS



NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR DEPLETED URANIUM OXIDE DISPOSAL

CEQ regulations at 40 CFR Part 1506.5(c), which have been adopted by DOE (10 CFR Part 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firms other clients)," 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal)

(a) ☒ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:
1.
2.
3.

Certified by:

Signature

Erlinda Silva
Name

Contract Manager
Title

July 27, 2018
Date

STC Environmental, LLC