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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

SUMMARY

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COVER SHEET

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

TITLE: *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)*

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

CONTACT: For further information on this supplemental environmental impact statement (SEIS), contact:

Jaffet Ferrer-Torres
Document Manager
Office of Environmental Management
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585
e-mail: DUF6_NEPA@em.doe.gov

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

William Ostrum
Acting NEPA Compliance Officer
Office of Regulatory Compliance, EM 4.31
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
email: askNEPA@hq.doe.gov

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 (Volume 69 of the *Federal Register*, page 34161 [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 Title 40 of the *Code of Federal Regulations* (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, ACRONYMS, AND CHEMICALS

CaF_2	calcium fluoride
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	*Code of Federal Regulations*
CO_2e	carbon dioxide equivalents
DD&D	decontamination, decommissioning, and demolition
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*
DU	depleted uranium
DUF_6	depleted uranium hexafluoride
ETTP	East Tennessee Technology Park (formerly K-25 site)
FR	*Federal Register*
FTE	full-time equivalent
HF	hydrogen fluoride
LCF	latent cancer fatality
LLW	low-level radioactive waste
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
NEPA	National Environmental Policy Act
NNSS	Nevada National Security Site
NRC	U.S. Nuclear Regulatory Commission
ROD	Record of Decision
ROI	region of influence
USEC	United States Enrichment Corporation
WIPP	Waste Isolation Pilot Plant

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)

SUMMARY

S.1 INTRODUCTION

The U.S. Department of Energy (DOE) has prepared this *Draft Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride* (DU Oxide SEIS) to evaluate alternatives for the transport and disposal of depleted uranium (DU) oxide[1] from the Paducah and Portsmouth Sites (Paducah and Portsmouth) in Paducah, Kentucky, and Piketon, Ohio, respectively. This DU Oxide SEIS has been prepared in accordance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations at Title 40 of the *Code of Federal Regulations* (40 CFR) Parts 1500–1508, and DOE NEPA implementing regulations at 10 CFR Part 1021. The locations of Paducah and Portsmouth are shown in **Figures S-1** and **S-2**, respectively.

