Department of Energy

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September 18, 2025

Mr. Brian Begley
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

PPPO-02-10034673-25

Ms. April Webb
Interim Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

Dear Mr. Begley and Ms. Webb:

TRANSMITTAL OF THE SCOPING DOCUMENT AND WORK PLAN FOR THE DEACTIVATION AND DECOMMISSIONING REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, DOE/LX/07-2514&D2

References:

1. Letter from A. Webb to A. Ladd, "RE: KDWM Submittal of Comments to the Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation / Feasibility Study (DOE/LX/07-2514&D1), Paducah Site, Paducah, McCracken County, Kentucky KY8-890-008-982," dated July 29, 2025
2. Letter from B. Begley to A. Ladd, "RE: U.S. Environmental Protection Agency Region 4 comments on the D1 Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2514&D1)," dated June 30, 2025
3. Letter from B. Begley to A. Ladd, "RE: U.S. Environmental Protection Agency Region 4 comments on Appendix C of the D1 Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/LX/07-2514&D1)," dated June 9, 2025
4. Letter from A. Webb to A. Ladd, "RE: KDWM Submittal of Comments to the Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation / Feasibility Study (DOE/LX/07-2514&D1), Paducah Site, Paducah, McCracken County, Kentucky, KY8-890-008-982," dated June 4, 2025

Please find enclosed the *Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2514&D2. This version of the document addresses Kentucky Department for Environmental Protection (KDEP) comments received on the D1 version on July 29, 2025, KDEP comments on Appendix C of the document on June 4, 2025, U.S. Environmental Protection Agency (EPA) comments received on the D1 version on June 30, 2025, and EPA comments received on Appendix C of the document on June 9, 2025.

Based on discussions during the August 21, 2025, Federal Facilities Agreement (FFA) managers' meeting, this D2 version of the document addresses technical comments. The resolution of applicable or relevant and appropriate requirement (ARAR)-based comments is being deferred to allow for continued discussions and collaboration among the FFA parties. These additional discussions and collaboration are warranted to support the iterative ARAR process.

Also enclosed are a redline version of the subject document that reflects changes made from the April 30, 2025, submission, a certification page, an KDEP comment response summary, an EPA comment response summary, and a comment response summary that shows other changes.

In accordance with Section XX.G.2 Appendix F of the FFA, KDEP and EPA have a 30-day review and comment period or by October 18, 2025. If the FFA parties have no substantive comments, then the U.S. Department of Energy requests a letter of concurrence.

If you have any questions or require additional information, please contact William Wessel at (270) 441-6869.

Sincerely,

APRIL LADD

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Date: 2025.09.18 09:51:17 -05'00'

April Ladd
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:

1. Certification Page
2. *Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2514&D2—Clean
3. *Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2514&D2—Redline
4. Comment Response Summary—KDEP Comments
5. Comment Response Summary—EPA Comments
6. Comment Response Summary—Other Changes

Administrative Record File—ARF DD

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CERTIFICATION

Document Identification: ***Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2514&D2, dated March 2025**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Four Rivers Nuclear Partnership, LLC

MYRNA REDFIELD (Affiliate)
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Myrna E. Redfield, Program Manager/Date Signed
Four Rivers Nuclear Partnership, LLC

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy

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April Ladd, Paducah Site Lead/Date Signed
Portsmouth/Paducah Project Office
U.S. Department of Energy

DOE/LX/07-2514&D2
Primary Document

Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-2514&D2
Primary Document

Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—September 2025

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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PREFACE

This *Scoping Document and Work Plan for the Deactivation and Decommissioning Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2514&D2, was prepared to provide the plan for conducting the remedial investigation and feasibility study to support a remedial action decision for the abovegrade structures at the U.S. Department of Energy Paducah Gaseous Diffusion Plant (PGDP). This report was prepared in accordance with the decision restructuring described in Appendix G, *Site Management Plan Paducah Gaseous Diffusion Plant Paducah, Kentucky Annual Revision—FY 2025*, DOE/LX/07-2508&D2, as appended to the Federal Facilities Agreement. This remedial action decision is one of three sitewide cleanup decisions underway: the Waste Disposal Alternatives Record of Decision (ROD), Deactivation and Decommissioning ROD, and the Environmental Media ROD, all of which are interrelated to form a complete holistic cleanup approach for PGDP.

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TABLES

FIGURES

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ACRONYMS

ACM	asbestos-containing material
ACO	administrative consent order
ARAR	applicable or relevant and appropriate requirement
BRE	baseline risk evaluation
CAMU	corrective action management unit
CCID	characterization and criticality incredible database
CCIPP	characterization and criticality incredible project plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CIP	cascade improvement program
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
COPC	chemical (or radionuclide) of potential concern
CSM	conceptual site model
CSOU	comprehensive site operable unit
CUP	cascade uprating program
D&D	deactivation and decommissioning
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ES&H	environment, safety, and health
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FR	*Federal Register*
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
HSS&Q	health, safety, support, and quality
IH	industrial hygiene
IS	industrial safety
KAR	*Kentucky Administrative Regulations*
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
N/A	not applicable
NAGPRA	Native American Graves Protection and Repatriation Act
NDA	nondestructive assay
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPL	National Priorities List
OREIS	Oak Ridge Environmental Information System
OSWDF	on-site waste disposal facility
OU	operable unit
P&E	purge and evacuation
PFAS	per- and polyfluoroalkyl substances

PGDP	Paducah Gaseous Diffusion Plant
PGE	process gas equipment
PHC	principal hazardous constituent
PORTS	Portsmouth Gaseous Diffusion Plant
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCW	recirculating cooling water
RDI	regulatory decision integration
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	record of decision
S&M	surveillance and maintenance
SAP	sampling and analysis plan
SCO	surface contaminated object
SI	site investigation
SMP	site management plan
SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
UCL95	95% upper confidence limit
U.S.C.	*United States Code*
VOC	volatile organic compound
WAC	waste acceptance criteria
WDA	waste disposal alternative
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an inactive uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). DOE is conducting environmental remediation activities at PGDP in accordance with the requirements of the Kentucky Department for Environmental Protection (KDEP) and the U.S. Environmental Protection Agency (EPA) under a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Federal Facility Agreement (FFA). Three CERCLA remedial action decision documents are proposed for submittal in 2029 (or earlier); Waste Disposal Alternatives (WDA) Record of Decision (ROD), Deactivation and Decommissioning (D&D) ROD, and Environmental Media ROD, all of which are interrelated to form a complete holistic cleanup approach for PGDP. This scoping document for D&D combines a remedial investigation (RI)/feasibility study (FS) and subsequent decisions for CERCLA response actions for all remaining inactive abovegrade structures, as identified in Appendix A, into a single final decision (including incorporating deactivation under the FFA/CERCLA process, as defined in the ROD).[1]

Characterization of abovegrade structures provides significant information about the types and extent of contamination. Key chemicals (or radionuclides) of potential concern (COPCs) from the on-site processes include technetium-99, uranium isotopes, transuranic radionuclides, other radionuclides, and heavy metals. Also, various semivolatile organic compounds and volatile organic compounds from maintenance activities as well as polychlorinated biphenyls and other organics from ancillary systems are present.

A conceptual site model was developed that identifies potential receptors that could be exposed to these COPCs from releases from the abovegrade structures. Three receptors have been identified for further evaluation; an on-site trespasser, an industrial worker, and an off-site resident. A qualitative human health baseline risk assessment will be documented in the RI/FS using information from the Paducah Site as well as from the other two DOE gaseous diffusion plants (GDPs), which have been demolished [i.e., East Tennessee Technology Park (ETTP) in Oak Ridge] or are currently in the process of being demolished (i.e., Portsmouth Site). A streamlined qualitative ecological risk assessment will identify potential impacts to the environment. There is limited ecological habitat on-site and almost no populations of ecological species that could be impacted by building degradation directly or through contaminant migration; however, potential impacts to populations from contaminants released from the buildings and migrating into off-site habitats will be considered.

Two remedial alternatives will be developed and evaluated in the FS. The first is the required no action alternative where the buildings and structures are left to degrade in place. The second is to remove all inactive abovegrade structures, treat (if necessary), and package waste for final disposition. The cost and analysis of final transportation and placement options for the waste generated will not be included in this decision, but will be included in the evaluation of alternatives in the WDA RI/FS. The development and evaluation of this alternative will assume that the WDA decision selects on-site disposal as an option. Preliminary action-specific and location-specific applicable or relevant and appropriate requirements (ARARs) have been identified for this alternative. ARARs are discussed in Sections 3.2 and 5.3 and are identified in Appendix B.

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[1] In addition to the abovegrade structures listed in Appendix A, facilities constructed to support remedy implementation, at a minimum, also are included in the scope. Any additional facilities included in this scope will be discussed with the FFA managers and addressed in the site management plan.

Historical data from the Paducah Site and comparison to data from the remediated ETTP in Oak Ridge and the Portsmouth Site are sufficient to evaluate the feasibility of remedial options for facilities at the Paducah Site and to provide a basis for the remedial decision that will be documented in the D&D ROD; however, additional data are needed to support the development of the radiological source term that would be generated by a D&D remedial action, to demonstrate compliance with the waste acceptance criteria (WAC) for the disposal facilities (for off-site and/or on-site disposal), and to meet regulatory requirements for packaging, transportation, and disposal. The data will also be useful to support development of analytical WAC for an on-site waste disposal facility if on-site disposal is selected as part of the WDA decision. The differences among the three GDPs have resulted in an identified need for targeted data collection from the high end of the cascade and purge systems to determine the upper-bounds of radionuclide and chemical contamination in the process gas equipment (PGE). Data are also needed on the chemical leachability of WAC-limiting radionuclides and hazardous metals in PGE and components to demonstrate compliance with the WAC.

1. INTRODUCTION

1.1 SCOPE AND OBJECTIVES

The Paducah Gaseous Diffusion Plant (PGDP) was placed on the National Priorities List (NPL) on May 31, 1994. In accordance with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. Department of Energy (DOE) entered into a Federal Facility Agreement (FFA) with the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) on February 13, 1998. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with the Resource Conservation and Recovery Act (RCRA) and CERCLA, including stakeholder involvement. The annual update of the Site Management Plan (SMP) [fiscal year (FY) 2025 SMP] sets forth enforceable milestones for FY 2025, FY 2026, and FY 2027, consistent with the memorandums of agreement signed in August 2017 and August 2019 and the FY 2018/FY 2019 SMP. A new overall cleanup strategy for the site was discussed among the FFA parties in late FY 2023 and documented in Appendix G, *Site Management Plan Paducah Gaseous Diffusion Plant Paducah, Kentucky Annual Revision—FY 2025*, DOE/LX/07-2508&D2 (DOE 2024a), as appended to the FFA. At that time, DOE proposed to integrate and accelerate Paducah Site cleanup decisions for environmental media, deactivation and decommissioning (D&D), and waste disposal alternatives (WDAs). The scope of the sitewide D&D Record of Decision (ROD) will include D&D of the abovegrade portion of structures at the Paducah Site. Decommissioning includes activities that take place after a facility has been deactivated and can include decontamination and dismantlement. Dismantlement involves the disassembly, or demolition and removal, of any structure or system. The sitewide D&D ROD will propose and combine all abovegrade structures into a single final decision (incorporating deactivation following the FFA/CERCLA process, as defined in the ROD). DOE is proceeding with deactivation work of the remaining facilities not operating to support DOE site activities during development of the RI/FS and until the D&D ROD is issued. Deactivation is the process of placing a facility in a safe and stable condition that is protective of workers, the public, and the environment until decommissioning is completed. Deactivation to date consists of de-energizing, draining fluids (e.g., oils, refrigerants), interior asbestos removal, and removal of radioactive/hazardous materials (e.g., universal waste). The consolidation of decisions into a sitewide focus is consistent with the approach that is successfully being used at DOE's Portsmouth Site.

The FFA at the Paducah Site requires the development of a scoping document and a remedial investigation (RI)/feasibility study (FS) work plan prior to implementing a RI/FS. The purpose of the scoping document is to obtain early input and minimize comments on the RI/FS work plan; however, the FFA also states that a scoping document may serve as a portion of the RI/FS work plan. To eliminate duplication of efforts, the RI/FS scoping document and RI/FS work plan will be combined.

The effort underway at PGDP is one of three environmental cleanup projects at gaseous diffusion plants (GDPs) with the Oak Ridge GDP D&D project being completed and the Portsmouth GDP D&D project underway. To plan for the Paducah Site D&D RI/FS, data collected from both sites along with data and information already existing at the Paducah Site are used to develop a combined D&D RI/FS scoping document and work plan because the facilities are similar in materials of construction, were built in the same time period, and had the same operations.

1.1.1 Scope and Role of the Deactivation and Decommissioning Decision

The scope of the D&D RI/FS is to address final remedial actions for the D&D OU facilities, the abovegrade components of the C-400 OU, and other abovegrade structures for which there is no future use. The list of abovegrade structures is identified in Appendix A.[2] This list includes facilities present at PGDP, which includes administrative, nonindustrial, and support facilities that have no potential for release of hazardous substances, and balance of plant facilities, which will have undergone CERCLA determinations regarding a release or potential threat of release. Facilities constructed to support remedy implementation also are included in the scope. The D&D remedial action will address the sources of hazardous substances within the defined scope of the D&D decision. The solid waste management units (SWMUs) that are abovegrade and/or contained within abovegrade structures are considered part of the abovegrade structure and will be addressed in advance of demolition or with demolition of the structure as appropriate under the D&D decision. The SWMUs that are at- or below grade will be addressed as appropriate under the Environmental Media decision. Any remedial action alternatives will include efforts through packaging waste for final disposition.

The goals of the D&D RI/FS are as follows:

- Goal 1: Define the contaminants of concern (COCs) in the abovegrade structures and develop a sufficient database of information maximizing the use of existing data from the Paducah Site and from the other GDPs to support the comparison of potential waste characteristics to the waste acceptance criteria (WAC) developed as part of the WDA decision. In addition, COC data will provide additional process knowledge to support future waste characterization efforts during implementation of the remedial action.

- Goal 2: Support justification for a remedial decision through a qualitative assessment of the risk of leaving the abovegrade structures standing with no further action [including no surveillance and maintenance (S&M)].

- Goal 3: Use historical and newly-collected data to develop and evaluate alternatives that will reduce risk to human health and the environment from these abovegrade structures.

The assessment of the sufficiency of existing data to support the RI/FS and the identification of any new data requirements have used EPA's data quality objective (DQO) process. It should be noted that a RI has been completed and approved for the C-400 Complex OU that is included in the scope of this decision. Results of the C-400 RI specific to the building and the other abovegrade structures will be incorporated into the D&D RI/FS.

1.1.2 Relationship to Other Decision 2029 Documents

To ensure a streamlined approach and more efficient strategy for the Paducah Site cleanup, the remaining site remedy decisions are being consolidated into four comprehensive decisions, with the conceptual contents of each described in this section.

- The Environmental Media RI/FS, proposed plan, and ROD documents will address the soil, slabs, subsurface structure and utilities, burial grounds, lagoons, surface water, and confirmed/probable dense nonaqueous-phase liquid (DNAPL) beneath the C-400 Complex.

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[2] In addition to the abovegrade structures listed in Appendix A, facilities constructed to support remedy implementation, at a minimum, also are included in the scope.

- The D&D RI/FS, proposed plan, and ROD will combine all abovegrade structures into a single final decision (incorporating some aspects of deactivation under the FFA/CERCLA process, as defined in the ROD).

- The WDA RI/FS addendum, proposed plan, and ROD will make a transportation and disposition decision for waste generated by the D&D and Environmental Media decisions.

- A final comprehensive site operable unit (CSOU) will consider appropriate actions for remaining work at the Paducah Site as defined by the SMP.

The relationships and documents associated with the first three decisions are illustrated in Figure 1. This scoping document is indicated with the "You Are Here" text. Any completed documents are shown with a check mark next to them.

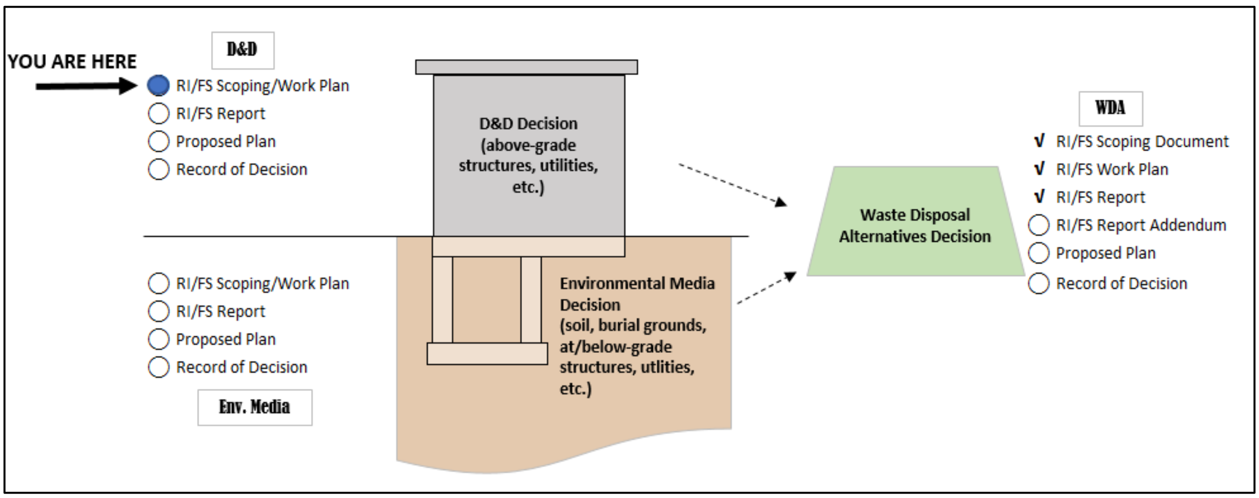

Figure 1. Decision Relationships

The WDA ROD is planned to be finalized first to establish a disposal path for waste generated by the D&D decision and Environmental Media decision. The D&D ROD is planned to be finalized next with the understanding of the disposal pathway. The Environmental Media ROD is planned to be finalized third.

Integration of the WDA, D&D, and Environmental Media RI/FS alternatives and remedy decisions is important to the efficient and holistic remediation of the Paducah Site. The scope of each RI/FS also needs to be discrete and clearly defined for alternative development, applicable or relevant and appropriate requirements (ARARs) identification, and evaluation of alternatives against the CERCLA criteria. Clear scope delineation provides a more accurate evaluation of alternatives in each RI/FS, avoiding the potential for duplicated costs to skew the decision-making process. Conceptual distinction between the scope of the WDA, D&D, and Environmental Media RI/FS alternatives follows.

- Cost and analysis of transportation and disposal for the waste generated by D&D and Environmental Media alternatives will be included in the WDA RI/FS.

- Construction and operation of a single system to treat contaminated liquids generated sitewide (e.g., storm water, dust suppression water, leachate, groundwater) is conceptually the most cost beneficial, implementable approach for Paducah Site remediation. To avoid duplication of costs, including wastewater treatment and disposition in the WDA RI/FS scope is the most logical. Wastewater is a waste stream and the WDA ROD is planned to be finalized first. If this approach is used, alternatives developed for D&D and Environmental Media would only include costs to contain, collect, and transfer potentially contaminated liquids to the site system.

- Deactivation prior to demolition will include abovegrade and below grade portions of facilities, which includes basements. In particular, the aforementioned deactivation will include the removal of regulated asbestos, oil, and segregable hazardous waste. Alternatives will assume that deactivation is completed prior to abovegrade demolition. Environmental Media alternatives will not include deactivation.

- The Environmental Media excavation alternatives will be developed as a continuous evolution of work following the completion of the abovegrade demolition alternative under the D&D decision. Alternatives developed for the D&D and Environmental Media RI/FSs will assume that at- and below grade remediation closely follows abovegrade remediation and that below grade structures will not be grouted. The excavation alternative will include management of any accumulated water after demolition, such that prolonged ponding or accumulation of water within below grade structures is minimized.

- Environmental Media excavation alternatives will assume that berms constructed to contain precipitation and dust suppression water during abovegrade demolition will remain for use during the at/below grade remediation. Costs for construction of these berms will not be duplicated in the Environmental Media alternatives.

Prior to the streamlining of the decisions, source units and areas of contamination at the Paducah Site have been combined into operable units (OUs) for evaluation of remedial alternatives. These OUs include the C-400 Complex OU, the Groundwater OU, Surface Water OU, the Lagoons OU, the Burial Grounds OU, the Soils OU, the Soils and Slabs OU, the Facility D&D OU, the Depleted Uranium Hexafluoride (DUF_6) Footprint Underlying Soils OU, the CERCLA Waste Disposal Alternatives OU, and the Comprehensive Site OU. Each OU is designed to remediate contaminated media associated with PGDP (DOE 2020). Table 1 provides a crosswalk of these OUs, and OU subprojects identified in the SMP, to each newly-proposed regulatory decision.

Table 1. OU Decision Crosswalk

Regulatory Decision ROD	Current OU
WDA	Waste Disposal Alternatives
D&D	Facility decommissioning (abovegrade structures only)
	C-400 Complex (abovegrade structures only)
	Remaining non-CERCLA decommissioning activities (not currently in an OU)
Environmental Media	Soils (SWMUs) — Soils remedial
	Soils and Slabs
	Facility decommissioning (at and below grade features)
	C-400 Complex (at and below grade features and confirmed/probable DNAPL in groundwater)
	Burial Grounds — SWMUs 2, 3, 4, 5, 6, 7, 30 — SWMUs 9, 10, 145 — Additional burial grounds (SWMUs 472, 520)

Table 1. OU Decision Crosswalk (Continued)

Regulatory Decision ROD	Current OU
Environmental Media (continued)	Groundwater — Southwest Plume sources [above the Regional Gravel Aquifer (RGA)] Potential additional groundwater sources (above the RGA)
	Surface Water
	Lagoons — Process lagoons — Water treatment system lagoon
CSOU	DUF_6 Footprint Underlying Soil (and other site components required for DUF_6 operations)
	Groundwater — Northeast Plume (interim ROD transition to final remedy) — Northwest Plume (interim ROD transition to final remedy) — Dissolved-Phase Plumes — Water Policy (removal action transition to final remedy)
	Comprehensive risk review of remaining site conditions

1.2 REGULATORY SETTING

The sections that follow provide a condensed version of the regulatory framework for the Paducah Site. The summary in this section is intended to provide readers with general knowledge of the facility and the regulatory protocol that guides environmental management activities at the Paducah Site. Additional information can be found in the *Site Management Plan Paducah Gaseous Diffusion Plant Paducah, Kentucky Annual Revision—FY 2025,* DOE/LX/07-2508&D2.

1.2.1 Administrative Order by Consent

EPA and DOE entered into the Administrative Consent Order (ACO) effective November 1988, after the discovery of contamination in residential wells north of PGDP. Kentucky provided regulatory review of the CERCLA ACO documents, but was not a signatory on the agreement. The ACO is a legally-binding agreement for the participating parties that initiated the investigation into the nature and extent of the contamination impacting these wells. The contaminants are believed to have originated as process-derived wastes or commonly-used materials employed during the operational history of PGDP.

The ACO initiated the investigative activities that were designed to determine the extent and sources of off-site contamination surrounding PGDP. The site investigation (SI) (Phase I and Phase II) was completed in 1992 under the guidelines of the ACO (CH2M HILL 1992). The requirements of the ACO were superseded by the execution of the FFA (EPA 1998).

1.2.2 Environmental Programs

Environmental sampling at the Paducah Site is a multimedia (air, water, soil, sediment, direct radiation, and biota) program of chemical, radiological, ecological, and environmental monitoring that consists of two activities: effluent monitoring and environmental surveillance. As part of the ongoing environmental activities, SWMUs have been identified. SWMUs that are abovegrade and/or contained within abovegrade structures are considered part of the abovegrade structure. Remediation of these SWMUs is continuing pursuant to CERCLA, and the corrective action conditions of the RCRA permit. RCRA and CERCLA requirements are coordinated by DOE, EPA, and KDEP through the FFA.

1.2.3 Resource Conservation and Recovery Act

The primary purpose of RCRA is to protect human health and the environment through the proper management of hazardous wastes at operating sites. RCRA requirements for the Paducah Site are contained in Paducah's Hazardous Waste Management Facility Permit (KY8-890-008-982, initially issued July 1991). This permit originally was issued by both Kentucky and EPA. Kentucky was authorized in 1996 for corrective action provisions. The RCRA permit contains the regulatory provisions for treatment, storage, and disposal units, as well as for provisions requiring corrective action for SWMUs.

1.2.4 Comprehensive Environmental Response, Compensation, and Liability Act/National Priorities List

PGDP was placed on the NPL on May 31, 1994. In accordance with Section 120 of CERCLA, DOE entered into an FFA with EPA and KDEP in 1998. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with RCRA and CERCLA, which includes stakeholder involvement through the annual update of the SMP (DOE 2024a). The SMP is appended to the FFA, as Appendix G, annually after approval. Section III, Purposes of Agreement, of the FFA identifies the general and specific purposes of the FFA.

1.2.5 National Environmental Policy Act

The intent of the National Environmental Policy Act (NEPA) is to promote a decision-making process that results in the minimization of adverse impacts to human health and the environment. On June 13, 1994, the United States Secretary of Energy issued a Secretarial Policy (Policy) on NEPA that addresses the NEPA requirements for actions taken under CERCLA (DOE 1994). Section II.E of the Policy indicates that to facilitate meeting the environmental objectives of CERCLA and respond to concerns of regulators consistent with the procedures of most other federal agencies, DOE will rely on the CERCLA process for the review of actions to be taken under CERCLA, and the CERCLA documentation will address NEPA values. DOE CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable (DOE 2020).

1.2.6 Investigative Overview

Areas included in the Paducah Site have undergone previous environmental investigations and remedial actions. The strategy for this scoping document/work plan is to conduct a combined RI/FS for the Paducah Site that includes an investigation of all remaining abovegrade structures. Data are used to assess risk and to develop and evaluate alternatives, as well as to develop a sufficient database to support the comparison of potential waste characteristics to the WAC developed as part of the WDA decision.

1.2.7 Integration with Existing Remedies and Open Commitments

The current Facility D&D OU includes decommissioning activities as defined in the joint policy issued under a DOE and EPA memorandum dated May 22, 1995, *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act CERCLA* (DOE 1995a).

Prior to shutdown of the GDP, a subproject of this OU consisted of 17 inactive facilities (15 small inactive facilities, C-340 Complex and C-410/C-420 Complex). The completion of the C-410/C-420 Complex removal action in FY 2016 marks the completion of the D&D OU Pre-GDP shutdown scope ("Paducah Federal Facility Agreement – Decontamination and Decommissioning Operable Unit Completion Notification Letter," PPPO-02-3334049-16, dated April 11, 2016).

The scope to be addressed by the D&D RI/FS, proposed plan, and ROD is defined to include inactive abovegrade structures and sitewide deactivation work not previously included in the D&D OU and remaining at the site at the time of the ROD. Consistent with stated purposes of the FFA to expedite the remediation process to protect human health and the environment (FFA Section III.B.11) and reduce costs of clean-up through the use of consultative approaches and elimination of unnecessary procedures (FFA Section III.B.14), the FFA parties have agreed that DOE will continue to deactivate facilities under DOE procedures during development of the RI/FS and until the D&D ROD is issued. The FFA parties recognize that continued deactivation efforts (e.g., draining fluids) are both protective and will accelerate the remediation of the site after the ROD is signed.

DOE will continue generating and shipping hazardous waste, used oil, bulk liquids, and universal waste generated during deactivation off-site, in compliance with applicable statutory and regulatory requirements, until the WDA ROD is finalized. Above ground materials and waste, whether already removed from a building, sitting on a slab, or still remaining in a building, will be characterized in the D&D remedial investigation, included in a range of remedial actions in the Feasibility Study, and part of the final CERCLA ROD. The WDA RI/FS Addendum (D2/R1/A1) under development will address the disposition of all materials evaluated under the scope of the D&D RI/FS.

1.3 PROJECT ORGANIZATION AND MANAGEMENT PLAN

This section presents the project organization for this D&D RI/FS. The topics addressed in this chapter include project organization, project coordination, project tasks and implementation plan, and project schedule.

1.3.1 Organization

The organization chart shown in Figure 2 outlines the management structure that will be used for implementing the D&D RI/FS. The responsibilities of key personnel are described in the following paragraphs.

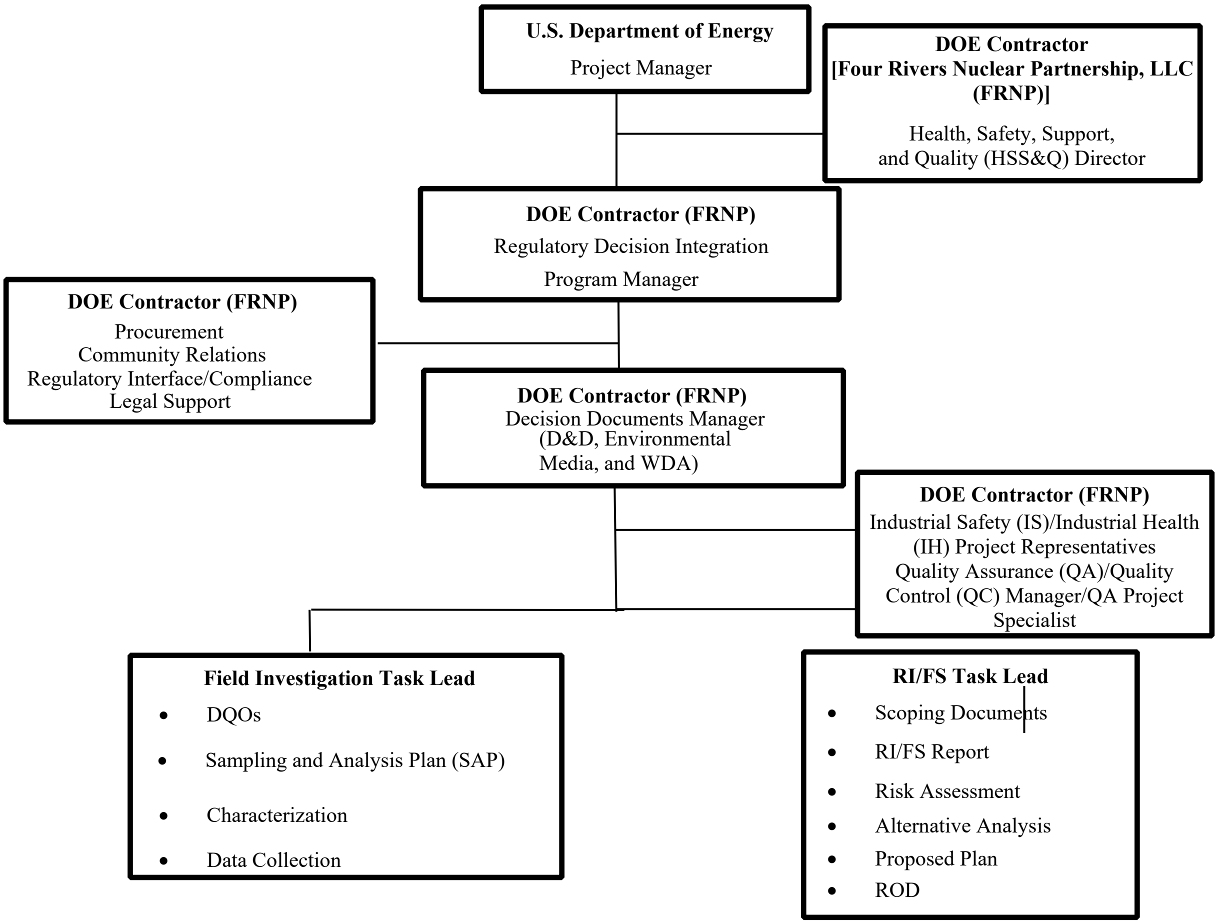

Figure 2. Organization Chart

1.3.1.1 DOE Project Manager

The DOE Project Manager has direct communication with the DOE Contractor Program Manager and is responsible for project oversight, overall compliance for the project, and for submitting various reports to, and interfacing with, EPA and KDEP.

1.3.1.2 Regulatory Decision Integration Program Manager

The individual in this position will have overall responsibility for technical, financial, and scheduling matters related to the project and will ensure that appropriate resources are available to facilitate execution of the RI/FS in a timely and efficient manner. The Regulatory Decision Integration (RDI) Program Manager will monitor performance throughout the project. This individual is also responsible for the communication of any changes to the DOE Project Manager.

1.3.1.3 Decision Documents Manager

The Decision Documents Manager will have the overall responsibility for implementation of the RI/FS for the D&D project. This individual will be responsible for implementing the investigation as well as all plans and activities conducted as part of the RI/FS, which includes monitoring the work plan implementation. The Decision Documents Manager will coordinate with other FRNP functions (e.g., procurement, regulatory compliance, community relations, legal) in implementation of the project. This manager will also coordinate with the Decision Documents Managers for the two other decisions to ensure close coordination between the decision processes.

1.3.1.4 Health, Safety, Support, & Quality Director

The DOE Contractor HSS&Q Director will have overall HSS&Q program responsibility for the Contractor. The HSS&Q Director will provide support and/or resources to the RDI Program Manager and/or the field team, as necessary. This individual will interface with DOE and the regulators, as appropriate.

1.3.1.5 QA/QC Manager/QA Project Specialist

The QA/QC Manager is responsible for developing, coordinating, maintaining, and approving applicable quality performance documents. This individual will establish, in coordination with the responsible implementing organizations, controls to ensure that conditions not in compliance with quality requirements are identified, controlled, and promptly corrected. The QA/QC Manager will approve the quality assurance project plan (QAPP). Additional details on the QA/QC Manager responsibilities can be found in the QAPP (Attachment C1).

The QA Project Specialist will support the project and provide oversight to ensure compliance with the quality assurance program description and associated QA/QC requirements for the D&D RI/FS work plan. In addition, the QA Project Specialist will coordinate implementation of the QAPP, monitor compliance with quality requirements, and ensure the institution of any corrective actions necessary to maintain a high level of quality. This individual will provide the specific support necessary to resolve any quality issues that arise during the project. This individual may conduct audits and surveillances and approve any field changes that may impact project quality.

1.3.1.6 IS/IH Project Representatives

The IS/IH project representative from the Safety and Health group is responsible for establishing standards and providing oversight to safety and health compliance, training, and performance. This individual will advise personnel of potential exposures and consequences, conduct inspections as necessary, assist in hazard analysis, perform IH sampling, provide IH monitoring, and will notify the plant shift superintendent, frontline manager, and site personnel of any event or condition that adversely or may adversely affect DOE, the DOE Prime Contractor, DOE Prime Contractor’s subcontractor, the public, or government property; as required in the Worker Safety and Health Program, and DOE Prime Contractor’s procedures.

1.3.1.7 Field Investigation Task Lead

The DOE Contractor Field Investigation Task Lead is responsible for the implementation of field activities to collect data and facility information in support of the RI/FS. This individual will interface with the D&D Decision Documents Manager to align project budget and resources for the field characterization effort. The Field Investigation Task Lead acts as the primary contact for coordination of subcontractor field efforts and coordinates scheduling of support services from other groups such as IS/IH personnel, Waste Management personnel, Radiological Control personnel, Protective Services, Fire Services, and the Infrastructure Management Contractor. This individual reports to the D&D Decision Documents Manager. This individual will interface with the RDI Program Manager, DOE, and the regulators, as appropriate.

1.3.1.8 RI/FS Task Lead

The RI/FS Task Lead will oversee and coordinate day-to-day activities associated with his/her assigned tasks to maintain the RI/FS on schedule. This individual will interact with the Decision Documents Manager on a daily basis and will relay directions to RI/FS team members as necessary. The RI/FS Task Lead will coordinate activities and exchange information necessary to ensure that his/her assigned RI/FS tasks are completed.

1.3.2 Project Tasks and Implementation Plan

The key project tasks to completing the RI/FS are presented as steps below.

(1) Initial scoping of the RI/FS project internally and with EPA and KDEP. During this process, existing information was evaluated to develop a common understanding of operational history and existing nature and extent of contamination. In turn, the existing knowledge and project DQOs were used to design a sampling strategy to address defined data needs.

(2) Preparation of the sampling plan that was developed from scoping meeting discussions and information and/or evaluations of existing data.

(3) Implementation of the sampling plan with collecting samples from PGE identified in the D&D sampling and analysis plan (SAP), following FFA approval of the SAP.[3]

(4) Implementation of fieldwork, which includes sampling, sample handling, investigation-derived waste management, and documentation. In addition, HSS&Q coordination will occur concurrently with the activities.

(5) Field and laboratory data obtained, reduced, verified, and assessed as required. Data validation will be coordinated by the Sample Management Office and will be initiated once the first sample delivery group of data has been received and checked for completeness and contract screening. Each of these steps will be handled separately and will follow prescribed procedures to ensure that defensible data are obtained. The data will be formatted for incorporation into the Paducah Oak Ridge Environmental Information System (OREIS) and archived for future use where feasible.

(6) Technical exchange meetings will be conducted among personnel from EPA, KDEP, DOE, and the DOE Prime Contractor to evaluate the existing and newly-collected data and to determine future actions.

(7) The D&D RI/FS report will be prepared and issued after samples and data have been processed and evaluated.

(8) Routine tasks will also be performed throughout the RI/FS and include the coordination of community relations during the project, DOE and regulatory interactions, and implementation of the QA program. Project management, tracking, and reporting will be conducted concurrently with all activities.

(9) Stakeholder-related activities will be conducted in accordance with the *Community Relations Plan under the Federal Facility Agreement at the U.S. Department of Energy Paducah Gaseous Diffusion Plant*, and any subsequent updates of the plan (DOE 2024b).

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[3] A record of conversation was signed by FFA managers to document the agreement that comments received on the SAP (Appendix C of this document) were resolved and fieldwork associated with Appendix C could commence in advance of the transmittal of the D2 version of the document for subsequent review and approval by the FFA parties.

1.3.3 Project Schedule

Table 2 provides a schedule of the activities proposed for the D&D RI/FS scoping document and work plan implementation, RI/FS report, the proposed plan, and the ROD. This schedule is an estimate for planning and the schedule is included here for informational purposes only and it is not intended to establish enforceable schedules or milestones. The project schedule is consistent with the enforceable milestones contained in Appendix 5 of the Paducah SMP (DOE 2024a).

Table 2. Project Schedule

Activities	Planning Schedule (Fiscal Year)
RI/FS Field Start	7/14/2025
D1 RI/FS Report	7/6/2026*
D1 Proposed Plan	9/25/2027*
D1 ROD	2nd Quarter 2029*

*Currently listed as enforceable milestones in the FY 2025 SMP (DOE 2024a).

1.4 ENVIRONMENTAL SETTING AND SITE CHARACTERIZATION

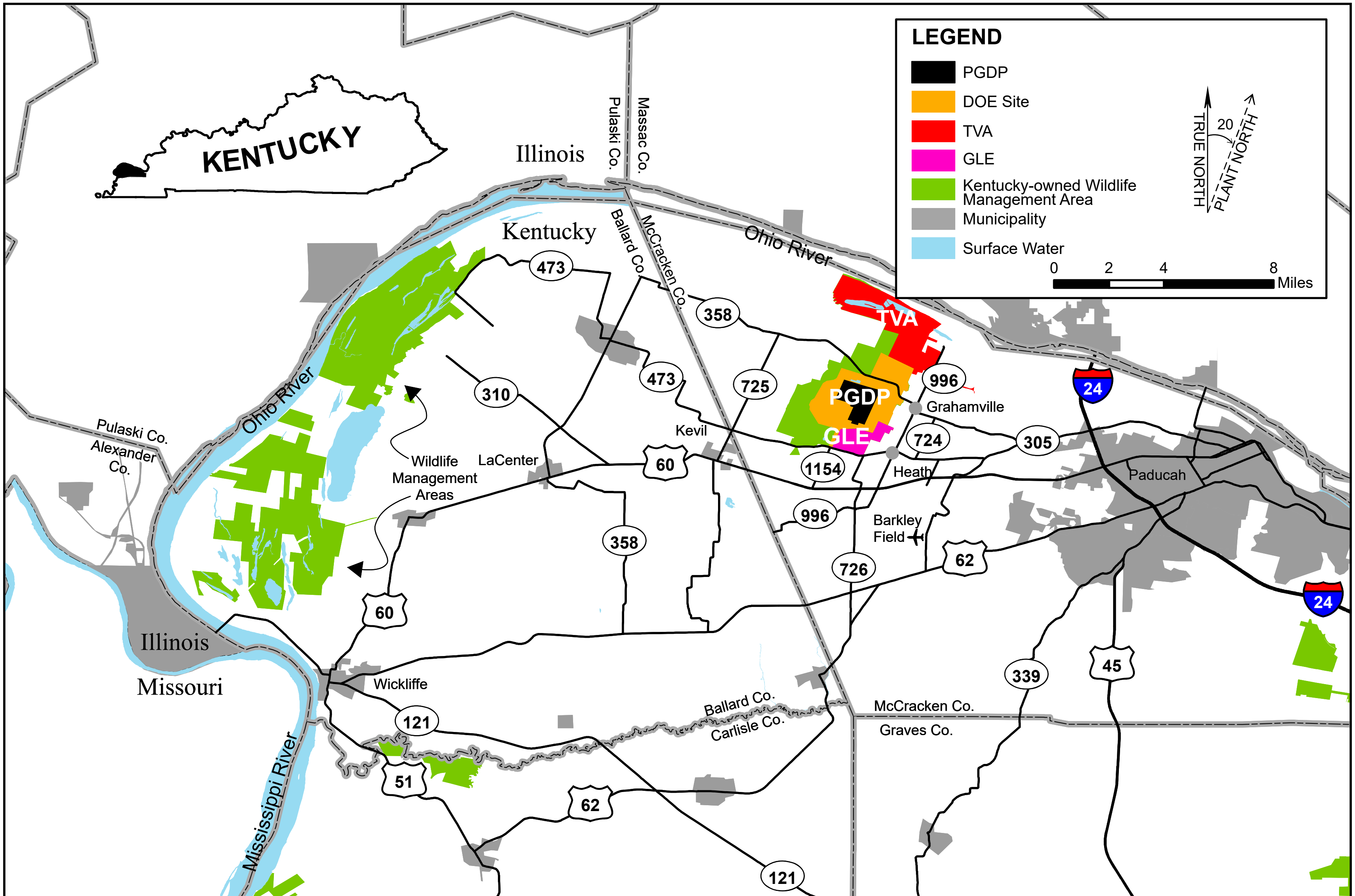
The Paducah Site consists of an inactive diffusion cascade system and associated support facilities. The enrichment process required extensive support facilities, and included a steam plant, four major electrical switchyards, four sets of cooling towers, a building for chemical cleaning and decontamination, a water treatment plant, and maintenance and laboratory facilities.

1.4.1 Location

The Paducah Site, consisting of approximately 3,556 acres, is located in western McCracken County, 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River (Figure 3). Approximately 2,129 acres are utilized for site operations and approximately 1,427 acres are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA).

Bordering the Paducah Site to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which the Shawnee Fossil Plant is located.

The topographic features at the Paducah Site include nearly level to gently-sloping dissected plains and the flood plain of the Ohio River. The elevations of the stream valleys in the dissected plains are up to 30 ft lower than the adjoining uplands. Local elevations range from 290 ft above mean sea level (amsl) along the Ohio River to 450 ft amsl southwest of the Paducah Site. Generally, the topography in the Paducah Site area slopes toward the Ohio River at an approximate gradient of 27 ft per mile (CH2M HILL 1992). Ground surface elevations vary from 360 ft amsl to 390 ft amsl within the 229 boundary area, hereinafter referred to as the fenced security area, and 340 amsl to 420 amsl within the greater Paducah Site.



MAP SOURCE INFORMATION
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Municipality Layer-- G:\GIS\iPEGASIS.gdb\tl_2021_21_place, …\tl_2021_17_place

Figure 3. Paducah Site Vicinity Map

1.4.2 Demography and Land Use

The Paducah Site is surrounded by WKWMA, Global Laser Enrichment, LLC, and sparsely-populated agricultural lands. The closest communities to the plant are Heath, Grahamville, and Kevil, all of which are located within 3 miles of the Paducah Site boundaries. Metropolis, Illinois, is located 5 miles to the northeast, Paducah, Kentucky, is located approximately 10 miles to the east, and Cape Girardeau, Missouri, is located approximately 40 miles to the northwest.

Historically, the economy of Western Kentucky has been based on agriculture, although there has been increased industrial development in recent years. The Paducah Site employs approximately 1,332 people, while the TVA Shawnee Fossil Plant employs an additional 224 people. Based on population data from the 2020 census, the total population within the counties that lie within a 50-mile radius of the Paducah Site is approximately 523,833; and approximately 48,061 people live within the three counties that contain the 10-mile radius of the plant (Massac County, Illinois, and Ballard and McCracken Counties, Kentucky). The estimated population of Paducah, Kentucky, is approximately 27,137. The population of McCracken County is estimated to be approximately 67,875 (DOC 2020).

In addition to the residential population surrounding the plant, WKWMA draws thousands of visitors each year for recreational purposes. WKWMA is used by visitors, primarily for hunting and fishing, but other activities include horseback riding, dog trials, hiking, and bird watching.

1.4.3 Site History and Contaminants

PGDP is an inactive uranium enrichment facility owned by DOE. The Paducah Site was established to support the nation's nuclear program. During World War II, the Kentucky Ordnance Works, a trinitrotoluene production facility, was operated from 1942 to 1945 in an area southwest of the plant on what is now a wildlife management area. Construction of PGDP began in 1951 and operations initiated in 1952, as one of three uranium enrichment facilities originally constructed in the United States. The two other gaseous diffusion facilities were located in Oak Ridge, Tennessee, and Portsmouth, Ohio. The Paducah Site was constructed by the Atomic Energy Commission in the early 1950s for the purpose of enriching uranium. PGDP was fully operational by 1955, supplying enriched uranium for commercial reactors and defense uses (FRNP 2024a). From 1953 until 1977, most of the uranium hexafluoride (UF_6) used by PGDP was produced from feedstock in the feed plant (C-410 Feed Plant Building), which was designed to process both natural uranium and uranium from reactor tails. The reactor tails included uranium that had been returned for re-enrichment from the plutonium production reactors at the DOE Hanford and Savannah River plants. As a result of nuclear reactions in the plutonium production reactors, the reactor tails contained Tc-99, and are believed to be the sole source of Tc-99 released to the environment at PGDP. Beginning in 1977, PGDP was supplied with UF_6 feedstock from commercial vendors, such as Honeywell in Metropolis, Illinois, and from foreign sources.

The process buildings, which housed the uranium enrichment cascade, are shown in Figure 4. Historical activities at the Paducah Site have generated various nonhazardous, hazardous, and radioactive wastes that have been managed, stored, and/or disposed of by different methods. These activities have, in some cases, resulted in the release of contaminants to the environment. The primary COCs at the Paducah Site are Tc-99, TCE, polychlorinated biphenyls (PCBs), and uranium.

In August 1988, TCE, an organic solvent, and Tc-99, a beta-emitting radionuclide, were detected in four private wells north of the Paducah Site. DOE placed the potentially-affected residences and businesses on alternate water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. Since that time, several investigations and response actions have taken place.

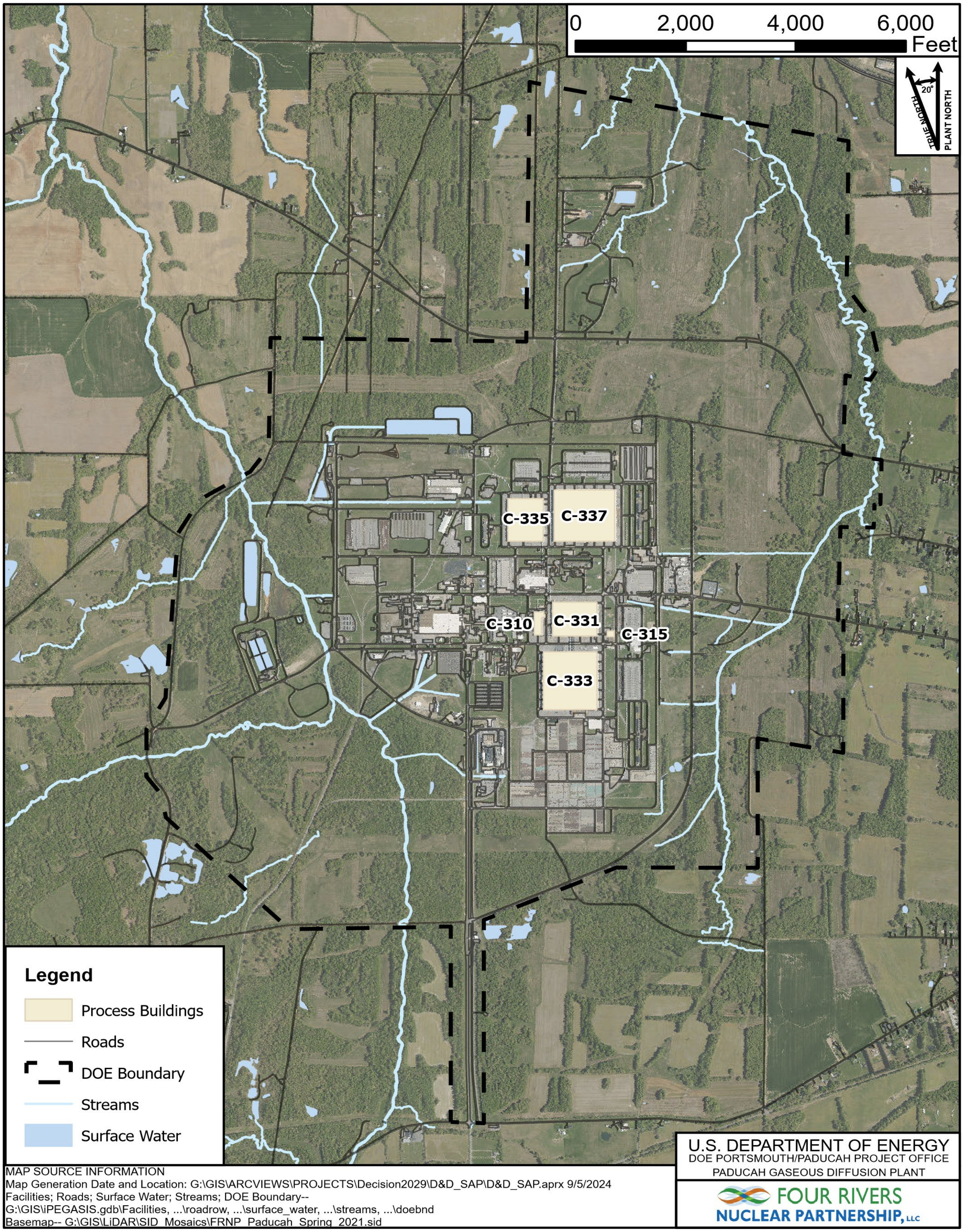

Figure 4. Paducah Process Buildings

Tc-99 is a man-made radionuclide created as a by-product of the fission of uranium. Initially, Tc-99 was introduced to PGDP in 1953 as a contaminant in feed material during a program in which spent nuclear reactor fuel was fed into the gaseous diffusion processes.

TCE had been used as a cleaning solvent at the uranium enrichment plant since its construction. In the C-400 Cleaning Building, process piping and equipment from the cascade system were cleaned with TCE. In 1986, TCE was found to have been discharged inadvertently (apparently for many years) from a sump pump in the degreaser area of C-400 to a storm sewer and was found to have leaked into the soil. Other potential sources of TCE releases at the Paducah Site are the TCE degreaser at the C-720 Maintenance and Storage Building and switchyard transformers that were washed with TCE. Reportedly, TCE also was used in the Kellogg Building during PGDP construction. Waste TCE was disposed of in on-site landfills and in a historical landfarming operation. In the Paducah Site cylinder drop tests, TCE was placed into a pit and used as a refrigerant in tests to determine cylinder integrity. The Paducah Site ceased use of TCE in 1993. Spilled TCE product is a RCRA Listed waste (U228) and spent solvents with TCE are considered RCRA F Listed waste.

PCBs have been found in sediment and fish downstream of the Paducah Site. PCBs have been used extensively as an insulating, nonflammable, and thermally-conductive fluid in electrical capacitors and transformers at the Paducah Site. The large switchyards that service the process buildings included PCB-filled transformers. PCBs also have been used as flame retardants (on the gaskets of diffusion cascades in other sections of the plant), as a hydraulic fluid, and are used in paints on equipment that is subject to high temperatures. PCBs have been released to the environment from spill sites throughout the industrial complex that resulted from specific transformer ruptures and as part of general operations over the years. CERCLA waste containing/contaminated with PCBs will be categorized and managed in accordance with TSCA ARARs finalized in the ROD.

Uranium, thorium, and transuranic elements (i.e., plutonium and neptunium) were detected in off-site sediments near the Paducah Site in 1988 (MMES 1989). Results ranged from approximately 2.5 to over 200 times background. Many of these sediments have been removed, which is discussed in Section 16 of the *Removal Action Report for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0357&D2 (DOE 2011). Sources of uranium releases are general plant operations.

The Energy Policy Act of 1992 provided for the lease of the enrichment facilities to a commercial entity that operated the enrichment facilities from 1998 to 2013. In May 2013, the United States Enrichment Corporation announced plans to terminate enrichment operations at PGDP. In 2014, the leased facilities were returned to DOE control, and then a DOE Contractor began managing the uranium enrichment facilities for DOE.

On April 15, 1999, DOE issued the final *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE 1999). In 2002, DOE began to design, build, and operate facilities at Paducah, Kentucky, and Portsmouth, Ohio. The facilities would convert the inventory of DUF_6 to triuranium octoxide (U_3O_8), a more stable form of uranium that is suitable for disposal or reuse, and hydrofluoric acid that will be sold for commercial use. Construction on the DUF_6 plant began in July 2004 and continued through 2008. Physical construction of the facility was completed on December 19, 2008. Following systems testing and thorough readiness reviews, operational readiness was conducted in 2010. Full operational status was announced in September 2011 (DOE 2012).

1.4.4 Description of Gaseous Diffusion Operations

The Paducah Site consists of four main process buildings, C-331, C-333, C-335, and C-337, and various support and auxiliary facilities. These facilities are approximately 70 years old and are deteriorating. In all, PGDP contains more than 100 permanent structures and many more temporary structures, with a total floor space of about 8 million ft^2. There also are cooling towers, electrical switchyards, and several support operations structures, which include sewage and liquid effluent treatment plants, and air plants, as well as facilities for previous decontamination and recovery operations, and coal and ash handling facilities. PGDP also maintains a fully-equipped fire department and emergency medical services.

The gaseous diffusion uranium enrichment process separated lighter uranium-235 (U-235) from heavier uranium-238 (U-238). UF_6 gas was forced through a series of porous membranes, or "barriers," with microscopic openings (Figure 5). U-235 moved through the barriers more easily, increasing in activity-based concentration as it moved through the process. About half of the gas diffused through the barrier and was fed to the next higher stage, while the remaining undiffused portion was recycled to the next lower stage. The diffused stream was slightly enriched with respect to U-235, and the stream not diffused was slightly depleted (KRCEE 2021).

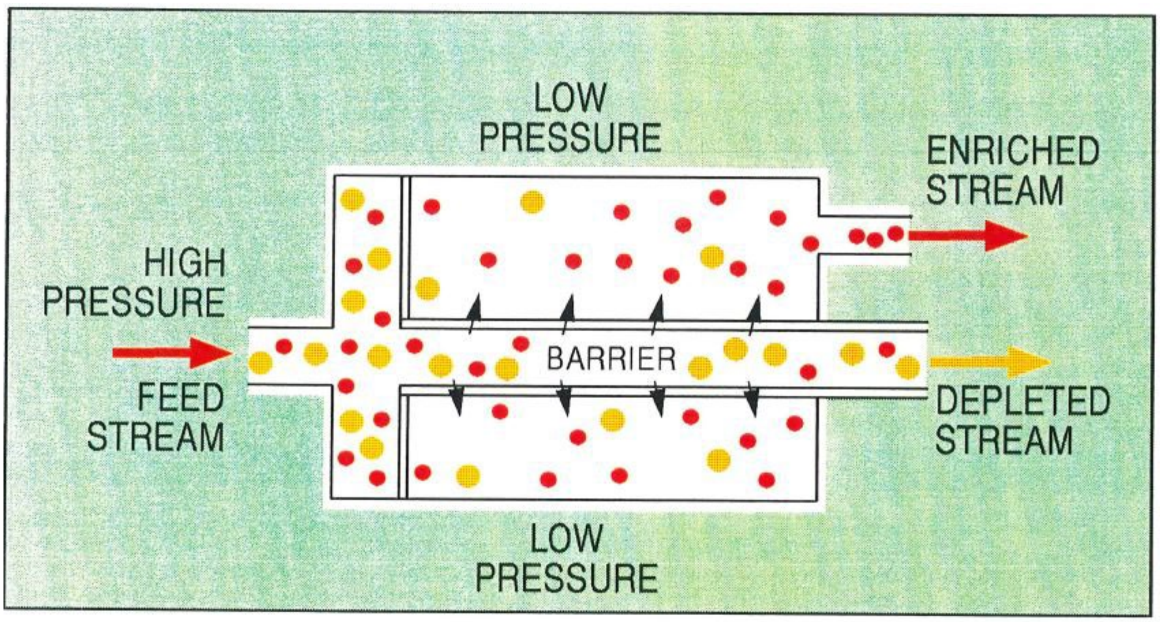

Figure 5. The Gaseous Diffusion Process

The basic separation equipment for gaseous diffusion is a "stage." At PGDP, a stage consisted of the following:

- A converter that contains porous separation media (referred to as the barrier material or barrier tubes);
- A gas cooler;
- A compressor driven by an electric motor (to move the UF_6 gas through the converter); and
- Interconnecting piping and a control valve to contain and control the gas flows (DOE 1996).

