Department of Energy

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APR 30 2018

Mr. Brian Begley
Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
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PPPO-02-4725841-18A

Ms. Julie Corkran
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Ms. Corkran:

TRANSMITTAL OF THE 2018 UPDATE OF THE PADUCAH GASEOUS DIFFUSION PLANT PROGRAMMATIC QUALITY ASSURANCE PROJECT PLAN (DOE/LX/07-2421&D1)

Please find enclosed the 2018 update of the *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan,* DOE/LX/07-2421&D1 (P-QAPP). The Generic Quality Assurance Project Plan (G-QAPP) has not been updated and is not included in this submittal.

The P-QAPP is a Secondary Document that has been prepared and updated in accordance with the approach discussed in a conference call on October 12, 2017, with Federal Facility Agreement (FFA) parties who are members of the P-QAPP Work Group (includes U.S. Department of Energy, U.S. Environmental Protection Agency, and Kentucky Department for Environmental Protection personnel) concerning the fiscal year 2018 Update to the Programmatic Quality Assurance Project Plan. As a Secondary Document, the FFA parties have 90 days to review and comment on the enclosed documents.

The P-QAPP was written to address elements of data collection that do not change from project-to-project and to collect these elements into a template to be used to prepare project-specific QAPPs.

If you have any questions or require additional information, please contact me at (270) 441-6862.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosure:
PGDP Programmatic Quality Assurance Project Plan, DOE/LX/07-2421&D1

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DOE/LX/07-2421&D1
Secondary Document

Paducah Gaseous Diffusion Plant
Programmatic Quality Assurance
Project Plan

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DOE/LX/07-2421&D1
Secondary Document

Paducah Gaseous Diffusion Plant
Programmatic Quality Assurance
Project Plan

Date Issued—April 2018

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Four Rivers Nuclear Partnership, LLC
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-EM0004895

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CONTENTS

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LIST OF QAPP WORKSHEETS

ACRONYMS

A	analytical
AA	atomic absorption
ACGIH	American Conference for Governmental Industrial Hygienists
BGOU	Burial Grounds Operable Unit
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical (or radionuclide) of potential concern
CSM	conceptual site model
CVAA	cold vapor atomic absorption
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DQI	Data Quality Indicator
DQO	data quality objective
ECD	electron capture detector
EDD	Electronic Data Deliverable
ELCR	excess lifetime cancer risk
ESP	Environmental Services Project
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FID	flame ionization detector
FIDLER	field instrument for detection of low energy radiation
FRNP	Four Rivers Nuclear Partnership, LLC
FSP	field sampling plan
GC	gas chromatography
GC-MS	gas chromatography/mass spectrometry
GPS	Global Positioning System
HI	hazard index
HSS&Q	Health, Safety, Support, and Quality
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICP-MS	inductively coupled plasma mass spectrometry
IDQTF	Intergovernmental Data Quality Task Force
KDEP	Kentucky Department for Environmental Protection
KDWM	Kentucky Division of Waste Management
LATA	Los Alamos Technical Associates, Incorporated
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
LSRS	LATA-Sharp Remediation Services, LLC
MCL	maximum contaminant level
MDA	minimum detectable activity
MDL	method detection limit
MPC	measurement performance criteria
MS	matrix spike
MW	monitoring well
N/A	not applicable
NAL	no action level for child resident from the Risk Methods Document
NDIRD	nondispersive infrared detector
OREIS	Oak Ridge Environmental Information System

OSWER	EPA Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon, polynuclear aromatic hydrocarbon
PAL	project action limit
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCB	polychlorinated biphenyl
PEGASIS	Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
P-QAPP	Programmatic Quality Assurance Project Plan
PM	project manager
PQL	practical quantitation limit
PQO	project quality objective
PT	proficiency testing
QA	quality assurance
QC	quality control
RAD	radionuclide
RADCON	radiation control
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RGA	Regional Gravel Aquifer
RI	remedial investigation
RMD	2018 Risk Methods Document
RPD	relative percent difference
S	sampling
S&A	sampling and analytical
SAP	sampling and analysis plan
SOP	standard operating procedure
SPP	systematic planning process
SVOA	semivolatile organic analyte
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TBD	to be determined
TOC	total organic carbon
TPD	training position description
TSA	technical systems audit
UCRS	Upper Continental Recharge System
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
VISL	Vapor Intrusion Screening Level
VOA	volatile organic analyte
VOC	volatile organic compound
XRF	X-ray fluorescence

1. INTRODUCTION

This update to the Programmatic Quality Assurance Project Plan (P-QAPP) has been prepared by Four Rivers Nuclear Partnership, LLC, (FRNP) based on the most recent programmatic Quality Assurance Project Plan (QAPP), *Programmatic Quality Assurance Project Plan* (DOE 2017a), which was developed to align with the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP Manual) guidelines for QAPPs (IDQTF 2005, as updated by the *Optimized UFP-QAPP Worksheets* guidance (IDQTF 2012). (NOTE: As in the optimized guidance, the original worksheet numbers are retained, but combined per the guidance.) Because the initial P-QAPP was developed with 37 worksheets and later migrated to the optimized format, additional information from the initial worksheets has been retained such that the updated P-QAPP contains more detail than called for in the Optimized UFP-QAPP guidance. Table 1 in Worksheet #1 provides a crosswalk between the UFP-QAPP and the *U.S. Environmental Protection Agency Guidance on Quality Assurance Project Plans* (EPA 2012).

The UFP-QAPP is a consensus quality systems document prepared by the Intergovernmental Data Quality Task Force (IDQTF), a working group made up of representatives from the U.S. Environmental Protection Agency (EPA), the U.S. Department of Defense (DoD), and the U.S. Department of Energy (DOE). Originally issued in 2005, the UFP-QAPP was developed to provide procedures and guidance for consistently implementing the national consensus standard: American National Standards Institute/American Society of Quality E-4, *Quality Systems for Environmental Data and Technology Programs*, for the collection and use of environmental data at federal facilities.

DOE quality requirements are defined in DOE Orders and, as a result, DOE (both on a national and site-specific level) does not accept the UFP-QAPP Manual and is not one of its signatories. DOE has, however, agreed to adopt the UFP-QAPP format (e.g., use of worksheets) and to incorporate, as appropriate, its quality requirements for Paducah projects through a P-QAPP.

This revised P-QAPP provides a template for development of future project-specific QAPPs. In migrating to the optimized worksheet format, additional information has been added to some of the worksheets to streamline the use of this P-QAPP in the preparation of project-specific QAPPs. As noted in the guidance (IDQTF 2012), this P-QAPP captures some of the elements that would comprise related project-planning documents, such as a sampling and analysis plan (SAP), work plan, and field sampling plan (FSP). The example worksheets provided in the P-QAPP were developed from previously developed and approved project-specific QAPPs or from the Optimized UFP-QAPP Worksheets guidance (IDQTF 2012).

The Paducah Gaseous Diffusion Plant (PGDP) site employs a range of sampling activities. The goal of this P-QAPP is to streamline the systematic planning process and provide uniformity of data collection and laboratory services by using this P-QAPP as a template in the development of project-specific QAPPs. Data collection activities often are focused on measuring concentrations of a chemical (or radionuclide) of potential concern (COPC). A COPC may be of concern for either potential human-health or ecological impacts.

This P-QAPP captures elements of data collection that do not materially change from project to project [e.g., the requirement to use current standard operating procedures (SOPs), target action levels, the analytical methods, the use of data validation]. In addition, it presents examples that allow the P-QAPP to be used as a template to develop a project-specific QAPP to include project-specific information [e.g., data quality objectives (DQOs), schedules, numbers, and types of samples].

To provide uniformity, this P-QAPP does the following:

- Refers to the SOPs already developed for the site;
- Provides routinely available analytical limits, in part, to support an evaluation of the suitability of these limits to meet DQOs as part of the development of the project-specific QAPP;
- Incorporates the *Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities*, DOE/OR/07-1595&D2 (DOE 1998); and
    - Standardizes data validation processes by linking the process to SOPs (see Worksheet #21).

Additional information is provided in the P-QAPP's four appendices:

(1) Appendix A, "Comparison of the Method Detection Limits for Water and Soil to the Project Action Limits Developed Using 2018 Child Resident No Further Action, Background, and Maximum Contaminant Level Concentrations";

[Note: Child resident no action levels (NALs), background values, and maximum contaminant level concentrations are taken from the *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/R9/V1 (DOE 2018). Maximum contaminant levels apply to water samples only.]

(2) Appendix B, "The Role of Independent Third Party Data Validation in Meeting Data Quality Objectives at Paducah Gaseous Diffusion Plant";

(3) Appendix C, "Discussion of the Quality Assurance Criteria To Be Applied to Field Analytical Methods"; and

(4) Appendix D, "Conceptual Site Model."

This document is not a substitute for the development of project-specific QAPPs, FSPs, the decisions on DQOs, type of analyses, number of samples, type of samples, project schedule, etc., and should not be used to support performance of individual projects. The systematic planning decisions for a given project will be included in the project-specific FSPs and QAPPs.

This P-QAPP focuses on providing worksheets describing fixed-base laboratory methods. However, selected field methods [e.g., X-ray fluorescence (XRF), colorimetric methods for polychlorinated biphenyls (PCBs), radionuclide surveys] that may be useful for specific projects are included. Information provided in this P-QAPP shall be reviewed and confirmed as appropriate as part of the development of the project-specific QAPP.

It is emphasized that the final, approved, project-specific QAPP is designed to be a stand-alone document containing the specifications and procedures necessary for project personnel to carry out their assigned responsibilities. For example, the field team should be able to rely on the project-specific QAPP (including the associated FSP and referenced procedures) for sampling instructions, including how to sample, where to sample, how many samples to collect, the types of bottles, preservatives, and related quality control (QC), etc. The approved project-specific QAPP shall list procedures to carry out tasks, including making available SOPs that provide this information. If required elements are contained in other documents, those documents may be referenced; however, the documents must be available to personnel responsible for reviewing and implementing the project-specific QAPP.

2. GUIDE TO PREPARING A PROJECT-SPECIFIC QAPP

This P-QAPP shall be used as a template to prepare a project-specific QAPP. Although used as a template in preparing the project-specific QAPP, the information presented as examples in the P-QAPP shall be reviewed and confirmed during the preparation of the project-specific QAPP. In alignment with the optimized UFP-QAPP worksheet guidance, each worksheet of the P-QAPP includes text (typically presented in green) that provides instruction on how to fill out each worksheet. Typically, the green text will be deleted in the project-specific QAPP. Black text is used for the worksheet template and examples. Because this P-QAPP is to be used as a template, the worksheets generally are presented as they will be filled out for a project-specific QAPP.

This document is presented with current position holders and roles. Some worksheets include names of current position holders. If the person filling a position changes, the approved QAPP need not be updated; rather, the change can be noted as part of routine communication. To the extent the next project-specific QAPP document has names, these will be updated/confirmed at the time of document generation. One alternative for tracking persons working on a project is to collect changes to the approved project-specific QAPP and provide the update in an attachment to the project-specific QAPP, potentially including a crosswalk of position titles to names with dates each person filled the position. The changes applied to a project-specific QAPP will be tracked and may be incorporated into the P-QAPP at its next review if the changes have programmatic implications.

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QAPP Worksheets #1 and #2. Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

This worksheet identifies the principal points of contact for organizations having decision authority in the project and documents their commitment to implement the QAPP. Signatories usually include the lead organization's project manager, quality assurance (QA) manager, and individuals with approval or oversight authority from each regulatory agency. Signatures indicate that officials have reviewed the QAPP and concur with its implementation as written. **If separate concurrence letters are issued (as is typical at PGDP), the original correspondence should be maintained with the final, approved, project-specific QAPP in the project file.** It is the lead organization's responsibility to make sure signatures are in place before work begins.

QAPP Worksheets #1 and #2. Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

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

Site Name/Project Name: Paducah Gaseous Diffusion Plant (PGDP)/*Project Name (to be added)*
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 Paducah Deactivation and Remediation Project
Work Assignment Number: *(to be added)*

Document Title: *Quality Assurance Project Plan for (project name)*

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

Preparer's Name and Organizational Affiliation: Chris Pracheil, Geosyntec Consultants, Inc.

Preparer's Address, Telephone Number, and E-mail Address: 180A Market Place Boulevard, Knoxville, TN 37922, cpracheil@geosyntec.com

Preparation Date (Month/Year): 4/2018

Document Control Number: DOE/LX/07-2421&D1

FRNP Waste, Materials, and Environmental Services Project Director	_____ Signature James Miller	Date:_____
FRNP Characterization Manager	_____ Signature Pamela Baird	Date:_____
FRNP Environmental Monitoring and Sample Management Office Project Manager	_____ Signature Lisa Crabtree	Date:_____
FRNP Quality Assurance Manager	_____ Signature Glenn Barberi	Date:_____

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

List guidance, plans, and reports from previous investigations relevant to this project.

1. Identify guidance used to prepare QAPP:

   - Intergovernmental Data Quality Task Force, March 2005. The *Uniform Federal Policy for Implementing Environmental Quality Systems*, Version 2.0.
   - Intergovernmental Data Quality Task Force, March 2005. The *Uniform Federal Policy for Quality Assurance Project Plans: Part 1 UFP QAPP Manual*, Version 1.0 (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 Worksheets*, Version 1.0.
   - 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.
   - Intergovernmental Data Quality Task Force, March 2012. *Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP QAPP Worksheets*.
   - *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume* 1. *Human Health* (DOE 2018).

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

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

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

5. List dates of scoping sessions that were held: Initial scoping sessions for programmatic QAPP held December 2010 and January 2011

   Initial scoping sessions for project-specific QAPP held **[add dates here]**

Guidance, plans, and reports from previous investigations relevant to an individual project to be added under the appropriate headers above.

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

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

Title:	**Approval Date(s):**
Data and Documents Management and Quality Assurance Plan for Paducah Environmental Management and Enrichment Facilities, DOE/OR/07-1595&D2 (DOE 1998)	10/5/1998
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-1269&D2/R1	5/14/2013 5/20/2013
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-1269&D21R2 (P–QAPP)	Not Applicable (N/A)
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2409&D1 (P–QAPP)	N/A

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

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

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

   If any of the elements and/or information is not applicable to the project, then indicate the omitted QAPP elements/information on Table 1.

