Department of Energy

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March 19, 2024

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

PPPO-02-10027002-24C

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

Dear Ms. Webb and Mr. Weeks:

TRANSMITTAL OF THE ADDENDUM TO 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/A1

Enclosed is the *Addendum to 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/A1. This document supports an investigation of the presumed trichloroethene source area located north of the C-400 Complex, as scoped with the Federal Facilities Agreement (FFA) parties on January 25, 2024, and February 1, 2024.

In accordance with Section XX.G and Appendix F of the Paducah FFA, the U.S. Environmental Protection Agency and the Kentucky Department for Environmental Protection have a 90-day review and comment period. If the FFA parties have no substantive comments, DOE requests a letter of concurrence.

If you have any questions or require additional information, please contact Richard Bonczek at (859) 321-7127.

Sincerely,

APRIL LADD
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April Ladd
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. *Addendum to 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/A1

Administrative Record File—400OUREMEDIAL

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CERTIFICATION

Document Identification: ***Addendum to 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/A1, March 2024**

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) Digitally signed by MYRNA REDFIELD (Affiliate) Date: 2024.03.19 13:04:50 -05'00'

Myrna E. Redfield, Program Manager
Four Rivers Nuclear Partnership, LLC

Date Signed

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
Portsmouth/Paducah Project Office
U.S. Department of Energy

Date Signed

DOE/LX/07-2433&D2/R1/A1
Primary Document

Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Primary Document

Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—March 2024

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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FIGURES

TABLES

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ACRONYMS

CSM	conceptual site model
DOE	U.S. Department of Energy
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
GWOU	groundwater operable unit
IRA	interim remedial action
LRGA	Lower Regional Gravel Aquifer
MIP	membrane interface probe
MRGA	Middle Regional Gravel Aquifer
MW	monitoring well
NSDD	North-South Diversion Ditch
NTU	nephelometric turbidity unit
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PID	photo-ionization detector
QAPP	quality assurance project plan
RI	remedial investigation
RGA	Regional Gravel Aquifer
SAP	sampling and analysis plan
SWMU	solid waste management unit
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
WAG	waste area group

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EXECUTIVE SUMMARY

This *Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* sampling and analysis plan (SAP) is comprised of the field sampling plan and its companion, the quality assurance project plan. The SAP supplements the approved remedial investigation (RI) for the C-400 Complex Operable Unit (OU) that was completed in December 2023 (DOE 2023b) and describes how additional sampling will support the development of remedial alternatives and the optimization of the Northwest Plume interim remedial action (IRA).

Supporting development of remedial alternatives and optimization of the Northwest Plume IRA will be achieved by filling the listed data gaps for the adjacent area north of the C-400 Complex that were jointly identified by U.S. Department of Energy, U.S. Environmental Protection Agency, and Kentucky Department for Environmental Protection.

- The nature and extent of the potential and/or confirmed/probable trichloroethene (TCE) source zone(s) in Upper Continental Recharge System (UCRS) soils and in Regional Gravel Aquifer (RGA) and McNairy Formation groundwater have not been fully characterized.[1]

- Technetium-99 (Tc-99) levels in UCRS soils and in RGA groundwater have not been fully characterized.

To fill these data gaps, this SAP describes a phased investigation as follows:

- Perform a membrane interface probe (MIP) survey consisting of 12–22 MIP borings advanced to the RGA/McNairy Formation interface, and as much as 20 ft depth in the McNairy Formation where dense non-aqueous phase liquid (DNAPL) is not pooled at the base of the RGA; and

- Install 5–10 soil borings advanced to the depth of the RGA/McNairy Formation interface at a minimum, located based on MIP results and selected by the Federal Facility Agreement parties, which includes sampling of the UCRS every 10 ft starting at 10 ft below ground surface, along with two groundwater samples collected in the middle and lower RGA from each boring. Groundwater samples will also be collected as possible from the McNairy Formation where MIP results indicate the presence of a confirmed/probable TCE source zone. The soil and groundwater samples will be analyzed for TCE, TCE degradation products, and Tc-99.

Both the existing historical data and the data generated from the new analyses will be used to characterize the nature and extent of potential TCE source zone(s), to define the extent of TCE and Tc-99 in the UCRS, RGA, and McNairy Formation in the area north and adjacent to the C-400 Complex, and to revise the C-400 Complex OU conceptual site model as needed.

[1] As defined in the C-400 Complex OU RI (DOE 2023b), multiple lines of evidence were used to define TCE sources zones composed of TCE DNAPL and high concentration TCE contamination. A potential TCE source zone is defined as TCE groundwater concentration between 11,000 and 33,000 micrograms per liter (µg/L) (1% and 3% effective solubility). A confirmed/probable TCE source zone is defined as soil concentrations > 100,000 micrograms per kilogram (µg/kg), MIP PID responses > 700,000 microvolts (µV), and TCE groundwater concentrations > 33,000 µg/L (3% effective solubility).

This SAP summarizes the information known about the area north of the C-400 Complex and describes how the additional investigation will be conducted to fill the data gaps to support the development of remedial alternatives and the optimization of the Northwest Plume IRA.

1. INTRODUCTION

This sampling and analysis plan (SAP) for the C-400 remedial investigation (RI) addendum investigation area north of the C-400 Complex at the U.S. Department of Energy's (DOE) Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky, is composed of a field sampling plan and its companion quality assurance project plan (QAPP). This SAP supplements the approved RI for the C-400 Complex Operable Unit (OU). It describes how samples will be collected and subsequently analyzed to provide additional information to revise the C-400 Complex OU conceptual site model (CSM) as needed, to support the development of remedial alternatives, and to support the optimization of the Northwest Plume interim remedial action (IRA). The newly acquired data will be used to fill data gaps described in Section 4 of this document, which were jointly identified by DOE, U.S. Environmental Protection Agency (EPA), and Kentucky Department for Environmental Protection.

The C-400 RI addendum investigation area is a predominantly grassy area located north and adjacent to the C-400 Complex (Figure 1). The investigation area contains the C-401 Transfer Line and portions of the North-South Diversion Ditch (NSDD). The area is approximately 54,675 ft^2 and is bounded by Virginia Avenue to the south and 11th Street to the east.

The C-401 Transfer Line [Solid Waste Management Unit (SWMU) 26] was used to convey liquid effluent from C-403 Neutralization Tank (SWMU 40) and the C-400 Discard Waste System (SWMU 203) to the C-404 holding pond, between 1952 and 1957. In 1957, the C-401 Transfer Line was abandoned and the effluent was discharged directly to the NSDD (SWMU 59) (MMES 1995).

The NSDD originates in the area north of the C-400 Complex and joins with Little Bayou Creek to the north of PGDP. A bypass system was installed and portions of the NSDD included in the C-400 RI addendum investigation area were excavated in 2004 to a depth of 4 ft. The excavated areas were backfilled with clean soil and clay (DOE 2005).

As documented in the *Site Management Plan Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Annual Revision—FY 2024*, discussions among the Federal Facility Agreement (FFA) parties were held in late fiscal year 2023 regarding the integration and acceleration of Paducah cleanup decisions for environmental media, decontamination, and waste disposition (DOE 2023a). As part of the accelerated cleanup, DOE agreed to sample north of the C-400 Complex to support optimization of the Northwest Plume IRA. Additionally, the investigation sampling will also provide information to revise the C-400 Complex OU CSM as needed and to support development of remedial alternatives.

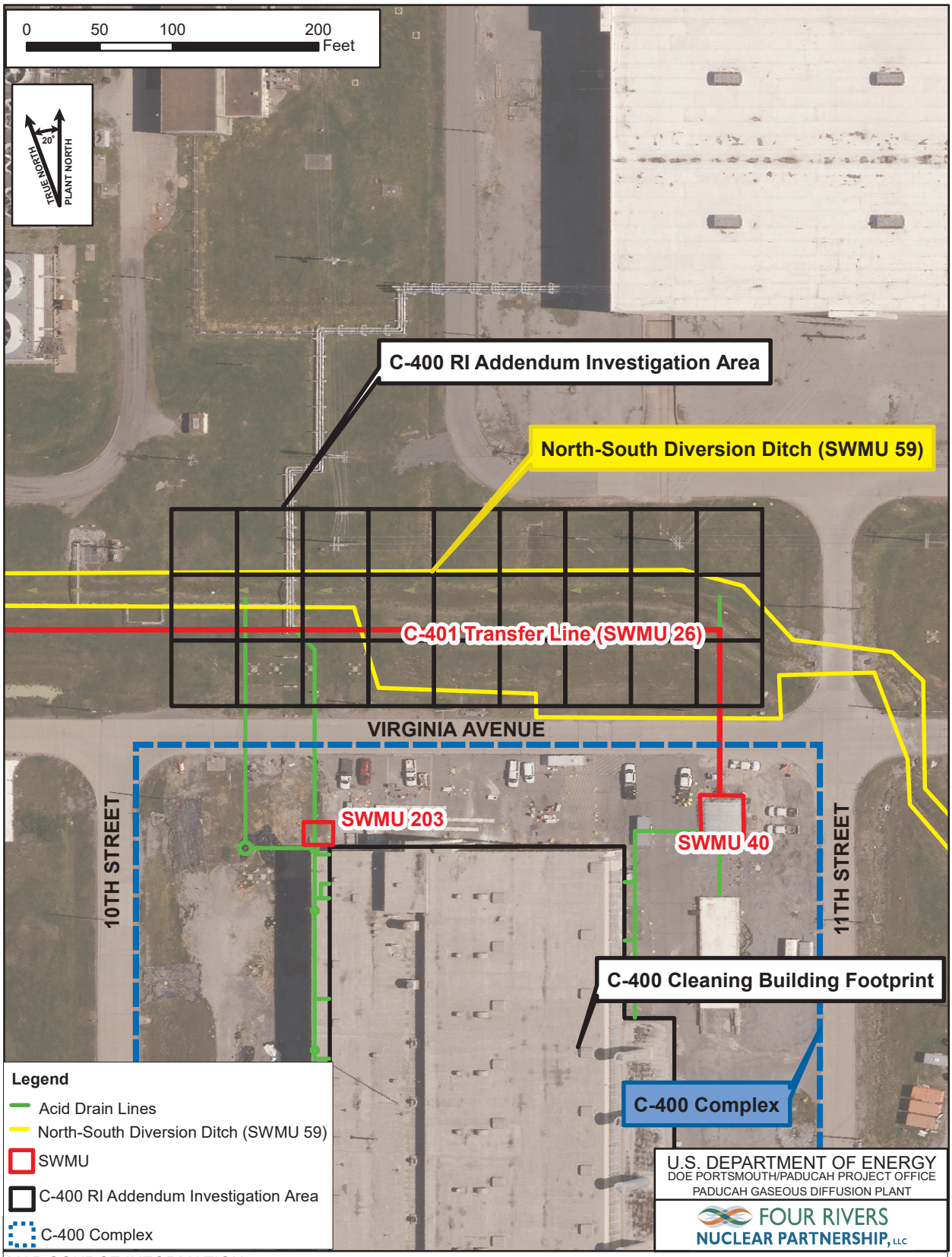


Figure 1. C-400 Remedial Investigation Addendum Investigation Area

2. REVIEW OF EXISTING DATA

Data relevant to the investigation area north of the C-400 Complex have been collected in three investigations:

- Waste Area Group (WAG) 6 RI;
- NSDD IRA; and
- C-400 Complex OU RI.

2.1 WASTE AREA GROUP 6 INVESTIGATION

The WAG 6 investigation included soil and groundwater sampling north of the C-400 Complex OU in an area identified as Sector 8 (DOE 1999). Sector 8 contains the C-401 Transfer Line (SWMU 26), which conveyed liquid effluent from the C-403 Neutralization Tank (SWMU 40), and the waste discard sump (SWMU 203) to the C-404 holding pond from 1952 to 1957.

Soil samples collected during the WAG 6 investigation in the RI addendum investigation area indicated a potential leak of the transfer pipeline based on comparison of the metals and radionuclides analytical results in soils and the analytical results of a pipeline sludge sample. Trichloroethene (TCE) and TCE degradation product concentrations in the samples of surface and subsurface soil from the Upper Continental Recharge System (UCRS) were all nondetect or below detection limits; however, analyses of grab groundwater samples collected from soil borings in the Regional Gravel Aquifer (RGA) indicated concentrations of TCE up to 91,000 micrograms per liter (µg/L) (Figure 2) and technetium-99 (Tc-99) up to 17,000 picocuries per liter (pCi/L) (Figure 3) in the RI addendum investigation area.