A schematic of a stage, which includes a compressor, converter, and interconnecting piping, is shown in Figure 6. Stages were grouped into "cells," which are the smallest groups of stages that can be removed

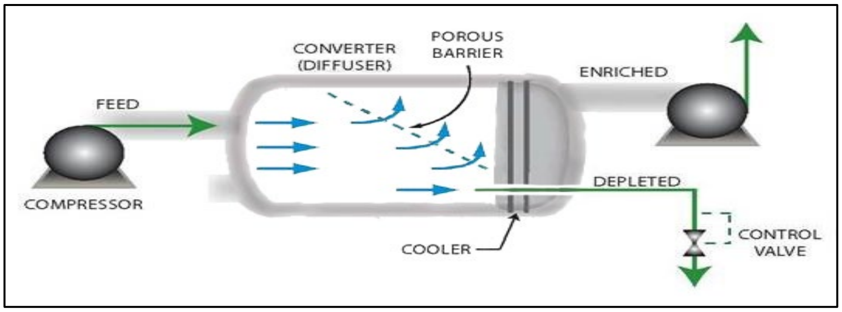

Figure 6. Gaseous Diffusion Stage at PGDP

from service, bypassed, and shut down for maintenance or other purposes (DOE 1996). PGDP process building units, cells, and stages are shown in Figure 7 and summarized in Table 3.

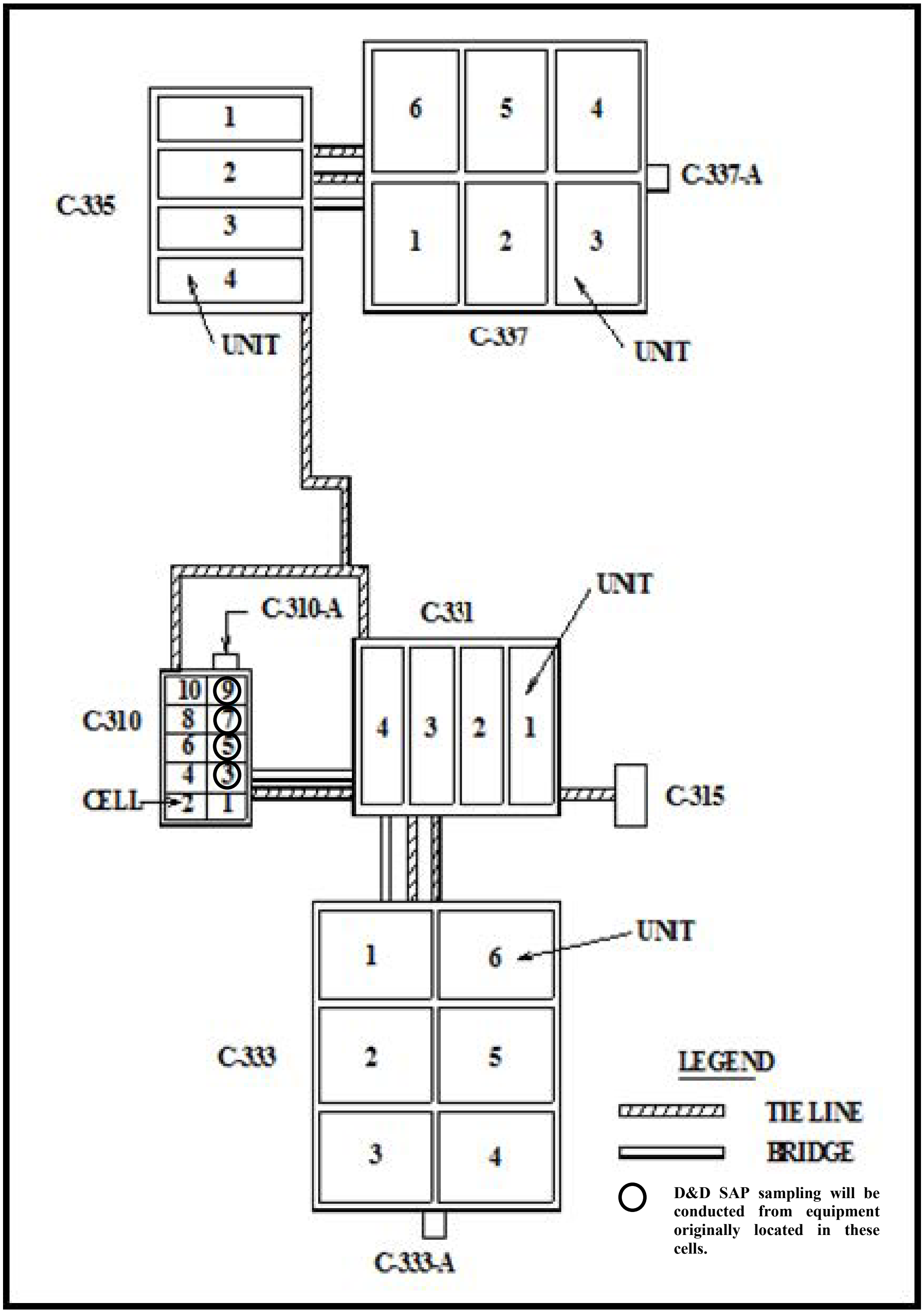

Figure 7. Plan View of the Larger Paducah Site Facilities

Table 3. PGDP Process Building Units, Cells, and Stages

Process Building	Equipment Size	Number of Units	Cells per Unit	Number of Cells	Stages per Cell	Number of Stages
C-310	Purge	1	10	10	6	60
C-331	'00'	4	10	40	10	400
C-333	'000'	6	10	60	8	480
C-335	'00'	4	10	40	10	400
C-337	'000'	6	10	60	8	480
	Totals	**21.0**		**210**		**1,820**

Source: *Application for United States Nuclear Regulatory Commission Certification, Volume 1, Paducah Gaseous Diffusion Plant Safety Analysis Report* (DOE 1996).

The PGDP enrichment cascade was arranged in two parallel cascades with one side (the lower cascade) consisting of C-331 and C-333 and the other side (the upper cascade) consisting of C-335 and C-337. The exact tie-in points of the overlaps would change, depending upon available power, desired product, or tails assay, etc., but were matched to an appropriate assay point to avoid mixing losses. The enrichment cascade was arranged in this parallel configuration to maximize efficiency and throughput while at the same time limiting product assay within established limits. Each stage is connected to the next upper and lower stage throughout the cascade. Bypass piping was provided for both cells and units, but individual stages could not be isolated or bypassed separately.

The largest equipment in use in the PGDP cascade was designated as '000'-sized equipment. The first size reduction in the cascade sent the process gas into '00'-sized equipment, and a final reduction near the top of the cascade took the process gas into 2X-sized equipment. Both '000' and '00' stages used axial flow compressors to provide the motive force to move the process gas through the system, while the smallest (2X-sized) equipment in the C-310 purge cascade used centrifugal compressors (commonly referred to as pumps). The stage size designations were predominantly due to the converter designations as 2X, '00,' and '000' (in order from smallest to largest). A typical '000' cell is shown in Figure 8.

As discussed above, the cascade was tapered by using the equipment size reductions. These transitions in the cascade occurred at the interfaces between buildings. Buildings C-331 and C-335 contained '00' equipment, while C-333 and C-337 contained '000' equipment. Only C-310 contained 2X-sized equipment. The buildings were arranged with the enrichment equipment on the second, or cell floor, with most of the auxiliary equipment and electrical support equipment located on the ground floors of the buildings. The enrichment equipment was enclosed in housings to retain heat so that the UF_6 was maintained in the gaseous state for the process to function.

Piping between buildings is referred to as tie lines. Tie lines provided a means to move process gas from building to building. The tie lines were connected to the facilities and were enclosed in elevated, heated housings. At those points in the cascade where there was a change in equipment size and a transition in pressure level, the gas pressure could be increased by passing it through a booster station. These stations were also used at the product and tails withdrawal points and at the junction with the purge cascade. The compressors were either axial or centrifugal, depending on the volumetric flow rate and pressure ratio required. In general, axial compressors were used to boost the "A" (enriched) stream, while centrifugal compressors were used to boost the "B" (depleted) stream. An axial compressor was used to boost the bottom overlap to the upper cascade, while centrifugal compressors were used on the top overlap.

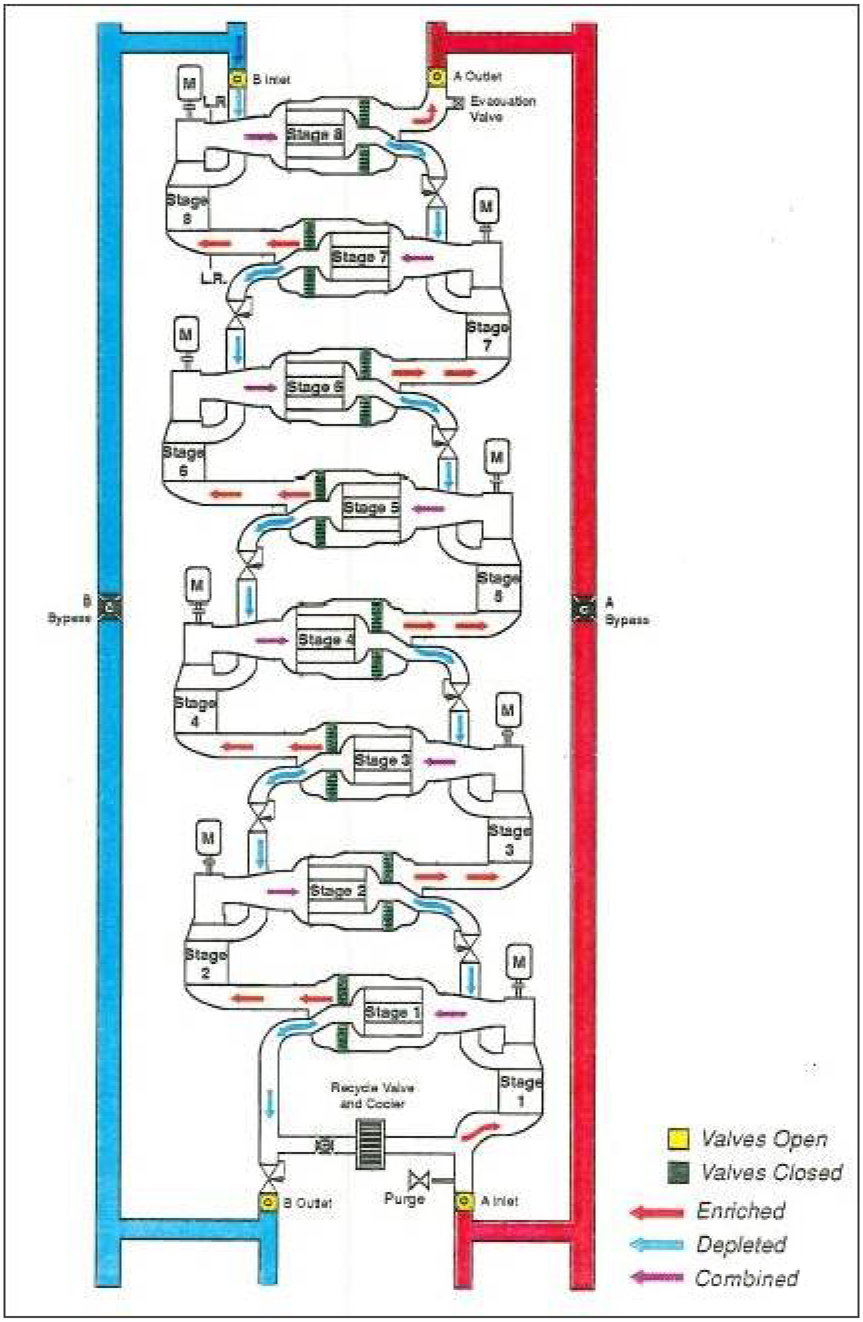

Figure 8. PGDP '000' Cell

Also included in the cascade process gas system were surge drums and freezer/sublimer units that provided surge volume for inventory fluctuation, power availability fluctuations, and for evacuation holding volume. Freezer/sublimer units were in certain cells in the process buildings (except C-310 and C-315) and could be operated separately or in conjunction to remove excess UF_6 inventory. Surge drums were in all of the process buildings except for C-310.

All cascade feed streams were supplied through feed headers connecting the cascade with feed autoclaves in the C-337-A Feed Vaporization Facility and C-333-A Feed Vaporization Facility. Product streams were withdrawn through headers connecting the cascade with condensation facilities located in C-310. The tails withdrawal facility was in the C-315 Surge and Waste Building, where the tails stream was drained as a liquid following the compression liquefaction process (DOE 1996).

The four PGDP process buildings were constructed to house the equipment and operations for uranium enrichment. Each process building was two stories high. PGE was located on the second floor, known as the cell floor, and the auxiliary equipment, support equipment, and control rooms were located on the first floor, known as the ground floor (DOE 1996).

Descriptions of the construction, configuration, contents, and auxiliary systems associated with each process building are presented below.

1.4.4.1 '00' Type Facilities (C-331 and C-335)

C-331 and C-335 were windowless, two stories, and framed of structural steel. They contained additional steel beams for seismic bracing and were roofed with pitch, felt, and gravel and single-ply membrane over an insulated steel deck. Floors throughout were of finished concrete with steel reinforcement. Exterior walls consisted of transite siding attached directly to the steel frame and terminating in low parapet walls capped with extruded aluminum fascia. Prominent exterior features included exhaust air ducts, large air louvers, a depressed truck/railroad spur alley with individual loading platforms, tie-line piping, and an enclosed man bridge. The structural framing was ASTM A7 steel.

The dimensions of the C-331 and C-335 facilities are provided in Table 4. Each facility consisted of eight individual structural sections separated by expansion joints. Two of these structural sections (along with associated equipment) formed what is referred to as a unit. Each facility consisted of a ground floor on grade, a cell floor, crane bays clear to the soffits of the trusses, and mezzanine bays between the crane bays. Each unit had two crane bays at the cell floor level separated by a mezzanine bay. Each unit was separated from the others by a mezzanine bay. In addition, the two end units had a bay, which served as a perimeter aisle way for pedestrian and vehicular traffic.

Table 4. Dimensions of PGDP Gaseous Diffusion Process Buildings

Process Building	Year Completed	Dimensions (ft)	Building Footprint (acres)
C-310	1952	463 × 134 × 75	–
C-315	1952	215 × 129 × 50	–
C-331	1952	807 × 643 × 90	11.8
C-333	1952	1,098 × 970 × 90	24.5
C-335	1954	807 × 643 × 90	11.8
C-337	1954	1,098 × 970 × 90	24.5

Source: CP1-NS-3000, *Documented Safety Analysis for the U.S. Department of Energy Paducah Site Deactivation Project*

The floor was a reinforced concrete slab on grade. Walls were predominately siding on exposed structural steel. The ceiling was approximately 22 ft and 6 inches above the ground floor and was actually the cell floor supported on exposed structural steel beams and columns.

Numerous pipes of various diameters crisscrossed the ceiling, connecting portions of systems located on the ground floor with portions located on the cell floor. This piping included lube oil, R-114 coolant, water, air, nitrogen, instrumentation, and steam and condensate lines. Sprinkler piping, ventilation ductwork, and electrical conduits were also present. The legacy gravity-feed lube oil supply tanks were housed in rooms located under the roof of the facility.

The cell floors of the C-331 and C-335 facilities housed the equipment used for the actual isotopic separation of uranium. Each cell floor plan consisted of four cascade units. Each unit consisted of two parallel rows (one in each crane bay) of five equipment groupings called cells. Each cell was composed of 10 stages, and each stage was comprised of a converter, a compressor, a compressor motor, a control valve, and associated piping. The piping arrangement allowed a cell to be bypassed (flow routed around the cell) and isolated for maintenance.

Cells, booster stations, and UF_6 piping were enclosed in housing of galvanized sheet metal and cement-asbestos sheets attached to steel framing. The housing retained heat so that UF_6 could be maintained in the gaseous state as required during legacy enrichment operations.

The cascade equipment housings in C-331 and C-335 provided a barrier in case of the release of hazardous material from a UF_6 primary system failure within the housing, and also prevented in-leakage of water.

The cell floor area of each facility was served by eight permanent 15-ton overhead bridge cranes. The cranes travel on rails supported by the columns and can travel the entire length of each unit. These cranes were used to handle heavy PGE as necessary and were used to transfer equipment to and from the cell floor through floor hatches located over the truck alley.

A greater than 3,000 ft^2 basement beneath the '00' facility area control room housed electrical cabinets and alarming system communications cables to and from the C-300 Central Control Building, as well as provided access to an underground tunnel.

1.4.4.2 '000' Type Facilities (C-333 and C-337)

These facilities were very similar in construction to that described above for C-331 and C-335. The facilities had a vaporized feed facility for each: C-333-A and C-337-A. The description of the C-331 and C-335 facilities and their two floors generally applies to C-333 and C-337 with the following exceptions.

The dimensions of the C-333 and C-337 facilities are provided in Table 4. Each facility consisted of 30 individual structural sections arranged in a 5 × 6 column matrix. Each section was separated by expansion joints. Four complete and two partial structural sections formed a facility unit. Each '000' facility had six such units. Each facility consisted of a ground floor on grade, a cell floor, and a three-level mezzanine bay. The mezzanine levels were located at 40 ft, 50 ft, and 64 ft, respectively, above ground level. In addition, crane bays that permit crane movements were located approximately 68 ft abovegrade. Each of these facilities consisted of five individual structures in series. The two end frames consisted of two crane bays, two mezzanine bays, and an exterior bay. The first interior frame (one on each side) consisted of two crane bays and two mezzanine bays. The center frame consisted of two 62 ft-wide crane bays, one 96 ft-wide crane bay, and two mezzanine bays.

The C-333 and C-337 ground floors measured approximately 1,052 ft × 970 ft and the ceilings were approximately 28 ft and 6 inches above the floors. The ground floor portions of the facility columns were encased in concrete.

The equipment housed on this floor was generally the same as that housed on the C-331 and C-335 ground floors; however, in C-333 and C-337, the equipment was configured within six distinct rectangular groupings, one for each unit. Both C-333 and C-337 each had 12 air intake enclosures, 30 open-steel stairways connecting the ground and cell floors, and two depressed truck/railroad spur alleys with five individual loading docks at the ground floor level.

These facilities each had six units with each unit consisting of 10 cells. Each cell consisted of eight stages for a total of 480 stages per facility. For C-333 Unit 6, Cells 1 through 4, PGE has been removed and replaced with the material sizing area.

The C-333 and C-337 cell floors were served by 15 permanent overhead bridge cranes per facility. Each main bay had 11 cranes. Four cranes were located in mezzanine (high) bays. The cranes were capable of traveling the entire length of the facility and each served a portion of three units. All main bay cranes, except the center main bay crane, could be operated as single- or double-trolley bridge cranes. When operated as single-trolley cranes, the cranes had a 23-ton capacity. When operated as double-trolley cranes, the cranes' capacity was 36 tons. The center main bay crane was a single-trolley bridge crane with a 23-ton capacity. Each mezzanine bay crane was a single-trolley bridge crane with a 15-ton capacity.

The legacy gravity-feed lube oil supply tanks were housed in rooms located on the roof of the facility. Each unit had one room located approximately at its center, and each room housed one supply tank. These gravity-feed lube oil supply tanks have been drained of lube oil, a hole drilled into the bottom of each so that they cannot be refilled, and the supply line was capped off. This significantly improved the prior fire hazard analysis-considered fire safety and lightning safety affecting configurations.

A greater than 5,000 ft^2 basement, beneath the '000' facility area control room, housed electrical cabinets and alarming system communications cables to and from the C-300 Central Control Building, as well as provided access to an underground tunnel.

1.4.4.3 Purge Cascade and Product Withdrawal Facility (C-310/C-310-A)

The purge cascade was in the C-310 Purge and Product Building. The function of the purge cascade included isotopic enrichment of U-235 and the separation of lighter molecular weight contaminant gases from the UF_6 for safe venting to the atmosphere through a permitted 200 ft vent stack adjacent to C-310.

The C-310 facility was a windowless, two-story steel-framed structure with reinforced concrete floors. The walls were of transite siding attached to the structural steel and the roof was a built-up roof with single-ply membrane over a precast steel-edged concrete deck. An enclosed bridge connected the cell floors of C-310 and C-331. The C-310 facility is no longer credited to perform a safety function during and after analyzed natural phenomena hazard events.

A small basement beneath the area control room housed electrical cabinets and provided access to an underground tunnel.

The C-310 facility had two floor levels, which were referred to as the cell floor and the ground floor. Instrument cubicles and valve control centers were located on the ground floor, in two rows running north and south, with the row east of the facility center line serving the odd-numbered cells and with the west row serving the even-numbered cells. The booster controls were located at the south end of these cubicles. The product withdrawal room was in the northeast corner. A computer room in the northwest corner of the facility housed the cascade automated data processing system mainframe.

The ground floor also contained the area control room, which housed the assay spectrometer room, monitoring and control for the purge cascade, and the showers and locker room. The lube oil system drain tank and pumps, seal exhaust pumps, withdrawal stations, the switchgear, and most of the auxiliary equipment was also on the ground floor.

The cell floor contained the cascade equipment, which included compressors, converters, condensers, pumps, and "B" booster stations.

The cell floor layout consisted of 10 cells, each containing six inline stages. The 60 converters were arranged side by side, with 30 converters along each side of the facility. Twelve centrifugal pumps served each cell with two pumps for each converter. Six pumps were situated along each side of the cell with the "A" pumps for the enriched stream and the "B" pumps for the depleted stream. Bypass piping, feed, and evacuation piping passed overhead above the cell floor through the center of the facility.

The tops purge system was located in the southwest corner of the cell floor. The tops purge system consisted of essentially two main parts, the tops booster station located on the cell floor and the purge equipment located directly beneath Cell 2 on the ground floor. A booster station was located in the southeast corner of the facility on the cell floor. This station was designated as the "B" booster station, which consisted of two centrifugal compressors. A motor test stand was located next to the booster station.

The legacy gravity-feed lube oil supply tank was housed in a room located on the roof of the facility. This room housed one supply tank. The gravity-feed lube oil supply tank has been drained of lube oil, a hole drilled into the bottom of the tank so that it cannot be refilled, and the supply line was capped off. This significantly improved the prior fire hazard analysis-considered fire safety and lightning safety affecting configurations.

Once the gaseous UF_6 was enriched in the isotope U-235 in the cascade, the UF_6 was pressured above atmosphere, condensed utilizing three scroll-type gas pumps (Normetex), and liquid drained into cylinders at the withdrawal station in the C-310-A Product Withdrawal Building. C-310-A was located at the northeast corner of C-310. C-310-A was a windowless, two-story, steel-framed structure similar to C-310.

The facility contained three condensers, two accumulators, which were used for the condensation of UF_6 product gas to a liquid for draining into UF_6 product cylinders located in the C-310 withdrawal area, and lube oil supply components and tank.

C-310 was equipped with two 6-ton capacity overhead cranes, which traversed above cell housings, facilitating maintenance work on motors, pumps, valves, and other cell equipment located on the cell floor. Hatches in the cell floor at the extreme north end of the facility opened over a rail and truck alley to facilitate the movement of equipment to the cell floor. Two 20-ton overhead cranes were located on the east side of the C-310 facility and were used to facilitate the movement of UF_6 cylinders to and from the withdrawal stations.

The C-310 cranes transited over the pumps and their discharge piping. The discharge piping from the pumps crossed from C-310 to C-310-A underneath the east crane.

1.4.4.4 Surge and Waste (Tails Withdrawal) Facility (C-315)

The purpose of the C-315 Surge and Waste Building was to condense and drain depleted UF_6 into a cylinder and to provide a surge volume. The surge and waste facility structure is no longer credited to perform a safety function during and after analyzed natural phenomena hazard events. This facility, located east of the C-331 facility, had three systems which were directly associated with the principal process of the plant. These systems were the surge system, process tails withdrawal system, and a dry air plant (which was numbered as the C-620 Air Compressor Room) and the electrical supply for C-315.

According to CP1-NS-3000, the central portion of the facility was a three-story section. This section contained the tails withdrawal system, the process gas stream, and the control room. The north section, which was the tallest one-story section, contained two large surge drums. The south section of C-620, which was one story, contained the dry air plant and the electrical switchgear for all three sections. An extension for switchgear and battery rooms was located on the west side of C-620.

The one-story sections were steel-framed with siding and a built-up roof. The central section consisted of a reinforced concrete structure up to the second floor with steel framing for the upper section. The roof over this area consisted of a built-up roof on a steel deck.

The control room, located on the ground floor, contained instrumentation necessary for monitoring and control of PGE. The tails withdrawal stations were located on the east side of the center section of the facility. The remainder of the ground floor contained the C-620 air plant, the two large surge drums, change house, lube oil drain tank, lube oil pumps, and electrical switchgear.

The second floor of the central portion of the facility contained the pumps, which were used to compress the UF_6 for liquefaction for tails withdrawal. The centrifugal pumps, three scroll-type gas pumps (Normetex), two UF_6 accumulators, and associated piping were enclosed in a once-heated housing to prevent freezing of UF_6. The electrical motors that drive the pumps were not enclosed.

The third-floor area contained the three UF_6 condensers that were used for UF_6 liquefaction and a portion of the ventilation system. The R-114 coolant/recirculating cooling water (RCW) heat exchangers and lube oil supply tanks were also located on this floor. Two 20-ton semi-gantry cranes were located on the east side of the C-315 facility. These cranes were used to move cylinders to and from the scale carts to the cylinder storage areas. One 5-ton overhead crane was located on the second floor to facilitate removal of pumps.

1.4.4.5 Auxiliary and other process gas systems

Numerous auxiliary systems that supported enrichment operations were in the process buildings. The primary process and nonprocess auxiliary systems, and their purposes are provided in Table 5.

Table 5. Summary of PGDP Auxiliary and Other Process Gas Systems

Auxiliary Systems	Purpose
Purge and evacuation (P&E)	Evacuation is required when small leaks enter the cascade equipment. These include the P&E stations and the wet air evacuation systems.
Plant air	Used for the enrichment process for the P&E of cascade components and it is also used for other miscellaneous uses.
Plant nitrogen	Supplied gaseous nitrogen for purging PGE and for process seal feed.
Plant steam and condensate	Utilized in the process buildings for heating building pipe enclosures to maintain the desired operating temperatures to prevent freeze-out of UF_6.
Surge drum	For storage of process gas and other gases.
Line recorder	For monitoring gases in the process system.
Cold recovery system	Featured pumps, coolant system, cold traps, and holding drums. These systems were only used very early in the life of the plant, but the equipment remains.

Table 5. Summary of PGDP Auxiliary and Other Process Gas Systems (Continued)

Auxiliary Systems	Purpose
Process coolant	Removed excess heat to maintain a desirable UF_6 operating temperature.
5.5 wt.% UF_6/R-114 separation	Froze out UF_6 from process gas that has been significantly contaminated with R-114 coolant.
Electrical system in process buildings	Consisted of transformers, switchgear, static capacitors, and motors.
Seal exhaust/wet air	Provided an exhaust for the seal cavities on the UF_6 compressors, P&E pumps, booster pumps, and for wet-air evacuation.
Process instrumentation	Maintained operating pressures accurately.
Process lube and hydraulic oil	Maintained a continuous supply of oil to the compressor bearings and motor bearing oil reservoirs and supplied oil to operate the hydraulic stage control valves in the '000' buildings.
Process ventilation	Maintained an environment wherein PGE could continuously operate at scheduled loads and distributed the process heat within the building to avoid UF_6 and water-freezing problems.
Fire protection	Provided interior fire protection of the process buildings.
Special gas	Used to condition previously-untreated surfaces as well as remove moisture before exposing the equipment to UF_6.

Source: *Application for United States Nuclear Regulatory Commission Certification, Volume 1, Paducah Gaseous Diffusion Plant Safety Analysis Report*, Section 3.3.5 Auxiliary Equipment (DOE 1996).

1.4.5 Geologic Setting

The Paducah Site is located in the Jackson Purchase region of Western Kentucky, which represents the northernmost extent of the Mississippi Embayment portion of the Coastal Plain Province.

1.4.6 Hydrogeology

The significant geologic units relative to shallow groundwater flow at the Paducah Site include the Terrace Gravel and Porters Creek Clay (south sector of the Paducah Site) and the Pleistocene Continental Deposits and McNairy Formation (underlying the Paducah Site and adjacent areas to the north). Groundwater flow in the Pleistocene Continental Deposits is a primary pathway for transport of dissolved contamination from the Paducah Site. Radiological and chemical contaminants from plant operations have been detected in the groundwater beneath the Paducah Site.

RGA groundwater is a potential drinking water aquifer (Class II) in accordance with EPA's 1986 groundwater classification guidance; however, the Paducah Site has provided bottled water for drinking water to site personnel through a commercial vendor since 2016 (EPA 1986). RGA groundwater is not used as a source of drinking water within the Paducah Site boundary because land use controls are in place that prevent the use of the groundwater through institutional controls (e.g., the current excavation/penetration permit program), deed restrictions, and alternate sources of water being available. The Water Policy Box has been implemented outside of the Paducah Site boundary to prevent groundwater use and to protect human health and the environment.

1.4.7 Surface Water Hydrology

The Paducah Site is situated in the western portion of the Ohio River basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. The Ohio River is located approximately 3.5 miles north of the Paducah Site. It is the most significant surface-water feature in the region, carrying over 25 billion gal/day of water through its banks. Several dams regulate flow in the Ohio River. The Ohio River stage near the Paducah Site is measured upstream at Paducah, Kentucky, and downstream at Olmsted, Illinois, by U.S. Geological Survey gauging stations.

The elevation of the Ohio River near the Paducah Site varied between 295 ft amsl and 335 ft amsl following operation of the Olmstead Dam beginning September 6, 2018. Water levels on the lower Ohio River generally are highest in late winter and early spring and lowest in late spring and early summer. The fenced security area of the Paducah Site is above the historical high water floodplain of the Ohio River and above the local 100-year flood elevation of the Ohio River (333 ft) (CH2M HILL 1991).

The fenced security area is situated on the divide between Little Bayou and Bayou Creeks. Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River along a 9-mile course. An 11,910-acre drainage basin supplies Bayou Creek. Little Bayou Creek becomes a perennial stream at the east outfalls of the Paducah Site. The Little Bayou Creek drainage originates within the Global Laser Enrichment, LLC property (Figure 3) and extends northward and joins Bayou Creek near the Ohio River along a 6.5 mile course within a 6,000-acre drainage basin.

Drainage areas for both creeks are generally rural; however, they receive surface drainage from numerous swales that drain residential, agricultural, and commercial properties, including the Paducah Site and the TVA Shawnee Fossil Plant. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River.

A network of ditches discharges effluent and surface water runoff from the Paducah Site to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System (KPDES) outfalls prior to discharge into the creeks. During the period of uranium enrichment operations at PGDP, most of the flow within Bayou and Little Bayou Creeks was from process effluents or surface water runoff from the Paducah Site. Radiological and chemical contaminants from plant operations have been detected in the sediments located downstream of the site.

Other surface water bodies in the vicinity of the Paducah Site include the following: Metropolis Lake, located east of the TVA Shawnee Fossil Plant; several small ponds, clay and gravel pits, and settling basins scattered throughout the area; and a marshy area just south of the confluence of Bayou Creek and Little Bayou Creek. The smaller surface water bodies are expected to have only localized effects on the regional groundwater flow pattern.

1.4.8 Ecological Setting

Much of the Paducah Site has been affected by human activity. Vegetation communities on the reservation are indicative of old field succession with grassy fields, field scrub-shrub, and upland mixed hardwoods. The open grassland areas, most of which are managed by WKWMA personnel, are mowed periodically or burned to maintain early successional vegetation, which is dominated by members of the *Compositae* (flowering plants) family and various grasses. Corn, millet, milo, and soybeans are commonly cultivated for wildlife forage (CH2M HILL 1992). Corn, soybeans, and sunflowers were cultivated for wildlife forage within the WKWMA in 2022.

Field scrub-shrub communities consist of sun-tolerant wooded species such as persimmon, maples, black locust, sumac, and oaks (CH2M HILL 1991). The undergrowth varies depending on the location of the woodlands. Wooded areas near maintained grasslands have an undergrowth dominated by grasses. Other communities have a thick undergrowth of shrubs, including sumac, pokeweed, honeysuckle, blackberry, and grape. Upland mixed hardwood communities feature a variety of upland and transitional species; dominant species include oaks, shagbark and shellbark hickory, and sugarberry (CH2M HILL 1991). The undergrowth varies from limited undergrowth for more mature stands of trees to dense undergrowth similar to that described for a scrub-shrub community.

Wildlife at the Paducah Site include species indigenous to hardwood forests, scrub-shrub, and open grassland communities. Rabbits, mice, opossum, vole, mole, raccoon, and deer frequent some nearby areas, and several groups of coyotes also live in areas around the Paducah Site. Aquatic habitats are used by muskrat and beaver. Results of the SI Phase 1 includes a list of representative species (CH2M HILL 1991). Birds include red-winged blackbirds, quail, sparrows, shrikes, mourning doves, turkeys, cardinals, meadowlarks, hawks, and owls. The Ohio River, which is 3.5 miles north of the Paducah Site, also serves as a major flyway for migratory waterfowl (DOE 1995b). Harvestable fish populations live in Bayou Creek, especially near the mouth of the creek at the Ohio River. Fish populations in Little Bayou Creek are in the minnow category.

A threatened and endangered (T&E) species investigation identified federal-listed, proposed, or candidate species potentially occurring at or near the Paducah Site (COE 1994). Updated information is obtained regularly from federal and Commonwealth of Kentucky sources. Potential habitat for 15 species of federal concern exists in the study area. Thirteen of these species are listed as endangered under the Endangered Species Act of 1973 (ESA), and two are listed as threatened. While potential habitats for endangered species exist on DOE property, none of the federal-listed or candidate species have been found on DOE property at the Paducah Site.

1.4.9 Climatology

The Paducah Site's climate is humid-continental. The term "humid" refers to the surplus of precipitation versus evapotranspiration that normally is experienced throughout the year. According to the National Weather Service for the period from 1991–2020, the average monthly precipitation is 4.19 inches, varying from an average of 3.11 inches in August (the monthly average low) to an average of 5.17 inches in April (the monthly average high). The total precipitation for 2023 was 55.83 inches, compared to the normal of 50.32 inches. The "continental" nature of the local climate refers to the dominating influence of the North American landmass. Continental climates typically experience large temperature changes between seasons. The mean annual temperature for the Paducah area for 2023 was 60.7°F. The normal average monthly temperature is 58.8°F, with the coldest month being January with an average temperature of 36.0°F and the warmest month being July with an average temperature of 79.7°F https://www.weather.gov/pah/monthlynormals.

The prevailing wind speed is from the south-southwest at approximately 10 miles per hour. Historically, stronger winds are recorded when the winds are from the southwest.

2. CHARACTERIZATION OF SITE/PREVIOUS ANALYTICAL DATA

The following sections discuss results of previous characterization and remediation activities, process and historical knowledge, and current characterization and/or investigations being conducted in the process facilities on the Paducah Site.

This section is not intended to summarize all investigations or characterization data obtained at PGDP, but to provide a description of the data at the level necessary to determine if adequate information exists to conduct a RI/FS, or if additional data are needed. Full discussion on data requirements for the RI/FS is provided in Section 6.

2.1 PROCESS FACILITIES

Knowledge of the gaseous diffusion process, historical information, and characterization data provides information on the COPCs (chemical of potential concerns) present in the process facilities at Paducah. COPCs associated with the process gas system and associated process facilities are described in this section.

2.1.1 Process and Historical Knowledge

The primary mission of the Paducah Site was to enrich uranium, and during plant operations, uranium enrichment was one of the most evaluated constituents throughout the process buildings. Uranium activity-based concentrations in each unit, stage, and cell within the process buildings were constantly being evaluated to ensure project operation and efficient production of enriched uranium. During uranium enrichment, activity-based concentrations of U-235 increase towards the top of the cascade and U-238 decreases. U-235 is a fissile radionuclide and can undergo inadvertent nuclear criticality if not managed correctly; therefore, characterization of uranium activity-based concentrations (U-238 vs. U-235) were constantly monitored. The highest assay at the Paducah Site had a maximum assay of 5.5 wt.% U-235.

Due to the nature of uranium enrichment operations, uranium radionuclides are the primary constituent (by volume/mass) present. All uranium radionuclides are radioactive and, therefore, they decay to other daughter products. Thorium-230 (Th-230) is the predominant uranium daughter product.

Other uranium daughter products, which would be present at low activity-based concentrations, include lead-210, radium-226, radium-228, actinium-227, thorium-228 (Th-228), thorium-229, thorium-232, and protactinium-231.

Tc-99 has been present at all three GDPs (Oak Ridge, Portsmouth, and Paducah) as a contaminant from the introduction of recycled uranium into the cascades. It is a long-lived fission product with a half-life of 213,000 years. Due to its high fission yield, long half-life, and mobility in the environment, Tc-99 is the most predominant radiological fission product/contaminant within the cascades.

A 1999 report, *Isotopic Distribution of Contamination Found at the U.S. Department of Energy Gaseous Diffusion Plants*, (BJC-OR-3412), discusses the history of gaseous diffusion and how Tc-99 was introduced into the enrichment cascade through enrichment of recycled uranium feed (BJC 1999). The report provides information relating to the quantities of Tc-99 and transuranic radionuclides that have been introduced into the cascade at each of the GDP locations. Some of the Tc-99 in the Paducah Site cascade was removed during the cascade improvement program/cascade uprating program (CIP/CUP) that was conducted during the late 1970s and early 1980 at the Paducah facilities. During these programs, many of the converters and compressors were removed and either decontaminated for reuse or replaced.

The barrier material from each converter is currently being removed when the converter is segmented and may be recycled or saved for future use. The levels of Tc-99 on the converter shell and adjacent equipment/piping may correlate with activity-based concentrations found in the barrier material, but it is believed that the Tc-99 activity-based concentrations found in the barrier material are to be the highest expected (or near highest) when compared to other equipment/components within the building.

Transuranic radionuclides were introduced at the Paducah Site when recycled uranium was used as feed. References have shown that the Paducah Site used greater amounts of recycled uranium as feed than at Portsmouth and Oak Ridge. For transuranic radionuclides, impurities/contaminants in the recycled uranium consisted of neptunium-237 (Np-237), plutonium-238 (Pu-238), plutonium-239 (Pu-239), and plutonium-240 (Pu-240) (BJC 1999). Although not considered a transuranic radionuclide (given it is a gamma emitter), plutonium-241 (Pu-241) would also be present. Pu-241 decays to americium-241 (Am-241), which is a transuranic radionuclide, and would grow over time; therefore, Pu-241 and Am-241 should also be considered COPCs for D&D waste streams. Transuranic radionuclides are present in activity-based concentrations below regulatory concern [estimated maximum activity-based concentration in wastes are less than 2 nanocuries per gram (nCi/g)] (FRNP 2020). Fission product radionuclides were also introduced into the facilities when recycled uranium was used as feed. The primary fission product radionuclides present are strontium-90 (Sr-90), Tc-99 (discussed earlier), and cesium-137 (Cs-137). Potassium-40 (K-40) is a neutron activation product in the context of the discussion on radionuclides associated with the introduction of reactor returns to the PGDP.

A Process Knowledge File Narrative for waste stream data package notes that trace amounts of hazardous metals are known to be present in the casting of metals in the GDP process stream (FRNP 2020). Characterization sampling on the converters from the C-333 building show that these metal components do not produce leachable metals at or above RCRA hazardous waste thresholds.

The arsenic compound in the feed is lighter than UF_6, so it traveled up the cascade and eventually worked its way predominately into the C-310 building cascade. Because the arsenic was not entirely eliminated from the PGDP process gas system, five converters from the C-333 building were strategically chosen and analyzed for arsenic and toxicity characteristic leaching procedure (TCLP) heavy metals. The sample results from these converters bound the potential arsenic concentration that could be present in PGE located in the C-333 building. Historically, the introduction of feed into the C-333 building occurred between Units 3 and 4 where the gradient was normal. This means that Units 1 and 2 were not exposed to the levels of arsenic contamination as much as Units 3 through 6. Evaluation of analyses of six samples collected from Units 2, 3, 4, and 5 of the C-333 building and two samples in Units 6 between 1992 and 2012 concluded that all the results for arsenic posed no regulatory concerns for hazardous waste.

A converter in the C-333 building that had been relocated from the Portsmouth Gaseous Diffusion Plant (PORTS) was analyzed in September 2019 for the presence of arsenic and other heavy metals, even though data existed from PORTS that showed arsenic was not a concern. Results of this sampling confirmed previous data.

Based on historical documentation, there is a potential presence of residual per- and polyfluoroalkyl substances (PFAS) in the PGDP process facilities. Lessons learned from PORTS, where PFAS samples are being collected across the effluent of multiple treatment trains, show that the treatment processes for landfill leachate are effective at reducing effluent to non-detectable levels. The specific focus of this SAP is aimed at determining levels of Tc-99 and uranium in components from the top of the cascade and leachability of those contaminants from PGE in a closed onsite disposal unit. This information is needed to refine inventory estimates for facility performance modeling and WAC evaluation. PFAS are being addressed by the centralized wastewater treatment design team, and the Paducah site will implement lessons learned and process knowledge into future design documents. Potential PFAS associated with liquid coolants and lubricants in the process facilities will be drained and removed during the deactivation process. As such, PFAS has been considered in the development of this plan but not warranted for analysis for this particular SAP and purpose.

2.1.2 Process Gas System Characterization Data

Detailed characterization of the C-333 building and C-333-A facility are currently being performed. The project plan, *Characterization and Criticality Incredible Project Plan for the C-333/C-333-A Process Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-CH-1002, (CCIPP) summarizes the characterization that is being performed (FRNP 2024b). The end state of the CCIPP implementation will include (1) characterization reports and data from intrusive sampling efforts supported by nondestructive assay (NDA) and/or surface contaminated object (SCO) measurements or (2) waste characterization package reports that include NDA and/or SCO measurements collected on the equipment as PGE and piping were removed and packaged for disposition.

The specific DQOs of the CCIPP include characterization of PGE and the COCs present in PGE can conservatively be assumed to be present in the ancillary structures and/or material of the facility. Ancillary structures and/or material include components that were known to be directly impacted by process gas, but were not part of the enrichment operations. Examples of these ancillary materials are the plant air system and the datum system.

A combination of *in situ* and *ex situ* characterization methods are currently being used. *In situ* characterization is defined as sampling performed on a component wherein the sample is not disturbed. Examples of *in situ* characterization include visual inspection and qualitative sodium iodide scanning. *Ex situ* characterization techniques require the disturbance or removal of the material being characterized. An example of this technique is an intrusive coupon sample, which is mechanically removed and analyzed by a laboratory.

The major PGE and/or components which are being characterized include:

- B-balanced elbows
- Valves
- Square-to-rounds
- Piping
- Freezer/sublimers
- Recycle coolers
- Cell bypass
- Unit bypass and tie-line
- Cell servicing area
- P&E pumps and headers
- Surge drums
- Compressors
- Converters
- Cell panels
- Feed lines
- Trap mix media/cold trap
- Tubing

The characterization and criticality incredible database (CCID) houses the component information and characterization results.

Results from this ongoing characterization and process knowledge of contaminants are discussed in this section for key constituents. The results from the ongoing characterization sampling effort in C-333 collected from the CCIPP are summarized in Table 6 to Table 8 and the data was pulled from the CCID. These results include inorganic compounds, TCLP metals, and radionuclides. The reported radionuclide results are taken from characterization reports completed for different populations (converters, surge drums, B-balanced elbows, etc.). These values are reported as a 95% upper confidence limit (UCL95) for conservatism, meaning that the average of any distribution for that population would fall below that value 95% of the time. The TCLP metals are based on coupon sample results from Unit 1 B-balanced elbows, cell evacuation piping, freezer/sublimers, and process gas piping. For inorganics (bulk metals), the results were pulled from Unit 6 B-balanced elbows.

Table 6. C-333 Radiological Characterization Data

Radionuclides	Minimum [picocuries per gram (pCi/g)]	Maximum (pCi/g)
Americium-240	0.147	33.085
Cs-137	0.0209	123.082
Cobalt-60 (Co-60)	0.0377	117.11
Np-237	0.216	702.076
Pu-238	0.0368	0.0683
Pu-239/240	0.802	51.169
K-40	304.229	1,288.446
Sr-90	1.26	97.59
Tc-99	2.25	4,337
Th-230	0.053	47.527
Th-232	6.505	27.548
Uranium-234 (U-234)	0.138	18,466
U-235	0.466	953.4
Uranium-236 (U-236)	0.135	7,117
U-238	1.62	29,701
U-235 wt.%	0.342	0.901

As expected, the maximum radionuclide results for uranium are high, as the samples came directly from SCO surveys on equipment in the C-333 cascade. The other maximum radionuclide results, particularly Tc-99, are also elevated, which is also expected because a part of the process gas introduced into the cascade came from reactor refeeds. Feed material was made from production reactor tails from 1953 until 1964 and intermittently from 1968 to 1977. The percentage of PGDP cascade feed material from reactor tails averaged 17% during the periods that this material was used, ranging from 65% in 1973 to 3% in 1975. After 1977, all feed came in the form of UF_6 from outside sources.

The maximum TCLP results indicate that some hold-up material samples taken from the B-balanced elbows surpassed the TCLP limits for arsenic and chromium. It is historically known that the B-Balancer can accumulate material, so some of them are expected to have a significant amount of contamination. Cadmium and mercury results did not exceed regulatory thresholds. Barium, lead, selenium, and silver were not detected in any of the samples, so they were shown as being less than the reporting limit (Table 7).

Table 7. C-333 Metal Characterization Data

Inorganics	Minimum (mg/kg)	Maximum (mg/kg)	TCLP Minimum (mg/L)	TCLP Maximum (mg/L)	TCLP Regulatory Level (mg/L)
Antimony	0.521	5.015	N/A	N/A	N/A
Arsenic	2.607	11.673	< 2.5	6.72	5.0
Barium	1.782	7.267	< 0.4	< 2	100.0
Beryllium	0.358	1.458	N/A	N/A	N/A
Cadmium	0.358	1.458	0.187	0.723	1.0
Chromium	1.383	173.422	1.76	7.4	5.0
Lead	0.521	29.577	< 0.2	< 1	5.0
Mercury	Not applicable (N/A)	N/A	0.0185	0.101	0.2
Nickel	9,531.3	38,408.8	N/A	N/A	N/A
Selenium	1.782	7.267	< 0.5	< 2.5	1.0
Silver	0.358	1.458	< 0.1	< 0.5	5.0
Thallium	0.358	1.458	N/A	N/A	N/A
Zinc	1.782	21.534	N/A	N/A	N/A

To characterize the converter shells and miscellaneous structural components, SCO survey data was obtained for each component. That SCO data was then fully applied to either uranium (α) or Tc-99 (β/γ). Those results were scaled using scaling factors derived from UCL95 results retrieved from Unit 6 piping in order to obtain the final isotopic distribution. This process adds conservatism to ensure that the results for each radioisotope are sufficiently bounding. The tube bundles were characterized using the NDA results from the Large Item Neutron Assay System, as well as the scaling factors derived from UCL95 results retrieved from the Unit 6 piping.

Table 8 provides analytical results of 10 converters with the most Tc-99 contamination based on results of the barrier material, the respective converter shell results, and their averages. These results confirm that the Tc-99 activity-based concentrations in the barrier material is considerably higher (generally one to two orders of magnitude higher) than those on the converter shells.

Table 8. C-333 Technetium-99 Converter Initial Sample Results

Converter ID	Converter Component ID	Shell Result (pCi/g)	Barrier Result (pCi/g)
333U6C02S02PGCN00-02	C-23314	4.33E+02	5.00E+04
333U6C02S06PGCN00-02	C-23330	1.72E+03	3.75E+04
333U6C02S03PGCN00-02	C-23069	5.19E+02	2.22E+04
333U6C04S02PGCN00-02	C-15089	6.39E+02	2.08E+04
333U6C02S05PGCN00-02	C-23032	2.58E+03	1.79E+04
333U6C04S01PGCN00-02	C-23315	1.36E+03	1.27E+04
333U6C07S01PGCN00-02	C-15105	4.62E+02	1.19E+04
333U6C04S08PGCN00-02	C-15266	2.15E+02	9.61E+03
333U6C04S06PGCN00-02	C-15462	9.56E+02	9.29E+03
333U6C04S05PGCN00-02	C-15237	1.18E+03	9.26E+03

2.2 SUPPORT AND ADMINISTRATIVE FACILITIES

2.2.1 Process and Historical Knowledge

Removal actions have been performed to address actual or potential releases from the D&D OU at the Paducah Site. Demolition of facilities in the C-410 Complex was completed in 2013. The *Engineering Evaluation/Cost Analysis for the C-410 Complex Infrastructure at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1952&D2/R2) identified radionuclides, metals, volatile organics, asbestos, and PCBs as contaminants present (DOE 2001). The results of the baseline risk evaluation (BRE) for the C-410 Complex indicate that long-term exposures to contaminated media pose a potential health risk. The BRE evaluated both workers and potential residents as receptors. The risk is primarily from contaminant migration from the complex, and risks under catastrophic releases are of special concern. This analysis indicates that current conditions exceed the acceptable risk range for site-related exposures under both current and potential future uses.

Decommissioning of the C-340 Metals Plant and C-746-A East End Smelter were completed in 2013 and 2010, respectively. The *Engineering Evaluation/Cost Analysis for the C-340 Metals Reduction Plant Complex and the C-746-A East End Smelter at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/LX/07-0131&D2/R1) identifies radiological contamination as the main COC due to historical processes performed in the facility (DOE 2010). Chemical hazards that are known to exist or suspected of being present prior to deactivation in C-340 included uranium compounds in various states of fluorination, paint containing lead, heavy metals and PCBs, asbestos-containing materials (ACMs), dust contaminated with lead, arsenic and beryllium, and volatile organic compounds (VOCs). A qualitative risk assessment included in the engineering evaluation/cost analysis indicates that a removal action is appropriate given risk to workers and the environment from the deterioration of structures and subsequent migration of hazardous substances.

As with the C-410 Complex and C-340 Metals Plant, radiological contamination was a primary COC encountered during the removal action for D&D of the C-405 Incinerator. The *Removal Action Report for the C-405 Incinerator at the Paducah Environmental Remediation Project, Paducah, Kentucky* (DOE/LX/07-0106&D2) states that the primary radionuclides in D&D of the C-405 Incinerator were uranium and Tc-99 (DOE 2008). Asbestos was present in transite siding, roof, and incinerator insulation. The roofing and siding were fastened to the structure with lead head bolts.

The C-400 RI report states that the facility is a primary source of off-site TCE and Tc-99 groundwater contamination at PGDP. Chemical releases have been associated with processes that occurred within C-400 Cleaning Building and with ancillary features (e.g., acid and discard waste line; sewers; storage/transfer areas). Significant quantities of chemicals (primarily TCE) and a variety of other constituents have been released to the environment at various areas within the C-400 Complex throughout its operational history; these chemicals are present in sludges, concrete/brick, soil, and groundwater. The remaining portions of the C-400 Cleaning Building following deactivation contain hazardous substances that are present in the infrastructure. According to the RI report, the hazardous substances in the infrastructure of C-400 Cleaning Building include ACM, PCBs, radionuclides, uranium metals, lead, and TCE. The C-400 Complex area has been subjected to a baseline risk assessment that concluded that actions needed to be taken. The report states that the results of the RI show that the characterization of the C-400 Complex is comprehensive. The full nature and extent of contamination in the C-400 Complex is provided in Section 4 of the C-400 RI Report (DOE 2023).

Characterization of abovegrade structures at PGDP has been performed in support of these removal and interim remedial actions, the C-400 RI/FS, facility maintenance, worker protection, and waste management activities. Data collected from sample events has been compiled from the OREIS database and is summarized in this section. Data compiled from OREIS was not screened based on the date that the sample was collected. The data provides information on the building materials that were used in the construction of the facilities as well as the spread of contamination during operation of the facility.

2.2.2 Support and Administrative Facilities Data

Paint samples have been analyzed for metals, PCBs, and radionuclides, producing 1,288 total analytical results from 189 different locations. Samples originated from locations such as C-400 Cleaning Building, C-721 Gas Manifold Storage Slab, C-742 Cylinder Storage Building, C-611-R High Pressure Fire Water Tank, C-200 Guard and Fire Headquarters, C-340 Metals Plant walls, C-410 Feed Plant, C-337 Process Building high pressure fire water system, C-730 Maintenance Service Building miscellaneous building materials, C-746-A North Warehouse, and C-402 Lime House building PGE. Twenty-three different metals were analyzed. All eight characteristic hazardous waste metals were detected in varying frequencies along with beryllium; the maximum detection being lead at 58,800 mg/kg detected in a sample from the C-402 Lime House building. PCBs were analyzed 156 times with the maximum detection being 11,000 mg/kg present in a sample of paint from a boiler from the C-600 Utility Plant. Radionuclides, such as uranium isotopes, Cs-137, Tc-99, Th-230, Np-237, and Pu-239/240 were detected with Tc-99 providing the highest activity-based concentration at 6,270 pCi/g in a sample collected from a degreaser tank located in the C-400 Cleaning Building east basement.

Concrete and asphalt has been sampled for metals, PCBs, radionuclides, VOCs, and semi-volatile organic compounds (SVOCs), producing a total of 20,683 analytical results. Samples have been collected from multiple concrete rubble piles, the C-745-K and C-745-M Cylinder Storage Yards, C-410 Feed Plant, C-400 Cleaning Building, and miscellaneous concrete materials located in Waste Area Grouping 17. Concrete wall cores have also been collected from the C-342-B Ammonia Dissociator Tank Shelter, C-410 Feed Plant, and the C-340 Metals Plant. Twenty-seven different metals were analyzed and all eight characteristic hazardous waste metals were detected in varying frequencies. The maximum detection was 509 mg/kg of lead present in a concrete core sample collected from the C-400 Cleaning Building. The maximum detection of PCBs was 14.1 mg/kg present in a sample of concrete collected from the floor of the C-340-B Metals Building mezzanine. Radionuclides, including uranium isotopes, Cs-137, Tc-99, Th-230, Np-237, and Pu-239/240, were detected. The maximum radionuclide activity-based concentration came from a piece of asphalt containing 2.00E+10 pCi/g for both U-233/234 and U-238; the location of this sample was not clearly documented in OREIS. Tc-99, another primary COPC, was detected up to 2.20E+09 pCi/g in a sample of concrete whose location was also not clearly documented in OREIS. Twenty-four SVOC constituents were detected amongst the 67 different SVOCs tested. The maximum SVOC detection was 40.6 mg/kg of phenanthrene, a polycyclic aromatic hydrocarbon, present in a concrete slab sample collected in the C-400 Cleaning Building. The maximum VOC concentration detected was total xylene at 5.0 mg/kg in a sample collected from a concrete slab also located in the C-400 Cleaning Building. Twenty-two different VOCs were detected from the 57 VOCs analyzed.

Analysis of floor sweepings and vacuum residues collected from facilities and legacy-packaged waste have produced 7,635 analytical results for metals, PCBs, radionuclides, VOCs, and SVOCs. Over 7,200 of these results are associated with samples of legacy waste for which OREIS does not provide the origin location. Nonetheless, these results provide information on COPCs present in PGDP facilities. The highest detection levels of metals in this data population were metals used in building materials, such as aluminum, calcium, and copper. Following these metals, nickel was present in the highest concentration at 7,690 mg/kg. The maximum PCB detection was 72,400 mg/kg. The maximum SVOCs and VOCs detected were phenanthrene at 210 mg/kg and TCE at 67.0 mg/kg, respectively. The maximum radionuclide activity-based concentration detected was Tc-99 at 292,000 pCi/g.

Analysis of samples shows the detection of asbestos in ceiling material, flooring, wall materials, and pipe insulation in PGDP buildings and trailers. Facilities like the process buildings are known to be clad in transite siding, which is made of asbestos. Asbestos has been detected in flooring material of the C-720 Change Houses, flooring material mastic in the C-537 Switchyard trailers and the C-100 Administration Building, among others. Asbestos is detected in insulation of piping or cable wrap in the C-400 Cleaning Building, C-410 Feed Plant, C-531 Switchyard, C-412 Trailer Complex, C-206 Former Pumper Drafter Pit, and the C-746-P Scrap Metal Yard (East), the C-410 Cleaning Building, C-200 Guard and Fire Headquarters, and C-340 Metals Plant. Radionuclides were also detected in insulation from the C-746-A building with a maximum detection attributed to Tc-99 at 34.7 pCi/g. These results are not unexpected because asbestos was commonly used in the construction of facilities before the 1970s.

2.3 PREVIOUS WASTE ACCEPTANCE CRITERIA AND REMEDIAL INVESTIGATION/ FEASIBILITY STUDY DISCUSSIONS ABOUT CHEMICALS (OR RADIONUCLIDES) OF POTENTIAL CONCERN

D&D COPCs (as well as how the COPCs were identified for the project) are detailed in the *Remedial Investigation/Feasibility Study Report for CERCLA Waste Disposal Alternatives Evaluation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0244&D2/R2, and include various VOCs, SVOCs, pesticides, PCBs, metals, and radionuclides (DOE 2018). The following uranium, transuranic, and technetium isotopes have been identified as COPCs for this scope and have been included in prior WAC modeling.

- Am-241
- Cs-137
- Np-237
- Pu-238
- Pu-239
- Pu-240
- Tc-99
- Th-230
- U-234
- U-235
- U-238

Based on site history, analytical data, and comparison of PGDP and the gaseous diffusion process with the former gaseous diffusion facilities at the East Tennessee Technology Park (ETTP), the chemicals in PGDP sitewide COPCs that are not considered COPCs for D&D waste include the following:

- Acrylonitrile
- Benzene
- Carbon tetrachloride
- 1,1-Dichloroethene (DCE)
- *trans*-1,2-DCE
- Hexachlorobenzene
- 2-Nitroaniline
- N-nitroso-di-N-propylamine
- Dioxins and furans

Significant organic analyte contamination within the PGDP PGE and components is not suspected. Dioxins and furans are typically by-products of high temperature operations, such as solid waste incineration or coal combustion. These operations are not substantial in PGDP process or support buildings; therefore, dioxin/furan by-products are not anticipated and were excluded.