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

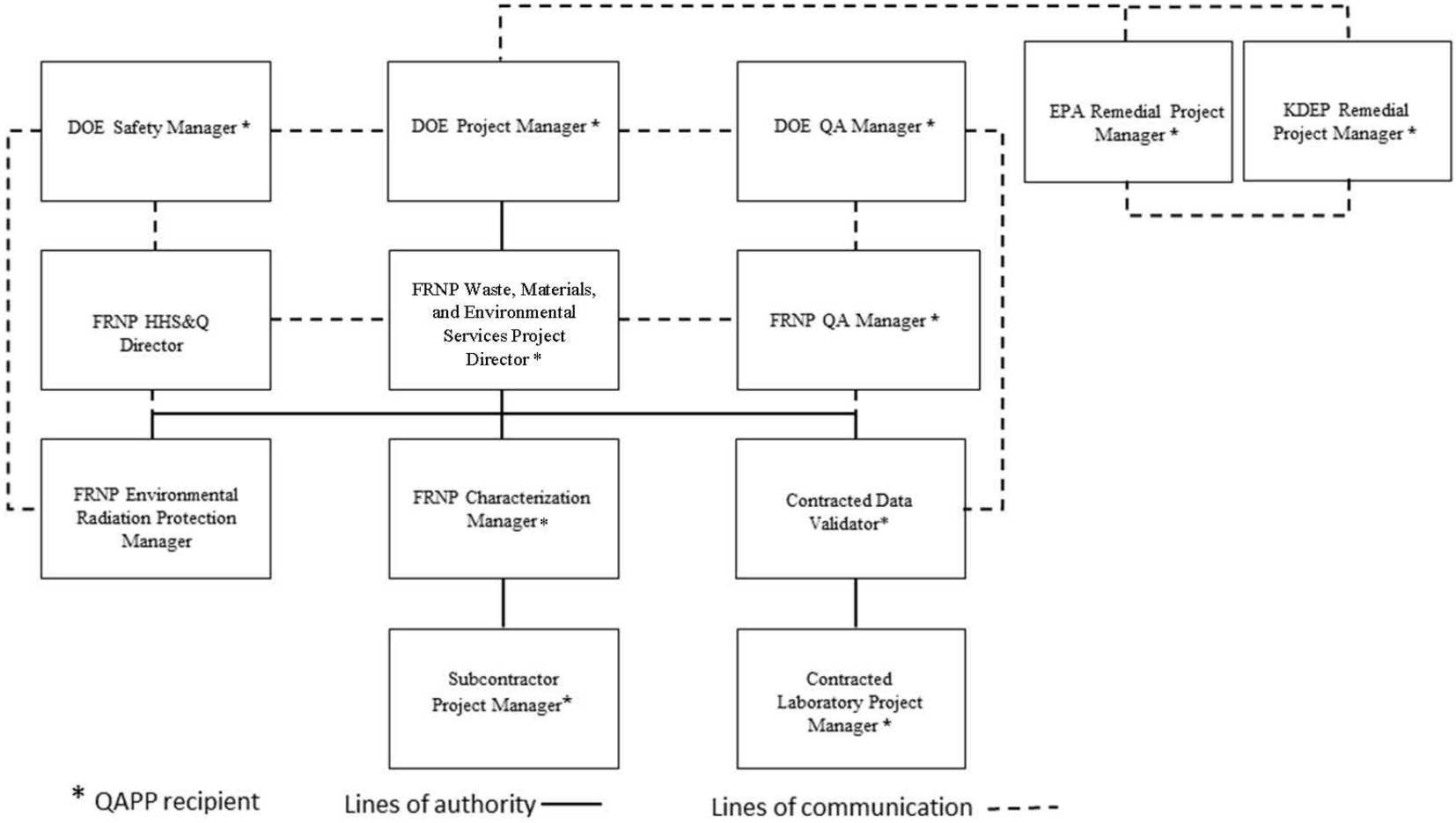
Optimized UFP-QAPP Worksheets		CIO 2106-G-05 QAPP Guidance Section	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, & 8	Personnel Qualifications and Sign-off 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	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	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	Assessment 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
(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)

This worksheet identifies key project personnel, as well as lines of authority and lines of communication among the lead agency, prime contractor, subcontractors, and regulatory agencies. An example is provided below. For the purpose of the draft QAPP, it is permissible to show "TBD" (to be determined) in cases where roles have not been assigned; however, key personnel must be identified in the final, approved QAPP.

For the purpose of document control, this worksheet also is used to document recipients of controlled copies of the QAPP (See Minimum Distribution List below). The draft QAPP, final QAPP, and any changes/revisions must be provided to QAPP recipients shown on that chart. Contractors and subcontractors shown on these charts and lists are responsible for document control within their organizations.

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



QAPP Worksheets #3 and #5. Project Organization and QAPP Distribution
(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)

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

QAPP Worksheet #3. Minimum Distribution List

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. This change will not require a review by FFA stakeholders because it is not a substantive change. 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 project-specific QAPP derived from this programmatic 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 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	Jennifer Woodard	(270) 441-6820	jennifer.woodard@lex.doe.gov	1
FFA Manager	DOE	Tracey Duncan	(270) 441-6862	tracey.duncan@lex.doe.gov	2
Project Manager (PM)	DOE	David Dollins	(270) 441-6819	dave.dollins@lex.doe.gov	3
Waste, Materials, and Environmental Services Project (ESP) Director	FRNP	James Miller	(270) 441-5113	james.miller@pad.pppo.gov	4
Characterization Manager	FRNP	Pamela Baird	(270) 441-5634	pamela.baird@pad.pppo.gov	5
FFA Manager	KDEP	Brian Begley	(502) 564-6716	brian.begley@ky.gov	6
PM	KDEP	Gaye Brewer	(270) 898-8468	gaye.brewer@ky.gov	7
FFA Manager	EPA	Julie Corkran	(404) 562-8547	corkran.julie@epa.gov	8
PM	EPA	Jon Richards	(404) 562-8648	richards.jon@epa.gov	9
Environmental Radiation Protection Manager	FRNP	LeAnne Garner	(270) 441-5136	leanne.garner@pad.pppo.gov	10
FFA Manager	FRNP	Jana White	(270) 441-5185	jana.white@pad.pppo.gov	11
Quality Assurance Manager	FRNP	Glenn Barberi	(270) 441-5741	glenn.barberi@pad.pppo.gov	12
Environmental Monitoring and Sample Management Office PM	FRNP	Lisa Crabtree	(270) 441-5135	lisa.crabtree@pad.pppo.gov	13

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

QAPP Worksheet #3. Minimum Distribution List (Continued)

Position Title	Organization	QAPP Recipients	Current Telephone Number	Current E-mail Address	Document Control Number
Health, Safety, Support, and Quality (HSS&Q) Director	FRNP	Roland Chretien	(270) 441-6238	roland.chretien@pad.pppo.gov	14
Sample Management Office	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	15

QAPP Worksheets #4, #7, and #8. Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2–2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

This worksheet is used to identify key project personnel for each organization performing tasks defined in this QAPP. In this example, organizations include the prime contractor and laboratory. Add spaces for additional organizations and personnel as needed. This worksheet lists individual's project titles or roles; qualifications; and any specialized/nonroutine training, certifications, or clearances required by the project (e.g., explosives and ordnance disposal technician, professional engineer, certified professional geologist).

ORGANIZATION: Four Rivers Nuclear Partnership, LLC

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
James Miller	Waste, Materials, and ESP Director, FRNP	> 4 years relevant work experience	No specialized training or certification. See Training Project Description (TPD).	
Pamela Baird	Characterization Manager, FRNP	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Lisa Crabtree	Environmental Monitoring and Sample Management Office PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jaime Morrow	Sample Management Office	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Sam Martin	Sample Team Leader	> 4 years relevant work experience	No specialized training or certification. See TPD.	

ORGANIZATION: Laboratory

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date*
Laboratory Project Manager	Analytical Laboratory Project Manager	> 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
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

This worksheet should be used to document specific issues (communication drivers) that will trigger the need to communicate with other project personnel or stakeholders. Its purpose is to ensure that there are procedures in place for providing the appropriate notifications and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, unexpected events, emergencies, nonconformances, and stop work orders. Examples are provided below; additional drivers may be added as needed.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	DOE, EPA, KDEP	DOE Site Lead: Jennifer Woodard, EPA Remedial Project Manager: Jon Richards, KDEP PM: Gaye Brewer	jennifer.woodard@lex.doe.gov richards.jon@epa.gov gaye.brewer@ky.gov	Formal communication among DOE, EPA, and KDEP.
Field progress reports	FRNP	FRNP Waste Materials, and ESP Director: James Miller	james.miller@pad.pppo.gov	Formal communication among the project staff, the site lead, and the DOE PM.
Stop work due to safety issues	FRNP	FRNP Waste, Materials, and ESP Director: James Miller and FRNP HSS&Q: Roland Chretien	james.miller@pad.pppo.gov roland.chretien@pad.pppo.gov	The FRNP will communicate work stoppages to DOE PM within 24 hours.
QAPP changes during project execution	FRNP	FRNP Waste, Materials, and ESP Director: James Miller and FRNP QA Manager: Glen Barberi	james.miller@pad.pppo.gov glenn.barberi@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE and EPA within 10 working days of receiving approval.

QAPP Worksheet #6. Communication Pathways (Continued)
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Field corrective actions	FRNP	FRNP Waste, Materials, and ESP Director: James Miller	james.miller@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE and EPA PMs.
Analytical laboratory interface	FRNP	FRNP Environmental Monitoring and Sample Management Office PM: Lisa Crabtree	lisa.crabtree@pad.pppo.gov	Communication between FRNP and analytical laboratory.
Laboratory quality control variances	Contracted Laboratory	Laboratory PM	TBD pamela.baird pad.pppo.gov	Notify FRNP Sample Management Office, Characterization Manager, and Waste, Materials, and ESP director to determine corrective actions.
Analytical corrective actions	Contracted Laboratory, FRNP	Laboratory PM, FRNP Waste, Materials, and ESP, Director: James Miller	TBD james.miller@pad.pppo.gov	Notify FRNP Sample Management Office, Characterization Manager, and Waste, Matrials, and ESP director. FRNP Waste, Materials, and ESP Director will notify EPA and DOE.
Data verification issues (e.g., incomplete records)	Wastren Advantage, Inc., FRNP	Data Validator, FRNP Waste, Materials, and ESP Director: James Miller	TBD james.miller@pad.pppo.gov	Data verification issues will be reported to laboratory PM, Characterization Manager, and FRNP Sample Management Office within 24 hours of discovery.
Data validation issues (e.g. noncompliance with procedures)	Wastren Advantage, Inc., FRNP	Data Validator, FRNP Waste, Materials, and ESP Director: James Miller	TBD james.miller@pad.pppo.gov	Problems with data quality will be reported to the Laboratory PM, Characterization Manager, and the FRNP QA Sample Management Office within 24 hours of discovery.

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 #6. Communication Pathways (Continued)
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

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 Work Plan/QAPP will be communicated upward through the chain of command to regulatory agencies using communication tools commensurate with the issue.

QAPP Worksheet #9. Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

Project Scoping Session Participant Sheet

A copy of this worksheet should be completed for each project planning session, whether sessions are internal (project teams only) or external (includes regulators and/or stakeholders). It is used to provide a concise record of participants, key decisions or agreements reached, and action items. Depending on the stage of planning, project-planning sessions should involve key technical personnel, as needed. Scoping sessions can be by phone, Web conferencing, and/or face-to-face meeting, depending upon logistical considerations. Previous meeting minutes can be included as attachments, if necessary, and referenced. Users may find it helpful to have copies of worksheets on hand for planning sessions, in whatever state of completion they may be; however, Worksheets 10, 11, 15, and 17 should be prioritized in the early stages of project planning. The following template may be modified to suit both the project and the specific planning session.

Project-specific QAPPs developed in association with FSPs will follow the same systematic planning process. The type and frequency of scoping sessions and the type and number of persons who participate in scoping sessions are related to the size and complexity of the project, technical components of the project, and the number of organizations involved. For example, small projects may use project teams that consist of only two or three people who convene via teleconference. A typical scoping component is a kick-off meeting to establish and define the roles and responsibilities of each team member, set out performance requirements for response times and project execution, and build a project team. QAPP Worksheet #9 will be completed for project-specific QAPPs. Example Worksheet #9 entries are provided below from the PGDP Solid Waste Management Unit (SWMU) 4 sampling.

QAPP Worksheet #9. Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

QAPP Worksheet #9. Project Scoping Session Participant Sheet

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 example worksheet below was completed as part of the scoping of a project.

Two scoping meetings were held concerning the SWMU 4 Sampling Project prior to developing the SAP and QAPP. The following tables include details about these meetings. A properly-prepared Worksheet #9 should include key decisions or agreements reached and action items. Scoping also may address potential relevant-to-the-project issues (e.g., geology, climate, population distributions, endangered species, etc.).

Name of Project: SWMU 4 Sampling
Date of Session: December 9, 2010
Scoping Session Purpose: DOE contractor internal scoping held to identify physical, hazard, and security constraints at SWMU 4 that might impact data collection.

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	LATA Kentucky	John Samples	270-441-5080	john.samples@lataky.com	PM
BGOU Manager	LATA Kentucky	Jim Erickson	270-441-5083	jim.erickson@lataky.com	Program management
Engineering Manager	LATA Kentucky	Randy Scott	270-441-5162	randy.scott@lataky.com	Engineering support
Sample/Data Management Manager	LATA Kentucky	Lisa Crabtree	270-441-5315	lisa.crabtree@lataky.com	Laboratory requirements
Risk Manager	LATA Kentucky	Joe Towarnicky	270-441-5134	joe.towarnicky@lataky.com	Technical support
QA specialist	LATA Kentucky	Ryan Nall	270-331-0852	ryan.nall@lataky.com	QA
Waste Engineer	LATA Kentucky	Robert Owens	270-441-5356	robert.owens@lataky.com	Waste disposition
Radiation Control (RADCON) Supervisor	LATA Kentucky	Matt Morin	270-441-5330	matt.morin@lataky.com	RADCON
RADCON Tech	LATA Kentucky	Jim Mullins	240-441-5395	jim.mullins@lataky.com	RADCON
Security	SST Security	Chuck Moreland	270-441-5078	chuck.moreland@swiftstaley.com	Physical security
Engineer	GEO Consultants	Chris Marshall	270-462-3882	chris.marshall@lataky.com	Estimator

QAPP Worksheet #9. Project Scoping Session Participant Sheet (Continued)

Name of Project: SWMU 4 Sampling
Date of Session: December 9, 2010
Scoping Session Purpose: Kickoff meeting

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Health and Safety	LATA Kentucky	Mark Mitchell	270-519-2292	mark.mitchell@lataky.com	Safety rep
Industrial Hygiene	LATA Kentucky	J. Scott McIntyre	270-441-5789	scott.mcintyre@lataky.com	IH
Security	SST Security	Charlie Cobb	270-441-5248	charlie.cobb@swiftstaley.com	Physical security
Facility Manager	LATA Kentucky	Eddie Windhorst	270-441-5170	edward.windhorst@lataky.com	Facility manager
Nuclear Safety	LATA Kentucky	John Justice	270-441-5207	john.justice@lataky.com	Nuclear safety

Notes/comments:

Consensus decisions made:

Action items:

Action	Responsible Party	Due Date

QAPP Worksheet #9. Project Scoping Session Participant Sheet (Continued)

Name of Project: SWMU 4 Sampling
Date of Session: January 18–19, 2011
Scoping Session Purpose: Reach agreement on the objectives of data collection with FFA managers

Name	Organization	Phone	E-mail
Ballard, Turpin	EPA	404-562-8553	ballard.turpin@epa.gov
Bonczek, Richard	DOE	859-219-4051	rich.bonczek@lex.doe.gov
Brewer, Gaye	Kentucky Division of Waste Management (KDWM)	270-898-8468	gaye.brewer@ky.gov
Brock, Stephanie	KY RHB	502-564-8390	stephaniec.brock@ky.gov
Burright, Jeff	Sapere Consulting	541-368-5390	jburright@sapereconsulting.com
Dawson, Jana	TechLaw	703-818-3254	jdawson@techlawinc.com
Duncan, Tracey	PRC	270-441-6803	tracey.duncan@lex.doe.gov
Erickson, Jim	LATA Kentucky	270-441-5083	jim.erickson@lataky.com
Garner, Nathan	KY RHB	502-564-8390	nathan.garner@ky.gov
Gibson, Jeff	KDWM	502-564-6716	jeffrey.gibson@ky.gov
Macdonald, Emily	Sapere Consulting	509-524-2344	emacdonald@sapereconsulting.com
Richards, Walt	PRC	270-444-6839	walt.richards@lex.doe.gov
Samples, John	LATA Kentucky	270-441-5080	john.samples@lataky.com
Struttmann, Todd	LATA Kentucky	270-816-8852	todd.struttmann@lataky.com
Towarnicky, Joe	LATA Kentucky	270-217-6789	joseph.towarnicky@lataky.com
Winner, Edward	KDWM	502-564-6716	edward.winner@ky.gov
Woodard, Jennifer	DOE	270-441-6820	jennifer.woodard@lex.doe.gov

Notes/comments:

Consensus decisions made:

Action items:

Action	Responsible Party	Due Date

QAPP Worksheet #10. Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

This worksheet is used to present the project's conceptual site model (CSM). The CSM is a tool to assist in the development of DQOs. The CSM primarily uses text and/or figures, but also may include tables to convey succinctly what currently is known about the site, and it should be updated as new data are collected. As with the QAPP in general, the level of detail in the CSM should be based on the graded approach. If an investigation includes multiple sites with unique characteristics or problems to be addressed, then a separate CSM should be prepared for each site.