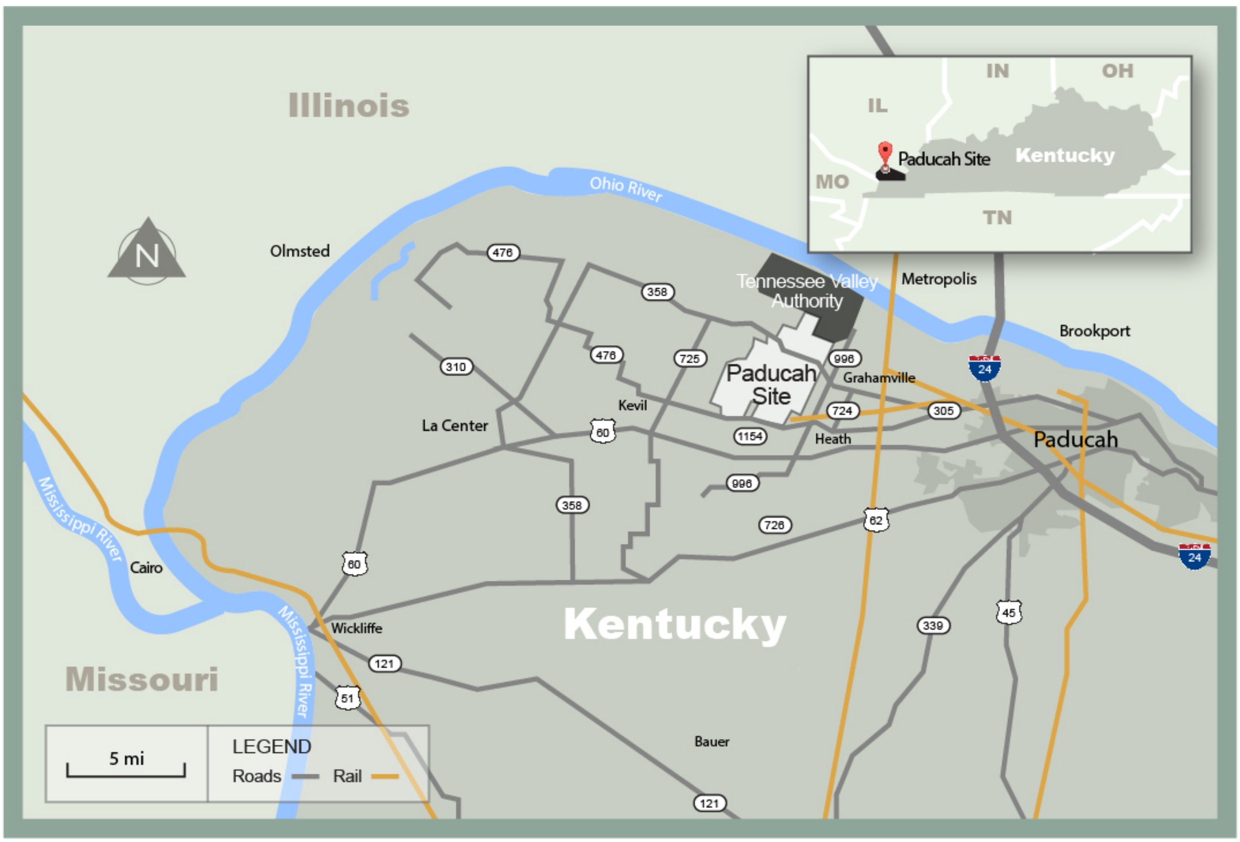

Figure S-1 Location of the Paducah Site

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[1] This DU Oxide SEIS also evaluates the environmental impacts of transport and disposal of related waste streams including empty and heel cylinders, calcium fluoride, and ancillary low-level radioactive waste, and mixed low-level radioactive waste.

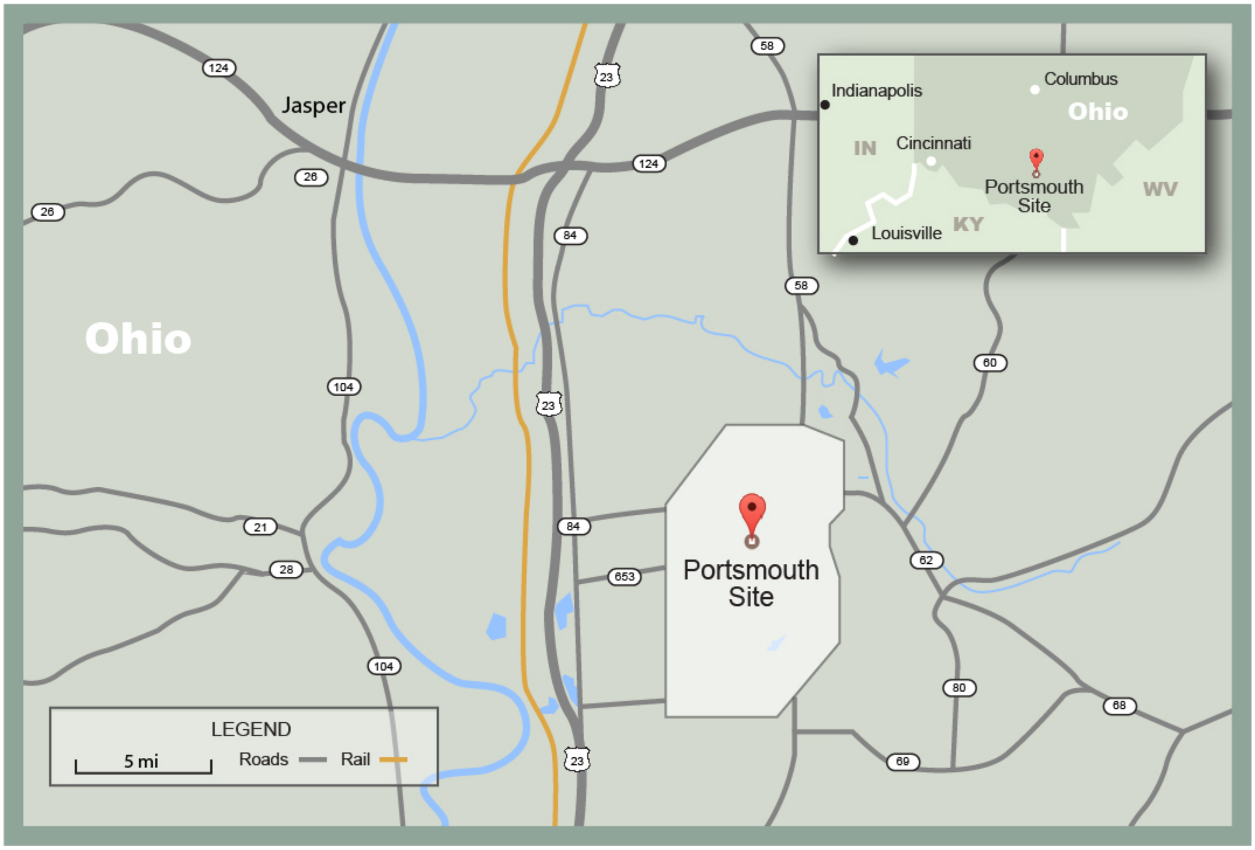

Figure S-2 Location of the Portsmouth Site

S.2 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 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)[2] 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 S-3** shows a typical DUF_6 storage cylinder.