3. INITIAL EVALUATION

Three GDPs have operated in the United States; one in Oak Ridge, Tennessee, one in Piketon, Ohio, and one in Paducah. The Oak Ridge plant has been completely demolished and demolition is underway at the one in Ohio (at the Portsmouth plant). Considerable information about release mechanisms, potential risk, and COCs have been obtained at these two facilities. Data collection is underway at the Paducah Site buildings, but much of the information presented in this section is from the RI conducted for the Portsmouth facilities, which used quite of bit of the information from the Oak Ridge facility.

This section presents the current understanding of how the structures at a nonoperating GDP could result in contaminant releases. It discusses the types of receptors that may be exposed to those releases, summarizes what is known about the risk from those releases, and discusses the potential contaminants that would cause the risk. Preliminary chemical and location-specific ARARs are presented. This section sets the stage for how the risk assessment will be conducted in the RI (Section 4) and the range of alternatives that will be explored in the FS (Section 5).

3.1 CONCEPTUAL MODEL OF RELEASE

The conceptual site model (CSM) identifies and provides a discussion of the potential receptors that could be exposed as a result of transport from the contaminant sources, previously described, to the locations where receptors could contact these contaminants. It also describes the release mechanisms. The receptors that will be considered in a streamlined evaluation of threats to human health include both on-site (within the boundary of the Paducah facility) and off-site (outside the boundary of the Paducah facility) receptors in the most likely downgradient locations from the sources.

3.1.1 Contaminant Sources and Release and Transport Mechanisms

Under the no-action alternative, assuming the process buildings, complex facilities, and other support facilities are left standing, human exposures could occur by inappropriate future use of the buildings and the equipment and/or materials in them or if migration of contaminants from the buildings occurs. In the case of on-site users of the buildings or waste piles, direct contact with contamination is likely. Although most of the contamination is contained in secondary structures (e.g., PGE), it could be released through metal oxidation (corrosion) and ultimately be washed out through breaches in the metal or through active physical disturbance. While corrosion rates vary widely based on metallic make-up and environmental conditions, corrosion of the equipment shells will occur and may accelerate once removed from the protection of the building structure. Additionally, contaminants released from the buildings could migrate into immediately surrounding environmental media. The migration pathways include the migration of contaminants in air (as dust particulates and/or volatilization), surface water as runoff, and groundwater.

3.1.2 On-Site Receptors

Two types of receptors are considered for the on-site scenario: a trespasser and an industrial worker. Residential use is not considered a viable receptor population due to the reasonably-anticipated industrial use of the Paducah Site. Under the no-action alternative, receptors may trespass into the decaying or fallen buildings. There is also a potential for future industrial workers to be exposed to contaminants from the process buildings, complex facilities, and other support facilities, if they are left standing.

- Trespassers—The trespasser is assumed to periodically traverse the industrialized area of Paducah, perhaps exploring or recreating in or immediately adjacent to the buildings. They would have intermittent exposure to building materials and to the contents within the buildings, including potentially-stored solvents. They would also have exposure to soil adjacent to the buildings, which may have become contaminated. The exposure routes of concern for the trespasser include:

— Inhalation of particulates generated from the degradation of contaminated equipment and building materials, wind-blown dust from waste, and surface soil, and VOCs in air (near dip vats);

— Incidental ingestion of particulates generated from the degradation of contaminated equipment and building materials, dust from waste, surface soil, and sediment;

— Dermal contact with contaminated equipment and building materials, dust from waste, surface soil, sediment, and surface water; and

— External exposure from ionizing radiation from contaminated equipment and building materials, dust from waste, surface soil, and sediment.

- Industrial Worker—This receptor is a worker whose activities are in or near the deteriorating structures. The individual uses the building or building waste inappropriately in the future under a loss of institutional controls. The worker could be working inside or outside. The worker would consume groundwater from Paducah. It is also assumed that the workers would not consume surface water from the Paducah Site, but that they could have contact with nearby surface water bodies. The exposure routes of concern for the industrial worker include:

— Inhalation of particulates from contaminated equipment and building materials, dust from waste, surface soil, and VOCs in air (near dip vats);

— Incidental ingestion of particulates from contaminated equipment and building materials, dust from waste, surface soil, and sediment;

— Dermal contact from contaminated equipment and building materials, dust from waste, surface soil, surface water, and sediment;

— External exposure from ionizing radiation from contaminated equipment and building materials, dust from waste, surface soil, and sediment; and

— Ingestion of groundwater.

3.1.3 Off-Site Receptors

The off-site receptor considered is a resident, which is the receptor with the highest exposure parameters as compared to other receptors. Currently, contaminated air, soil/sediment, and surface water at the Paducah Site have not reached any off-site media with which an off-site residential receptor may come in contact. TCE has been detected in groundwater from off-site monitoring wells headed to the Ohio River. DOE places the potentially-affected residences and businesses on alternate water supplies.

- Off-Site Resident—This is a neighbor who lives along the Paducah Site boundary and could be potentially exposed on a long-term basis to contaminants released from the buildings and migrating off the Paducah Site. Under the no-action alternative, there is a potential for off-site residents near the Paducah Site boundary to be exposed to contaminants migrating from the deteriorating process buildings, complex facilities, and other support facilities. Contamination off the Paducah Site could result from the migration of contaminants in air (as wind-generated particulates), surface water as runoff, and groundwater. The potential exposure routes of concern from these migration pathways would include the following:

- Inhalation of particulates from wind-blown dust from waste and surface soil and VOCs in groundwater;
- Incidental ingestion of particulates from wind-blown dust from waste and surface soil as well as sediment;
- Dermal contact with wind-blown dust from waste and surface soil as well as surface water, sediment, and groundwater;
- External exposure from ionizing radiation from wind-blown dust from waste and surface soil as well as sediment; and
- Ingestion of groundwater.

Potential residential exposure to contaminants in surface water that is used for irrigation of food crops and as a drinking source for cattle is a secondary exposure pathway, as shown in the CSM (Figure 9); however, this pathway is considered marginal in terms of exposure relative to the other primary exposure pathways.

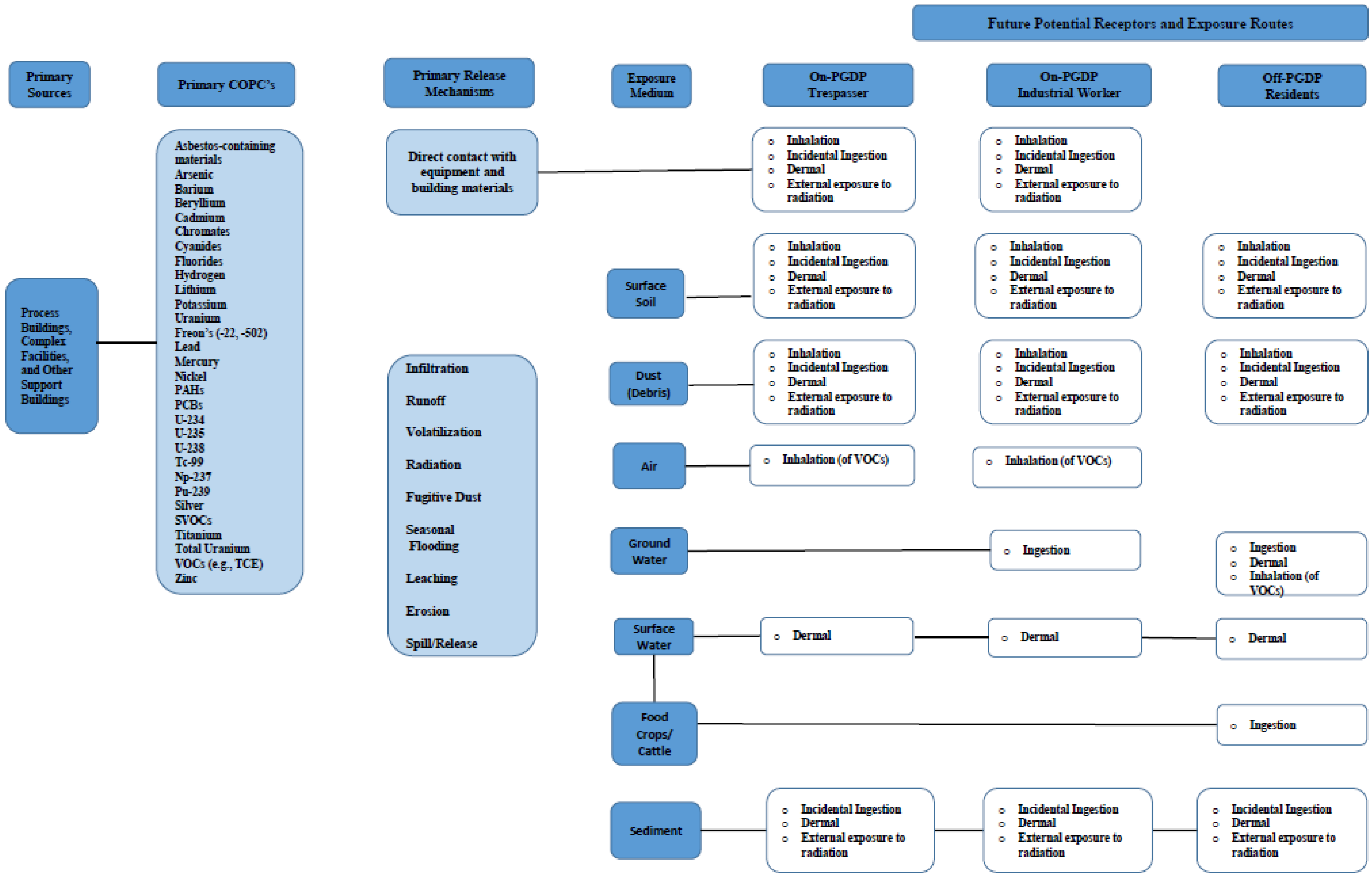

Figure 9. Paducah Conceptual Site Model for Human Receptors

3.2 PRELIMINARY CHEMICAL AND LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT

3.2.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

Chemical-specific requirements set health or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants. These requirements generally set protective cleanup levels for the chemicals of concern in the designated media (e.g., groundwater) or otherwise indicate a safe level of discharge that may be incorporated when considering a specific remedial activity. These are not relevant for a D&D decision.

3.2.2 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs generally are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations.

The preliminary location-specific ARARs for the D&D decision are included in Table B.1. and summarized below.

3.2.2.1 Wetlands

Potential wetland areas have been identified at PGDP. If the remedial actions undertaken involve the destruction of wetlands, or otherwise has a negative impact on wetlands, the substantive requirements of 10 *CFR* Part 1022, *Compliance with Floodplain and Wetland Environmental Review Requirements*, would be an ARAR. Activities will be designed to avoid or minimize impacts to wetlands that are identified at PGDP. The substantive requirements in 10 *CFR* Part 1022 instruct DOE to avoid, to the extent possible, adverse impacts associated with the destruction of wetlands and the occupancy and modification of wetlands. In the event that wetlands would be impacted, mitigation activities would be incorporated into remedial designs where such impact occurs. Measures that mitigate the adverse effects of actions in a wetland may include, but are not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-sensitive areas; however, any necessary mitigation activities or compensatory measures would be identified at a later date. The U.S. Army Corps of Engineers (COE) would be consulted. If any action involves the discharge of dredge or fill material into waters of the United States, 40 *CFR* § 230.10, *Restrictions on discharge*, and 33 *CFR* § 323.3 would be ARARs.

3.2.2.2 Floodplains and streams

Floodplain protection as described in 10 *CFR* § 1022.3 requires that floodplain values be protected to the extent possible. If remedial actions are undertaken that would impact a designated floodplain, the substantive requirements found in 10 *CFR* Part 1022 would be considered ARARs.

3.2.2.3 Fish and wildlife

The Fish and Wildlife Coordination Act 16 *U.S.C.* §§ 661-666(e) requires federal agencies to consider the effects of water-related projects on wildlife resources with a view to the conservation of wildlife resources by preventing loss of and damage to such resources. This would include federal agency action that impounds, modifies, diverts, or controls a stream or other body of water except where the maximum surface area of an impoundment is less than 10 acres or for land management activities by federal agencies with respect to federal lands under their jurisdiction.

3.2.2.4 Threatened or endangered species

Animal species and their critical habitats that are identified under the ESA (16 *U.S.C.* § 1531 *et seq*.) have been identified in the vicinity of PGDP. The ESA provides for the protection from extinction of T&E species. Pursuant to the ESA, federal agency actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken. Only the substantive provisions of the ESA apply to on-site actions.

An ecological resource investigation inside the PGDP security fence did not detect any T&E species or their preferred habitat (CDM Federal Programs Corporation 1994). The U.S. Fish and Wildlife Service has not designated a critical habitat for any species within the DOE property. Outside the PGDP fence on the DOE site, potential habitats for federally-listed T&E species were reviewed, and the Indiana bat habitat was evaluated during the COE environmental investigation (COE 1994). The COE study determined that the total potential bat habitat consisted of 20% of the 2,456-acre study area. These requirements are potential ARARs in the event that T&E species or their habitats are found at remedial action sites.

The Kentucky Energy and Environment Cabinet Office of Kentucky Nature Preserves has developed the Kentucky Biological Assessment Tool, a conservation planning and data exploration tool, to identify potential federally- and state-listed rare, threatened, or endangered species or habitats in a project area. According to 401 *KAR* Chapter 30 § 031.3, waste sites or facilities are prohibited from taking federally-listed endangered or threatened species or adversely impacting their critical habitat. In addition, Executive Order 13186, *Responsibilities of Federal Agencies To Protect Migratory Birds*, directs federal agencies to further the purposes of the Migratory Bird Treaty Act (16 *U.S.C.* §§ 703-712) by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources (i.e., birds and their habitats) when conducting agency actions.

3.2.2.5 Protection of historic property and archaeological resources

Federal agencies must take into account the effect of an undertaking that may impact any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register (54 *U.S.C.* § 306108). Further, federal agencies must initiate measures to assure that where, as a result of federal action, a historic property is to be altered or demolished, timely steps are taken to make or have made appropriate records (54 *U.S.C.* § 306103).

The Archaeological and Historic Preservation Act of 1974 (incorporated in 54 *U.S.C.* § 312501 through 312508 in 2014) provides for the preservation of historical and archaeological data that might be irreparably lost or destroyed as a result of the alterations of terrain caused by the federal construction of a dam or other alteration caused by federal construction projects. The presence of archaeological or historic resources may make these regulations applicable.

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 *U.S.C.* § 3001 *et seq*.) governs Native American remains and objects found on federal lands. Upon inadvertent discovery, all activity in the area must cease and a reasonable effort made to protect the items discovered before resuming such activity [25 *U.S.C.* § 3002(d)]. The substantive provisions of the NAGPRA may be considered an ARAR for the inadvertent discovery of Native American remains and objects.

3.3 PRELIMINARY RISK ASSESSMENT SUMMARY

The risk characterization estimates the potential for adverse health effects as a result of exposure to contaminants and the associated toxicity characteristics of the hazardous substances. In a quantitative assessment, this process ends with a list of COCs, as well as pathways of concern. This information guides alternative development to ensure that any action taken addresses the risk posed by exposure to plant contaminants. For a qualitative risk assessment, COCs are identified from the list of COPCs, using the understanding of the prevalence of the contaminant in remaining sources, their potential for release and/or migration, and their inherent toxicity.

The pathways of concern are identified as a result of the typical contribution of the pathways when risk is quantified. For instance, the use of surface water to irrigate crops generally is inconsequential compared to ingestion of groundwater.

If the Paducah Site abovegrade structures are allowed to remain in place without maintenance over time, wind, rain, and freeze/thaw cycles would cause degradation of the building structures, eventually resulting in failure of the structures (e.g., roof leaks/failures, asbestos transite siding blowing off buildings and structures, and concrete crumbling and collapsing). In turn, this may result in an increased threat for exposure of receptors. Additionally, oxidation of metal components may eventually lead to decay, resulting in breaches that allow infiltrating water to wash contaminants out and move them away from the components in an overland flow to surface water. Threats to human health from exposure to contaminants such as asbestos, PCBs, lead, mercury, beryllium, Tc-99, TCE, or uranium isotopes are minimal under current conditions; however, future uncontrolled releases would cause increased threats to human health via the exposure pathways discussed above. As these buildings continue to age, the threat of radiological and chemical substance releases would increase, and actual releases to the environment would increase. For example, radiological and chemical substances could be released directly to the environment through a breach in a containment wall, roof, or other physical control as the buildings age and deteriorate. In addition to degradation causing a release, there is the potential that future users of the Paducah Site may breach PGE and buildings, becoming exposed to what are safely-encased contaminants and causing a sudden release of these contaminants.

3.4 PRELIMINARY CONTAMINANTS OF CONCERN

Based on operations at the buildings at the Paducah Site, radioactive contamination and associated risks are expected to be unacceptable for all of the on-site receptors. Process buildings contain large quantities of uranium and Tc-99. Once degradation of PGE occurs, releases of UF_6 (the form of uranium in equipment) will occur and upon contact with moisture, hydrogen fluoride (HF) and uranyl fluoride will be formed. Although this form of uranium is soluble, historic releases to the atmosphere and subsequent deposition to soils have not shown migration to water sources, thus indicating an insoluble form of uranium in the environment. Tc-99 is mobile and likely to migrate to water sources where it could be a threat through ingestion. The other radionuclides, such as Np-237 and Pu-239, are in much smaller quantities and are not expected to cause unacceptable risks.

The risks to the industrial worker from radionuclides are expected to be greater than those to the trespasser (based on higher exposure frequency and duration). The main routes of exposure would be external exposure to ionizing radiation and incidental ingestion. The uranium isotopes are not very mobile, and soil is the most likely medium for external exposure to radiation. Tc-99 is very mobile and has migrated to underlying groundwater. Ingestion of on- and off-site groundwater by a future industrial worker or off-site resident could result in an unacceptable risk. Tc-99 is unlikely to stay in the soil long enough to cause a risk. Dermal exposure to contaminated sediment is a potential for future users of the creeks, and there is a potential for incidental ingestion of contaminated surface water during swimming/wading for recreational users of the creek.

ACM is ubiquitous in the building materials; exposures may impact the on-site receptors via inhalation. Because of the large sizes of the process buildings, it is expected that large quantities of ACM are present. Large quantities of PCBs from seals and gaskets in ductwork could be a future source of unacceptable exposure to receptors through ingestion and dermal contact. Soil is the main medium of exposure, although exposure to PCB-containing equipment could be unacceptable. If migration to surface water does occur from releases from the buildings, dermal exposure to contaminated sediment is a potential for future users of the creeks.

Based on operations at the Paducah Site and other investigations, it is known that TCE and degradation products (e.g. vinyl chloride, DCE, 1,2-DCE, *trans*-1,2-dichlorothene, and *cis*-1,2-dichloroethene) are present and are considered preliminary, COCs, and is a source of risk, and exposures to future on-site receptors could occur via inhalation. TCE was used significantly in the C-400 Cleaning Building and the C-720 Maintenance & Storage Building. As a result, local TCE spill areas and piping releases are sources of TCE groundwater contamination. The most likely exposed receptors to future TCE releases to groundwater are the industrial worker and the off-site resident, and the pathway with the greatest risk potential is groundwater ingestion.

Chromium is expected to be a concern because of RCW, which contained chromium compounds. Potential releases of hexavalent chromium from the piping to the environment and that may be present in soil would be a risk to on-site receptors via inhalation or ingestion of contaminated soils. Chromium has been associated with groundwater contamination and may be an issue for an industrial worker through ingestion. In addition, the Risk Methods Document specifies the use of Chromium (VI) screening values for Total Chromium results unless it is determined on a project-specific basis that Chromium (VI) is not present. For purposes of both D&D and Environmental Media Remedial Investigations, the projects will assume the chromium detected in environmental media is Chromium (VI) as a more protective approach. The Environmental Media risk assessment will provide further discussion in the uncertainty evaluation, as appropriate. Subsequent analyses related to chromium speciation may be warranted during a remedial design investigation depending on the media and location (e.g., areas related to the recirculating cooling water system) and further discussion in the uncertainty, as appropriate.

The other COPCs in the buildings are not expected to be released in large enough quantities to impact either on-site or off-site receptors. Although there are many items that contain metals, it is assumed that the degradation of these items may occur slowly over time, and the concentrations released would be minimal. There are likely to be other COCs from historical releases from the buildings (especially when they were operational) via exposure to environmental media, but continued future releases of contaminants outside of the list below are expected to be minimal; therefore, the following are COCs for risk from future exposure to abovegrade structures (other contaminants may be of concern for determining waste disposal):

- Uranium and uranium isotopes (U-234, U-235, U-238)
- Tc-99
- ACM
- TCE and degradation products (e.g. vinyl chloride, DCE, 1,2-DCE, *trans*-1,2-dichlorothene, and *cis*-1,2-dichloroethene)
- PCBs
- Chromium

4. RISK ASSESSMENT APPROACH

This section presents the approach that will be used to assess potential threat to human health, safety, and the environment from the D&D no-action conditions. Under no action, the abovegrade structures would eventually degrade and no waste disposition would occur, resulting in releases of contaminants with migration to where exposures to human and ecological receptors may occur. The risk assessment approach will use existing knowledge about the sources, migration pathways, and potential receptors to develop a CSM (described preliminarily in Section 3) to understand the potential threats to human health and the environment. The potential threat analysis will be streamlined. A qualitative evaluation of potential threats to potential receptors via identified release pathways will be based on the no-action conditions, under which the former GDP buildings and abovegrade structures at the Paducah Site are assumed to no longer undergo S&M, existing security and institutional controls are eliminated, and the resultant condition is that the buildings degrade and ultimately release currently-contained contamination.

The approach to assessing the potential threat to human health is qualitative and presented in Section 4.1. The potential effects to ecological species will also be addressed qualitatively and the approach is discussed in Section 4.2. Unlike a typical quantitative baseline risk assessment, a qualitative assessment does not depend on a detailed data set, just a general understanding of the structure conditions. The need for remedial action on abovegrade structures will be easily established through a qualitative assessment. No additional data collection is needed to support this qualitative assessment.

4.1 APPROACH TO HUMAN HEALTH RISK ASSESSMENT

A streamlined evaluation of risk to human health for the no-action condition will be conducted for purposes of determining whether remedial actions are warranted. The potential threat to human health will be assessed and discussed for the major buildings, permitting the risk evaluation to consider unique building conditions and hazardous material inventories in the buildings and the likelihood of these buildings to contribute additional contaminant mass to the environment. Relating the known conditions within the buildings to existing and relevant environmental data provides information on not only the release potential of the remaining hazardous materials in the buildings, but also on the relative movement of many of these same materials, in the form of contaminants, in the environment as a result of historical spill and release events.

This qualitative human health risk evaluation will identify potential site-related contaminants using previous investigations and process knowledge and develop an exposure CSM to identify the sources of the COPCs, their likely migration pathways and potential exposure routes, and their ultimate fate in the environment. Using toxicity information, the COCs will be identified for applicable receptors. The qualitative risk assessment in this RI/FS uses the same steps as a baseline risk assessment, but each step is conducted on the basis of process and plant knowledge instead of contaminant-specific data. For instance, the potential COPC identifications are based on operations that occurred in the various buildings or on environmental data associated with past releases from the buildings, as well as on information from the other GDPs. The identifications are not based on a screening of building analytical data against risk-based levels.

Likewise, the final identification of COCs and potential exposure pathways of concern are based on process knowledge about the prevalence of contamination sources and their likelihood to release, as well as their fate in the environment. In summary, risk is characterized in this analysis by qualitatively integrating process information and toxicity information about the contaminants likely to be present with exposure information for hypothetical receptors.

This streamlined evaluation will include the risk from not conducting D&D action, which is the no-action alternative. Under the no-action alternative, no D&D, S&M activities, or institutional controls would occur, and the equipment, buildings, and structures would continue to deteriorate. Structures would gradually degrade and ultimately fail. No waste management practices would be in place to remove the waste from PGDP. The resulting waste would be left in place, and uncontrolled dispersion of contaminants from within the structures and equipment eventually would occur. Natural structural degradation is a slow process characterized by incremental degradation of structural components, eventually leading to episodic collapse; therefore, persons in and around the deteriorating buildings would also be at risk from physical hazards such as being struck by falling structural components or the collapse of floors, resulting in falls.

4.2 APPROACH TO ECOLOGICAL RISK ASSESSMENT

A streamlined ecological risk evaluation will be developed focusing on the potential impacts to the environment from contaminant releases from the buildings as they continue to degrade. Impacts from degradation of the buildings would be best represented by current conditions in the soil and groundwater; therefore, this section of the RI will discuss the types of contaminants that have historically been released to the soil, groundwater, and by extension, surface water that may be of ecological concern. This streamlined evaluation will develop a CSM illustrating potential impacted species and the contaminant transport pathways. There is limited ecological habitat in the industrialized portion of the site where the buildings addressed by this action are located; therefore, there are almost no populations of ecological species that can be impacted by building degradation in the plant area; however, there may be impacts to populations from contaminants released from the buildings and migrating into off-site habitats.

The environmental media RI will quantify the risk from these historical and potentially future contaminant releases away from the site from the degrading buildings. The D&D ecological risk assessment will remain focused on a qualitative assessment of risks from the buildings themselves.

5. LIKELY ALTERNATIVES

In order to complete a determination of the data needs, potential alternatives need to be identified. Then, an assessment of what data may be needed to support an evaluation of those alternatives can be made. Typically, the needs of the cost estimate drive the data needs as the alternatives need to be defined sufficiently to be able develop a cost estimate at a +50/-30% level. This section first presents some preliminary remedial action objectives (RAOs) and then discusses the likely range of remedial alternatives and what data may be needed to fully evaluate these alternatives.

5.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

RAOs are developed during the RI/FS process to set goals that ensure the protection of human health and the environment. The purpose of this action is to make a remediation decision to address all abovegrade structures and infrastructure identified at the Paducah Site. According to EPA RI/FS guidance (EPA 1988), RAOs consist of medium-specific goals for protecting human health and the environment. There are no chemical-specific ARARs to guide selection of medium-specific goals as part of RAOs for this action because this decision is not an environmental remediation decision; therefore, the preliminary RAOs are risk-based.

The C-400 RI developed the following remedial action objective (RAO) for the abovegrade structures in the C-400 Complex OU. Preliminary RAOs developed for the D&D RI/FS have considered this RAO (DOE 2023).

- C-400 Complex Infrastructure RAO: Eliminate, reduce, or otherwise mitigate the potential for releases of hazardous substances from infrastructure (including slabs, aboveground structures, and subsurface structures) to soil, groundwater, or surface water.

For this D&D RI/FS, broad preliminary RAOs have been developed. Consideration was given to the fact that the Paducah Site is best suited to be used as an industrial facility in the future and that natural ecological habitats would be prevalent only outside of the industrialized area and, therefore, would be impacted only through the release of contamination to the surface water or soil/groundwater. To be protective of human health and the environment, any selected alternative addressing abovegrade structures must meet the following RAOs:

- Protect an industrial user by removing building or structure contamination that could pose a future threat to an industrial worker.

- Protect soil, surface water, and groundwater from further degradation resulting from the migration of contaminants from buildings and structures to surface water and through the soil column to groundwater by removing abovegrade structures that are contaminated with hazardous substances and could cause an unacceptable environmental release (as defined by the Environmental Media RAOs).

Only RAOs that completely remove the potential for release (i.e., demolition) are being considered. Actions that contain the contamination are not being considered.

5.2 PRELIMINARY ALTERNATIVES

Two remedial alternatives are anticipated to be developed to address all abovegrade structures and infrastructure at the Paducah Site that have no future use. They are the no-action alternative and one action alternative; remove all inactive structures, treat as necessary, and package waste for final disposition. Cost and analysis of the final transportation and placement options for the waste generated will not be included in this RI/FS, but will be included in the evaluation of alternatives in the WDA RI/FS.

A renovation and reuse alternative is not planned to be developed in the RI/FS. The primary reasons that this alternative is not developed include the nature of the structures, their current state of deterioration, and the lack of any identified future need or use beyond their current mission use. Many of the buildings/structures were built for a specialized use (e.g., monitoring stations, storage tanks, pump stations) and are not conducive to being remodeled for other uses. Some, such as the process buildings, are so large that any decontamination and remodeling efforts would be cost prohibitive. Further, there is likely no market for the buildings. For example, despite many years of marketing and communication efforts by the community reuse organization, no user could be found for the large K-31 and K-33 process buildings in Oak Ridge, even after the equipment had been removed and they had been decontaminated. All process buildings as well as the major maintenance shops and support facilities in Oak Ridge and in Portsmouth are being demolished. Many of the Paducah Site buildings were built in the 1950s and 1960s, making them 60- to 70-years-old with few (if any) upgrades over the years. A majority of the buildings/structures and infrastructure at the Paducah Site was used for managing nuclear materials, and they are suspected of containing radiological and other contamination.

Estimating D&D of abovegrade structures and infrastructure is driven by deactivation, decommissioning, decontamination efforts, demolition efforts, and waste disposal costs. Because this GDP is very similar to the other two that are undergoing (or have completed) remedial actions, D&D efforts can be assumed and estimated based on the work at the other sites. A cost estimate for other deactivation activities and demolition of the facilities will be primarily based on the size and materials of construction of the structure. No additional data are needed. Waste disposal costs are part of the WDA RI/FS and, therefore, this driver of the estimate is not relevant to the D&D RI/FS. Nevertheless, because of the efforts at PORTS and Oak Ridge, there is more than enough information to assume a disposal outlet for the waste generated by this D&D effort, so no new data are needed to support that aspect of the WDA RI/FS.

However, in the process of evaluating an on-site alternative, a data gap concerning the process building information has been identified and is the subject of the rest of this scoping document. This data will be used to support the development of the radiological source term that would be generated by a D&D remedial action to demonstrate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal), and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be helpful to support development of analytical WAC for an on-site waste disposal facility (OSWDF) if on-site disposal is selected as part of the WDA decision.

5.3 PRELIMINARY ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste. Selection of a particular remedial action would invoke appropriate action-specific ARARs that may specify particular performance standards or technologies.

The preliminary ARARs presented in this section address the management of generated wastes, which includes appropriate characterization of wastes generated, standards for the closure of waste units (hazardous waste management units and SWMUs), air emissions including the control of fugitive emissions, and the control of surface water. There are no underground storage tanks addressed under the D&D scope of work.

A key assumption in developing ARARs for this alternative is that the waste resulting from the deactivation and demolition of abovegrade structures would be treated as required by the waste generator before disposal, including treatment to meet any applicable RCRA land disposal restrictions, Toxic Substances Control Act (TSCA) requirements, and any relevant and appropriate Kentucky regulations governing radioactive wastes, as well as meeting all WAC established for disposal facilities.

The preliminary action-specific ARARs are included in Table B.1. and are summarized below. It should be noted that the preliminary ARARs provided in this document are subject to change during development of the RI/FS as alternatives are developed in detail. A specific list of ARARs is not typically included in a scoping document or RI/FS work plan and this list may not be complete. Nonetheless, DOE is providing a preliminary list of ARARs to facilitate discussion with regulators and refinement of ARARs during development of the RI/FS. Approval of this scoping document/work plan by EPA and KDEP does not create a binding commitment to these ARARs because ARARs are not finalized until the ROD is signed. DOE requests that comments received on the ARARs contained in this scoping document/work plan be resolved during development of the RI/FS, as the detailed development and evaluation of sitewide remediation alternatives for Environmental Media, D&D, and waste disposition proceed.

5.3.1 General Construction/Operation Activities

General site preparation activities, such as excavation for runoff control berms and construction of support buildings, would trigger general requirements for storm water runoff and air emission control measures. ARARs for these common activities are discussed here.

Storm Water Runoff. Storm water discharges from activities involving construction operations that result in the disturbance of land ≥ 1 acre require implementation of good site planning and best management practices.

Air Emissions. Emissions into the air include those of a fugitive nature as well as point source emissions from stacks, vents, or other point source release into the air. Fugitive emission of airborne particulate concentrations may result from construction, D&D, and operations activities. Fugitive emissions are regulated by Kentucky through administrative rules at 401 *KAR* 63:010, *Fugitive emissions*. An operator must take reasonable precautions to prevent particulate matter from becoming airborne. These requirements would be applicable.

40 *CFR* Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities*, addresses atmospheric radionuclide emissions from DOE facilities and applies to airborne emissions during construction, D&D, and operation activities. National Emission Standards for Hazardous Air Pollutants (NESHAP) limits ambient air radionuclide emissions from DOE facilities to levels that would prevent any individual from receiving an effective dose equivalent (EDE) of 10 millirem/year (mrem/yr) or more (40 *CFR* § 61.92, *Standard*). Nonpoint-source fugitive radionuclide emissions are estimated by plant monitoring stations. Point source emissions will be estimated as required and may involve the installation of stack monitoring devices should EDE estimates be > 0.1 mrem/year.

DOE has determined that the NESHAP for Site Remediation is applicable to Paducah Site operations if there is an exceedance of the 1 megagram/year threshold (40 *CFR* Part 63; Subpart GGGGG, *National Emission Standards for Hazardous Air Pollutants: Site Remediation*). New facilities that include process vents or stacks will be evaluated under this regulation to ensure that emission control requirements are properly addressed.

Treatment of Wastewater. Storm water and dust suppression water comprise the primary sources of surface water requiring control, including the potential for the application of treatment prior to discharge to receiving waters. If collected wastewater is treated on-site, any on-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Clean Water Act § 402, *National Pollutant Discharge Elimination System*, or 307(b) (i.e., KPDES-permitted) are exempt from the requirements of RCRA Subtitle C standards for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment [40 *CFR* § 264.1(g)(6); 40 *CFR* § 260.10, *Definitions*; 40 *CFR* § 270.1(c)(2); 53 *FR* 34079, September 2, 1988].

The FFA parties have disputed the ARARs and/or to be considereds (TBCs) associated with effluent standards for Atomic Energy Act of 1954 source, special nuclear, and byproduct materials in wastewater. At this time, the resolution of the dispute defers establishment of radionuclide effluent standard ARARs until the proposed plan and ROD stage of remedy selection. Appendix B contains the DOE order as a TBC with the understanding that EPA does not agree with this position. The order is included not to create a dispute, but to facilitate discussion and resolution of the issue before the proposed plan stage.

As described in Section 1.1.2, DOE is evaluating the development of a centralized wastewater treatment system to treat contaminated liquids generated by Paducah Site remediation. Only one remedy should evaluate this approach as part of its alternatives and finalize the associated ARARs. Preliminary ARARs regarding treatment and discharge of wastewater will be adjusted in the D&D RI/FS according to the final scope of the alternatives and discussion by the FFA parties. The preliminary ARARs in Appendix B may not all be required.

5.3.2 Operation of Staging Areas for Deactivation and Demolition Waste Materials

Staging of wastes generated during facility deactivation and debris generated during D&D may be performed. Depending on the duration of the management of staging areas or the planned operation of a staging area, appropriate controls would be provided to address storm water runoff and fugitive dust emissions.

5.3.3 Waste Management

Primary wastes (e.g., contaminated debris) and secondary wastes generated during remedial activities will be characterized to determine whether it should be classified as RCRA-hazardous wastes (or containing or contaminated with RCRA-hazardous waste), TSCA waste, low-level radioactive waste(s), and/or mixed waste(s). Depending on the results of the characterization, each waste stream will be managed in accordance with RCRA, TSCA, or DOE order and/or manual requirements. Wastes managed on-site must comply with the substantive requirements of the aforementioned ARARs and the WAC of the disposal facility.

In many cases, debris generated from demolition may result in heterogeneous waste streams. Characterization activities will focus on determining the overall average properties of the waste streams, using both representative sampling and process/generator knowledge in accordance with ARARs and approaches described in EPA preamble discussions contained in 57 *FR* 958 (January 9, 1992) (Preamble to the Proposed Rule—Treatment Standards for Contaminated Debris). Any RCRA-hazardous debris must be treated to meet disposal facility WAC, which could include land disposal restrictions treatment standards for hazardous debris set in accordance with 40 *CFR* § 268.45, *Treatment standards for hazardous debris*, or alternate treatment standards if the debris is being disposed of in a corrective action management unit (CAMU) and is considered CAMU-eligible.

"CAMU-eligible waste" is defined in 40 *CFR* § 264.552 (a)(1) and generally includes all solid and hazardous waste and debris that are managed for implementing cleanup, but excludes some intact containers or certain types of non-land-based units. ARARs regarding management of CAMU-eligible waste are included in Appendix B.

A key concept of the CAMU rule is the identification and treatment of principal hazardous constituents (PHCs). PHCs are defined as those constituents that "pose a risk to human health or the environment that is substantially higher than the cleanup levels or goals at the site" as established in a site-specific decision document (e.g., ROD) [40 *CFR* § 264.552(e)(4)(i)]. At PGDP, each of the cleanup projects associated with the individual decisions would be responsible for characterization, identification, and treatment of the PHCs it generates, provided that the selected remedy involves disposal in a CAMU.

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6. NEED FOR DATA COLLECTION

For the D&D project, needed data/information supports two efforts:

(1) Assessment of the buildings to support a D&D remedial decision, and

(2) Identification of the anticipated waste streams (e.g., support WAC compliance and future waste disposal decisions).

Detailed characterization of buildings to demonstrate WAC compliance will be performed in the future during remedial design activities.

Remedial Decision. For the D&D remedial decision, the existing sources of information and data are sufficient to support an evaluation of remedial alternatives and the selection of a remedial alternative. A description of the facilities, including their potential hazards, will be obtained from existing facility condition reports, field inspections, photographs, safety analysis reports, and hazard analyses that have been developed in the course of doing work associated with each building/facility. Data and other information collected for the D&D remedial decision is sufficient to support a streamlined evaluation of the risk posed to human health and the environment by the release or threat of release of contaminants from PGDP abovegrade structures and sufficient to support a decision whether to remove, reuse, or take no action. A streamlined risk evaluation will consider the exposure to contaminants that might occur if the facilities degrade over time and considers the following receptors: on-site receptors (workers) and off-site receptors (plant neighbors and other members of the public near PGDP), and, as appropriate, environmental receptors.

Waste Streams and Contaminant Source Term. Information from materials of construction, radiological surveys, NDA results, field inspections, and existing analytical data that may be available provides more information concerning the potential hazards and assists in identifying the various waste streams. The quantity of waste (including waste type and form) has previously been assessed for all buildings at PGDP and is included in a waste volume database. However, additional information regarding the nature and distribution of contaminants that may be present in various waste streams to be generated during CERCLA D&D are needed. A D&D SAP (Appendix C) has been designed to determine the upper-bounds of contaminant concentrations expected in the D&D waste to support development of the radiological source term that would be generated by a D&D remedial action to demonstrate compliance with the WAC for the disposal facilities (for off-site and/or on-site disposal), and to meet regulatory requirements for packaging, transportation, and disposal.

6.1 USE OF HISTORICAL DATA

RI/FS needs and existing data sources for the D&D remedial decision are identified in Table 9. Based on this information, no additional or new analytical data are needed for the D&D remedial decision.

Table 9. Data Availability for D&D Remedial Decision

RI/FS Needs	Question	Existing Data Source
Describe abovegrade structures in site description section	What was the use of the buildings and potential hazards?	Existing reports, process knowledge, safety analysis reports, field walkdowns/inspections.

Table 9. Data Availability for D&D Remedial Decision (Continued)

RI/FS Needs	Question	Existing Data Source
Assess threat under no action (risk)	What is the type and level of contamination of the materials?	Materials of construction, radiological survey results, NDA results, existing analytical data.
Define potential receptors	What potential receptors could be exposed to contamination?	General site knowledge, potential land use options.
Identify technologies and develop alternatives	What technologies are effective, implementable, and cost effective?	Literature, previous D&D projects at Oak Ridge ETTP, PORTS, etc.
Develop waste volumes and estimates for demolition	What is the configuration and materials of construction of the buildings?	Drawings, field inspections. (volumes and costs already developed for all large buildings).
Identify waste streams and volumes	What is the type and level of waste to be generated by D&D of the buildings?	Field inspections, materials of construction, radiological survey results, NDA results, existing analytical data, hazard analyses/radiological inventories.

Data availability and needs for development, or refinement, of the D&D waste stream/source term are identified in Table 10.

Table 10. Data Availability for Source Term Development

Source Term Needs	Question	Existing Data Source
Describe waste stream volumes	What are the estimated waste volumes for D&D?	Existing reports, field walkdowns/inspections, building takeoffs.
Develop waste categories/types for demolition	What are the materials of construction for the buildings?	Drawings, field inspections, hazard analysis reports.
Identify waste stream contaminants	What are the COCs and level of contamination in the buildings (material/equipment)?	Site COPCs, materials of construction, radiological survey results, NDA results, existing analytical data, hazard analyses/radiological inventories.

- Historical data from Paducah and comparison to data from the remediated ETTP in Oak Ridge and the Portsmouth Site are sufficient to complete the RI/FS and make a remedial action decision; however, there is an additional PGDP-specific data need to support development of the radiological source term that would be generated by a D&D remedial action to demonstrate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal), and to meet regulatory requirements for packaging, transportation, and disposal. Targeted data collection is needed from the high end of the PGDP cascade and purge systems to determine the upper bounds of radionuclide and chemical contamination in the process equipment. This is due to the fact that PGDP is a low-enrichment GDP while K-25 at ETTP and X-326 at PORTS were high-enrichment facilities.

- PGDP received and processed more recycled uranium from other DOE reactors (e.g., Hanford and Savannah River) than ETTP and PORTS, although PGDP sent some of its low-enriched UF_6 from the recycled uranium to both ETTP and PORTS for further enrichment. A total of 101,268 metric tons of recycled uranium was fed at the Paducah Site between 1953 and 1976 while Oak Ridge and PORTS were fed approximately 5,627 and 574 metric tons of recycled uranium, respectively, during this period of time (BJC 1999). The recycled uranium included radiological contaminants not otherwise associated with uranium ore (e.g., Tc-99, Np-237, Am-241, Pu-239/240).

- Routine and periodic maintenance programs at the two facilities (PORTS and PGDP) differed, such as the CIP/CUP that was implemented at PGDP. Equipment changes during CIP/CUP likely removed most transuranic isotopes that had entered PGE before being changed out; however, because some piping and valving was not changed out, these transuranics may be retained as COCs for the piping.

These uncertainties can be mitigated by collection of additional targeted data to establish bounding conditions where contaminant concentrations might be expected at higher levels.

Additional Data Needs. Additional data are needed for refinement of the waste stream/source term. Characterization of C-333 that is currently underway will be used, but data are needed from the top of the cascade and purge systems to better determine the upper-bounds of radionuclide and chemical contamination in PGE. Tc-99 activity-based concentrations can exceed WAC and the locations of higher activity-based concentrations of Tc-99 in the system need to be confirmed. Additionally, hazardous metals (e.g., arsenic) may be of interest in the process systems. Samples are needed from selected converters, compressors, and piping from the top of the cascade. It is assumed that the barrier material in the converters will be removed and not be part of the waste stream.

Data are needed on the chemical leachability of WAC-limited radionuclides/hazardous metals in PGE and components. Sample coupons from PGE and components will undergo batch leach testing in an aqueous solution that would be similar to that within an OSWDF if on-site disposal is selected as part of the WDA decision.

For data comparability and continuity with existing PGE characterization protocols at PGDP, duplicate samples for total contaminant measurements (nitric acid leaching) will be collected and analyzed for inclusion in the Paducah Site facility characterization database. Both types of measurements (total contaminant measurements and batch leach testing representative of disposal conditions) are needed to support WAC development (for Tc-99) and to evaluate the volume of waste that would be eligible for on-site disposal.

6.2 DATA QUALITY OBJECTIVES AND SAMPLING STRATEGY

6.2.1 Step 1—State the Problem

DOE is evaluating alternatives to determine the final status of abovegrade structures at the Paducah Site for D&D concurrently with evaluating alternatives for CERCLA waste disposal.

For the D&D remedial decision, it has been determined that no additional data are needed. The existing sources of information and data are sufficient to support the RI/FS report, including an evaluation of remedial alternatives and the selection of a remedial alternative.

Data (chemical and radiological) are needed to better understand the nature and location of specific contaminants in the D&D waste streams to demonstrate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to develop a refined radiological source term for performance assessment modeling of a potential OSWDF if on-site disposal is selected as part of the WDA decision. The problem statement can be summarized as follows:

- Does sufficient data exist regarding the nature and distribution of contaminants present in various waste streams to be generated during CERCLA D&D activities to demonstrate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal?

6.2.2 Step 2—Identify the Decisions (the Goal of the Study)

The goal of the study is to provide data necessary to evaluate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to develop/refine the D&D waste contribution to the source term for performance assessment modeling to support disposition. Some of the principal study questions follow.

(1) Does enough data exist to evaluate the D&D alternatives to make a remedy decision?

- Remedial action decision—should the facilities be demolished?

(2) Does enough data exist to evaluate compliance with an analytical WAC for disposition?

- Are the COCs known?

- Are the chemicals/radionuclides of a nature/form that are resistant to leaching and alter the maximum concentration of the contaminant allowed by the WAC (e.g., is Tc-99 plated on metal and not leachable)?

(3) Does enough data exist to understand the concentration and distribution of contaminants in the D&D waste?

- What volume of waste would likely require off-site disposal, assuming an on-site disposal option?
- What is the form of any contaminant holdup mass in PGE and components?
- Does waste require treatment prior to disposal?
- Does waste meet requirements for packaging and transportation related to off-site disposal?

(4) Does enough data exist to support the radiological source term development required by DOE Order 435.1 Chg 2 (AdminChg), *Radioactive Waste Management*?

6.2.3 Step 3—Identify Information Inputs

Historical engineering documents exist that illustrate how each PGE component supported UF_6 gas processing and inventory management. In addition, several historical reports exist that describe the radionuclide contamination expected to be present on the component surfaces, as well as specific locations within the cascade that might have elevated levels of contamination.

The primary type of information needed is obtained through a review of the process knowledge and existing intrusive sampling data. Existing analytical data for the C-333 PGE at the Paducah Site is extensive. Another source of information is NDA data from PGE. Lighter contaminants, such as Tc-99, are known to diffuse to the upper parts of the enrichment cascade. If existing data are not available for the upper cascade, new data will be needed.

Where site-specific data are not available, surrogate data from former GDPs (i.e., ETTP and PORTS) will be used to supplement available data. Process and operation similarities between PGDP and the two former

GDPs make this data a valid resource. The uncertainty in using waste information from the other GDPs as surrogates for unavailable data at PGDP is the potential difference between the facilities themselves, including operational history, processes, historical releases, disposal practices, etc. Surrogate data from PORTS is particularly useful for materials of construction (i.e., materials used for the building construction, but not including PGE and components).

Data are needed from the top of the cascade and purge systems to better determine the upper-bounds of radionuclide and chemical contamination in PGE and components. To characterize the upper cascade, intrusive samples need to be collected for radionuclides and hazardous metals from appropriate components of the enrichment cascade. Isotopic data are needed for radionuclides with the analytes of interest including Tc-99, U-238, U-235, U-234, U-236, Am-241, Pu-238, Pu-239/240, Np-237, Th-228, Th-230, Cs-137, Co-60, K-40, and Sr-90. Tc-99 is typically a limiting contaminant relative to the WAC and the locations of higher activity-based concentrations of Tc-99 in the system need to be confirmed. Additionally, hazardous metals (e.g., arsenic, chromium) are of interest in the process gas systems. Data are also needed on the chemical leachability of WAC-limiting radionuclides/hazardous metals in PGE and components.

6.2.4 Step 4—Define the Boundaries of the Study

The estimated D&D waste volumes indicate that over 80% of the anticipated waste is from D&D of the process and process support buildings (C-331, C-333, C-335, C-337, C-310, C-315, C-400, C-710, and C-720). The C-310 building has the highest enrichment level of the cascade, therefore, characterization efforts will focus efforts for sampling on components in C-310. Additional characterization efforts for each building will take place during remedial design as needed to support demolition.

PGE is the equipment used to enrich uranium directly (i.e., compressors, converters, valves, seals, and the piping between the converters and compressors). The major uncertainty as to ability of the waste to go to any planned on-site disposal facility is associated with PGE and auxiliary process systems.

Judgmental, or biased, sampling locations will be based on process knowledge to sample equipment where higher concentrations of contaminants are expected. Note that additional sampling, incorporating statistical based random sampling, will occur during the remedial design phase of work to demonstrate the WAC of the receiving facility is being met when the waste is generated.

Sampling problems that may be encountered include: mitigating the potential hazard of fluorine or HF in PGE; ensuring that Nuclear Criticality Safety has verified that there are no issues with cutting at the sample location; ensuring that NDA resources are available to scan PGE; access issues, and ensuring that adequate craft resources and equipment are available to support sampling efforts.

6.2.5 Step 5—Develop the Analytic Approach

Specific action levels are not defined for this characterization. The process buildings are being characterized to evaluate the potential disposition of the demolition waste. This data will also be useful to determine the upper-bounds of contamination to support performance assessment modeling for disposition.

Uncertainty in the analytical approach will be addressed, which includes sampling uncertainty (field duplicates), laboratory uncertainty (laboratory duplicates, field duplicates, and matrix spike/matrix spike duplicates), and systematic uncertainty (e.g., lack of access, safety issues).

Samples will be analyzed for, at a minimum, uranium isotopes, Tc-99, Am-241, Np-237, Pu-239/240, Cs-137, Co-60, K-40, Sr-90, thorium isotopes, and metals.

All samples will be subject to leaching (e.g., TCLP extraction for hazardous metals, batch leaching tests for radionuclides, and total nitric acid leach test similar to that done under the CCIPP) prior to analytical analyses to determine potential availability and mobility of radionuclides and hazardous metals.

6.2.6 Step 6—Specify Performance (Acceptance) Criteria

The QAPP, to be included as an attachment to the D&D SAP, identifies the acceptance criteria for the analytical sampling activities. Laboratory and field QC measures will be instituted to reduce uncertainty.

6.2.7 Step 7—Develop the Plan for Obtaining Data

This step is presented in Section 5 of the D&D SAP (Appendix C).

A summary of the sampling locations is provided in Table 11.

Table 11. Sample Locations

Sample No.	Item Description	Component ID	Notes	Cell
1	Centrifugal Pump Assembly	331U0LME259PGPM00-00	C-310 5/1A	5
2	Centrifugal Pump Assembly	331U0LME257PGPM00-00	C-310 9/4A	9
3	12-inch Expansion Joint with Elbow	331U0LME245PGXJ00-00	C-310 5/2 Removed 3/5/2010	5
4	Centrifugal Pump Assembly	331U0LME258PGPM00-00	C-310 Cell 3 Stage 4B	3
5	Centrifugal Pump	331U0LME232PGPM00-00	C-310 7/5B Removed 1998	7
6	12-inch Expansion Joint	331U0LME244PGXJ00-00	C-310 Cell 5 Stage 2 Removed 3/5/2010	5

This field sampling plan for the D&D RI/FS is presented in Appendix C, "Deactivation and Decommissioning Project Sampling and Analysis Plan."

7. HEALTH AND SAFETY PLAN

This D&D decision will incorporate by reference the health and safety requirements from Section 10, Health and Safety Plan, of the *Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/LX/07-2433&D2/R1) (C-400 RI/FS Work Plan HASP). The C-400 RI/FS Work Plan HASP will be applicable, as written, with the following exception: replace references to the C-400 building, C-400 RI/FS, C-400 Complex OU, etc. with abovegrade structures, D&D RI/FS, facilities included in the D&D OU, etc. Additional work control documents may be developed and utilized, as necessary, to accomplish the work scope.

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8. REFERENCES

BJC (Bechtel Jacobs Company LLC) 1999. *Isotopic Distribution of Contamination Found at the U.S. Department of Energy Gaseous Diffusion Plants*, BJC-OR-3412, prepared by Science Applications International Corporation (SAIC), October.

CDM (Camp Dresser and McKee Federal Programs Corporation) 1994. *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant*, 7916-003-FR-BBRY, CDM Federal Programs Corporation, August.

CH2M Hill 1991. *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant Paducah, Kentucky*, KY/ER-4, U.S. Department of Energy, Paducah, KY, March.

CH2M Hill 1992. *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* KY/SUB/13B-97777C P-03/1991/1, U.S. Department of Energy, Paducah, KY, April.

COE (U.S. Army Corps of Engineers) 1994. *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky*, Five Volumes, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

DOC (U.S. Department of Commerce) 2020. "United States Census Bureau: McCracken County, Kentucky," accessed October 14, 2014, https://data.census.gov/profile/McCracken_County,_Kentucky?g=050XX00US21145.

DOE (U.S. Department of Energy) 1994. Memorandum for Secretarial Officers and Heads of Field Elements, "Secretarial Policy Statement on the National Environmental Policy Act," U.S. Department of Energy, Washington, DC, June 13.

DOE 1995a. *Policy on Decommissioning of Department of Energy Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)*, Joint policy from the U.S. Department of Energy and U.S. Environmental Protection Agency, May 22.

DOE 1995b. *Environmental Assessment for the Construction, Operation, and Closure of the Solid Waste Landfill at the Paducah Gaseous Diffusion Plant Paducah, Kentucky*, DOE/EA-1046, U.S. Department of Energy, Oak Ridge, TN, March.

DOE 1996. *Application for United States Nuclear Regulatory Commission Certification, Volume 1 – Paducah Gaseous Diffusion Plant Safety Analysis Report*, USEC-01, U.S. Department of Energy, Paducah, KY, February.

DOE 1999. *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1727&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 2001. *Engineering Evaluation/Cost Analysis for the C-410 Complex Infrastructure at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1952&D2/R2, U.S. Department of Energy, Paducah, KY, May.

DOE 2008. *Removal Action Report for the C-405 Incinerator at the Paducah Environmental Remediation Project, Paducah, Kentucky*, DOE/LX/07-0106&D2, U.S. Department of Energy, Paducah, KY, September.

DOE 2010. *Engineering Evaluation/Cost Analysis for the C-340 Metals Reduction Plant Complex and the C-746-A East End Smelter at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/LX/07-0131&D2/R1), U.S. Department of Energy, Paducah, KY, January.

DOE 2011. *Removal Action Report for Contaminated Sediment Associated with the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0357&D2, U.S. Department of Energy, Paducah, KY, April.

DOE 2012. *Paducah Site Annual Site Environmental Report for Calendar Year 2011*, PAD-REG-1012, U.S. Department of Energy, Paducah, KY, September.

DOE 2018. *Remedial Investigation/Feasibility Study Report for CERCLA Waste Disposal Alternatives Evaluation at the Paducah Gaseous Diffusion Plant Paducah, Kentucky*, DOE/LX/07-0244&D2/R2, U.S. Department of Energy, Paducah, KY, July.

DOE 2020. *Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant*, *Paducah, Kentucky*, DOE/LX/07-2433&D2/R1, U.S. Department of Energy, Paducah, KY, March.

DOE 2023. *Remedial Investigation Report for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-2474&D2, U.S. Department of Energy, Paducah, KY, July.

DOE 2024a. *Site Management Plan Paducah Gaseous Diffusion Plant Paducah, Kentucky Annual Revision—FY 2025*, DOE/LX/07-2508&D2, U.S. Department of Energy, Paducah, KY, December.

DOE 2024b. *Community Relations Plan under the Federal Facility Agreement at the U.S. Department of Energy Paducah Gaseous Diffusion Plant*, DOE/LX/07-2503&D1, U.S. Department of Energy, Paducah, KY, June.

EPA (U.S. Environmental Protection Agency) 1986. *Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy*, Final Draft, Office of Ground-water Protection, U.S. Environmental Protection Agency, Washington, DC, December.

EPA 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, EPA/540/G-89/004, Office of Solid Waste and Emergency Response (OSWER) Directive No. 9355.3-01, U.S. Environmental Protection Agency, Washington, DC, October.

EPA 1998. *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707, U.S. Environmental Protection Agency, Atlanta, GA, February 13.

FRNP (Four Rivers Nuclear Partnership, LLC) 2020. *Process Knowledge File Narrative Waste Stream Data Package*, PGDP-PAD000005, Special Waste Debris, Rev. 1, Four Rivers Nuclear Partnership, LLC, Paducah, KY, February.

FRNP 2024a. *National Emission Standards for Hazardous Air Pollutants Annual Report for 2023 U.S. Department of Energy Radiological Emissions at the Paducah Gaseous Diffusion Plant*, FRNP-RPT-0349, Four Rivers Nuclear Partnership, LLC, Paducah, KY, June.

FRNP 2024b. *Characterization and Criticality Incredible Project Plan for the C-333/C-333A Process Facility at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-CH-1002/FR4, Four Rivers Nuclear Partnership, LLC, Paducah, KY, August.

KRCEE (Kentucky Research Consortium for Energy and Environment) 2021. "United States Department of Energy Paducah Gaseous Diffusion Plant Virtual Museum," accessed September 12, 2024, https://pgdpvirtualmuseum.org/index.html.

MMES (Martin Marietta Energy Systems, Inc.) 1989. Paducah Gaseous Diffusion Plant Site Environmental Report for 1988, Martin Marietta Energy Systems, Inc., ES/ESH-8/V3, May.