Overall, the WAG 6 investigation concluded that TCE and Tc-99 were the primary groundwater contaminants for the C-400 Complex. TCE source zones to groundwater were primarily located in the southern half of the C-400 Complex. The potential primary Tc-99 source zone to groundwater was identified as the NSDD.

2.2 NORTH-SOUTH DIVERSION DITCH

As part of the IRA at the NSDD, which included surface water, sediment, and shallow soils actions, soils of the RI addendum investigation area were excavated to a depth of 4 ft and the area was restored with clean soil and clay. Prior to site restoration, verification soil samples were collected from the top 3 inches of the exposed bottom of the excavation. Analytical results were compared to cleanup levels identified in the NSDD Record of Decision and were found to be within the specified cleanup limits (DOE 2005); however, the NSDD was believed to have contributed to groundwater contamination (DOE 2001).

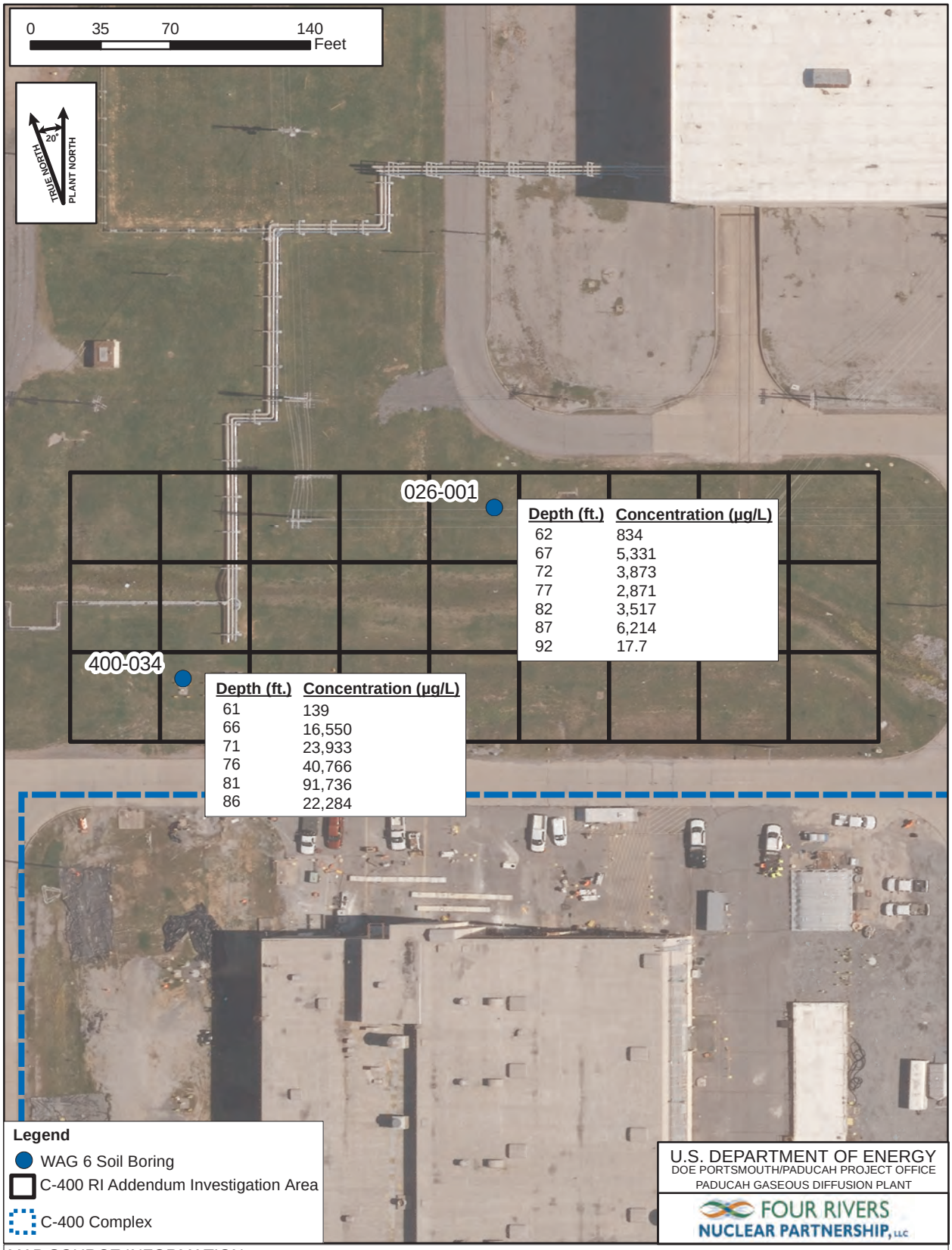


Figure 2. WAG 6 TCE in the RGA Groundwater

Figure 3. WAG 6 Tc-99 in the RGA Groundwater

2.3 C-400 COMPLEX OU REMEDIAL INVESTIGATION

The C-400 Complex OU RI included the collection of groundwater from four monitoring wells (MWs) (MW343, MW421, MW422, and MW423) located in the C-400 RI addendum investigation area north of the C-400 Complex (DOE 2023b). Three of the MWs (MW421, MW422, and MW423) contain multiple sampling ports to collect samples at different intervals in the RGA (Middle RGA to Lower RGA). Groundwater samples were collected quarterly from April 2021 to January 2022. Analytical results for TCE in the RI addendum investigation area, summarized in Table 1 and shown in Figure 4, ranged from 1,600 µg/L to 55,200 µg/L. As discussed in the C-400 RI report, TCE concentrations exceeding 11,000 µg/L are one line of evidence to support the presence of a potential TCE dense non-aqueous phase liquid (DNAPL) source zone. The use of this value is consistent with EPA terminology as defined in *Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites,* which uses 1% effective solubility (TCE = 11,000 µg/L) to indicate that DNAPL may be present in the vicinity of the monitoring point (EPA 2009). Additionally, the RI investigation defined TCE groundwater concentrations > 33,000 µg/L (3% effective solubility) as one line of evidence to indicate a confirmed/probable TCE source zone.

Table 1. TCE Concentration (µg/L) C-400 RI Report Investigation MW343, MW421, MW422, and MW423

Well ID	MW343	MW421-PRT1	MW421-PRT2	MW421-PRT3	MW422-PRT1	MW422-PRT2	MW422-PRT3	MW423-PRT1	MW423-PRT2	MW423-PRT3
RGA Zone	**Lower Regional Gravel Aquifer (LRGA)**	**Middle Regional Gravel Aquifer (MRGA)**	**MRGA**	**LRGA**	**MRGA**	**MRGA**	**LRGA**	**MRGA**	**MRGA**	**LRGA**
April 2021	12,400 H	4,860 Y1	3,130 Y1	43,300	4,700	22,600 Y1	19,800 Y1	4,090 Y1	21,400 Y1	22,600 Y1
July 2021	13,400	1,960	6,610	33,200	2,430	16,700	16,900	1,600	13,000	15,200
October 2021	4,760	2,980 B	9,120 B	55,200	3,510	20,600	20,700	3,490	17,000	21,400
January 2022	10,600	2,110 B	7,640	40,700	3,230	18,400	20,900	3,180	19,500	21,100

B—The analyte was found in the associated blank as well as in the sample.
H—Analysis was performed outside of holding time requirement.
Y1—Matrix spike/matrix spike duplicate recovery was outside of acceptance criteria.

Groundwater results for Tc-99, summarized in Table 2 and shown in Figure 5, identify elevated activity of Tc-99 in RGA groundwater below the RI addendum investigation area. The maximum activity of Tc-99 detected in RGA groundwater for the entire C-400 RI investigation was 31,700 pCi/L at MW423-PRT1.

Table 2. Tc-99 Activity (pCi/L) C-400 RI Report Investigation MW343, MW421, MW422, and MW423

Well ID	MW343	MW421-PRT1	MW421-PRT2	MW421-PRT3	MW422-PRT1	MW422-PRT2	MW422-PRT3	MW423-PRT1	MW423-PRT2	MW423-PRT3
RGA Zone	**LRGA**	**MRGA**	**MRGA**	**LRGA**	**MRGA**	**MRGA**	**LRGA**	**MRGA**	**MRGA**	**LRGA**
April 2021	22,600	2,190	905	328	24,500	2,960	2,010	31,700	10,100	3,310
July 2021	17,200	2,510	700	232	27,500	1,890	1,610	22,700	6,210	2,430
October 2021	14,100	1,730	597	231	25,100	1,450	1,460	29,000	2,820	2,860
January 2022	17,300	689	397	256	11,300	1,810	1,490	22,400	7,170	2,700