[2] 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.

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. These cylinders are stored two layers high on outdoor gravel or concrete storage areas known as “yards.” The bottom cylinders are placed on concrete saddles to keep them off the ground (ANL 2016). **Figure S-4** shows a DUF_6 cylinder storage yard.

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 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) (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 DU Oxide SEIS. The empty and heel (mostly empty) cylinders[3] (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). Disposal of empty and heel cylinders is evaluated in this DU Oxide SEIS.

Figure S-3 Typical Depleted Uranium Hexafluoride Storage Cylinder (Source: ANL 2001)

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

Figure S-4 Depleted Uranium Hexafluoride Cylinder Storage Yard (Source: BWXT 2016)

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 1999a) issued 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[4] 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.

On June 18, 2004, DOE issued Final EISs for the construction and operation of DUF_6 conversion facilities and other actions at Paducah and Portsmouth (69 FR 34161). The 2004 EISs were prepared as a second level of the tiered[5] environmental review process being used to evaluate and implement DOE's DUF_6 long-term management program. The above-mentioned EISs included evaluations of the environmental impacts of the transport and disposal of DU oxide, emptied and heel DUF_6 storage cylinders, and calcium fluoride (CaF_2)—a conversion byproduct—and ancillary LLW and 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 at Energy*Solutions* (formerly known as Envirocare of Utah, Inc.), a commercial LLW disposal facility near Clive, Utah.

[4] 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.

[5] According to 40 CFR Part 1500, tiering of EISs refers to the 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.

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 had inadvertently 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 any supplemental NEPA analysis would be provided for review and comment.

S.3 CHANGES SINCE THE PADUCAH EIS AND PORTSMOUTH EIS 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 described in 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 DOE should consider 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 purposes of analysis 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). 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 SEIS evaluates only the management of DU oxide, empty and heel cylinders, CaF_2, and ancillary LLW and mixed low-level radioactive waste (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.

S.4 PURPOSE AND NEED FOR AGENCY ACTION

The purpose and need for this action is 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 RODs for the 2004 EISs that deferred DOE's decision related to the transport and disposition of DU oxide at potential off-site disposal facilities.

S.5 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 S-5** shows the locations of facilities discussed in this DU Oxide SEIS.

Under the U.S. Enrichment Corporation (USEC) Privatization Act (42 U.S. Code § 2297h–11), DOE is required to accept LLW and 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 any 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 the receipt, conversion, storage, handling, and disposal of commercial DUF_6 is presented in Appendix C of the DU Oxide SEIS. Where appropriate, the impacts of the management of commercial DUF_6 at

Paducah and Portsmouth, and the transport and disposal of this material, are included in the cumulative impacts analysis of this DU Oxide SEIS.