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APPENDIX A

ABOVEGRADE STRUCTURES

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Abovegrade Structures

NUMBER	DESCRIPTION
C-100	Administration Building
C-101	Cafeteria
C-102	Hospital
C-102-T02	Office Trailer
C-102-T05	Office Trailer
C-103	DOE Site Office and Annex
C-104	Access Control Facility
C-105	New Emergency Operations Center
C-106	Disintegrator Facility
C-200	Guard and Fire Headquarters
C-200-A	Office Trailer
C-200-C-T01	Storage Shed
C-200-C-T02	Storage Shed
C-200-C-T03	Vehicular Parking (Carport)
C-200-C-T04	Vehicular Parking (Carport)
C-201	Emergency Equipment Storage Building
C-202	Guard Training Building
C-203	Emergency Vehicle Shelter
C-204	Former Disintegrator Building
C-205	Respirator Issue Facility
C-206	Former Pumper Drafter Pit
C-207	Former Fire Training Facility
C-208	Firing Range
C-209	Protective Force Building
C-210	Security Management Office Building
C-211	Training Building
C-215-M	Security IMAC Portal (CA09040)
C-216-M	Security IMAC Portal (CA09042)
C-224	Main Guard Post 15 Building
C-225	Post 48 Building
C-233	Office Trailer/Guard House
C-300	Central Control Building
C-302	Operations Division Data Center
C-303	Supervisory Control and Data Acquisition System
C-304	Office Building
C-304 Annex	Office Building Annex
C-310	Purge and Product Building
C-310-331-A	Bridge (Enclosed)
C-310-331-B	Tie Line
C-310-A	Product Withdrawal Building
C-315	Surge and Waste Building
C-315-331	Tie Line
C-320	Communication Building

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-331	Process Building
C-331-333-A	Bridge (Enclosed)
C-331-333-B	Tie Line (East)
C-331-333-C	Tie Line (West)
C-331-335	Tie Line
C-331-410	Tie Line (Abandoned Remnant)
C-331-B1	Equipment Storage (Carport)
C-333	Process Building
C-333-A	Feed Vaporization Facility
C-333-T10	Breakroom Trailer
C-333-T11	Meeting/Office Trailer
C-333-T12	Meeting/Office Trailer
C-333-T13	Shower and Change Trailer
C-333-T14	Meeting/Office Trailer
C-333-T15	Meeting/Office Trailer
C-333-T16	Meeting/Office Trailer
C-333-T17	Meeting/Office Trailer
C-333-TB	Vending
C-335	Process Building
C-335-337-A	Bridge (Enclosed)
C-335-337-B	Tie Line (North)
C-335-337-C	Tie Line (South)
C-337	Process Building
C-337-A	Feed Vaporization Facility
C-350	Drying Agent Storage Building
C-350-A	Emergency Shower
C-360	Toll Transfer and Sampling Building
C-360-A	Toll Transfer and Sampling Building Annex
C-400	Cleaning Building
C-400-T01	Office Trailer
C-409	Stabilization Building
C-409-A	Large Item Neutron Assay System (LINAS) (Annex)
C-410-D	Fluorine Storage Building
C-410-K	Fluorine Facility Building
C-410-L	Quonset Hut
C-411-T01	Equipment Storage (Carport)
C-412-A	Above Ground Storm Shelter
C-412-B	Above Ground Storm Shelter
C-412-C	Above Ground Storm Shelter
C-412-D	Above Ground Storm Shelter
C-412-R	Sealand Storage Container
C-412-S	Sealand Storage Container
C-412-T01	Office Trailer
C-412-T02	Office Trailer
C-412-T03	Office Trailer

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-412-T04	Office Trailer
C-412-T05	Office Trailer
C-412-T07	Shower and Change Trailer
C-412-T08	Office Trailer
C-412-T09	Office Trailer
C-412-T10	Office Trailer
C-412-T11	Shower Trailer
C-412-T11A	Shower Trailer
C-412-T12	Shower and Change Trailer
C-412-T13	Office Trailer
C-412-T14	Office Trailer
C-412-T15	Office Trailer
C-412-T16	Breakroom Trailer
C-412-T17	Breakroom Trailer
C-412-T19	Storage Shed
C-412-T20	Shower Trailer
C-415	Feed Plant Storage Building
C-415-T01	Sealand Storage Container
C-416-T01	Sealand Storage Container
C-531-1	Switch House
C-531-2	Switchyard
C-531-3A	Fire Valve House No. 1
C-531-3B	Fire Valve House No. 2
C-532	Relay House
C-533-1	Switch House
C-533-2	Switchyard
C-533-3A	Fire Valve House No. 1
C-533-3B	Fire Valve House No. 2
C-533-3C	Fire Valve House No. 3
C-533-3D	Fire Valve House No. 4
C-535-1	Switch House
C-535-2	Switchyard
C-535-3A	Fire Valve House No. 1
C-535-3B	Fire Valve House No. 2
C-535-4	Test Shop (Maintenance Office)
C-536	Relay House
C-537-1	Switch House
C-537-2	Switchyard
C-537-3A	Fire Valve House No. 1
C-537-3B	Fire Valve House No. 2
C-537-3C	Fire Valve House No. 3
C-537-3D	Fire Valve House No. 4
C-537-4	Test Shop
C-540-A	Oil Pump House
C-540-B	Oil Storage Tank (Northwest)

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-540-C	Oil Storage Tank (Southwest)
C-540-D	Oil Storage Tank (Northeast)
C-540-E	Oil Storage Tank (Southeast)
C-541-A	Oil Pump House
C-541-B	Oil Storage Tank (Northwest)
C-541-C	Oil Storage Tank (Southwest)
C-541-D	Oil Storage Tank (Northeast)
C-541-E	Oil Storage Tank (Southeast)
C-600	Utility Plant
C-600-A	C-600 Steam Pkg Boilers—PB-01 and PB-05
C-600-T01	Equipment Storage (Carport)
C-600-1	Cooling Tower
C-601	Nitrogen Generator Building Addition
C-601-A	Steam Plant Fuel Storage Tank (Center)
C-601-B	Steam Plant Fuel Storage Tank (South)
C-601-C	Steam Plant Fuel Oil Pump House
C-604	Utilities Maintenance Building
C-605	Substation Building
C-606	Coal Crusher Building
C-607	Emergency Air Compressor Generator Building
C-611-A1	Activated Carbon Storage Building
C-611-B	Head House
C-611-B1	Polymer Feed System Enclosure
C-611-F2	Chemical Feed Building for C-611-F1
C-611-F3	Activated Carbon Feed Facility
C-611-H	Filter Building and Pump Station
C-611-J	Pump House (Settled Water)
C-611-O	Sanitary Water Storage Tank
C-611-P	Pump House
C-611-S	Storage and Chlorine Facility
C-611-U-CaO	Lime storage bin
C-611-U-CO2	CO2 tank
C-611-U-FF	Solid ferric sulfate storage bin
C-611-U-SA	Soda ash storage bin
C-611-T02	Equipment Storage (Carport)
C-611-U	Softening Facility (West)
C-611-X	Softening Facility (East)
C-612-B1	Above Ground Storm Shelter
C-612-T04	Wooden Storage Building
C-612-T05-T08	Sealand Storage Containers
C-612-T09-T12	Sealand Storage Containers
C-613-01	Basin Pump Station
C-613-02	Basin Pump Station
C-615	Sewage Treatment Plant
C-615-C	Sewage Plant Monitoring Building

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-615-C1	Sodium Hypochlorite Conversion Chemical Storage Building
C-615-D	Digester
C-615-E	Trickling Filter
C-615-F	Dry Bed for Trickling Filter
C-615-G	Sewage Lift Station
C-615-H	Sewage Lift Station
C-615-H1	Sewage Lift Station
C-615-H2	Sewage Lift Station
C-615-H3	Sewage Lift Station
C-615-H5	Sewage Lift Station
C-615-H8	Sewage Lift Station
C-615-L	Oil Control Monitoring Station
C-615-M	Oil Control Structure
C-616-A	Chemical Feed Building
C-616-B	Clarifier (East)
C-616-C	Lift Station
C-616-H1	Ferrous Sulfate Storage Tank (East)
C-616-H2	Ferrous Sulfate Storage Tank (West)
C-616-J	Reduction Tank (East)
C-616-K	Service Building
C-616-M	Clarifier (West)
C-616-N	Reduction Tank (West)
C-617-A	Effluent Control Station
C-620	Air Compressor Room
C-631-1	Pump House
C-631-2	Cooling Tower
C-631-3	Pump House (Firewater)
C-631-4	Blending Pump House
C-631-5	Blending Cooling Tower (West)
C-631-6	Blending Cooling Tower (East)
C-633-1	Pump House
C-633-2A	Cooling Tower (South)
C-633-2B	Cooling Tower (North)
C-633-3	Blending Pump House
C-633-4	Blending Cooling Tower (North)
C-633-5	Blending Cooling Tower (South)
C-633-6	Sand Filter Building
C-635-1	Pump House
C-635-2	Cooling Tower
C-635-3	Blending Pump House
C-635-4	Blending Cooling Tower (North)
C-635-5	Blending Cooling Tower (South)
C-635-6	Recirculating Heat Utilization Pump House
C-637-1	Pump House
C-637-2A	Cooling Tower (South)

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-637-2B	Cooling Tower (North)
C-637-3	Blending Pump House
C-637-4	Blending Cooling Tower (North)
C-637-5	Blending Cooling Tower (South)
C-637-6	Sand Filter Building
C-709	Plant Laboratory Annex
C-710	Technical Services Building
C-720	Maintenance and Storage Building
C-720-A	Compressor Shop
C-720-B	Machine Shop Addition
C-720-C	Converter Shop Addition
C-720-C1	Paint Shop
C-720-D	Transformer Building
C-720-E	Change House Addition
C-720-G	Warehouse
C-720-G1	TOX Room
C-720-G2	TOX Room
C-720-H	Warehouse
C-720-J	Air Lock
C-720-K	Instrument Shop Addition
C-720-T09	Equipment Storage (Carport)
C-724-A	Carpenter Shop Annex
C-724-B	Carpenter Shop
C-724-C	Paint Shop
C-724-D	Lumber Storage Building
C-725	Janitorial Storage
C-726	Sandblast Building
C-728	Motor Cleaning Facility
C-730-A1	Above Ground Storm Shelter
C-730-T05	Office Trailer
C-730-T06	Office Trailer
C-731	Railroad Repair Equipment Storage Building
C-733	Waste Oil and Chemical Storage Facility
C-734	Salt Storage Structure
C-740-B	Oil Drum Storage Shelter
C-741	Mobile Equipment Shed
C-743-B1	Above Ground Storm Shelter
C-743-C1	Above Ground Storm Shelter
C-743-T01	Office Trailer
C-743-T02	Office Trailer
C-743-T13	Office Trailer
C-743-T14	Instrument Shop Trailer
C-743-T15	Office Trailer
C-743-T16	Office Trailer
C-744	Material Handling Building
C-745-J	Radioactive Material Storage Yard

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-746-A	North Warehouse
C-746-G	Electrical Equipment Storage
C-746-Q	Hazardous and LLW Storage Facility
C-746-Q1	High Assay Waste Storage Building
C-746-U1	Landfill Office Building
C-746-U2	Landfill Equipment Building
C-746-U3	Landfill Leachate Facility
C-746-U4 to U9 (6 total)	Sealand Storage Containers
C-746-U10	Storage Building
C-746-U11	Storage Building
C-746-U12	Storage Building
C-746-U13A	Above Ground Storm Shelter
C-746-U-T14	Shower Trailer
C-746-U15	Leachate Treatment Facility
C-746-U16	Leachate Storage Facility
C-746-U-S	Truck Scale At Landfill
C-746-X	Electrical Equipment Storage Building
C-747-A-T04	Scale House Shed
C-750	Garage Building
C-752-A	Waste Storage Facility
C-752-A-ENC	Waste Containment Enclosure
C-752-A-T10	Office/Breakroom Trailer
C-752-B-T01	Refueling Station Trailer
C-752-C -T01-A	Lab/Breakroom Trailer
C-752-C-T01-T08	Sealand Storage Trailers
C-752-EV	Electric Vehicle Charging Station
C-753-A	TSCA Waste Storage Facility
C-754	Low Level Waste Storage
C-754-A	Waste Management Staging Area
C-754-B	Guard Training Facility
C-755-A	Maintenance Shop
C-755-A1	Storage Shed
C-755-B	Change House Building
C-755-C	Storage Facility
C-755-D	Electrical Storage
C-755-E1	Above Ground Storm Shelter
C-755-F1	Above Ground Storm Shelter
C-755-G1	Above Ground Storm Shelter
C-755-H1	Above Ground Storm Shelter
C-755-J	Sealand Storage Containers (3)
C-755-K	Sealand Storage Container
C-755-M	Wooden Storage Shed
C-755-M1	Wooden Storage Shed
C-755-M2	Wooden Storage Shed
C-755-M3	Wooden Storage Shed
C-755-M4	Wooden Storage Shed

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-755-P1	Wooden Storage Shed
C-755-P2	Wooden Storage Shed
C-755-Q	Sealand Storage Container
C-755-S	Office Trailer
C-755-T	Wooden Storage Shed
C-755-T01	Office Trailer
C-755-T02	Office Trailer
C-755-T03	Office Trailer
C-755-T04	Office Trailer
C-755-T05	Office Trailer
C-755-T07	Breakroom Trailer
C-755-T08B	Shower and Changeroom Trailer
C-755-T09	Office Trailer
C-755-T10	Storage Trailer
C-755-T13	Sealand Storage Container
C-755-T14	Sealand Storage Container
C-755-T16	Shower and Changeroom Trailer
C-755-T17A	Shower Trailer
C-755-T19	Office/Breakroom Trailer
C-755-T20	Office/Breakroom Trailer
C-755-T22A	Office/Breakroom Trailer
C-755-T23	Office Trailer
C-755-T24	Storage Shed
C-755-T26	Office/Breakroom Trailer
C-755-T27	Office Trailer
C-755-T28	Office Trailer
C-755-T29	Storage Shed
C-755-T30	Storage Shed
C-755-U	Metal Carports/Equipment Sheds (6)
C-755-V	Former Salt Storage
C-755-W	Small Maintenance Shop
C-755-X	Storage Shed
C-755-Y	Sealand Storage Container
C-757	Solid and Low-Level Waste Process Facility
C-759-A	Carport—Formerly ISOCS
C-761	Staging Area—Gravel Pad
C-762-A	Equipment Storage (Carport)
C-762-T02	Storage Shed
C-764-D1	Above Ground Storm Shelter
C-764-D2	Above Ground Storm Shelter
C-764-T01	Office Trailer
C-764-T02	Conference/Office Trailer
C-764-T03	Office Trailer
C-764-T04	Office Trailer
C-764-T05	Office Trailer

Abovegrade Structures (Continued)

NUMBER	DESCRIPTION
C-764-T06	Office Trailer
C-764-T07	Office Trailer
C-764-T08	Office Trailer
C-764-T09	Office Trailer
C-764-T10	Office Trailer
C900057 (Bridge 1)	South Acid Road Bridge

If a reuse potential for a building/structure or infrastructure is identified in the future, and the facility is shown to be free of contamination according to DOE Order (O) 458.1 Chg 4 (LtdChg), *Radiation Protection of the Public and the Environment*, and applicable portions of DOE O 5400.5 Chg 2, *Radiation Protection of the Public and the Environment*, this could be modified to remove the building/structure or infrastructure from the scope of the decision.

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APPENDIX B

PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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ACRONYMS

ACM	asbestos-containing material
ALARA	as low as reasonably achievable
AOC	area of contamination
ARAR	applicable or relevant and appropriate requirement
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CI	compression ignition
CWA	Clean Water Act
D&D	deactivation and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EDE	effective dose equivalent
E.O.	executive order
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
HMR	Hazardous Materials Regulations
ICE	internal combustion engine
KAR	*Kentucky Administrative Regulations*
KPDES	Kentucky Pollutant Discharge Elimination System
LLW	low-level waste
M	manual
MVAC	motor vehicle air conditioning
NPDES	National Pollutant Discharge Elimination System
NWP	Nationwide Permit
O	order
OSHA	Occupational Safety and Health Administration
PGDP	Paducah Gaseous Diffusion Plant
POTW	publicly owned treatment works
RACM	regulated asbestos-containing material
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
TBC	to be considered
TBEL	technology-based effluent limitation
TED	total equivalent dose
TSCA	Toxic Substances Control Act
U.S.C.	*United States Code*
UTS	universal treatment standard
VOHAP	volatile organic hazardous air pollutant
WQBEL	water quality-based effluent limitation
WWTU	wastewater treatment unit

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B.1. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

B.1.1 INTRODUCTION

Congress specified in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, *Cleanup Standards*, that remedial actions for the cleanup of hazardous substances must require a level or standard of control that attains those requirements, criteria, standards, or limitations under federal or more stringent state environmental laws that are legally applicable or relevant and appropriate requirements (ARARs) to the hazardous substances or circumstances at a site (unless an ARAR is waived). ARARs include those federal and state laws/regulations that are designed to protect the environment and other important considerations such as cultural resources. ARARs do not include occupational safety or worker radiation protection requirements. The U.S. Environmental Protection Agency (EPA) requires compliance with the Occupational Safety and Health Administration (OSHA) standards independent of the ARARs process. Neither the regulations promulgated by OSHA nor U.S. Department of Energy (DOE) Orders related to occupational safety are addressed as ARARs. These requirements would be addressed in the required health and safety plans for any action.

CERCLA Section 121(e) exempts on-site CERCLA activities from administrative permitting requirements [see 40 *CFR* § 300.400(e)]. In addition, CERCLA on-site remedial response actions are required to comply only with the substantive requirements of a law or regulation. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation.

The following terms are used throughout this appendix.

- **Applicable Requirements.** Are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting law that are legally applicable and specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 *CFR* § 300.5, *Definitions*).

- **Relevant and Appropriate Requirements.** Are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site (40 *CFR* § 300.5).

- **To Be Considered (TBC) Guidance.** In addition to federal or state-promulgated regulations, there are other advisories, criteria, or guidance to be considered for a particular release that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies [40 *CFR* § 300.400(g)(3)].

The remainder of this appendix will address those preliminary requirements that apply to deactivation and decommissioning (D&D) actions through the CERCLA (i.e., ARARs) process. Development of ARARs is an iterative, negotiated process, beginning with a large realm of potential ARARs found in the remedial investigation/feasibility study report, with revisions, additions, and deletions occurring as the remedial process progresses, until the ARARs are finalized as the record of decision (ROD) is signed. ARARs included in this appendix are intended to continue discussions and facilitate agreement on the ARARs and TBCs for the alternative evaluations. Section 5.3 of the D&D scoping document and work plan provides further explanation as to why action-specific ARARs that have been the subject of extended discussions, or even disputes, are included in this preliminary list. The contextual description of ARARs in Section 5.3 of the D&D scoping document and work plan and the preliminary ARARs list are meant to be considered together.

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance

Location/Action	Summary of Requirements	Prerequisite	Citation
Floodplains/Wetlands			
Presence of floodplain as defined in 10 *CFR* § 1022.4	Avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains.	DOE actions that involve potential impacts to, or take place within, floodplains—**applicable**.	10 *CFR* § 1022.3(c)
	Undertake a careful evaluation of the potential effects of any action taken in a floodplain. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on floodplains.		10 *CFR* § 1022.3(b) and (d)
	Restore and preserve natural and beneficial values served by floodplains to the extent practicable.	DOE actions that involve potential impacts to, or take place within, floodplains—**applicable**.	10 *CFR* § 1022.3(a)(3)
	Measures that mitigate the adverse effects of actions in a floodplain including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-sensitive areas.		10 *CFR* § 1022.13(a)(3)
	If no practicable alternative to locating or conducting the action in the floodplain is available, then before taking action, design or modify its action in order to minimize potential harm to or within the floodplain, consistent with the policies set forth in Executive Order (E.O.) 11988, *Floodplain Management*, and E.O. 11990, *Protection of Wetlands*.		10 *CFR* § 1022.14(a)
Nationwide Permit Program	Must comply with the substantive requirements of the Nationwide Permit (NWP) 38, General Conditions, as appropriate.	Discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands by a federal agency other than the U.S. Army Corps of Engineers—**relevant and appropriate**.	NWP (38) Cleanup of Hazardous and Toxic Waste 33 *CFR* § 323.3(b)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Location encompassing aquatic ecosystem as defined in 40 *CFR* § 230.3(b)	Except as provided under § 404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**relevant and appropriate**.	40 *CFR* § 230.10(a) and (c)
	No discharge of dredged or fill material is permitted: (1) Causes or distributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard. (2) Violates any applicable toxic effluent standard or prohibition under Section 307 of the Toxic Substances Control Act (TSCA). (3) Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification of a habitat which is determined by the Secretary of Interior or Commerce, as appropriate, to be a critical habitat under the Endangered Species Act of 1973, as amended. If an exemption has been granted by the Endangered Species Committee, the terms of such exemption shall apply in lieu of this subparagraph; (4) Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**relevant and appropriate**.	40 *CFR* § 230.10(b)
	Except as provided under § 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps		40 *CFR* § 230.10(d)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Location encompassing aquatic ecosystem as defined in 40 *CFR* § 230.3(b) (continued)	have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 *CFR* § 230 Subpart H *et seq*. identifies such possible steps.		
Cultural Resources			
Presence of archaeological or historic data	Provide for the preservation of significant historical and archeological data which might otherwise be irreparably lost or destroyed as a result of any alternation of terrain caused as a result of any federal construction project.	Federal construction project that would cause the irreparable loss or destruction of significant historical or archeological data—**relevant and appropriate**.	54 *U.S.C.* § 312502(a)
Presence of historical property	The head of any federal agency having direct or indirect jurisdiction over a proposed federal or federally assisted undertaking in any state and the head of any federal department or independent agency having authority to license any undertaking, prior to the approval of the expenditure of any federal funds on the undertaking or prior to the issuance of any license, shall take into account the effect of the undertaking on any historic property. The head of the federal agency shall afford the council a reasonable opportunity to comment with regard to the undertaking.	Federal agency undertaking that may impact historical properties listed or eligible for inclusion on the National Register of Historic Places—**applicable**.	54 *U.S.C.* § 306108
Endangered, Threatened, or Rare Species			
Presence of federally endangered or threatened species, as designated in 50 *CFR* §§ 17.11 and 17.12 or critical habitat of such species	Ensure that such actions are not likely to jeopardize the existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat unless an exemption.	Action authorized, funded, or carried out by a federal agency—**applicable**.	16 *U.S.C.* § 1536(a)(2)
Site Preparation and Excavation Activities			
Activities causing fugitive dust emissions	No person shall cause, suffer, or allow any material to be handled, processed, transported, or	Fugitive emissions from land-disturbing activities (e.g.,	401 *KAR* 63:010 § 3(1) (a), (b), (d), (e) and (f)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Activities causing fugitive dust emissions (continued)	stored; a building or its appurtenances to be constructed, altered, repaired, or demolished, or a road to be used without taking reasonable precaution to prevent particulate matter from becoming airborne. Such reasonable precautions shall include, when applicable, but not be limited to the following: • Use, where possible, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land; • Application and maintenance of asphalt, oil, water, or suitable chemicals on roads, materials stockpiles, and other surfaces which can create airborne dusts; • Covering, at all times when in motion, open bodied trucks transporting materials likely to become airborne; • The maintenance of paved roadways in a clean condition; and • The prompt removal of earth or other material from a paved street which earth or other material has been transported thereto by trucking or earth moving equipment or erosion by water.	handling, processing, transporting, or storing of any material, demolition of structures, construction operations, grading of roads, or the clearing of land)—**applicable**.	
	No person shall cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate.	Fugitive emissions from land-disturbing activities (e.g., handling, processing, transporting, or storing of any material, demolition of structures, construction operations, grading of roads, or the clearing of land)—**applicable**.	401 *KAR* 63:010 § 3(2)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Radiation protection of the public and the environment	Except as provided in 458.1(4)(c), exposure to individual members of the public from radiation shall not exceed a total effective dose equivalent (EDE) of 0.1 rem/year [100 millirem (mrem)/year], exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Radionuclide emissions from all exposure modes from all DOE activities (including remedial actions) at a DOE facility—**TBC**.	DOE Order (O) 458.1(4)(b) and (c)
Radiation dose limits for individual members of the public	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Dose received from operations—**relevant and appropriate**.	10 *CFR* § 20.1301(a)(1) 902 *KAR* 100:019 § 8 (1)(a)
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Best management storm water controls will be implemented and may include, as appropriate, erosion and sedimentation control measures, structural practices (e.g., silt fences, straw bale barriers) and vegetative practices (e.g., seeding); storm water management (e.g., diversion); and maintenance of control measures in order to ensure compliance with the standards in Section A.5 Storm Water Discharge Quality.	Storm water runoff associated with construction activities taking place at a facility [Paducah Gaseous Diffusion Plant (PGDP)] with an existing Best Management Practices Plan—**TBC**.	Appendix A of the PGDP Best Management Practices Plan (2024)—Examples of Storm Water Controls
	Implement measures to control pollutants in storm water discharges during and after construction in accordance with substantive requirements provided by permits issued pursuant to 40 *CFR* § 122.26(c).	Storm water discharges associated with an industrial activity as defined in 40 *CFR* § 122.26(b)(14) (x) and 401 *KAR* 5:002 § 1(183)—**applicable**.	40 *CFR* § 122.26(c)(1)(ii)(C) and (D) 401 *KAR* 5:060 § 8

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
	Low-Level Waste (LLW) Waste Management		
Management, storage and disposal of LLW	Management, storage, and disposal must be conducted in a manner such that exposure to members of the public to radiation from radioactive waste complies with ALARA process requirements and does not exceed a total equivalent dose (TED) of 25 mrem in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.	Management, storage, and disposal of low-level radioactive waste—**TBC**.	DOE O 458.1(4)(h)(1)(c)
Disposal of LLW in a landfill	Void spaces within the waste and, if containers are used, between the waste and its container shall be reduced to the extent practical.	Generation of LLW for disposal in a landfill—**TBC**.	DOE Manual (M) 435.1-1 (IV)(G)(1)(d)(1)
Disposal of solid LLW at DOE facilities	Shall meet waste acceptance requirements before it is transferred to the receiving facility.	Generation of LLW for disposal at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(J)(2)
Disposal of radioactive material	Waste shall not be pyrophoric. Pyrophoric material contained in waste shall be treated, prepared, and packaged to be nonflammable.	Generation of LLW for disposal—**relevant and appropriate**.	902 *KAR* 100:021 § 7(1)(g)
Structural stability of LLW	Waste shall have structural stability. A structurally stable waste form shall maintain its physical dimension and its form under expected disposal conditions, such as: • Weight of overburden and compaction equipment; • Presence of moisture and microbial activity; and • Internal factors such as radiation effects and chemical changes.	Generation of LLW for disposal—**relevant and appropriate**.	902 *KAR* 100:021 § 7 (2)(a)(1)
	Structural stability may be provided by: • The waste form itself; • Processing the waste to a stable form; or • Placing the waste in a disposal container or structure that provides stability after disposal.	Generation of LLW for disposal—**relevant and appropriate**.	902 *KAR* 100:021 § 7 (2)(a)(2)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
	Discharge of Wastewater from Treatment System		
Protection of surface waters	The minimum water quality criteria established in this administrative regulation shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 *KAR* 10:029, Section 4 Mixing Zones. Surface waters shall not be aesthetically or otherwise degraded by substances that: (a) Settle to form objectionable deposits; (b) Float as debris, scum, oil, or other matter to form a nuisance; (c) Produce objectionable color, odor, taste, or turbidity; (d) Injure or are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life; (e) Produce undesirable aquatic life or result in the dominance of nuisance species; or (f) Cause fish flesh tainting.	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.	401 *KAR* 10:031 § 2(1)(a-f)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Protection of surface waters (continued)	Surface waters may be designated as having one (1) or more legitimate uses established in 401 *KAR* 10:026 and associated criteria protective of those uses. Nothing in this administrative regulation shall be construed to prohibit or impair the legitimate beneficial uses of these waters. The criteria in Sections 2 Minimum Criteria Applicable to All Surface Waters, 4 Aquatic Life, 6 Pollutants, and 7 Recreational Waters of this administrative regulation represent minimum conditions necessary to: (a) Protect surface waters for the indicated designated use; and (b) Protect human health regarding fish consumption.	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.	401 *KAR* 10:031 § 3(1)
	The concentration of phenol shall not exceed 300 μg/L as an instream value.*		401 *KAR* 10:031 § 2(2)*
Consideration of natural conditions	On occasion, surface water quality may be outside of the limits established to protect designated uses because of natural conditions. If this occurs during periods when stream flows are below the flow that is used by the cabinet to establish effluent limitations for wastewater treatment facilities, a discharger shall not be considered a contributor to instream violations of water quality standards, if treatment results in compliance with permit requirements.		401 *KAR* 10:031 §3(2)
Stream flow requirements for Water Quality-based Effluent Limitations (WQBELs)	Stream flows for water quality-based permits. The following stream flows shall be utilized if deriving Kentucky Pollutant Discharge Elimination System (KPDES) permit limitations to protect surface waters for the listed uses and purposes: (a) Aquatic life protection shall be 7Q10; (b) Water-based recreation protection shall be	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.	401 *KAR* 10:031 §3(3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Stream flow requirements for Water Quality-based Effluent Limitations (WQBELs) (continued)	7Q10; (c) Domestic water supply protection shall be determined at points of withdrawal as: 1. The harmonic mean for cancer-linked substances; and 2. 7Q10 for noncancer-linked substances (d) Human health protection regarding fish consumption and for changes in radionuclides shall be the harmonic mean; and (e) Protection of aesthetics shall be 7Q10.		
Numeric water quality criteria*	Allowable instream concentrations of pollutants are listed as water column values in Table 1 of this section unless otherwise indicated.*	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.*	401 *KAR* 10:031 §6, Table 1*
Water quality criteria for warm water aquatic habitat*	The parameters and associated criteria in subparagraphs (a) through (k) shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arborous growth, agricultural, and industrial uses.*	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY designated as Warm Water Aquatic Habitat—**applicable**.*	401 *KAR* 10:031 §4(1)(a-k)*
Water quality criteria for recreational waters*	(1) Primary contact recreation water. The criteria provided in subparagraph (b), pH shall be between six and zero-tenths (6.0) to nine and zero-tenths (9.0) and shall not change more than one and zero-tenths (1.0) pH unit within this range over a period of twenty-four (24) hours, shall apply to waters designated as primary contact recreation use during the primary contact recreation season of May 1 through October 31. (2) Secondary contact recreation water. The criteria provided in subparagraph (b), pH shall be between six and zero-tenths (6.0) to nine and zero-tenths (9.0) and shall not change more than one and zero-tenths (1.0) pH unit within this range	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY designated Recreational—**applicable**.*	401 *KAR* 10:031 §7(1)(b), (2)(b)*

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Water quality criteria for recreational waters (continued)*	over a period of twenty-four (24) hours shall apply to waters designated for secondary contact recreation use during the entire year.*		
Antidegradation requirements	Where the quality of surface waters exceeds that necessary to support propagation of fish, shellfish, wildlife and recreation in and on the water, that quality shall be maintained and protected unless the cabinet finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the cabinet's continuing planning process required by 33 *U.S.C.* 1313 and 40 *CFR* § 130.5, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. (a) For point source discharges, water quality shall be maintained and protected in these waters according to the procedures specified in 401 *KAR* 10:030, Section 1(2)(b) or (3)(b). (b) In allowing degradation or lower water quality, the cabinet shall assure water quality adequate to protect existing uses fully. (c) The cabinet shall assure that there shall be achieved the highest statutory and regulatory requirements for waste treatment by all new and existing point sources and that nonpoint sources of pollutants be controlled by application of all cost effective and reasonable best management practices.	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable.**	401 *KAR* 10:029 § 1(2)
General duty to mitigate for discharge of wastewater	Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has a reasonable likelihood of adversely affecting	Point source discharge of pollutants to surface waters—**applicable.**	401 *KAR* 5:065 § 2(1) and 40 *CFR* § 122.41(d)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
General duty to mitigate for discharge of wastewater (continued)	human health or the environment.		
Operation and maintenance of treatment system	Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with the effluent standards. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures.	Discharge of pollutants to surface waters—**applicable**.	401 *KAR* 5:065 § 2(1) and 40 *CFR* § 122.41(e)
Protection of human health from fish consumption	The water quality criteria for the protection of human health related to fish consumption in Table 1 of Section 6 Pollutants of this administrative regulation shall apply to all surface water at the edge of the assigned mixing zones except for those points where water is withdrawn for domestic water supply use (a) The criteria are established to protect human health regarding the consumption of fish tissue and shall not be exceeded. (b) For those substances associated with a cancer risk, an acceptable risk level of not more than one (1) additional cancer case in a population of 1,000,000 people, or 1 x 10-6 shall be utilized to establish the allowable concentration.	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable.**	401 *KAR* 10:031 §2(3)*
Technology-based effluent limitations (TBELs) for wastewater discharge	To the extent that EPA-promulgated effluent limitations are inapplicable, shall develop on a case-by-case best professional judgment basis under § 402(a)(1)(B) of the Clean Water Act (CWA), TBELs by applying the appropriate factors listed in 40 *CFR* § 125.3(d) and shall consider: • The appropriate technology for this category or class of point sources, based upon all	Discharge of pollutants to surface waters from other than a publicly owned treatment works (POTW)—**applicable**.	40 *CFR* § 125.3(c)(2)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Technology-based effluent limitations (TBELs) for wastewater discharge (continued)	available information; and • Any unique factors relating to the discharger.		
	Technology-based treatment requirements are applied prior to or at the point of discharge.		40 *CFR* § 125.3(e)
	Technology-based treatment requirements cannot be satisfied through the use of "non-treatment" techniques such as flow augmentation and in-stream mechanical aerators.		40 *CFR* § 125.3(f)
Water quality standards and State requirements*	Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality. * *NOTE: DOE is not required to obtain a permit for any part of a remedial action conducted entirely on-site, per CERCLA § 121(e). Use of the terms "permit" and "permittee" reflect regulatory language; in this remedial action, "permit" can generally be taken to mean the ROD, and "permittee" to mean DOE. Limitations that otherwise would be included in a permit will be identified in a CERCLA ROD or post-ROD Federal Facility Agreement (FFA) Primary document.*	Discharge that causes or has the reasonable potential to cause, or contributes to an excursion above any State water quality standard, including State narrative criteria for water quality—**applicable.***	40 *CFR* § 122.44(d)(1)(i) 401 *KAR* 5:065 § 2(4)*
Establishing effluent limits for whole effluent toxicity*	When the permitting authority determines, using the procedures in paragraph (d)(1)(ii) of this section, that a discharge causes, has the reasonable potential to cause, or contributes to an instream excursion above the numeric criterion for whole effluent toxicity, the permit must contain effluent limits for whole effluent toxicity.* *NOTE: DOE is not required to obtain a permit for*	Discharge that causes or has the reasonable potential to cause, or contributes to an instream excursion above the numeric criterion for whole effluent toxicity—**applicable**.*	40 *CFR* § 122.44(d)(1)(iv) 401 *KAR* 5:065 § 2(4)*

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Establishing effluent limits for whole effluent toxicity* (continued)	*any part of a remedial action conducted entirely onsite, per CERCLA § 121(e). Use of the terms "permit" and "permittee" reflect regulatory language; in this remedial action, "permit" can generally be taken to mean the ROD, and "permittee" to mean DOE. Limitations that otherwise would be included in a permit will be identified in a CERCLA ROD or post-ROD FFA Primary document.*		
Establishing WQBELs using a calculated numeric water quality criterion	Permitting authority must establish effluent limits using a calculated numeric water quality criterion for the pollutant which the permitting authority demonstrates will attain and maintain applicable narrative water quality criteria and will fully protect the designated use. Such criterion may be derived using an explicit State policy or regulation interpreting its narrative water quality criterion, supplemented with other relevant information which may include EPA's Water Quality Standards Handbook, October 1983, risk assessment data, exposure data and current EPA criteria documents. *NOTE: DOE is not required to obtain a permit for any part of a remedial action conducted entirely on-site, per CERCLA § 121(e). Use of the terms "permit" and "permittee" reflect regulatory language; in this remedial action, "permit" can generally be taken to mean the ROD, and "permittee" to mean DOE. Limitations that otherwise would be included in a permit will be identified in a CERCLA ROD or post-ROD FFA Primary document.*	Determination of effluent limits where a State has not established a water quality criterion for a specific pollutant—**applicable.**	40 *CFR* § 122.44(d)(1)(vi)(A) 401 *KAR* 5:065 § 2(4)
WQBELs for wastewater discharge	When developing WQBELs under this paragraph the permitting authority shall ensure that: (a) The level of water quality to be achieved by limits on point source(s) established under	Point source discharge of pollutants to surface waters—**applicable.**	40 *CFR* § 122.44(d)(1)(vii) 401 *KAR* 5:065 § 2(4)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
WQBELs for wastewater discharge (continued)	this paragraph is derived from, and complies with all applicable water quality standards; and (b) Effluent limits developed to protect narrative or numeric water quality criteria are consistent with the assumptions and any available waste load allocation for the discharge prepared by the State and approved by EPA pursuant to 40 *CFR* § 130.7. *NOTE: DOE is not required to obtain a permit for any part of a remedial action conducted entirely onsite, per CERCLA § 121(e). Use of the terms "permit" and "permittee" reflect regulatory language; in this remedial action, "permit" can generally be taken to mean the ROD, and "permittee" to mean DOE. Limitations that otherwise would be included in a permit will be identified in a CERCLA ROD or post-ROD FFA Primary document.*		
	Attain or maintain a specified water quality through water quality related effluent limits established under section 302 of CWA.	Discharge of pollutants to surface waters—**applicable**.	40 *CFR* § 122.44(d)(2) 401 *KAR* 5:065 § 2(4)
Variance from TBELs	If conditions exist or are believed to exist that preclude compliance with the requirements of TBELs, a non-POTW may request a variance from otherwise applicable effluent limitations as established in 40 *CFR* § 122.21(m). *NOTE: Variance shall be made as part of the FFA CERCLA document review and approval process.*	Discharge of pollutants to surface waters—**applicable.**	401 *KAR* 5:055 § 6
Minimum monitoring requirements for discharges from on-site CERCLA wastewater treatment unit (WWTU)	In addition to § 122.48, and to assure compliance with permit limitations, the following monitoring requirements shall be followed: (i) The mass (or other measurement specified in the permit) for each pollutant limited in	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface water—**applicable**.	40 *CFR* § 122.44(i)(1) 401 *KAR* 5:065 § 2(4)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Minimum monitoring requirements for discharges from on-site CERCLA WWTU (continued)	the permit; (ii) The volume of effluent discharged from each outfall; (iii) Other measurements as appropriate including pollutants in internal waste streams under § 122.45(i); pollutants in intake water for net limitations under § 122.45(f); frequency, rate of discharge, etc., for non-continuous discharges under § 122.45(e); pollutants subject to notification requirements under§ 122.42(a); and pollutants in sewage sludge or other monitoring as specified in 40 *CFR* Part 503; or as determined to be necessary on a case-by-case basis pursuant to section 405(d)(4) of the CWA. *NOTE: DOE is not required to obtain a permit for any part of a remedial action conducted entirely onsite, per CERCLA § 121(e). Use of the terms "permit" and "permittee" reflect regulatory language; in this remedial action, "permit" can generally be taken to mean the ROD or post-ROD Primary Document such as a Remedial Design, and "permittee" to mean DOE. Monitoring parameters, including frequency of sampling, will be developed as part of the CERCLA process and included in a Remedial Design, remedial action work plan (RAWP), or other appropriate FFA CERCLA document.*		
Effluent limitations	All effluent limitations, standards and prohibitions shall be established for each outfall or discharge point, except as provided under § 122.44(k)	Continuous discharge of pollutants to surface waters—**applicable**.	40 *CFR* § 122.45(a) 401 *KAR* 5:065 § 2(5)
	All effluent limitations, standards and prohibitions, including those necessary to achieve water quality standards, shall unless impracticable be stated as: Maximum daily and average monthly discharge	Continuous discharge of pollutants to surface waters—**applicable**.	40 *CFR* § 122.45(d)(1) 401 *KAR* 5:065 § 2(5)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Effluent limitations (continued)	limitations for all discharges.		
Mixing zone limitations	The cabinet may assign definable geometric limits for mixing zones for a discharge of a pollutant or pollutants within a discharge based on the following criteria: (a) Applicable limits shall include the linear distances from the point of discharge, surface area involvement, volume of receiving water, and shall take into account other nearby mixing zones; (b) Dilution provided by assigned mixing zones shall not be allowed until applicable limits are assigned by the cabinet in accordance with this section; (c) In a stream or river, unless assigned on or before December 8, 1999, an assigned mixing zone, from the point of discharge in a spatial direction, shall not exceed one third (1/3) of the width of the receiving stream or one-half (1/2) of the cross-sectional area; (e) An assigned mixing zone shall be limited to an area or volume that shall not adversely affect the designated uses of the receiving water and shall not be so large as to adversely affect an established community of aquatic organisms; (f) The location of a mixing zone shall not: 1. Interfere with fish spawning or nursery areas, fish migration routes, public water supply intakes, or bathing areas; 2. Preclude the free passage of fish or other aquatic life; or 3. Jeopardize the continued existence of	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—applicable	401 *KAR* 10:029 §4(1)(a-c), (e-h) 40 *CFR* § 122.45(d)(1) 401 *KAR* 5:065 § 2(5)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Mixing zone limitations (continued)	endangered or threatened aquatic species listed under Section 4 of the Endangered Species Act, 16 *U.S.C.* 1531 through 1544, or result in the destruction or adverse modification of their critical habitat; (g) For thermal discharges, a successful demonstration conducted under Section 316(a) of the CWA, 33 *U.S.C.* Section 1326(a), shall constitute compliance with this section; and (h) Unless assigned by the cabinet on or before September 8, 2004, there shall not be mixing zones for bioaccumulative chemicals of concern.		
Mixing zone limitations for toxic substances	Concentrations of toxic substances that exceed the acute criteria for protection of aquatic life in 401 *KAR* 10:031 shall not exist within an assigned mixing zone or in the discharge itself unless a zone of initial dilution is assigned. (a) A zone of initial dilution shall be assigned pursuant to subsection (3) of this section. (b) Chronic criteria for the protection of aquatic life and criteria for the protection of human health regarding the consumption of fish tissue shall be met at the edge of the assigned mixing zone.	Point source discharge of toxic pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.	401 *KAR* 10:029 §4(2)
Mixing Zone—zone of initial dilution	The following requirements shall apply to a zone of initial dilution: (a) The cabinet shall require an applicant to provide a technical evaluation for a zone of initial dilution; and (b) Concentrations of toxic substances shall not exceed the acute criteria for the protection of aquatic life at the edge of the assigned	Point source discharge of pollutants as defined in 40 *CFR* § 122.2 into surface waters of the Commonwealth of KY—**applicable**.	401 *KAR* 10:029 §4(3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Mixing Zone—zone of initial dilution (continued)	zone of initial dilution, except, numeric acute criteria may be exceeded within the zone if the frequency and duration of exposure of aquatic organisms are not sufficient to cause acute toxicity.		
Transport or conveyance of collected Resource Conservation and Recovery Act (RCRA) wastewater to a WWTU located on the facility	All tank systems, conveyance systems, and ancillary equipment used to treat, store, or convey wastewater to an on-site wastewater treatment facility are exempt from the requirements of RCRA Subtitle C standards. *NOTE: For purposes of this exclusion, any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey CERCLA remediation wastewater to a CERCLA on-site WWTU that meets all of the identified CWA ARARs for point source discharges from such a facility, are exempt from the requirements of RCRA Subtitle C standards.*	On-site WWTUs (as defined in 40 *CFR* § 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., KPDES-permitted) that managed hazardous wastewaters—**applicable**.	40 *CFR* § 264.1(g)(6) 401 *KAR* 39:090 § 1
Control and Management of Radionuclides from DOE Activities in Liquid Discharges	Except for tritium and sanitary sewers, apply best available technology if, at the point of discharge, the discharge contributes > 10 mrem (0.1 mSv) annual TED to members of the public.	Discharge of radioactive concentrations to surface water—**TBC**.	DOE O 458.1 (4)(g)(5)
Criteria for discharge of wastewater with radionuclides into surface water	Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment ALARA. *NOTE: The EPA has stated that the Nuclear Regulatory Commission dose-based limit of 25/75/25 mrem per year (mrem/year) for*	Discharge of radioactive concentrations to surface water—**relevant and appropriate**.	10 *CFR* § 61.41

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Criteria for discharge of wastewater with radionuclides into surface water (continued)	*radionuclide releases (all pathways) equates to roughly 10 mrem/year EDE, which EPA has determined comports with CERCLA's generally accepted cancer risk range.*		
	Management and Disposal of Toxic Substances Control Act (TSCA) Waste		
Management of TSCA wastes prior to disposal	Other wastes that are not chemically compatible with polychlorinated biphenyls (PCBs) shall be segregated from the PCBs throughout the handling and disposal process.	Disposal of PCBs or PCB Items in chemical waste landfill—**applicable**.	40 *CFR* § 761.75(b)(8)(i)
	May be disposed of provided such waste is pretreated and/or stabilized (e.g., chemically fixed, evaporated, mixed with dry inert absorbent) to reduce its liquid content or increase its solid content so that a nonflowing consistency is achieved to eliminate the presence of free liquids prior to final disposal.	Generation, Packaging, and Disposal of PCB bulk liquids not exceeding 500 ppm—**applicable**.	40 *CFR* § 761.75(b)(8)(ii)
	May be disposed of if each container is surrounded by an amount of inert sorbent material capable of absorbing all of the liquid contents of the container.	Generation, Packaging, and Disposal of PCB container with liquid PCB between 50 ppm and 500 ppm—**applicable**.	40 *CFR* § 761.75(b)(8)(ii)
Management of PCB-contaminated electrical equipment (except capacitors)	Prior to disposal, must remove all free-flowing liquid from the electrical equipment and dispose of the removed liquid in accordance with 40 *CFR* § 761.60(a).	Generation, Packaging, and Disposal of PCB-contaminated electrical equipment (as defined in 40 *CFR* § 761.3) for disposal—**applicable**.	40 *CFR* § 761.60(b)(4)
Management of PCB-contaminated articles	Prior to disposal, must remove all free-flowing liquid from the article, disposing of the liquid in compliance with the requirements of 40 *CFR* § 761.60(a)	Generation, Packaging, and Disposal of PCB-contaminated articles (as defined in 40 *CFR* § 761.3) for disposal—**applicable**.	40 *CFR* § 761.60 (b)(6)(ii)
Management of PCB items	Any person removing from use a PCB Item containing an intact and nonleaking PCB article must dispose of it in accordance with § 761.60(b), or decontaminate it in accordance with § 761.79. PCB Items where the PCB articles are no longer	Management of PCB waste for storage or disposal—**applicable**.	40 *CFR* § 761.50(b)(2)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Management of PCB items (continued)	intact and nonleaking are regulated for disposal as PCB bulk product waste under § 761.62(a) or (c).		
Management of PCB waste	Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* Part 761, Subpart D.	Storage or disposal of waste containing PCBs at concentrations ≥ 50 ppm—**applicable**.	40 *CFR* § 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found. Cleanup and/or disposal of PCB remediation waste may be self-implementing [40 *CFR* § 761.61(a)], performance-based [40 *CFR* § 761.61(b)], or risk-based [40 *CFR* § 761.61(c)].	Cleanup or disposal of PCB remediation waste as defined in 40 *CFR* § 761.3—**applicable**.	40 *CFR* § 761.61
Storage and management of PCB waste and/or PCB/radioactive waste in non-RCRA regulated unit	Any PCB waste shall be disposed of as required by Subpart D of this Part within one year from the date it was determined to be PCB waste and the decision was made to dispose of it. This date is the date of removal from service for disposal and the point at which the one-year time frame for disposal begins. PCB/radioactive waste removed from service for disposal is exempt from the one-year time limit provided that the provisions of paragraphs (a)(2)(ii) and (a)(2)(iii) of this section are followed and the waste is managed in accordance with all other applicable federal, state, and local laws and regulations for the management of radioactive material.	Storage of PCBs and PCB items at concentrations > 50 ppm designated for disposal—**applicable**.	40 *CFR* § 761.65(a)(1)
Cleanup of new PCB spills	Spills shall be cleaned up in accordance with 40 *CFR* Part 761, Subpart G, "PCB Spill Cleanup Policy."	Release into the environment of materials containing PCBs at ≥ 50 ppm, which occurs after May 4, 1987—**applicable**.	40 *CFR* § 761.125

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
	There may be exceptional spill situations that require less stringent cleanup or a different approach to cleanup because of factors associated with the particular spill. These factors may mitigate expected exposures and risks or make cleanup to these requirements impracticable.		40 *CFR* § 761.120(a)(4)
Location/Action	**Summary of Requirements**	**Prerequisite**	**Citation**
Decontamination of water containing PCBs to levels acceptable for discharge	For water discharged to a treatment works or to navigable waters, decontaminate to < 3 µg/L (approximately < 3 ppb) or a PCB discharge limit included in a permit issued under Section 307(b) or 402 of the CWA; or	Discharge of water containing PCBs to a treatment works or navigable waters—**applicable**.	40 *CFR* § 761.79 (b)(1)(ii)
Decontamination of water containing PCBs to levels acceptable for unrestricted use	Decontaminate to ≤ 0.5 µg/L (approximately ≤ 0.5 ppb) for unrestricted use.	Release of water containing PCBs for unrestricted use—**applicable**.	40 *CFR* § 761.79 (b)(1)(iii)
Management of PCB/radioactive waste	Any person storing such waste ≥ 50 ppm PCBs must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* § 761.65(a)(1), (b)(1)(ii) and (c)(6)(i).	Generation of PCB/radioactive waste for disposal—**applicable**.	40 *CFR* § 761.50 (b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties. If, after taking into account only the PCB properties in the waste, the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill, then the person may dispose of such waste without regard to the PCBs, based on its radioactive properties alone.		40 *CFR* § 761.50 (b)(7)(ii)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Demolition of Facilities Containing Regulated Asbestos-Containing Material (RACM) and Asbestos Control			
Demolition of a facility containing RACM	Remove all RACM from the facility before demolition, unless conditions set forth in 40 *CFR* § 61.145 (c)(1)(i-iv) apply, and follow the procedures for asbestos emission control and RACM handling as appropriate and detailed in 40 *CFR* § 61.145(c)(1) through (7).	Demolition of a facility that contains RACM exceeding the volume requirements of 40 *CFR* § 61.145(a)(1)—**applicable**.	40 *CFR* § 61.145(a)(1) 401 *KAR* 58:025 Section 2 (1) and (2)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Removal of friable asbestos prior to demolition	Work practice requirements for the removal of friable asbestos prior to demolition.	Demolition of a facility which may cause a disturbance of friable asbestos material and the demolition exceed the thresholds in 40 *CFR* § 61.145(a) **relevant and appropriate**.	401 *KAR* 58:040 § 4(2)(a-r)
Removal of friable asbestos prior to demolition (continued)	RACM need not be removed before demolition if: • It is Category I nonfriable asbestos-containing material (ACM) that is not in poor condition and is not friable; • It is on a facility component that is encased in concrete or other similarly hard material and is adequately wet whenever exposed during demolition; • It is not accessible for testing and was, therefore, not discovered until after demolition began and, as a result of the demolition, the material cannot be safely removed (exposed RACM and • asbestos-contaminated debris must be adequately wet at all times); or • It is Category II nonfriable ACM and the probability is low that the materials will become crumbled, pulverized, or reduced to powder during demolition.		401 *KAR* 58:025 § 2 (1) and (2)
Management of ACM prior to disposal	Discharge no visible emissions to the outside air or use one of the emission control and waste treatment methods specified in paragraphs (a)(1) through (a)(4) of 40 *CFR* § 61.150	Generation, collection, processing, packaging, and transportation of any asbestos-containing waste material that is not Category I or II nonfriable ACM waste that did not become crumbled, pulverized, or reduced to powder [40 *CFR* § 61.150(a)(5)]—**applicable**.	40 *CFR* § 61.150(a)(1)–(a)(4) 401 *KAR* 58:025