The CSM should include the following information:

- Background information (i.e., site history, unless this information is presented in an Executive Summary);
- Sources of known or suspected hazardous waste;
- Known or suspected contaminants or classes of contaminants;
- Primary release mechanism;
- Secondary contaminant migration;
- Fate and transport considerations;
- Potential receptors and exposure pathways;
- Land use considerations;
- Key physical aspects of the site (e.g., site geology, hydrology, topography, climate); and
- Current interpretation of nature and extent of contamination to the extent that it will influence project-specific decision making.

Data gaps and uncertainties associated with the CSM need to be identified clearly.

QAPP Worksheet #10 may be used as an outline for the problem discussion in the QAPP. **The project team developing the project-specific FSP and associated QAPP may choose to include this information in the body of the report rather than populating this worksheet.** An example Worksheet #10 follows.

QAPP Worksheet #10. Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)
[Example taken from C-400 Vapor Intrusion Work Plan (DOE 2017b)]

See Appendix D of this document.

QAPP Worksheet #11. Project/Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

Project Quality Objectives/Systematic Planning Process Statements

This worksheet is used to develop and document project quality objectives (PQOs) or DQOs using a systematic planning process (SPP). Examples of SPP include (1) the DQO process[1] and (2) the U.S. Army Corps of Engineers' Technical Planning Process.[2] This statement (along with all other statements in this P-QAPP) must be confirmed in the preparation of the project-specific QAPP or modified, as needed. The type of SPP used will vary based on the graded approach. This worksheet mainly is populated as text, although some diagrams that capture decision processes are recommended. Regardless of the SPP applied, the QAPP must document the environmental decisions that need to be made and the level of data quality needed to ensure that those decisions are based on sound scientific data. The following guidelines are based on EPA's seven-step DQO process.

1. State the Problem. The problem statement should be consistent with information contained in the CSM (Worksheet #10).

2. Identify the Goals of the Study. Identify specific study questions and define alternative outcomes. The goals for either decision or estimation problems should explain how the data will be used to answer questions and choose among the stated alternatives. Characterizing the "nature and extent of contamination" is a commonly stated but inappropriate study goal because it is vague and not focused on potential outcomes.

3. Identify Information Inputs. Specify the types of data that are required to fill gaps in the CSM. Explain in specific terms how data will be used. In addition to analytical data, this could include published information on geology, climate, population distributions, endangered species, etc. Information inputs should be consistent with decisions made during project scoping, as documented on Worksheet #9.

4. Define the Boundaries of the Study. Specify the target population and characteristics of interest, define spatial/temporal limits, and the scale of inference (i.e., which populations will be represented by which data). Developing the list of target analytes presents one of the greatest opportunities for streamlining a project, because it can help avoid unnecessary costs associated with sampling, analysis, data review, reporting, and management. Target analytes should be focused on specific constituents reasonably known or suspected to be present. The list of target analytes should be based on data gaps in the CSM. Focusing the list of analytes also provides better opportunities for optimizing method performance to best suit those analytes.

[1] *Guidance on Systematic Planning Using the Data Quality Objectives Process*, U.S. EPA, EPA QA/G-4, February 2006.
[2] *Technical Project Planning Process*, U.S. Army Corps of Engineers, EM 200-1-2, August 1998.

QAPP Worksheet #11. Project/Data Quality Objectives (Continued)
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

Project Quality Objectives/Systematic Planning Process Statements

5. Develop the Analytic Approach. Define the parameter(s) of interest; specify the type of inference (e.g., "samples from groundwater monitoring wells x, y, and z will represent potable water at the site); and develop the logic for drawing conclusions from findings (i.e., which sample results will be used to support which decisions.) For decision problems, these are expressed as "if---then" statements, or decision rules, that link potential results with conclusions or future actions. For estimation problems, specify the estimator and the estimation procedure.

6. Specify Performance or Acceptance Criteria. For projects that involve hypothesis testing (e.g., presence or absence of contamination exceeding some threshold value) for decision-making, this will involve specifying probability limits for decision errors. For estimations and other analytic approaches (e.g., estimating the volume of groundwater or soil potentially requiring remediation), this will involve the development of performance criteria (for new data being collected) or acceptance criteria (for existing data being considered for use).

7. Develop the Detailed Plan for Obtaining Data. Worksheet #11 generally will briefly explain the basis for the sampling design and then refer to Worksheet #17, Sample Design and Rationale, for further details. Worksheets #19, 20, 24–28, and 30 will specify analysis design requirements.

QAPP Worksheet #11. Project/Data Quality Objectives (Continued)
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Step 1. State the Problem:

Problem Statement: *Determine if a vapor intrusion study is needed and if so, then how to be consistent with EPA protocol.*

—Adapted from EPA letter, dated September 30, 2014: "…Further information will be obtained by taking the following actions: a vapor intrusion study will be conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology."

Problem Description: Trichloroethene (TCE) and other VOCs are present in the Upper Continental Recharge System (UCRS) and the Regional Gravel Aquifer (RGA) soils and groundwater around C-400. Due to the concentration of TCE/VOCs, vapor from the TCE/VOCs has the potential to migrate into the C-400 building and pose a possible risk to the workers.

Problem Approach:

- The planning team will review existing data; identify data gaps, if any; and, if necessary, determine what new data are needed to evaluate the potential for vapor intrusion into the C-400 Building.
- Planning Team: FFA parties; leader; DOE
- Conceptual Model: Evaluate EPA Vapor Intrusion CSM, adapt to PGDP conditions. Evaluate vapor intrusion driving factors against PGDP CSM conditions.
- Determine Resources:
  - Schedule: within 18 months of 9/30/2014
  - Budget: Based upon scope
  - Personnel: FPDP

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Step 2: Identify the Goal of the Study

Determine degree of vapor intrusion at C-400 relative to appropriate benchmarks

- C-400 status: Working toward being demo ready
  - Anticipated that only remediation workers to be in building after end of fiscal year 2016
  - Anticipated nonremediation worker potential exposure less than two years
- Current use: Support for demo-ready process and laundry
  - Most staff are remediation workers
  - Benchmark different for remediation workers and nonremediation workers
- Approach: compare historical indoor air concentrations in work areas to benchmarks
  - Remediation worker benchmarks based on worker health and safety: uses American Conference for Governmental Industrial Hygienists (ACGIH) numbers
  - Nonremediation worker benchmark: Vapor Intrusion Screening Level (VISL) for commercial scenario adjusted to actual potential for exposure http://www.epa.gov/oswer/vaporintrusion/documents/VISL-calculator.xlsm

Current Hypotheses:

- Vapor intrusion not an issue for remediation workers in C-400 who are protected by a worker health and safety plan; historical/current monitoring demonstrates [VOC] below benchmark
- Vapor intrusion may be an issue for nonremediation workers because detection limits of past monitoring may not be above benchmark values

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Decision Statement Development

- If C-400 occupants are only remediation workers and thus protected by an in-place worker health and safety program, then historical and recent monitoring demonstrate vapor intrusion is not an issue at C-400 for these workers because workplace air concentrations are below ACGIH levels

- If there are C-400 occupants who are not remediation workers and recent monitoring demonstrates that workplace air concentrations are below the VISL values, as adjusted for realistic exposure potential, then vapor intrusion is not an issue at C-400 for these workers

Step 3. Identify Information Inputs:

Identify Information Inputs (What Information Do We Need)

- Industrial hygiene (IH) samples results compared to ACGIH value for TCE
  - TCE IH ACGIH benchmark = 10 ppm time weighted average (TWA) (8-hour TWA)
  - Vinyl chloride (VC) ACGIH benchmark = 1 ppm TWA
  - 1,2-dichloroethene (DCE) ACGIH benchmark = 200 ppm TWA

- Historical air sampling results evaluated using the CSM
- Determination of the number of nonremediation workers currently working in C-400
- Evaluation of the potential for relocation of the workers/activities (office, laundry)
- Evaluation of the timing for relocation of workers/activities

Step 4. Identify the Boundaries of the Study:

Target Populations/Spatial Boundaries

- Nonremediation workers in C-400 designated work areas (e.g., office, laundry, etc.)
- Remediation workers in C-400; work in entire C-400 Building to remove unused equipment, asbestos, etc.

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Temporal Limits

- Nonremediation workers expected exposure less than two years
- Recent air samples collected under current building use (i.e., post-PGDP shutdown)

Scale of Inference

- If VOC concentrations below AGCIH limits, inference is that vapor intrusion is not a problem for remediation workers at C-400
- If VOC concentrations below VISL values (commercial) adjusted for reasonably anticipated exposure, inference is that vapor intrusion is not a problem for nonremediation workers
  - Adjustment for maximum of 2 years exposure for workers (post-PGDP) compared to VISL exposure duration of 25 years
  - Adjustment changes driving factor for TCE from Excess Lifetime Cancer Risk (ELCR) to Hazard Index (HI)
    - TCE HI = 8.8 $\mu g/m^3$ (from VISL calculator commercial)
    - VC driving factor = ELCR × 25/2 = 2.8 $\mu g/m^3$ (from VISL calculator) * 12.5 = 35 $\mu g/m^3$ (Note: VC HI = 440 $\mu g/m^3$)

Step 5. Develop the Analytical Approach:

Remediation Workers

- Compare [VOC] results of air samples at C-400 to ACGIH values
- If [VOC] (and method detection limit) is < ACGIH values, then vapor intrusion is considered not to be an issue for remediation workers and no additional study is needed for remediation workers

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Nonremediation Workers

- Compare [VOC] results of indoor air samples at C-400 to adjusted VISL values
- If [VOC] ([and method detection limit (MDL)] in air is < 8.8 µg/m^3 TCE (and < 35 µg/m^3 VC), then vapor intrusion is not considered to be an issue for nonremediation workers and no additional study is needed
- If [VOC] (or MDL) in air is > 8.8 µg/m^3 TCE (or > 35 µg/m^3 VC), then design investigation to generate new air results from nonremediation worker occupied areas

Step 5 Summary: Develop the Analytical Approach

- Compared recent IH [VOC] to ACGIH values and found [VOC] and MDL < ACGIH levels
- Compared recent IH [VOC] to adjusted VISL values and found MDLs and one detection > VISL
- **Thus, if nonremediation workers are to remain in C-400, propose sample indoor air of C-400 areas, including laundry and office**

Step 6. Specify Performance or Acceptance Criteria:

Verify when there only will be remediation workers in C-400; establish and maintain access limitations

- Existing access controls (standard practices and procedures)

If nonremediation workers to remain in C-400, collect samples in work areas, analyze, confirm [VOC] and MDL < adjusted VISL

- Propose collect six SUMMA samples over 10-hours on working days including at office/laundry
  - [TCE] and MDL < 8.8 µg/m^3
  - [VC] and MDL < 35 µg/m^3

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)
[Example taken from C-400 Vapor Intrusion Study Work Plan (DOE 2017b)]

Step 6 Summary: Specify Performance or Acceptance Criteria

- Verify when there will be only remediation workers in C-400; if not, hypothesis not confirmed
- If nonremediation workers remain, collect air samples and confirm [VOC] and MDL < VISL

Step 7. Develop the Detailed Plan for Obtaining Data:

Identify whether nonremediation workers to remain

- If no, C-400 evaluation complete
- If yes, develop SAP

Submit SAP for review and approval to FFA parties

QAPP Worksheet #11. Project Quality Objectives/Systematic Planning Process Statements (Continued)

General Notes on Project Quality Objectives/Systematic Planning Process

The following should be considered in the preparation of a project-specific QAPP to ensure that the project quality objectives are met:

- Aluminum analyses in surface soil that will be used for ecological screening also should include pH analysis.
- Metals analyses for surface water to be used for ecological screening should include hardness analysis.
- Lead (Pb) limits are being reevaluated by EPA; future QAPPs may need to update Project Action Limits (PALs) for lead.
- Field methods will not meet the same DQOs as lab data; however, field methods provide additional information at reduced cost.
- Data from grab water samples will not meet the same DQOs as samples from properly installed and developed wells.
- Current SOPs should be provided on electronic storage media along with submitted project-specific QAPP.

QAPP Worksheet #12. Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

This worksheet documents the quantitative measurement performance criteria (MPC) in terms of precision, bias, and sensitivity for both field and laboratory measurements and is used to guide the selection of appropriate measurement techniques and analytical methods. MPC are developed to ensure collected data will satisfy the PQOs or DQOs documented on Worksheet #11. A separate worksheet should be completed for each type of field or laboratory measurement. For analytical methods, MPC should be determined for each matrix, analyte, and concentration level. [Qualitative MPC (representativeness and comparability) should be addressed in the sample design, which is documented on Worksheet #17.] If MPC are analyte-specific, include this detail in a separate table or modify this worksheet as necessary. Example QAPP Worksheet #12 information is provided below, representing the currently used analytical methods. The listed methods have been reviewed to ensure that the criteria summarized below are aligned with those presented in the method. In the preparation of the project-specific QAPP, this information shall be confirmed. Changes in the method or laboratory can result in changes to these criteria.

QAPP Worksheet #12. Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Sampling will follow the referenced standard operating procedures. The following tables provide the measurement performance criteria.

QAPP Worksheet #12-A. Measurement Performance Criteria (VOCs, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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[6]	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[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage..
[6] 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.

QAPP Worksheet #12-B. Measurement Performance Criteria (Metals, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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	200.8/ SW-846-6010/6020 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-C. Measurement Performance Criteria (Mercury, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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-846-7471 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-D. Measurement Performance Criteria (PCBs, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP[3, 4]**	**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-846-8082 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-E. Measurement Performance Criteria (Radionuclides, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-F. Measurement Performance Criteria (Radionuclides, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-G. Measurement Performance Criteria (Radionuclides, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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	Gamma spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage..
Note: Cobalt-60 was deleted from the P-QAPP because it is not a site-related constituent of potential concern. Should an individual project investigate cobalt-60, it should be added back to the project-specific QAPP.

QAPP Worksheet #12-H. Measurement Performance Criteria (Radionuclides, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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—P≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-I. Measurement Performance Criteria (SVOCs, Soil/Sediment)

Matrix	Soil/Sediment
Analytical Group[1]	Semivolatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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-846-8270 See Worksheet #23	Precision—Lab	RPD—< 25%	Laboratory Duplicates	A
		Precision	RPD—< 35%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-J. Measurement Performance Criteria (SVOCs, Water)

Matrix	Water
Analytical Group[1]	Semivolatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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-846-8270 See Worksheet #23	Precision—Lab	RPD—< 25%	Laboratory Duplicates	A
		Precision	RPD—< 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

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

Matrix	Water/Groundwater
Analytical Group[1]	Volatile Organic Compounds
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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[6]	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[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

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

Matrix	Water/Groundwater
Analytical Group[1]	Metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP[3, 4]**	**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	200.8/ SW-846-6010/6020 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-M. Measurement Performance Criteria (Mercury, Water)

Matrix	Water/groundwater
Analytical Group[1]	Metals (Mercury)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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-846-7470 See Worksheet #23	Precision—Lab	RPD—≤ 20%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-N. Measurement Performance Criteria (PCBs, Water)

Matrix	Water/groundwater
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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-846-8082 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

PQL = practical quantitation limit; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

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

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, thorium-230, uranium-234, uranium-235, uranium-238)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP[3, 4]**	**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	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias	% recovery[6]	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[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

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

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (cesium-137)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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	Gamma spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity; RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated 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-Q. Measurement Performance Criteria (Radionuclides, Water)

Matrix	Water/groundwater
Analytical Group[1]	Radionuclides (technetium-99)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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[6]	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[5]	90%	Data Completeness Check	S&A

MDA = minimum detectable activity
RPD = relative percent difference.
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] 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.