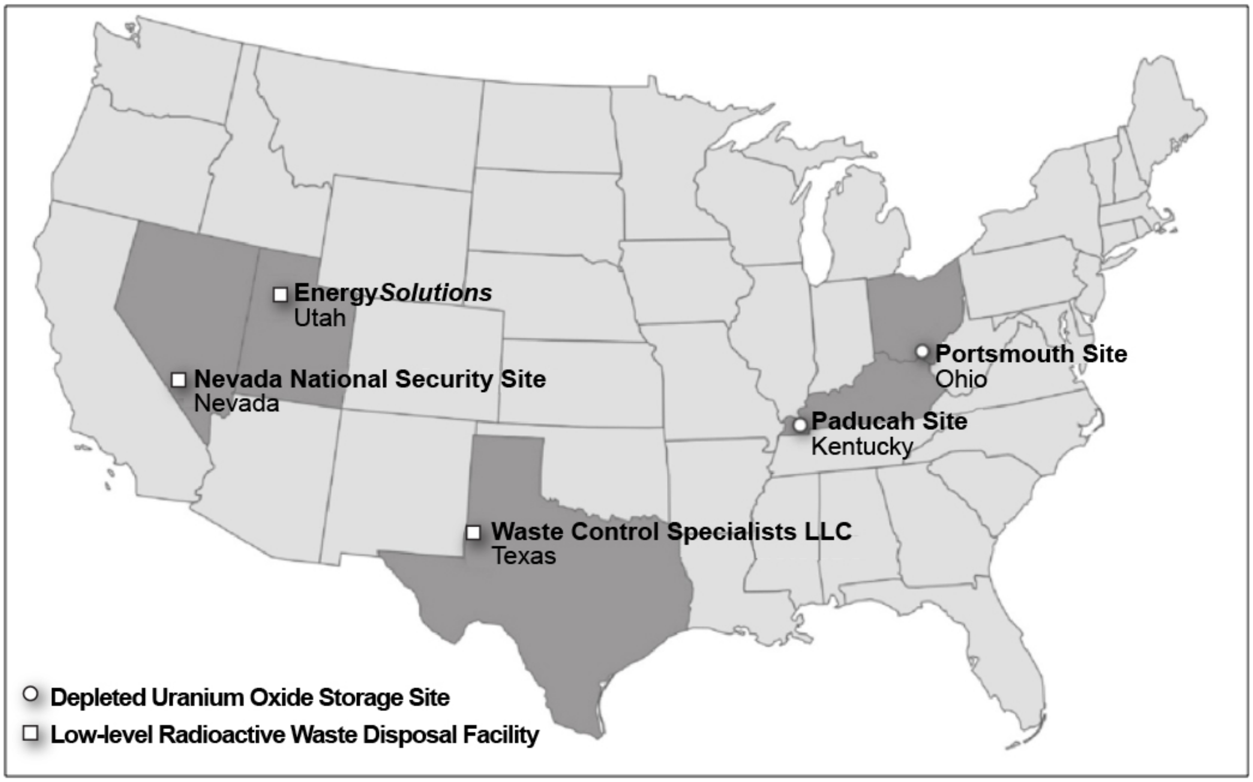

Figure S-5 Locations of Facilities Discussed in the DU Oxide SEIS

S.6 PUBLIC INVOLVEMENT

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; hence, 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.

S.7 ACTIVITIES RELATED TO THE PROPOSED ACTION

This section briefly describes activities at the two sites that were evaluated in the 2004 EISs. These activities will continue at the sites and provide context for the alternatives evaluated in this DU Oxide SEIS. Because they were evaluated in the 2004 EISs, most of these activities are not evaluated in this DU Oxide SEIS. Conversion and storage activities are similar at Paducah and

Portsmouth. Consistent with activities considered in the ROD for the Paducah DUF_6 conversion facility, all DUF_6 cylinders that were stored at ETTP have been shipped to Paducah for conversion.

During the DUF_6 conversion process described in detail in the 2004 EISs, DUF_6 is vaporized and converted to a mixture of uranium oxides (primarily triuranium octaoxide) 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) and 18 metric tons (19.8 tons) per year of CaF_2 are estimated to be generated at Paducah and Portsmouth, respectively, during the conversion process. Per the 2004 EISs, the CaF_2 may contain very low levels of radionuclide contamination; therefore, this DU Oxide SEIS conservatively 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 transport 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]

Only the management of DU oxide, empty and heel cylinders, CaF_2, and ancillary LLW and MLLW are evaluated in this DU Oxide SEIS. 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 44649) and are not reevaluated in this DU Oxide SEIS. **Figure S-6** shows the activities analyzed in this DU Oxide SEIS.

[6] 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.