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Disposal of ACM	All asbestos-containing waste material shall be deposited as soon as practicable at a waste disposal site operated in accordance with the provisions of 40 *CFR* § 61.154 or an EPA-approved site that converts RACM and asbestos-containing waste materials into nonasbestos (asbestos-free) materials according to the provisions of 40 *CFR* § 61.155.	Removal and disposal of RACM except Category I nonfriable asbestos-containing material—**applicable**.	40 *CFR* § 61.150(b)(1)–(3) 401 *KAR* 58:025
Waste Generation, Characterization, and Segregation Associated with Operations			
Characterization of industrial wastewater	Industrial wastewater discharges that are point source discharges subject to regulation under Section 402 of the CWA as amended, are not solid wastes for the purpose of hazardous waste management. [Comment: This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored, or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment.] *NOTE: For the purpose of this exclusion, the CERCLA on-site treatment system will be considered equivalent to a WWTU and the point source discharges subject to regulation under CWA Section 402, provided the effluent meets all identified CWA ARARs.*	Generation of industrial wastewater for treatment and discharge into surface water**—applicable**.	40 *CFR* § 261.4(a)(2) 401 *KAR* 39:060 § 3
Characterization of solid waste	Must determine if solid waste is excluded from regulation under 40 *CFR* § 261.4.	Generation of solid waste as defined in 40 *CFR* § 261.2**—applicable**.	40 *CFR* § 262.11(b) 401 *KAR* 39:080 § 1(1)
	Must determine if waste is listed as a hazardous waste in subpart D of 40 *CFR* Part 261.	Generation of solid waste that is not excluded under 40 *CFR* § 261.4—**applicable**.	40 *CFR* § 262.11(c) 401 *KAR* 39:080 § 1(1)
	Must determine whether the waste is identified in subpart C of 40 *CFR* Part 261 by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 *CFR* Part 261 and not excluded under 40 *CFR* § 261.4—**applicable**.	40 *CFR* § 262.11(d) 401 *KAR* 39:080 § 1(1)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Characterization of solid waste (continued)	Must refer to Parts 261, 264, 265, 266, 267, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste that is determined to be hazardous—**applicable**.	40 *CFR* § 262.11(e) 401 *KAR* 39:080 § 1(1)
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) that, at a minimum, contains all the information that must be known to treat, store, or dispose of the waste in accordance with 40 *CFR* §§ 264 and 268.	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**.	40 *CFR* § 264.13(a)(1) and (2) *401 KAR* 39:090 § 1
	Must determine if the hazardous waste meets the treatment standards in 40 *CFR* §§ 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste.	Generation of a hazardous waste**—applicable**.	40 *CFR* § 268.7(a) 401 *KAR* 39:060 § 4
Determinations for land disposal of hazardous waste	Must determine the underlying hazardous constituents as defined in 40 *CFR* § 268.2(i) in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of § 268.42 Table 1) for storage, treatment or disposal—**applicable**.	40 *CFR* § 268.9(a) 401 *KAR* 39:060 § 4
Characterization of LLW	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance criteria of the receiving facility.	Generation of LLW for disposal at a DOE facility**—TBC**.	DOE M 435.1-1 (IV)(I)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Characterization of LLW (continued)	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)
	• physical and chemical characteristics;		DOE M 435.1-1(IV)(I)(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(IV)(I)(2)(b)
	• weight of the container and contents;		DOE M 435.1-1(IV)(I)(2)(c)
	• identities, activities, and concentration of major radionuclides;		DOE M 435.1-1(IV)(I)(2)(d)
	• characterization date;	Generation of LLW for disposal at a DOE facility—**TBC**.	DOE M 435.1-1(IV)(I)(2)(e)
	• generating source; and		DOE M 435.1-1(IV)(I)(2)(f)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with the performance objectives contained in DOE O 435.1.		DOE M 435.1-1(IV)(I)(2)(g)
Characterization and management of universal waste	A large quantity handler of universal waste is prohibited from disposing, diluting, or treating universal waste except by responding to releases as provided in 40 *CFR* § 273.37; or by managing specific wastes as provided in 40 *CFR* § 273.33.	Generation of universal waste [as defined in 40 *CFR* § 273.9 for disposal—**applicable**.	40 *CFR* § 273.31 401 *KAR* 39:080 § 3 (1–3)
	A large quantity handler of universal waste must manage universal waste in accordance with 40 *CFR* Part 273 in a way that prevents releases of any universal waste or component of a universal waste to the environment.		40 *CFR* § 273.33 401 *KAR* 39:080 § 3(1–3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Characterization and management of universal waste (continued)	A large quantity handler of universal waste must contain any universal waste battery that shows evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions in a container. Container must be closed, structurally sound, compatible with the contents of the battery, and lack evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions.	Generation of universal waste batteries as defined in 40 *CFR* § 273.9—**applicable**.	40 *CFR* § 273.33(a)(1) 401 *KAR* 39:080 § 3(1–3)
	A large quantity handler of universal waste must contain any mercury-containing equipment that shows evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions in a container. Container must be closed, structurally sound, compatible with the contents of the thermostat, and lack evidence of leakage, spillage, or damage that could cause leakage under reasonably foreseeable conditions, and be reasonably designed to prevent the escape of mercury into the environment by volatilization or any other means.	Generation of universal waste mercury-containing equipment as defined in 40 *CFR* § 273.9—**applicable**.	40 *CFR* § 273.33(c)(1) 401 *KAR* 39:080 § 3(1–3)
	May remove the mercury-containing ampule or the open original housing holding the mercury from mercury-containing equipment and manage and dispose of it in accordance with regulations.		40 *CFR* § 273.33(c)(2)–(4) 401 *KAR* 39:080 § 3(1–3)
	Must label or mark the universal waste to identify the type of universal waste.		40 *CFR* § 273.34 401 *KAR* 39:080 § 3(1–3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Characterization and management of universal waste (continued)	Batteries, or container or tank in which the batteries are contained, must be labeled or marked clearly with any one of the following phrases: "Universal Waste–Battery(ies)" or "Waste Battery(ies)" or "Used Battery(ies)."		40 *CFR* § 273.34(a) 401 *KAR* 39:080 § 3(1–3)
	May accumulate waste for no longer than 1 year from the date the waste is generated or received from another handler unless the requirements of 40 *CFR* § 273.35(b) are met.		40 *CFR* § 273.35(a) 401 *KAR* 39:080 § 3(1–3)
	May accumulate universal waste for longer than 1 year from the date the universal waste is generated or received from another handler if such activity is solely for the purpose of accumulation of such quantities of universal waste as necessary to facilitate proper recovery, treatment, or disposal. However, the handler bears the burden of proving that such activity was solely for this purpose.		40 *CFR* § 273.35(b) 401 *KAR* 39:080 § 3(1–3)
	Shall ensure that all employees are thoroughly familiar with proper waste handling and emergency procedures relative to their responsibilities during normal facility operations and emergencies.		40 *CFR* § 273.36 401 *KAR* 39:080 § 3(1–3)
	A large quantity handler of universal waste must immediately contain all releases of universal wastes and other residues from universal wastes, and must determine whether any material resulting from the release is hazardous waste, and if so, must manage the hazardous waste in compliance with all applicable requirements.		40 *CFR* § 273.37 401 *KAR* 39:080 § 3(1–3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Management of universal waste lamps (fluorescent, mercury vapor)	A large quantity handler of universal waste must contain any lamp in containers or packages that are structurally sound, adequate to prevent breakage, and compatible with the contents of the lamps. Such containers and packages must remain closed and must lack evidence of leakage, spillage, or damage that could cause leakage of hazardous constituents under reasonably foreseeable conditions.	Generation of universal waste lamps as defined in 40 *CFR* § 273.9—**applicable**.	40 *CFR* § 273.33(d)(1) 401 *KAR* 39:080 § 3(1–3)
	A large quantity handler of universal waste lamps must immediately clean up and place in a container any lamp that is broken and must place in a container any lamp that shows evidence of breakage, leakage, or damage that could cause the release of mercury or other hazardous constituents to the environment.		40 *CFR* § 273.33(d)(2) 401 *KAR* 39:080 § 3(1–3)
	Each lamp or container or package in which such lamps are contained must be labeled or marked clearly with one of the following phrases: "Universal Waste-Lamp(s)," or "Waste Lamps," or "Used Lamps."		40 *CFR* § 273.34(e) 401 *KAR* 39:080 § 3(1–3)
	Mark or label the individual item with the date the lamp(s) became a waste, or mark or label the container or package with the date the wastes were received.		40 *CFR* § 273.35(c) 401 *KAR* 39:080 § 3(1–3)
Management of used oil	Used oil shall not be stored in a unit other than a tank, container, or RCRA regulated unit.	Generation and storage of used oil, as defined in 40 *CFR* § 279.1 that meets the applicability requirements of 40 *CFR* § 279.10—**applicable**.	40 *CFR* § 279.22(a) 401 *KAR* 39:080 § 4 (1, 2, and 7)
	Containers and aboveground tanks used to store used oil must be in good condition (no severe rusting, apparent structural defects, or deterioration) and not leaking (no visible leaks).		40 *CFR* § 279.22(b)(1) and (2) 401 *KAR* 39:080 § 4 (1, 2, and 7)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Disposal of hazardous used oil	Used oils that are identified as a hazardous waste and cannot be recycled in accordance with must be managed in accordance with the hazardous waste management requirements.	Generation of used oil—**applicable**.	40 *CFR* § 279.81(a) 401 *KAR* 39:080 § 4 (1, 2, and 7)
Disposal of nonhazardous used oils	Used oils that are not hazardous wastes and cannot be recycled must be disposed in accordance with the applicable requirements.		40 *CFR* § 279.81(b) 401 *KAR* 39:080 § 4 (1, 2, and 7)
Staging and Storage of Wastes for Disposal			
Temporary on-site storage of remediation waste in staging piles	Must be located within the contiguous property under the control of the owner/operator where the wastes are to be managed in the staging pile originated. For purposes of this section, storage includes mixing, sizing, blending, or other similar physical operations so long as intended to prepare the wastes for subsequent management or treatment.	Accumulation of non-flowing hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 *CFR* § 260.10—**applicable**.	40 *CFR* § 264.554(a)(1) 401 *KAR* 39:090 § 1
	Staging piles may be used to store hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) based on approved standards and design criteria designated for that staging pile. *NOTE: Design and standards of the staging pile should be included in CERCLA remedial design document approved by EPA*.		40 *CFR* § 264.554(b) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Operation of a staging pile	Must not operate for more than two years, except when an operating term extension under 40 *CFR* § 264.554(i) is granted. *NOTE: Must measure the two-year limit (or other operating term specified) from first time remediation waste placed in staging pile.* *NOTE: It is recognized that a staging pile for the waste disposal facility (WDF) may need to be operated past the two-year time limit. Any time period greater than two years will be documented and justified in the ROD. The ROD would provide a process for further Post-ROD extensions of the operating term by using a memorandum in the administrative record that documents the justification with the concurrence of the federal facility agreement (FFA) parties.*	Storage of remediation waste in a staging pile—**applicable**.	40 *CFR* § 264.554(d)(1)(iii) 401 *KAR* 39:090 § 1
	Must not use staging pile longer than the length of time designated by EPA in appropriate decision document. *NOTE: It is recognized that a staging pile for the WDF may need to be operated past the two-year time limit. Any time period greater than two years will be documented and justified in the ROD. The ROD would provide a process for further Post-ROD extensions of the operating term by using a memorandum in the administrative record that documents the justification with the concurrence of the FFA parties.*		40 *CFR* § 264.554(h) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Performance criteria for staging pile	The standards and design criteria for a staging pile must: • facilitate a reliable, effective, and protective remedy; and • be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer as necessary to protect human health and the environment (e.g., use of liners, covers, runoff/run-on controls as appropriate).		40 *CFR* § 264.554(d)(1)(i) and (ii) 401 *KAR* 39:090 § 1
Design criteria for staging pile	In setting the standards and design criteria the director must consider the following factors: • Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes to be stored in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • Potential for human and environmental exposure to potential releases from the unit.	Accumulation of non-flowing hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 *CFR* § 260.10—**applicable**.	40 *CFR* § 264.554(d)(2)(i)–(vi) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Staging pile prohibitions	Must not place ignitable or reactive remediation waste in a staging pile unless the remediation waste has been treated, rendered, or mixed before placed in the staging pile so that: • The remediation waste no longer meets the definition of ignitable or reactive under 40 *CFR* § 261.21 or 40 *CFR* § 261.23; and • You have complied with 40 *CFR* § 264.17(b); or Must manage the remediation waste to protect it from exposure to any material or condition that may cause it to ignite or react.	Storage of ignitable or reactive remediation waste in staging pile—**applicable**.	40 *CFR* § 264.554(e) 401 *KAR* 39:090 § 1 40 *CFR* § 264.554(e)(1) 401 *KAR* 39:090 § 1 40 *CFR* § 264.554(e)(1)(i) 40 *CFR* § 264.554(e)(1)(ii) 401 *KAR* 39:090 § 1 40 *CFR* § 264.554(e)(2) 401 *KAR* 39:090 § 1
	Must not place incompatible wastes in the same staging pile unless you have complied with 40 *CFR* § 264.17(b).	Storage of "incompatible" remediation waste, as defined in 40 *CFR* § 260.10, in staging pile—**applicable**.	40 *CFR* § 264.554(f)(1) 401 *KAR* 39:090 § 1
	Must separate the incompatible materials, or protect them from one another by using a dike, berm, wall, or other device.	Storage of "incompatible" remediation waste, as defined in 40 *CFR* § 260.10, in staging pile—**applicable**.	40 *CFR* § 264.554(f)(2) 401 *KAR* 39:090 § 1
	Must not pile remediation waste on same base where incompatible wastes or materials were previously piled unless the base has been decontaminated sufficiently to comply with 40 *CFR* § 264.17(b).		40 *CFR* § 264.554(f)(3) 401 *KAR* 39:090 § 1
Operation of a staging pile	Does not constitute land disposal of hazardous waste or create a unit that is subject to the minimum technological requirements of Section 3004(o) of RCRA.	Placement of hazardous remediation wastes into a staging pile—**applicable**.	40 *CFR* § 264.554(g) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Closure of staging pile of remediation waste	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate. Must decontaminate contaminated sub-soils in a manner that EPA determines will protect human and the environment. *NOTE: The time period for closure will be specified in the appropriate CERCLA documentation, which may be greater than 180 days.*	Storage of remediation waste in staging pile in ***previously contaminated area***—**applicable**.	40 *CFR* § 264.554(j)(1) and (2) 401 *KAR* 39:090 § 1
	Must be closed within 180 days after the operating term according to 40 *CFR* §§ 264.258(a) and 264.111 or 265.258(a) and 265.111. *NOTE: The time period for closure will be specified in the appropriate CERCLA documentation, which may be greater than 180 days.*	Storage of remediation waste in staging pile in ***uncontaminated area***—**applicable**.	40 *CFR* § 264.554(k) 401 *KAR* 39:090 § 1
Storage of hazardous wastes restricted from land disposal	Prohibits storage of hazardous waste restricted from land disposal unless the generator stores such waste in tanks, containers, or containment buildings on site solely for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal.	Accumulation of hazardous wastes restricted from land disposal solely for purpose of accumulation of quantities as necessary to facilitate proper recovery, treatment, or disposal—**applicable**.	40 *CFR* § 268.50 401 *KAR* 39:060 § 4

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Hazardous waste facility—general inspection requirements	Must inspect facility for malfunctions and deterioration, operator errors, and discharges to identify any problems and remedy any deterioration or malfunction of equipment or structures on a schedule that ensures that the problem does not lead to an environmental or human health hazard.	Operation of a RCRA hazardous waste facility—**applicable**.	40 *CFR* § 264.15(a) and (c) 401 *KAR* 39:090 § 1
Hazardous waste facility—purpose and implementation of a contingency plan	Substantive requirements will be met to minimize hazards to human health or the environment from fires, explosions or any unplanned sudden or nonsudden release of hazardous waste or hazardous waste constituents to air, soil, or surface water.	Operation of a RCRA hazardous waste facility—**applicable**.	40 *CFR* § 264.51(a) 401 *KAR* 39:090 § 1
Temporary on-site storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that waste is placed in containers that comply with conditions set forth in 40 *CFR* §§ 262.17(a)(1)(i–vii).	Accumulation of RCRA hazardous waste on-site as defined in 40 *CFR* § 260.10—**applicable**.	40 *CFR* § 262.17 401 *KAR* 39:080 § 1
	If container is not in good condition or if it begins to leak, must transfer waste into a container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.171 401 *KAR* 39:090 § 1
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.	40 *CFR* § 264.111(a)	40 *CFR* § 264.172 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Temporary on-site storage of hazardous waste in containers (continued)	Keep containers closed during storage, except to add/remove waste.		40 *CFR* § 264.173(a) and (b) 401 *KAR* 39:090 § 1
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak.		40 *CFR* § 264.173(a) and (b) 401 *KAR* 39:090 § 1
Closure of RCRA container accumulation area	Must close the unit in a manner that	Closure of a RCRA container accumulation area—**applicable**.	40 *CFR* § 264.111 401 *KAR* 39:090 § 1
	• Minimizes the need for further maintenance.		40 *CFR* § 264.111(a) 401 *KAR* 39:090 § 1
	• Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to ground or surface waters or to the atmosphere.		40 *CFR* § 264.111(b) 401 *KAR* 39:090 § 1
	• Complies with the substantive closure requirements of 40 *CFR* Part 264, including, but not limited to, the requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, 264.351, 264.601-.603, and 264.1102.		40 *CFR* § 264.111(c) 401 *KAR* 39:090 § 1
Use and management of containers holding hazardous waste	If container is not in good condition or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 262.171 401 *KAR* 39:080 § 1
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 *CFR* § 264.172 401 *KAR* 39:090 § 1
	Keep containers closed during storage, except to add/remove waste.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.173(a) 401 *KAR* 39:090 § 1
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak.		40 *CFR* § 264.173(b) 401 *KAR* 39:090 § 1
	Area must have a containment system designed and operated in accordance with 40 *CFR* § 264.175(b), except as otherwise provided by 40 *CFR* § 264.175(c).	Storage of RCRA hazardous waste in containers with free liquids—**applicable**.	40 *CFR* § 264.175(a) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Use and management of containers holding hazardous waste (continued)	Base must underlie containers which is free of cracks or gaps and is sufficiently impervious to contain leaks, spills, and accumulated precipitation until the collected material is detected and removed.		40 *CFR* § 264.175(b)(1) 401 *KAR* 39:090 § 1
	The base must be sloped or the containment system must be otherwise designed and operated to drain and remove liquids resulting from leaks, spills, or precipitation, unless the containers are elevated or are otherwise protected from contact with accumulated liquids.		40 *CFR* § 264.175(b)(2) 401 *KAR* 39:090 § 1
	The containment system must have sufficient capacity to contain 10% of the volume of containers or the volume of the largest container, whichever is greater.		40 *CFR* § 264.175(b)(3) 401 *KAR* 39:090 § 1
	Run-on into the containment system must be prevented unless the collection system has sufficient excess capacity in addition to that required in paragraph (b)(3) of this section to contain any run-on which might enter the system.		40 *CFR* § 264.175(b)(4) 401 *KAR* 39:090 § 1
	Spilled or leaked waste and accumulated precipitation must be removed from the sump or collection area in a timely manner as is necessary to prevent overflow of the collection system.	Storage of RCRA hazardous waste in containers with free liquids—**applicable**.	40 *CFR* § 264.175(b)(5) 401 *KAR* 39:090 § 1
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA hazardous waste in containers that do not contain free liquids (other than F020, F021, F022, F023, F026, and F027)—**applicable**.	40 *CFR* § 264.175(c)(1)-(2) 401 *KAR* 39:090 § 1
Inspection of RCRA container storage area	At least weekly, must inspect areas where containers are stored, looking for leaking containers and for deterioration of containers and the containment system caused by corrosion or other factors.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.174 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Special requirements for ignitable or reactive waste	Containers holding ignitable or reactive waste must be located at least 15 m (50 ft) from the facility's property line.	Storage of ignitable or reactive RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.176 401 *KAR* 39:090 § 1
Special requirements for incompatible waste	• Incompatible wastes or incompatible wastes and materials must not be placed in the same container, unless § 264.17(b) is complied with. • Hazardous waste must not be placed in an unwashed container that previously held an incompatible waste or material. • A storage container holding a hazardous waste that is incompatible with any waste or other materials stored nearby in other containers, piles, open tanks, or surface impoundments must be separated from the other materials or protected from them by means of a dike, berm, wall, or other device.	Storage of incompatible RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.177(a)-(c) 401 *KAR* 39:090 § 1
Closure of a containment system	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 *CFR* § 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of Parts 262 through 266 of this chapter.]	Storage of RCRA hazardous waste in containers in a unit with a containment system—**applicable**.	40 *CFR* § 264.178 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • Minimizes the need for further maintenance; • Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • Complies with the closure requirements of subpart, but not limited to, the requirements.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.111 401 *KAR* 39:090 § 1
Storage of PCB waste and/or PCB/radioactive waste in non-RCRA regulated unit	Except as provided in 40 *CFR* § 761.65 (b)(2), (c)(1), (c)(7), (c)(9), and (c)(10), after July 1, 1978, owners or operators of any facilities used for the storage of PCBs and PCB items designated for disposal shall comply with the storage unit requirements in 40 *CFR* § 761.65(b)(1) and (b)(2).	Storage of PCBs and PCB Items at concentrations ≥ 50 ppm designated for disposal—**applicable**.	40 *CFR* § 761.65(b)
	Storage facility shall meet the following criteria:		40 *CFR* § 761.65(b)(1)
	Adequate roof and walls to prevent rainwater from reaching stored PCBs and PCB items;		40 *CFR* § 761.65(b)(1)(i)
	Adequate floor that has continuous curbing with a minimum 6-inch high curb. Floor and curb must provide a containment volume equal to at least two times the internal volume of the largest PCB article or container or 25% of the internal volume of all articles or containers stored there, whichever is greater. *NOTE*: *6-inch minimum curbing not required for area storing PCB/radioactive waste;*		40 *CFR* § 761.65(b)(1)(ii)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Storage of PCB waste and/or PCB/radioactive waste in non-RCRA regulated unit (continued)	No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from curbed area;		40 *CFR* § 761.65(b)(1)(iii)
	Floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, nonporous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* § 761.65(b)(1)(iv)
	Not located at a site that is below the 100-year flood water elevation.		40 *CFR* § 761.65(b)(1)(v)
Storage of PCB waste and/or PCB/radioactive waste in a RCRA-regulated container storage area	Does not have to meet storage unit requirements in 40 *CFR* § 761.65(b)(1) provided unit:	Storage of PCBs and PCB Items at concentrations ≥ 50 ppm designated for disposal—**applicable**.	40 *CFR* § 761.65(b)(2)
	• is permitted by EPA under RCRA § 3004 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* Part 761; or		40 *CFR* § 761.65(b)(2)(i)
	• qualifies for interim status under RCRA § 3005 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* Part 761; or		40 *CFR* § 761.65(b)(2)(ii)
	• is permitted by an authorized state under RCRA § 3006 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* Part 761. *NOTE: For purpose of this exclusion, CERCLA remediation waste (which is also considered PCB waste), can be stored on-site provided the area meets all of the identified RCRA container storage ARARs and spills of PCBs are cleaned up in accordance with Subpart G of 40 CFR* Part *761.*		40 *CFR* § 761.65(b)(2)(iii)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Storage for disposal	Storage area must be properly marked as required by 40 *CFR* § 761.40(a)(10).	Storage of PCBs and PCB items at concentrations ≥ 50 ppm in containers for disposal—**applicable**.	40 *CFR* § 761.65(c)(3)
	Any leaking PCB Items and their contents shall be transferred immediately to a properly marked nonleaking container(s).		40 *CFR* § 761.65(c)(5)
	Except as provided in 40 *CFR* § 761.65(c)(6)(i) and (c)(6)(ii), container(s) shall be in accordance with requirements set forth in U.S. Department of Transportation (DOT) hazardous materials regulations (HMR) at 49 *CFR* Parts 171–180.		40 *CFR* § 761.65(c)(6)
	Container(s) shall be marked as illustrated in 40 *CFR* § 761.45(a).		40 *CFR* § 761.40(a)(1)
Storage of PCB/radioactive waste in containers	For liquid wastes, containers must be nonleaking. For nonliquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 *CFR* § 761.65(b)(1)(ii); and	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performance standards—**applicable**.	40 *CFR* § 761.65(c)(6)(i)(A) 40 *CFR* § 761.65(c)(6)(i)(B)
	For both liquid and nonliquid wastes, containers must meet all substantive requirements pertaining to nuclear criticality safety.		40 *CFR* § 761.65(c)(6)(i)(C)
Risk-based storage of PCB bulk product waste	May store bulk product waste in a manner other than prescribed in 40 *CFR* § 761.65, if approved in writing from EPA providing that the method will not pose an unreasonable risk of injury to human health or the environment. *NOTE*: *EPA approval of alternative methods will be obtained through a CERCLA FFA primary document that is approved by EPA*.	Storage of PCB bulk product waste in a manner other than prescribed in 40 *CFR* § 761.65**—applicable**.	40 *CFR* § 761.62(c)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Temporary storage of bulk PCB remediation waste or PCB bulk product waste in a waste pile	May be stored at the clean-up site or site of generation subject to the following conditions: • waste must be placed in a pile designed and operated to control dispersal by wind, where necessary, by means other than wetting; • waste must not generate leachate through decomposition or other reactions.	Storage of PCB remediation waste or PCB bulk product waste in a waste pile—**applicable**.	40 *CFR* § 761.65(c)(9)(i) 40 *CFR* § 761.65(c)(9)(ii)
	Storage site must have a liner designed, constructed, and installed to prevent any migration of wastes off or through liner into adjacent subsurface soil, groundwater or surface water at any time during the active life (including closure period) of the storage site.		40 *CFR* § 761.65(c)(9)(iii)(A)
	Liner must be • constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure because of pressure gradients, physical contact with waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;		40 *CFR* § 761.65(c)(9) (iii)(A)(1)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Temporary storage of bulk PCB remediation waste or PCB bulk product waste in a waste pile (continued)	• placed on foundation or base capable of providing support to liner and resistance to pressure gradients above and below the liner to prevent failure because of settlement compression or uplift;		40 *CFR* § 761.65(c)(9)(iii)(A)(2)
	• installed to cover all surrounding earth likely to be in contact with waste.	Storage of PCB remediation waste or PCB bulk product waste in a waste pile—**applicable**.	40 *CFR* § 761.65(c)(9)(iii)(A)(3)
	Has a cover that meets the above requirements and installed to cover all of the stored waste likely to be contacted by precipitation, and is secured so as not to be functionally disabled by winds expected under normal weather conditions at the storage site; and		40 *CFR* § 761.65(c)(9)(iii)(B)
	Requirements of 40 *CFR* § 761.65(c)(9) may be modified under the risk-based disposal option of 40 *CFR* § 761.61(c).		40 *CFR* § 761.65(c)(9)(iv)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Low-Level Radioactive Waste Management			
Temporary staging and storage of LLW	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water.	Management and storage of LLW at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage.	Management, storage, and staging of LLW at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(N)(3)
Staging of LLW	Shall be for the purpose of the accumulation of such quantities of wastes necessary to facilitate transportation, treatment, and disposal.	Staging of LLW at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(N)(7)
Packaging of LLW	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.	Storage of LLW in containers at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(L)(1)(b)
Packaging of LLW for off-site disposal	Requirements to facilitate handling and provide health and safety protection of personnel at the disposal site.	Packaging of LLW for off-site shipment of LLW to a commercial Nuclear Regulatory Commission or Agreement State licensed disposal facility—**relevant and appropriate**.	902 *KAR* 100:021 § 7 (1)(b–g)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility.	Treatment of LLW for disposal at a DOE LLW disposal facility—**TBC**.	DOE M 435.1-1(IV)(O)
Treatment of uranium- and thorium-bearing LLW	Such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause exceedance of Rn-222 emission limits of DOE O 458.1(4)(h)(1) and will not result in premature structure failure of the facility.	Placement of potentially biodegradable contaminated waste in a long-term management facility—**TBC**.	DOE O 458.1(4)(h)(1)(d)(3)
RCRA Waste Land Disposal Requirements			
Disposal of characteristic wastewaters in an National Pollutant Discharge Elimination System (NPDES)-permitted WWTU	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the United States pursuant to a permit issued under 402 of the CWA (i.e., NPDES permitted) unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* § 268.40 or are D003 reactive cyanide.	Land disposal of RCRA restricted hazardous wastewaters that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 *CFR* Part 268**—applicable**.	40 *CFR* § 268.1(c)(4)(i) 401 *KAR* 39:060 § 4
Prohibition of dilution to meet land disposal restrictions	Except as provided under 40 *CFR* § 268.3(b) must not in any way dilute a restricted waste or the residual from treatment of a restricted waste as a substitute for adequate treatment to achieve compliance with land disposal restriction levels.	Land disposal, as defined in 40 *CFR* § 268.2, of RCRA-restricted hazardous soils—**applicable**.	40 *CFR* § 268.3(a) 401 *KAR* 39:060 § 4
Disposal of RCRA prohibited waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* § 268.40 before land disposal.	Land disposal, as defined in 40 *CFR* § 268.2, of prohibited RCRA hazardous waste—**applicable**.	40 *CFR* § 268.40(a) 401 *KAR* 39:060 § 4

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Disposal of RCRA waste in a land-based unit (continued)	All underlying hazardous constituents [as defined 40 *CFR* § 268.2(i)] must meet the Universal Treatment Standards (UTSs), found in 40 *CFR* § 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well—**applicable**.	40 *CFR* § 268.40(e) 401 *KAR* 39:060 § 4
	May be disposed of if it is treated according to the alternative treatment standards of 40 *CFR* § 268.49(c) or according to the UTSs specified in 40 *CFR* § 268.48, applicable to the listed hazardous waste and/or applicable characteristic of hazardous waste if the soil is characteristic.	Land disposal, as defined in 40 *CFR* § 268.2, of restricted hazardous soils—**applicable**.	40 *CFR* § 268.49(b) 401 *KAR* 39:060 § 4
	May be disposed if treated prior to land disposal as provided in 40 *CFR* § 268.45(a)(1)-(5) unless it is determined under 40 *CFR* § 261.3(f)(2) that the debris is no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard provided in 40 *CFR* § 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 *CFR* § 268.2, of restricted hazardous debris—**applicable**.	40 *CFR* § 268.45(a) 401 *KAR* 39:060 § 4
Disposal of treated hazardous debris	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 *CFR* § 268.45 and which no longer exhibits a characteristic, is not a hazardous waste, and need not be managed in RCRA Subtitle C facility.	Treated debris contaminated with RCRA-listed or characteristic waste—**applicable**.	40 *CFR* § 268.45(c) 401 *KAR* 39:060 § 4
	Must not be placed in a landfill unless the waste and the landfill meet applicable provisions of 40 *CFR* Part 268 and: • The resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under § 261.21 or § 261.23 of this chapter; and • Section 264.17(b) is complied with.	Disposal of ignitable or reactive RCRA waste—**applicable**.	40 *CFR* § 264.312(a) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Disposal of treated hazardous debris (continued)	Containers holding free liquids must not be placed in a landfill, unless:	Placement of bulk or containerized hazardous waste liquids in a landfill—**applicable**.	40 *CFR* § 264.314(c)
	All free-standing liquid has been removed by decanting, or other methods; or has been mixed with sorbent or solidified so that free-standing liquid is no longer observed; or has been otherwise eliminated; or		40 *CFR* § 264.314(c)(1)
	Container is very small, such as an ampule; or		40 *CFR* § 264.314(c)(2)
	Container is designed to hold free liquids for use other than storage, such as a battery or capacitor or		40 *CFR* § 264.314(c)(3)
	Container is a lab pack as defined in 40 *CFR* § 264.316 and is disposed of in accordance with 40 *CFR* § 264.316.		40 *CFR* § 264.314(c)(4)
	Sorbents used to treat free liquids to be disposed of in landfills must be nonbiodegradable as described in 40 *CFR* § 264.314(d)(1).		40 *CFR* § 264.314(d)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Property and Equipment Decontamination Requirements			
Release of property with residual radioactive material to an off-site commercial facility	Residual Radioactive Material. Property potentially containing residual radioactive material must not be cleared from DOE control unless either (a) The property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or (b) The property is evaluated and appropriately monitored or surveyed to determine: 1. The types and quantities of residual radioactive material within the property; 2. The quantities of removable and total residual radioactive material on property surfaces (including residual radioactive material present on and under any coating); 3. That for property with potentially contaminated surfaces that are difficult to access for radiological monitoring or surveys, an evaluation of residual radioactive material on such surfaces is performed which is (a) Based on process and historical knowledge meeting the requirements of paragraph 4.k.(5) of this Order and monitoring and or surveys, to the extent feasible; (b) Sufficient to demonstrate that applicable specific or pre-approved DOE Authorized Limits will not be exceeded; and	Generation of DOE materials and equipment with residual radioactive material—**TBC**.	DOE O 458.1(4)(k)(3)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Release of property with residual radioactive material to an off-site commercial facility (continued)	4. That any residual radioactive material within or on the property is in compliance with applicable specific or pre-approved DOE Authorized Limits.		
Decontamination standards for removing PCBs from non-porous surfaces and non-porous surfaces covered with a porous surface (e.g. paint) for distribution in commerce	For tools and equipment, in contact with liquid or non-liquid PCBs, to be released for unrestricted use must meet the decontamination standard of 10 µg/100 cm^2 or undergo the appropriate decontamination method.	Decontamination of moveable equipment, tools and sampling equipment—**applicable**.	40 *CFR* § 761.79(b)(3)
Decontamination/disposal of equipment	During the partial and final closure periods, all contaminated equipment, structures and soils must be properly disposed of or decontaminated unless otherwise specified in §§ 264.197, 264.228, 264.258, 264.280 or § 264.310.	Closure of RCRA hazardous waste landfill—**relevant and appropriate**.	40 *CFR* § 264.114 401 *KAR* 39:090 § 1
Management of Wastes in a Corrective Action Management Unit (CAMU) or Area of Contamination (AOC)			
Designation and management of CAMUs	CAMU-eligible waste means all solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris that are managed for implementing cleanup. As-generated wastes from ongoing industrial operations at a site are not CAMU-eligible wastes.		40 *CFR* § 264.552(a)(1)(i) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Designation and management of CAMUs (continued)	Wastes that would otherwise meet the description in paragraph (a)(1)(i) of this section are not "CAMU-Eligible Wastes" where: (A) The wastes are hazardous wastes found during cleanup in intact or substantially intact containers, tanks, or other non-land-based units found above ground, unless the wastes are first placed in these units as part of cleanup, or the units are excavated during the course of cleanup; The Regional Administrator exercises the discretion in paragraph (a)(2) of this section to prohibit the wastes from management in a CAMU.		40 *CFR* § 264.552(a)(1)(ii) 401 *KAR* 39:090 § 1
	Notwithstanding paragraph (a)(1)(i) of this section, where appropriate, as-generated non-hazardous waste may be placed in a CAMU where such waste is being used to facilitate treatment or the performance of the CAMU.		40 *CFR* § 264.552(a)(1)(iii) 401 *KAR* 39:090 § 1
	The placement of bulk or noncontainerized liquid hazardous waste or free liquids contained in hazardous waste (whether or not sorbents have been added) in any CAMU is prohibited except where placement of such wastes facilitates the remedy selected for the waste.	Management of CAMU-eligible wastes within a CAMU—**applicable**.	40 *CFR* § 264.552(a)(3) 401 *KAR* 39:090 § 1
	Placement of CAMU-eligible wastes into or within a CAMU does not constitute land disposal of hazardous wastes.		40 *CFR* § 264.552(a)(4) 401 *KAR* 39:090 § 1
	Consolidation or placement of CAMU-eligible wastes into or within a CAMU does not constitute creation of a unit subject to minimum technology requirements.		40 *CFR* § 264.552(a)(5) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Designation, design, operation, and closure of a CAMU used for storage and/or treatment only	CAMUs used for storage and/or treatment only are CAMUs in which wastes will not remain after closure. Such CAMUs must be designated in accordance with all of the requirements 40 *CFR* § 264.552, except as follows: Such CAMUs that operate in accordance with time limits established in the staging pile regulations are subject to requirements for staging piles in lieu of performance standards and requirements for CAMUs. CAMUs that are used for storage and/or treatment only and that do not operate in accordance with the time limits established in the staging pile regulations at § 264.554(d)(1)(iii), (h), and (i): (i) Must operate in accordance with a time limit, established by the Regional Administrator, that is no longer than necessary to achieve a timely remedy selected for the waste, and (ii) Are subject to the requirements for staging piles at § 264.554(d)(1)(i) and (ii), § 264.554(d)(2), § 264.554(e) and (f), and § 264.554(j) and (k) in lieu of the performance standards and requirements for CAMUs in this section at paragraphs (c) and (e)(4) and (6). *NOTE: It is recognized that a CAMU for storage and/or treatment for the waste disposal facility may need to be operated past the two-year time limit. Any time period greater than two years will be documented and justified in the ROD. The ROD would provide a process for further Post-ROD extensions of the operating term by using a memorandum in the administrative record that documents the justification with the concurrence of the FFA parties.*	Management of CAMU-eligible wastes within a CAMU used for storage and/or treatment only—**applicable**.	40 *CFR* § 264.552(f) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Operation of a temporary unit	A temporary unit must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the temporary unit originated. The Regional Administrator may replace the design, operating, or closure standards applicable to these units under 40 *CFR* Part 264 or 265 with alternative requirements which protect human health and the environment. *NOTE: Alternative design, operating, or closure standards will be developed as part of the CERCLA process and approved by EPA in a remedial design, RAWP, or other appropriate FFA CERCLA document.*	Use of temporary tanks and container storage areas to treat or store hazardous remediation wastes during remedial activities—**applicable**.	40 *CFR* § 264.553(a) 401 *KAR* 39:090 § 1
	Any temporary unit to which alternative requirements are applied in accordance with 40 *CFR* § 264.553(a) shall be: • Located within the facility boundary; and • Used only for treatment and storage of remediation wastes. *NOTE: Alternate requirements for a temporary unit would be approved through the CERCLA document review process.*	Use of temporary tanks and container storage areas to treat or store hazardous remediation wastes during remedial activities—**applicable**.	40 *CFR* § 264.553(b)(1) and (2) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Design criteria for temporary unit	In establishing standards to be applied to a temporary unit, the Regional Administrator shall consider the following factors: (1) Length of time such unit will be in operation; (2) Type of unit; (3) Volumes of wastes to be managed; (4) Physical and chemical characteristics of the wastes to be managed in the unit; (5) Potential for releases from the unit; (6) Hydrogeological and other relevant environmental conditions at the facility which may influence the migration of any potential releases; and (7) Potential for exposure of humans and environmental receptors if releases were to occur from the unit.	Use of temporary tanks and container storage areas to treat or store hazardous remediation wastes during remedial activities—**applicable**.	40 *CFR* § 264.553(c) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Off-site disposal of CAMU-eligible wastes	The Regional Administrator with regulatory oversight at the location where the cleanup is taking place may approve, using the CERCLA process, placement of CAMU-eligible wastes in hazardous waste landfills not located at the site from which the waste originated, without the wastes meeting the requirements of RCRA 40 *CFR* Part 268, if the conditions in paragraphs (a)(1) through (3) of this section are met: (1) The waste meets the definition of CAMU-eligible waste in § 264.552(a)(1) and (2). (2) The principal hazardous constituents in such waste are identified, in accordance with § 264.552(e)(4)(i) and (ii), and such principal hazardous constituents are treated to any of the following standards specified for CAMU-eligible wastes: (i) The treatment standards under § 264.552(e)(4)(iv); or (ii) Treatment standards adjusted in accordance with § 264.552(e)(4)(v)(A), (C), (D) or (E)(*1*); or (iii) Treatment standards adjusted in accordance with § 264.552(e)(4)(v)(E)(2), where treatment has been used and that treatment significantly reduces the toxicity or mobility of the principal hazardous constituents in the waste, minimizing the short-term and long-term threat posed by the waste, including the threat at the remediation site. (3) The landfill receiving the CAMU-eligible waste must have a RCRA hazardous waste permit, meet the requirements for new landfills in Subpart N of this part, and be	Placement of CAMU-eligible wastes in hazardous waste landfills not located at the site from which the waste originated—**applicable**.	40 *CFR* § 264.555(a) 401 *KAR* 39:090 § 1

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Off-site disposal of CAMU-eligible wastes (continued)	authorized to accept CAMU-eligible wastes; for the purposes of this requirement, "permit" does not include interim status. *NOTE: Approval of disposal in an off-site hazardous waste landfill shall be made as part of the FFA CERCLA document review and approval process.*		
Designation of AOC	EPA guidance provides regulatory flexibility under RCRA for management of waste, environmental media, or debris generated and managed within the designated AOC. Management activities within the AOC such as movement/consolidation and *in situ* treatment are not considered placement under RCRA and, as such, do not trigger land disposal requirements or minimum technology requirements.	Management of hazardous waste and environmental media or debris contaminated with hazardous waste—**TBC**.	EPA Policy Memorandum, dated March 13, 1996: "Use of the Areas of Contamination (AOC) Concept During RCRA Cleanups."
Activities Causing Emissions into the Air			
Activities causing radionuclide emissions	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem per year.	Radionuclide emissions at a DOE facility—**applicable**.	40 *CFR* § 61.92 401 *KAR* 57:002 § 2
Air emissions from stacks	Shall not cause, suffer, allow, or permit any continuous emission into the open air from a control device or stack associated with any affected facility, which is equal to or greater than twenty (20) percent opacity.	Release of particulates from an affected facility or source associated with new process operations as defined in 401 *KAR* 59:010 § 2, which are not subject to another emission standard in Chapter 59—**applicable**.	401 *KAR* 59:010 § 3(1)(a)
	Shall not cause, suffer, allow, or permit any continuous emission into the open air from a control device or stack associated with any affected facility which is in excess of the quantity specified in Appendix A.		401 *KAR* 59:010 § 3(2)
Air emissions from site remediation activities	For each site remediation with an affected source designated under § 63.7882, standards specified in §§ 63.7885 through 63.7955 must be met, as applicable to the affected source, unless site remediation meets the requirements for an exemption under paragraph (b) of this section.	Release of hazardous air pollutants related to the cleanup of remediation material that is co-located with a major source of hazardous air pollutants at the facility provided those emissions exceed 1 Mg/year—**applicable**.	40 *CFR* § 63.7884(a)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
General standards for process vents used in treatment of volatile organic compounds	For each affected process vent, except as exempted under paragraph (c) of this section, you must meet one of the options in paragraphs (b)(1) through (3) of this section. (1) You control hazardous air pollutant (HAP) emissions from the affected process vents according to the standards specified in §§ 63.7890 through 63.7893. (2) You determine for the remediation material treated or managed by the process vented through the affected process vents that the average total volatile organic hazardous air pollutant (VOHAP) concentration, as defined in § 63.7957, of this material is less than 10 parts per million by weight (ppmw). Determination of the VOHAP concentration is made using the procedures specified in § 63.7943. (3) If the process vent is also subject to another subpart under 40 *CFR* Part 61 or 40 *CFR* Part 63, you control emissions of the HAP listed in Table 1 of this subpart from the affected process vent in compliance with the standards specified in the applicable subpart. This means you are complying with all applicable emissions limitations and work practice standards under the other subpart (e.g., you install and operate the required air pollution controls or have implemented the required work practice to reduce HAP emissions to levels specified by the applicable subpart). This provision does not apply to any exemption of the affected source from the emissions limitations and work practice standards allowed by the other applicable subpart.	Process vents as defined in 40 *CFR* § 63.7957 used in site remediation of media that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *CFR* § 63.7885(c)(1)—**relevant and appropriate**.	40 *CFR* § 63.7885(b) 401 *KAR* 63.002 §§ 1 and 2(llll)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Air emissions from non-emergency stationary diesel engines	Owners and operators of 2007 model year and later nonemergency stationary compression ignition (CI) internal combustion engine (ICE) with a displacement of less than 30 liters per cylinder must comply with the emission standards for new CI engines in § 60.4201 for their 2007 model year and later stationary CI ICE, as applicable.	Owners and operators of stationary diesel engines that commence construction after July 11, 2005, where the stationary engines are manufactured after April 1, 2006—**applicable**.	40 *CFR* § 60.4204(b)
Air emissions from emergency stationary diesel engines	Owners and operators of pre-2007 model year emergency stationary CI ICE with a displacement of less than 10 liters per cylinder that are not fire pump engines must comply with the emission standards in Table 1 to this subpart. Owners and operators of pre-2007 model year emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder that are not fire pump engines must comply with the Tier 1 emission standards in 40 *CFR* Part 1042, appendix I.	Operation of pre-2007 model year emergency stationary compression ignition internal combustion engines, as defined in 40 *CFR* § 60.4219 with a displacement of less than 10 liters per cylinder that are not fire pump engines—**applicable**.	40 *CFR* § 60.4205(a)
	Owners and operators of 2007 model year and later emergency stationary CI ICE with a displacement of less than 30 liters per cylinder that are not fire pump engines must comply with the emission standards for new nonroad CI engines in § 60.4202, for all pollutants, for the same model year and maximum engine power for their 2007 model year and later emergency stationary CI ICE.	Operation of 2007 model year and later emergency stationary compression ignition internal combustion engines with a displacement of less than 30 liters per cylinder that are not fire pump engines—**applicable**.	40 *CFR* § 60.4205(b)
	Owners and operators of emergency stationary CI engines with a displacement of greater than or equal to 30 liters per cylinder must meet the requirements in this section. (1) For engines installed prior to January 1, 2012, limit the emissions of NOX in the stationary CI internal combustion engine exhaust to the following:	Operation of emergency stationary compression ignition internal combustion engines with a displacement of greater than or equal to 30 liters per cylinder—**applicable**.	40 *CFR* § 60.4205(d)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Air emissions from emergency stationary diesel engines (continued)	(i) 17.0 g/KW-hr (12.7 g/HP-hr) when maximum engine speed is less than 130 rpm; (ii) 45 n−0.2 g/KW-hr (34 n−0.2 g/HP-hr) when maximum engine speed is 130 or more but less than 2,000 rpm, where n is maximum engine speed; and (iii) 9.8 g/kW-hr (7.3 g/HP-hr) when maximum engine speed is 2,000 rpm or more.		
Disposal of refrigeration equipment	With the exception of the substitutes in the end uses listed in 40 *CFR* § 82.154(a)(1)(i)–(x), no person maintaining, servicing, repairing, or disposing of appliances may knowingly vent or otherwise release into the environment any refrigerant or substitute from such appliances.	Appliances that contain Class I or II substances used as a refrigerant—**applicable**.	40 *CFR* § 82.154(a)(1)
	De minimis releases associated with good faith attempts to recycle or recover refrigerants are not subject to this prohibition.		40 *CFR* § 82.154(a)(2)
	No person may dispose of such appliances, except for small appliances, motor vehicle air conditioning (MVACs) systems, and MVAC-like appliances, without: • Observing the required practices set forth in 40 *CFR* §§ 82.155, 82.156, and 82.157 and • Using equipment that is certified for that type of appliance pursuant to 40 *CFR* § 82.158.		40 *CFR* § 82.154(b)
Beryllium			
Release of beryllium-contaminated equipment or other items	Must clean beryllium-contaminated equipment or other items to the lowest contamination level practicable, not to exceed the levels established in 10 *CFR* § 850.31(b) and (c) and label them before release.	Release of beryllium-contaminated equipment or other items to general public or another DOE facility—**applicable**.	10 *CFR* § 850.31(a)

Table B.1. Preliminary List of Potential Location- and Action-Specific ARARs and TBC Guidance (Continued)

Location/Action	Summary of Requirements	Prerequisite	Citation
Release of beryllium-contaminated equipment or other items (continued)	Before being released to the general public or another DOE facility, ensure that the removable contamination level of equipment and item surfaces does not exceed the higher of 0.2 µg/100 cm^2 or the concentration level of beryllium in soil at the point or release, whichever is greater;		10 *CFR* § 850.31(b)(1)
	Ensure equipment or item is labeled in accordance with 10 *CFR* § 850.38(b); and		10 *CFR* § 850.31(b)(2)
	Release is conditioned on the recipient's commitment to implement controls that will prevent foreseeable beryllium exposure.		10 *CFR* § 850.31(b)(3)
	Before being released to another facility performing work with beryllium, must ensure that removal contamination level of equipment and other item surfaces does not exceed 3 µg/100 cm^2;	Release of beryllium-contaminated equipment or other items to another facility performing work with beryllium—**applicable**.	10 *CFR* § 850.31(c)(1)
	Ensure equipment or item is labeled in accordance with 10 *CFR* § 850.38(b); and		10 *CFR* § 850.31(c)(2)
	Enclose or place in sealed, impermeable bags or containers to prevent the release of beryllium dust during handling or transportation.	Release of beryllium-contaminated equipment or other items to another facility performing work with beryllium—**applicable**.	10 *CFR* § 850.31(c)(3)
Disposal of beryllium-containing waste or beryllium-contaminated equipment and other items	Must control the generation of beryllium-containing waste or beryllium-contaminated equipment and other items through the application of waste minimization principles.	Generation of beryllium-containing waste or beryllium-contaminated equipment and other items—**applicable**.	10 *CFR* § 850.32(a)
	Dispose of in sealed, impermeable bags, containers, or enclosures to prevent the release of beryllium dust during handling and transportation. Bags, containers, and enclosures must be labeled according to 10 *CFR* § 850.38.		10 *CFR* § 850.32(b)

*The recent U.S. Supreme Court decision [SCOTUS (Supreme Court of the United States) 2025. *City and County of San Francisco, California v. Environmental Protection Agency*, Docket No. 23-753, Washington, DC, March 4) may impact how this ARAR is utilized and/or finalized in the decision document.

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APPENDIX C

DEACTIVATION AND DECOMMISSIONING PROJECT SAMPLING AND ANALYSIS PLAN

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CONTENTS

FIGURE

TABLES

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ACRONYMS

ASTM	American Society for Testing and Materials
CCID	characterization and criticality incredible database
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical (or radionuclide) of potential concern
D&D	deactivation and decommissioning
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FFA	federal facility agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
HSS&Q	Health, Safety, Support, and Quality
IDW	investigation-derived waste
IH	industrial hygiene
KDEP	Kentucky Department for Environmental Protection
N/A	not applicable
NDA	nondestructive assay
OREIS	Oak Ridge Environmental Information System
OSWDF	on-site waste disposal facility
PEMS	Project Environmental Management System
PGDP	Paducah Gaseous Diffusion Plant
PM	program manager
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
PGE	process gas equipment
RDI	regulatory decision integration
RI	remedial investigation
SAP	sampling and analysis plan
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
TCLP	toxicity characteristic leaching procedure
WAC	waste acceptance criteria
WDA	waste disposal alternatives
WMP	waste management plan

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C.1. INTRODUCTION AND PROJECT BACKGROUND

This sampling and analysis plan (SAP) summarizes the sampling approach and protocols for the characterization of the process gas systems in support of the deactivation and decommissioning (D&D) project at the Paducah Gaseous Diffusion Plant (PGDP). This characterization is conducted in support of the ongoing remedial investigation (RI)/feasibility study (FS) process for this project. This SAP addresses data needs related to evaluating D&D waste streams relative to on-site or off-site disposition.

The collection of intrusive and nonintrusive samples, and measurements for characterization of the process gas systems and auxiliary process system components, are proposed in this SAP. Intrusive characterization will consist of the collection of physical samples from the process gas system and analyzing for metals and radionuclides. Nonintrusive characterization will consist of collecting sodium iodide scans to support the identification of biased sample locations. During the RI/FS, the data will be used to validate process knowledge assumptions regarding the distribution of radioactive and chemical (nonradioactive) hazardous constituents held up within the process gas system of the former gaseous diffusion process gas equipment (PGE). This includes validating assumptions as to the location of technetium-99 (Tc-99) in the cascade.

Data collection under this plan will be used to demonstrate compliance with the waste acceptance criteria (WAC) for disposal facilities (for off-site and/or on-site disposal) and to meet the regulatory requirements for packaging, transportation, and disposal. Intrusive (physical) samples will be collected at predetermined locations and analyzed for uranium isotopes and other constituents. Intrusive sampling of PGE involves the removal of metal "coupons," which are pieces of metal cut or drilled from piping or other PGE components. Physical samples will include coupons from the centrifugal pump assemblies in areas that are identified as likely locations for deposits of contaminants. Additional sampling of barrier material is not proposed under this D&D SAP, as barrier material is not considered for on-site disposal due to classification concerns. Samples collected under this D&D SAP will be used to evaluate the makeup of any holdup material in PGE and to establish the relationship among the radionuclides, as well as the major isotopes of uranium. This data will also be useful to support development of analytical WAC for an on-site waste disposal facility (OSWDF) if on-site disposal is selected as part of the waste disposal alternatives (WDA) project.

This D&D SAP will identify a minimum number of samples that will be collected to support the RI/FS. Additional sampling/characterization of the buildings will continue after the remedial decision to ensure WAC attainment.

C.1.1 SITE HISTORY AND CONTAMINANTS

A summary of site history and contaminants including historical operations at PGDP, a description of the gaseous diffusion process and equipment, along with physical descriptions of the four large gaseous diffusion process buildings (C-331, C-333, C-335, and C-337) and their associated auxiliary systems is presented in Section 1 of the D&D scoping document and work plan.

C.1.2 PROJECT OBJECTIVE

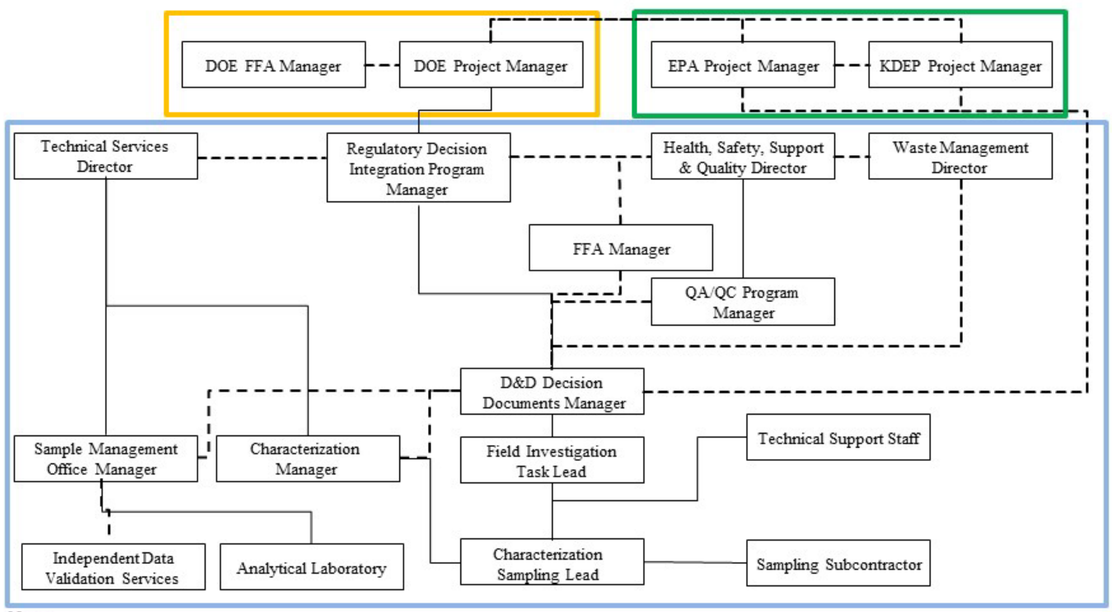
The objective of this D&D SAP is to gather the information necessary to support the D&D RI/FS. This D&D SAP is written to guide characterization and sampling so that they are performed in a technically acceptable manner and meet project data quality objectives (DQOs). The need for data collection is outlined in Section 6 of the D&D scoping document and work plan.

C.2. SUMMARY OF EXISTING DATA

A summary of existing data is provided in Section 2 of the D&D scoping document and work plan.

C.3. PROJECT ORGANIZATION AND RESPONSIBILITIES

This section describes the organization and management structure to be used in implementing this SAP for the D&D project. The project organization chart (Figure C.1) shows the management structure that will be used to implement this SAP. The responsibilities of the project positions are described in this section of this SAP.



Notes:
DOE personnel are in Orange Box, Regulatory personnel are in Green Box, and DOE Prime Contractor personnel are in Blue Box.
Solid lines indicate lines of authority and dashed lines indicate lines of communication.

Figure C.1. D&D SAP Organization Chart

C.3.1 PROJECT ORGANIZATION, RESPONSIBILITIES, AND STAFFING

C.3.1.1 DOE Project Manager

The DOE Project Manager has direct communication with the DOE Contractor Program Manager (PM) and is responsible for project oversight, overall compliance for the project, and for submitting various reports to, and interfacing with, the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection.

C.3.1.2 Regulatory Decision Integration Program Manager

The individual in this position will have overall responsibility for technical, financial, and scheduling matters related to the project and will ensure that appropriate resources are available to facilitate execution of the SAP in a timely and efficient manner. The Regulatory Decision Integration (RDI) PM will monitor field team performance throughout the project. This individual is also responsible for the communication of any field change orders to the DOE PM.

C.3.1.3 Health, Safety, Support, and Quality Director

The Health, Safety, Support, and Quality (HSS&Q) Director will have overall HSS&Q program responsibility for the Contractor. The HSS&Q Director will provide support/resources to the RDI PM and/or the field team, as necessary. This individual will interface with DOE and the regulators, as appropriate.

C.3.1.4 D&D Decision Documents Manager

The Decision Documents Manager will have the overall responsibility for implementation of the RI/FS for the D&D project. This individual will be responsible for implementing the investigation as well as all plans and activities conducted as part of the RI/FS, which includes monitoring the work plan implementation. The Decision Documents Manager will coordinate with other Four Rivers Nuclear Partnership, LLC, (FRNP) functions (e.g., procurement, regulatory compliance, community relations, legal) in the implementation of the project. This manager will also coordinate with the Decision Documents Manager for the two other decisions to ensure close coordination among the decision processes.

C.3.1.5 Field Investigation Task Lead

The Field Investigation Task Lead is responsible for the implementation of field activities to collect data and facility information in support of the RI/FS. This individual will interface with the D&D Decision Documents Manager to align project budget and resources for the field characterization effort. The Field Investigation Task Lead acts as the primary contact for coordination of subcontractor field efforts and coordinates scheduling of support services from other groups such as industrial safety/industrial hygiene (IH) personnel, Waste Management personnel, Radiological Control personnel, Protective Services, Fire Services, and the Infrastructure Management Contractor. This individual reports to the D&D Decision Documents Manager. This individual will interface with the RDI PM, DOE, and the regulators, as appropriate.

C.3.1.6 Characterization Sampling Lead

The Characterization Sampling Lead is responsible for leading and coordinating the day-to-day activities of various resources assigned to the collection of data and samples in the field. The Characterization Sampling Lead will oversee activities that include fieldwork, sample collection, management of investigation-derived waste (IDW), and sampling team leads, project team members, and sample technicians.

C.3.1.7 Sample Management Office Manager

The Sample Management Office Manager will be responsible for contracting any fixed-based laboratory used for sample analyses during sampling activities. This individual will provide coordination for sample shipment to the laboratory, review the data assessment/validation packages, and transmit data packages to the appropriate data repository. This individual will be responsible for managing data generated during implementation of the SAP.

C.3.2 PROJECT COORDINATION

Coordination and liaison between the DOE Prime Contractor and subcontractor personnel will occur at various levels and among personnel appropriate to each level. DOE, regulatory agencies, and the DOE Prime Contractor will communicate via telephone, email, and face-to-face meetings, as appropriate. Deviations from the SAP will be communicated upward through the chain of command to the regulatory agencies using communication tools that are commensurate with the issue.

C.4. DATA QUALITY OBJECTIVES

The DQOs for this SAP are provided in Section 6.2 of the D&D scoping document and work plan.

C.5. FIELD ACTIVITIES

Historical data from the Paducah Site and comparison to data from the remediated East Tennessee Technology Park in Oak Ridge, Tennessee, and the Portsmouth, Ohio, site are sufficient to evaluate the feasibility of remedial options for facilities at the Paducah Site and to provide a basis for the remedial decision that will be documented in the D&D Record of Decision; however, additional data are needed to support the development of the radiological source term that would be generated by a D&D remedial action, to demonstrate compliance with WAC for the disposal facilities (for off-site and/or on-site disposal), and to meet regulatory requirements for packaging, transportation, and disposal. The data will also be useful to support the development of analytical WAC for an OSWDF if on-site disposal is selected as part of the WDA decision.

This SAP describes the objectives and requirements to characterize primary PGE (converters and compressors) and process auxiliary equipment (includes other process gas systems such as surge drums, instrument lines, etc.) in the process buildings (C-331, C-333, C-335, and C-337) and product/withdrawal facilities (C-310 Purge and Product Building and C-315 Surge and Waste Building) for chemicals (or radionuclides) of potential concern (COPCs). Characterization sampling and analysis will be conducted to provide data of known and acceptable quality for use in determining the nature, waste types, and volumes associated with the PGE. Additional SAPs will be written after the remedial decision to characterize materials of construction (structural steel, concrete, walls, etc.) for verification of WAC for wastes associated with D&D of the process buildings and waste disposition.

This section identifies the media to be sampled during the field investigation and specifies the methods for collecting and analyzing the samples. Investigation activities will use standard industry practices that are consistent with Contractor procedures and protocols. Procedures and methods that will guide this field project are listed in the quality assurance project plan (QAPP) (Attachment C1). If field conditions differ from those anticipated, the sampling approach, if appropriate, will be evaluated and revisions to the sampling program will be made as needed. Safety and security concerns associated with sampling PGE are addressed in more detail in the task-specific work control documents associated with these sampling activities.

C.5.1 CHARACTERIZATION OF PROCESS GAS EQUIPMENT

This section describes the equipment types, estimated waste volumes, sample design, sample locations, and sample media, and specifies methods for collecting and analyzing samples. Investigation activities will use standard industry practices that are consistent with EPA procedures and protocols; and procedures that are identified in associated task-specific package(s).

C.5.1.1 Equipment Type

The three process gas system equipment types identified for characterization consist of: (1) converters, (2) compressors, and (3) auxiliary process support systems. The converters and compressors were the primary PGE used to enrich uranium as part of the gaseous diffusion cascades and, therefore, were in direct contact with process gas. The auxiliary process support systems were also in contact with the process gas. Samples collected from the components identified in Section C.5.1.3 will be used to represent these three types of process gas system equipment.

In each process building with gaseous diffusion cascades, the process gas system is arranged in units. Each unit contains converters, compressors, and auxiliary PGE. While the configuration of these components in the units is relatively the same across these buildings, the physical size, number of units, and components within each unit varies. The C-331 Process Building contains four units with 40 cells, totaling 400 stages of converters, compressors, and associated piping and valves; the C-333 Process Building contains six units with 60 cells, totaling 480 stages of converters, compressors, and associated piping and valves; the C-335 Process Building contains four units with 40 cells, totaling 400 stages of converters, compressors, and associated piping and valves; and the C-337 Process Building contains six units with 60 cells, totaling 480 stages of converters, compressors, and associated piping and valves. The C-310 Purge and Product Building contains one unit with 10 cells and 60 stages.

C.5.1.2 Sample Design

The sampling program was designed to address the criteria described in EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection* (EPA 2002). Judgmental or biased sampling is applied where a high degree of process knowledge is available on which to base sample design. At PGDP, a high degree of process knowledge has been retained in historical documents and by the large number of long-term operations personnel. Across the operational life of the cascade system, the design and production configuration remained relatively unchanged. The cascade was designed to change the isotopic ratio of uranium as it flowed through the process at measurable rates. Contaminants in the cascade, introduced primarily through the feed stream, followed this same path as the gas enrichment stream and either plated out in the system or exited as a constituent of the product stream, as determined by the individual molecular weights of the contaminants. Contaminants not associated with the feed stream were limited to those associated with process gas system construction materials and would be localized to the metal/alloys comprising individual cascade components.

Process knowledge associated with the process gas system was categorized into three distinct segments. Each segment was defined, based on an understanding of the unique attributes of individual contaminants of concern that were relevant to their expected distribution within the process gas system. Thus, process knowledge provides the basis of the sampling design. These segments included:

- The expected distribution of the major isotopes of uranium given the way the cascades were operated, with the highest enrichment levels found in the C-335 Process Building and the C-310 Purge and Product Building.