QAPP Worksheet #12-R. Measurement Performance Criteria [Uranium (XRF), Soil]

Matrix	Soil
Analytical Group[1]	Metals (uranium)
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	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-846-6200 (XRF) See Worksheet #23	Precision	RPD—35%	Field Duplicates	S
		Precision—Lab	Duplicate result within 95% CI of original reading	Laboratory Duplicates	A
		Accuracy/Bias Contamination	No target compounds > QL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data Completeness Check	S&A

CI = confidence interval
QL = quantitation limit
RPD= relative percent difference
XRF = X-ray fluorescence
[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #21.
[4] The most current version of the method will be used.
[5] Completeness is calculated 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-S. Measurement Performance Criteria (Total PCBs, Soil/Sediment)

Matrix	Soil/sediment
Analytical Group[1]	Total PCBs (Aroclor 1016, 1232, 1242, 1248, 1254, 1260)
Concentration Level	Moderate

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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)**
Per manufacturer's instructions	SW-846-4200 (immunoassay test kit) See Worksheet #23	Precision	N/A	Compare results against laboratory values	S
		Accuracy/Bias Contamination	N/A	Compare results against laboratory values	A
		Completeness[5]	N/A	Compare results against laboratory values	S&A

N/A = not applicable
QL = quantitation limit
PCB = polychlorinated biphenyl

[1] If information varies within an analytical group, separate by individual analyte.
[2] No procedure specific to method; use manufacturer's instructions.
[3] SW-846 Method; No SOP specific to Method; use manufacturer's instructions.
[4] The most current version of the method will be used.
[5] Completeness is calculated 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-T. Measurement Performance Criteria (PAHs, Soil/Sediment)

Matrix	Soil/sediment
Analytical Group[1]	PAHs (3-, 4-, 5-ring compounds including phenanthrene, anthracene, fluorine, benzo(a)anthracene, chrysene, fluoranthene, pyrene)
Concentration Level	Moderate

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**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)**
Per manufacturer's instructions	SW-846-4035 (PAH test kit) See Worksheet #23	Precision	N/A	Compare results against laboratory values and/or Field Duplicates	S
		Accuracy/Bias Contamination	N/A	Compare results against laboratory values Method Blanks/Instrument Blanks and/or Field Duplicates	A
		Completeness[5]	N/A	Compare results against laboratory values Data Completeness Check	S&A

N/A = not applicable
QL = quantitation limit
PAH = polycyclic aromatic hydrocarbon

[1] If information varies within an analytical group, separate by individual analyte.
[2] No procedure specific to method; use manufacturer's instructions.
[3] SW-846 Method; No SOP specific to Method; use manufacturer's instructions.
[4] The most current version of the method will be used.
[5] Completeness is calculated 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-U. Measurement Performance Criteria (VOCs, Air)

Matrix	Air
Analytical Group[1]	VOCs including trichloroethene; 1, 2-dichloroethene; vinyl chloride; 1,1-dichloroethene
Concentration Level	Very Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria (MPC)**[6]	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	EPA-TO-15, See Worksheet #23	Precision—Lab	N/A	Evaluate lab data packages GC/MS results	A
		Precision	RPD ≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[7]	Laboratory Sample Spikes	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data Completeness Check	S&A

N/A = not applicable

[1] If information varies within an analytical group, separate by individual analyte.
[2] Reference number from QAPP Worksheet #21.
[3] Reference number from QAPP Worksheet #23.
[4] The most current version of the method will be used.
[5] Completeness is calculated as the number of valid analytical results reported divided by the number of analytical results requested , multiplied by 100 to obtain the percentage.
[6] MPC is listed as N/A for EPA-TO-15 because air samples are stand-alone samples, and the results of one sample cannot be used to evaluate sampling and analysis precision, accuracy, or bias. Thus, MPC cannot be provided. Replicate samples will be collected per the work plan and they will be reviewed to estimate the degree of sampling precision, accuracy, and bias without defined MPC.
[7] 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.
NOTE: Worksheets #12-U, #15-L, and associated information on air sampling have been added to the P-QAPP even though these worksheets have not been part of an approved project-specific QAPP at the request of the P-QAPP Working Group.

QAPP Worksheet #13. Secondary Data Uses and Limitations
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

This worksheet should be used to identify sources of secondary data (i.e., data generated for purposes other than this specific project or data pertinent to this project generated under a separate QAPP) and summarize information relevant to their uses for the current project. This worksheet should be supplemented by text describing specifically how secondary data will be used. The project team needs to carefully evaluate the quality of secondary data (in terms of precision, bias, representativeness, comparability, and completeness) to ensure they are of the type and quality necessary to support their intended uses. Secondary data can include the following: sampling and testing data collected during previous investigations, historical data, background information, interviews, modeling data, photographs, aerial photographs, topographic maps, and published literature. When evaluating the reliability of secondary data and determining limitations on their uses, consider the source of the data, the time period during which they were collected, methods by which data were collected, potential sources of uncertainty, the type of supporting documentation available, and the comparability of data collection methods to the currently proposed methods. Examples are provided below.

QAPP Worksheet #13. Secondary Data Uses and Limitations
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

QAPP Worksheet #13. Secondary Data Criteria and Limitations Table
(Example taken from SWMU 4 Project)

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
OREIS Database	Various	Various	Data will be used to determine the nature and extent of soil, sediment, surface water, and groundwater contamination. The data in the OREIS database will be used in conjunction with newly acquired data to fill data gaps, as described in Worksheet #10 (e.g., COC data in the OREIS database will be used in conjunction with newly acquired data, using professional judgment considering the uncertainties of the historical data, to determine whether COCs are present in the burial cells, as well as the extent and mass of TCE contamination with sufficient accuracy to complete a remedial design for a remedy in the burial cells).	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used. The changes that may have taken place in the *in situ* environmental media because collecting older data must be considered.

QAPP Worksheet #13. Secondary Data Uses and Limitations (Continued)
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

QAPP Worksheet #13. Secondary Data Criteria and Limitations Table (Continued)

Historical Documentation	CH2M Hill 1992. *Results of the Site Investigation, Phase II, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/Sub/13B-97777C P03/1991/1. Clausen, J. L., K. R. Davis, J. W. Douthitt, and B. E. Phillips 1992. *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*, KY/E-150, Paducah, KY. DOE 2000a. *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895/V1-V4&D1, U.S. Department of Energy, Paducah, KY, September. DOE 2000b. *Data Report for the Sitewide Remedial Evaluation for Source Areas Contributing to Off-site Groundwater Contamination at the Paducah Gaseous Diffusion Plant, Paducah Kentucky*, DOE/OR/07-1845&D1). DOE 2007. *Site Investigation Report for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2/R1. DOE 2010. *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0030&D2/R1. DOE 2011a. *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2010 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD/ENR/0130.	DOE contractors, soil and water, 1998–2008 Various	Information will be used in conjunction with newly collected data to determine whether COCs are present in the burial cells, as well as the extent and mass of TCE contamination with sufficient accuracy to complete a remedial design for a remedy in the burial cells. Information will be used as guidance on related project work.	Data have been verified, assessed, and validated (if validation required). Rejected data will not be used. Information from historical documents will be limited to the available documentation as it relates to a specific project. Use of historical data may be limited based on how long ago the data were collected and whether site conditions have changed since data collection.

NOTE; OREIS is the repository for PGDP environmental and waste characterization analytical results. OREIS is a limited access database. Most of the results in OREIS are downloaded to PEGASIS periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

QAPP Worksheets #14/16. Project Tasks & Schedule
(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Summary of Project Tasks

The QAPP should include a project schedule showing specific tasks, the person or group responsible for their execution, and planned start and end dates. Options for presenting this information include the following template or a Gantt chart that can be attached and referenced. Examples of activities that should be listed include key on-site and off-site activities. Any critical steps and dates should be highlighted.

The table will not need to be included as a worksheet as long as a schedule is included with the site-specific FSP. If the schedule is provided in the FSP, the QAPP should include a statement such as the following: The project-specific FSP includes a project-specific schedule with the minimum of the information included in Worksheet #16.

An example Worksheet #14/16 follows

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization/demobilization	FRNP	March 1, 2018	March 11, 2018	Field notes	March 18, 2018
Sample collection—soils	FRNP	March 2, 2018	March 7, 2018	Field notes	March 14, 2018
Sample collection—groundwater	FRNP	March 3, 2018	March 7, 2018	Field notes	March 14, 2018
Analysis	Contract Lab	March 2018	April 1, 2018	Report of analysis	April 1, 2018
Validation	Wastren Advantage Inc.	April 1, 2018	May 1, 2018	Validation summary	May 1, 2018
Usability assessment	Project Team	May 2018	May 2018	Usability assessment summary report	May 30, 2018

QAPP Worksheet #15. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

This worksheet should be completed for each matrix, analyte, analytical method, and concentration level (if applicable). Its purpose is to ensure the selected analytical laboratory and method can provide accurate data (i.e., quantitative results with known precision and bias) at the project action limit (PAL). During the systematic planning process, identify target analytes, PALs, and the reference limits (e.g., regulatory limits or risk-based limits) on which action limits are based. (If more than one set of reference limits is applicable, add additional columns.) Target analytes that are critical to project-specific decision-making should be highlighted. Next, determine the matrix-specific quantitation limit goal. The quantitation limit goal should be lower than the PAL by an amount determined by the DQOs/PQOs. This information, along with the MPC documented on Worksheet #12, should be used to select analytical methods and laboratories. Once the methods and laboratories have been selected, the remaining columns should be completed with laboratory-specific information. Project teams need to keep in mind that the laboratory-specific quantitation limit usually is determined in reagent water; therefore, the project quantitation limit goal (matrix-specific quantitation limit) will be higher. Explanations should be provided in cases where the quantitation limit is greater than either the project quantitation limit goal or the PAL. The laboratory must provide documentation that demonstrates precision and bias at the laboratory-specific quantitation limit. The laboratory-specific quantitation limit cannot be lower than the lowest calibration standard for any given method and analyte.

For the initially developed project-specific QAPP, the laboratory-specific columns should be filled out with target values to be used in laboratory solicitation and to support identification of the potential need to seek lower detection limits. The final laboratory-specific values will be populated and the project-specific QAPP updated once the laboratory has been contracted.

As part of the preparation of a project-specific QAPP, the PAL values should be updated with the most recent values or with project-specific values, as appropriate. As these values are updated, the P-QAPP will need to be updated accordingly.

QAPP Worksheet #15. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

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

Matrix: Water
Analytical 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[e] (µg/L)
Acrylonitrile	107-13-1	0.052/0.0523	Tapwater[d]/NAL	Yes	5	1.5
Benzene	71-43-2	5.0/0.455	MCL/NAL	Yes	1	0.3
Carbon tetrachloride	56-23-5	5.0/0.455	MCL/NAL	Yes	1	0.3
Chloroform	67-66-3	80/0.221	MCL[f]/NAL	Yes	1	0.3
1,1-Dichloroethene	75-35-4	7.0/28.5	MCL/NAL	Yes	1	0.3
cis-1,2-Dichloroethene	156-59-2	70/3.61	MCL/NAL	Yes	1	0.3
trans-1,2-Dichloroethene	156-60-5	100/9.29	MCL/NAL	Yes	1	0.3
Ethylbenzene	100-41-4	700/1.50	MCL/NAL	Yes	1	0.3
Tetrachloroethene	127-18-4	5.0/4.06	MCL/NAL	Yes	1	0.3
Trichloroethene	79-01-6	5.0/0.283	MCL/NAL	Yes	1	0.3
Vinyl Chloride	75-01-4	2.0/0.0188	MCL/NAL	Yes	1	0.3

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

VOC	CAS Number	Project Action Limit/NAL (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL[e] (µg/L)
Total Xylenes	1330-20-7	10,000/19.3	MCL/NAL	Yes	3	0.3
o-Xylene	95-47-6	19/19.3	Tapwater/NAL	Yes	1	0.3
m-Xylene	108-38-3	19/19.3	Tapwater/NAL	Yes	2	0.3
p-Xylene	106-42-3	19/19.3	Tapwater/NAL	Yes	2	0.3

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

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level (see EPA 2016)
MDL = method detection limit
NAL = no action level for the child resident scenario taken from the 2018 Risk Methods Document (RMD) (DOE 2018)
PQL = practical quantitation limit
VOC = volatile organic compound

[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.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2017 (EPA 2017a).
[e] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[f] As Total trihalomethanes.

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

Matrix: Water
Analytical Group: Metals

Metal	CAS Number	Project Action Limit/NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/L)	MDL[e] (mg/L)
Aluminum	7429-90-5	2.0/2.00	Tapwater[d]/NAL	Yes	0.05	0.015
Antimony	7440-36-0	0.0060/0.000779	MCL/NAL	Yes	0.003	0.001
Arsenic	7440-38-2	0.010/0.0000517	MCL/NAL	Yes	0.005	0.0017
Barium	7440-39-3	2.0/0.377	MCL/NAL	Yes	0.002	0.0006
Beryllium	7440-41-7	0.0040/0.00246	MCL/NAL	Yes	0.0005	0.0002
Boron	7440-42-8	0.40/0.399	Tapwater/NAL	Yes	0.015	0.004
Cadmium	7440-43-9	0.0050/0.000922	MCL/NAL	Yes	0.001	0.00011
Chromium (total)	7440-47-3	0.10/2.25[f]	MCL/NAL	Yes	0.01	0.002
Chromium VI	18540-29-9	0.000035/0.000035	Tapwater/NAL	Yes	0.01	0.0033
Cobalt	7440-48-4	0.0006/0.000601	Tapwater/NAL	Yes	0.001	0.0001
Copper	7440-50-8	1.3/0.0799	MCL/NAL	Yes	0.001	0.00035
Iron	7439-89-6	1.4/1.40	Tapwater/NAL	Yes	0.1	0.033
Lead	7439-92-1	0.015/0.015	MCL[g]/NAL	Yes	0.002	0.0005
Manganese	7439-96-5	0.043/0.0434	Tapwater/NAL	Yes	0.005	0.001

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

Matrix: Water
Analytical Group: Metals

Metal	CAS Number	Project Action Limit/ NAL (mg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/L)	MDL[e] (mg/L)
Mercury (inorganic salts)	7439-97-6[g]	0.0020[h]/0.000566[h]	MCL/NAL	Yes	0.0002	0.000067
Molybdenum	7439-98-7	0.010/0.00998	Tapwater[d]/NAL	Yes	0.0005	0.000165
Nickel (soluble salts)	7440-02-0g	0.039[h]/0.0392 [h]	Tapwater[d]/NAL	Yes	0.002	0.0005
Selenium	7782-49-2	0.050/0.00998	MCL/NAL	Yes	0.005	0.0015
Silver	7440-22-4	0.0094/0.00941	Tapwater[d]/NAL	Yes	0.001	0.0002
Thallium (soluble salts)	7440-28-0	0.0020/0.000020	MCL/NAL	Yes	0.002	0.00045
Uranium (soluble salts)	7440-61-1	0.030/0.000399	MCL/NAL	Yes	0.0002	0.000067
Vanadium	7440-62-2	0.0086/0.00864	Tapwater[d]/NAL	Yes	0.01	0.003
Zinc	7440-66-6	0.60/0.600	Tapwater[d]/NAL	Yes	0.01	0.0035

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

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the RMD
PQL = practical quantitation limit

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD and MCLs reproduced in 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] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2017.
[e] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[f] An NAL is not available for chromium (total); therefore, the NAL for chromium III was used.
[g] The MCL established by the EPA for lead is based on a treatment technique action level of 0.015 mg/L.
[h] The PAL/NAL values (for metals identified as salts) were derived for metal salts; the CAS number is presented for the elemental form.