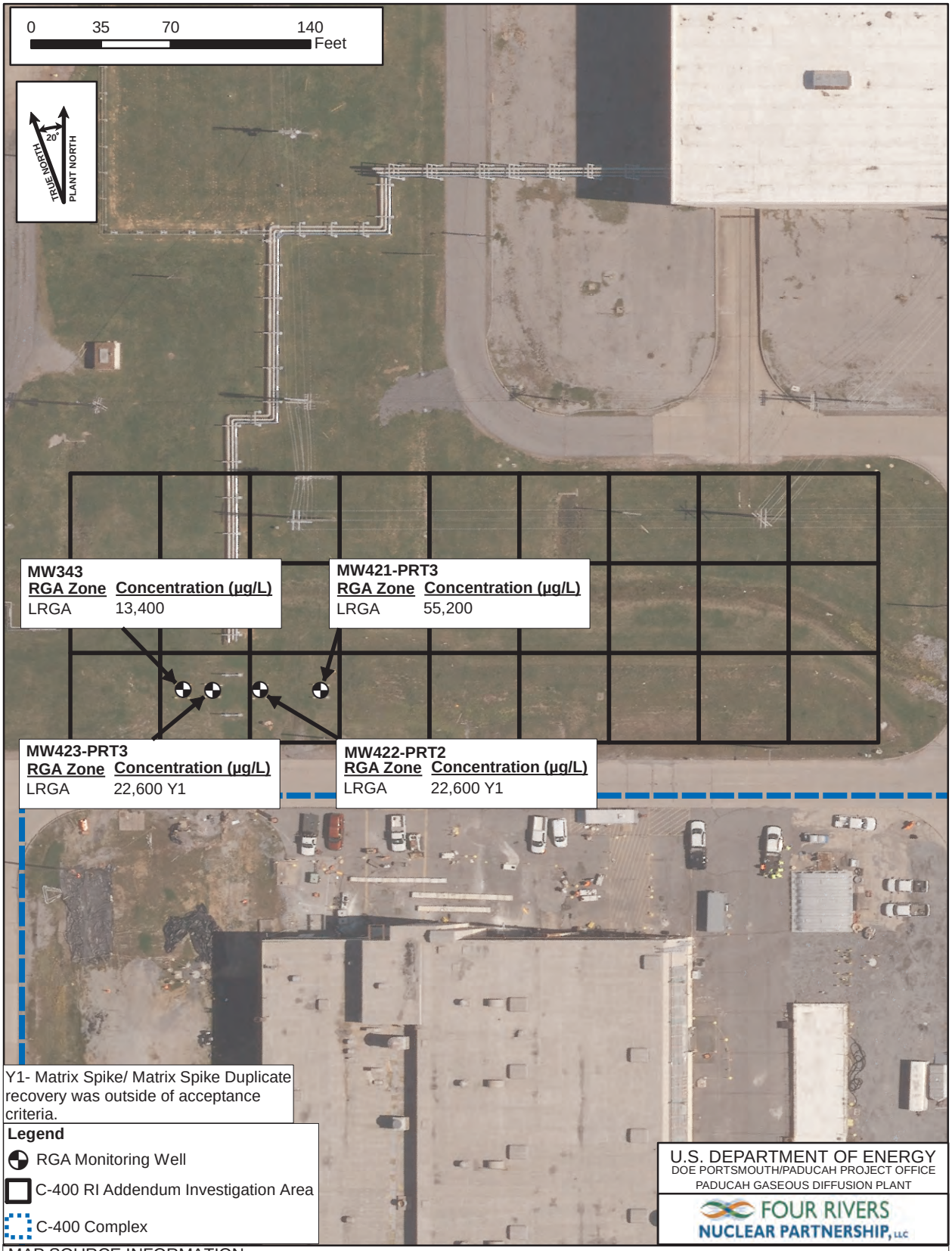


Figure 4. C-400 RI Investigation Max TCE GW Concentration North of C-400

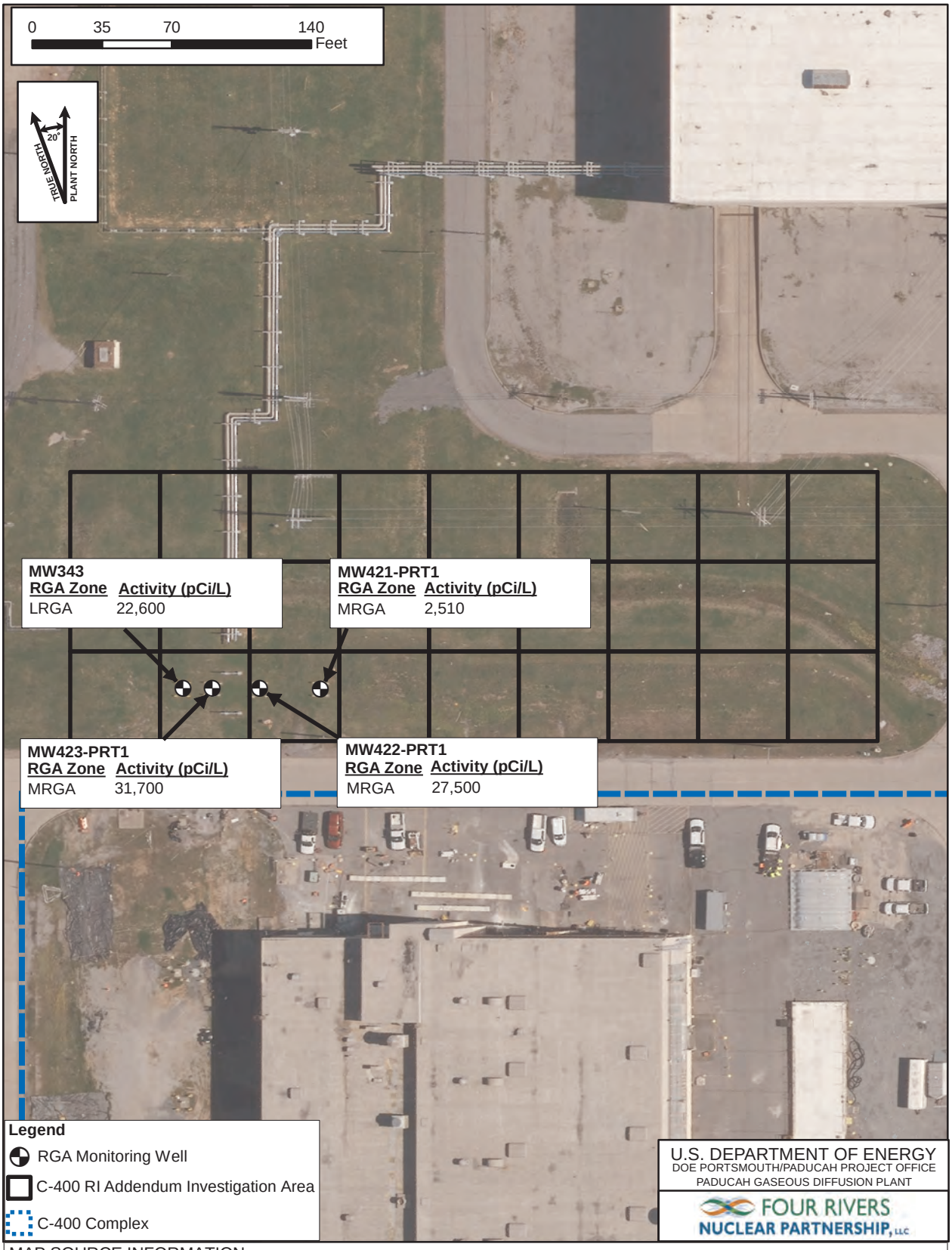


Figure 5. C-400 RI Investigation Max Tc-99 GW Activity North of C-400

3. CONCEPTUAL SITE MODEL

The C-400 Complex RI report (DOE 2023b) establishes the basis for the conceptual site model for groundwater and soil contamination of the C-400 Complex OU. The RI identifies contaminant sources to soil and groundwater that exceeded acceptable risk criteria. As determined by the WAG 6 and C-400 Complex OU remedial investigations, TCE and Tc-99 were the primary groundwater contaminants. TCE source zones to groundwater were primarily located in the south half of the C-400 Complex. The primary Tc-99 source zone to groundwater is located under the west side of the C-400 Cleaning Building and associated with the historic spray booth operations.

The C-400 Complex OU RI results indicate that a TCE source zone is located north of C-400 Complex and is a source of the Northwest Plume. Wastewater contaminated with TCE and Tc-99 generated by the C-400 Cleaning Building was historically discharged into the C-400 Discard Waste System (SWMU 203), located near the northwest corner of the C-400 Cleaning Building; and into the C-403 Neutralization Tank (SWMU 40), located near the northeast corner of the C-400 Complex. These SWMUs drained north through piping beneath Virginia Avenue and to the open NSDD. The discharges may have resulted in vertical downward migration of TCE and Tc-99 into the underlying soils and groundwater.[2] This conclusion is supported by eastward-increasing trends of TCE concentrations >11,000 μg/L in the lower RGA in MW421 and MW422, located north of the C-400 Complex (Figure 6).

4. DATA GAPS

The existing data set is sufficient to support the development of remedial alternatives for the C-400 Complex OU block area; however, it is insufficient to support the development of remedial alternatives that may address potential TCE source zones north of the C-400 Complex and to support optimization of the Northwest Plume IRA.

The primary data gaps associated with characterization in the area north of and adjacent to the C-400 Complex are as follows.

[2] The remedial action of the NSDD only addressed surface water, sediment, and shallow soils (DOE 2001). The groundwater operable unit (GWOU) will address sources of contamination to groundwater. Current information on contaminant nature and extent at the NSDD indicates that surface soils [i.e., soils from 0 to 1 ft below ground surface (bgs)] and shallow subsurface soils (i.e., soils up to 4 ft bgs) at the NSDD probably are not a current source of contamination to groundwater. However, current information on contaminant nature and extent in deeper subsurface soils is sparse, and deeper subsurface soils at the NSDD could be a source of contamination to groundwater, as recognized during discussions concerning the GWOU. If this is determined to be the case, any sources of contamination found in deeper subsurface soils that contribute to unacceptable groundwater contamination will be addressed as part of the GWOU (DOE 2002).

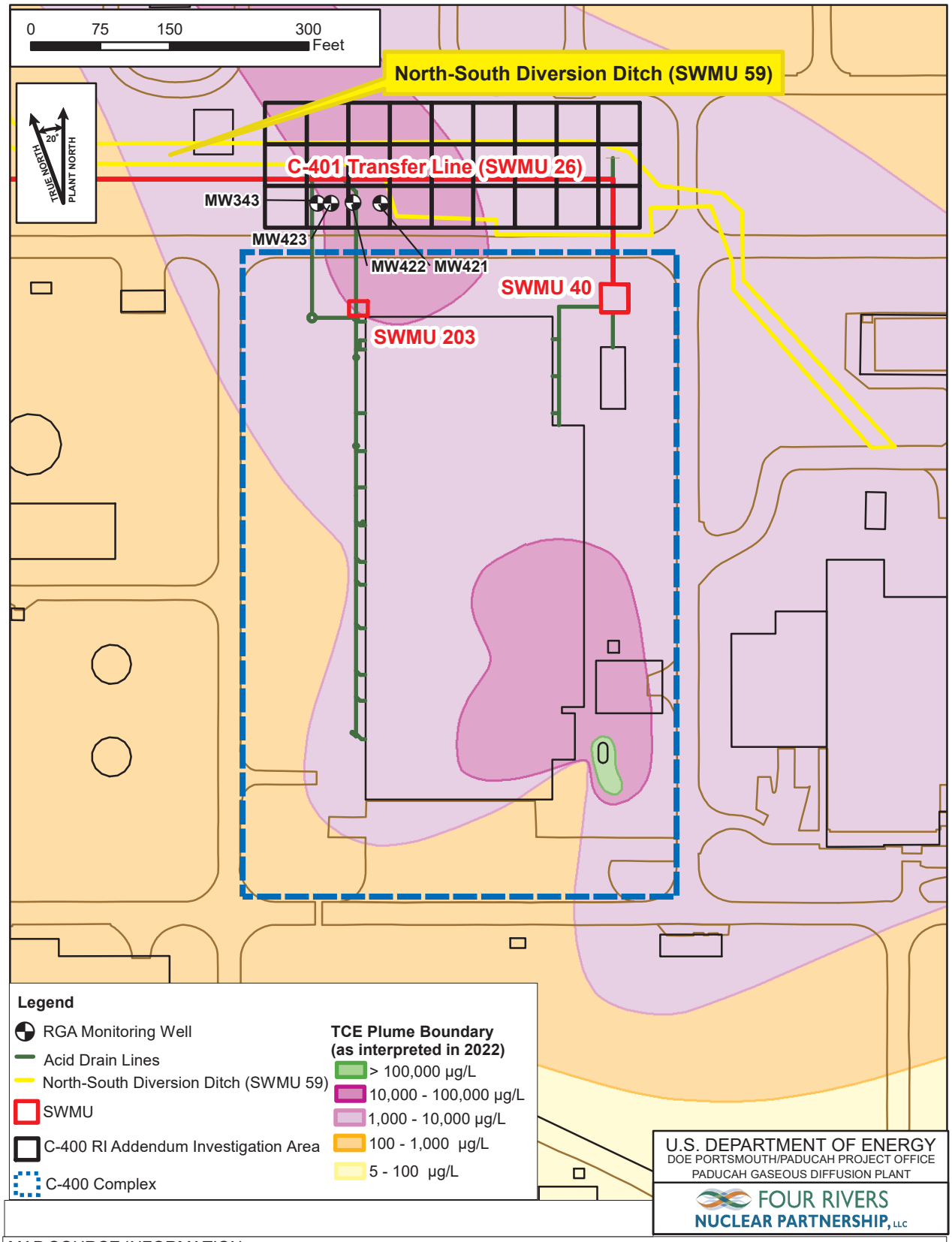


Figure 6. TCE in the Regional Groundwater Aquifer in 2022

- The nature and extent of potential and confirmed/probable TCE source zone(s) in UCRS soils and in the RGA and the McNairy Formation have not been fully characterized.[3]

- Tc-99 levels in UCRS soils and in RGA groundwater have not been fully characterized.

5. SAMPLING MEDIA AND METHODS

This section was developed consistent with discussions held among the FFA parties throughout the RI addendum scoping process (January 25, 2024, and February 1, 2024). Locations shown in this section are general. Locations may be adjusted as field conditions warrant (e.g., drilling refusal, unforeseen obstructions).

Sampling activities will focus on the soils and groundwater north of the C-400 Complex to a depth of 20 ft into the McNairy Formation (approximately 110 ft bgs). Activities will consist of two phases of field activities: characterization of dissolved phase TCE and TCE degradation products and soil conductivity via membrane interface probe (MIP) surveys, followed by the collection of soil and groundwater samples for TCE, TCE degradation products, and Tc-99.

The tentative sequence for field activities begins with MIP characterization. The FFA parties will review the data from the completed MIP characterization to locate borings for the collection of soil and groundwater samples.