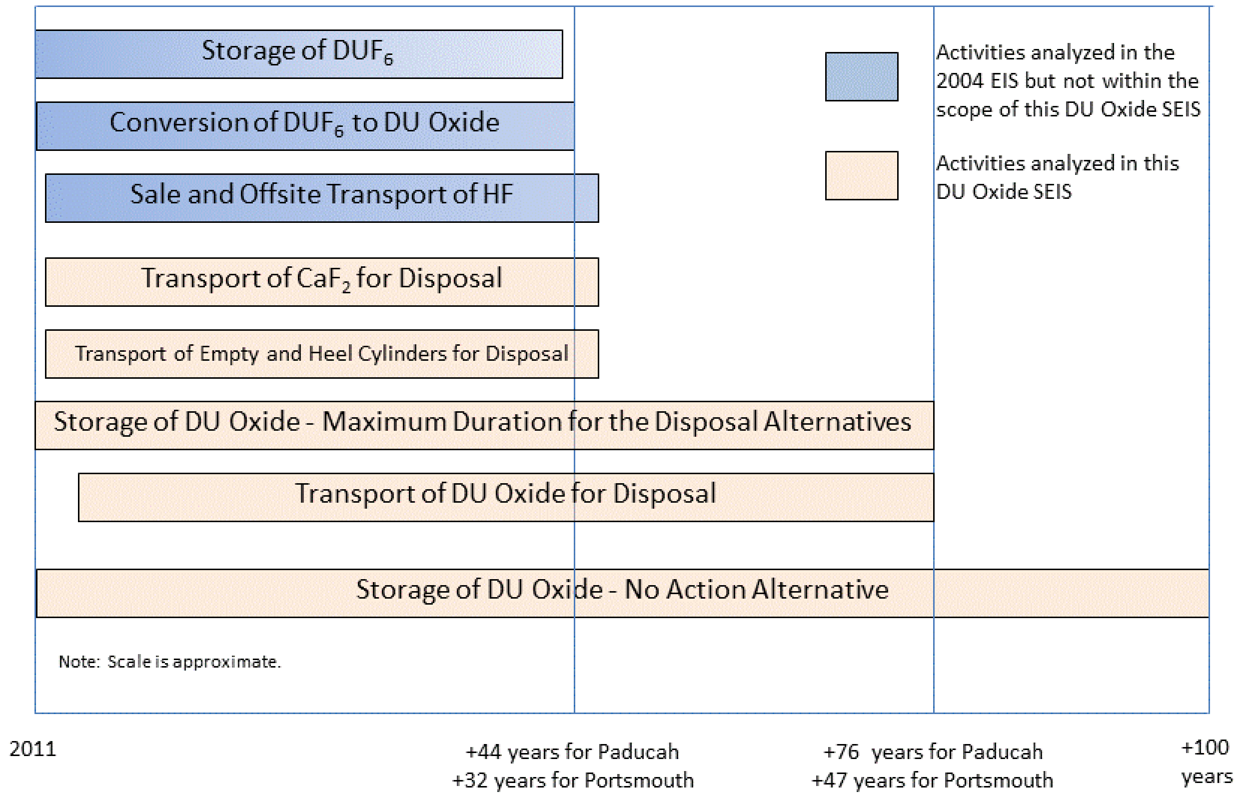

Figure S-6 Anticipated Activities at the Paducah and Portsmouth Sites Analyzed in this DU Oxide SEIS[7]

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 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

[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 analyses revised quantities of these materials for disposal and includes disposal at an additional facility (i.e., WCS).

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]

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).

S.8 DESCRIPTION OF ALTERNATIVES

This section describes the three Action Alternatives for disposal of the DU oxide produced by the conversion process and the No Action Alternative. Evaluation of a No Action Alternative is required under the NEPA.

S.8.1 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 the DU oxide is 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

[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.
[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 (LCF), 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.

heel cylinders is conservatively analyzed to occur over 34 years at Paducah and over 22 years at Portsmouth.

There are also 220 and 365 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 monitoring and inspecting the storage yards and containers in accordance with the Cylinder Surveillance and Maintenance Plan (MCS 2017) described in Section S.7. 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.

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, other ancillary LLW and MLLW would be shipped to the LLW disposal sites.

Transportation from Paducah and Portsmouth and disposal at Energy*Solutions* and NNSS of empty and heel cylinders, CaF_2, and ancillary LLW and MLLW were analyzed in the 2004 EIS (DOE 2004a, 2004b). Because the quantities of these wastes have changed and DOE is considering disposal at WCS, transportation and disposal of these wastes are reevaluated in this DU Oxide SEIS.

S.8.2 ACTION ALTERNATIVES

Under the Action Alternatives, DU oxide would be transported and disposed of at one or more of the 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.

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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 the handling of a transportation package or to consolidate two or more packages. The overpack does not include the transport vehicle or freight container.

As mentioned under the No Action Alternative, 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). Under the Action Alternatives, the drums of DU oxide would be shipped to the disposal facilities via truck or rail along with the cylinders of DU oxide.

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). 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 under the No Action Alternative, 14,000 empty and heel cylinders, CaF_2, and ancillary LLW and MLLW would be shipped to the LLW disposal sites. Transport from Paducah and Portsmouth and disposal at Energy*Solutions* and NNSS of DU oxide in cylinders (or bulk bags) was analyzed in the 2004 EISs (DOE 2004a, 2004b). Because the quantities of these wastes have changed and DOE is considering disposal at WCS, transport and disposal of these waste is reevaluated in this DU Oxide SEIS.

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 purposes of analysis, this DU Oxide SEIS assumes the intermodal facility located in Barstow, California, would be used. **Figure S-7** and **Figure S-8** show the analyzed routes from Paducah and Portsmouth, respectively, to the potential disposal sites.

DU oxide cylinders are moved around the sites using a straddle buggy or NCH-35. 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 rail cars or truck beds using overhead cranes (PPPO 2018). Cylinder movement is performed in accordance with technical procedures. USEC-651, *The UF6 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.