- The anticipated distribution of Tc-99 in the system and its propensity to accumulate in the upper end of the cascade and within the purge cascade in C-310.

- The expected distribution of low activity-based concentration transuranic constituents within the feed piping in the C-333 Process Building and C-333-A Feed Vaporization Facility, or the C-337 Process Building and C-337-A Feed Vaporization Facility, due to the compounds' chemical properties.

On the basis of this process knowledge, the characterization program was designed to apply judgmental (or biased) sampling. The judgmental (biased) sampling applies the detailed process knowledge to pinpoint the upper bounds of the activity-based concentration of uranium isotopes and system contaminants (specifically Tc-99). PGE samples will be subject to multiple leaching analyses including the toxicity characteristic leaching procedure (TCLP) extraction for hazardous metals, batch leaching tests for radionuclides (Attachment C2), and total nitric acid leach test similar to that done under the characterization and criticality incredible project plan, described in Section 2.1.2 of the D&D scoping document and work plan, prior to analytical analyses to determine potential availability and mobility of radionuclides and hazardous metals.

C.5.1.3 Sample Locations

Table C.1 identifies the judgmental sample locations associated with the sampling program. There are six primary sample locations identified. The equipment being sampled has been previously disconnected from the cascade in the C-310 Purge and Product Building and the equipment is currently stored in the C-331 Process Building. The samples are primarily related to the compressor/centrifugal pump assemblies. Refer to C.6.3.1 for explanation of sample numbering and component IDs.

Table C.1. Sample Locations

Sample No.	Item Description	Component ID	Notes	Cell
331PGECPN-A-##	Centrifugal Pump Assembly	331U0LME259PGPM00-00	C-310 5/1A	5
331PGECPN-B-##	Centrifugal Pump Assembly	331U0LME257PGPM00-00	C-310 9/4A	9
331PGECPN-C-##	12-inch Expansion Joint with Elbow	331U0LME245PGXJ00-00	C-310 5/2 Removed 3/5/2010	5
331PGECPN-D-##	Centrifugal Pump Assembly	331U0LME258PGPM00-00	C-310 Cell 3 Stage 4B	3
331PGECPN-E-##	Centrifugal Pump	331U0LME232PGPM00-00	C-310 7/5B Removed 1998	7
331PGECPN-F-##	12-inch Expansion Joint	331U0LME244PGXJ00-00	C-310 Cell 5 Stage 2 Removed 3/5/2010	5

C.5.1.4 Sample Requirements

C.5.1.4.1 Pre-sampling, sampling, and post-sampling activities

Table C.2 includes, but is not limited to, a sequence of controls that may be required prior to the collection of samples from the specified PGE. All pre-sampling and sampling activities shall be performed in accordance with the task-specific work package(s).

Table C.2. Pre-sampling and Sampling Activities

Pre-sampling Activities
• Determine sampling location(s). • Assess radiological and IH for area access. • Develop work package(s). • Develop work controls for sampling in area(s). • Remove interferences (e.g., transite panels). • Inventory components being sampled. • Determine wet air passivation of the components/area. • Mark sample locations.
Sampling Activities
• Samplers package/ship samples. • Nondestructive assay (NDA) personnel perform sodium iodide scans of area/component. • Crew cuts component/removes coupon. • Samplers collect coupon sample. • Samplers package/ship samples.

Sampling operations shall comply with as low as reasonably achievable principles. Health and safety procedural requirements will be followed, which includes, but is not limited to, IH monitoring and health physics support.

C.5.1.4.2 Marking sample locations

Sample locations will be marked using adhesive tape, paint, or any other potentially nondestructive method. Locations may be marked on one or both sides of the sample, but not at the actual location that is to be sampled. Marked locations will be cut on either side of the marker (adhesive tape, paint, etc.), to ensure sample integrity.

C.5.1.4.3 Sample collection

Samples will be collected following applicable and approved field sampling protocols, procedures, and task-specific work packages.

At the sample location, the minimum volume of sample material of the PGE and/or any encountered deposit samples will be collected using either the appropriate powered hand tool (e.g., hole saw, sawzall) or scoop (e.g., plastic or stainless steel scoop) in accordance with the task-specific work control document. The recommended physical sample-size requirements, sample containers, preservatives, and hold times for the samples are provided in Table C.3.

A new or disposable tool (e.g., drill bit, saw blade, hole saw) will be used at each sample location to ensure the integrity of the sample and to minimize cross-contamination. Cold-cutting techniques will be used to minimize the volatilization of contaminants.

Any samples collected for TCLP metals analysis will be size-reduced, in accordance with the task-specific work control document and Table C.3. Any field duplicates will be collected in accordance with quality control (QC) procedures. Samples will be placed into the recommended samples containers that are provided in Table C.3 and documented, labeled, stored, transferred, and packaged in accordance with applicable procedures.

Coupon samples may be sent intact (no additional size reduction, e.g., 6 inches metal coupon) to the laboratory unless the sample needs to be size-reduced to fit in the sample container. Much of this information will be based on laboratory requirements and are to be determined and reviewed by the approved laboratory. Size reduction, if required, shall be performed in a manner that does not compromise the sample integrity, is in accordance with the applicable approved task-specific work control documents and plans (i.e., work package, sampling procedures), and is documented on the sample data form.

Sample containers will be placed into a nuclear criticality-safe and compliant container in accordance with the task-specific work control documents for handling and transport, as needed. Sample control and transfer will be maintained in accordance with the chain-of-custody procedures.

A daily status of the number of samples collected and sample locations shall be provided to the D&D Field Investigation Task Lead or designee on the next workday. Any issues affecting sample collection shall be brought to the attention of the D&D Field Investigation Task Lead or designee. Prior approval from the D&D Field Investigation Task Lead or designee is required for any deviations from this SAP (see Section C.10 for details).

Cold-cutting methods will be used to avoid the loss of contaminants by volatilization at high temperatures. Out-gassing or fuming of samples and/or equipment openings, if any, should be documented and reported.

Table C.3. Sample Requirements

Analyte Group	Matrix	Matrix Type	Recommended Container	Minimum Sample Size[a,b]	Preservative[c]	Holding Time
Radiochemical analyses[d]	Solid	Metal Coupon	16 oz wide-mouth high-density polyethylene (HDPE) container or poly bag	100 cm^2	None	180 days
		PGE Deposit	1 to 4 oz wide-mouth HDPE container	5 g		
Total metals[e]	Solid	PGE Deposit	1 to 4 oz wide-mouth HDPE container	5 g	Chill ≤ 6°C	180 days (metals); 28 days (mercury)
TCLP metals	Solid	PGE Deposit	1 to 8 oz wide-mouth glass jar with Teflon®-lined lid	100 g	Chill ≤ 6°C	180 days (metals); 28 days (mercury)
Batch leaching tests (see Attachment C2)	Solid	Metal Coupon	16 oz wide-mouth HDPE container or poly bag	Minimum 250 g (prefer three coupons ≥ 80 g each) for each type of equipment sampled.	Not applicable (N/A)	N/A

[a] Proposed sample size; the sample size is determined by the greater of 1) the minimum sample size required by the appropriate analytical method; or 2) the requirements of the analytical laboratory.
[b] If the minimum volume requirement is not obtained (i.e., deposit material collected is less than 5 g), then the laboratory will perform analyses in the following order of precedence: radiological, total metals (includes TCLP metals).
[c] Laboratory method may dictate to cool samples for preservation; nuclear criticality safety controls may prevent initial cooling preservation of the sample immediately after sample collection until received by the laboratory prior to criticality screening. If this condition occurs, it will be noted in the sample comments or other applicable locations.
[d] Metal coupons and any deposit material contained on them will be leached according to FRNP standard coupon leaching procedure (i.e., ~ 6 molar nitric acid solution) as defined in analytical lab statement of work (SOW).
[e] In cases where uranyl fluoride is visibly present and easily obtained, the residual material (i.e., PGE deposit) is considered the target media for sampling. Otherwise, total metals can be analyzed from the leachate generated from the FRNP standard coupon leaching procedure and reported in units of mg/sample.

C.5.1.5 Laboratory Analysis

PGE deposits and leachate from a nitric acid leaching process of metal coupons will be tested for the analytes listed in Table C.4. For the nitric acid leaching, the sample will be placed in an ~ 6-molar concentration nitric acid solution with an approximate concentration for a minimum of 4 hours, in order to dissolve any surface deposits and surface paint, and to leach radiological contamination from the sample surface. The leachate will be decanted to a graduated cylinder and both the sample and the container will be rinsed with the ~ 6-molar concentration nitric acid solution. The rinse water will be combined in the cylinder with the decanted liquid and then the liquid will be brought to a total volume > 250 mL.

Table C.4. Analytical Methods and Analytes

Sample Description	Analytical Group	Analytical Method	Minimum Reported Analytes
Nitric acid leachate from metal coupon and PGE deposit (if available)	Radionuclides	Alpha spectroscopy	Americium-241 Neptunium-237 Plutonium-238 Plutonium-239/240 Thorium-228 Thorium-230 Thorium-232
		Inductively coupled plasma-mass spectroscopy	Uranium-234 Uranium-235 Uranium-236 Uranium-238 Total Uranium wt.% Uranium-235
		Gamma spectroscopy	Cesium-137 Cobalt-60 Potassium-40
		Liquid scintillation	Technetium-99
		Gas flow proportional counting	Strontium-90
PGE deposit (if available)	TCLP metals	SW-846-3050B (prep), SW-846-1311 (extraction), and SW-846-6010/6020 (metals)/SW-846-7470 (mercury)	Antimony Arsenic Barium Beryllium Cadmium Chromium Lead Mercury Nickel Selenium Silver Thallium Vanadium Zinc

Table C.4. Analytical Methods and Analytes (Continued)

Sample Description	Analytical Group	Analytical Method	Minimum Reported Analytes
PGE deposit (if available, otherwise nitric acid leachate from metal coupon)	Total metals	SW-846-3050B (prep)/ 6010B/6020 (metals), SW-846-7471 (mercury)	Antimony Arsenic Barium Beryllium Cadmium Chromium Lead Nickel Selenium Silver Thallium Vanadium Zinc Mercury

Data on the leachability of uranium, Tc-99, and other select radionuclides from coupons will also be obtained as described in Attachment C2. Some of the materials may be placed in a potential OSWDF if on-site disposal is selected as part of the WDA decision. This leachability information is needed to estimate the reasonable maximum contamination levels in leachate from the D&D waste stream. Data (chemical and radiological) are needed to better understand the nature and location of specific contaminants in the D&D waste streams to demonstrate compliance with WAC for the disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to develop a refined radiological source term for performance assessment modeling of a potential OSWDF if on-site disposal is selected as part of the WDA decision. Laboratory analysis associated with the batch-leaching test plan are provided in Table C2.1 of Attachment C2.

C.5.1.6 Quality Control Frequency

To ensure the validity and reliability of the analytical data for the project, QC samples will be collected in accordance with QAPP Worksheet #20, *Field QC Summary.* The QC sample collection type and frequency are provided in Table C.5 with the details discussed in subsequent paragraphs.

Table C.5. QC Sample Collection and Frequency

QC Sample Type	Frequency
Equipment rinseate blank	1 per 20 samples (for decontamination of sampling equipment)
Field blank	1 per 20 samples (based on field conditions)
Field duplicate	1 per 20 samples

An equipment rinseate blank is a sample collected of reagent-grade water (e.g., American Society for Testing and Materials [ASTM] Type II) that is poured over and/or through decontaminated sampling equipment. The purpose of the equipment rinseate blank is to assess the adequacy of the decontamination process on non-disposable sampling equipment. Per EPA guidelines, one equipment rinseate blank is required for every 20 samples collected using decontaminated equipment; it will be analyzed for the same parameters as the investigative sample.

A field blank may be either a sample collected of reagent-grade water (e.g., ASTM Type II) that is prepared in the field (i.e., poured into analytical laboratory-approved sample containers) and subjected to all aspects of sample collection, field processing, preservation, transportation, and laboratory handling as an environmental sample. Reagent-grade water field blanks are discretionary and collected in dusty environments and/or from areas where volatile organic compounds (e.g., exhaust fumes, paint fumes) are suspected to be present in the atmosphere and originate from a source other than the source being sampled, resulting in potential cross-contamination of primary samples collected. If field conditions warrant per EPA guidelines, one field blank sample will be collected for every 20 samples and analyzed for the same parameters as the investigative sample.

Field duplicate samples are either replicated or collocated. Field duplicates are similar to split samples, except that the same laboratory analyzes both samples. These samples do not assess site heterogeneity, but only specific sample point heterogeneity. The material may be homogenized before being divided (except volatiles). Collocated samples are two or more separate portions collected from side-by-side locations at the same point in time and space so to be considered identical. These samples are used to assess the precision of the total method, including sampling, analysis, and site heterogeneity. These separate samples are said to represent the same population and are carried through all steps of the sampling and analytical procedures in an identical manner. Per EPA guidelines, one field duplicate sample is required for every 20 samples collected, provided that the same analyses will be run on all 20 samples.

C.5.1.7 Laboratory Requirements

The specific parameters and analytes were selected based on process knowledge, existing characterization data, and the parameters required to meet the anticipated disposal facility WAC. Analyses required to characterize the PGE are provided in Table C.4. Sample preparation, analyses, and QC requirements will be performed in accordance with this SAP, applicable EPA methods, and laboratory standard operating protocols for all analyses. Detection and reporting levels for each analyte will be sufficient to meet the requirements.

C.5.1.7.1 Sample Preparation

All laboratory analysis used to analyze characterization samples of process building waste will be performed by a DOE Consolidated Audit Program (DOECAP)-approved laboratory. The DOECAP performs annual audits and periodic assessments, as necessary, of all participating laboratory facilities in areas, including but not limited to laboratory quality assurance (QA) program, information management systems, materials management operations, waste disposal, and analytical method performance and compliance. The DOECAP analytical laboratories are approved for use and consistently generate data of defensible quality for use on DOE sites/projects.

The laboratory will perform sample preparation, analyses, and QC requirements in accordance with this SAP, the laboratory SOW, and approved standard operating procedures (SOPs). Before a change is made, any deviations from the specified parameters must be approved by the project. Radionuclide and chemical analyses will be performed in accordance with approved SOPs.

NOTE: If the sample's minimum volume requirement is not obtained per Table C.3 (i.e., deposit material collected is less than 5 g), then the laboratory will perform analyses in the following order of precedence: radionuclides, total metals (includes TCLP metals as needed).

The specific parameters and analytes were selected based on process knowledge, parameters required to meet the anticipated disposal facility WAC, and parameters needed to ensure compliance with Resource Conservation and Recovery Act regulations. Target detection limits are intended to be at or below regulatory levels or the anticipated disposal facility WAC. Every effort should be made to meet these limits. Actual detection limits may be sample-specific, especially in the case of samples having complex matrices, but the data measurement objective is to obtain data with detection limits adequate to satisfy these levels. Deviations from target detection limits must be documented in the case narrative.

C.5.1.7.2 Laboratory QA/QC samples

The laboratory QA/QC samples that will be analyzed, as needed, are listed in the QAPP (Attachment C1).

The laboratory shall be responsible for all QA/QC and corrective actions as defined per the analytical methods, and the required methodology.

C.5.1.7.3 Sample/waste management

The laboratory will archive leachate (from the leachability testing) for 90 days prior to disposal. The laboratory will dispose of the leachate solutions (after the archival period) and sample media at an appropriate, approved disposal facility.

C.5.2 FIELD PROCEDURES

Procedures to be used in implementing this SAP are listed in the QAPP (Attachment C1).

C.5.2.1 Chain of Custody

Procedures CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling,* should be followed for all samples. The chain-of-custody documents sample possession from time of collection, through transfers of custody, to receipt at the laboratory, and into the subsequent analysis. Samplers shall maintain custody, document transfer, and ship samples in accordance with CP3-ES-2709 and CP3-ES-5004.

C.5.2.2 Quality Control Sampling

QC samples are used to detect the presence and concentration of contaminants resulting from field activities and measure/control variables in sample handling. QA/QC samples should be collected during sampling in accordance with CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation*. This procedure establishes the guidelines for the preparation of QC collected during field characterization activities. The implementation of alternative sampling procedures could be necessary if any unanticipated problems develop during the field investigation. Alternative sampling procedures, or deviations, consist of either sampling plan variances or sampling plan nonconformances.

C.5.2.3 Decontamination of Sampling Equipment

The objectives of decontamination are to remove contaminants from surfaces, mitigate the spread of contaminants to uncontaminated surfaces, prevent cross-contamination of sample matrices, and minimize personnel exposure and waste volume. The samplers will use the approved equipment decontamination procedure CP4-ES-2702, *Decontamination of Sampling Equipment and Devices*. Samplers shall clean and decontaminate nondisposable sampling equipment and devices in accordance with the decontamination of sampling equipment procedure. This procedure establishes the methodologies for cleaning and decontaminating the sampling equipment and devices that encounter sample media and/or contaminants. Decontamination of sampling equipment and devices, because of differing contaminant characteristics, may require additional cleaning and decontamination procedures and methods. Additional requirements may be stated in the task-specific work control documents (i.e., work packages).

C.5.3 SAMPLING METHODS

Activities associated with the sampling of PGE shall be in accordance with task-specific work packages.

C.5.4 FIELD MEASUREMENT PROCEDURES AND CRITERIA

Field measurements (e.g., radiological surveys) shall be in accordance with task-specific work control documents and plans.

C.5.5 SAMPLE CONTAINERS AND PRESERVATION TECHNIQUES

Recommended sample containers, minimum sample size, preservation, and holding times are provided in Table C.3.

C.5.6 FIELD QUALITY CONTROL SAMPLING PROCEDURES

Refer to Section C.5.2.2.

C.5.7 DECONTAMINATION PROCEDURES

Refer to Section C.5.2.3.

C.6. FIELD OPERATIONS DOCUMENTATION

Project records, including field operating records, field investigation data, sample collection information, and analytical data records will be managed in accordance with PGDP procedures. The D&D Field Investigation Task Lead is responsible for reviewing and approving the project records and for ensuring that the project records are transferred to the PGDP project files for long-term storage. While the project is active, conforming copies of records will be maintained at the project field office in secure locations either as hard or electronic copies.

Field operating records include, but are not limited to, sample data forms and chain-of-custody forms. As these records are completed by the project team, the records will be reviewed, processed, evaluated on-site, and submitted to the Characterization Sampling Lead for review. Sample chain-of-custody forms contain sample-specific information that was recorded during the collection of the sample. Any deviations from the sampling plan are noted on the sample chain-of-custody form or sample data form. The sampling team reviews each sample chain-of-custody form for accuracy and completeness as soon as practical following sample collection. A copy of the sample chain-of-custody forms are submitted to the sample management office (SMO) prior to sample shipment. Sample data forms are submitted to the SMO once the forms are reviewed by the Field Investigation Task Lead.

Training and qualification records for each employee are maintained in the project field office. Training and certification records are reviewed prior to the assignment of work to verify that the individual has the appropriate training, certifications, and/or qualifications.

C.6.1 SAMPLE DATA FORMS

Field documentation will conform to the FRNP procedure CP3-ES-2700, *Sample and Miscellaneous Data Forms*. The sample data form will be provided by the SMO and generated from the Project Environmental Measurements System (PEMS) database, which will be used for sample planning, generation of chain-of-custody records and sample labels, sample tracking, and the interim repository for analytical results. Chain-of-custody forms and sample data forms will contain sample-specific information for each field sample collected, including field QC samples. Generally, chain-of-custody forms and sample data forms will include the following information:

- Name of sampler
- Project name and number
- Sample identification number
- Sampling location, station code, and description
- Sample medium or media
- Sample collection date
- Sample collection device
- Sample visual description
- Sample type
- Analytes
- Analysis/method
- Type of container
- Number of containers
- Volume of container
- Preservative (type/volume)
- Destination laboratory

C.6.2 PHOTOGRAPHIC RECORDS

Photographic records will be obtained as necessary to document sample locations or off-normal conditions. Photographic records will be documented on the sample data forms for reference and recorded on a photographic log.

C.6.3 SAMPLE DOCUMENTATION

Sampling will be documented on the sample data forms and the laboratory chain-of-custody forms (see Section 6.2). Field sample data forms and chain-of-custody forms will be copied and scanned, and the electronic copies will be retained as part of the project files.

C.6.3.1 Sample Numbering System

Sample identification numbers are assigned by the project. The proposed sample-numbering scheme used for this SAP and the PEMS database will be as follows:

- Generic Sample Number: LLLPGECPN-X-##
- where:
- LLL is the location (building) where the samples are stored (331)
- PGE notes the samples are from Process Gas Equipment

- CPN notes the samples are metal coupons
- X denotes unique sample description (A for Sample No. 1, B for Sample No. 2, etc.)
- ## denotes unique sample event number (-01 for first sampling event, -02 if needed, etc.)

Characterization and criticality incredible database (CCID) numbers associated with each sample will be documented in PEMS and Oak Ridge Environmental Information System (OREIS) in the comment field and uploaded into the CCID.

Additional codes for CCID sample numbering are found in Appendix C of procedure CP3-CH-1003, *Component Inventory Management*.

C.6.3.2 Sample Labels and/or Tags

Physical samples obtained for laboratory analysis or for future evaluation will be handled, packaged, and labeled in accordance with CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*.

C.6.3.3 Chain-of-Custody Records

Procedures CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*, and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling,* will be followed for all samples. The chain-of-custody documents sample possession from time of collection, through transfers of custody, to receipt at the laboratory, and into the subsequent analysis. Chain-of-custody records will accompany each sample; the laboratory will not analyze samples that are not accompanied by a correctly prepared chain-of-custody record. A sample will be considered under custody if it is in the possession of the sampling team, in view of the sampling team, or transferred to a secured (i.e., locked) location. Chain-of-custody records will follow the requirements as specified in a DOE Prime Contractor-approved procedure for keeping records. The laboratory chain-of-custody form will be generated and used to collect and track samples from collection until transfer to the laboratory.

The Characterization Sampling Lead is responsible for the review and confirmation of the accuracy and completeness of the chain-of-custody form and for the custody of samples in the field until proper transfer to the laboratory. The Characterization Sampling Lead or his/her designee is responsible for sample custody until the samples are properly packaged, documented, and released to the analytical laboratory.

C.6.4 FIELD ANALYTICAL RECORDS

No field analytical records are anticipated to be generated during this sampling effort.

C.6.5 DOCUMENTATION PROCEDURES/DATA MANAGEMENT AND RETENTION

Field sample data forms and other documentation that is generated by the sampling team will be handled as field operating records and will be reviewed to confirm accuracy and completeness, approved, and signed daily by independent subject matter expert(s) to show that all field protocols were met. A member of the sampling team will sign for verification. Data will be available in the future D&D RI/FS.

At least two conformed copies of data forms and deliverables will be generated during the project and stored at different locations. Original forms will accompany the samples to the laboratory and conformed copies of the forms will be retained by the SMO. Analytical data will be archived for at least 7 years by the laboratory.

Data management will be conducted in accordance with the *Paducah Gaseous Diffusion Plant Data Management Plan*, DOE/LX/07-2498&D1, and in conjunction with the procedures and methods listed in the QAPP (Attachment C1). The project will implement data management processes to meet the requirements of the OREIS database. The primary and most comprehensive source of the analytical data for the Paducah Site is from the OREIS database that are supported in SQL Server™ on servers located at the Paducah Site. Upon completion of data review and clearance for release, project data will be transferred from the PEMS database to OREIS.

The FRNP SMO Manager will assess the accuracy and completeness of all data submitted. All data that are entered into the PEMS database and submitted to OREIS shall correspond with the data contained in the original laboratory reports, field data collection forms, sample chain-of-custody forms, and other documents that are associated with the sampling and laboratory analysis tasks.

Data generated through intrusive sampling will be maintained in PEMS and transferred to the CCID after data is downloaded into OREIS. Appropriate data qualifiers will be utilized. NDA data (sodium iodide scans) will be housed in the Wavefront Laboratory Information Management System database. Wavefront and NDA data, along with the characterization reports and other characterization summary information, will be associated with each component in CCID. Component information will be housed in CCID.

For analytical data, the electronic data packages, which are generated and internally reviewed by the contracted laboratory, will be considered the original versions. Electronic submittals, such as the PEMS database deliverables, establish the form of transaction of key elements of the generated database.

C.7. SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Shipments of samples from the field to the laboratory will occur typically within 48 hours of collection. Samples requiring analyses with short holding times will be identified and designated as such on the chain-of-custody form and shipped on the date of collection.

Upon laboratory receipt of the samples, the laboratory sample custodian will note the condition and temperature of the cooler received as well as any questions or observations concerning sample integrity. The laboratory sample custodian will record the condition and verify the presence of each sample named on the chain-of-custody form. Nonconformances noted in the sample identifications, types of analyses, or sample condition upon receipt will be documented and the FRNP SMO Manager will be notified. The laboratory will maintain an internal sample tracking record that will document the date of sample removal from storage; extraction, preparation, and analysis information; and laboratory-assigned sample number, which is affixed to each sample container upon sample receipt.

Field samples may only be held for a time period that does not exceed or affect the required method extraction and analysis holding times. Samples may be accumulated at the laboratory to form an analytical batch that consists of a maximum of 20 field samples of the same matrix or similar composition. Associated field QC samples, field blanks, equipment rinseate blanks, and field duplicates will be designated on the chain-of-custody form and may be included in the analytical batch. Samples and sample extracts will be stored by the laboratory in their original containers in refrigerators designated by the subcontracted laboratory. The minimum storage time for the samples and the sample extracts is a function of the analytical method holding time for a given analysis.

Samples will be tracked in the PEMS database as the samples are collected, packaged, and shipped or delivered to the laboratory for analysis.

C.8. INVESTIGATION-DERIVED WASTES OR CONTAMINANTS

IDW is considered part of the site and will be managed along with other wastes associated with the site, consistent with the final remedy. All waste generated will be managed according to the most recent revision of the *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan*, CP2-WM-0001 (WMP). A copy of the WMP (electronic or hardcopy) will be available on-site during execution of the SAP. The task-specific work package(s) may include additional procedures for managing waste from sampling the PGE.

Management of IDW emphasizes the following objectives:

- Manage the waste(s) in a manner that is protective of human health and the environment.
- Minimize waste generation, as feasible, thereby reducing unnecessary costs (analytical, storage, disposal, etc.).
- Select appropriate storage and/or disposal methods for generated waste(s).

Waste management activities must comply with this SAP, applicable contractor procedures, and *Waste Acceptance Criteria for the Treatment, Storage, and Disposal Facilities at the Paducah U.S. Department of Energy Site,* CP2-WM-0011, for on-site treatment, storage, and disposal facilities that may be designated to receive SAP waste. Off-site disposal of CERCLA-generated waste must comply with the CERCLA Off-Site Rule.

During the course of the SAP, additional Contractor and DOE waste management requirements may be identified. If necessary, revisions will be made to the WMP to ensure project compliance.

C.9. FIELD ASSESSMENT PROCEDURES

Field assessment procedures are implemented to provide the quality of data suitable for their intended use and to ensure that the project DQOs are met. Field QC and laboratory QC checks are performed to determine if the analysis is in control and if the sample matrix adversely affects the quantitative result.

C.9.1 CONTRACTOR QUALITY CONTROL

The Contractor QC will be performed in accordance with the QAPP (Attachment C1).

C.9.2 SAMPLING APPARATUS AND FIELD INSTRUMENTATION CHECKLIST

Field testing and monitoring equipment will be inspected and calibrated, in accordance with materials and testing procedures before use, and utilized and maintained in accordance with manufacturers' requirements. Detailed requirements for calibrations are outlined in QAPP Worksheet #22, *Field Equipment Calibration, Maintenance, Testing, and Inspection*. Testing and monitoring equipment includes hand-held equipment used for health and safety air monitoring and radiation emissions monitoring. Calibration standards for these instruments will be representative of the measured parameter's concentrations on site, be in good condition, and be replaced when expired. Each day an instrument is used, its calibration will be checked against at least one certified standard. For radiological instrumentation, the response is checked prior to its use. A radioactive source is used to conduct this check. Instruments will be calibrated in accordance with the manufacturers' requirements.

The date, time, and results of all calibration and source checks will be noted in an instrument calibration log. If an instrument is out of calibration, it will not be used until it is recalibrated and the recalibration will be recorded in the instrument calibration log. Calibrated instruments or equipment will be uniquely identified using the manufacturer's serial number or other unique identification markings.

C.10. NONCONFORMANCE/DEVIATIONS

Any field changes or sample deviations to this plan requires authorization from the D&D Field Investigation Task Lead. Authorization may be communicated via telephone, verbal, email, or written instructions. Deviations from the SAP will be communicated upward through the chain of command to the regulatory agencies, if applicable, using communication tools that are commensurate with the issue. Modifications to planned activities and deviations from procedures shall be recorded.

Equipment that fails calibration or becomes inoperable during use will be tagged, removed from service, and separated from serviceable equipment to prevent inadvertent use. Such equipment will be repaired and recalibrated or replaced as appropriate. Equipment that has failed calibration will not be used until the equipment has been repaired or replaced.

The following are examples of deviations from this SAP during sample collection activities that require authorization from the D&D Field Investigation Task Lead designee:

- Relocation of QA/QC (e.g., moving a field duplicate or field blank to another sample location);
- Addition of analyses to a sample location based on visual observations (i.e., oily substance observed on the PGE);
- Addition of samples;
- Relocation of samples due to access issues; and
- Removal of analyses from a specific PGE sample.

Obtaining authorization for field changes will ensure that deviations do not affect the overall sample design per this SAP.

C.11. REFERENCES

DOE 2024. *Paducah Gaseous Diffusion Plant Data Management Plan*, DOE/LX/07-2498&D1, U.S. Department of Energy, Paducah, KY, February.

EPA (U.S. Environmental Protection Agency) 2002. *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA/240/R-02/005, U.S. Environmental Protection Agency, Washington, DC, December.

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ATTACHMENT C1

QUALITY ASSURANCE PROJECT PLAN

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LIST OF QAPP WORKSHEETS

ACRONYMS

AES	atomic emission spectrometry
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical (or radionuclide) of potential concern
CPAP	Contractor Performance Assurance Program
CRQL	contract-required quantitation limit
D&D	deactivation and decommissioning
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FRNP	Four Rivers Nuclear Partnership, LLC
FS	feasibility study
GDP	gaseous diffusion plant
HSS&Q	health, safety, support, and quality
ICP	inductively coupled plasma
IDQTF	Intergovernmental Data Quality Task Force
KDEP	Kentucky Department for Environmental Protection
LCS	laboratory control sample
MCL	maximum contaminant level
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAL	no action level
NDA	nondestructive assay
OREIS	Oak Ridge Environmental Information System
OSWDF	on-site waste disposal facility
PAL	project action limit
PGDP	Paducah Gaseous Diffusion Plant
PGE	process gas equipment
PM	project manager
PORTS	Portsmouth Gaseous Diffusion Plant
PQL	practical quantitation limit
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RADCON	radiological control
RDI	regulatory decision integration
RI	remedial investigation
RMD	risk methods document
RPD	relative percent difference
SAP	sampling and analysis plan
SMO	Sample Management Office
SOP	standard operating procedure

SOW	statement of work
TBD	to be determined
TCLP	toxicity characteristic leaching procedure
TPD	training position description
TSA	technical systems audit
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
WAC	waste acceptance criteria

Quality Assurance Project Plan (QAPP) Worksheets #1 and #2. Title and Approval Page

Site Name/Project Name: Paducah Gaseous Diffusion Plant (PGDP)/Deactivation and Decommissioning (D&D) Sampling and Analysis Plan (SAP)

Site Location: Paducah, Kentucky

Site Number/Code: KY8890008982
Contractor Name: Four Rivers Nuclear Partnership, LLC (FRNP)
Contractor Number: Contract No. DE-EM0004895
Contract Title: Paducah Gaseous Diffusion Plant Deactivation and Remediation Project
Work Assignment Number: *Not applicable (N/A)*

Document Title: *Quality Assurance Project Plan for Deactivation and Decommissioning Sampling and Analysis Plan*

Lead Organization: U.S. Department of Energy (DOE)

Preparer's Name and Organizational Affiliation: Bill Jones, FRNP

Preparer's Address, Telephone Number, and Email Address: 5511 Hobbs Rd, Kevil, KY 42053, (270) 349-2482, Bill.Jones@pad.pppo.gov

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Preparation Date (Month/Year): 04/2025
Document Control Number: DOE/LX/07-2514&D1

	FRANK MILLER (Affiliate) Digitally signed by FRANK MILLER (Affiliate) Date: 2025.09.10 10:49:16 -05'00'
FRNP Regulatory Decision Integration (RDI) Program Manager	Signature/Date Frank Miller
FRNP Deactivation and Decommissioning (D&D) Decision Documents Manager	WILLIAM JONES (Affiliate) Digitally signed by WILLIAM JONES (Affiliate) Date: 2025.09.10 10:49:32 -04'00' Signature/Date Bill Jones
FRNP Sample Management Office (SMO) Manager	JAIME MORROW (Affiliate) Digitally signed by JAIME MORROW (Affiliate) Date: 2025.09.10 08:39:16 -05'00' Signature/Date Jaime Morrow
FRNP Quality Assurance (QA)/ Quality Control (QC) Manager	JENNIE FREELS (Affiliate) Digitally signed by JENNIE FREELS (Affiliate) Date: 2025.09.10 10:10:34 -05'00' Signature/Date Jennie Freels

QAPP Worksheets #1 and #2. Title and Approval Page (Continued)

1. Identify guidance used to prepare QAPP:

   - Intergovernmental Data Quality Task Force (IDQTF), March 2005. Uniform Federal Policy for Implementing Environmental Quality Systems, Version 2, (DTIC ADA 395303 or EPA-505-F-03-001 or DOE/EH-0667) (IDQTF 2005a).
   - IDQTF, March 2005. Uniform Federal Policy for Quality Assurance Project Plans: Part 1 UFP-QAPP Manual, Version 1 (DTIC ADA 427785 or EPA-505-B-04-900A) (IDQTF 2005b).
   - IDQTF, March 2005. Workbook for Uniform Federal Policy for Quality Assurance Project Plans: Part 2A UFP-QAPP Workbook, Version 1 (DTIC ADA 427486 or EPA-505-B-04-900C) (IDQTF 2005c).
   - IDQTF, March 2005. Uniform Federal Policy for Quality Assurance Project Plans: Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities, Version 1, (DTIC ADA 426957 or EPA-505-B-04-900B) (IDQTF 2005d).
   - IDQTF, March 2012. Uniform Federal Policy for Quality Assurance Project Plans Optimized UFP-QAPP Worksheets (IDQTF 2012).

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1707

3. Identify approval entities: DOE, U.S. Environmental Protection Agency (EPA) Region 4, and Kentucky Department for Environmental Protection (KDEP)

4. Indicate whether the QAPP is a generic or a project-specific QAPP (circle one).

5. List dates of scoping sessions that were held: N/A

6. List dates and titles of QAPP documents written for previous site work, if applicable: N/A

QAPP Worksheets #1 and #2. Title and Approval Page (Continued)

7. List organizational partners (stakeholders) and connection with lead organization:
   EPA Region 4 [Federal Facility Agreement (FFA) member], KDEP (FFA member)

8. List data users: DOE, FRNP, subcontractors, EPA Region 4, KDEP, stakeholders

9. Table C1.1 provides a crosswalk of required QAPP elements.

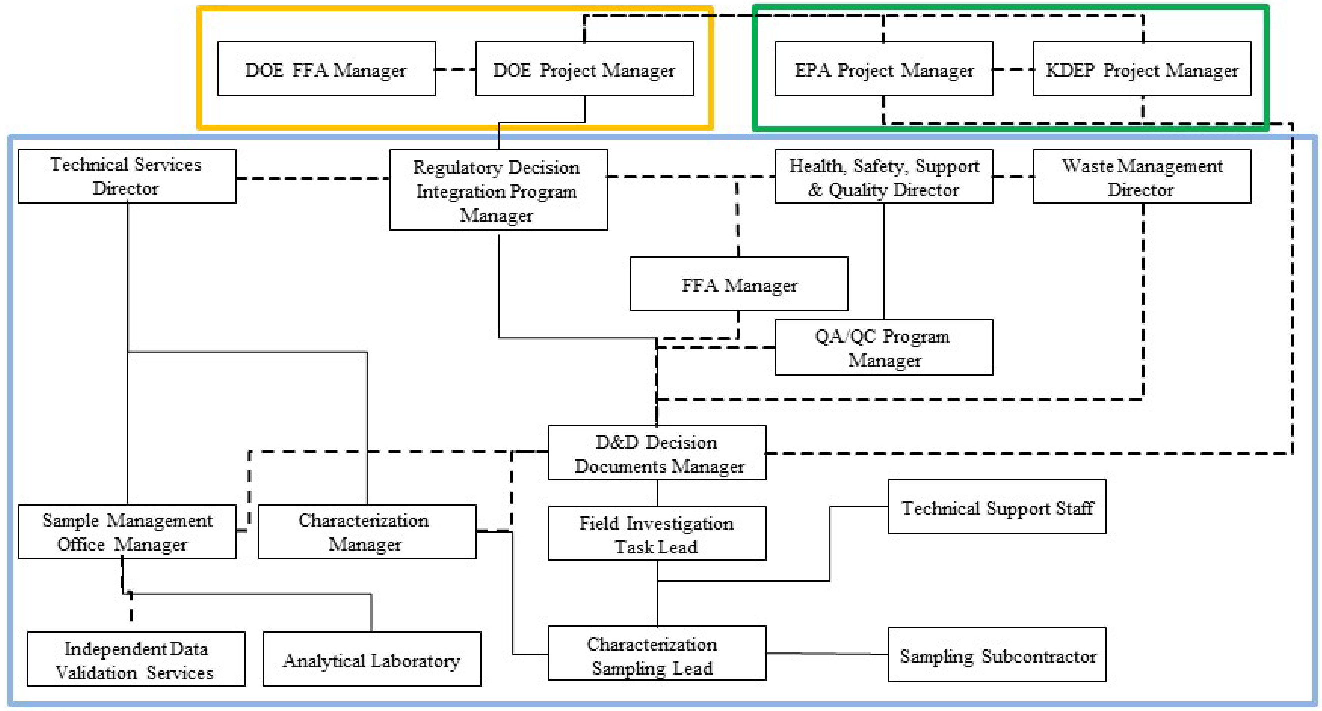
This QAPP includes all 28 combined worksheets that are required based on Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) guidance, as updated by the optimized worksheet guidance (37 total worksheets). Each of these worksheets has been reviewed to ensure the accuracy of the information presented in this QAPP.

The referenced plans and procedures for the Paducah Site can be accessed via FRNP's public documents website (FRNP 2025).

Table C1.1. Crosswalk: UFP-QAPP Workbook to 2106-G-05-QAPP

Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP Elements for Evaluating Existing Data
14 & 16	Project Tasks & Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits (PAL) and Laboratory-Specific Detection/Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC Summary	2.3.5	Quality Control Requirements
21	Field Standard Operating Procedures (SOPs)	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies, and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, & 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

QAPP Worksheets #3 and #5. Project Organization and QAPP Distribution



Notes:
DOE personnel are in Orange Box, Regulatory personnel are in Green Box, and DOE Prime Contractor personnel are in Blue Box.
Solid lines indicate lines of authority and dashed lines indicate lines of communication.

QAPP Worksheets #3 and #5. Project Organization and QAPP Distribution (Continued)
Minimum Distribution List

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current Email Address
FFA Manager	DOE	April Ladd	(270) 441-6843	april.ladd@pppo.gov
Project Manager (PM)	DOE	William Wessel	(270) 441-6869	william.wessel@pppo.gov
RDI Program Manager	FRNP	Frank Miller	(270) 349-7108	frank.miller@pad.pppo.gov
D&D Decision Documents Manager	FRNP	Bill Jones	(270) 349-2482	bill.jones@pad.pppo.gov
FFA Manager	KDEP	April Webb (Interim)	(502) 782-6470	april.webb@ky.gov
PM	KDEP	April Webb (Interim)	(502) 782-6470	april.webb@ky.gov
FFA Manager	EPA	Brian Begley	(229) 564-6529	begley.brian@epa.gov
PM	EPA	Brian Begley	(229) 564-6529	begley.brian@epa.gov
FFA Manager	FRNP	Megan Mulry	(270) 441-5705	megan.mulry@pad.pppo.gov
Health, Safety, Support, and Quality (HSS&Q) Director	FRNP	Duke Moscon	(270) 441-6538	duke.moscon@pad.pppo.gov
QA/QC Manager	FRNP	Jennie Freels	(270) 441-5407	jennie.freels@pad.pppo.gov
Technical Services Director	FRNP	Caleb Kline	(270) 441-6405	caleb.kline@pad.pppo.gov
SMO Manager	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov
Characterization Manager	FRNP	Caleb Kline (Acting)	(270) 441-6405	caleb.kline@pad.pppo.gov
Field Investigation Task Lead	FRNP	TBD	TBD	TBD
Data Validator	A2RGC, LLC	Matthew Richardson	(865) 291-4715	mrichardson@geosyntec.com
Environmental Services Director	FRNP	Bruce Ford	(270) 441-5357	bruce.ford@pad.pppo.gov
Environmental Stewardship Manager	FRNP	Katrina Hall	(270) 441-5204	katrina.hall@pad.pppo.gov

QAPP Worksheets #3 and #5. Project Organization and QAPP Distribution
Minimum Distribution List (Continued)

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current Email Address
Environmental Remediation Manager	FRNP	Todd Powers	(270) 441-5791	todd.powers@pad.pppo.gov
Characterization Sampling Lead	FRNP	Chris Skinner	(270) 441-5675	chris.skinner@pad.pppo.gov
Waste Management Director	FRNP	Carrie Maxie	(270) 441-5457	carrie.maxie@pad.pppo.gov
Analytical Laboratory	Southwest Research Institute	Elaine Wild	(210) 522-6745	elaine.wild@swri.org

QAPP Worksheets #4, #7, and #8. Personnel Qualifications and Sign-off Sheet

ORGANIZATION: FRNP

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
Frank Miller	RDI Program Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See training position description (TPD).	
Bill Jones	D&D Decision Documents Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jaime Morrow	SMO Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Chris Skinner	Characterization Sampling Lead	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Duke Moscon	HSS&Q Director, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Katrina Hall	Environmental Stewardship Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Todd Powers	Environmental Remediation Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Matthew Richardson	Data Validator	Bachelor degree plus relevant experience	No specialized training or certification.	Follows FRNP data validation plans.
Elaine Wild	Analytical Laboratory PM	> 4 years relevant work experience	No specialized training or certification.	Follows the laboratory statement of work (SOW).

*Signature indicates personnel have read and agreed to implement this QAPP as written.

QAPP Worksheet #6. Communication Pathways

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	DOE, EPA, KDEP	DOE PM: William Wessel EPA Remedial PM: Brian Begley; KDEP PM: April Webb (Acting)	william.wessel@pppo.gov begley.brian@epa.gov april.webb@ky.gov	Formal communication among DOE, EPA, and KDEP.
FFA	DOE, EPA, KDEP	DOE FFA Manager: April Ladd; EPA FFA Manager: Brian Begley; KDEP FFA Manager: April Webb (Acting)	april.ladd@pppo.gov begley.brian@epa.gov april.webb@ky.gov	Formal communication among DOE, EPA, and KDEP.
Field progress reports	FRNP	FRNP RDI Program Manager: Frank Miller; FRNP PM: Bill Jones	frank.miller@pad.pppo.gov bill.jones@pad.pppo.gov	Formal communication among the project staff, the site lead, and the DOE PM.
Stop work due to safety issues	FRNP	FRNP RDI Program Manager Frank Miller; FRNP HSS&Q Director: Duke Moscon	frank.miller@pad.pppo.gov duke.moscon@pad.pppo.gov	FRNP will communicate work stoppages to DOE PM as required by procedure.
QAPP changes prior to fieldwork	FRNP	FRNP RDI Program Manager: Frank Miller; FRNP QA/QC Manager: Jennie Freels	frank.miller@pad.pppo.gov jennie.freels@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA.

QAPP Worksheet #6. Communication Pathways (Continued)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
QAPP changes during project execution	FRNP	FRNP RDI Program Manager: Frank Miller; FRNP QA/QC Manager: Jennie Freels	frank.miller@pad.pppo.gov jennie.freels@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA.
Field corrective actions	FRNP	FRNP RDI Program Manager: Frank Miller	frank.miller@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs.
Sample receipt variances	FRNP	FRNP SMO Manager: Jaime Morrow	jaime.morrow@pad.pppo.gov	Communication between FRNP and analytical laboratory.
Analytical laboratory interface	FRNP	FRNP SMO Manager: Jaime Morrow	jaime.morrow@pad.pppo.gov	Communication between FRNP and analytical laboratory.
Laboratory QC variances	Southwest Research Institute	Laboratory PM: Elaine Wild	elaine.wild@swri.org	Notify FRNP SMO. SMO will notify FRNP PM to determine corrective actions.
Analytical corrective actions	Southwest Research Institute, FRNP	Laboratory PM: Elaine Wild; FRNP SMO Manager: Jaime Morrow	elaine.wild@swri.org jaime.morrow@pad.pppo.gov	Notify FRNP SMO. SMO will notify the project.
Data verification issues (e.g., incomplete records)	A2RGC, LLC	Data Validator: Matthew Richardson; FRNP SMO Manager: Jaime Morrow	mrichardson@geosyntec.com jaime.morrow@pad.pppo.gov	Data verification issues will be reported to the FRNP SMO.
Data validation issues (e.g., noncompliance with procedures)	A2RGC, LLC	Data Validator: Matthew Richardson; FRNP SMO Manager: Jaime Morrow	mrichardson@geosyntec.com jaime.morrow@pad.pppo.gov	Issues with data quality will be reported to the FRNP SMO.
Data review corrective actions	FRNP	FRNP SMO Manager: Jaime Morrow	jaime.morrow@pad.pppo.gov	SMO will notify the project.

NOTE: This QAPP is position-based with names of the current positions presented. In the event the contractor changes and the position titles change, DOE will notify EPA and KDEP of the change.

QAPP Worksheet #9. Project Planning Session Summary

To be completed later or deleted.

Name of Project: D&D SAP
Date of Session: N/A
Scoping Session Purpose: DOE and its contractors, EPA and its contractors, and KDEP met to scope the D&D SAP and develop data quality objectives (DQOs).

Position Title	Affiliation	Name	Phone #	Email Address	Project Role
PM	DOE				Project management
PM	FRNP				Project management
FFA Manager and PM	EPA				Project management
FFA Manager	KDEP				Project management
PM	KDEP				Project management
Technical Advisor	EPA				Project management
Technical support	Cabinet for Health and Family Services				Technical support

Notes/comments: N/A

Consensus decisions made: N/A

Action items: N/A

QAPP Worksheet #10. Conceptual Site Model

See Sections 1 and 2 of the D&D scoping document and work plan.

QAPP Worksheet #11. Project/Data Quality Objectives

Step 1. State the Problem:

DOE is evaluating alternatives to determine the final status of abovegrade structures at the Paducah Site for D&D concurrently with evaluating alternatives for CERCLA waste disposal.

For the D&D remedial decision, it has been determined that no additional data are needed. The existing sources of information and data are sufficient to support the remedial investigation (RI)/feasibility study (FS) report, including an evaluation of remedial alternatives and the selection of a remedial alternative.

Data (chemical and radiological) are needed to better understand the nature and location of specific contaminants in the D&D waste streams to demonstrate compliance with the waste acceptance criteria (WAC) for the disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to develop a refined radiological source term for performance assessment modeling of a potential on-site waste disposal facility (OSWDF) if on-site disposal is selected as part of the WDA decision. The problem statement can be summarized as follows:

- Does sufficient data exist regarding the nature and distribution of contaminants present in various waste streams to be generated during CERCLA D&D activities to demonstrate compliance with the WAC for the disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal?

Planning Team: FFA parties, FRNP

- Conceptual Model: See Section 1 and Section 2 of the D&D scoping document and work plan
- Determine Resources:
  - Schedule: See Worksheets #14 and #16
  - Budget: Based upon final scope of work
  - Personnel: FRNP

Step 2. Identify the Goals of the Study:

The goal of the study is to provide data necessary to estimate compliance with the WAC for the disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to develop/refine the D&D waste contribution to the source term for performance assessment modeling to support disposition. Some of the principal study questions follow.

A. Does enough data exist to evaluate the D&D alternatives to make a remedy decision?
   - Remedial action decision—should the facilities be demolished?

QAPP Worksheet #11. Project/Data Quality Objectives (Continued)

B. Does enough data exist to evaluate compliance with an analytical WAC for disposition?
   - Are the contaminants of concern (COCs) known?
   - Are the chemicals/radionuclides of a nature/form that are resistant to leaching and alter the maximum concentration of the contaminant allowed by the WAC? [e.g., is technetium-99 (Tc-99) plated on metal and not leachable?]

C. Does enough data exist to understand the concentration and distribution of contaminants in the D&D waste?
   - What volume of waste would likely require off-site disposal, assuming an on-site disposal option?
   - What is the form of any contaminant holdup mass in the process equipment and components?
   - Does waste require treatment prior to disposal?
   - Does waste meet requirements for packaging and transportation related to off-site disposal?

D. Does enough data exist to support the radiological source term development required by DOE O 435.1 Chg 2 (Admin Chg), *Radioactive Waste Management*?

Step 3. Identify Information Inputs:

Historical engineering documents exist that illustrate how each process gas equipment (PGE) component supported uranium hexafluoride (UF_6) gas processing and inventory management. In addition, several historical reports exist that describe the radionuclide contamination expected to be present on the component surfaces, as well as specific locations within the cascade that might have elevated levels of contamination.

The primary type of information needed is obtained through a review of the process knowledge and existing intrusive sampling data. Existing analytical data for the C-333 PGE at the Paducah Site is extensive. Another source of information is nondestructive assay (NDA) data from PGE. Lighter contaminants, such as Tc-99, are known to diffuse to the upper parts of the enrichment cascade. If existing data are not available for the upper cascade, new data will be needed.

Where site-specific data are not available, surrogate data from former gaseous diffusion plants (GDPs) [i.e., East Tennessee Technology Park and Portsmouth Gaseous Diffusion Plant (PORTS)] will be used to supplement available data. Process and operation similarities between PGDP and the two former GDPs make this data a valid resource. The uncertainty in using waste information from the other GDPs as surrogates for unavailable data at PGDP is the potential difference between the facilities themselves, including operational history, processes, historical releases, disposal practices, etc. Surrogate data from PORTS is particularly useful for materials of construction (i.e., materials used for the building construction but not including PGE and components).

QAPP Worksheet #11. Project/Data Quality Objectives (Continued)

Data is needed from the top of the cascade and purge systems to better determine the upper bounds of radionuclide and chemical contamination in PGE and components. To characterize the upper cascade, intrusive samples need to be collected for radionuclides and hazardous metals from appropriate components of the enrichment cascade.

Isotopic data is needed for radionuclides with the analytes of interest including Tc-99, uranium-238 (U-238), uranium-235 (U-235), uranium-234 (U-234), uranium-236 (U-236), americium-241 (Am-241), plutonium-238 (Pu-238), plutonium-239/240 (Pu-239/240), neptunium-237 (Np-237), thorium-228 (Th-238), thorium-230 (Th-230), thorium-232 (Th-232), cesium-137 (Cs-137), cobalt-60 (Co-60), potassium-40 (K-40), and strontium-90 (Sr-90). Tc-99 is typically a limiting contaminant relative to the WAC and the locations of higher activity-based concentrations of Tc-99 in the system need to be confirmed. Additionally, hazardous metals (e.g., arsenic, chromium) are of interest in the process gas systems. Data is also needed on the chemical leachability of WAC limiting radionuclides/hazardous metals in PGE and components.

Step 4. Identify the Boundaries of the Study:

The estimated D&D waste volumes indicate that over 80% of the anticipated waste is from D&D of the process and process support buildings (C-331, C-333, C-335, C-337, C-310, C-315, C-400, C-710, and C-720). The C-310 building has the highest enrichment level of the cascade; therefore, characterization efforts will focus efforts for sampling on components in the C-310. Additional characterization efforts for each building will take place during remedial design as needed to support demolition.

PGE is the equipment used to enrich uranium directly (i.e., compressors and converters). Auxiliary process systems are support systems that were in contact with process gas (e.g., valves, seals, piping between the converters and compressors). The major uncertainty as to ability of the waste to go to any planned on-site disposal facility is associated with the process equipment and auxiliary process systems.

Judgmental, or biased, sampling locations will be based on process knowledge to sample equipment where higher concentrations of contaminants are expected. Note that additional sampling, incorporating statistical based random sampling, will occur during the remedial design phase of work to demonstrate the WAC of the receiving facility is being met when the waste is generated.

Sampling problems that may be encountered include: mitigating the potential hazard of fluorine or hydrogen fluoride in PGE; ensuring that nuclear criticality safety has verified there are no issues with cutting at the sample location; ensuring NDA resources are available to scan PGE; access issues, and ensuring adequate craft resources and equipment are available to support sampling efforts.

Step 5. Develop the Analytical Approach:

Specific action levels are not defined for this characterization. The process buildings are being characterized to evaluate the potential disposition of the demolition waste. This data will also be useful to determine the upper bounds of contamination to support performance assessment modeling for disposition.

QAPP Worksheet #11. Project/Data Quality Objectives (Continued)

Uncertainty in the analytical approach will be addressed including: sampling uncertainty (field duplicates), laboratory uncertainty (laboratory duplicates, field duplicates, and matrix spike (MS)/matrix spike duplicates (MSD), and systematic uncertainty (e.g., lack of access, safety issues).

Samples will be analyzed for, at a minimum, uranium isotopes, (including wt.% of U-235), thorium isotopes, Tc-99, Am-241, Np-237, Pu-239/240, Cs-137, Co-60, K-40, Sr-90, and metals.

Select samples will be subject to leaching [e.g., toxicity characteristic leaching procedure (TCLP) extraction for hazardous metals, batch leaching tests, total nitric acid leach tests for radionuclides] prior to analytical analyses to determine potential availability and mobility of radionuclides and hazardous metals. The total nitric acid leaching is the standard coupon leaching method used by FRNP.

Step 6. Specify Performance or Acceptance Criteria:

Laboratory and field quality control (QC) measures will be instituted to reduce uncertainty. Analytical samples results will undergo assessment and validation. A minimum of 10% of the sample results will be validated for this project. Data validation will apply only to the definitive data and will only occur on the coupons/deposit samples. No data validation will occur on testing outlined in Attachment C2. Level IV validation will occur for the normal characterization testing only. The results of the testing outlined in Attachment C2 will be evaluated separately and documented in a future CERCLA document.

Step 7. Develop the Detailed Plan for Obtaining Data:

The step is presented in Section 5 of the D&D SAP (Appendix C).

QAPP Worksheet #12-A. Measurement Performance Criteria (Metals, Water)

Matrix	Water/laboratory leachate				
Analytical Group[a]	Metals (arsenic, calcium, chromium (total), iron, magnesium, manganese, nickel, potassium, silicon, sodium, and uranium)				
Concentration Level	Low				
Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	EPA-SW-846-6010/6020 See Worksheet #23	Precision—Lab	Relative percent difference (RPD)—≤ 20%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes	A
		Accuracy/Bias	RPD—80–120%	Interference Check Sample	A
		Accuracy/Bias Contamination	No target compounds > practical quantitation limit (PQL)	Method Blanks/Instrument Blanks	A
		Completeness[e]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-B. Measurement Performance Criteria (Anions, Water)

Matrix	Water/laboratory leachate				
Analytical Group[a]	Anions (Fluoride, Chloride, Sulfate, Nitrate, Phosphate)				
Concentration Level	Low				
Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	SW-846-9056A See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Completeness[e]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-C. Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/laboratory leachate
Analytical Group[a]	Radionuclides (Am-241, Np-237, Pu-238, Pu-239/240, Th-228, Th-230, Th-232)
Concentration Level	Low

Sampling Procedure[b]	Analytical Method/SOP[c]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
See Worksheet #21	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes[e]	A
		Accuracy/Bias Contamination	No target compounds > minimum detectable activity (MDA)	Method Blanks/Instrument Blanks	A
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] For isotopes reported by alpha spectroscopy, MS/MSD is not required, which is consistent with the *Department of Defense and Department of Energy Quality Systems Manual for Environmental Laboratories* (DOD/DOE QSM).
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-D. Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/laboratory leachate
Analytical Group[a]	Radionuclides (Tc-99)
Concentration Level	Low

Sampling Procedure[b]	Analytical Method/SOP[c]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
See Worksheet #21	Liquid scintillation See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes[e]	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] Reference number from QAPP Worksheet #23.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] For radionuclides reported by liquid scintillation, MS/MSD is not required, which is consistent with the DOD/DOE QSM.
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-E. Measurement Performance Criteria (Metals, Solids)

Matrix	Solid (metal coupon/deposit)
Analytical Group[a]	Metals (antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc)
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP[c]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	SW-846-6010/6020 or SW-846-7471	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes	A
		Accuracy/Bias	RPD—80-120%	Interference Check Sample	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseate Blanks	S
		Completeness[e]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-F. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Solid (metal coupon/deposit)				
Analytical Group[a]	Radionuclides (total uranium[b], U-234, U-235, U-236, and U-238)				
Concentration Level	Medium-High				
Sampling Procedure[c]	**Analytical Method/SOP**[d]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	Inductively Coupled Plasma (ICP)-MS See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[e]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseate Blanks	S
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] The total uranium listed represents the total of the uranium isotopes that is analyzed by ICP-MS.
[c] Reference number from QAPP Worksheet #21.
[d] Reference number from QAPP Worksheet #23.
[e] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-G. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Solid (metal coupon/deposit)
Analytical Group[a]	Radionuclides (Am-241, Np-237, Pu-238, Pu-239/240, Th-228, Th-230, and Th-232)
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes[e]	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseate Blanks	S
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] For radionuclides reported by alpha spectroscopy, MS/MSD is not required, which is consistent with the DOD/DOE QSM.
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-H. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Solid (metal coupon/deposit)
Analytical Group[a]	Radionuclides (Cs-137, Co-60, K-40)
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	Gamma spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseate Blanks	S
		Completeness[d]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Completeness is calculated by two methods:
- as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-I. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Solid (metal coupon/deposit)
Analytical Group[a]	Radionuclides (Tc-99)
Concentration Level	Medium—High

Sampling Procedure[b]	Analytical Method/SOP[c]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
See Worksheet #21	Liquid scintillation See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes[e]	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseate Blanks	S
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] For radionuclides reported by liquid scintillation, MS/MSD is not required, which is consistent with the DOD/DOE QSM.
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-J. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Solid (metal coupon/deposit)				
Analytical Group[a]	Radionuclides (Sr-90)				
Concentration Level	Medium—High				
Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	Gas Flow Proportional Counter	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseate Blanks	S
		Completeness[e]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[e] Completeness is calculated by two methods:
- as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
- as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-K. Measurement Performance Criteria (Bicarbonate, Water)

Matrix	Water/laboratory leachate
Analytical Group[a]	Bicarbonate alkalinity
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	SM 2320B	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Completeness[d]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] Reference number from QAPP Worksheet #21.
[c] The most current version of the method the laboratory is accredited to perform will be used.
[d] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #12-L. Measurement Performance Criteria (Radionuclides, Solids)

Matrix	Water/laboratory leachate
Analytical Group[a]	Radionuclides (total uranium[b], U-234, U-235, U-236, and U-238)
Concentration Level	Medium-High

Sampling Procedure[c]	**Analytical Method/SOP**[d]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)**
See Worksheet #21	ICP-MS See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Accuracy/Bias	% recovery[e]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > MDA	Method Blanks/Instrument Blanks	A
		Completeness[f]	90%	Data Completeness Check	S&A

[a] If information varies within an analytical group, separate by individual analyte.
[b] The total uranium listed represents the total of the uranium isotopes that is analyzed by ICP-MS.
[c] Reference number from QAPP Worksheet #21.
[d] Reference number from QAPP Worksheet #23.
[e] Percent recovery is laboratory-specific, calculated from studies performed every six months. Percent recovery ranges will be provided in the laboratory data packages based on the most current study.
[f] Completeness is calculated by two methods:
— as the number of valid analytical results reported divided by the number of analytical results planned, multiplied by 100 to obtain the percentage.
— as the number of valid analytical results reported divided by the number of analytical results requested, multiplied by 100 to obtain the percentage.