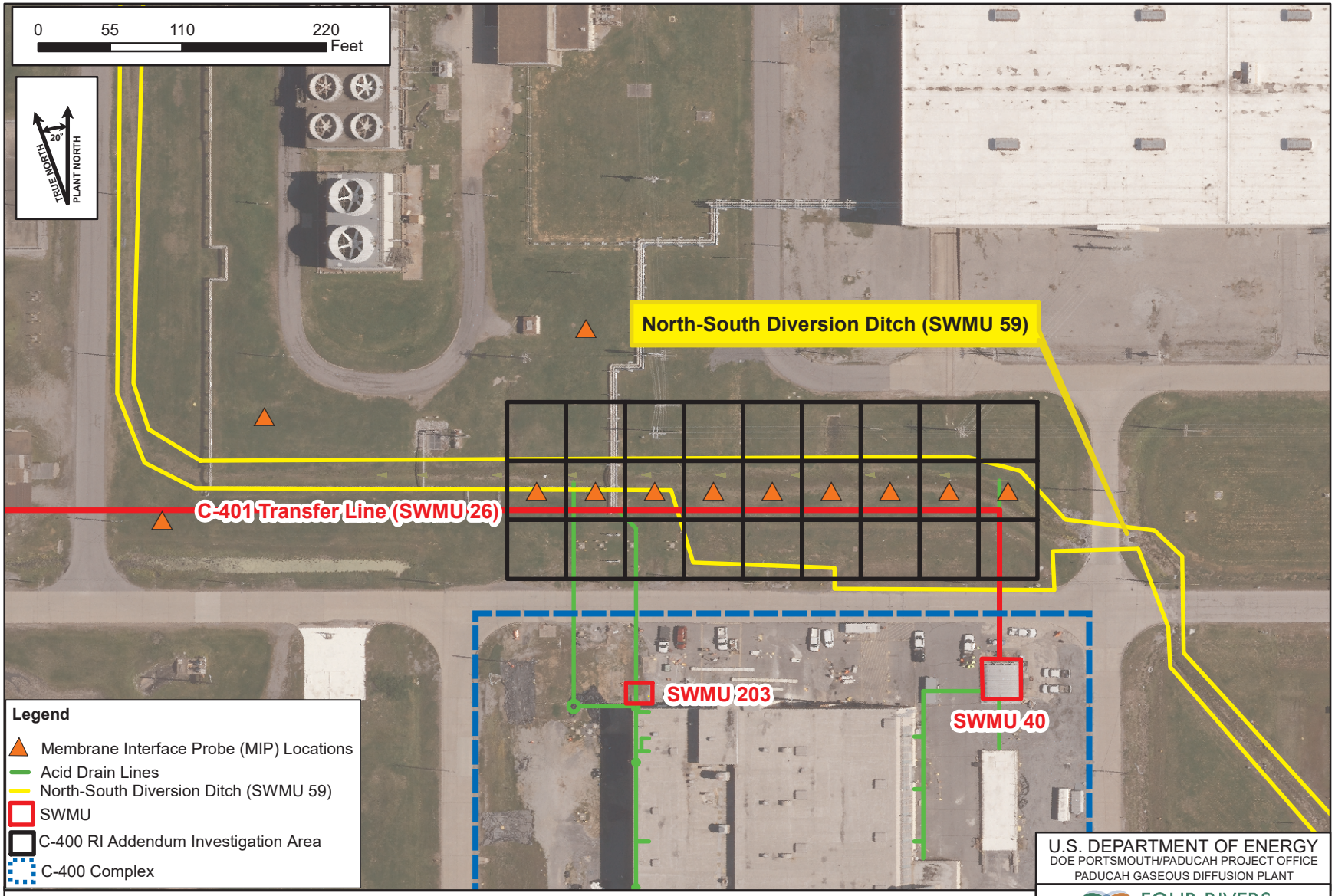
5.1 MEMBRANE INTERFACE PROBE CHARACTERIZATION

The field sampling plan includes downhole profile surveys using MIP tooling to provide initial characterization of TCE and TCE degradation products in the dissolved phase. Nine locations on a 45 × 45 ft grid pattern will be drilled in an approximate 135 ft × 405 ft target area north of the C-400 Complex with an additional three perimeter locations to the north and west of the target area (Figure 7). Locations may be adjusted as field conditions warrant (e.g., drilling refusal, unforeseen obstructions). MIP tooling will be advanced to a maximum depth of 20 ft into the McNairy Formation (approximately 110 ft bgs).

The electrical conductivity log recorded during the advancement of the MIP tooling can be used to identify the top of the McNairy Formation. If the MIP log does not indicate high levels of TCE and TCE degradation products indicative of DNAPL at the RGA/McNairy Formation interface, then the tooling will be advanced 20 ft into the McNairy Formation. If levels of TCE and TCE degradation products at the RGA/McNairy Formation interface are indicative of DNAPL, then the boring will be terminated and abandoned.

Upon completion of each MIP profile, the MIP tooling will be withdrawn and the driller will abandon the open borehole as discussed in Section 5.4.

[3] As defined in the C-400 Complex OU RI (DOE 2023b), multiple lines of evidence were used to define TCE sources zones composed of TCE DNAPL and high concentration TCE contamination. A potential TCE source zone is defined as TCE groundwater concentration between 11,000 and 33,000 µg/L (1% and 3% effective solubility). A confirmed/probable TCE source zone is defined as soil concentrations > 100,000 micrograms per kilogram (µg/kg), MIP PID responses > 700,000 microvolts (µV), and TCE groundwater concentrations > 33,000 µg/L (3% effective solubility).



MAP SOURCE INFORMATION
Map Generation Date and Location: 3/4/2024 G:\GIS\ARCVIEWS\PROJECTS\C-400\NWRAWP\C400RIAddendumMIPLocationsLANDSCAPE2.mxd
Basemap: G:\GIS\LiDAR\SID_Mosaics\FRNP_Paducah_Spring_2021.sid;
C-400 Block: G:\GIS\iPEGASIS.gdb\C400_Block;MIP Locations: G:\GIS\ARCVIEWS\PROJECTS\C-400\NWRAWP\MIPs.shp;
SWMUs: G:\GIS\iPEGASIS.gdb\SWMUs
Utilities:G:\GIS\SHAPES\UTILITES\acid and contaminated drains
Investigation Area: G:\GIS\ARCVIEWS\PROJECTS\C-400\NWRAWP\SampleGrid.shp

Figure 7. C-400 RI Addendum MIP Locations

Up to 10 contingency MIP profiles are available to address any remaining data gaps. The FFA parties will review the collective MIP data after the scheduled 12 MIP profiles are completed to determine if further MIP characterization is required.

5.2 SUBSURFACE SOIL SAMPLING

Following review of the MIP data by the FFA parties, five soil borings and up to five contingency borings will be drilled using direct-push technology (DPT) for the collection of soil samples for the analysis of TCE, TCE degradation products, and Tc-99 levels. Starting at a depth of 10 ft, soil samples will be collected from every 10 ft interval to the bottom of the UCRS at an approximate 60 ft depth. Soil samples will be collected in accordance with CP4-ES-2300, *Collection of Soil Samples*, CP4-ER-1020, *Collection of Soil Samples with Direct Push Technology Sampling*, or other appropriate work controls that may be developed if field conditions warrant. Field instruments will be used to screen collected soil cores for volatile organic compounds (VOCs) and radiological contamination. Samples for TCE and TCE degradation products will be collected from every 10 ft interval from the depth of the highest level of VOCs as determined by field photo-ionization detector (PID) readings. Additionally, samples will be collected for Tc-99 analysis every 10 ft interval from the depth of the highest beta/gamma activity. Radiological screening of the soil cores will be conducted in accordance with the procedures identified by QAPP Worksheet #21 in the appendix.

Soil Cores

The project will utilize DPT to collect soil cores through the UCRS to a target depth of 60 ft bgs, employing a dual-tube sampling system which collects 5 ft cores with a 1-inch diameter.

Upon collection, the soil core will be laid out in a top-to-bottom order on a table in a designated sample area in the vicinity of the drill rig. While the soil core still remains within the sample liner, the sample liner will be scanned radiologically with handheld instruments to identify any occurrences of radiological contamination that require special handling. Instruments compliant with DOE Prime Contractor procedures will be used for this effort.

Upon release of the soil core by the radiological control technician, the total recovered core length for the sample interval will be measured within the liner and recorded with the soil core depth being marked in 1 ft true depth intervals.[4] The sampling team will then conduct a PID survey of the soil core, accessing the soil core through puncture holes in the soil liner at 1 ft true depth intervals. PID survey results will be documented in a log book maintained by the field geologists.

Following completion of PID surveys for each 10 ft core run, the sample crew will open the soil core liners. The zone with the highest PID readings will be identified, and a sample for TCE and TCE degradation products will be collected immediately and stored in an iced cooler. If PID readings are consistent throughout the soil core, direct observation of discrete color, odor, or sand texture may be used to determine the sample depth. An additional sample of TCE and TCE degradation products may be collected at the discretion of the field geologist based on core conditions and MIP survey results.

[4] Sample and scan intervals will be identified by downhole depth. With the exception of obvious loss of core, depth intervals in the soil liner are corrected for length of soil core recovery by a multiplication factor that is defined as the total length of core recovered divided by the length of the downhole sample interval. For example, a sample liner containing 15 ft of recovery for a 10-ft sample interval would have a multiplication factor of 15/10 or 1.5. Scan intervals of 1.0 ft downhole depth would be spaced 1.0 ft × 1.5 (1.5 ft) apart.

After collection of samples for TCE and TCE degradation products, the cores will be scanned for beta/gamma activity at 1 ft true depth intervals using handheld instruments, and the results will be documented. The depth of highest beta/gamma activity will be identified, and then a sample will be collected for Tc-99 analysis. If beta/gamma levels are consistent throughout the soil core, then direct observation of discrete color, odor, or sand texture may be used to determine the sample depth.

A description of the core will be developed following sampling. Boring logs will be prepared for each soil boring.

5.3 GROUNDWATER SAMPLING

RGA grab groundwater samples will be collected from each of the soil boring locations, in accordance with CP4-ES-2101, *Groundwater Sampling*. Samples collected will be analyzed for TCE, TCE degradation products, and Tc-99.

- If turbidity of the groundwater sample > 100 nephelometric turbidity units (NTUs),[5] then results can be used qualitatively.

- If turbidity of the groundwater sample < 100 NTUs, then results can be used quantitatively.

Grab samples will be used in concert with MIP survey data in the RI addendum report. Data from the grab groundwater samples will be used to qualitatively assess nature and extent; however, data will not be used for risk assessment.

Two RGA groundwater samples will be collected from each of the boreholes for VOCs and Tc-99. Groundwater sample depths will be based on VOC results from adjacent MIP profile locations. If the MIP results do not distinguish depth intervals with higher VOC concentrations, then samples will be collected from depths of approximately 70 ft bgs (middle RGA) and approximately 80 ft bgs (lower RGA).

The groundwater sample system will utilize a mill-slotted rod of approximately 1.5-inch diameter mounted on the base of a hollow DPT probe rod assembly. The mill-slotted probe rod assembly will be advanced to the target sample depth. If the mill-slotted probe rod assembly is unable to be advanced through the RGA or if the milled slot becomes clogged, then a DPT screen point water sampler may be used instead.

Upon reaching the targeted sample depth, the depth to water will be measured for 5–10 minutes to ensure that the milled slots or screen slots are open and that the sampler is in connection with the RGA. If the depth to water is significantly shallower or greater than the actual depth of the top of the mill-slotted probe rod assembly, then the milled/screen slots are considered plugged. The drilling crew will retract the rods 1 ft and re-advance the milled-slotted probe rod assembly 1 ft deeper than the previous depth, up to five times, in an attempt to wipe the milled/screen slots open. The drilling crew will measure the depth to water after each attempt to determine whether the slots have opened. If the final depth-to-water measurement indicates that the milled/screen slots have still not opened, then the drilling crew will inject air to open the clogged milled/screen slots.[6]

Once the milled/screen slots are deemed open, an inertial pump assembly will be installed with the pump intake set 1 ft above the top of the mill-slotted rod/screen and begin purging at an approximate rate of

[5] EPA field guidance uses 10 NTUs.
[6] A cap with an air valve will be placed on the top of the rods and the air will be injected through the air valve.

0.25 gal per minute. The sampling crew will purge 5 gal of water from the borehole while collecting and recording field stabilization parameters (i.e., temperature, conductivity, pH, turbidity) for every gallon purged. Once 5 gal of water have been purged, samples will be collected for TCE, TCE degradation products, and Tc-99.

Groundwater samples will be collected from boreholes in the McNairy Formation where the adjacent MIP survey indicated PID values are > 700,000 µV below 1 ft depth in the McNairy Formation, or where PID values were > 300,000 µV below 1 ft depth in the McNairy Formation and the halogen-specific detector response was a spike of similar voltage.

The McNairy Formation groundwater samples will only be collected from sand horizons in the McNairy Formation at a minimum depth of 5 ft below the RGA/McNairy Formation interface. The 5 ft sample depth criterion is a practical assurance that the groundwater sampler screen is hydraulically isolated from the RGA groundwater above and that RGA groundwater is not leaking along the outside of the DPT probe rods and into the sampler screen.

Following completion of groundwater sampling activities, the boreholes will be abandoned as described in Section 5.4.

5.4 BOREHOLE ABANDONMENT

Upon completion of MIP probing or sampling in a borehole, filling and/or sealing materials will be placed promptly in the borehole. A tremie pipe, approximately 1.25 inches in diameter, will be inserted into the borehole to 50 ft bgs. In previous experiences on-site, the RGA matrix has readily collapsed and filled the open boreholes as probe rods were withdrawn. The drill crew will then fill the borehole with fine sand (20/40 or 30/45 grade) to the bottom of the tremie pipe, which is a modification to the current well abandonment procedure.[7] The intent is to fill any remaining open borehole in the RGA with a sand plug that will allow placement of a bentonite seal throughout the UCRS above the RGA interval.[8]

Following the placement of sand, the borehole will be filled with bentonite grout through the tremie pipe to within 1 ft of the top of land surface. The grout will be allowed to settle overnight and will be topped off if necessary. The remainder of the borehole will then be filled with clean sand.