Transport, both by rail and truck, would be in accordance with DOT regulations 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.*

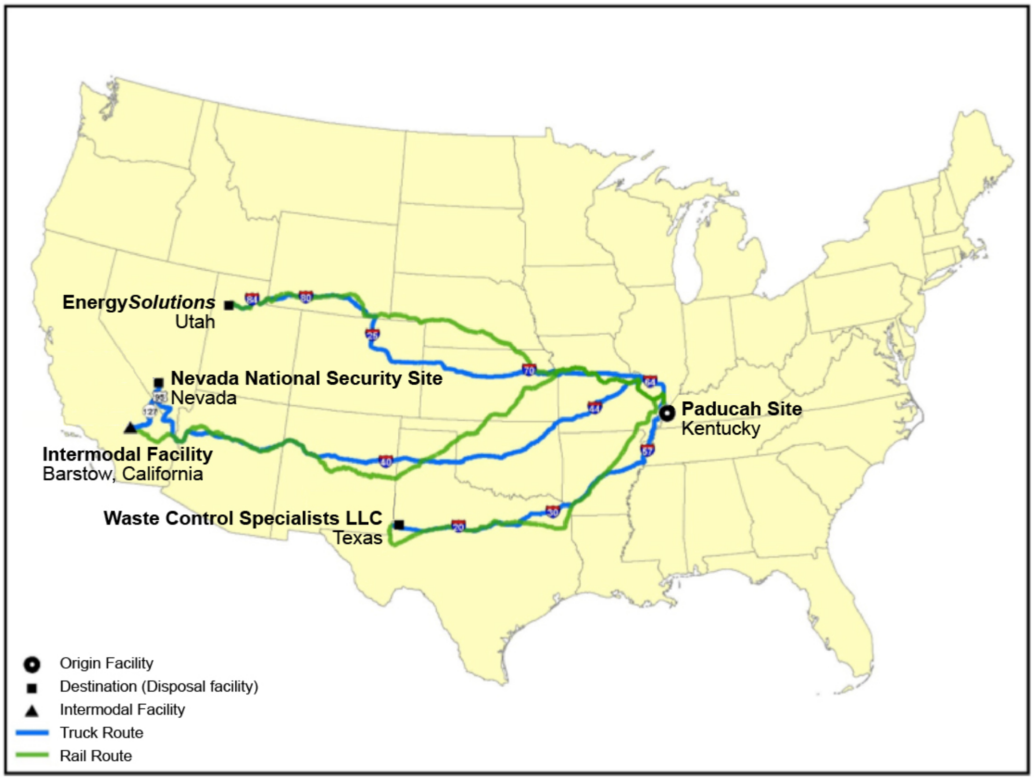

Figure S-7 Analyzed Rail and Truck Routes from Paducah to Potential Disposal Sites

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

Table S-1 shows the key attributes of the activities analyzed under the DU Oxide SEIS alternatives.

Table S-1 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 Evaluated 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 Energy*Solutions*, NNSS, or WCS	NA	258,000 cubic yards	NA	128,000 cubic yards

Notes: 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.

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

[b] 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; however, the time periods considered for storage of DU oxide at Paducah and Portsmouth are 44 and 32 years, respectively (PPPO 2018). This corresponds with the duration of conversion activities plus a 10-year cushion to account for unforeseen delays.

[c] As an option, DU oxide could be disposed of in bulk bags. At Paducah, 41,016 bulk bags would be needed; 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] Under the scenario where HF cannot be sold and is instead converted to CaF_2 and disposed of as LLW. 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, and the schedule for shipping DU oxide to the disposal sites, 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 at 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 impacts 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 of storage (i.e., be the most conservative).

[g] 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 at Portsmouth over a period of 15 years after completion of conversion operations. 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).

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 2016). As discussed in the 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 2016).

Disposal of Waste at the Nevada National Security Site

Disposal at NNSS was evaluated in the 2004 EISs. Continued disposal of LLW from DOE and certain U.S. Department of Defense (DoD) facilities at NNSS was also evaluated 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 2013a). LLW management and disposal occurs within the NNSS Area 5 Radioactive Waste Management Complex. 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 NNSA sites and certain DoD sites throughout the United States. This is consistent with the February 25, 2000, ROD (65 FR 10061) for the *Final Waste Management Programmatic EIS for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (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 and 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 to NNSS.

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 near the border with New Mexico. This facility can accept waste by rail or truck transport. This disposal site 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 disposal of waste for which the Federal Government is responsible as defined by the Low-Level Radioactive Waste Policy Act, as amended (WCS 2016). The Federal Waste Disposal Facility is licensed through September 2024, with provision for 10-year renewals thereafter under Texas Commission on Environmental Quality Radioactive Material License CN60061689. DOE has signed an agreement to take ownership of the Federal Waste Disposal Facility after the post-closure care period.