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

Matrix: Water
Analytical Group: PCBs

PCB	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (µg/L)	MDL[d] (µg/L)
Aroclor-1016	12674-11-2	0.50[e]/0.140	MCL/NAL	Yes	0.1	0.0333
Aroclor-1221	11104-28-2	0.50[e]/0.00471	MCL/NAL	Yes	0.1	0.0333
Aroclor-1232	11141-16-5	0.50[e]/0.00471	MCL/NAL	Yes	0.1	0.0333
Aroclor-1242	53469-21-9	0.50[e]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1248	12672-29-6	0.50[e]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1254	11097-69-1	0.50[e]/0.00785	MCL/NAL	Yes	0.1	0.0333
Aroclor-1260	11096-82-5	0.50[e]/0.00785	MCL/NAL	Yes	0.1	0.0333

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

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 RMD
PCBs = polychlorinated biphenyls
PQL = practical quantitation limit

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD and MCLs reproduced in the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process. This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the MDL, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[e] MCL for Total PCBs.

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] MDA[d] (pCi//L)
Americium-241	14596-10-2	0.504	NAL	Yes	1
Cesium-137+D	10045-97-3	1.71	NAL	Yes	10
Neptunium-237+D	13994-20-2	0.763	NAL	Yes	1
Plutonium-238	13981-16-3	0.398	NAL	Yes	1
Plutonium-239/240	15117-48-3/14119-33-6	0.387	NAL	Yes	1
Technetium-99	14133-76-7	4 mrem/year-dose[e], 900/19.0	MCL/NAL	Yes	25
Thorium-230	14269-63-7	0.572	NAL	Yes	1
Uranium-234	13966-29-5	10.24/0.739	MCL[e]/NAL	Yes	1
Uranium-235+D	15117-96-1	0.466/0.728	MCL[e]/NAL	Yes	1
Uranium-238+D	24678-82-8	9.99/0.601	MCL[e]/NAL	Yes	1

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

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

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD and MCLs reproduced in the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet 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 method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDAs identified in the worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[e] The value derived by the EPA from the 4 mrem/yr MCL for Tc-99 is 900 pCi/L (see http://www.epa.gov/reg-flex/radionuclides-drinking-water-small-entity-compliance-guide-february-2002). An alternate value derived by the EPA from the 4 mrem/yr 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).

QAPP Worksheet #15-E. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: Metals

Metal	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/kg)	MDL[d] (mg/kg)
Aluminum	7429-90-5	7,740	NAL	Yes	10	3
Antimony	7440-36-0	3.13	NAL	Yes	1	0.33
Arsenic	7440-38-2	0.356	NAL	Yes	1	0.2
Barium	7440-39-3	1,530	NAL	Yes	0.4	0.1
Beryllium	7440-41-7	15.6	NAL	Yes	0.1	0.02
Boron	7440-42-8	1,560	NAL	Yes	3	0.8
Cadmium	7440-43-9	5.28	NAL	Yes	0.2	0.02
Chromium III	7440-47-3	11,700[e]	NAL	Yes	0.6	0.2
Chromium VI	18540-29-9	0.301	NAL	Yes	0.4	0.12
Cobalt	7440-48-4	2.34	NAL	Yes	0.2	0.06
Copper	7440-50-8	313	NAL	Yes	0.2	0.066
Iron	7439-89-6	5,480	NAL	Yes	20	6.6
Lead	7439-92-1	400	NAL	Yes	0.4	0.1

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

Matrix: Soil/Sediment
Analytical Group: Metals

Metal	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/kg)	MDL[d] (mg/kg)
Manganese	7439-96-5	183	NAL	Yes	1	0.2
Mercury (inorganic salts[f])	7439-97-6	2.35	NAL	Yes	0.01	0.004
Molybdenum	7439-98-7	39.1	NAL	Yes	0.2	0.06
Nickel (soluble salts)	7440-02-0	155	NAL	Yes	0.4	0.1
Selenium	7782-49-2	39.1	NAL	Yes	1	0.33
Silver	7440-22-4	39.1	NAL	Yes	0.5	0.1
Thallium (soluble salts)	7440-28-0	0.0782	NAL	Yes	0.4	0.06
Uranium (soluble salts)	7440-61-1	1.56	NAL	Yes	0.04	0.013
Vanadium	7440-62-2	39.3	NAL	Yes	0.5	0.1
Zinc	7440-66-6	2,350	NAL	Yes	2	0.4

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

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 RMD
PCB = polychlorinated biphenyl
PQL = practical quantitation limit

[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.

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

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

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

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

[f] The PAL/NAL values (for metals identified as salts) were derived for metal salts; the CAS number is presented for the elemental form.

QAPP Worksheet #15-F. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: PCBs

PCB	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL (mg/kg)	MDL[d] (mg/kg)
Aroclor-1016	12674-11-2	0.206	NAL	Yes	0.0033	0.001099
Aroclor-1221	11104-28-2	0.0752	NAL	Yes	0.0033	0.001099
Aroclor-1232	11141-16-5	0.0708	NAL	Yes	0.0033	0.001099
Aroclor-1242	53469-21-9	0.0791	NAL	Yes	0.0033	0.001099
Aroclor-1248	12672-29-6	0.0792	NAL	Yes	0.0033	0.001099
Aroclor-1254	11097-69-1	0.0588	NAL	Yes	0.0033	0.001099
Aroclor-1260	11096-82-5	0.0803	NAL	Yes	0.0033	0.001099

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

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 RMD
PQL = practical quantitation limit
PCBs = polychlorinated biphenyls

[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.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs, and this information will be appended to the QAPP.

QAPP Worksheet #15-G. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]
					MDA[d] (pCi/g)
Americium-241	14596-10-2	1.75	NAL	Yes	1
Cesium-137+D	10045-97-3	0.0402	NAL	Yes	0.1
Neptunium-237+D	13994-20-2	0.0911	NAL	Yes	1
Plutonium-238	13981-16-3	4.26	NAL	Yes	1
Plutonium-239/240	15117-48-3/ 14119-33-6	3.77/3.80	NAL	Yes	1
Technetium-99	14133-76-7	110	NAL	Yes	5
Thorium-230	14269-63-7	4.92	NAL	Yes	1
Uranium-234	13966-29-5	5.77	NAL	Yes	1
Uranium-235+D	15117-96-1	0.148	NAL	Yes	1
Uranium-238+D	24678-82-8	0.556	NAL	Yes	1

NOTE: For consistency at a programmatic level, these worksheets will be reviewed and updated for project-specific QAPPs. Worksheet #15 of each project-specific QAPP will have a Project QL column that will be related to action levels deemed appropriate for the specific analytes as a result of three-party project scoping.

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

[a] This programmatic 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 COC 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 method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.

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

Matrix: Soil/Sediment
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[d] (µg/kg)
1,1-Dichloroethene	75-35-4	22,700	NAL	Yes	1	0.33
cis-1,2-Dichloroethene	156-59-2	15,600	NAL	Yes	1	0.33
trans-1,2-Dichloroethene	156-60-5	10,200	NAL	Yes	1	0.33
Acrylonitrile	107-13-1	255	NAL	Yes	5	1.7
Benzene	71-43-2	1,160	NAL	Yes	1	0.33
Carbon Tetrachloride	56-23-5	653	NAL	Yes	1	0.33
Chloroform	67-66-3	316	NAL	Yes	1	0.33
Ethylbenzene	100-41-4	5,780	NAL	Yes	1	0.33
Tetrachloroethene	127-18-4	8,100	NAL	Yes	1	0.33
Trichloroethene	79-01-6	412	NAL	Yes	1	0.33
Vinyl chloride	75-01-4	59.2	NAL	Yes	1	0.33
Total Xylenes	1330-20-7	57,600	NAL	Yes	3	1
p-xylene	106-42-3	56,100	NAL	Yes	2	0.67
m-xylene	108-38-3	55,100	NAL	Yes	2	0.67
o-xylene	95-47-6	64,500	NAL	Yes	1	0.33

NOTE: Worksheet #15 will be prepared with preliminary target laboratory-specific PQLs and MDLs to be used to procure the laboratory. Once selected, the PQL/MDL information will be updated.

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 RMD
PQL = practical quantitation limit

[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 PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs, and this information will be appended to the QAPP.

QAPP Worksheet #15-I. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (SVOCs, Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: SVOCs

SVOC	CAS Number	Project Action Limit (µg/kg)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL[d] (µg/kg)	MDL[d] (µg/kg)
Acenaphthene	83-32-9	185,000	NAL	Yes	33.3	10
Acenaphthylene	208-96-8	185,000[e]	NAL	Yes	33.3	10
Anthracene	210-12-7	923,000	NAL	Yes	33.3	10
Carbazole	86-74-8	10,400	NAL	Yes	33.3	10
Dieldrin[1]	60-57-1	13.0	NAL	Yes	1.34	0.33
Fluoranthene	206-44-0	123,000	NAL	Yes	33.3	10
Hexachlorobenzene	118-74-1	212	NAL	Yes	333	100
Naphthalene	91-20-3	3,830	NAL	Yes	33.3	10
2-Nitroaniline	88-74-4	35,600	NAL	Yes	333	110
N-nitroso-di-n-propylamine	621-64-7	29.7	NAL	Yes	333	100
Phenanthrene	85-01-8	185,000[e]	NAL	Yes	33.3	10
Pyrene	129-00-0	92,300	NAL	Yes	33.3	10
Total PAHs (carcinogenic)	50-32-8	47.8	NAL	Yes	N/A	N/A

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

[1] SW-846 Method 8081
CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
N/A = not applicable
NAL = no action level for child resident scenario from the RMD
PAH = polycyclic aromatic hydrocarbon
PQL = practical quantitation limit
SVOC = semivolatile organic compound

[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.
[b] Analytes marked with COPC are from Table 2.1 of the RMD (DOE 2018) and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[e] Acenaphthylene and phenanthrene use values for acenaphthene as a surrogate.

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

Matrix: Water
Analytical Group: SVOCs

SVOC	CAS Number	Project Action Limit (µg/L)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL[c] (µg/L)	MDL[e] (µg/L)
Acenaphthene	83-32-9	53/53.5	Tapwater[d]/NAL	Yes	1	0.3
Acenaphthylene[f]	208-96-8	53.5	NAL	Yes	1	0.3
Anthracene	210-12-7	180/177	Tapwater/NAL	Yes	1	0.3
Carbazole	86-74-8	2.03	NAL	Yes	1	0.3
Dieldrin[1]	60-57-1	0.0018/0.00175	Tapwater/NAL	Yes	0.04	0.0125
Fluoranthene	206-44-0	80/80.2	Tapwater/NAL	Yes	1	0.3
Hexachlorobenzene	118-74-1	1.0/0.00976	MCL/NAL	Yes	10	3
Naphthalene	91-20-3	0.17/0.165	Tapwater/NAL	Yes	1	0.3
2-Nitroaniline	88-74-4	19/18.9	Tapwater/NAL	Yes	10	3
N-nitroso-di-n-propylamine	621-64-7	0.011/0.0108	Tapwater/NAL	Yes	10	3
Phenanthrene[f]	85-01-8	53.5	NAL	Yes	1	0.3
Pyrene	129-00-0	12/12.1	Tapwater/NAL	Yes	1	0.3
Total PAHs (carcinogenic)[g]	50-32-8	0.20/0.0251	MCL/NAL	Yes	0.2[h]	N/A

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

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MCL = maximum contaminant level
MDL = method detection limit
NAL = no action level for child resident scenario from the RMD
PAH = polycyclic aromatic hydrocarbon
PQL = practical quantitation limit
SVOC = semivolatile organic compound
[1] SW-846 Method 8081

[a] This QAPP references the MCLs (or EPA screening level for tapwater if no MCL) to support project planning and identify whether lower reporting limits may be needed for some constituents. The worksheet also lists the NALs established by the RMD and MCLs reproduced in the RMD. In some cases, the laboratories may not be able to reach detection limits below the NAL. In these cases, the project team will address this issue in the decision process.
[b] Analytes marked with COPC are from Table 2.1 of the RMD and represent the list of chemicals, compounds, and radionuclides compiled from COPCs retained as COCs in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the PAL/NAL, FRNP will have the laboratory report to the method detection limit, qualifying the result as estimated. Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[d] Tapwater—Source: EPA regional screening levels, Tapwater Supporting Table (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2017.
[e] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs and this information will be appended to the QAPP.
[f] Acenaphthylene and phenanthrene use NALs for acenaphthene as a surrogate.
[g] Total PAHs uses MCL for benzo(a)pyrene.
[h] Nonstandard laboratory method may be necessary to meet PQL.

QAPP Worksheet #15-K. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Uranium [XRF], Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: Metals (uranium by XRF)

Metal	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific	
					PQL (mg/kg)	MDL (mg/kg)
Uranium	7440-61-1	10[b]	Project scoping	Yes	N/A	10

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
N/A = not applicable
PQL = practical quantitation limit

[a] Analytes marked with COPC are from Table 2.1 of the RMD.
[b] The PAL for uranium was set to ensure the DQOs agreed to by the FFA parties were met using the XRF analytical method. The PAL approaches the PGDP surface soil background concentration of 4.9 mg/kg for uranium, and is below the risk-based NAL of 23.4 mg/kg for the child resident (DOE 2018). Finally, an acknowledged XRF subject matter expert confirmed detection at the PAL could be achieved reliably with an XRF calibrated to detect uranium.

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

Matrix: Air
Analytical Group: VOCs

VOC	CAS Number	Project Action Limit ($\mu g/m^3$)	Project Action Limit Reference[a]	Site COPC?[b]	Laboratory-Specific[c]	
					PQL ($\mu g/m^3$)	MDL[e] ($\mu g/m^3$)
1,1-Dichloroethene	75-35-4	880	VISL, Commercial	Yes	2.0	0.59
cis-1,2-Dichloroethene	156-59-2	N/A	No VISL	Yes	2.0	0.59
trans-1,2-Dichloroethene	156-60-5	N/A	No VISL	Yes	2.0	0.59
Trichloroethene	79-01-6	3.0	VISL, Commercial	Yes	2.7	0.81
Vinyl Chloride	75-01-4	2.8	VISL, Commercial	Yes	1.28	0.38

NOTE: Worksheets #12-U, #15-L, and associated information on air sampling have been added to the P-QAPP at the request of the P-QAPP Working Group, though these worksheets have not been part of an approved project-specific QAPP.

CAS = Chemical Abstracts Service
COPC = chemical (or radionuclide) of potential concern
MDL = method detection limit
PQL = practical quantitation limit
VOC = volatile organic compound

[a] VISL = Vapor Intrusion Screening Level, Version 3.5.2 (EPA 2017b) (Commercial, Carcinogen Target Risk = 1.0E-6, Target Hazard Quotient = 1.0).
[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] Laboratory has a PQL of 0.5 parts per billion (in air) by volume (ppbv) and MDL of 0.15 ppbv. These values were converted to $\mu g/m^3$ at 25°C.