6. SAMPLE ANALYSIS

The sample analyses for this investigation will characterize soil and groundwater, and project-generated waste materials. Specific analytical requirements, methods, and procedures applicable to this field sampling plan are described in the QAPP in the appendix.

[7] The driller will be required to obtain a variance for well abandonment from the Kentucky Division of Water.
[8] In previous experiences on-site, bentonite placed in an RGA borehole bled off into the aquifer.

7. SAMPLING PROCEDURES

Fieldwork and sampling at PGDP will be conducted in accordance with DOE Prime Contractor-approved medium-specific work instructions or procedures consistent with the *Environmental Investigations Standard Operating Procedure and Quality Assurance Manual* (EPA 2001). The DOE Prime Contractor will document changes on field request forms as detailed in the QAPP. Table 3 provides an example list of investigation activities that may require work instructions or procedures.

Table 3. Example RI Addendum Activities Requiring Work Instructions or Procedures

Investigation Activity
Chain-of-Custody
Cleaning and Decontaminating Sample Containers and Sampling Equipment
Data Entry
Data Validation
Equipment Decontamination
Environmental Radiological Screening
Field Measurement Procedures: pH, Temperature, Conductivity, Dissolved Oxygen, and Eh (Oxidation Reduction Potential)
Field Quality Control
Groundwater Sampling Procedures: Water Level Measurements
Identification and Management of Waste Not From a Radioactive Material Management Area
Labeling, Packaging, and Shipping of Environmental Field Samples
Lithologic Logging
Monitoring Well Purging and Groundwater Sampling
Off-Site Decontamination Pad Operating Procedures
On-Site Handling and Disposal of Waste Materials
Opening Containerized Waste
PID Measurements
Records Management
Pumping Liquid Wastes into Tankers
Quality Assured Data
Sampling of Containerized Wastes
Soil Sampling
Use of Field Logbooks
Well and Temporary Boring Abandonment

8. DOCUMENTATION

Field documentation will be maintained throughout the RI addendum in various types of documents and formats including the field log books, sample labels, chain-of-custody forms, and sample data forms. Additional information on documentation is provided in Section 9, "Field Sampling Plan," and Section 12, "Data Management Implementation Plan," of the C-400 RI/FS Work Plan (DOE 2020).

A field planning meeting will occur before work begins at the site, so that all involved personnel will be informed of the requirements of the fieldwork associated with the project. Whenever new personnel join the field team, they will be briefed on the appropriate work controls. Additional planning meetings may be held if the scope of work changes significantly.

Before implementation of the field program, the appropriate readiness assessment process will be conducted in accordance with DOE Prime Contractor procedures.

The documentation for the investigation will be reported as an addendum to the RI for the C-400 Complex OU. The RI addendum will include a description of the project, site background, data quality objectives, MIP survey results, soil and groundwater results, and data evaluation and assessment.

9. SAMPLE LOCATION SURVEY

A survey of sampling locations will be conducted upon completion of RI addendum field activities. Where possible, temporary markers consisting of painting, flagging, or the placing of wooden or metal stakes will be used to mark boring locations. A thorough description of each location will be made during field sampling. This documentation will be used for the survey effort if permanent sampling location markers are disturbed or if permanent markers cannot be placed at the time of sampling. A member of the RI addendum project team will accompany the survey crew to provide information regarding the location of sampling points. Each sample point will be surveyed for its horizontal and vertical location using the PGDP coordinate system for horizontal control and the North American Vertical Datum of 1988 for vertical control. Work will be performed by or under the responsible charge of a professional land surveyor registered in the Commonwealth of Kentucky. Coordinates will be entered into the Paducah Project Environmental Measurements System and will be transferred with the stations ready-to-load file to the Paducah Oak Ridge Environmental Information System.

10. REFERENCES

DOE (U.S. Department of Energy) 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. *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant Paducah, Kentucky*, DOE/OR/07-1857&D2, U.S. Department of Energy, Paducah, KY, August.

DOE 2002. *Record of Decision for Interim Remedial Action at the North-South Diversion Ditch at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1948&D2, U.S. Department of Energy, Paducah, KY, August.

DOE 2005. *Remedial Action Completion Report for the North- South Diversion Ditch Sections 1 & 2 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2195&D2, U.S. Department of Energy, Paducah, KY, September.

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 2023a. *Site Management Plan Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Annual Revision—FY 2024*, DOE/LX/07-2495&D1, U.S. Department of Energy, Paducah, KY, November.

DOE 2023b. *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, December.

EPA (U.S. Environmental Protection Agency) 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, U.S. Environmental Protection Agency, Washington, DC, November.

EPA 2009. *Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites*. EPA/600/R-09/110, U.S. Environmental Protection Agency, Washington, DC, September.

MMES (Martin-Marietta Energy Systems, Inc.) 1995. *C-400 Process and Structure Review*, KY/ERWM-38, Martin-Marietta Energy Systems, Inc., Paducah, KY, May.

APPENDIX

QUALITY ASSURANCE PROJECT PLAN (QAPP) WORKSHEETS

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QAPP WORKSHEETS

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QAPP Worksheets #1 and #2. Title and Approval Page

Site Name/Project Name: *Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*
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 (PGDP) Paducah Deactivation and Remediation Project
Work Assignment Number: Not Applicable (N/A)

Document Title: *Quality Assurance Project Plan for the Addendum to the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Operable Unit at the Paducah Gaseous Diffusion Plan, Paducah Kentucky*

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

Preparer's Name and Organizational Affiliation: Evan Clark, Four Rivers Nuclear Partnership, LLC

Preparer's Address, Telephone Number, and E-mail Address: 5511 Hobbs Road, Kevil, KY, 42053, Phone (270) 441-6247, evan.clark@pad.pppo.gov

Preparation Date (Month/Year): 1/2024

Document Control Number: DOE/LX/07-2433&D2/R1/A1

FRNP Environmental Services Director	_____ Signature Bruce Ford	Date:_____
FRNP Environmental Stewardship Manager	_____ Signature Bruce Ford, Acting	Date:_____
FRNP Sample Management Office Manager	_____ Signature Jaime Morrow	Date:_____
FRNP Quality Assurance/Quality Control Program Manager	_____ Signature Jennie Freels	Date:_____

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

1. Identify guidance used to prepare quality assurance project plan (QAPP):

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Implementing Environmental Quality Systems*, Version 2.0, 126 pages.

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans*: *Part 1 UFP-QAPP Manual*, Version 1.0, 177 pages (DTIC ADA 427785 or EPA-505-B-04-900A).

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans*: *Part 2A UFP-QAPP Workbook*, Version 1.0, 44 pages.

   Intergovernmental Data Quality Task Force, March 2005. *The Uniform Federal Policy for Quality Assurance Project Plans: Part 2B, Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities*, Version 1.0, 76 pages.

   Intergovernmental Data Quality Task Force, March 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets*, 42 pages.

   Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, *Volume 1 Human Health*, DOE/LX/07-0107&D2/R14/V1.

   Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2490&D1.

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

3. Identify approval entity: 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: January 25, 2024, and February 1, 2024—Data Quality Objective (DQO) Sessions

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

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

Title:	**Approval Date(s):**
C-400 Vapor Intrusion Study Work Plan to Support the Additional Actions for the CERCLA Five-Year Review at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/LX/07-2403&D2/R1 Errata	August 2017
Paducah Gaseous Diffusion Plant C-400 Cleaning Building Basement Slab and Subsurface Structures Sampling and Analysis Plan, DOE/LX/07-2430&D1	July 2018
Appendix D, Paducah Gaseous Diffusion Plan C-400 Basement Slab and Subsurface Structures Data Summary Report, DOE/LX/07-2442&D1	N/A (Work Performed outside the FFA)
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	March 2020

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

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

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

This QAPP includes all 28 combined worksheets that are required based on 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.

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

Optimized UFP-QAPP Worksheets		**CIO 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 (CSM)	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 and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits 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 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 Require
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

Distribution is based on the position title. A change in the individual within an organization will not trigger a resubmittal of the QAPP. DOE may choose to update this worksheet and submit page changes to the document holders. Alternatively, as with other changes to the approved project-specific QAPP, personnel changes may be tracked and included as an attachment to the QAPP. Managers are responsible for distribution to their staffs.

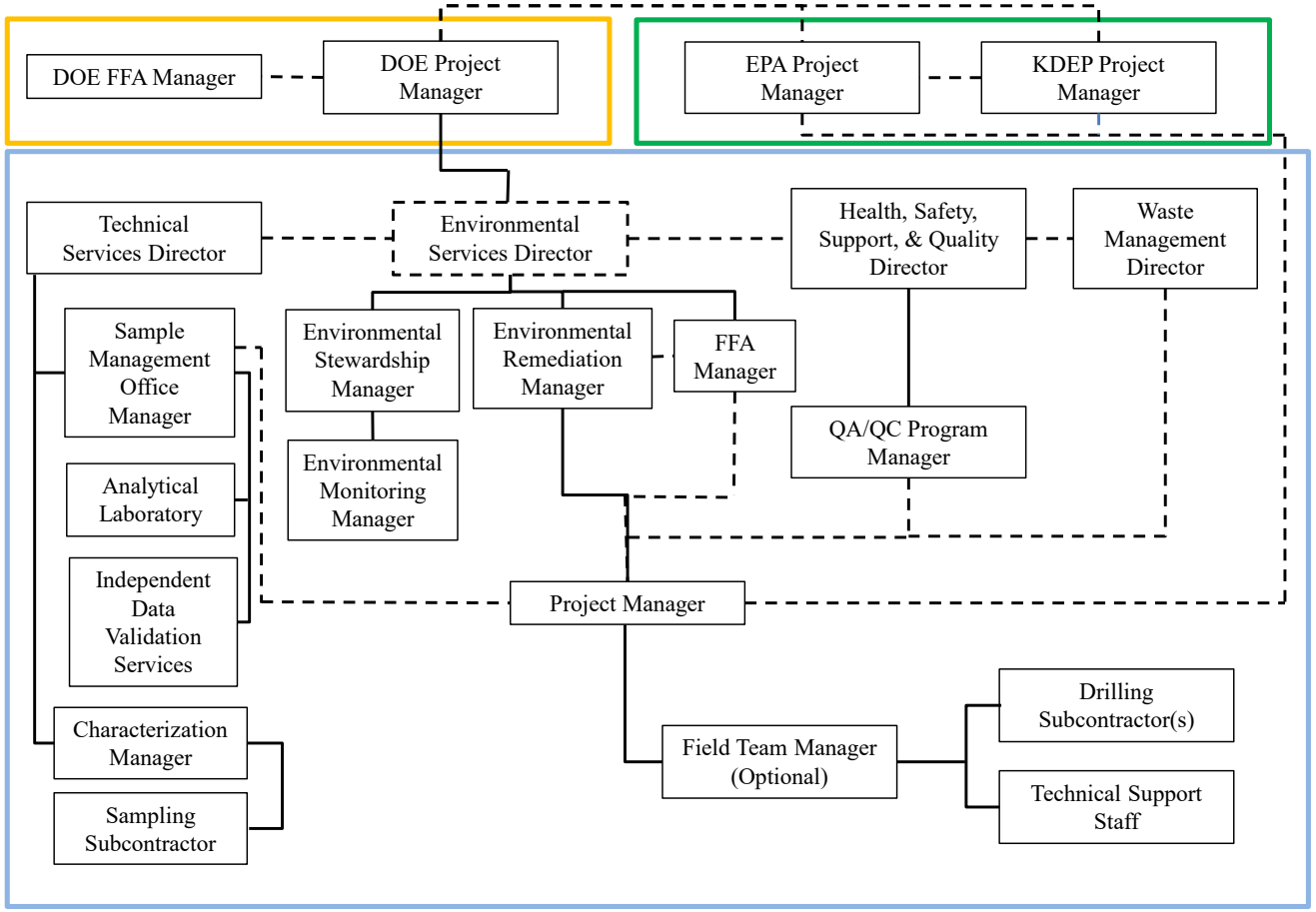
Controlled copies of the C-400 Complex Remedial Investigation/Feasibility Study (RI/FS) Addendum QAPP will be distributed according to the distribution list below. This list will be updated, as needed, and kept by the FRNP Records Management Department. Each person receiving a controlled copy also will receive any updates/revisions. If uncontrolled copies are distributed, it will be the responsibility of the person distributing the uncontrolled copy to provide updates/revisions.