QAPP Worksheet #13. Secondary Data Uses and Limitations

Secondary Data Type	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Factors Affecting Reliability and Limitations on Data Use
Paducah Oak Ridge Environmental Information System (OREIS) Database	Various	Various	The data will be used in conjunction with RI/FS data to be collected at a later date.	Data have been verified, assessed, and validated (10% of the sample results will be validated). Rejected data will not be used.
Characterization and Criticality Incredible Database	Various	Various	Data used in conjunction with new RI/FS data to evaluate contaminant distribution in the Paducah cascade.	Data have been verified, assessed, and validated (10% of the sample results will be validated). Rejected data will not be used.
Historical Documentation	Various	Various	Information will be used in conjunction with newly collected data to determine levels and distribution of chemicals (or radionuclides) of potential concern (COPCs) in the Paducah cascade. Information will be used as guidance on related project work.	Data have been verified, assessed, and validated (if applicable). Rejected data will not be used. Information from historical documents will be limited to the available documentation as it relates to a specific project. Use of historical data may be limited based on how long ago the data were collected and whether site conditions have changed since data collection.

NOTE: Data validation will apply only to the definitive data and will only occur on the coupons/deposit samples. No data validation will occur on testing outlined in Attachment C2. Level IV validation will occur for the normal characterization testing only. The results of the testing outlined in Attachment C2 will be evaluated separately and documented in a future CERCLA document.

QAPP Worksheets #14 and #16. Project Tasks & Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization/demobilization	FRNP	TBD	TBD	Field notes	TBD
Sample collection	FRNP	TBD	TBD	Field notes	TBD
Analysis	Southwest Research Institute	TBD	TBD	Report of analysis	TBD
Validation	A2RGC, LLC	TBD	TBD	Validation summary	TBD
Data report	Project Team	TBD	TBD	Data report	TBD

QAPP Worksheet #15-A. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Water)

Matrix: Water/Laboratory Leachate
Analytical Group: Metals

Analyte	Chemical Abstracts Service (CAS) Number	PAL/No Action Level (NAL) (mg/L)	PAL Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/L)	Method Detection Limit (MDL)[d] (mg/L)
Arsenic	7440-38-2	0.010/5.17E-05	MCL/NAL	Yes	0.005	0.002
Calcium	7440-70-2	N/A	N/A	No	0.2	0.2
Chromium (total)	7440-47-3	0.10/2.25[e]	Maximum contaminant level (MCL)/no action limit (NAL)	Yes	0.01	0.003
Iron	7439-89-6	1.4/1.40	Tap water/NAL	Yes	0.1	0.033
Magnesium	7439-95-4	N/A	N/A	No	0.03	0.03
Manganese	7439-96-5	0.043/0.0434	Tap water/NAL	Yes	0.005	0.001
Nickel	7440-02-0	0.039/0.0392[f]	Tap water/NAL	Yes	0.002	0.0006
Potassium	7440-09-7	N/A	N/A	No	0.15	0.15
Silicon	7440-21-3	N/A	N/A	No	0.1	0.1
Sodium	7440-23-5	N/A	N/A	No	0.3	0.3
Uranium	7440-61-1	0.030/0.000399[f]	MCL/NAL	Yes	0.0004	6.40E-05

NOTE: Worksheet #15 will be prepared with preliminary target laboratory-specific PQLs and MDLs to be used to procure the laboratory.

[a] This QAPP references the MCLs (or EPA screening level for tap water if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs for the resident scenario established by the Risk Methods Document (RMD) and MCLs for the resident scenario reproduced in the RMD. The PAL is the lower of the NALs for the child resident and adult resident scenarios from the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.

[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.

[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.

[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.

[e] An NAL is not available for chromium (total); therefore, the NAL for chromium (III) was used.

[f] The PAL/NAL values were derived for metal soluble salts.

QAPP Worksheet #15-B. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Anions, Water)

Matrix: Water/Laboratory Leachate
Analytical Group: Anions

Analyte	CAS Number	PAL (mg/L)	PAL Reference[a]	Site COPC?[b]	Laboratory-Specific	
					PQL (mg/L)	MDL[c] (mg/L)
Fluoride	16984-48-8	4.0	MCL	No	0.1	0.045
Chloride	16887-00-6	N/A	N/A	No	0.1	0.045
Nitrate	14797-55-8	10	MCL	No	0.1	0.045
Sulfate	14808-79-8	N/A	N/A	No	0.1	0.045
Phosphate (orthophosphate)	14265-44-2	N/A	N/A	No	0.1	0.045

NAL = no action level for child resident scenario from the RMD
NOTE: Worksheet #15 will be prepared with preliminary target laboratory specific PQLs and MDLs to be used to procure the laboratory.
[a] This QAPP references the MCLs to support project planning and identify whether lower reporting limits may be needed for some constituents.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.

QAPP Worksheet #15-C. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

Matrix: Water/Laboratory Leachate
Analytical Group: Radionuclides

Analyte	CAS Number	PAL (pCi/L)	PAL Reference[a]	Site COPC?[b]	Laboratory-Specific[c]
					MDA[d] (pCi/L)
Am-241	14596-10-2	15/0.0677	MCL/NAL	Yes	1
Np-237	13994-20-2	15/0.0783	MCL/NAL	Yes	1
Pu-238	13981-16-3	15/0.0156	MCL/NAL	Yes	1
Pu-239/240	15117-48-3/14119-33-6	15/15; 0.0603/0.0318	MCL/NAL	Yes	1
Tc-99	14133-76-7	4 mrem/year-dose[e] 900/19.0	MCL/NAL	Yes	25
Th-228	14274-82-9	N/A	N/A	No	1
Th-230	14269-63-7	15/0.0166	MCL/NAL	Yes	1
Th-232	7440-29-1	15/0.0363	MCL/NAL	Yes	1
U-234	13966-29-5	10.24/0.0162	MCL[f]/NAL	Yes	32
U-235	15117-96-1	0.466/0.0714	MCL[f]/NAL	Yes	1
U-236[f]	13982-70-2	N/A	N/A	Yes	1
U-238[f]	7440-61-1	9.99/0.0158	MCL[f]/NAL	Yes	1

NOTE: NAL = no action level for child resident scenario from the RMD
Worksheet #15 will be prepared with preliminary target laboratory specific PQLs and MDLs to be used to procure the laboratory.
[a] This QAPP references the MCLs (or EPA screening level for tap water if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD for the resident secular equilibrium scenario and MCLs reproduced in the RMD. The PAL is the lower of the NALs for the child resident and adult resident scenarios is used from the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] Radiological parameters will be reported per laboratory SOPs and the DOD/DOE QSM.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDAs identified in the worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[e] The value derived by the EPA from the 4 mrem/year MCL for Tc-99 is 900 pCi/L (see https://www.epa.gov/sites/default/files/2015-06/documents/compliance-radionuclidesindw.pdf). An alternate value derived by the EPA from the 4 mrem/year MCL is 3,790 pCi/L and was proposed in the July 18, 1991, *Federal Register*, http://nepis.epa.gov [document number 570-Z-91-049 (search term: 570Z91049)].
See Table A.9 of the RMD for Tc-99 dose-based groundwater screening levels resulting in a 4 mrem/year dose based upon more recent dosimetry.
[f] Based on RMD.

QAPP Worksheet #15-D. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Solids)

Matrix: Solid (Metal coupon/deposit)
Analytical Group: Metals

Analyte	CAS Number	PAL (mg/kg)	PAL Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/kg)	MDL[d] (mg/kg)
Antimony	7440-36-0	3.13	NAL	Yes	2	0.33
Arsenic	7440-38-2	0.356	NAL	Yes	1	0.338
Barium	7440-39-3	1,530	NAL	Yes	0.8	0.1
Beryllium	7440-41-7	15.6	NAL	Yes	0.1	0.02
Cadmium	7440-43-9	0.530	NAL	Yes	0.2	0.02
Chromium (total)	7440-47-3	11,700[e]	NAL	Yes	0.6	0.2
Lead	7439-92-1	200	NAL	Yes	0.4	0.1
Mercury	7439-97-6	2.35	NAL	Yes	0.04	0.02
Nickel	7440-02-0	145	NAL	Yes	0.4	0.1
Selenium	7782-49-2	39.1	NAL	Yes	1	0.36
Silver	7440-22-4	39.1	NAL	Yes	0.5	0.1
Thallium	7440-28-0	0.0782	NAL	Yes	0.4	0.14
Uranium[f]	7440-61-1	1.56	NAL	Yes	0.04	0.0132
Vanadium	7440-62-2	39.3	NAL	Yes	4	0.3
Zinc	7440-66-6	2,350	NAL	Yes	4	0.8

NOTE: NAL for child resident scenario from the RMD.
Worksheet #15 will be prepared with preliminary target laboratory-specific PQLs and MDLs to be used to procure the laboratory.
[a] This QAPP references the NALs established by the RMD for the resident scenario to support project planning and identify whether lower reporting limits may be needed for some constituents. The PAL is the lower of the NALs for the child resident and adult scenarios from the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[e] An NAL is not available for chromium (total); therefore, the NAL for chromium (III) was used.
[f] The PAL/NAL values were derived for metal soluble salts.

QAPP Worksheet #15-E. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Solids)

Matrix: Metal coupon/deposit
Analytical Group: Radionuclides

Analyte	CAS Number	PAL (pCi/g)	PAL Reference[a]	Site COPC?[b]	Laboratory-Specific[c] MDA (pCi/sample)
Am-241	14596-10-2	0.0455	NAL	Yes	3
Co-60	10198-40-0	N/A	N/A	No	TBD
Cs-137	10045-97-3	0.0395	NAL	Yes	5
Np-237	13994-20-2	0.0466	NAL	Yes	3
K-40	3966-00-2	N/A	N/A	No	TBD
Pu-238	13981-16-3	0.011	NAL	Yes	3
Pu-239/240	15117-48-3/14119-33-6	0.0397/0.00854	NAL	Yes	3
Sr-90	10098-97-2	N/A	N/A	No	1
Tc-99	14133-76-7	112	NAL	Yes	5
Th-230	14269-63-7	0.0111	NAL	Yes	1
Th-232	7440-29-1	0.00857	NAL	Yes	1
U-234	13966-29-5	0.0111	NAL	Yes	32
U-235	15117-96-1	0.0401	NAL	Yes	1
U-236	13982-70-2	N/A	N/A	No	1
U-238	7440-61-1	0.0109	NAL	Yes	1

NOTE: NAL for child resident scenario from the RMD

[a] This QAPP references the NALs established by the RMD and MCLs reproduced in the RMD to support project planning and identify whether lower reporting limits may be needed for some constituents. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process within the project-specific QAPP.

[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.

[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the MDA is above the PAL/NAL, FRNP. will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.

QAPP Worksheet #17. Sampling Design and Rationale

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach): On the basis of this process knowledge, the characterization program was designed to apply judgmental (or biased) sampling. The judgmental (biased) sampling applies the detailed process knowledge to pinpoint the upper bounds of the concentration of uranium isotopes and system contaminants (specifically Tc-99).

Describe the sampling design and rationale in terms of which matrices will be sampled: The sample design is provided in Section C.5.1.2 of the D&D SAP (Appendix C).

What analyses will be performed and at what analytical limits? See Worksheets #12 and #15.

Where are the sampling locations (including QC, critical, and background samples)? See Section C.5.1.3 of the D&D SAP (Appendix C).

How many samples to be taken? See Section C.5.1.3 of the D&D SAP (Appendix C).

What is the sampling frequency (including seasonal considerations)? (May refer to map or Worksheet #18 for details.) N/A—one-time sampling event.

QAPP Worksheet #18. Sampling Locations and Methods

Sampling locations are specified in Section 5.1.3 of the D&D SAP (Appendix C).

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (Identify Field Duplicate %)	Sampling SOP Reference	Rationale for Sampling Location
TBD	Metal coupon/ deposit	N/A	Total Metals	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Metal coupon/ deposit	N/A	TCLP Metals	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Metal coupon/ deposit	N/A	Radionuclides	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water*	N/A	Metals	N/A (per leach test plan)	See Worksheet #21	See Worksheet #17
TBD	Water*	N/A	Radionuclides	N/A (per leach test plan)	See Worksheet #21	See Worksheet #17
TBD	Water*	N/A	Anions	N/A (per leach test plan)	See Worksheet #21	See Worksheet #17
TBD	Water*	N/A	Bicarbonate alkalinity	N/A (per leach test plan)	See Worksheet #21	See Worksheet #17

*Water/laboratory leachate sampled in accordance with the leaching test plan (Attachment C2).

QAPP Worksheets #19 and #30. Sample Containers, Preservation, and Hold Times

Laboratory: Southwest Research Institute
List any required accreditations/certifications: DOE Consolidated Audit Program (DOECAP), if applicable
Back-up Laboratory: N/A
Sample Delivery Method: Overnight delivery

Analyte Group	Matrix	Matrix Type	Recommended Container	Minimum Sample Size[a,b]	Preservative[c]	Holding Time
Radiochemical analyses[d]	Solid	Metal Coupon[d]	16 oz wide-mouth high density polyethylene (HDPE) container or poly bag	100 cm^2	None	180 days
		PGE Deposit	1 to 4 oz wide-mouth HDPE container	5 g		
Total metals[d]	Solid	PGE Deposit	1 to 4 oz wide-mouth HDPE container	5 g	Chill ≤ 6°C	180 days (metals); 28 days (mercury)
TCLP metals	Solid	PGE Deposit	1 to 8 oz wide-mouth glass jar with Teflon®-lined lid	100 g	Chill ≤ 6°C	180 days (metals); 28 days (mercury)
Batch leaching tests (see Attachment C2)	Solid	Metal Coupon	16 oz wide-mouth HDPE container or poly bag	Minimum 250 g (prefer three coupons ~ 80 g each) for each type of equipment sampled.	N/A	N/A

[a] Proposed sample size; the sample size is determined by the greater of 1) the minimum sample size required by the appropriate analytical method; or 2) the requirements of the analytical laboratory.
[b] If the minimum volume requirement is not obtained (i.e., deposit material collected is less than 5 g), then the laboratory will perform analyses in the following order of precedence: radiological, total metals (includes TCLP metals).
[c] Laboratory method may dictate to cool samples for preservation; nuclear criticality safety controls may prevent initial cooling preservation of the sample immediately after sample collection until received by the laboratory prior to criticality screening.
[d] In cases where uranyl fluoride is visibly present and easily obtained, the residual material (i.e., PGE deposit) is considered the target media for sampling. Otherwise, total metals can be analyzed from the leachate generated from the FRNP standard coupon leaching procedure and reported in units of mg/sample.

QAPP Worksheet #20. Field QC Summary

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	MSs	MSDs	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Solid (metal coupon/deposit)	Metals	6–12	1	1	1	1	1	N/A	N/A	11–17
Solid (metal coupon/deposit)	TCLP Metals	6–12	1	1	1	N/A	N/A	N/A	N/A	11–17
Solid (metal coupon/deposit)	Radionuclides	6–12	1	N/A	N/A	1	1	N/A	N/A	11–17

MS/MSDs are not required for alpha spectroscopy, gamma spectroscopy, and/or liquid scintillation methods.
These samples are required for equipment that is decontaminated and reused during the sampling event; no equipment blanks are required for new or disposable equipment that is not used at more than one sample location.

QAPP Worksheet #21. Field SOPs

Reference Number	Title and Number Revision Date[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1	CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2022)	Contractor	N/A	N	N/A
2	CP2-ES-5102, *Radiochemical Analysis Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2022)	Contractor	N/A	N	N/A
3	CP2-ES-5107, *Inorganic Analyses Data Verification and Validation, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (7/1/2022)	Contractor	N/A	N	N/A
4	CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans* (10/31/2022)	Contractor	N/A	N	N/A
5	CP3-ES-5003, *Quality Assured Data* (8/1/2024)	Contractor	N/A	N	N/A
6	CP3-ES-0043, *Temperature Control for Sample Storage* (10/31/2022)	Contractor	Sampling	N	N/A
7	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System* (11/1/2022)	Contractor	N/A	N	N/A
8	CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases* (11/3/2022)	Contractor	N/A	N	N/A
9	CP4-ES-2002, *Sampling of Structural Elements and Miscellaneous Surfaces* (5/15/2023)	Contractor	N/A	N	N/A
10	CP3-ES-2700, *Sample and Miscellaneous Data Forms* (5/16/2024)	Contractor	N/A	N	N/A
11	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (4/20/2023)	Contractor	Sampling	N	N/A
12	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/11/2023)	Contractor	N/A	N	N/A
13	CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals* (11/4/2024)	Contractor	N/A	N	N/A
14	CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling* (12/3/2024)	Contractor	N/A	N	N/A
15	CP3-ES-5007, *Data Management Coordination* (1/27/2025)	Contractor	N/A	N	N/A
16	CP3-QA-1003, *Management and Self-Assessment* (10/30/2023)	Contractor	N/A	N	N/A

QAPP Worksheet #21. Field SOPs (Continued)

Reference Number	Title and Number Revision Date[a]	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
17	CP3-RD-0010, *Records Management Process* (2/28/2024)	Contractor	N/A	N	N/A
18	CP5-RP-2016, *Radiological Protection Contamination Control and Monitoring Technical Basis Document* (5/11/2023)	Contractor	N/A	N	N/A
19	CP5-RP-2022, *Radiological Protection Instrumentation Operation Technical Basis Document* (2/1/2024)	Contractor	N/A	N	N/A
20	CP3-RP-1109, *Radioactive Contamination Control and Monitoring* (1/11/2024)	Contractor	N/A	N	N/A
21	CP4-RP-1110, *Radiation Surveys* (6/18/2024)	Contractor	N/A	N	N/A
22	CP4-RP-1309, *Setup for Operability Tests of Portable Field Instruments* (2/29/2024)	Contractor	N/A	N	N/A
23	CP4-RP-1336, *Radiological Instrumentation Field Operability Tests* (2/29/2024)	Contractor	N/A	N	N/A
24	CP2-WM-0001, *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan* (6/17/2024)	Contractor	N/A	N	N/A
25	CP3-SM-1101, *Work Package Development* (7/10/2025)	Contractor	N/A	N	N/A
26	CP3-ES-0038, *Sampling Non-Fissile Material* (4/18/2023)	Contractor	N/A	N	N/A
27	CP3-CH-1001, *Process Equipment and Pipe Sampling* (2/13/2023)	Contractor	N/A	N	N/A
28	CP4-ES-2410, *Sampling of Fissile/Potentially Fissile Material* (10/19/2023)	Contractor	N/A	N	N/A
29	CP5-ND-2500, *Method Manual for Qualitative Sodium Iodide Scans at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (11/25/2024)	Contractor	N/A	N	N/A
30	CP4-ND-1003, *Nondestructive Assay Scans* (11/21/2024)	Contractor	N/A	N	N/A

[a] SOPs are posted to the FRNP external public website (FRNP 2025). It is understood that SOPs are contractor-specific. The project reports will specify any deviation between the procedures presented in this worksheet, those at the FRNP intranet website, and those actually used during the project.
[b] The work will be conducted by FRNP staff or a subcontractor. In either case, SOPs listed will be followed.

QAPP Worksheet #22. Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Alpha Scintillator	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Remove from service and replace or recalibrate prior to reuse	Radiological Control (RADCON) Supervisor	Manufacturer's specifications
Geiger Mueller	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Remove from service and replace or recalibrate prior to reuse	RADCON Supervisor	Manufacturer's specifications
Gamma Scintillator or field instrument for detection of low energy radiation	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Remove from service and replace or recalibrate prior to reuse	RADCON Supervisor	Manufacturer's specifications
GPS Gamma Ray Survey Instrumentation	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Annually or as needed	Pass/Fail	Remove from service and replace or recalibrate prior to reuse	RADCON Supervisor	Manufacturer's specifications

*Additional equipment may be needed; additional equipment will follow manufacturer's specifications for calibration, maintenance, inspection, and testing. Calibration data will be documented on sample data forms consistent with CP3-ES-2700, *Sample and Miscellaneous Data Forms*.

QAPP Worksheet #23. Analytical SOPs

Reference Number[a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/ Matrix	Instrument	Organization Performing Analysis	Modified for Project Work?(Y/N)
6010	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	Definitive	Metals/Solid and Water	ICP	Southwest Research Institute	No
6020	Inductively Coupled Plasma-Mass Spectrometry	Definitive	Metals/Solid and Water	ICP-Mass Spectrometry	Southwest Research Institute	No
7470/ 7471	Mercury in Liquid Waste (Manual Cold-Vapor Technique)	Definitive	Metals (Mercury)/Solid	Atomic Absorption	Southwest Research Institute	No
9056	Determination of Inorganic Anions by Ion Chromatography	Definitive	Anions/Water	Ion Chromatography	Southwest Research Institute	No
SM 2320 B	Bicarbonate Alkalinity	Definitive	Miscellaneous (Bicarbonate Alkalinity)/Water	Titration	Southwest Research Institute	No
ICP-MS[b]	Inductively Coupled Plasma-Mass Spectrometry	Definitive	Rads (Uranium Isotopes)/Solid and Water	ICP-MS	Southwest Research Institute	No
Gas Flow Proportional[b]	Gas Flow Proportional	Definitive	Rads/Solid and Water	Gas Flow Proportional Counter	Southwest Research Institute	No
Alpha Spec[b]	Alpha Spectrometry	Definitive	Rads/Solid and Water	Alpha Spectrometry	Southwest Research Institute	No
Gamma Spec[b]	Gamma Spectrometry	Definitive	Rads/Solid and Water	Gamma Spectrometry	Southwest Research Institute	No
Liquid Scintillation[b]	Tc-99 by Liquid Scintillation	Definitive	Rads/Solid and Water	Liquid Scintillation	Southwest Research Institute	No

[a] Information will be based on laboratory used. Analysis will be by the most recent revision.
[b] Analytical methods for radiochemistry parameters are laboratory-specific.

QAPP Worksheet #24. Analytical Instrument Calibration

Laboratories used by the DOE Prime Contractor are participants in DOECAP. In the fall of 2017, DOECAP began implementing accreditation of environmental laboratories through third-party organizations. If not in DOECAP, laboratories are audited by contractors for compliance with DOECAP program requirements. As such, laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program as summarized in the SOPs. The laboratory is responsible for maintaining instrument calibration information per its QA Plan, including control charts established for instrumentation.

Whenever possible, the laboratory uses recognized procedures for calibration such as those published by EPA or American Society for Testing and Materials. If established procedures are not available, the laboratory develops a calibration procedure based on the type of equipment, stability, characteristics of the equipment, required accuracy, and the effect of operation error on the quantities measured. Whenever possible, physical reference standards associated with periodic calibrations such as weights or certified thermometers with known relationships to nationally recognized standards are used. Where national reference standards are not available, the basis for the reference standard is documented. Equipment or instruments that fail calibration or become inoperable during use are tagged to indicate they are out of calibration. Such instruments or equipment are repaired and successfully recalibrated prior to reuse. High resolution mass spectrometer instruments undergo extensive tuning and calibration prior to running each sample set. The calibrations and ongoing instrument performance parameters are recorded and reported as part of the analytical data package.

Instrument*	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference

*The laboratory is responsible for maintaining instrument calibration information per its QA plan, including control charts established for instrumentation. This information is audited. Additional certifications may be needed based on project-specific requirements (e.g., National Environmental Laboratory Accreditation Program, KDEP Drinking Water Laboratory Program). Field survey/sampling instrumentation will be calibrated according to manufacturer's instructions.

QAPP Worksheet #25. Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
All	Per laboratory quality manual	QC standards	Per laboratory quality manual	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
ICP-MS ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Initial and/or continuing calibration criteria must be met.	Repeat maintenance activity or remove from service.	Laboratory Area Supervisor	See Worksheet #23
pH Meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value.	Repeat maintenance activity or remove from service.	Laboratory Manager	See Worksheet #23
Spectro-photometer	Flush/replace tubing	QC standards	Tubing	As needed	Must meet initial and/or continuing calibration criteria.	Repeat maintenance activity or remove from service.	Laboratory Manager	See Worksheet #23
Cold Vapor Atomic Absorption	Replace tubing, check instrument lines and connections, check windows in cell, and ensure lamp operational.	Metals	Instrument lines and connections, windows, and lamp	As needed	Must meet initial and/or continuing calibration criteria.	Repeat maintenance activity or remove from service.	Laboratory Area Supervisor	See Worksheet #23

*The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

QAPP Worksheets #26 and #27. Sample Handling, Custody, and Disposal

Sampling Organization: FRNP
Laboratory: Southwest Research Institute
Method of sample delivery (shipper/carrier): Overnight
Number of day from reporting until sample disposal: Six months (182 days)

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP reference
Sample labeling	Sampling Teams/DOE Prime Contractor and Subcontractors	CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Chain-of-custody form completion	Sampling Teams/DOE Prime Contractor and Subcontractors	CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Packaging	Sampling Teams/DOE Prime Contractor and Subcontractors	CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Shipping coordination	SMO/DOE Prime Contractor	CP3-ES-2709, *Chain-of-Custody Forms, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Sample receipt, inspection, and log-in	Sample Management/Contracted Laboratory	01-0401-050, *Receipt and Log-in of Non-Radioactive and Radioactive Samples and Materials*
Sample custody and storage	Sample Management/Contracted Laboratory	01-0401-050, *Receipt and Log-in of Non-Radioactive and Radioactive Samples and Materials*
Sample disposal	Sample Management/Contracted Laboratory	01-0401-004, *Disposal of Hazardous Non-Radioactive Material*; and ESS-P300.03, *Radioactive Waste Disposal Tracking*

QAPP Worksheet #28-A. Analytical Quality Control and Corrective Action (Aqueous)

Matrix: Aqueous Samples (water/laboratory leachate)						
Analytical Group/Concentration Level: Metals, Anions, Radionuclides, Wet Chemistry						
Sampling SOP: See Worksheet #21						
Analytical Method/SOP Reference: 6010/6020/7470, 9056A, Alpha Spec, Gamma Spec, Liquid Scint, Gas Flow Proportional Counter, and ICP-MS for U isotopes.						
Sampler's Name/Field Sampling Organization: FRNP						
Analytical Organization: Southwest Research Institute						
No. of Sample Locations: 6						
QC Sample	**Frequency/Number[a]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Field blank	Minimum 5%	≤ contract-required quantitation limit (CRQL)[b]	Verify results; reanalyze	Laboratory should alert project	Contamination Accuracy/bias	See data validation plans.
Equipment blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze		Contamination Accuracy/bias	See data validation plans.
Spiked field samples (MS and/or MSD)	1 per analytical batch[c]	See data validation plans CP2-ES-0026, -5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See data validation plans.
Laboratory control sample (LCS)	1 per analytical batch[d]	See data validation plans CP2-ES-0026, -5102, -5107	Check calculations and instrument; reanalyze affected samples		Contamination Accuracy/Bias	See data validation plans.
Method Blank	1 per analytical batch	See data validation plans CP2-ES-0026, -5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See data validation plans.
Internal standards	All samples and standards	See data validation plan CP2-ES-5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See data validation plans.
Field duplicate	Minimum 5%	See data validation plans CP2-ES-0026, -5102, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/Precision	Specific RPD defined for each group in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -5102, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	Specific RPD defined for each group in Worksheet #12

QAPP Worksheet #28-A. Analytical Quality Control and Corrective Action (Aqueous) (Continued)

QC Sample	Frequency/Number[a]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Tracers/Carriers	Each sample tested by a radiochemical separations method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples	Laboratory analyst	Accuracy	See data validation plans.

[a] The number of QC samples is listed on Worksheet #20.
[b] Unless dictated by project-specific parameters, ≤ CRQL.
[c] MS/MSDs will be spiked with all reported analytes per the DOD/DOE QSM. MS/MSDs will not be required consistent with the DOD/DOE QSM for alpha spec, gamma spec, and liquid scintillation methods (RADs).
[d] LCS will be spiked with all reported analytes per the DOD/DOE QSM.

QAPP Worksheet #28-B. Analytical Quality Control and Corrective Action (Solids)

Matrix: Solids (metal coupon/deposit)						
Analytical Group/Concentration Level: Metals, Radionuclides						
Sampling SOP: See Worksheet #21						
Analytical Method/SOP Reference: 6010/6020/7471, Alpha Spec, Gamma Spec, Liquid Scint, Gas flow Proportional Counter, and ICP-MS for uranium isotopes						
Sampler's Name/Field Sampling Organization: FRNP						
Analytical Organization: Southwest Research Institute						
No. of Sample Locations: 6						
QC Sample	**Frequency/Number[a]**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Field blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze	Laboratory should alert project	Contamination Accuracy/bias	See data validation plans.
Equipment blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze		Contamination Accuracy/bias	See data validation plans.
Spiked field samples (MS and/or MSD)	1 per analytical batch[c]	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precisi on	See data validation plans.
LCS	1 per analytical batch[d]	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Contamination Accuracy/Bias	See data validation plans.
Method Blank	1 per analytical batch	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See data validation plans.
Internal standards	All sample blanks and QA samples	See data validation plan CP2-ES-5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See data validation plans.
Field duplicate	Minimum 5%	See data validation plans CP2-ES-5102, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	Specific RPD defined for each group in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-5102, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	Specific RPD defined for each group in Worksheet #12
Tracers/Carriers	Each sample tested by a radiochemical separations method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples	Laboratory analyst	Accuracy	See data validation plans.

[a] The number of QC samples is listed on Worksheet #20.
[b] Unless dictated by project-specific parameters, ≤ CRQL.
[c] MS/MSDs will be spiked with all reported analytes per the DOD/DOE QSM. MS/MSDs will not be required consistent with DOD/DOE QSM for alpha spec, gamma spec, and liquid scintillation methods (RADs).
[d] LCS will be spiked with all reported analytes per the DOD/DOE QSM.

QAPP Worksheet #29. Project Documents and Records

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Sample data forms	Field Team	Field Team Leader	Project File
Chain-of-custody forms	Field Team	Field Team Leader	Project File
Air bills	Contract Laboratory	Contract Laboratory	Project File
Equipment calibration forms	Field Team	Field Team Leader	Project File
Deviations	PM	Project Director	Project File
Corrective action reports	PM	Project Director	Project File
Correspondence	PM	Project Director	Project File

Project Assessments			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Data verification checklists	SMO/Data Validator	SMO	Project File
Data validation report	Data Validator	SMO	Project File
Data usability assessment report	SMO/Data Validator	SMO	Project File

Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Level IV laboratory reports	Laboratory Staff	Laboratory PM	Project File
Electronic data deliverables	Laboratory Staff	Laboratory PM	Project File

QAPP Worksheets #31, #32, and #33. Assessments and Corrective Action

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Date	Assessment Deliverable	Deliverable Due Date
On-site analytical technical systems audit (TSA)	Field Team Leader/ FRNP	Prior to start of on-site analytical work and every 2 weeks thereafter	TBD	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Repot	Per Individual Laboratory QA Manual
Management Assessment	Project Director/ FRNP	Interim management review following site mobilization; final management review upon completion of fieldwork	TBD	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*
Independent Assessment	Contractor Performance Assurance Program (CPAP) Manager	As needed	TBD	As described in CP3-QA-1004, *Independent Assessment Program*	As described in CP3-QA-1004, *Independent Assessment Program*
Field Sampling TSA	Field Team Leader/FRNP	Field Sampling Corrective Action Response (following CP3-QA-3001, *Issues Management*)	24 hours from receipt of memorandum	Field Team Leader/FRNP	CPAP Manager/FRNP
On-site analytical TSA	Field Team Leader/ FRNP	On-site Analytical Corrective Action Response (following CP3-QA-3001, *Issues Management*)	48 hours from receipt of memorandum and before further analyses can be conducted.	Field Team Leader/ FRNP	CPAP Manager/FRNP
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Internal Audit Report Deficiency Memorandum	7 days following receipt of PT deficiency report and before analysis field samples	Laboratory Technical Director	QA/QC Manager/FRNP

QAPP Worksheets #31, #32, and #33. Assessments and Corrective Action (Continued)

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Time Frame for Response	Responsibility for Implementing Corrective Action	Responsible for Monitoring Corrective Action implementation
Management Assessment	Project Director/ FRNP	Management Response	As described in CP3-QA-1003, *Management and Self-Assessment*	As assigned in Management Response	CPAP Manager/FRNP
Independent Assessment	Director/Manager of the Assessed Organization	As required by CP3-QA-1004, *Independent Assessment Program*	As required by CP3-QA-1004, *Independent Assessment Program*	Field Team Leader/ FRNP	CPAP Manager/FRNP

QAPP Worksheet #34. Data Verification and Validation Inputs

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	X	
Field Records			
5	Sample data forms	X	X
6	Equipment calibration records	X	X
7	Chain-of-custody forms	X	X
8	Sampling diagrams/surveys	X	X
9	Relevant correspondence	X	X
10	Change orders/deviations	X	X
11	Field audit reports	X	X
12	Field corrective action reports	X	X
Analytical Data Package			
13	Cover sheet (laboratory identifying information)	X	X
14	Case narrative	X	X
15	Sample receipt records	X	X
16	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
17	Communication records	X	X
18	Limit of detection/limit of quantification establishment and verification	X	X
19	Standards traceability	X	X
20	Instrument calibration records	X	X
21	Definition of laboratory qualifiers	X	X
22	Results reporting forms	X	X
23	QC sample results	X	X
24	Corrective action reports	X	X
25	Raw data	X	X
26	Electronic data deliverables	X	X

QAPP Worksheet #35. Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Sample data forms	QAPP, Field SOPs	Verify that records are present and complete for each day of field activities. Verify that all planned samples including field QC samples were collected and that sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and were reported in accordance with requirements. Verify that any required field monitoring was performed and results are documented.	Field Team Leader/FRNP— SMO/FRNP
Data deliverables, analytes, and holding times	QAPP, contract, and procedures	The documentation from the contractual screen will be included in the data assessment packages, per DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*. Data assessment codes and definitions are included in the data assessment package.	Laboratory PM/Contract Laboratory SMO/FRNP
Chain-of-custody, sample handling, sampling methods, and field transcription	QAPP, contract, and procedures	These items will be validated during the data assessment process as required by DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*, and CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans*. The documentation of this validation will be included in the data assessment packages.	SMO/FRNP
Analytical methods and procedures, laboratory data qualifiers, and standards	QAPP, contract, and procedures	These items will be reviewed during the data validation process as required by DOE Prime Contractor data validation plans. Data validation will be performed in parallel with data assessment. The data validation report and data validation codes will be considered when the data assessment process is being finalized. Data validation codes and definitions are listed in the plans used for validation (see Worksheet #36).	Data Validation Subcontractor and SMO/FRNP

QAPP Worksheet #35. Data Verification Procedures (Continued)

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Audit reports, corrective action reports	QAPP and procedures	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	CPAP Manager/FRNP
Deviations and qualifiers	QAPP and procedures	Any deviations and qualifiers resulting from process will be documented in the data assessment packages.	SMO/FRNP

QAPP Worksheet #36. Data Validation Procedures

Data Validator: A2RGC, LLC

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator* (Title and Organizational Affiliation)
Step IIa/IIb	Solid (Metal coupon/deposit)	All	All	National Functional Guidelines; Worksheets #12, #15, and #28; and CP2-ES-5102, and CP2-ES-5107	Data Validator: Matthew Richardson; A2RGC, LLC

*Validation is to be conducted by a qualified individual, independent from sampling, laboratory, project management, or other decision-making personnel for the task. This could be an outside party or someone within FRNP who is not involved in the project. Data validation will apply only to the definitive data and will only occur on the coupons/deposit samples. No data validation will occur on testing outlined in Attachment C2. Level IV validation will occur for the normal characterization testing only. The results of the testing outlined in Attachment C2 will be evaluated separately and documented in a future CERCLA document

QAPP Worksheet #37. Data Usability Assessment

The purpose of this portion of the project is to obtain samples from select areas within the process buildings targeting PGE (converter shells, compressors, etc.) and piping. The samples collected then will be analyzed for contamination. The data will be utilized to the extent needed to inform future environmental planning associated with waste disposition. Samples from PGE/piping will also be used in leachability tests to determine how much contamination (primarily Tc-99) may leach off any equipment.

FRNP will determine the adequacy of data based on the results of validation and verification. The usability step involves assessing whether the process execution and resulting data meet project quality objectives documented in this D&D SAP.

Summarize the usability assessment process and procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: Analytical data are verified and assessed per procedure CP3-ES-5003, *Quality Assured Data*. Data assessment packages will be created per this procedure. Data assessment packages will include analytical data, chains-of-custody, data verification and assessment queries, and other project-specific information needed for personnel to review the package adequately. Data assessment packages will be reviewed to document any issues pertaining to the data and to indicate if DQOs of the project were met. For data selected for validation, the following plans are used: CP2-ES-5102, and CP2-ES-5107.

Describe the evaluative procedures used to assess overall measurement error associated with the project: Precision, accuracy, representativeness, comparability, completeness, and sensitivity parameters will be evaluated per procedure, CP3-ES-5003, *Quality Assured Data*. This information will be included in the data assessment packages for review by project personnel. Data assessment also will include documentation of QC exceedances, trends, and/or bias in the data set. Data assessment will document any statistics used.

Identify the personnel responsible for performing the usability assessment:

Project Director: Frank Miller
Project QA Manager: Jennie Freels
Characterization: Mike Dunn
D&D Decision Documents Manager: Bill Jones
Data Validator: Mathew Richardson; A2RGC, LLC
SMO: Jaime Morrow
Field Team Leader: TBD

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies: Data assessment packages will be created, which will include data assessment comments/questions and laboratory comments.

C1.1 REFERENCES

FRNP 2025. "DOE PPPO Public Documents," accessed June 17, 2025, https://pubdocs.pad.pppo.gov/.

IDQTF (Intergovernmental Data Quality Task Force) 2005a. *Uniform Federal Policy for Implementing Environmental Quality Systems Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs*, Version 2, DOD: DTIC ADA 395303, EPA: EPA-505-F-03-001, DOE: DOE/EH-0667), Intergovernmental Data Quality Task Force comprised of representatives from the U.S. Department of Defense, U.S. Department of Energy, and U.S. Environmental Protection Agency, Washington, DC, March.

IDQTF 2005b. *Uniform Federal Policy for Quality Assurance Project Plans Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual*, EPA: EPA-505-B-04-900A, DOD: DTIC ADA 427785, Intergovernmental Data Quality Task Force comprised of representatives from the U.S. Department of Defense, U.S. Department of Energy, and U.S. Environmental Protection Agency, Washington, DC, March.

IDQTF 2005c. *Workbook for Uniform Federal Policy for Quality Assurance Project Plans Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs: Part 2A UFP-QAPP Workbook*, Version 1, DOD: DTIC ADA 427486, EPA: EPA-505-B-04-900C, Intergovernmental Data Quality Task Force comprised of representatives from the U.S. Department of Defense, U.S. Department of Energy, and U.S. Environmental Protection Agency, Washington, DC, March.

IDQTF 2005d. *Uniform Federal Policy for Quality Assurance Project Plans Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities*, Version 1, DOD: DTIC ADA 426957, EPA: EPA-505-B-04-900B, Intergovernmental Data Quality Task Force comprised of representatives from the U.S. Department of Defense, U.S. Department of Energy, and U.S. Environmental Protection Agency, Washington, DC, March.

IDQTF 2012. *Uniform Federal Policy for Quality Assurance Project Plans Optimized UFP-QAPP Worksheets*, Intergovernmental Data Quality Task Force comprised of representatives from the U.S. Department of Defense, U.S. Department of Energy, and U.S. Environmental Protection Agency, Washington, DC, March.

ATTACHMENT C2

BATCH LEACHING TEST PLAN

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CONTENTS

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TABLES

FIGURES

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ACRONYMS

ASTM	American Society for Testing and Materials
D&D	deactivation and decommissioning
DQO	data quality objective
Eh	reduction-oxidation potential
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
MS	mass spectrometry
OSWDF	on-site waste disposal facility
PA	performance assessment
PGDP	Paducah Gaseous Diffusion Plant
PGE	process gas equipment
QA	quality assurance
QAPP	quality assurance project plan
SAP	sampling and analysis plan
TCLP	toxicity characteristic leaching procedure
WAC	waste acceptance criteria

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C2.1. INTRODUCTION

The purpose of this test plan is to obtain data on the leachability of uranium and technetium-99 (Tc-99) solids that are present on materials generated during deactivation and decommissioning (D&D) that need to be disposed of properly. Some of the materials may be placed in a potential on-site waste disposal facility (OSWDF) if on-site disposal is selected as part of the WDA decision. This information is needed to evaluate if the D&D waste stream that includes process gas equipment (PGE) will be in compliance with the waste acceptance criteria (WAC) for disposal facilities and if it will meet requirements for packaging, transportation, and disposal. This information, and related data, will also be useful to estimate reasonable maximum contamination levels in leachate that could be used to simulate impacts under certain failure scenarios of disposition. Contaminant concentrations in leachate will be evaluated to determine if the mass of contamination on materials placed in the cell is acceptable with respect to the protection of human health and the environment.

As part of the evaluation process for disposition, WAC and a performance assessment (PA) must be developed to evaluate the long-term human health and environmental risks associated with placing the D&D waste in a potential OSWDF if on-site disposal is selected as part of the WDA decision. There are two key areas for data collection to support the WAC compliance determination and PA: (1) release of uranium, Tc-99, and other contaminants from fluid contacting the PGE and debris; and (2) geochemical mechanisms and hydrological parameters that control the release and migration of the contaminants. This test plan will also provide data that addresses the first item and provides some preliminary discussion on the second item.

An operational history of the site and the gaseous diffusion process are provided in Sections 1.4.2 and 1.4.4 of the D&D scoping document and work plan. The field methods executed to collect PGE samples used in this test plan, are provided in Section C.5.1 of the D&D sampling and analysis plan (SAP) (Appendix C). This test plan addresses the leaching potential of uranium, Tc-99, and other select radionuclides from metal PGE samples from Paducah Gaseous Diffusion Plant (PGDP) process buildings. Current sampling activities and schedule constraints place limits on the available samples and testing methods that will be used to derive estimates of leaching coefficients by the end of January 2026. Samples from the C-310 Purge and Product Building, which houses the PGE expected to have the highest uranium-235 (U-235) and Tc-99 activities, will be used to estimate the release of contamination from similar and less contaminated PGE in the remaining process buildings. The use of samples from the most contaminated PGE will bias the leaching results to the highest expected concentrations. A two-step batch leach test; solubility batch test; and verification tests that examine the variation of pH, reduction-oxidation potential (Eh), and bicarbonate concentration will be used to generate estimates on the mass of uranium and Tc-99 that can be extracted from the PGE and the leachate compositions. As column tests require more sample material and information on the geometry of waste placed in the disposal cell (e.g., porosity and permeability), and neither are available at this time, a batch-testing approach was selected for execution.

Data quality objectives (DQOs) for this test plan are provided in Section C2.2 of this test plan. The DQO format follows standard U.S. Environmental Protection Agency (EPA) protocol, where the problem is stated, decisions and goals are identified, needed input to the decisions is identified, the boundary of the study is defined, decision rules and errors are listed, and design optimization is considered.

Section C2.3 of this test plan covers the design of the two-step batch leach test, solubility batch test, and verification tests. Test matrices are presented to summarize the number of batch tests, duplicate runs, fluid types, sampling frequency, and the analyte list for each sampling event. The test procedures are described to illustrate the methods and types of data that will be collected, and this is followed by a discussion of the generation of the numerical data sets, evaluation of results, and assumptions that influence the interpretation and conclusions drawn from the data.

Finally, a quality assurance project plan (QAPP) for the generated analytical data can be found in Attachment C1. The QAPP notes the analytical methods, sample size, laboratory duplicate frequency, and/or other quality assurance (QA) practices to ensure the integrity of the data sets generated by the study.

C2.2. LEACHING TEST DATA QUALITY OBJECTIVES

The DQO process provides a structured approach to planning projects where environmental data are used to support decision making. Use of the DQO process leads to efficient and effective expenditures of resources; consensus on the type, quality, and quantity of data needed to meet the project goals; and full documentation of actions taken during development of the project. For this project, the concepts defined in *Guidance on Systematic Planning Using the Data Quality Objectives Process* will be applied to the qualitative assessment of data needs; however, because this project is not the typical investigation of contaminant releases to the environment, DQO guidance will be applied with a graded approach (EPA 2006).

In accordance with EPA DQO guidance, there are seven steps in the DQO process. The first five can be applied to any decision that utilizes qualitative or quantitative data to support decision making, while Steps 6 and 7 are specific to supporting quantitative (statistical) analysis of data.

- Step 1—State the problem (define the problem that necessitates the study).
- Step 2—Identify the goal of the study (state how environmental data will be used in meeting objectives and solving the problem, identify study questions, and define alternative outcomes).
- Step 3—Identify information inputs (identify data and information needed to answer study questions).
- Step 4—Define the boundaries of the study (specify target population and characteristics of interest).
- Step 5—Develop the analytic approach (define the parameter of interest).
- Step 6—Specify performance (acceptance) criteria (develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use).
- Step 7—Develop the plan for obtaining data.

In this project, DQOs have been developed for the data designed to support evaluation of the release of uranium, Tc-99, and other contaminants from fluid contacting the PGE and debris after disposition.

Step 1—State the Problem

Preliminary characterization of PGE and piping indicates uranium, Tc-99, and other contaminants are present. The PGE and/or piping and D&D debris may be placed in a potential OSWDF if on-site disposal is selected as part of the WDA decision. The concentration of contaminants in leachate generated from the waste forms placed in the proposed cell will be used to demonstrate WAC compliance for the D&D waste and evaluate the performance, with respect to human health and the environment, prior to regulatory approval to construct the cell. Management, regulatory, and characterization personnel at PGDP will prepare and implement a plan to provide data and solve this problem by the end of January 2026.

Step 2—Identify the Goal of the Study

The goal of this study is to provide data necessary to evaluate compliance with the WAC for disposal facilities (for off-site and/or on-site disposal) and to meet regulatory requirements for packaging, transportation, and disposal. This data will also be useful to identify the contaminants that leach from the identified PGE and components, and D&D debris, measure the steady-state concentration of each contaminant in leachate derived from batch testing and use the results to estimate contaminant concentrations in leachate that may migrate, and derive leaching coefficients and solubility limits that can be used with transport models to demonstrate that the engineered and natural barriers of the proposed cell are adequate to protect human health and the environment. If the collected data indicate that some of the waste forms produce leachate concentrations that are too great for the release assumptions and regulatory time frame used in the transport model, then alternative outcomes may include treatment of the waste form prior to disposal or off-site disposal of troublesome waste forms.

Step 3—Identify Information Inputs

A two-step batch leach test and solubility batch test (Section C2.3 of this test plan), with samples of contaminated PGE, and site groundwater, will be performed to identify leachable contaminants and their steady-state or solubility limit in solution. The leachate will be sampled and analyzed at specific intervals to establish the steady-state concentration for each contaminant. Final leachate samples will be fully characterized for major and minor ions, if sufficient fluid volume is available after all radionuclide analyses are performed. The final concentration of contaminants in the leachate solid phase will also be determined at the end of the second leach test and solubility test to provide the needed information to calculate leaching coefficients, the fraction of extractable contaminant in the waste form, and solubility limits. Information on the initial composition of site groundwater used in the batch tests is required to interpret the results of contaminant concentrations that develop in the leachate; therefore, groundwater used for the batch tests will be fully characterized for major and minor ions and the radionuclides of interest. Locations and methodology for the sampling of PGE used in this study are identified Section C.5.1.3 of the D&D SAP (Appendix C).

Step 4—Define the Boundaries of the Study

There are four gaseous diffusion buildings and the C-310 Purge and Product Building that have PGE and piping that could become waste forms. Based on historical sampling and process knowledge, the C-310 Purge and Product Building houses the most contaminated of the gaseous diffusion buildings at PGDP. Samples to be used in the batch tests will be obtained from the C-310 Purge and Product Building equipment as described in Section C.5 of the D&D SAP (Appendix C). Because of this, the batch tests will produce contaminant concentrations in leachate that are biased high. Two material types have been identified as the most contaminated waste forms: the centrifugal pump assemblies and piping (expansion joints).

Contact solution for the batch tests will be obtained from uncontaminated Paducah Site groundwater and trichloroethene (TCE)-spiked groundwater. The basis for the selection of these contact fluids is that soil with and without TCE contamination will be placed in the proposed disposal cell with the PGE and debris, and the large surface area of the soil particles will react with precipitation to generate a fluid that can be simulated by the groundwater and TCE groundwater.

Step 5—Develop the Analytic Approach

Preliminary analytical results on digested samples of PGE indicate the contaminants of concern to be Tc-99, thorium-228 (Th-238), thorium-230 (Th-230), thorium-232 (Th-232), U-234, U-235, uranium-236 (U-236), uranium-238 (U-238), americium-241 (Am-241), neptunium-237 (Np-237), plutonium-238 (Pu-238), and plutonium-239/240 (Pu-239/240); therefore, these contaminants are expected to appear in the leachate. Several analytical methods will be used to obtain the required data to support this study (Table C2.1). The leachate will be analyzed for total uranium, Tc-99, pH, Eh, and temperature at specified intervals to evaluate when the solution has reached steady-state prior to analyzing for the complete list of contaminants. When either two consecutive leachate sample results agree within 10% or 42 days is reached, the leachate will be analyzed for the following: fluoride, total uranium, Tc-99, Th-228, Th-230, Th-232, U-234, U-235, U-236, U-238, Am-241, Np-237, Pu-238, Pu-239/240, temperature, pH, and Eh (if sufficient fluid volume is available, the final leachate will be analyzed for major and minor ions). At the conclusion of the two-step leach and solubility tests, the solid phase will be completely digested [no hydrogen fluoride (HF)] and analyzed for fluoride, total uranium, Tc-99, Th-228, Th-230, Th-232, U-234, U-235, U-236, U-238, Am-241, Np-237, Pu-238, and Pu-239/240 (if sufficient fluid volume is available, the final digestate will be analyzed for major and minor ions, excluding those ions that are contained in the acid used to digest the sample). Section C2.3 describes the test procedures and sampling intervals.

Table C2.1. Analytical Methods

Analyte	Method
Fluoride, Chloride, Nitrate, Sulfate, Phosphate	Ion Chromatography
Bicarbonate Alkalinity	Titration
Arsenic, Sodium, Potassium, Calcium, Magnesium, Silicon, Iron, Manganese, Chromium, Nickel	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
Total Uranium	ICP-MS
Tc-99	Liquid Scintillation
Th-228, Th-230, Th-232	Alpha Spectrometry
U-234, U-235, U-236, U-238	ICP-MS
Am-241	Alpha Spectrometry
Np-237	Alpha Spectrometry
Pu-238, Pu-239/240	Alpha Spectrometry

Step 6—Specify Performance (Acceptance) Criteria

Solid samples for each of the equipment waste forms to be tested (pump assemblies and expansion joints) will be obtained as described in Section C.5 of the D&D SAP (Appendix C).

Because of the limited data for each waste form from the selected process buildings, a rigorous statistical approach with Type I and II errors is not specified and the performance (acceptance) criteria for the data are centered on whether the data are too conservative for their intended use. If the use of conservative data (i.e., data collected from the most contaminated PGE) demonstrates that the proposed disposal cell is protective of human health and the environment, the acceptance and approval of the cell will confirm that the leach study has met its goals; however, if the conservative data show that the release rates do not protect human health and the environment, additional batch tests on the less contaminated PGE may be needed.

Step 7—Develop the Plan for Obtaining Data

The D&D SAP (Appendix C) and this test plan state the approach and methods that will be implemented to obtain the data. Changes to these plans may occur due to collection of new data or management/regulator decisions that warrant a change in the assumptions or types of debris to be used in the batch tests.

Section C.5.1.3 of the D&D SAP (Appendix C) summarizes the sample locations (e.g., PGE and components) for the batch tests.

Approximately 250 g of sample are planned to be collected from the PGE and components to provide the material for the batch tests. Due to the nature of the testing, it is preferable to obtain three coupons of approximately 80 g each from each type of PGE and components sampled.

The use of groundwater that reflects the interaction of precipitation with the minerals and solids in contaminated and uncontaminated soil on the Paducah Site fits a simple conceptual model of the PGE being surrounded by contaminated and uncontaminated soil after disposition (groundwater will be collected from one or more site groundwater monitoring wells during ongoing monitoring well sampling). Soil particles have a high surface area per unit volume of material and chemical reactions between precipitation and soil particles are likely to be the principal control on fluid compositions. Analytical results from the batch leach, solubility and verification tests, and groundwater samples, will be used with geochemical models to simulate and evaluate the potential range of fluid compositions (pH, Eh, bicarbonate, uranium, Tc-99, etc.).

C2.3. DESIGN OF THE TWO-STEP AND SOLUBILITY BATCH LEACH TESTS

The method selected for the two-step batch leach testing of PGE and component samples requires a test schedule of over 4 months. Data will be collected to identify the most leachable contaminants in the waste forms and estimate the total extractable mass of each contaminant. The leaching coefficient of each contaminant in the waste will be calculated based on the analytical results. A similar method and approach were used at the U.S. Department of Energy on-site disposal facility in Piketon, Ohio, as presented in the *Analytical Results and Data Evaluation for Batch Leach Tests Performed on Samples Collected from Process Gas Equipment in Building X-326, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio* (DOE 2013*)*. It is a two-step process because after the fluid in the first leach test has reached steady state with respect to total uranium and Tc-99, the fluid will be decanted, and the waste debris will be placed in contact with fresh fluid and the leach test will be repeated a second time. This process is illustrated on Figure C2.1. Waste types to be tested and the radionuclides of interest have been identified in Section C2.2.

In parallel to the second batch leach step, a solubility batch test (Figure C2.2) will be run with a portion of the leachate generated by the first step and a split of the sample used for the two-step batch leach test. The split from the initial solid sample used in the two-step batch leach test will be size reduced to evaluate the role of particle size on the mass of released contamination. The size of the original sample pieces used in the batch leach test are many times smaller than the size of PGE pieces that will be placed in a potential OSWDF if on-site disposal is selected as part of the WDA decision, and further size reduction is very unlikely to change results; however, to test this hypothesis, the pieces used for the solubility testing will be sized reduced per toxicity characteristic leaching procedure (TCLP) protocol.