QAPP Worksheet #15-L. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Air) (Continued)

Supplemental Information on Air Sampling, including Benchmarks for Exposure of Pregnant Women to TCE

"TRICHLOROETHYLENE: ASSESSING & MANAGING VAPOR INTRUSION RISKS," slides prepared by Kelly Schumacher, EPA Region 7, see http://www.mowastecoalition.org/resources/Documents/Vapor%20Intrusion%20Seminar/Schumacher%20TCE%20VI%20HHRA.pdf

Region 7: Two co-critical endpoints (each can support RfC independently):

- Autoimmune disease following chronic exposure in adults (1.8 $\mu g/m^3$)
- Heart defects following exposure during early pregnancy (2.0 $\mu g/m^3$)

Region 7: One supporting endpoint (less confidence than critical endpoints):

- Nephrotoxicity (kidney effects) following chronic exposure in adults (3.0 $\mu g/m^3$)

Add information on air sampling, including benchmarks for exposure of pregnant women to TCE.

EPA's Developmental Toxicity Risk Assessment Guidelines states that "a single exposure at a critical time in development may produce an adverse developmental effect." A single exposure to ***some*** level of TCE at any time during the three-week critical window of valvuloseptal morphogenesis could result in one or more types of heart defects. The Integrated Risk Information System combined the incidence of all the types of heart defects observed in the critical study to calculate the benchmark dose level (lower, 95% confidence) associated with a 1% excess risk of an "abnormal heart." Since the heart defects occurred throughout valvuloseptal morphogenesis, **the critical exposure period used to derive the RfC = 3 weeks.**

Schumacher cited: June 30, 2014, EPA Region 9 Interim Action Levels and Response Recommendations to Address Potential Developmental Hazards Arising from Inhalation Exposures to TCE in Indoor Air from Subsurface Vapor Intrusion.

QAPP Worksheet #15-L. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Air) (Continued)

Supplemental Information on Air Sampling, Including Benchmarks for Exposure of Pregnant Women to TCE (Continued)

EPA Region 9 Interim TCE Indoor Air Response Action Levels— Residential and Commercial TCE Inhalation Exposure from Vapor Intrusion		
Exposure Scenario	**Accelerated Response Action Level (HQ=1)**	**Urgent Response Action Level (HQ=3)**
Residential*	2 µg/m^3	6 µg/m^3
Commercial/Industrial** (8-hour workday)	8 µg/m^3	24 µg/m^3
Commercial/Industrial** (10-hour workday)	7 µg/m^3	21 µg/m^3

*The residential HQ=1 accelerated response action level is equivalent to the inhalation reference concentration (RfC) since exposure is assumed to occur continuously.

**Commercial/Industrial accelerated response action levels are calculated as a time-weighted average from RfC, based on the length of a workday and rounding to one significant digit (e.g., for an 8-hour workday:
Accelerated Response Action Level = (168 hours per week/40 hours per week) × 2 µg/m^3 = 8 µg/m^3). Time-weighted adjustments can be made as needed for workplaces with longer work schedules.

Note: Indoor air TCE exposures corresponding to these accelerated response action levels would pose cancer risks near the lower end of the Superfund target cancer risk range, considering the IRIS toxicity assessment; thus, the health protective risk range for both accelerated response actions and long-term exposures becomes truncated to: 0.5–2 µg/m^3 for residential exposures and 3–8 µg/m^3 for 8-hour/day commercial/industrial exposures.

Schumacher also cited EPA REGION 10: "…to protect against potential noncancer fetal malformation outcomes, it is appropriate to recommend that average exposures over any 21-day period of time not exceed the concentrations in air or other media that are calculated to be protective…." Not to be exceeded, average 21-day exposure to women of reproductive age to prevent fetal cardiac malformations, HQ = 1.0:

- Residential settings = 2.0 µg/m^3
- Industrial/commercial settings = 8.4 µg/m^3
- Based on 260 days/year (i.e., 5 days/week for 52 weeks/year)

QAPP Worksheet #15-L. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Air) (Continued)

Supplemental Information on Air Sampling, Including Benchmarks for Exposure of Pregnant Women to TCE (Continued)

Schumacher also cited: Massachusetts Department of Environmental Protection

Imminent Hazard Values for Pregnant Women and Those Who May Become Pregnant

Residential Exposure Scenario	**Indoor Air Concentration**	**Concern Level**	**Actions**
Fetal developmental effects (Subchronic Exposure Noncancer Risk, HQ = 1)	> 6 µg/m^3	Imminent Hazard 2-hour Notification	Immediate Response Action Goal to reduce levels to *at least* less than 6 µg/m^3 ASAP (within several days if possible)
Typical Workplace Exposure Scenario	**Indoor Air Concentration**	**Concern Level**	**Actions**
Fetal developmental effects Subchronic Exposure Noncancer Risk, HQ = 1)	> 24 µg/m^3	Imminent Hazard 2-hour Notification	Immediate Response Action Goal to reduce levels to *at least* less than 24 µg/m^3 ASAP (within several days if possible)

QAPP Worksheet #17. Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Sampling Design and Rationale

This worksheet should be used to describe the sampling design and the basis for its selection. This worksheet mainly will consist of text. It documents the last step of the systematic planning process. If a site consists of multiple areas to be sampled, a separate worksheet should be used for each.

There are two general types of sampling designs: (1) probability-based designs, which should be used when statistical conclusions are required; and (2) judgmental designs, which are more applicable to help refine CSMs when further study is planned or to confirm previous findings, but that usually do not provide sufficient basis on their own to support statistical conclusions. Advice on selecting appropriate sample designs may be found in Chapter 2 of *Guidance for Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5s (EPA 2002). *Regardless of the type of design selected, this worksheet should explain the basis for its selection.* It also should describe the following:

1. The physical boundaries for the area under study (include maps or diagrams);

2. The time period being represented by the collected data;

3. The descriptions and basis for dividing the site into sampling areas (e.g., decision units, exposure units) that support the decision statements documented on Worksheet #11;

4. The basis for the number and placement of samples within sampling areas;

5. If sample locations are specified in the QAPP, descriptions of how actual sample positions will be located once in the field (include maps or diagrams);

6. If a sample cannot be collected where planned, the decision process for changing the location;

7. If sample locations will be determined in the field, the decision process for doing so; and

8. Contingencies in the event field conditions are different than expected and could have an effect on the sample design.

QAPP Worksheet #17. Sampling Design and Rationale (Continued)

Site-specific sampling process design and rationale may be outlined in a companion FSP developed for projects. Either the FSP or Worksheet #17 will provide the sampling and analysis requirements for each project, sampling locations, frequencies, rationale for selection, and analytical parameters for each location.

QAPP Worksheet #17. Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

QAPP Worksheet #17-A. Sampling Design and Rationale

Worksheet #17 provides the sampling and analysis requirements for the project, including sampling locations, frequencies, rationale for selection, and analytical parameters for each location. The exact sample locations and the total number of samples might change from those described, depending on field conditions encountered. The purpose of the sampling process design is to describe relevant components of the investigation design; define the key parameters to be investigated; indicate the number and type of samples to be collected; and describe where, when, and how the samples are to be collected. The example information provided below is for a SWMU 4 investigation project.

This sheet is a summary of the project and will be described in the project-specific FSP sampling design and rationale information. The project manager will ensure these components are part of the FSP. Completion of a separate Worksheet #17 to identify where these components are located in the FSP is at the discretion of the project manager.

QAPP Worksheet #17-A. Sampling Design and Rationale (Continued)

Example from SWMU 4. **Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach):** Describe in the project-specific FSP or describe in this worksheet for simple projects.

Describe the sampling design and rationale in terms of which matrices will be sampled: A description of the analyses, methods, and the method detection limits should be provided. The choice of methods and method detection limits should be justified, especially regarding screening levels that will not be attained.

- **What analyses will be performed and at what analytical limits?** See Worksheets #12 and #15.
- **Where are the sampling locations (including QC, critical, and background samples)?** See FSP.
- **How many samples to be taken?** See FSP.

What is the sampling frequency (including seasonal considerations)? (May refer to map or Worksheet #18 for details.)

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, judgmental statistical approach): The investigation will be implemented in five phases. A general description of the planned work for each phase is described below. Contingencies and decision rules for the planned work are found in Section 5 of the SAP/work plan. The FFA parties have agreed that the additional investigative sampling at SWMU 4 as contained within the Field Sampling Plan will conclude sampling for the SWMU 4 project such that EPA and/or KDEP will not request or require any additional sampling other than confirmatory sampling for the remainder of the SWMU 4 project.

Phase I will utilize passive soil gas technology to identify areas within the SWMU that feature elevated VOC soil vapor readings. The rationale for this phase is to provide screening level data to determine the best location of subsequent data collection efforts. These are employed because they are fast, easy, inexpensive, and provide data adequate for this screening-level phase of the project. Though the sphere, or radius, of effectiveness is influenced by many factors (e.g., depth and concentration of the source, soil porosity) and is difficult to determine, the method will detect VOCs over a larger area than a conventional soil sample. The first phase also will consist of collecting surface soil samples to determine contaminant distribution and concentration in surface soils. This will be accomplished using five-point composite sampling that will be analyzed using field techniques (i.e., PCB test kits and metals analysis by XRF) and sending 10% of the total to a fixed-base laboratory. The rationale for this is to get the maximum coverage of the area while minimizing analytical costs.

QAPP Worksheet #17-A. Sampling Design and Rationale (Continued)

Phase II will collect shallow (< 20 ft bgs) samples. These samples will be used to identify VOC concentrations, along with other COCs, in the disposal cells and adjacent shallow soils. The results from the passive soil gas sampling and historical soil and water sample results will be used to select locations that are the most likely to contain elevated COCs. Test pits also will be excavated to gather subsurface information between 0 and 20 ft bgs. (Note: Though test pits are considered part of Phase II, for logistical reasons, they will be excavated after Phase V.) Additionally, Phase II will include installation of seven shallow (20 ft bgs) UCRS monitoring wells; water elevations and samples will be collected from these wells. Phase III will include a maximum of 27 Direct Push Technology borings to 60 ft bgs at the locations agreed to by the FFA parties. The rationale for this phase is to determine the depth and the lateral extent of contamination.

Phase IV will install 10 borings to the top of the McNairy Formation, approximately 105 ft. The rationale for these borings is to determine the extent and mass of TCE source term with sufficient accuracy to effectively and efficiently complete a remedial design for source term in the RGA.

Phase V will include installation of five additional RGA monitoring wells. The rationale for this sampling is to define the nature and extent of VOC source term so that a remedial design for VOCs can be completed. Samples will be collected from soil and water (where encountered) at UCRS (Hydrogeologic Unit 4)/RGA interface to identify where VOC source term may have penetrated to the RGA. Additional samples will be collected from soil at the RGA interface with the McNairy to complete a remedial design for a VOC remedy in the RGA, if a free-phase TCE source is found at the base of the RGA. A second objective of Phase V is to collect sufficient quality and quantity of data to determine the RGA groundwater velocity and flow direction.

Describe the sampling design and rationale in terms of which matrices will be sampled: Passive soil gas sampling will be used to determine the locations of soil boring based on the highest VOC concentrations. Soil and water samples will be collected from the borings to a depth of 105 ft. Samples will be analyzed for VOCs, SVOCs, PCBs, metals, and radionuclides (refer to QAPP Worksheet #18 for the number samples and analytical methods by depth). Twenty-two soil borings will be sampled down to 20 ft bgs. Data from the 20 ft borings will be used in part to select locations for 27 borings that will be extended to 60 ft bgs. Ten additional borings will be advanced 105 ft (approximate bottom of the RGA/top of the McNairy Formation). Contingency sampling, as described in Section 5 of the SAP/Work Plan, may occur.

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

Standard Environmental Sampling: Total volatile organic analyte (VOA) analysis by SW-846, 8260; PCB extraction by SW-846-3150C for water, PCB extraction for soil by SW-846-3540C or SW-846-3546, analysis by 8082, metal analysis by SW-846, 200.8/6010B/6020; radiological analysis by alpha spec, gamma spec, and liquid scintillation; semivolatile organic analyte (SVOA) analysis by SW-846, 8270. See Worksheet #15 for method detection limit.

Engineering and Design Sampling: Chemical oxygen demand by EPA 410.4; total and dissolved organic carbon by SW-846-9060 EPA 415.1, slug test by ASTM D7242-06. See Worksheet #17-B for complete list and additional details.

Where are the sampling locations (including QC, critical, and background samples)? See Worksheet #18.

How many samples to be taken? 161 soil samples, up to 132 water samples (dependent on water yield). See Worksheet #18.

What is the sampling frequency (including seasonal considerations)? This is a one-time sampling event except for the 20 ft wells installed under the scope of Phase II, which will be measured monthly for 12 months in order to determine the effects of various seasonal conditions on groundwater level. Installed wells will be sampled once upon completion; subsequent sampling will be based on the Environmental Monitoring Plan for the PGDP (FRNP 2018), which is updated annually. Thus seasonal conditions at the time of sampling are unknown. Passive soil gas sampling is the only other sampling that may be affected by seasonal conditions; it is assumed that unsaturated soil conditions are optimal for this data gathering; the manufacturer will be consulted and the deployment schedule may be altered to avoid seasonal saturation.

QAPP Worksheet #17-B. Sampling Design and Rationale (Engineering and Design Sampling)

Analysis	Media Type	# of Samples	Test/Analytical Method	Project Reference Value	PQL
Standard Penetration Test	Soil	4 UCRS, 3 RGA	ASTM D1586-11	N/A	N/A
Grain Size Data	Soil	4 UCRS, 3 RGA	ASTM D422-63(2007)	N/A	N/A
Air Permeability	Soil	1	ASTM D6539-13	N/A	N/A
Percolation Test	Soil	4 UCRS	ASTM D338509	N/A	N/A
Fraction Organic Carbon	Soil	1	SW-846-9060 as modified for soil samples	N/A	N/A
Electron Donor Parameters					
Chemical Oxygen Demand	Water	2	EPA 410.4	N/A	27 mg/L
Total Organic Carbon	Water	2	EPA 415.1/ SW-846-9060	20 mg/L	1 mg/L
Dissolved Organic Carbon	Water	2	EPA 415.1/ SW-846-9060	20 mg/L	1 mg/L
Field Parameters					
DO	Water	All Water	Hach® Quanta Hydrolab	0.5 mg/L	0.2 mg/L
pH	Water	All Water	Hach® Quanta Hydrolab	5 to 9 Std Units	02. Std Units
Redox	Water	All Water	Hach® Quanta Hydrolab	50 mV against Ag/AgCl	20 mV
Temperature	Water	All Water	Hach® Quanta Hydrolab	20°C	+/- 0.1°C
Specific Conductance		All Water	Hach® Quanta Hydrolab	N/A	0.001 mS/cm
Alkalinity	Water	4 UCRS, 3 RGA	Hach® Alkalinity Test Kit, Model AL-DT	N/A	0.1–10 mg/L
Slug test	Water	5	ASTM D7242-06	N/A	N/A
Microbial Parameters					
Microbial Community	Water	2	Laboratory SOP	N/A	N/A
Water Quality Parameters					
Sulfate	Water	1	EPA 300.0/SW-846-9056	N/A	2 mg/L
Chloride	Water	1	EPA 300.0/SW-846-9056	N/A	2 mg/L
Calcium	Water	1	SW-846-6010B	N/A	1 mg/L
Nitrate	Water	1	EPA 300.0/SW-846-9056	N/A	4 mg/L
Ferrous Iron	Water	1	SM 3500-Fe B	N/A	0.2 mg/L

QAPP Worksheet #18. Sampling Locations and Methods
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)

QAPP Worksheet #18. Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples

The primary value of this worksheet is as a completeness check for field personnel and auditors/assessors. As with Worksheet #17 above, this sheet is a summary of the project and will be described in the project-specific FSP sampling design and rationale information. The project manager will ensure these components are part of the FSP. Completion of a separate Worksheet #18 to identify where these components are located in the FSP is at the discretion of the project manager.