S.8.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

In addition to the Action Alternatives evaluated in this DU Oxide SEIS, DOE identified the following additional alternatives that it considered for evaluation but ultimately dismissed from detailed study, as discussed in the text below: (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 the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.

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 analyzes DU oxide transportation 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 646,000 metric tons [712,000 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 transportation 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* or 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, air transportation 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 transport 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.

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 of disposal units 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 the DU Oxide SEIS, on-site disposal for DU oxide is not analyzed.

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 in operation in Barnwell County, South Carolina, and on 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 on 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.[11] Therefore, disposal of DU oxide at the Barnwell and Hanford Site commercial facilities is not analyzed in detail. 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 on the Hanford Site

[11] 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 1999b), 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.

does not accept LLW or MLLW generated from off-site sources, but may do so in the future after the on-site Waste Treatment Plant is in operation.[12] 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 the disposal of DU oxide, disposal at the Hanford Site is not analyzed in detail.

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 the WIPP, a deep geologic repository in New Mexico, to transuranic waste[13] generated from the Nation's atomic energy defense activities. The DU oxide destined for disposal would be 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 high degree of isolation from the environment. For these reasons, disposal of DU oxide in WIPP is not analyzed in detail.

S.9 COMPARISON OF ALTERNATIVES

S.9.1 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[14] 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 S.9.3).

This DU Oxide SEIS does not address 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 RODs for these EISs (69 FR 44654; 69 FR 44649). The impacts of these activities are considered part of potential cumulative impacts.

No Action Alternative: 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

[12] 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 Hanford at least until the Waste Treatment Plant at Hanford becomes operational.

[13] 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 the concurrence of the U.S. Environmental Protection Agency, 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).

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

beginning with storage of the first DU oxide cylinders in 2011 and ending in 2110.[15] 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 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).[16] This corresponds to 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 56 to 66 years at Paducah and for 68 to 78 years at Portsmouth.

Impacts associated with the following activities under the No Action Alternative are considered in this DU Oxide SEIS: (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. 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 Energy*Solutions*, NNSS, or WCS from the disposal of the 46,000 bulk bags of CaF_2 (if HF could not be recycled into commerce), 14,000 empty and heel cylinders, and ancillary LLW and MLLW from container surveillance and maintenance activities.

Action Alternatives: 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 estimated potential environmental impacts for these alternatives including: (1) impacts from storage of DU oxide at Paducah and Portsmouth until shipment to the disposal site, (2) impacts from the transport 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.

DU oxide would be stored at Paducah and Portsmouth until it is shipped to the disposal site. As described under the No Action Alternative, based on the rate of conversion of DUF_6 to DU oxide, DOE believes conversion activities will occur over a 34- to 44-year period at Paducah, and over a 22- to 32-year period at Portsmouth (PPPO 2018).[17] Because the shipment schedule is uncertain,

[15] 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 lifecycle 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.

[16] 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.

[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.

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 completed 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 transporting the 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 447,000 metric tons (492,000 tons) of DU oxide. The transport of DU oxide from Portsmouth via truck or rail would require about 15 years, also based on the transport of up to 1,440 cylinders per year. About 22,850 cylinders would be transported from Portsmouth, containing 199,000 metric tons (220,000 tons) of DU oxide (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 has assumed 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 has assumed 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 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 as part of the licensing and permitting process.

S.9.2 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 environmental impacts at Paducah and Portsmouth under the No Action and Action Alternatives are summarized in **Table S-2**. 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 S-3**. The tables are intended to facilitate comparison of the alternatives.

Table S-2 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. Therefore, impacts on infrastructure at Paducah and Portsmouth would be expected to be minor. Long term storage of cylinders may require maintenance, repair, or replacement of select infrastructure if the storage duration exceeds designed life.				
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 greenhouse gases 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 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 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 cylinders, and/or CaF_2 would be minimal and			

Resource Area / Parameter		**Paducah**			**Portsmouth**		
		Action Alternatives		**No Action**	**Action Alternatives**		**No Action**
		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.						
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 level).						
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 (i.e., 2.6 micrograms 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 per 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 Standard 1098-2017). The 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						

Resource Area / Parameter		Paducah		Portsmouth	
		Action Alternatives	No Action	Action Alternatives	No Action
Human Health and Safety – Normal 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 per 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 Standard 1098-2017). Values presented are for DU cylinder 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..				
	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. Therefore, no LCFs would be expected in the general population. Values presented are for DU 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[1].				
	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.				