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current E-mail Address	Document Control Number
Paducah Site Lead	DOE	April Ladd	(270) 441-6843	april.ladd@pppo.gov	1
Project Manager (PM)	DOE	Rich Bonczek	(859) 321-7127	rich.bonczek@pppo.gov	2
FFA Manager	DOE	April Ladd	(270) 441-6843	april.ladd@pppo.gov	3
Environmental Services Director	FRNP	Bruce Ford	(270) 441-5357	bruce.ford@pad.pppo.gov	4
Environmental Stewardship Manager	FRNP	Bruce Ford, Acting	(270) 441-5357	bruce.ford@pad.pppo.gov	5
Environmental Remediation Manager	FRNP	Bruce Ford, Acting	(270) 441-5357	bruce.ford@pad.pppo.gov	6
C-400 Complex RI/FS Addendum PM	FRNP	Bruce Ford, Acting	(270) 441-5357	bruce.ford@pad.pppo.gov	7
FFA Manager and PM	KDEP	April Webb	(502) 782-6470	april.webb@ky.gov	8
FFA Manager and PM	EPA	Victor Weeks	(404) 562-9189	weeks.victor@epa.gov	9
FFA Manager	FRNP	LeAnne Garner	(270) 441-5436	leanne.garner@pad.pppo.gov	10
QA/Quality Control (QC) Program Manager	FRNP	Jennie Freels	(270) 441-5407	jennie.freels@pad.pppo.gov	11
Sample Management Office (SMO) Manager	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	12
Environmental Monitoring Manager	FRNP	Brett Smothers	(270) 441-6613	Brett.Smothers@pad.pppo.gov	13
Health, Safety, Support, and Quality (HSS&Q) Director	FRNP	Duke Moscon	(270) 441-6538	Duke.Moscon@pad.pppo.gov	14

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

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current E-mail Address	Document Control Number
Technical Services Director	FRNP	Caleb Kline	(270) 441-6405	caleb.kline@pad.pppo.gov	15
Waste Management Director	FRNP	Carrie Maxie	(270) 441-5457	carrie.maxie@pad.pppo.gov	16
Field Team Leader	FRNP	Shay Mitchell	(270) 441-5430	shay.mitchell@pad.pppo.gov	17
Contract Laboratory PM	GEL Laboratories	Valerie Davis	(843) 769-7391	vsd@gel.com	18
Subcontractor PM (Sampling)	GEO Consultants, LLC	Cody Boulton	(270) 816-3415	cody.boulton@pad.pppo.gov	19
Subcontractor PM (Drilling)	To Be Determined (TBD)	TBD	TBD	TBD	20

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



Note: DOE personnel are in Orange Box, Regulatory personnel are in Green Box, and DOE Prime Contractor personnel are in Blue Box.

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

ORGANIZATION: DOE Prime Contractor

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
Bruce Ford	Environmental Services Director	> 4 years relevant work experience	No specialized training or certification. See Training Position Description (TPD).	
Bruce Ford, Acting	C-400 RI/FS PM, 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.	
Cody Boulton	Sample Team Leader, GEO Consultants, LLC	> 4 years relevant work experience	No specialized training or certification.	
TBD	Drilling Contract PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	

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

QAPP Worksheet #6.
Communication Pathways

NOTE: Formal communication across company or regulatory boundaries occurs via letter. Other forms of communication, such as e-mail, telephone calls, meetings, etc., will occur throughout the project. Regular project communication among DOE, the Site Contractor, and the regulatory agencies concerning project progress is expected. Deviations from the addendum to the C-400 Complex Remedial Investigation/Feasibility Study QAPP will be communicated upward through the chain of command to regulatory agencies using communication tools commensurate with the issue.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	DOE, EPA, KDEP	DOE PM: Rich Bonczek; EPA Remedial PM: Victor Weeks; KDEP PM: April Webb	rich.bonczek@pppo.gov weeks.victor@epa.gov april.webb@ky.gov	Formal communication among DOE, EPA, and KDEP.
Field progress reports	FRNP	FRNP Environmental Services Director: Bruce Ford	bruce.ford@pad.pppo.gov	Formal communication among the project staff, the site lead, and the DOE PM.
Stop work due to safety issues	FRNP	FRNP Environmental Services Director: Bruce Ford and FRNP HSS&Q Director: Duke Moscon	bruce.ford@pad.pppo.gov duke.moscon@pad.pppo.gov	FRNP will communicate work stoppages to DOE PM as required by procedure.
QAPP changes during project execution	FRNP	FRNP Environmental Services Director: Bruce Ford and FRNP Quality Assurance/Quality Control Program Manager: Jennie Freels	bruce.ford@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 Environmental Services Director: Bruce Ford	bruce.ford@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs.
Analytical laboratory interface	FRNP	FRNP SMO Manager: Jaime Morrow	jaime.morrow@pad.pppo.gov	Communication between FRNP and analytical laboratory.

QAPP Worksheet #6. (Continued)
Communication Pathways

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Laboratory quality control variances	Contracted Laboratory	Laboratory PM: Valerie Davis (GEL)	vsd@gel.com	Notify FRNP SMO. FRNP SMO will notify FRNP PM to determine corrective actions.
Analytical corrective actions	Contracted Laboratory, FRNP	Laboratory PM: Valerie Davis (GEL), FRNP SMO Manager: Jaime Morrow	vsd@gel.com jaime.morrow@pad.pppo.gov	Notify FRNP SMO. FRNP SMO will notify the project.
Data verification issues (e.g., incomplete records)	A2RGC, LLC, FRNP	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, FRNP	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.

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

Project scoping is the key to the success of any project and is part of the systematic planning process. The preparation of this QAPP included review of past documents produced and planning meetings to establish the objectives of the project. The worksheet below was completed as part of the scoping of the addendum to the RI/FS Work Plan for the C-400 Complex Operable Unit (OU) prior to developing the SAP and QAPP. The following tables include details about these meetings.

Name of Project: Addendum to the C-400 RI/FS Work Plan for the C-400 Complex OU
Date of Session: January 25, 2024 and February 8, 2024
Scoping Session Purpose: DOE and its contractors, EPA and its contractors, and KDEP met to scope the addendum to RI/FS Work Plan for the C-400 Complex and develop DQOs.

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	DOE	Rich Bonczek	(859) 321-7127	rich.bonczek@pppo.gov	Project Management
Project Manager	FRNP	Bruce Ford	(270) 441-5357	bruce.ford@pad.pppo.gov	Environmental Services Director and Project Management
Project Manager	KDEP	April Webb	(502) 782-6470	april.webb@ky.gov	Project Management
Project Manager	EPA	Victor Weeks	(404) 562-9189	weeks.victor@epa.gov	Project Management
Technical Support	EPA	Ben Bentowski	(404) 562-8507	bentkowski.Ben@epa.gov	Technical Support
Technical Support	FRNP	Evan Clark	(270) 441-6247	evan.clark@pad.pppo.gov	Technical Support
Technical Support	ETAS	Martin Clauberg	(865) 259-7155	martin.clauberg@pppo.gov	Technical Support
Technical Support	FRNP	Bryan Clayton	(270) 441-5412	bryan.clayton@pad.pppo.gov	Technical Support
Technical Support	EPA	Eva Davis	(580) 436-8548	davis.eva@epa.gov	Technical Support
Technical Support	FRNP	Ken Davis	(270) 441-5049	ken.davis@pad.pppo.gov	Technical Support
Technical Support	TechLaw	Jonathan Dziekan		jonathan.dziekan@TechLawConsultants.com	Technical Support
Technical Support	KDEP	Mary Evans		mary.evans@ky.gov	Technical Support
Technical Support	FRNP	Robert Flynn	(270) 441-5174	robert.flynn@pad.pppo.gov	Technical Support
Technical Support	FRNP	Stefanie Fountain	(865) 291-4689	stefanie.fountain@pad.pppo.gov	Technical Support

CHFS = Cabinet for Health and Family Services

QAPP Worksheet #9.
Project Planning Session Summary (Continued)

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Technical Support	CHFS	Nathan Garner	(502) 564-8390	nathan.garner@ky.gov	Technical Support
Technical Support	KDEP	Will Grasch		will.grasch@ky.gov	Technical Support
Technical Support	ETAS	Jennifer Johnson	(270) 441-6846	jennifer.johnson@pppo.gov	Technical Support
Technical Support	DOE	Kelly Layne		kelly.layne@pppo.gov	Technical Support
Technical Support	TechLaw	Mac McRae	(678) 493-1247	mmcrae@techlawinc.com	Technical Support
Technical Support	FRNP	Shay Mitchell	(270) 441-5430	shay.mitchell@pad.pppo.gov	Technical Support
Technical Support	KDEP	Todd Mullins	(502) 782-6420	todd.mullins@ky.gov	Technical Support
Technical Support	FRNP	Megan Mulry	(270) 441-5705	megan.mulry@pad.pppo.gov	Technical Support
Technical Support	KDEP	Bart Schaffer	(502) 782-6390	bart.schaffer@ky.gov	Technical Support
Technical Support	KDEP	Sonja Smiley	(502) 782-6452	sonja.smiley@ky.gov	Technical Support
Technical Support	ETAS	Bruce Stearns	(270) 441-6809	bruce.stearns@pppo.gov	Technical Support
Technical Support	ETAS	Tracy Wood	(270) 441-6866	tracy.wood@pppo.gov	Technical Support

CHFS = Cabinet for Health and Family Services

Consensus decisions made:

- Twelve Membrane Interface Probe (MIP borings) locations agreed upon by FFA parties.
- Upon review of initial MIP data by FFA parties, up to 10 contingency MIP borings and 5-10 soil borings will have their locations selected by the FFA parties.
- Analytical compounds chosen by the FFA parties.
- Action items were identified and resolved during scoping activities by the FFA parties and incorporated into the work plan as appropriate.

QAPP Worksheet #10. Conceptual Site Model

See Section 3 of this work plan addendum.

QAPP Worksheet #11.
Project/Data Quality Objectives

Step 1. State the Problem:

Hazardous substances that historically have been present in and/or migrated from the C-400 Complex and its solid waste management units (SWMUs) have been released into the surrounding environmental media. These substances, in turn, have infiltrated the groundwater and have been transported through subsurface pathways. The nature and extent of contamination have been defined adequately for some SWMUs and areas, and risk assessments have been prepared. For other SWMUs and areas, the nature and extent of contamination have not been defined adequately enough to assess whether potential contaminants pose unacceptable risks to human health and the environment at the C-400 Complex and at downgradient exposure points. Data gaps must be identified so that comprehensive RI and FS reports can be prepared for the C-400 Complex.

Problem Description: Groundwater analytical levels in monitoring wells adjacent to and north of the C-400 Complex indicate the potential of a trichloroethene (TCE) source zone in the Regional Gravel Aquifer (RGA) outside of the C-400 Complex. Additional investigation of this area is required to characterize the nature and extent of the TCE source zone, if present, to revise the C-400 Complex OU CSM, and to support the development of remedial alternatives, and to support changes to the Northwest Plume Interim Remedial Action to further optimize the hydraulic control of and containment mass removal for the northwest TCE and technetium-99 (Tc-99) plume.

Problem Approach:

- The planning team will review plans, regulations, DOE Orders, and permits to determine monitoring requirements.
- Planning Team: FFA parties, FRNP
- Determine Resources:
  - Schedule: See Worksheets #14 and 16
  - Budget: Based upon final scope of work
  - Personnel: FRNP

Step 2: Identify the Goal of the Study

- Characterize nature and extent of potential and confirmed/probable TCE source zone(s) in Upper Continental Recharge System (UCRS) soils and RGA and McNairy Formation groundwater north of the C-400 Complex.

- Characterize the Tc-99 levels in UCRS soils and RGA groundwater north of the C-400 Complex.

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

Step 3. Identify Information Inputs:

Identify Information Inputs (What Information Do We Need)

- MIP data for qualitative use to determine the nature and extent of the potential UCRS, Regional Gravel Aquifer (RGA), and McNairy Formation TCE source zone(s).

- Soil and groundwater sample results for quantitative use to characterize TCE and Tc-99 contamination levels in the UCRS, RGA, and McNairy Formation north of the C-400 Complex.

Step 4. Identify the Boundaries of the Study:

The study area consists of an approximate 405 ft × 135 ft area north of the C-400 Complex OU bounded by Virginia Street to the south and approximately bounded by 11th Street to the east.

Data needs to meet the measurement quality objective and data quality indicators established by the systematic planning process consistent with procedures *Quality Assured Data*, CP3-ES-5003; *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, CP2-ES-0063; *Developing, Implementing, and Maintaining Data Management Implementation Plans*, CP3-ES-1003; and QAPP worksheets 12-A through 12-D.

Step 5. Develop the Analytical Approach:

The samples will undergo chemical and radiological analysis at a contract laboratory, consistent with the contract protocols.

Step 6. Specify Performance or Acceptance Criteria:

- Analytical sample results must successfully undergo assessment and validation to be used to support the C-400 Complex RI and FS reports and in support of CERCLA analysis. A minimum of 10% of the total number of the RI addendum investigation samples will undergo Level IV validation for this project.