Worksheet #18 facilitates checks to make sure all planned samples have been collected and appropriate methods have been used. Ideally, this worksheet should list each individual sample that is planned to be collected, including field QC samples. Samples with common entries may be grouped, but field QC samples and samples that are unique must be listed separately. If a sample is being collected in increments, use only one line to identify the sample as it will be analyzed; there is no need to list the increments separately. (If the increments are placed in separate containers to be combined in the laboratory, then each container must be labeled.) If a project involves the collection of a large number of samples, however, it may be acceptable to list groups of similar samples on a single row. Detailed sampling SOPs must be available to field personnel and should be included as an appendix to the QAPP and referenced in this worksheet. The comments field can be used as a reminder to note any special sample handling required in the field and/or Global Positioning System (GPS) coordinates. A map with locations marked should be included. Use additional worksheets as necessary.

QAPP Worksheet #18. Sampling Locations and Methods (Continued)
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)

QAPP Worksheet #18. Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples

Worksheet #18 provides information pertaining to sampling planned for this project. Example taken from SWMU 4 Project.

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Concentration Level[b]	Number of Samples (Identify Field Duplicate %)[c]	Sampling SOP Reference[d]	Rationale for Sampling Location
TBD	Soil	Surface/ subsurface	Metals 6200 by XRF	Unknown	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	Surface/ subsurface	PCB by Hach® Pocket Colorimeter™ II Test Kit (or equivalent)	Unknown	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	Surface/ subsurface	Gamma radiation by sodium iodide detector (or equivalent)	Unknown	N/A	N/A	See Worksheet #17
TBD	Soil	Surface/ subsurface	Metals	Unknown	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	Surface/ subsurface	PCBs	Unknown	TBD (minimum of 5%)	See Worksheet #21	See Worksheet #17

QAPP Worksheet #18. Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples (Continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Concentration Level[b]	Number of Samples (Identify Field Duplicate %)[c]	Sampling SOP Reference[d]	Rationale for Sampling Location
TBD	Soil	0–20 ft (5 ft intervals)	VOC, SVOCs, PCBs, Radiological, Metals	Low	94 (4 samples from each of 22, 20 ft-borings, and 1 sample from each of 6 test pits) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	20–60 ft (10 ft intervals)	VOCs (all intervals); Metals, Radiological, and PCBs in the Top and Bottom Intervals	Low	108 (4 samples from each of 27, 60 ft borings) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	0–20 ft	VOC, SVOCs, PCBs, Radiological, Metals	Low	35 (1 sample from each of 22, 20 ft borings, 1 from each of 7 newly installed UCRS MWs, and 1 from each of 6 test pits) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	20–60 ft	VOCs	Low	27 (1 sample from each of 27, 60 ft borings) (minimum of 5%)	See Worksheet #21	See Worksheet #17

QAPP Worksheet #18. Sampling Locations and Methods/Standard Operating Procedure Requirements Table for Screening Samples (Continued)

Example (including footnotes) from SWMU 4

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Concentration Level[b]	Number of Samples (Identify Field Duplicate %)[c]	Sampling SOP Reference[d]	Rationale for Sampling Location
TBD	Soil	0–1 ft	PCBs test kits, XRF Metals analysis (performed in field lab); PCBs, Metals SVOCs, radiological (performed in fixed-base lab)	Low	154 (1 sample from each of 154 five-point composite grids) will be sent to a field lab, of these 16 will be sent to a fixed-base lab for verification (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	60–105	VOCs, Tc-99	Low	20 (2 intervals from each of 10 105 ft borings) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Water	60–105	VOCs, Tc-99	Low	95 (9 intervals from each of 10 105 ft borings and 1 from each of 5 newly installed RGA MWs) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0–105	Geotechnical	Low	8 samples taken for grain size and air permeability (no duplicates)	See Worksheet #21	See Worksheet #17
TBD	Soil gas	0–1 ft	VOCs	Low	48	See Worksheet #21	See Worksheet #17

[a] See Analytical SOP References Table (Worksheet #23).
[b] If historical data provide information on anticipated concentration, that information will be populated on this sheet.
[c] Contingency locations not included.
[d] See Field SOP References Table (Worksheet #21).

N/A = not applicable
PCB = polychlorinated biphenyl
SOP = standard operating procedure
TBD = to be determined
XRF = X-ray fluorescence

QAPP Worksheet #19 and 30. Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

The purpose of this worksheet is to serve as a reference guide for field personnel. It is also an aid to completing the chain-of-custody form and shipping documents. Complete this table for each laboratory used. If laboratory accreditation/certification is required for this project, the project team must verify that the laboratory maintains current accreditation/certification status for each analyte/matrix/method combination, as applicable, throughout its involvement with the project. If the accreditation expiration dates are the same for entries then a global expiration date can be added at the top of the table, as appropriate.

Laboratory: (Name, sample receipt address, point of contact, e-mail, and phone numbers)

List any required accreditations/certifications:

Back-up Laboratory: N/A

Sample Delivery Method:

Example

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
VOCs	Surface Water	EPA Methods 5035 & 8260C/ SA-VO-004	Nov 12, 2018	3 × 40 ml VOA vials	HCl to pH< 2; 0–6˚C	N/A	14 days	28 days
SVOCs	Groundwater	EPA Method 8270D/ SA-SM-033	Nov 12, 2018	2 × 1000 ml amber glass	0–6˚C	7 days	40 days	28 days

QAPP Worksheet #19 and 30. Sample Containers, Preservation, and Hold Times (Continued)
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Example (Continued)

Analyte/ Analyte Group	Matrix	Method/SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
PCBs	Groundwater	EPA Method 8082A/ PT-GC-005	Nov 12, 2018	2 × 1000 ml amber glass	0–6˚C	N/A	NA*	28 days
Metals	Soil/ Sediment	EPA Method 6010D/ SA-ME-70	Nov 12, 2018	1 × 4 oz. wide mouth glass jar	4 ± 2 ˚C	N/A	180 days	28 days
Radionuclides	Soil/ Sediment	DOE Method GA-01-R/ ST-RC-0102	Nov 12, 2018	1 × 16 oz. wide mouth plastic jar	NA	N/A	180 days	28 days
Mercury	Soil/ Sediment	EPA Method 7471B/ SA-ME-028	Nov 12, 2018	1 × 4 oz. wide mouth glass jar	4 ± 2 ˚C	N/A	28 days	28 days
VOCs	Air	EPA-Method TO-15	Nov 12, 2018	SUMMA® canister with 10-hour sample duration	N/A	N/A	30 days	28 days

NOTE: Sample volume and container requirements will be specified by the laboratory.
* There is no analytical holding time listed for PCB analysis by EPA Method 8082A.

HCL = hydrochloric acid

QAPP Worksheet #20. Field QC Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

Field Quality Control Sample Summary Table

This worksheet provides a summary of the types of samples to be collected and analyzed for the project. Its purpose is to show the relationship between the number of field samples and associated QC samples for each combination of analyte/analytical group and matrix. This worksheet also is useful for informing the laboratory of the number of samples to expect and for preparing analytical cost estimates. The number and types of QC samples should be based on project-specific DQOs, and this worksheet should be adapted as necessary to accommodate project-specific requirements. Not all types of QC samples shown in the example below will be necessary for all projects. However, some projects may require additional QC samples (e.g., proficiency testing samples), which can be listed in the "other" column.

Samples that are collected at different depths at the same location, and analyzed separately, should be counted as separate field samples. Even if they are taken from the same container as the parent field sample, matrix spikes (MSs) and MS duplicates are counted separately, because they are analyzed separately. If composite samples or incremental samples are being collected, include only the sample that will be analyzed, subsamples and increments should not be listed separately; however, containers making up the sample (as received by the laboratory) must be labeled.

The Optimized –UFP QAPP guidance provides the following example table for field QC.

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Soil	VOCs (low conc.)	40	2	2	2	0	0	1	N/A	47
Soil	RCRA Metals	60	3	3	3	0	1	0	N/A	69
Water	SVOCs	40	2	2	2	0	1	0	N/A	47

QAPP Worksheet #21. Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

Project Sampling SOP References Table

This worksheet is intended for use to document the specific field procedures being implemented, which is important for measurement traceability. The QAPP must contain detailed descriptions of procedures for field activities, including sample collection; sample preservation; equipment cleaning and decontamination; equipment testing, maintenance, and inspection; and sample handling and custody. If these procedures are included in existing SOPs, then the SOPs should be reviewed to make sure they either are (1) sufficiently prescriptive to be implemented as written or (2) modified as necessary for this project. If an SOP provides more than one procedure or option (for example, one SOP covers the use of several different types of field equipment for the same procedure) this worksheet must note the specific option or equipment being used. Basic information about the SOPs should be provided in this table, and the SOPs themselves should be included in an appendix to the QAPP. Field SOPs must be readily available to field personnel responsible for their implementation. The QAPP must explain any planned modifications to field SOPs. Modifications should be noted clearly on the SOPs. The specific type(s) of SOP modifications/deviations must be summarized in the comments column or a reference provided.

QAPP Worksheet #21. Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

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	CP4-ES-0043, *Temperature Control for Sample Storage* (12/19/2017)	Contractor	Sampling	N	N/A
2	CP2-WM-0001, *FRNP Waste Management Plan* (10/20/2017)	Contractor	N/A	N	N/A
3	CP2-ES-0026, *Wet Chemistry and Miscellaneous Analyses Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
4	CP2-ES-0811, *Pesticide and PCB Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
5	CP4-ES-1001, *Transmitting Data to the Paducah Oak Ridge Environmental Information System (OREIS)* (12/21/2017)	Contractor	N/A	N	N/A
6	CP2-ES-0063, *Environmental Monitoring Data Management Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (12/13/2017)	Contractor	N/A	N	N/A
7	CP4-ES-2100, *Groundwater Level Measurement* (1/2/2018)	Contractor	Sampling	N	N/A
8	CP4-ES-2101, *Groundwater Sampling* (1/10/2018)	Contractor	Sampling	N	N/A
9	CP4-ES-2203, *Surface Water Sampling* (1/4/2018)	Contractor	Sampling	N	N/A
10	CP4-ES-2302, *Collection of Sediment Samples Associated with Surface Water* (1/18/2018)	Contractor	Sampling	N	N/A
11	CP4-ES-0074, *Monitoring Well Inspection and Maintenance* (1/3/2018)	Contractor	Sampling	N	N/A
12	CP4-ES-2700, *Logbooks and Data Forms* (12/4/2017)	Contractor	N/A	N	N/A
13	CP4-ES-2702, *Decontamination of Sampling Equipment and Devices* (1/4/2018)	Contractor	Sampling	N	N/A

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

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
14	CP4-ES-2704, *Trip, Equipment, and Field Blank Preparation* (1/2/2018)	Contractor	N/A	N	N/A
15	CP4-ES-2708, *Chain-of-Custody Forms, Field Sample Logs, Sample Labels, and Custody Seals* (12/12/2017)	Contractor	N/A	N	N/A
16	CP3-ES-5003, *Quality Assured Data* (1/9/2018)	Contractor	N/A	N	N/A
17	CP3-ES-5004, *Sample Tracking, Lab Coordination, and Sample Handling Guidance* (12/5/2017)	Contractor	N/A	N	N/A
18	CP4-ES-5007, *Data Management Coordination* (12/7/2017)	Contractor	N/A	N	N/A
19	CP2-ES-5102, *Radiochemical Data Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
20	CP2-ES-5103, *Polychlorinated Dibenzodioxins-Polychlorinated Dibenzofurans Verification and Validation* (12/13/2017)	Contractor	N/A	N	N/A
21	CP2-ES-5105, *Volatile and Semivolatile Data Verification and Validation* (12/20/2017)	Contractor	N/A	N	N/A
22	CP2-ES-5107, *Inorganic Data Validation and Verification* (12/13/2017)	Contractor	N/A	N	N/A
23	CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Implementation Plans* (12/27/2017)	Contractor	N/A	N	N/A
24	CP4-ES-1002, *Submitting, Reviewing, and Dispositioning Changes to the Environmental Databases OREIS and PEMS* (12/21/2017)	Contractor	N/A	N	N/A
25	CP4-ER-1035, *Vapor Sampling* (1/10/2018)	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, SOPs listed will be followed.
N/A = not applicable

QAPP Worksheet #22. Field Equipment Calibration, Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

This worksheet should document procedures for calibrating, maintaining, testing, and/or inspecting field equipment (e.g., tools, pumps, gauges, magnetometers, pH meters, water-level measurement devices). If these activities are documented in an SOP or manufacturer's instructions, and the relevant SOP or instruction is attached, then the frequency, acceptance criteria, and corrective action columns may be left blank. Note that the information summarized in this worksheet should be recorded in the field notes/logs.

QAPP Worksheet #22. Field Equipment Calibration, Maintenance, Testing, and Inspection (UFP-QAPP Manual Section 3.1.2.4) (EPA 2106-G-05 Section 2.3.6)

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
MiniRAE Photoionization Detector (PID) Toxic Gas Monitor with 10.5 eV Lamp or Similar Meter	Calibrate at the beginning of the day; check at the end of the day	As needed in the field; semiannually 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	Recalibrate or service as necessary	Field Team Leader	Manufacturer's specifications

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

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
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
Ferrous Iron Colorimeter	Accuracy check at the beginning of each day	Return to instrument rental for replacement	Measure with standard solution	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Return to rental company for replacement	Field Team Leader	Manufacturer's specifications
PCB Colorimeter	Accuracy check at the beginning of each day	As needed	Measure with standards	Upon receipt, successful operation	Check daily before each use	Within range of manufacturer's standard	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Titrator (for total residual chlorine)	Calibrate to manufacturer's solution weekly	As needed	Measure with standard solution	Upon receipt, successful operation	Weekly	With range of manufacturer's standard	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Global flow meter	Calibrate when replace battery	As needed	Spin prop to verify instrument reading	Upon receipt, successful operation	Check daily before each use	Pass/Fail	Service by manufacturer	Field Team Leader	Manufacturer's specifications
Electron 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
Hach® flow meter	Calibrate to readings on flume	Quarterly or as needed	Measure against flume	Upon receipt, successful operation	Weekly as needed	Pass/Fail	Service by manufacturer	Field Team Leader	Manufacturer's specifications

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

Field Equipment*	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Alpha Scintillator	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Geiger Mueller	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Daily prior to use	Pass/Fail	Return to rental company for replacement	RCT Supervisor	Manufacturer's specifications
Gamma Scintillator or FIDLER	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
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
GPS Gamma Ray Survey Instrumentation	Annually or as specified by manufacturer	Annually or as needed	Daily prior to use	Upon receipt, successful operation	Annually or as needed	Pass/Fail	Return to rental company for replacement	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*.
FIDLER = field instrument for detection of low energy radiation
GPS = Global Positioning System
N/A = not applicable
PCB = polychlorinated biphenyl
RCT = radiological control technician

QAPP Worksheet #23. Analytical SOPs
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

Analytical SOP References Table

This worksheet documents information about the specific sample preparation and analytical procedures to be used, which is important for measurement traceability. Screening data are used for interim investigations and/or will not be used for final risk assessment or site assessment decisions unless they have been confirmed with definitive procedures. SOPs for sample preparation and analytical procedures must be current and referenced whether these activities are performed in the field or in an off-site laboratory. If this information is not known at the time the QAPP is being prepared (i.e., laboratory selection has not occurred), it is acceptable to enter "TBD" for the required information. This worksheet must be completed, however, before the QAPP is approved. If required by the project, copies of the SOPs should be included as a hard copy or electronic appendix. The project team should review SOPs to make sure they are either (1) sufficiently prescriptive to be implemented as written or (2) modified, as necessary, for this project. If an SOP provides more than one procedure or option [e.g., extraction procedures for analytes of different concentration levels (SW5035), sulfur cleanup options (SW3660), or derivatization techniques (SW8151)], the specific option being implemented must be noted. This worksheet must summarize planned modifications to existing SOPs, and modifications should be noted clearly on the copies of the SOPs themselves. Personnel responsible for implementing sample preparation and analytical SOPs must have access to the specific SOPs they are using.