Resource Area / Parameter		Paducah		Portsmouth	
		Action Alternatives	No Action	Action Alternatives	No Action
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
	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 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 (yd^3/yr) (percent of current generation)	4,600 (NWS)	4,600 (NWS)	3,700 (NWS)	3,700 (NWS)

Resource Area / Parameter	Paducah		Portsmouth	
	Action Alternatives	No Action	Action Alternatives	No Action
	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 the empty and heel cylinders and CaF_2 would exceed 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 wastes 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.			
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; D&D = decontamination and decommissioning; 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; HI = hazard index; 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 S-3 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[d]
	Crew LCF	0 (0.1)	0 (0.2)	0 (0.09)	0 (2×10^{-4})[d]
	Population dose (person-rem)	590	722	403	0.7 [4]
	Population LCF	0 (0.3)	0 (0.4)	0 (0.2)	0 (4×10^{-4})[d]
	Truck – Accidents				
	Population LCF risk	4×10^{-4}	5×10^{-4}	3×10^{-4}	1×10^{-7}[(d)]
	Traffic fatalities	11	11	10	1[(d)]
Transportation DU oxide in bulk bags and 69,000 empty and heel cylinders option [c]	***Rail – Incident-free***				
	Crew dose (person-rem)	1,356	1,610[(a*)]	< Energy*Solutions*[c]	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[f]	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[f]	2×10^{-6}
	Traffic fatalities	2	2 [a*]		0.2
	Truck – Incident-free				
	Crew dose (person-rem)	571	655	< Energy*Solution* [g]	0.3
	Crew LCF	0 (0.3)	0 (0.4)		0 (2×10^{-4})
	Population dose (person-rem)	273	319	< or = to Energy*Solutions* or NNSS[f]	0.7
	Population LCF	0 (0.2)	0 (0.2)		0 (4×10^{-4})

Resource Area / Parameter		Action Alternatives			No Action
		Energy*Solutions*	NNSS	WCS	
	Truck – Accidents				
	Population LCF risk	4×10^{-2}	2×10^{-2}	< or = to Energy*Solutions* or NNSS[f]	1×10^{-7}
	Traffic fatalities	4	5		1
	Discussion: Transportation 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 an accident.				
Transport of CaF_2 [d]	**Truck:** Traffic Fatalities	6.4	7.0	5.8	5.0 to 6.2
	Rail: Traffic Fatalities	1.0	2.50	1.2	1.7 to 3.8
	Discussion: Transportation 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[1]	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.

[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 at Barstow, California. The impacts for the entire transportation route are reported in this table.

[a*] The 2004 EISs (DOE 2004a, 2004b) assume that 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.

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

[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 travelled and the speed of the transport vehicle. 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 travelled 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, the traffic on the transportation routes, and the speed of the transport vehicle. 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 transportation 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.

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

S.9.3 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 future 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 DUF_6 to DU oxide conversion facilities; waste management; decontamination, decommissioning, and demolition (DD&D) of surplus facilities, and environmental remediation. The affected environment information presented in the 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,[18] 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.

As summarized in Section S.9.2, 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

[18] 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.

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 S-4** and **S-5**, respectively.

Table S-4 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[j]	5.0[j]	5.0[j]	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 in Chapter 3 of this DU Oxide SEIS). 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 S-5 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[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 in Chapter 3 of this DU Oxide SEIS). 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 S-4 and S-5, 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 2017).

As described in this DU Oxide SEIS, 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.

As shown in Tables S-4 and S-5, the alternatives evaluated in this DU Oxide SEIS would generate LLW in the form of empty and heel cylinders, and CaF_2, and ancillary LLW and MLLW. The quantities of waste generated under the alternatives evaluated in this DU Oxide 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[19] and off-site capabilities 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 S-6**, the cumulative impacts of 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, 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 LLW and MLLW from Portsmouth would be disposed of at off-site facilities, such as Energy*Solutions*, NNS, 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.

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

Table S-6 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 – 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	78,300	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.

[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 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, b). 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 (54,051 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 EnergySolutions, NNSS, and WCS (see Chapter 4, Section 4.5.4, of this DU Oxide SEIS).

		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

[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.

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 transport 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 future 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, and trace gases, which absorb infrared radiation and are referred to as "greenhouse gases" (DOE 2015a).

The greenhouse gases 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 greenhouse gas 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 analyzed Action Alternatives could contribute in a small way to the climate change impacts described above.

S.10 PREFERRED ALTERNATIVE

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

S.11 REFERENCES

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