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

- For the purposes of this RI addendum investigation, source zones composed of TCE dense non-aqueous phase liquid and high concentration TCE contamination will be defined using multiple lines of evidence. Potential TCE source zones are defined as areas with groundwater TCE contamination between 11,000 and 33,000 micrograms per liter (µg/L). Confirmed/probable TCE source zones are defined as areas with groundwater TCE contamination > 33,000 µg/L, TCE concentrations in soil > 100,000 micrograms per kilogram (µg/kg), and MIP photoionization detector (PID) responses > 700,000 microvolts (µV).

Step 7. Develop the Detailed Plan for Obtaining Data:

- The process of obtaining data has been laid out in the SAP section.

QAPP Worksheet #12-A.
Measurement Performance Criteria (Radionuclides, Soil)

Matrix	Soil
Analytical Group[a]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[b]	Analytical Method/SOP[c]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	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-846-8260 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy Bias	% recovery	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[d]	No target compounds > PQL	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[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] 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 (Radionuclides, Sediment)

Matrix	Soil
Analytical Group[a]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**	**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	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 Rinseates	S
		Completeness[e]	90%	Data completeness check	S&A

MDA = minimum detectable activity; RPD = relative percent difference
Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.
[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] 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 (VOCs, Water)

Matrix	Water/Groundwater
Analytical Group[a]	Volatile Organic Compounds (VOCs)
Concentration Level	Low

Sampling Procedure[b]	**Analytical Method/SOP**[c]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**	**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-846-8260 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[d]	Laboratory Sample Spikes	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	Trip Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[e]	90%	Data completeness check	S&A

PQL = practical quantitation limit; RPD = relative percent difference
[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] 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/Groundwater
Analytical Group[a]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[b]	Analytical Method/SOP[c]	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)	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—≤ 25%	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 Rinseates	S
		Completeness[e]	90%	Data completeness check	S&A

MDA = minimum detectable activity
RPD = relative percent difference
[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] 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
Oak Ridge Environmental Information System (OREIS) Database	Various	Various	Data will be used to determine the nature and extent of soil and groundwater contamination in conjunction with RI addendum data to be collected at a later date.	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used if there is sufficient time to resample and obtain a result that will not be rejected during validation.
Historical Documentation	Various	Various	Information will be used as guidance on related project work.	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: OREIS is the repository for Paducah Gaseous Diffusion Plant (PGDP) environmental and waste characterization analytical results. OREIS is a limited access database. Environmental data are downloaded from OREIS to the Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS) periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

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	November 2024	January 2025	Field Notes	January 2025
Sample Collection	FRNP	November 2024	January 2025	Field Notes	January 2025
Analysis	Contract Lab	November 2024	March 2025	Report of Analysis	March 2025
Validation	A2RGC, LLC	January 2025	March 2025	Validation Summary	March 2025
Data Report	Project Team	January 2025	June 2025	Data Report	June 2025

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

Matrix: Soil
Analytical Group: VOCs

VOC	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/kg)	MDL (µg/kg)
1,1-Dichloroethene	75-35-4	22,700	NAL	Yes	1	0.333
cis-1,2-Dichloroethene	156-59-2	6,260	NAL	Yes	1	0.333
trans-1,2-Dichloroethene	156-60-5	6,960	NAL	Yes	1	0.333
Trichloroethene	79-00-5	412	NAL	Yes	1	0.333
Vinyl Chloride	75-01-4	59.2	NAL	Yes	1	0.333

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
NAL = no action level for child resident scenario from the risk methods document (RMD)
PQL = practical quantitation limit
VOC = volatile organic compound

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

[a] This QAPP references the maximum containment levels (MCLs) (if available) 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 child resident scenario. 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 chemicals of concern (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 project action limit (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 #15-B.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Soil)

Matrix: Soil
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c] MDA (pCi/g)
Technetium-99	14133-76-7	112	NAL	Yes	5

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDA = minimum detectable activity
NAL = no action level for child resident scenario from the RMD

Analytical laboratory results will be reported on a dry weight basis, as applicable, unless specified otherwise.

[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 #15-C.
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Water)

Matrix: Water
Analyte Group: VOCs

VOC	Chemical Abstracts Service (CAS) Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL(µg/L)
1,1-Dichloroethene	75-35-4	7.0/28.5	MCL/NAL	Yes	1	0.333
cis-1,2-Dichloroethene	156-59-2	70/3.47	MCL/NAL	Yes	1	0.333
trans-1,2-Dichloroethene	156-60-5	100/6.78	MCL/NAL	Yes	1	0.333
Trichloroethene	79-01-6	5.0/0.283	MCL/NAL	Yes	1	0.333
Vinyl Chloride	75-01-4	2.0/0.0188	MCL/NAL	Yes	1	0.333

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level (see EPA Regional Screening Levels https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables)
MDL = method detection limit
NAL = no action level for child resident scenario taken from the RMD
PQL = practical quantitation limit
VOC = volatile organic compound

[a] This QAPP references the MCLs (if available) 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 child resident scenario.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from chemicals of potential concern 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.

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

Matrix: Water
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c] MDAs (pCi//L)
Technetium-99	14133-76-7	4 mrem/year-dose[d], 900/19.0	MCL/NAL	Yes	25

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level
MDA = minimum detectable activity
NAL = no action level for child resident scenario from the RMD

[a] This QAPP references the MCLs (if available) 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 child resident scenario. 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] Radionuclide parameters will be reported per laboratory SOPs and the U.S. Department of Defense and Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories.

[d] 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]).

QAPP Worksheet #17.
Sampling Design and Rationale

The purpose of this project-specific QAPP is to document the collection protocols and sampling methodologies associated with the C-400 Complex RI addendum under CERCLA. The boundaries of the investigation are north of the C-400 Complex are presented in figures in Section 5. Various media will be sampled during the course of this investigation, including, but not limited to, subsurface soils, and groundwater. In addition, radiological field scans and field parameters will be collected when appropriate. An additional element of the scope is the selection of preferred analytical methods (radionuclides and VOCs) performing radiological scans and sampling and analysis of subsurface soil and groundwater samples. Additional details on the sampling design and rationale are provided in Section 5.

QAPP Worksheet #18.
Sampling Locations and Methods

Worksheet #18 provides information pertaining to sampling planned for this project.

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Concentration Level[b]	Number of Samples (Field Duplicate Sample 5% Total See Work Sheet #20)[c]	Sampling SOP Reference[d]	Rationale for Sampling Location
TBD	Soil	UCRS	VOCs and Radionuclides	TBD	50 soil (Minimum of 5%)	See Worksheet #21	See Worksheet #17
	Groundwater	RGA	VOCs and Radionuclides	TBD	20 groundwater (Minimum of 5%)	See Worksheet #21	See Worksheet #17

SOP = standard operating procedure
N/A = not applicable
UCRS = Upper Continental Recharge System
RGA = Regional Gravel Aquifer

[a] See Analytical SOP References Table (Worksheet #23).
[b] See Section 2 for historical data.
[c] Potential McNairy Formation groundwater samples not included.
[d] See Field SOP References Table (Worksheet #21).

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

Laboratory: GEL Laboratories, LLC, 2040 Savage Road, Charleston, SC 29407, Valerie Davis, vsd@gel.com, (843) 556-8171

List any required accreditations/certifications (requirement dependent upon analysis performed): DOE Consolidated Audit Program (DOECAP), if applicable.

Back-up Laboratory: N/A

Sample Delivery Method: Direct Delivery or Overnight/Federal Express or UPS (United Parcel Service) in accordance with the on-site transportation plan or U.S. Department of Transportation requirements.

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date[a]	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
VOCs	Soil	See Worksheet #23	6/2025	3 × 5-g Encore Samplers and 2-oz wide mouth glass jar	0–6°C	48 hours (EnCore™ Sampler)	14 days	28 days
Radionuclides (Tc-99)	Soil	See Worksheet #23	6/2025	500 mL wide-mouth plastic straight side	None	N/A	180 days	28 days
VOCs	Water	See Worksheet #23	6/2025	3 × 40 mL glass VOA vial	HCl pH < 2, 0–6°C, no headspace	N/A	14 days for preserved	28 days
Radionuclides (Tc-99)	Water	See Worksheet #23	6/2025	1 L plastic	HNO_3 pH < 2[b]	N/A	180 days	28 days

NOTE: Sample volume and container requirements will be specified by the laboratory. This table includes standard requirements for routine analytical groups.
*See Analytical SOP References table (Worksheet #23).
HCl = hydrochloric acid; HNO_3 = nitric acid
[a] Indicates the next FRNP Approved Suppliers List review date.
[b] Check with specific laboratory conducting analyses to ensure that acidification will not interfere with laboratory procedures.

QAPP Worksheet #20.
Field Quality Control Sample Summary Table

This worksheet provides a summary of the types of samples to be collected and analyzed for the project.

Matrix	Analyte/ Analytical Group	Field Samples*	Field Duplicates*	Matrix Spikes* (MS)	Matrix Spike Duplicates* (MSD)	Field Blanks*	Equipment Blanks*	Trip Blanks*	Other	Total # of Analyses*
Soil	VOCs	50	6	6	6	6	6	1 per day or 1 per cooler containing VOC samples	N/A	80
Soil	Radionuclides	50	6	6	6	6	6	N/A	N/A	80
Groundwater	VOCs	20	1	1	1	1	1	1 per day or 1 per cooler containing VOC samples	N/A	25
Groundwater	Radionuclides	20	1	1	1	1	1	N/A	N/A	25

N/A = not applicable
VOC = volatile organic compound

*Potential McNairy Formation groundwater samples not included.

QAPP Worksheet #21.
Project Sampling SOP References Table

SOPs to be used on this project are summarized below.

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
1	CP3-ES-0043, *Temperature Control for Sample Storage* (9/28/2022)	Contractor	Sampling	N	N/A
2	CP2-WM-0001, *Four Rivers Nuclear Partnership, LLC, Paducah Deactivation and Remediation Project Waste Management Plan* (1/22/2021)	Contractor	N/A	N	N/A
3	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System* (10/5/2022)	Contractor	N/A	N	N/A
4	CP2-ES-0063, *Environmental Monitoring Data Management Implementation Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (7/10/2019)	Contractor	N/A	N	N/A
5	CP4-ES-2100, *Groundwater Level Measurement* (4/17/2023)	Contractor	Sampling	N	N/A
6	CP4-ES-2101, *Groundwater Sampling* (4/19/2023)	Contractor	Sampling	N	N/A
7	CP4-ES-0074, *Monitoring Well Inspection and Maintenance* (4/17/2023)	Contractor	Sampling	N	N/A
8	CP4-ES-2700, *Logbooks and Data Forms* (10/10/2022)	Contractor	N/A	N	N/A
9	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (4/19/2023)	Contractor	Sampling	N	N/A
10	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/11/2023)	Contractor	N/A	N	N/A

QAPP Worksheet #21. (Continued)
Project Sampling SOP References Table

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
11	CP3-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* (10/4/2022)	Contractor	N/A	N	N/A
12	CP3-ES-5003, *Quality Assured Data* (4/26/2023)	Contractor	N/A	N	N/A
13	CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling* (11/22/2022)	Contractor	N/A	N	N/A
14	CP3-OP-0500, *Performance/Process Observations and Tour Process* (5/18/2023)	Contractor	N/A	N	N/A
15	CP3-QA-1003, *Management and Self Assessment* (10/30/2023)	Contractor	N/A	N	N/A
16	CP3-RD-0010, *Records Management Process* (1/18/2024)	Contractor	N/A	N	N/A
17	CP4-ES-2303, *Borehole Logging* (1/7/2021)	Contractor	N/A	N	N/A
18	CP4-ER-1020, *Collection of Soil Samples with Direct Push Technology Sampling* (4/17/2023)	Contractor	N/A	N	N/A
19	CP4-RP-1110, *Radiation Surveys* (1/25/2023)	Contractor	N/A	N	N/A
20	CP4-ES-5007, *Data Management Coordination* (10/25/2022)	Contractor	N/A	N	N/A
21	CP2-ES-5102, *Radiochemical Analysis Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017)	Contractor	N/A	N	N/A
22	CP2-ES-5105, *Volatile and Semivolatile Analyses Data Verification and Validation Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (9/27/2018)	Contractor	N/A	N	N/A
23	CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans* (10/4/2022)	Contractor	N/A	N	N/A
24	CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases* (10/5/2022)	Contractor	N/A	N	N/A

[a] SOPs are posted to the FRNP intranet website. External FFA parties can access this site using remote access with privileges upon approval. It is understood that SOPs are contractor specific.
[b] The work will be conducted by FRNP staff or a subcontractor. In either case, the most current version of the SOPs listed will be followed.