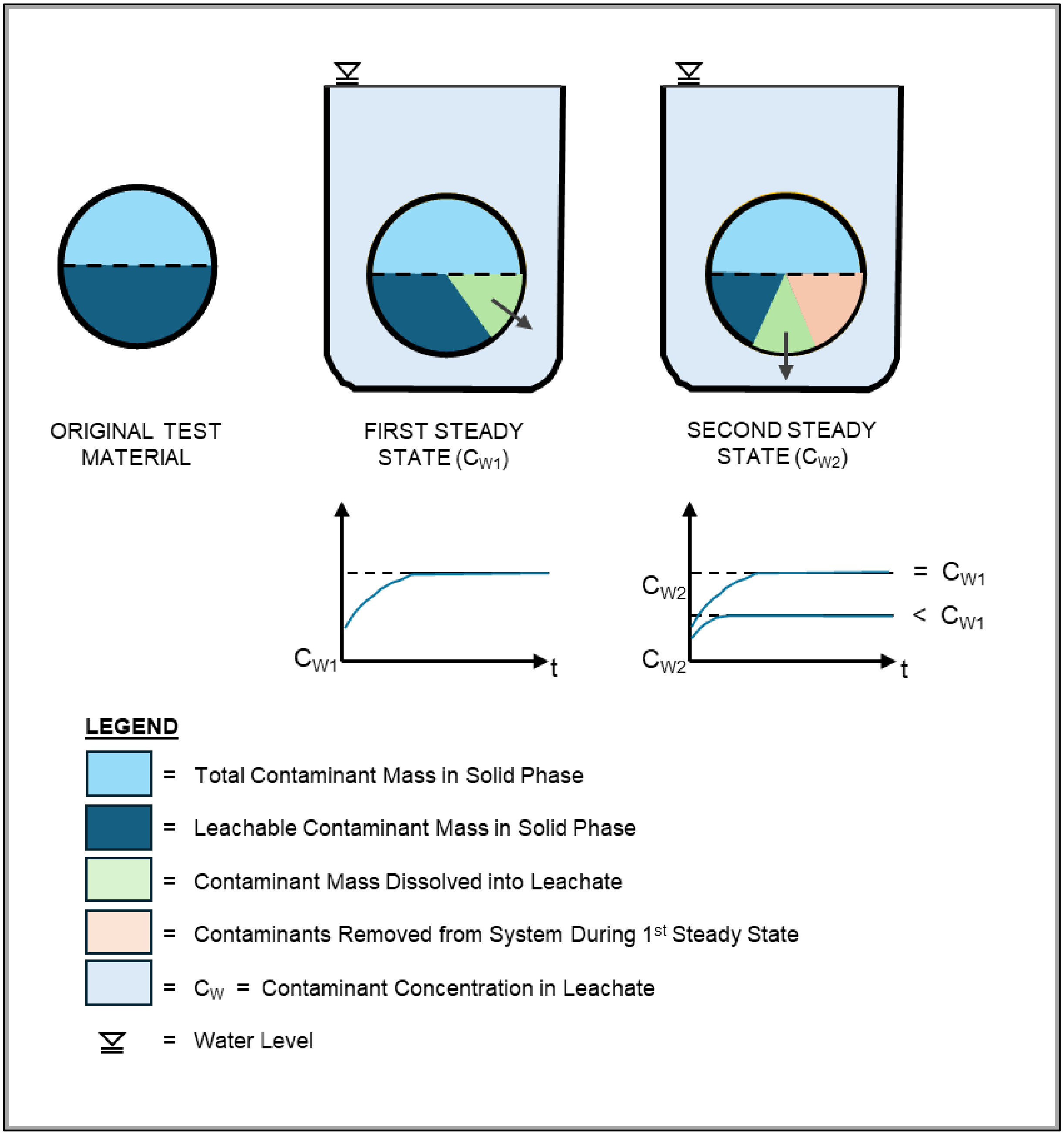

Figure C2.1. Conceptual Model of Two-Step Leach Process

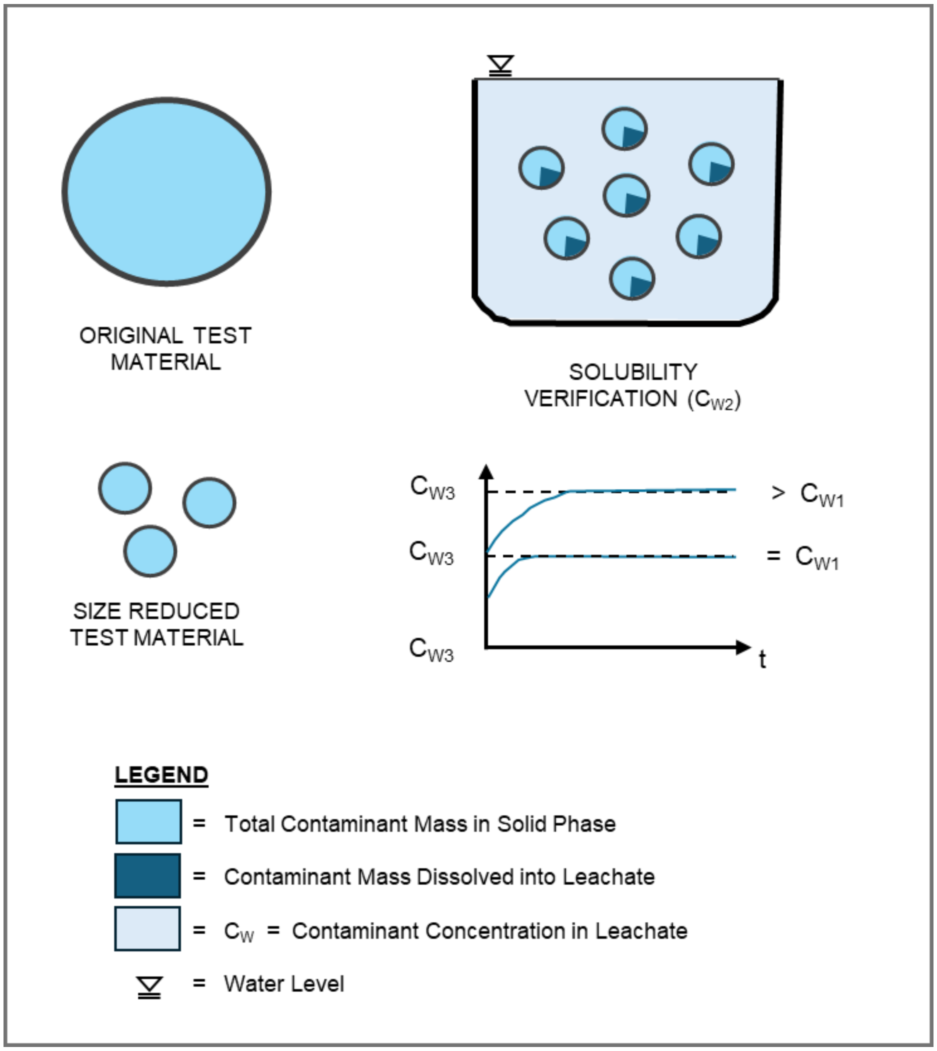

Figure C2.2. Conceptual Model of Solubility Batch Test

The solubility test will be performed at a lower fluid/solid mass ratio (approximately 12) because only a fraction of the step-one leachate will be used and the solid mass from the split sample will be similar to the mass used in the two-step batch test. The concentration of contaminants in the leachate from step one of the two-step batch leach test will not change when contacted with size-reduced material in the solubility test if the contaminants have reached a solubility limit during step one. This will also be confirmed if the contaminant concentrations in the leachate from step two are within 10% of the concentrations in the leachate from step one. Conversely, if the concentration of a contaminant increases when it is contacted with the size-reduced material in the solubility test, it indicates the waste form holds a highly soluble species.

Verification tests will be performed after the second-step of the batch leach test to evaluate the leaching of the solids under higher pH, Eh, and bicarbonate conditions, which may enhance leaching of the uranium and Tc-99.

Waste types to be placed in the proposed OSWDF if on-site disposal is selected as part of the WDA decision will be leached by a fluid composition that is likely to be similar to the composition of site groundwater. As the bulk equipment and debris items will be placed with contaminated and uncontaminated soil and compacted to reduce porosity and permeability within the disposal cell, the high surface area and residual moisture of the soil particles is likely to control the fluid composition. Based on this conceptual scenario, the fluid compositions for the batch tests will be uncontaminated groundwater obtained from the site and the same uncontaminated groundwater spiked with TCE to stimulate the TCE-contaminated groundwater plume. The purpose for using TCE in the contact solution is it mimics the TCE-contaminated soil that will be placed in the proposed disposal cell and it may provide a competitive redox species for the oxidized uranium and Tc-99 (uranyl and pertechnetate) aqueous ions, because TCE can be degraded by reductive dehalogenation, if an electron source is available. The implication of this is that the presence of TCE may inhibit the reduction of uranium and Tc-99 to less mobile species when conditions in the disposal cell become anoxic. The use of uncontaminated and TCE groundwater in the batch tests will provide data that can be used to evaluate this conceptual scenario.

C2.3.1 TEST MATRICES

The proposed test matrix for the two-step batch leach test (Table C2.2) considers multiple independent samples (identified as -1, -2, etc.) from each component type (e.g., pump-1, pump-2, pump-3, pump-4, joint-1, joint-2). When possible, duplicate samples corresponding to the samples with the assumed highest measured radionuclide activities will be selected for the batch tests. Each material sample will be split into three approximately equal mass fractions (≥ 80 g each); one split will be leached with uncontaminated groundwater, one split with TCE groundwater, and the remaining split used in the solubility batch test as discussed below. To avoid further processing and size-reduction of the material for the two-step batch testing, three splits will be used for the testing. A total of 12 batch tests will be run for the first step, and 12 additional tests for the second step. The protocol in Table C2.2 is repeated for the second round of tests and one-half of the samples are then used for the verification tests (discussed below).

For the solubility test matrix (Table C2.3), the third fraction of the sample split for the two-step batch leach will be size-reduced (per TCLP protocol) to enhance the dissolution kinetics and labeled with an "s" modifier (e.g., -1s) to identify it as a solubility sample. There are only six tests for the solubility test matrix because the original material sample is divided into three splits and two are used for the two-step batch test, which leaves a single split for the solubility test (i.e., there is not enough mass to do both a groundwater and TCE groundwater solubility test on every sample). Accordingly, the third split remaining from each sampled component used in the two-step batch tests will be used for solubility tests with the uncontaminated groundwater and TCE groundwater, respectively.

The initial contact solution for the solubility tests will come from the leachate produced by the first step of the two-step batch leach test. For example, 1 L of the final leachate from the pump-1-groundwater step-one test (Table C2.2) will be used as the contact solution for the pump-1s-L/groundwater solubility test (Table C2.3). In the same manner, 1 L of leachate from the pump-2-TCE groundwater step-one test will be used for the pump-2s-L/TCE groundwater solubility test.

For the verification test matrix (Table C2.4), the initial contact solution will come from the leachate produced by the second step of the two-step batch leach test. For example, 1 L of the final leachate from the pump-1-groundwater step-two test (Table C2.2) will be used as the contact solution for the pump-1v-L/groundwater verification test (Table C2.3). The verification tests will evaluate the change in Tc-99 and uranium concentrations as pH, Eh, and bicarbonate concentration are varied in the leachate.

Table C2.2. Test Matrix for Two-Step Batch Leach

Test Matrix		Sampling Intervals, Volumes, and Radionuclides								
Material[c]	Fluid	2 hours	24 hours	72 hours	168 hours	336 hours	504 hours[a]	672 hours[a]	840 hours[a]	1,008 hours
		0.08 day	1 day	3 days	7 days	14 days	21 days	28 days[b]	35 days[b]	42 days[b]
Pump-1	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-1	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-2	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-2	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-3	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-3	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-4	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Pump-4	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Joint-1	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Joint-1	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Joint-2	GW	A	A	A	A	A	B (A)	B (A)	B (A)	B
Joint-2	TCE GW	A	A	A	A	A	B (A)	B (A)	B (A)	B

[a] Analyze B list if the last two consecutive A list results agree within 10% or 42 days is reached, otherwise do A list and push B list to next sample date.
[b] Contingent sampling date; not needed if B list analyzed at previous date.
[c] Materials identified with the numeral 1 or 3 will be used for the verification testing with 1 L of the final filtered leachate.
Notes:
A = measure temperature, pH, and Eh with probe; remove 50 mL with filtered syringe; and split 10 mL for total uranium and 40 mL for Tc-99.
B = Filter remaining fluid and measure temperature, pH, and Eh with probe and submit fluid for analysis for fluoride, total uranium, Tc-99, Th-228, Th-230, Th-232, U-234, U-235, U-238, Am-241, Np-237, Pu-238, and Pu-239/240. If sufficient sample volume is available, analyze the remaining fluid for alkalinity, chloride, bicarbonate, nitrate, sulfate, phosphate, arsenic, sodium, potassium, calcium, magnesium, silicon, iron, manganese, chromium, and nickel.
GW = uncontaminated groundwater from the site; Pump = centrifugal pump assembly; Joint = expansion joint.

Table C2.3. Test Matrix for Solubility Batch Leach

Test Matrix		Sampling Intervals, Volumes, and Radionuclides				
Material	**Fluid**	**24 hours**	**72 hours**	**168 hours**	**504 hours**	**1,008 hours**
		1 day	**3 days**	**7 days**	**21 days**	**42 days**
Pump-1s	L/GW	A	A	A	A	B
Pump-2s	L/TCE GW	A	A	A	A	B
Pump-3s	L/GW	A	A	A	A	B
Pump-4s	L/TCE GW	A	A	A	A	B
Joint-1s	L/GW	A	A	A	A	B
Joint-2s	L/TCE GW	A	A	A	A	B

Notes:
A = measure temperature, pH, and Eh with probe; remove 50 mL with filtered syringe; and split 10 mL for total uranium and 40 mL for Tc-99.
B = filter remaining fluid and measure temperature, pH, and Eh with probe and submit fluid for analysis for fluoride, total uranium, Tc-99, Th-228, Th-230, Th-232, U-234, U-235, U-236, U-238, Am-241, Np-237, Pu-238, and Pu-239/240. If sufficient sample volume is available, analyze the remaining fluid for bicarbonate alkalinity, chloride, sulfate, phosphate, arsenic, sodium, calcium, magnesium, silicon, iron, manganese, potassium, chromium, and nickel.
L/GW = leachate from Table C2.2 derived using uncontaminated GW; L/TCE GW = leachate from Table C2.2 derived from TCE GW; Pump = centrifugal pump assembly; Joint = expansion joint

Table C2.4. Verification Test Matrix to Assess the Variation in the Leachable Contaminant Mass as a Function of Solution pH, Eh, and Bicarbonate Levels

Verification Test Matrix														
Material	**Fluid**	**0-2 hours**	**72 hours**	**144 hours**	**168 hours**	**240 hours**	**312 hours**	**336 hours**	**408 hours**	**480 hours**	**504 hours**	**576 hours**	**648 hours**	**672 hours**
		--	**3 days**	**6 days**	**7 days**	**10 days**	**13 days**	**14 days**	**17 days**	**20 days**	**21 days**	**24 days**	**27 days**	**29 days**
Pump-1v	L/GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F
Pump-1v	L/TCE GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F
Pump-3v	L/GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F
Pump-3v	L/TCE GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F
Joint-1v	L/GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F
Joint-1v	L/TCE GW	C	C	C	C, D	C	C	C, D, E	E	E	E, D	E	E	E, F

Notes:
C = Measure T, pH, and Eh. Adjust solution to a pH of approximately 9 with sodium carbonate and Eh to a minimum of 150 mV with hydrogen peroxide.
D = Remove 50 mL of leachate, filter and split for uranium total (10 mL) and Tc-99 (40 mL) measurements.
E = Measure T, pH, and Eh. Adjust solution to a pH of approximately 5 with nitric acid and Eh to a minimum of 350 mV with hydrogen peroxide, if needed, and then record new pH and Eh measurements.
F = Filter remaining fluid and submit fluid for analysis of fluoride, total uranium, Tc-99, Th-228, Th-230, Th-232, U-234, U-235, U-236, U-238, Np-237, Am-241, Pu-238, and Pu-239/240. If sufficient sample volume is available, then analyze the remaining fluid for chloride, bicarbonate alkalinity, nitrate, sulfate, phosphate, arsenic, sodium, potassium, calcium, magnesium, silicon, iron, manganese, chromium, and nickel.
L/GW = leachate from Table C2.2 derived using uncontaminated GW; L/TCE GW = leachate from Table C2.2 derived from TCE GW; Pump = centrifugal pump assembly; Joint = expansion joint.

C2.3.2 TEST PROCEDURES

Sample preparation, batch testing, and leachate measurements will be performed in an analytical laboratory using the procedures provided below. The two-step batch test (Figure C2.1), solubility test (Figure C2.2), and verification test will be carried out according to the detail provided below using the test matrices provided in Section C2.4.1 (Tables C2.2, C2.3, and C2.4). A summary of the procedure is provided here to acquaint non-laboratory personnel with the methodology.

Solid sample mass should be in the range of 80 to 100 g, and identified material types will be weighed to the nearest 0.01 g and placed in a suitable container of sufficient volume such that it can be used with a TCLP tumble apparatus. All samples for the two-step batch tests (Table C2.2) will be run at a liquid/solid mass ratio of approximately 25:1 per American Society for Testing and Materials (ASTM) Standard Test Method C1733-21, *Standard Test Method for Distribution Coefficients of Inorganic Species by Batch Method*. The solubility tests (Table C2.3) will be run with size-reduced material and 1 L of leachate derived from the first steady state reached in step one of the two-step batch leach test; therefore, the solubility tests will be performed in parallel to the second step of the two-step batch leach test. Verification tests (Table C2.4) will be run after the second step of the two-step batch leach test because one-half of the solid samples will be needed for the verification testing.

All vessels for the two-step leach test will be sampled 2 hours after the fluid has been added to the beaker, and thereafter according to the times in Table C2.2. For each beaker, the temperature, pH, and Eh will be measured and the values recorded prior to removing a fluid sample. A clean syringe with a built-in 0.45 µm filter will be inserted into the beaker and 50 mL of sample will be collected and split to analyze for total uranium (10 mL) and Tc-99 (40 mL). The filter media will be selected to not adsorb the radionuclides of interest. The original fluid volume in each beaker will be reestablished by adding 50 mL of the initial contact fluid (uncontaminated or contaminated groundwater) back to the beaker.

The two-step batch tests will continue to be sampled (as noted above) and analyzed according to the schedule in Table C2.2 until total uranium and Tc-99 results for two consecutive samples are within ±10%, thus representing steady state. When steady state has been achieved, or Day 42 is reached, the entire fluid volume in each beaker will be filtered through a 0.45 micron filter in a glass cone assembly to collect the leachate in a clean beaker for temperature, pH, and Eh measurements. The solids will be retained, and after the pH, and Eh measurements are recorded, the solids and filter paper will be carefully rinsed with 100 mL of the appropriate initial contact solution (contaminated or uncontaminated groundwater) and the rinseate will be collected in the beaker holding the final leachate. The sample will be preserved after alkalinity and ion chromatography sample splits are collected and a dilution correction will be performed on the analytical result to account for the addition of the 100 mL rinse. The sample will be analyzed for the analytes identified in Table C2.2, Note B.

The rinsed solids will be placed in a clean container and step two of the batch test will be performed with the same contact fluids and methods identified in Table C2.2 and described above. At the completion of the second leach test (step two), the rinsed solids identified with the numeral "1" or "3" and 1 L of the associated leachate will be set aside for the verification testing (discussed below). Solid samples identified with the numeral "2" or "4" will be completely digested and analyzed for the analytes identified in Table C2.2, Note B. The filtered leachate will be analyzed for the analytes identified in Table C2.2, Note B.

Solubility batch tests (Table C2.3) will use the third split from the solid sample used in the two-step batch test and they will be initiated when the first steady-state condition is achieved in the two-step batch leach test. The solid sample will be sized reduced per TCLP protocol, and the pieces will be placed in a container suitable for a TCLP tumble apparatus. After the first steady-state condition is reached for Step 1 of the two-step leach test, 1 L of the filtered leachate from each batch test that has a number 1-groundwater and a number 2-TCE groundwater combination (or a number 3-groundwater and number 4-TCE combination, Table C2.2) will be taken and added to the container that contains the solid which matches the solid in the two-step batch test (e.g., steady-state leachate from pump-1-groundwater is added to the container that contains sample pieces of pump-1s-L/groundwater; pump-2-TCE groundwater is added to pump-2s-L/TCE groundwater).

All vessels for the solubility tests will be sampled 24 hours after the fluid has been added to the beaker, and thereafter according to the times in Table C2.3. For each beaker, a clean syringe with a built in 0.45 µm filter will be inserted into the beaker and 50 mL of sample will be collected and split to analyze for total uranium (10 mL) and Tc-99 (40 mL). The filter media will be selected to not adsorb the radionuclides of interest. The temperature, pH, and Eh will be measured, and the values recorded after removing a fluid sample.

The solubility batch tests will continue to be sampled (as noted above) and analyzed according to the schedule in Table C2.3 until day 42 is reached. When day 42 is reached, the entire fluid volume in each beaker will be filtered through a 0.45 µm filter in a glass cone assembly to collect the leachate in a clean glass beaker for temperature, pH, and Eh measurements. The filtered leachate will be split into a 250 mL fraction for the adsorption tests (discussed below) and the remainder preserved and analyzed for the analytes identified in Table C2.3, Note B. The solids present in the filter/glass cone assembly will be retained and completely digested, and the liquid will be analyzed for the analytes in Table C2.3, Note B.

Verification tests will be performed with one-half of the samples from Step 2 of the batch leach test and 1 L of the final filtered leachate from step two of the test (Table C2.4). Note that using 1 L of the leachate volume for the verification step will reduce the initial fluid/solid mass ratio from approximately 25 to 12.5. The tests will be performed to assess the variation of pH, Eh, and bicarbonate concentration on the release of Tc-99 and uranium from the solids. The leachate will be added to the solids and adjusted to a pH of approximately 9 with sodium carbonate and to a minimum Eh value of 150 mV with hydrogen peroxide. An upper pH of approximately 9 is reasonable because it accounts for a mixture of soil and concrete rubble which could generate basic pH conditions. The pH and Eh will be measured and adjusted per the schedule in Table C2.4 and on days 7 and 14, filtered samples will be collected for uranium and Tc-99 analysis.

After collecting the day 14 samples, the solution pH will be adjusted to a pH of approximately 5 using nitric acid and to a minimum Eh value of 350 mV using hydrogen peroxide. A pH of 5 is slightly less than the lowest pH measurements observed for groundwater samples collected on the site and it is unlikely that fluids would be lower due to the buffering capacity of the large volume of soil that would be placed in the cell. The pH and Eh will be checked and adjusted according to the schedule in Table C2.4, and on days 21 and 28, filtered samples will be collected for uranium and Tc-99 analysis. On day 28, the filtered leachate and the solids will be collected, digested, and analyzed for analytes listed in Table C2.4, Note F.

Soil placed around the PGE after disposition is likely to lower potential leachate concentrations by adsorption of the contaminants to the soil particle surface.

C2.3.2.1 Two-Step Batch Leach Test

This procedure covers the materials and activities needed to perform a two-step batch leach test, and subsequent verification tests, on samples obtained from PGE at PGDP. A laboratory batch method will be followed, where the samples collected from the PGE will be contacted with site groundwater to leach contamination from the solid. When the leachate generated in the first batch test reaches steady-state concentrations for total uranium and Tc-99, the leachate will be collected and analyzed for all radionuclides of interest and the test will be repeated a second time (i.e., a two-step batch leach test). At the end of the second step, one-half of the solid and leachate samples will be used for verification tests that will assess the change in leachable mass as pH, Eh, and bicarbonate concentrations are varied. Using the initial mass of the sample, the volume of contact solution in the batch test, and measured concentrations, important leaching coefficients will be calculated for waste debris that may be placed in a proposed on-site disposal cell.

Apparatus

- *Laboratory ware* (e.g., polyethylene beakers, pipettes, TCLP tumbling apparatus) will be cleaned in a manner that is consistent with the required precision and detection limits of the analytical instruments.

- *Centrifuge*, capable of attaining 1,400 g, or filtering apparatus.

- *Filters*, polyethylene filter cones, and syringe filters capable of removing particles ≥ 0.45 micrometers. Filter media must be selected to prevent adsorption of radionuclides on the filter during sample collection activities.

- *Analytical balance*, capable of measuring to 0.01 g.

- *Portable monitoring instruments* to measure pH, Eh, and temperature of the samples.

- *Analytical instruments* appropriate for the measurement of the radionuclides of interest at the detection limits specified in Appendix C.

Test matrix

The test matrix for batch leach tests is shown in Table C2.2.

Procedure

(1) Weigh each of the three pieces of material provided for each of four centrifugal pump assembly samples (80–100 g per piece) to the nearest 0.01 g and record the values in the logbook. (NOTE: The four samples will be designated "1", "2", etc., and cross-referenced in the lab book to the sample location in the process building. Splits will be designated as pump-1-groundwater, pump-1-TCE groundwater, pump-1s-L/groundwater, pump-2-groundwater, pump-2-TCE groundwater, and pump-2s-L/TCE groundwater, etc. The pump-1s-L/groundwater, pump-3s-L/groundwater, pump-2s-L-groundwater, and pump-4s-L/TCE groundwater splits will be set aside for the solubility test.)

(2) Weigh each of the three pieces of material provided for each of the two expansion joint samples to the nearest 0.01 g, and record the values in a logbook. (NOTE: The two samples of expansion joints will be designated "1" and "2" and cross-referenced in the lab book to the sample location in the process building. Splits will be labeled as joint-1-groundwater, joint-1-TCE groundwater, joint-1s-L/groundwater, joint-2-groundwater, joint-2-TCE groundwater, joint-2s-L/TCE groundwater, etc. The joint-1s-L/groundwater, and joint-2s-L/TCE groundwater splits will be set aside for the solubility test.)

(3) Place the solid debris into suitable clean vessels that are sized to meet the liquid/solid mass ratio of 25:1 and label the vessels as noted above for the splits. [NOTE: The solid mass is multiplied by 25 to arrive at the required grams of contact solution, which should be close to 2,500 g (i.e., 25 × 100 g), or about 2.5 L of contact solution.]

(4) Measure the volume of uncontaminated groundwater or TCE groundwater and record the values in the logbook.

(5) Slowly add the contact solution to each vessel and record the time. Cap the vessel, secure it to the TCLP tumble apparatus, and activate a gentle tumble. (NOTE: Match the groundwater contact solution to solids that have the groundwater label and TCE groundwater solution to solids marked TCE groundwater.)

(6) For the sample intervals identified in the test matrix by the letter "A," stop the TCLP tumble apparatus at least 30 minutes before measuring temperature, pH, and Eh. Measure temperature, pH, and Eh, and record the values. Using a clean syringe with a 0.45 micron filter, carefully remove 50 mL of fluid and split the sample into 10 mL and 40 mL aliquots for total uranium and Tc-99 analysis. (NOTE: Save each filter from each sampling event to a unique container that is labeled to match the leachate container from which the sample was drawn. The filters associated with the "1" or "3" samples will be digested in Step 28 and those with the "2" or "4" samples in Step 29.)

(7) Add 50 mL of the appropriate initial contact fluid back to the vessel to account for the removal of the sample volume, cap the vessel, and start a gentle tumble of the vessel.

(8) When two consecutive sample events produce results within 10% for both total uranium and Tc-99, terminate the batch test at the next sample interval (or terminate the batch test at Day 42).

(9) Set up a clean vessel that can hold the leachate volume and a clean cone with a 0.45 micron filter and sufficient volume to hold the solid debris. Label each vessel to correspond to the batch test vessels. (NOTE: There are 12 batch tests in the test matrix.)

(10) Agitate the leachate and pour approximately two-thirds of the leachate volume through the 0.45 micron filter within the cone that is positioned to drain into a clean vessel. (NOTE: A coarse prefilter may be used prior to the 0.45 micron filter if significant amounts of fine particulate are in the vessels. Retain the coarse prefilter with the 0.45 micron filter for digestion with the solid particles.)

(11) Agitate the fine particles in the remaining leachate by swirling the fluid in the vessel to suspend all fine products and slowly pour the leachate into the appropriate filter apparatus. (NOTE: During this filter step, the large solids in the vessel with the leachate can be retained in the vessel by using a coarse screen to cover the vessel opening while the leachate and suspended fines are decanted into the filter apparatus or place large solids in the filter apparatus, taking care to avoid tearing the filter paper. If particles are left in the vessel, then they will be collected during the rinse performed in Step 13.)

(12) Measure the pH, Eh, and temperature of the filtered leachate and record the values.

(13) Pour approximately 500 mL of the filtered leachate into the batch test vessel, swirl the filtrate to rinse the vessel and large solids and pour the rinseate into the cone filter apparatus and collect the rinseate with the filtered leachate sample generated in Step 11. (NOTE: Repeat the rinse a second and third time if visible particles remain in the vessel.)

(14) Using 100 mL of the appropriate initial contact solution, rinse the interior sides of the empty batch test vessel and large solids and pour the rinseate into the cone apparatus and collect the rinseate with the filtered leachate sample generated in Step 13. (NOTE: A dilution correction will be applied to the analytical results to account for the 100 mL of fresh contact solution added to the filtered leachate.)

(15) Remove the solids from the old vessel or filter apparatus for the first leach step and place them in a clean new vessel that is sized to meet the liquid/solid mass ratio of 25:1. Label the new vessels for second leach step to correspond to the labels on the vessels used for first leach step.

(16) If the filter paper shows small residue particles, dry the filter at ambient temperature before inverting the filter in the proper sample container to gently shake them off. [NOTE: Retain the filter paper for digestion in Step 28 ("1" samples) or Step 29 ("2" samples).]

(17) Using 100 mL of reagent grade nitric acid, rinse the interior of each empty test vessel and collect the acid rinse in a separate 250 mL container for each test vessel. Repeat the rinse a second time and collect the rinseate in the 250 mL container. [NOTE: Save the acid rinses collected in the 250 mL containers and add each acid rinse to its corresponding filter digestate in Step 28 ("1" or "3" samples) or Step 29 ("2" or "4" samples).]

(18) For the final filtered leachate from the first leach step, generated in Step 14, identify the vessels that will provide leachate for the solubility tests (pump-1-groundwater, pump-2-TCE groundwater, pump-3-groundwater, and pump-4-TCE groundwater, etc.) and remove 1 L of filtered leachate from each vessel and place it into the appropriate vessel to be used for the solubility test (e.g., 1 L from pump-1-groundwater to vessel marked pump-1s-L/groundwater, 1 L from pump-2-TCE groundwater to vessel marked pump-2s-L/TCE groundwater, etc.). (NOTE: The solubility procedure is discussed in a separate section and it will be executed in parallel with the second step of the batch leach test.)

(19) Remove a 50 mL split from the filtered leachate generated in Step 14 for chromatography analysis and a 400 mL split for alkalinity analysis and preserve the remaining filtered leachate sample.

(20) Analyze the leachate samples for the constituents identified in Table C2.2, Note B.

(21) Measure the volume of groundwater or TCE groundwater and record the values in the logbook. (NOTE: The required grams of contact solution will be identical to that used in the first batch leach test, which should be close to 2,500 g (i.e., 25 × 100 g), or about 2 L of contact solution.)

(22) Begin the second step of the batch leach test by slowly adding the contact solution to each vessel and record the time. Cap the vessel, secure it to the TCLP tumble apparatus, and activate a gentle tumble. (NOTE: Match the groundwater contact solution to solids that have the groundwater label and TCE groundwater solution to solids marked TCE groundwater.)

(23) Repeat Steps 6 through 14.

(24) For the filtered leachate samples generated from the second leach step, identify the vessels with the number 1 and 3 samples (pump-1-groundwater, pump-1-TCE groundwater, pump-3-groundwater, pump-3-TCE groundwater) and remove 1 L of filtered leachate from each vessel and place it into the appropriate vessel to be used for the verification tests (e.g., 1 L from pump-1-groundwater to vessel marked pump-1v-L/groundwater, 1 L from pump-1-TCE groundwater to vessel marked pump-1v-L/TCE groundwater).

(25) Remove the solid samples with "1" or "3" from the old vessels or filter apparatus from the second leach step and place them in the appropriate verification vessel, as noted in Step 24. Remove the solid samples with "2" or "4" from the old vessels or filter apparatus and place them with the appropriate filters for digestion per Step 29.

(26) If the filter paper used for the "1" or "3" samples show small residue particles, then dry the filter at ambient temperature before inverting the filter over the proper verification container to gently shake them off and retain the filter paper for digestion in Step 28. For filters associated with the "2" or "4" samples, retain the filters for digestion in Step 29.

(27) Using 100 mL of reagent grade nitric acid, rinse the interior of each empty test vessel with the nitric acid and collect the rinseate in a separate 250 mL container for each test vessel. Repeat the rinse a second time and collect the rinseate in the 250 mL container. [NOTE: Save the acid rinses collected in the 250 mL containers and add each acid rinse to its corresponding filter digestate in Step 28 ("1" or "3" samples) or Step 29 ("2" or "4" samples).]

(28) For the "1" or "3" samples, digest the filters and particles present on them (from first and second).

— Leach steps of the batch test, add the acid rinses to the digestate, and analyze the digestate only for fluoride and the radionuclides identified in Table C2.2, Note B. (NOTE: Do not use HF in the digestion or remove a sample split for fluoride analysis prior to final digestion with HF.)

(29) For the "2" or "4" samples, digest the solids, filters and particles present on the filters (from first and second leach steps of the batch test), add the acid rinses to the digestate, and analyze the digestate only for fluoride and the radionuclides identified in Table C2.2, Note B. (NOTE: Do not use HF in the digestion or remove a sample split for fluoride analysis prior to final digestion with HF.)

C2.3.2.2 Solubility Batch Test

This procedure covers the materials and activities needed to perform a solubility batch test on samples obtained from PGE at PGDP. A laboratory batch method will be followed, where the samples collected from the PGE will be sized reduced and contacted with the leachate generated by step one of the two-step batch leach test described above.

Increasing the surface area of the material and placing it in a leachate that exhibits steady-state contaminant concentrations, after contact with a split of the same material, will increase the probability of attaining a solubility limit for the radionuclides of interest. Analytical instruments will measure the radionuclide concentrations in the leachate multiple times over a six-week period to establish the limit. The time to deplete the contaminant mass can be derived for PA models using the initial contaminant mass in the sample, the solubility limits, adsorption distribution values, and estimates of fluid transport times through the proposed OSWDF (if on-site disposal is selected as part of the WDA decision).

Apparatus

- *Laboratory ware* (e.g., polyethylene beakers, pipettes, TCLP tumbling apparatus) will be cleaned in a manner that is consistent with the required precision and detection limits of the analytical instruments.

- *Centrifuge*, capable of attaining 1,400 g, or filtering apparatus.

- *Filters*, polyethylene filter cones, and syringe filters capable of removing particles ≥ 0.45 micrometers. Filter media must be selected to prevent adsorption of radionuclides on the filter during sample collection activities.

- *Analytical balance*, capable of measuring to 0.01 g.

- *Portable monitoring instruments* to measure pH, Eh, and temperature of the samples.

- *Analytical instruments* appropriate for the measurement of the radionuclides of interest at the detection limits specified in Appendix C.

Test matrix

The test matrix for solubility batch tests is shown in Table C2.3.

Procedure

(1) Collect the materials from the first step of the two-step batch leach test (pump-1s-L/groundwater, pump-2s-L/TCE groundwater, pump-3s-L/groundwater, pump-4s-L/TCE groundwater, joint-1s-L/groundwater, and joint-2s-L/TCE groundwater).

(2) Size reduce the material per TCLP protocol, weigh each size-reduced fraction to the nearest 0.01 g, and record the values in the logbook.

(3) Place the size-reduced material into the properly labeled vessels holding the leachate generated from the first step of the batch leach procedure.

(4) Cap the vessels, secure each vessel to a TCLP tumble apparatus, and activate a gentle tumble.

(5) For the sample intervals identified in the Table C2.3 by the letter "A," stop the TCLP tumble apparatus at least 30 minutes before measuring temperature, pH, and Eh. Measure temperature, pH, and Eh and record the values. Using a clean syringe with a 0.45 micron filter, carefully remove 50 mL of fluid and split the sample into 10 mL and 40 mL aliquots for total uranium and Tc-99 analysis. (NOTE: Save each filter from each sampling event to a unique container that is labeled to match the leachate container from which the sample was drawn.)

(6) After each sampling event, cap the vessels, secure each vessel to a TCLP tumble apparatus, and activate a gentle tumble.

(7) When Day 42 is reached, terminate the solubility test and recover the leachate for final analysis.

(8) Set up a clean vessel that can hold the leachate volume and a clean glass cone with a 0.45 micron filter and sufficient volume to hold the solid debris. Label each vessel to correspond to each solubility test vessels. (NOTE: There are six solubility tests in the test matrix).

(9) Agitate the leachate and pour approximately two-thirds of the leachate volume through the 0.45 micron filter within the cone that is positioned to drain into a clean vessel. (NOTE: A coarse prefilter may be used prior to the 0.45 micron filter if significant amounts of fine particulate are in the vessels. Retain the coarse prefilter with the 0.45 micron filter for digestion with the solid particles.)

(10) Agitate the fine particles in the remaining leachate by swirling the fluid in the vessel to suspend all fine products and slowly pour the leachate into the appropriate filter apparatus. (NOTE: During this filter step, the solids in the vessel with the leachate can be retained in the vessel by using a coarse screen to cover the vessel opening while the leachate and suspended fines are decanted into the filter apparatus or place the solids into the filter cone taking care to avoid tearing the filter paper. If particles remain in the vessel, they will be collected with the rinse performed in Step 11.)

(11) Pour approximately 500 mL of the filtered leachate into the test vessel, swirl the filtrate to rinse the vessel and large solids, and pour the rinseate into the cone filter apparatus and collect the rinseate with the filtered leachate sample generated in Step 10. (NOTE: Repeat the rinse a second and third time if visible particles remain in the vessel.)

(12) Measure the pH, Eh, and temperature of the filtered leachate and record the values.

(13) Using 100 mL of the appropriate initial contact solution, rinse the interior sides of the empty batch test vessel and large solids and pour the rinseate into the cone filter apparatus and collect the rinseate with the filtered leachate sample generated in Step 10. (NOTE: A dilution correction will be applied to the analytical results to account for the 100 mL of fresh contact solution added to the filtered leachate.)

(14) Remove the solid samples from the test vessels or filter apparatus and place them with the appropriate filters for digestion per Step 19.

(15) Using 100 mL of reagent grade nitric acid, rinse the interior of each empty solubility test vessel with the nitric acid and collect the rinseate in a separate 250 mL container for each test vessel. Repeat the rinse a second time and collect the rinseate in the 250 mL container. (NOTE: Save the acid rinse collected in the container and add it to the final digestate in Step 19.)

(16) For the filtered samples labeled pump-1s-L/groundwater, pump-2s-L/TCE groundwater, etc., remove a 250 mL split and place the fluid in an appropriate labeled container.

(17) For the four filtered samples identified in Step 16, remove a 50 mL sample for ion chromatography analysis, preserve the remaining leachate, and analyze the leachate for the list of constituents identified in Table C2.3, Note B. (NOTE: Alkalinity will be omitted for these samples due to insufficient volume.)

(18) For the filtered samples labeled pump-3s-L/groundwater and pump-4s-L/TCE groundwater, etc., remove a 50 mL sample for chromatography analysis, a 400 mL sample for alkalinity analysis, preserve the remaining leachate, and analyze the leachate for the list of constituents in Table C2.3, Note B.

(19) Digest the solid and particles present on the filters (syringe filters and final cone filter), add the acid rinses to the digestate, and analyze the digestate only for fluoride and the radionuclides identified in Table C2.3, Note B. (NOTE: Do not use HF in the digestion or remove a sample split for fluoride analysis prior to final digestion with HF.)

C2.3.2.3 Verification Batch Test

This procedure covers the materials and activities needed to perform a verification batch test on samples obtained from PGE at PGDP. A laboratory batch method will be followed, where one-half of the batch tests from the second step of the batch leach test (discussed above) will be carried forward for verification testing to evaluate the variation in uranium and Tc-99 concentrations in leachate as pH, Eh, and carbonate concentration are varied in the leachate over a four-week period. The pH, Eh, and carbonate ranges selected for testing are based on the expected range of geochemical conditions in a potential OSWDF if on-site disposal is selected as part of the WDA decision filled with equipment and contaminated site soil. Selected pH and Eh values will be checked several times a week and adjusted to the target value, if needed, and samples will be collected for uranium and Tc-99 analysis on a weekly basis. Analytical results for uranium and Tc-99 will be evaluated and compared to the results from the batch leach test to assess the effect of pH, Eh, and carbonate concentration on the mobility of uranium and Tc-99.

Apparatus

- *Laboratory ware* (e.g., polyethylene beakers, pipettes, TCLP tumbling apparatus.) will be cleaned in a manner that is consistent with the required precision and detection limits of the analytical instruments.

- *Centrifuge*, capable of attaining 1,400 g, or filtering apparatus.

- *Filters*, polyethylene filter cones, and syringe filters capable of removing particles ≥ 0.45 micrometers. Filter media must be selected to prevent adsorption of radionuclides on the filter during sample collection activities.

- *Analytical balance*, capable of measuring to 0.01 g.

- *Portable monitoring instruments* to measure pH, Eh, and temperature of the samples.

- *Analytical instruments* appropriate for the measurement of the radionuclides of interest at the detection limits specified in Appendix C.

Test matrix

The test matrix for verification tests is shown in Table C2.4.

Procedure

(1) Collect the designated samples (solids and leachate) from the second step of the two-step batch leach test (pump-1v-L/groundwater, pump-1v-L/TCE groundwater, pump-3v-L/groundwater, and pump-3v-L/TCE groundwater, etc.).

(2) For each of the verification vessels prepared in Step 1, adjust the pH and Eh of the solution per letter "C" in Table C2.4, cap the vessels, secure them to the TCLP tumble apparatus, and activate a gentle tumble. Continue to adjust the pH and Eh per the schedule in Table C2.4.

(3) For the sample intervals identified in the Table C2.4 by the letter "D," stop the TCLP tumble apparatus at least 30 minutes before measuring temperature, pH, and Eh. Adjust the pH and Eh as indicated in Table C2.4 before collecting a sample. Using a clean syringe with a 0.45 micron filter, carefully remove 50 mL of fluid and split the sample into 10 mL and 40 mL aliquots for total uranium and Tc-99 analysis. (NOTE: Save each filter from each sampling event to a unique container that is labeled to match the leachate container from which the sample was drawn. These filters will be digested with the solids in Step 12.)

(4) On Day 14, perform Step 3 and then adjust the pH and Eh of the solution per letter "E" in Table C2.4, cap the vessels, secure them to the TCLP tumble apparatus, and activate a gentle tumble. Continue to adjust the pH and Eh per letter "E" and collect samples per letter "D" (Step 3), as noted in the Table C2.4 schedule.

(5) On Day 28, adjust the pH and Eh of the solution per letter "E" in Table C2.4 and set up a clean vessel that can hold the leachate volume and a clean cone with a 0.45 micron filter and sufficient volume to

hold the solid debris. Label each vessel to correspond to the six verification test vessels. (NOTE: There are six verification tests in the test matrix).

(6) Agitate the leachate and pour approximately two-thirds of the leachate volume through the 0.45 micron filter within the cone that is positioned to drain into a clean vessel. (NOTE: A coarse prefilter may be used prior to the 0.45 micron filter if significant amounts of fine particulate are in the vessels. Retain the coarse prefilter with the 0.45 micron filter for digestion with the solid particles.)

(7) Agitate the fine particles in the remaining leachate by swirling the fluid in the vessel to suspend all fine products and slowly pour the leachate into the appropriate filter apparatus. (NOTE: During this filter step, the large solids in the vessel with the leachate can be retained in the vessel by using a coarse screen to cover the vessel opening while the leachate and suspended fines are decanted into the filter apparatus or place the large solids in the filter cone taking care to avoid tearing the filter paper. If particles are left in the vessel, they will be collected during the rinse performed at Step 8.)

(8) Pour approximately 200 mL of the filtered leachate into the verification test vessel, swirl the filtrate to rinse the vessel, and pour the rinseate into the cone filter apparatus and collect the rinseate with the filtered leachate sample generated in Step 7. (NOTE: Repeat the rinse a second and third time if visible particles remain in the vessel.)

(9) Using 100 mL of the appropriate initial contact solution, rinse the interior sides of the empty batch test vessel and large solids, and pour the rinseate into the cone filter apparatus and collect the rinseate with the filtered leachate sample generated in Step 7. (NOTE: A dilution correction will be applied to the analytical results to account for the 100 mL of fresh contact solution added to the filtered leachate.)

(10) Remove the solid samples from the test vessels or filter apparatus and place them with the appropriate filters for digestion per Step 14.

(11) Using 100 mL of reagent grade nitric acid, rinse the interior of each empty test vessel with the nitric acid, and collect the rinseate in a separate 250 mL container for each test vessel. Repeat the rinse a second time and collect the rinseate in the 250 mL container. (NOTE: Save the acid rinse collected in the container and add it to the final digestate in Step 14.)

(12) Remove a 50 mL split from the filtered leachate generated in Step 9 for chromatography analysis and a 400 mL split for alkalinity analysis and preserve the remaining filtered leachate sample.

(13) Analyze the leachate samples for the constituents identified in Table C2.4, Note F.

(14) Digest the solid and particles present on the filters (from the verification tests), add the acid rinses to the digestate and analyze the digestate only for fluoride and the radionuclides identified in Table C2.4, Note F. (NOTE: Do not use HF in the digestion or remove a sample split for fluoride analysis prior to final digestion with HF.)

C2.3.3 ANALYTICAL METHODS, EVALUATION, AND DATA REDUCTION

Final digestion of the solids will occur at the end of the testing, and the digestate will be analyzed using the methods specified in Table C2.1. Additionally, the empty test vessels will be rinsed with nitric acid and the acid rinseate collected for analysis to account for mass in the empty vessels, and all filters used during the testing process will be digested to account for the mass on the filter media. The analytical methods for the acid rinseate and filter digestate will be the same as those used for the solid digestate.

Two-Step Batch Leach Test

Execution of the test illustrated on Figure 1 will produce the following data sets:

- Weight (g) of each sample split prior to the leach tests;
- Volume (L) of fluid added to each leach test;
- Initial leachate concentrations (µg/L or pCi/L) for Step 1, A list;
- Final steady-state leachate concentrations (µg/L or pCi/L) for Step 1, B list;
- Initial leachate concentrations (µg/L or pCi/L) for Step 2, A list;
- Final steady-state leachate concentrations (µg/L or pCi/L) for Step 2, B list; and
- Concentration (µg/L or pCi/L) of ions and radionuclides in Table C2.2, Note B for the liquid derived from the acid digestion of the solids after termination of Step 2 of the leach test.

After evaluation of the data sets, the initial concentration of the contaminant in the waste form, mass of contaminant released to the fluid, contaminant leaching coefficients and the extractable fraction of the contaminant in the waste will be calculated with the following equations:

Initial concentration (µg/g or pCi/g) of the radionuclides in the waste form (C_{S0}):

$$C_{S0} = [\Sigma(C_{wi} \times Vi) + (C_{w1} \times V) + (C_{w2} \times V) + (C_{wD} \times V_{wD})]/W$$

where:

W = initial mass (g) of the waste form

V = initial volume (L) of fluid in each test

V_i = volume of the i^{th} interim sample (L), collected during the entire two-step procedure

C_{wi} = leachate concentration (µg/L or pCi/L) for the i^{th} interim sample

C_{w1} = final leachate concentration (µg/L or pCi/L) from Step 1

C_{w2} = final leachate concentration (µg/L or pCi/L) from Step 2

V_{wD} = volume (L) of the digested solid at the end of Step 2

C_{wD} = concentration of the contaminant in the final digestate (µg/L or pCi/L).

Contaminant mass (µg or pCi) released from the solid to the fluid (M_{w1} and M_{w2}):

$$M_{w1} = \Sigma(C_{wi} \times V_i)1 + C_{w1} \times V \text{ (Step 1)}$$

$$M_{w2} = \Sigma(C_{wi} \times V_i)2 + C_{w2} \times V \text{ (Step 2)}$$

Leaching coefficient for total contaminant mass at the end of Step 1 (K_{Lt}):

$$K_{Lt} = C_{s1}/C_{w1}$$

where:

C_{s1} = concentration (µg/g or pCi/g) of the contaminant in the waste form after Step 1.

Extractable fraction of contaminant in waste form (m_e):

$$m_e = [(C_{w1})2 \times V]/[C_{s0} \times W \times (C_{w1}-C_{w2})]$$

Leaching coefficient of extractable contaminant mass (K_{Le}):

$$K_{Le} = C'_{s1}/C_{w1} = C'_{s2}/C_{w2} = (C_{w2} \times V)/[(C_{w1}-C_{w2}) \times W]$$

where:

C'_{s1} = extractable concentration of contaminant remaining in the solid after Step 1

C'_{s2} = extractable concentration of contaminant remaining in the solid after Step 2

Solubility Batch Test

Execution of the test procedure illustrated on Figure C2.2 will produce the following data sets:

- Weight (g) of each sample split (six) prior to the solubility tests;
- Volume (L) of leachate for the solubility test that is obtained from the first steady-state concentration reached in the two-step batch test;
- Initial leachate concentrations (µg/L or pCi/L), A list;
- Final steady-state leachate concentration (µg/L or pCi/L), B list; and
- Concentration (µg/L or pCi/L) of B list radionuclides in the liquid derived from the acid digestion of the solids after termination of the solubility test.

After evaluation of the data sets, the initial concentration of the contaminant in the waste form will be calculated with the following equation:

Initial concentration (µg/g or pCi/g) of the radionuclides in the waste form used for the solubility test (C_{S0s}):

$$C_{S0s} = [\Sigma(C_{wi} \times V_i) + ((C_{w3} - C_{w1}) \times V_s)+(C_{wDs} \times V_{wDs})]/W_s$$

where:

W_s = initial mass (g) of the waste form in the solubility test

V_s = final volume (L) of fluid in each solubility test

C_{w1} = final leachate concentration (µg/L or pCi/L) from step one of the two-step batch test, which is the initial fluid composition for the solubility test

V_i = volume of the i[th] interim sample (L) collected before final sample

C_{wi} = leachate concentration (µg/L or pCi/L) for the i[th] interim sample

C_{w3} = final leachate concentration (µg/L or pCi/L) from the solubility test

V_{wDs} = volume (L) of the digested solid at the end of the solubility test

C_{wDs} = concentration of the contaminant in the final digestate (µg/L or pCi/L) derived from the solids used in the solubility test.

Contaminant mass (µg or pCi) released from the solid to the fluid (M_{w3}):

$$M_{w3} = \Sigma(C_{wi} \times V_i) + ((C_{w3} - C_{w1}) \times V_s)$$

Verification Tests

Execution of the tests listed in Table C2.4 will produce the following data sets:

- Volume (L) of fluid added to each verification test;
- Total uranium and Tc-99 concentrations (µg/L or pCi/L) for samples from weeks 1, 2, 3, and 4;
- Final leachate concentration (µg/L or pCi/L) of ions and radionuclides in Table C2.4, Note F; and
- Concentration (µg/L or pCi/L) of ions and radionuclides in Table C2.4, Note F for the liquid derived from the acid digestion of the solids after the verification test.

After evaluation of the data sets, the initial concentration of the contaminant in the waste form will be calculated with the following equation:

Initial concentration (µg/g or pCi/g) of the radionuclides in the waste form used for the two-step batch leach and verification tests (C_{S0v}):

$$C_{S0v} = [\Sigma(C_{wi} \times V_i) + (C_{w1} \times V) + (C_{w2} \times V) + ((C_{w4} - C_{w2}) \times V_v) + (C_{wDv} \times V_{wDv})]/W$$

where:

C_{wi} = leachate concentration (µg/L or pCi/L) for the i[th] interim sample collected during two-step batch leach and verification tests

V_i = volume of the i[th] interim sample (L)

C_{w1} = final leachate concentration (µg/L or pCi/L) from step one of the two-step leach test

C_{w2} = final leachate concentration (µg/L or pCi/L) from step two of the two-step leach test

V = initial volume (L) of fluid in each step of the two-step batch leach test

C_{w4} = final leachate concentration (µg/L or pCi/L) from the verification test

V_v = final volume (L) of fluid in each verification test

C_{wDv} = concentration of the contaminant in the final digestate (µg/L or pCi/L)

V_{wDv} = volume (L) of the digested solid at the end of the verification test

W = initial mass (g) of the waste form

C2.3.4 EVALUATION OF ANALYTICAL RESULTS

The measured steady-state concentrations of contaminants for the two-step batch leach and solubility batch tests and the calculated leaching coefficients and extractable mass of the contaminant provide important information on the solubility of the contaminant form in the waste and potential release concentrations.

The addition of the solubility test results to the results for the two-step batch leach test will enhance the evaluation of the leaching behavior of the material collected from the PGE and piping. For example, the lower liquid/solid mass ratio and additional material mass for the solubility test will provide data that can be used to confirm solubility or high leachability of the samples. This can be confirmed if the results from the solubility test are within 10% of C_{w1} and C_{w2} (i.e., $C_{w1} = C_{w2} = C_{w3}$). Additionally, if only C_{w1} and C_{w3} are within 10%, it suggests a solubility limit was reached but there was insufficient contaminant mass in the two-step test to reach a second solubility limit in step two.

In contrast, when a very soluble form of the contaminant is present in the waste and a solubility limit is not reached in step one of the two-step test, the contaminant concentration in the steady-state leachate from step two will be less than that in step one (i.e., $C_{w2} < C_{w1}$), and both will be less than the concentration measured from the solubility test (i.e., $C_{w2} < C_{w1} < C_{w3}$). For this latter case, the complete dissolution of a highly soluble contaminant form (i.e., no solubility limit is reached) can be confirmed if the mass of contaminant released from step one of the two-step test and the solubility test are within 10% (i.e., $M_{w1} = M_{w3}$). This conclusion would be supported by a much lower concentrations of the contaminant in the leachate generated in step two of the two-step test (i.e., $C_{w1} >> C_{w2}$).

Although these are the expected common outcomes for the data sets, there are more complicated kinetic interpretations possible. For example, if a high solubility phase dissolves and a second phase with lower solubility is kinetically able to nucleate and precipitate within the 42-day time frame of the solubility test, the solubility test may show a lower concentration than leachate from step one of the two-step test (i.e., $C_{w3} < C_{w1}$). A similar case may develop for the two-step test where in step one a soluble contaminant mass is released and a solubility limit is reached for a secondary phase that precipitates. When fresh contact solution is added for step two, the secondary phase goes into solution and is kinetically inhibited and does not precipitate a second time. For this case, the steady-state concentration for step-one would be less than step two (i.e., $C_{w1} < C_{w2}$). Other possible scenarios are high initial concentrations followed by lower concentrations if significant sorption of uranium and Tc-99 occurs on iron oxyhydroxide particles generated from the oxidation of some of the carbon steel equipment components.

There are several important assumptions that stand behind the equations and interpretation of the results generated from the two-step batch leach test. The mathematical equations model a leaching process that includes dissolution, adsorption, and desorption of contaminant phases, and there are special conditions when dissolution of a phase reaches a solubility limit. Evaluation of the results for samples and duplicates is very dependent on the ability to collect adjacent field samples that are similar in the types and extent of contamination. Key assumptions are as follows.

- Replacing 50 mL of the leaching solution in the two-step batch test after each 50 mL sampling event does not significantly change the concentration at the next sampling event.

- A constant linear isotherm is maintained between the leaching solution and waste solids in the two-step batch tests.

- A sample and its corresponding splits are similar with respect to the type, form, and amount of the contaminant present on the solid.

- Groundwater from the site is the most reasonable contact fluid for the batch tests because site soil placed around the debris in the disposal facility will control the final composition of the rainwater that falls on the compacted debris and soil.

- A liquid/solid mass ratio of 25:1 (ASTM Standard Test Method C1733-21) is taken to reflect a future failure scenario of the disposal facility when the mass of fluid moving through the waste form in a period of about 40 days is approximately equal to 25:1.

- The use of samples from PGE from the upper end of the Paducah Site cascade will provide a conservative estimate of U-235 and Tc-99 release from similar PGE in the lower cascade.

- Tc-99 and uranium are the primary contaminants of concern for the PGE and piping, and when they reach a steady-state condition in the leachate, the other radionuclides present have also reached a steady-state concentration.

- For the verification tests, pH, Eh, and bicarbonate concentration are the most important variables to assess the maximum mass of uranium and Tc-99 that will leach from the solids.

The replacement of 50 mL of sample with fresh contact solution after each interim sample event is unlikely to alter the results of the next sampling event because the initial volume of contact solution is on the order of 2,000 mL. This large volume of contact solution is required to perform the final radioisotope analysis and QA analysis for all radionuclides of concern. A smaller volume of fluid (1,000 mL) will be used for the solubility test to assess the variation in the leaching concentrations as a function of the liquid/solid mass ratio.

The assumption of a constant linear isotherm is required to generate the mathematical expressions, but it is tentative because it requires that the types and forms of the contaminant species do not change between the first and second batch test. If a highly soluble form is depleted after the first batch test or a solubility limit is reached, then the assumption is invalid.

Paducah Site soil with and without TCE or other volatile organic compounds will be placed around the PGE in the proposed disposal cell. Rainwater falling on the compacted soil and debris in the disposal facility will evolve into a composition that reflects site groundwater because the soil particles have a high surface area for dissolution reactions and the mass of soil will exceed the mass of the debris in the disposal cell.

The liquid/solid mass ratio of 25:1, cited in ASTM procedure C1733-21, will be used for all vessels in the two-step batch test to simulate future conditions when the cap of the disposal facility has failed and fluid fronts move through the cell (i.e., fluid residence time in the pores is decreased).

When steady-state concentrations are established in the leachate for uranium and Tc-99, the remaining leachate will be filtered and analyzed for the radionuclides listed in Table C2.2, Note B. It is possible that the other isotopes will not reach a steady-state concentration at the same time as uranium and Tc-99; however, as they are infrequently detected and less mobile than uranium and Tc-99, they are classified as secondary contaminants of concern with respect to dose drivers for the PA model. Additionally, if all radionuclides were analyzed at each interim sample event, a very large volume of fluid and sample mass would be required to maintain the test design. There will not be a sufficient sample mass to accommodate increasing the volume of water for the batch tests.

The pH, Eh, and bicarbonate are the most important solution variables that control the mass of uranium and Tc-99 released to the leachate. These values are adjusted during the verification tests to examine whether higher levels of pH, Eh, and bicarbonate yield a higher release of the uranium and Tc-99 mass on the PGE under the potential range of conditions, including high Eh during the waste placement stage.

C2.4. REFERENCE

DOE (U.S. Department of Energy) 2013, *Analytical Results and Data Evaluation for Batch Leach Tests Performed on Samples Collected from Process Gas Equipment in Building X-326, Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/PPPO/03-0421&D2, U.S. Department of Energy, Piketon, OH, February.

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