QAPP Worksheet #22.
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

The following is the field equipment to be used on the project.

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
PID	Calibrate at the beginning of the day; check at the end of the day	As needed in the field; annually by the supplier	Measure known concentration of isobutylene 100 ppm (calibration gas)	Upon receipt, successful operation	Calibrate a.m., check p.m.	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Water Quality Meter	Calibrate at the beginning of the day	Performed monthly and as needed	Measure solutions with known values (National Institute for Standards and Technology traceable buffers and conductivity calibration solutions)	Upon receipt, successful operation	Daily before each use	pH: ± 0.1 s.u. Specific Conductivity: ± 3% ORP: ± 10 mV DO: ± 0.3 mg/L Temp: ± 0.3ºC	Return to rental company for replacement and report equipment failure for potential NCR	Field Team Leader	Manufacturer's specifications
Turbidity Meter (Nephthelometer)	Calibrate daily before each use	As needed	Measure solutions with known turbidity standards	Upon receipt, successful operation	Daily before each use	N/A (instrument zeroed)	Manually zero meter or service as necessary and recalibrate	Field Team Leader	Manufacturer's specifications
Electronic Water Level Meter	N/A	None	Check daily before each use	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	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	Return to rental company for replacement and report equipment failure for potential NCR	RCT Supervisor	Manufacturer's specifications
Field Equipment GPS	Daily check of known point beginning and end of each field day	Per manufacturers specifications	Measure known control points and compare values	Upon receipt, successful operation	Beginning and end of each field day	Pass/Fail	Service by manufacturer	Field Team Leader	Manufacturer's specifications

QAPP Worksheet #22. (Continued)
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
MIP Transfer Line and Detectors	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Service by manufacturer	RCT Supervisor	Manufacturer's specifications
MIP Soil Conductivity Tip	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Service by manufacturer	RCT 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 in logbooks consistent with CP4-ES-2700, *Logbooks and Data Forms*.

DO = dissolved oxygen
GPS = Global Positioning System
MIP = membrane interface probe
N/A = not applicable
NCR = nonconformance report
ORP = oxygen-reduction potential
PID = Photoionization Detector
RCT = radiological control technician

QAPP Worksheet #23.
Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analytical Group/Matrix	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
SW846-8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC-MS)	Definitive	VOCs/Soil and Groundwater	Per SOP	GEL Laboratories, LLC	No
Liquid Scintillation	Tc-99 by Liquid Scintillation	Definitive	Radionuclides/Soil and Groundwater	Liquid Scintillation	GEL Laboratories, LLC	No

QAPP Worksheet #24.
Analytical Instrument Calibration Information

Laboratories used by FRNP are participants in DOECAP. In the fall of 2017, DOECAP began providing certification 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 their Quality Assurance (QA) Plan including control charts established for all 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
See Worksheet #23	Calibration is in accordance with the laboratory QA Plan.						

*The laboratory is responsible for maintaining instrument calibration information per their QA Plan, including control charts established for instrumentation. This information is audited. This information is audited annually. Additional certifications may be needed based on project-specific requirements (e.g., National Environmental Laboratory Accreditation Program). Field survey/sampling instrumentation will be calibrated according to manufacturer's instructions.

QAPP Worksheet #25.
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

The contracted laboratory(s) is a participant in DOECAP. As such, laboratory instrument and equipment maintenance, testing, and inspection are conducted under a certified quality system as documented in the laboratory's quality manual (however named).

QAPP Worksheet #25.
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (Continued)

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
GC-MS	Replace/clean ion source; clean injector, replace injector liner, replace/clip capillary column, flush/replace tubing on purge and trap; replace trap	QC standards	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	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. Laboratory(s) contracted will participate in DOECAP, with the exception of the laboratory used to support acute and chronic toxicity analysis in support of the Kentucky Pollutant Discharge Elimination System (KPDES) permit. This laboratory is a KPDES Wastewater Laboratory certified by the Commonwealth of Kentucky and provides the required information to FRNP to be included on the approved suppliers list. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

GC-MS = gas chromatography-mass spectrometer
QC = quality control

QAPP Worksheets #26 and #27.
Sample Handling, Custody, and Disposal

Sampling Organization: GEO Consultants, LLC

Laboratory: GEL Laboratories, LLC

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-2708, *Chain-of-Custody Forms, Field Sample Logs, 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-2708, *Chain-of-Custody Forms, Field Sample Logs, 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-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Shipping coordination	SMO/DOE Prime Contractor	CP3-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals*; and CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling*
Sample receipt, inspection, & log-in	Sample Management/Contracted Laboratory	Contracted Laboratory SOP
Sample custody and storage	Sample Management/Contracted Laboratory	Contracted Laboratory SOP
Sample disposal	Sample Management/Contracted Laboratory	Contracted Laboratory SOP

QAPP Worksheet #28-A.
QC Samples Table (Soil)

Matrix: Soil
Analytical Group/Concentration Level: VOC and Radionuclides (Tc-99)
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: GEO Consultants
Analytical Organization: GEL Laboratories, LLC
No. of Sample Locations: 10

QC Sample	Frequency/Number[a]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze	Laboratory should alert project	Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL[b]	Verify results; reanalyze		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples (MS and/or MSD)	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks (LCS)	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

QAPP Worksheet #28-A. (Continued)
QC Samples Table (Sediment)

QC Sample	Frequency/Number[a]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate Standards	All samples, blanks, and QA (or QC) samples	See data validation plans CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All sample blanks and QA samples	See data validation plans CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	See data validation plans CP2-ES-5102 and 5105	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 and 5105	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*
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 procedure CP3-ES-5003, *Quality Assured Data*

[a] The number of QC samples is listed on Worksheet #20.
[b] Unless dictated by project-specific parameters, ≤ CRQL.

QAPP Worksheet #28-B.
QC Samples Table (Aqueous)

Matrix: Groundwater
Analytical Group/Concentration Level: VOCs and Radionuclides (Tc-99)
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: See Worksheet #23
Sampler's Name/Field Sampling Organization: GEO Consultants
Analytical Organization: GEL Laboratories, LLC
No. of Sample Locations: 10

QC Sample	Frequency/Number[a]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze	Laboratory should alert project	Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Trip blank	1 per cooler containing VOC samples	≤ CRQL[b]	Verify results; reanalyze		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL[b]	Verify results; reanalyze		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples (MS and/or MSD)	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks [laboratory control sample (LCS)]	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

QAPP Worksheet #28-B. (Continued)
QC Samples Table (Aqueous)

QC Sample	Frequency/Number[a]	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blank	1 per analytical batch	See data validation plans CP2-ES-5102 and 5105	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate standards	All samples, blanks, and QA (or QC) samples	See data validation plans CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All samples and standards	See data validation plans CP2-ES-5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	See data validation plans CP2-ES-5102 and 5105	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 and 5105	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*
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 procedure CP3-ES-5003, *Quality Assured Data*

[a] The number of QC samples is listed on Worksheet #20.
[b] Unless dictated by project-specific parameters, ≤ contract-required quantitation limit (CRQL).

QAPP Worksheet #29.
Project Documents and Records Table

This worksheet describes how information will be collected, verified, and stored. Its purpose is to support data completeness, data integrity, and ease of retrieval.

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Field Logbook or Data Sheets	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	Project Manager	Project Director	Project File
Corrective Action Reports	Project Manager	Project Director	Project File
Correspondence	Project Manager	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	Data Validator	SMO	Project File

Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Level IV Laboratory Reports	Laboratory Staff	Laboratory Project Manager	Project File
Electronic Data Deliverables	Laboratory Staff	Laboratory Project Manager	Project File

QAPP Worksheets #31, #32, and #33.
Assessments and Corrective Action

This worksheet is used to document responsibilities for conducting project assessments, responding to assessment findings and implementing corrective action. Appropriately scheduled assessments (e.g., field sampling technical systems audits at the beginning of sampling) allow management to implement corrective action in a timely manner, thereby correcting nonconformances and minimizing their impact on DQOs/project quality objectives. Assessment checklists should be included in the QAPP or referenced.

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Date	Assessment Deliverable	Deliverable Due Date
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Report	Per Individual Laboratory QA Manual

QAPP Worksheets #31, #32, and #33. (Continued)
Assessments and Corrective Action

Assessment Response and Corrective Action:

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
Off-site Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Internal Audit Report Deficiency Memorandum	7 days following receipt of proficiency testing deficiency report and before analysis field samples	Laboratory Technical Director	DOECAP-Accreditation Program

QAPP Worksheet #34.
Data Verification and Validation Inputs

This worksheet is used to list the inputs that will be used during data verification and validation. Data verification is a check that specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs, and the QAPP. Records subject to verification and validation are listed below.

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Planning Documents/Records			
1	Approved QAPP	X	X
2	Contract	X	X
3	Field SOPs	X	X
4	Laboratory SOPs	X	X
Field Records			
5	Field Logbooks and/or 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	Drilling logs	X	X
10	Geophysics reports	X	X
11	Relevant correspondence	X	X
12	Change orders/deviations	X	X
13	Field audit reports	X	X
14	Field corrective action reports	X	X

QAPP Worksheet #34. (Continued)
Data Verification and Validation Inputs

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	X	X
16	Case narrative	X	X
17	Internal laboratory chain-of-custody	X	X
18	Sample receipt records	X	X
19	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
20	Communication records	X	X
21	Project-specific proficiency testing sample results	X	X
22	Limit of detection/limit of quantification establishment and verification	X	X
23	Standards Traceability	X	X
24	Instrument calibration records	X	X
25	Definition of laboratory qualifiers	X	X
26	Results reporting forms	X	X
27	QC sample results	X	X
28	Corrective action reports	X	X
29	Raw data	X	X
30	Electronic data deliverable	X	X

QAPP Worksheet #35.
Data Verification Procedures

This worksheet documents procedures that will be used to verify project data. Data verification is a completeness check to confirm that required activities were conducted, specified records are present, and the contents of the records are complete.

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Field logbook and/or 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—Performs daily review SMO and Data Reviewer/FRNP—Performs review as part of data verification and data assessment
Chain-of-custody forms	QAPP, Field SOPs	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook/data form. Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	Field Team Leader/FRNP—Performs daily review SMO and Data Reviewer/FRNP—Performs review as part of data verification and data assessment Data Validator/A2RGC, LLC—Performs review as part of data validation

QAPP Worksheet #35. (Continued)
Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Laboratory deliverables	QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the COCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Laboratory PM/Contract Laboratory—Performs review before data is released SMO and Data Reviewer/FRNP—Performs review part of data verification and data assessment Data Validator/A2RGC, LLC—Performs review as part of data validation
Audit reports, corrective action reports	QAPP	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

QAPP Worksheet #36.
Data Validation Procedures

This worksheet documents procedures that will be used to validate project data. Data validation is an analyte and sample-specific process for evaluating compliance with contract requirements, methods/SOPs, and MPC. The scope of data validation needs to be defined during project planning because it affects the type and level of documentation required for both field and laboratory activities. If data validation procedures are contained in an SOP or other document, the procedures should be referenced in this table and included as an attachment to the QAPP.

Data Validator: A2RGC, LLC

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator* (Title and Organizational Affiliation)
Step IIa/IIb	Soil and Groundwater	All	All	National Functional Guidelines; Worksheets #12, #15, and #28; CP2-ES-5102 and CP2-ES-5105	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.

QAPP Worksheet #37. Data Usability Assessment

The purpose of the project is to obtain subsurface soil and groundwater samples from select areas northwest of the C-400 Complex. The samples collected then will be analyzed for potential contamination. Ten boring locations were selected by the FFA parties from which analytical samples will be collected. The data will be utilized to the extent needed to support characterization of affected soil and groundwater in the area northwest of the C-400 Complex.

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 work plan.

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Project Director: Bruce Ford
Project QA Manager: Jennie Freels
C-400 Complex RI/FS PM: Bruce Ford, Acting
Data Reviewer: TBD
Data Validator: A2RGC, LLC
Sample Management Office: Jaime Morrow
Field Team Leader: Shay Mitchell

Describe how the usability assessment will be documented:

Data usability will be documented through validation reports as well as through the data assessment review checklist and comment form included in the data assessment packages. Data assessment packages will be created, which will include data assessment comments/questions and laboratory comments. Data verification and assessment queries indicating any historical outliers will be included in the data assessment packages.

FRNP shall 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 the QAPP.

Field and 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 field and 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-5105.

PARCCS parameters (precision, accuracy, representativeness, comparability, completeness, and sensitivity) 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.