QAPP Worksheet #23. Analytical SOP's
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

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)
8260	Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	VOAs/Soil and Water	GC/MS	GEL or TestAmerica	No
8082	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	Definitive	PCBs/ Soil and Water	GC	GEL or TestAmerica	No
6010	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	Definitive	Metals/Soil	ICP	GEL or TestAmerica	No
6020	Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)	Definitive	Metals/ Water	ICP-MS	GEL or TestAmerica	No
8270[1]	Semivolatile Organic Compounds (SVOCs) by Gas Chromatography/Mass Spectrometry (GC/MS)	Definitive	SVOCs/ Water	GC/MS	GEL or TestAmerica	No
7470/7471	Cold vapor Atomic Absorption (AA)	Definitive	Mercury/ Soil and Water	AA	GEL or TestAmerica	No
4035	Soil Screening for Polynuclear Aromatic Hydrocarbons (PAHs) by Immunoassay	Screening	PAHs/ Soil	Field Test Kit	FRNP	No
4020	Screening for Polychlorinated Biphenyls by Immunoassay	Screening	PAHs/ Soil	Field Test Kit	FRNP	No
9060	Total Organic Carbon (TOC)	Definitive	Wet Chemistry Parameters/ Soil	TOC Analyzer (NDIRD)	GEL or TestAmerica	No

QAPP Worksheet #23. Analytical SOP References Table (Continued)

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)
9040	pH Electrometric Measurement	Definitive	Physical/ Soil	pH Meter	GEL or TestAmerica	No
TO-15	Determination Of VOCs In Air Collected In Specially-Prepared Canisters And Analyzed by GC/MS	Definitive	VOCs/ Air	GC/MS	ALS	No
Gas Flow Proportional***	Gas Flow Proportional	Definitive	Rads/Soil and Water	Gas flow proportional counter	GEL or TestAmerica	No
Alpha Spec***	Alpha Spectrometry	Definitive	Rads/Soil and Water	Alpha Spectrometry	GEL or TestAmerica	No
Gamma Spec***	Gamma Spectrometry	Definitive	Rads/Soil and Water	Gamma Spectrometry	GEL or TestAmerica	No
Liquid Scintillation***	Tc-99 by Liquid Scintillation	Definitive	Rads/Soil and Water	Liquid Scintillation	GEL or TestAmerica	No

*Information will be based on laboratory used. Analysis will be by the most recent revision.
**GEL Laboratories information is applicable to Phase I, II, and the initial 11 borings on Phase III.
***Analytical methods for radiochemistry parameters are laboratory specific.
NDIRD = nondispersive infrared detector
[1] Only samples from Phase I and Phase II will be analyzed for SVOCs.

QAPP Worksheet #24. Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

This worksheet should be completed for analytical instruments, whether used in the field or the laboratory. As appropriate to the instrument, calibration procedures should include tuning, initial calibration, calibration blank, initial calibration verification (second source), continuing calibration verification, linear dynamic range (ICP and ICP/MS only), and verification of detection and quantification limits (however defined.) See also Worksheet #15. If information for a specific procedure is provided in an SOP, and the SOP is attached, then this worksheet can reference the SOP and identify the responsible person.

QAPP Worksheet #24. Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

QAPP Worksheet #24. Analytical Instrument Calibration

The contracted laboratory(s) will be DOECAP certified. 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 QA Plan including control charts established for instrumentation. This information is audited annually by DOECAP.

Whenever possible, the laboratory uses recognized procedures for calibration such as those published by EPA or American Society for Testing and Materials. If established procedures are not available, the laboratory develops a calibration procedure based on the type of equipment, stability, characteristics of the equipment, required accuracy, and the effect of operation error on the quantities measured. Whenever possible, physical reference standards associated with periodic calibrations such as weights or certified thermometers with known relationships to nationally recognized standards are used. Where national reference standards are not available, the basis for the reference standard is documented. Equipment or instruments that fail calibration or become inoperable during use are tagged to indicate they are out of calibration. Such instruments or equipment are repaired and successfully recalibrated prior to reuse. High resolution mass spectrometer instruments undergo extensive tuning and calibration prior to running each sample set. The calibrations and ongoing instrument performance parameters are recorded and reported as part of the analytical data package.

Instrument*	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference

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

QAPP Worksheet #25. Analytical Instrument and Equipment Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.2.3)
(EPA 2106-G-05 Section 2.3.6)

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

The project team should determine whether it is necessary to complete fields in this table. For example, if the selected laboratory is operating under a quality system that conforms to ISO 17025:2005, then the activities documented in this table will be documented in the laboratory's quality manual (however named). In this case, it may be acceptable simply to reference the quality manual (including revision number and date.) If the project has specific requirements that are different from those contained in the laboratory's quality manual, this table should be completed for those items.

The contracted laboratory(s) will be DOECAP certified. As such, laboratory instrument and equipment maintenance, testing, and inspection are performed under a certified quality system as documented in the laboratory's quality manual (however named). In most cases, it may be acceptable simply to reference the DOECAP certification. If the project has specific requirements that are different from those contained in the laboratory's quality manual, this table should be completed for those items.

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

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

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*
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
GC	Electron capture detector (ECD)/flame ionization detector (FID) maintenance; replace/clip capillary column	QC standards	ECD, FID, injector, injector liner, column, column flow	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Section Manager	See Worksheet #23
ICP-AES	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Initial and/or continuing calibration criteria must be met	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23
ICP-MS	Clean plasma torch; clean filters; clean spray and nebulizer chambers; replace pump tubing	Metals	Torch, filters, nebulizer chamber, pump, pump tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23

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*
pH meter	Clean probe	QC standards	Probe	As needed	The value for each of the certified buffer solutions must be within ± 0.05 pH units of the expected value	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
Spectro-photometer	Flush/replace tubing	QC standards	Tubing	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Manager	
TOC Analyzer (NDIRD)	Replace sample tubing, clean sample boat, replace syringe	QC standards	Tubing, sample boat, syringe	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Manager	See Worksheet #23
CVAA	Replace tubing, check instrument lines and connections, check windows in cell, ensure lamp operational	Metals	Instrument lines and connections, windows and lamp	As needed	Must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Laboratory Area Supervisor	See Worksheet #23

CVAA = cold vapor atomic absorption
FID = flame ionization detector
GC-MS = gas chromatography-mass spectrometry
GC = gas chromatography
ICP-AES = inductively coupled plasma atomic emission spectroscopy
ICP-MS = inductively coupled plasma mass spectroscopy
NDIRD = nondispersive infrared detector
QC = quality control
TOC = total organic carbon

*The laboratory is responsible for maintaining instrument and equipment maintenance, testing, and inspection information per their QA Plan. This information is audited annually by DOECAP. Laboratory(s) contracted will be DOECAP audited. Field survey/sampling instrumentation will be maintained, tested, and inspected according to manufacturer's instructions.

QAPP Worksheet #26 and 27. Sample Handling, Custody, and Disposal
(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Section 2.3.3)

This worksheet is used to document responsibilities for maintaining custody of samples from sample collection through disposal. Examples of forms, sample labels, and chain-of-custody documentation should be included as an attachment to the QAPP. The information in this worksheet table can be referenced to the appropriate SOPs if they are attached to the QAPP.

The Optimized–UFP QAPP guidance provides the following text and table for sample handling, custody, and disposal.

Sampling Organization:

Laboratory:

Method of sample delivery (shipper/carrier):

Number of day from reporting until sample disposal:

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-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 Guidance*
Chain of custody form completion	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-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 Guidance*
Packaging	Sampling Teams/DOE Prime Contractor and Subcontractors	CP4-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 Guidance*
Shipping coordination	Sample Management Office /DOE Prime Contractor	CP4-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 Guidance*
Sample receipt, inspection, & log-in	Sample Management/Contracted Laboratory	DV-QA-003, Rev. 25 Sample Management and Chain of Custody
Sample custody and storage	Sample Management/Contracted Laboratory	DV-QA-003, Rev. 25 Sample Management and Chain of Custody
Sample disposal	Sample Management/Contracted Laboratory	DV-QA-003, Rev. 25 Sample Management and Chain of Custody

QAPP Worksheet #28. Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

The purpose of this worksheet is to ensure that the selected analytical methods are capable of meeting project-specific MPC, which are based on PQOs/DQOs. Complete a separate worksheet for each sampling technique, analytical method/SOP, matrix, and analytical group. If method/SOP QC acceptance criteria do not meet the project-specific MPC, the data obtained may be unusable for making reliable project decisions. In this case, the project team should consider selecting an alternate method or modifying the method. The list of QC samples in this example is incomplete. See Section 2.2 of Part 2B of the UFP-QAPP QA/QC Compendium, the QA Matrix in Section 3.4, and Tables 4, 5, and 6 for further information and guidance on QC samples.

QAPP Worksheet #28. Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

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

Matrix: Aqueous Samples
Analytical Group/Concentration Level: VOC, Metals, PCBs, Rads, SVOCs[1]
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: 8260, 200.8/6010/6020,8082, Alpha Spec, Gamma Spec, Liquid Scint, 8270
Sampler's Name/Field Sampling Organization: FRNP
Analytical Organization: GEL
No. of Sample Locations: 157

QC Sample	Frequency/Number*	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**	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**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks	1 per analytical batch	See data validation plans 5105, -5107	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

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

QC Sample	Frequency/Number*	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-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate Standards	All sample blanks and QA samples	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	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-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Verify results re-prepare and reanalyze	Laboratory analyst	Precision	See procedure CP3-ES-5003, *Quality Assured Data*

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

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective	Data Quality Indicator (DQI)	Measurement Performance Criteria
Tracers/Carriers	Each sample tested by a radiochemical separations method	See data validation plan CP2-ES-5102	Check calculations and instrument; reanalyze affected samples	Laboratory analyst	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*

*The number of QC samples is listed on Worksheet #20.
**Unless dictated by project-specific parameters, ≤ contract-required quantitation limit (CRQL).
[1] Only samples from Phase I and Phase II will be analyzed for SVOCs.

QAPP Worksheet #28-B. QC Samples Table (Soil/Sediment)

Matrix: Soils/Sediments
Analytical Group/Concentration Level: VOC, Metals, PCBs, Radionuclides, SVOCs[1]
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: 8260, 200.8/6010/6020,8082, Alpha Spec, Gamma Spec, Liquid Scint, 8270
Sampler's Name/Field Sampling Organization: FRNP
Analytical Organization: GEL Laboratories
No. of Sample Locations: 384

QC Sample	Frequency/Number*	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**	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**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Equipment blank	Minimum 5%	≤ CRQL**	Verify results; reanalyze		Contamination—Accuracy/bias	See procedure CP3-ES-5003, *Quality Assured Data*
Spiked field samples	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy/Precision	See procedure CP3-ES-5003, *Quality Assured Data*
Laboratory spiked blanks	1 per analytical batch	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Contamination—Accuracy/Bias	See procedure CP3-ES-5003, *Quality Assured Data*

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

QC Sample	Frequency/Number*	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-0026, -0811, 5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples	Laboratory should alert project	Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Surrogate Standards	All sample blanks and QA samples	See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107	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-0026, -0811, 5102, -5105, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	None	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50% soils, RPD < 25% aqueous, Specific RPD defined for each group in Worksheet #12
Laboratory duplicate	Per laboratory procedure	See data validation plans CP2-ES-0026, -0811, 5102, -5105, -5107	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*

*The number of QC samples is listed on Worksheet #20.
**Unless dictated by project-specific parameters, ≤ CRQL.
[1] Only samples from Phase I and Phase II will be analyzed for SVOCs.

QAPP Worksheet #28-C. QC Samples Table (Air)

Matrix: Air
Analytical Group/Concentration Level: VOCs/Low
Sampling SOP: See Worksheet #21
Analytical Method/SOP Reference: TO-15
Sampler's Name/Field Sampling Organization: FRNP
Analytical Organization: GEL
No. of Sample Locations: 10 Locations for a total of 13 + 1 duplicate = 14 samples

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate	1 per 20 samples*	As with other samples	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	RPD ≤ 50%
Routine Laboratory	Per lab SOP	Per lab SOP	Per lab SOP	Per lab SOP	Per lab SOP	Per lab SOP

*At least one field duplicate will be collected for each sampling event; if more than 20 samples are collected, then a field duplicate will be collected for each set of 20 samples (and appropriate fractions thereof if more than 20 samples are collected).

QAPP Worksheet #29. Project Documents and Records
(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

This worksheet should be used to record information for documents and records that will be generated for the project. It describes how information will be collected, verified, and stored. Its purpose is to support data completeness, data integrity, and ease of retrieval.

The Optimized–UFP QAPP guidance provides the following example tables for project documents and records.

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**
Field audit checklists	Project Manager	Project Director	Project File
Data verification checklists	Sample Management Office/ Data Validator	Sample Management Office	Project File
Data validation report	Data Validator	Sample Management Office	Project File
Data usability assessment report	Data Validator	Sample Management Office	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
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)

Planned Project Assessments Table

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/PQOs. 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
Readiness Review	Project Director/ FRNP	One assessment one week prior to mobilization	[fill in planned dates]	Readiness Review Memorandum and Checklist	48 hours following assessment
Field Sampling technical systems audit (TSA)	Field Team Leader/ FRNP	One each on first day of soil, biota, and groundwater sampling episodes	[fill in planned dates]	Field Sampling TSA Memorandum and Checklist	48 hours following assessment
On-site analytical TSA	Field Team Leader/ FRNP	Prior to start of on-site analytical work and every 2 weeks thereafter	[fill in planned dates]	On-site Analytical TSA Memorandum and Checklist	48 hours following assessment
Offsite Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Repot	Per Individual Laboratory QA Manual
Management Review	Project Director & QA Manager/ FRNP	Interim management review following site mobilization; final management review upon completion of fieldwork	[fill in planned dates]	QA Management Report	48 hours following management review

QAPP Worksheets #31, 32, and 33. Assessments and Corrective Action (Continued)
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)

Planned Project Assessments Table

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
Readiness Review	Project Director/ FRNP	Readiness Review Corrective Action Response	24 hours from receipt of readiness review memorandum	As directed by PD	QA Manager/FRNP
Field Sampling TSA	Field Team Leader/FRNP	Field Sampling Corrective Action Response	24 hours from receipt of memorandum	Field Team Leader/FRNP	QA Manager/FRNP
On-site analytical TSA	Field Team Leader/ FRNP	On-site Analytical Corrective Action Response	48 hours from receipt of memorandum and before further analyses can be conducted.	Field Team Leader/ FRNP	QA Manager/FRNP
Offsite Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Internal Audit Report Deficiency Memorandum	7 days following receipt of PT deficiency report and before analysis field samples	Laboratory Technical Director	QA Manager/FRNP
Management Review	Project Director/ FRNP	QA Management Response	48 hours from receipt of QA management report	As assigned in QA Management Response	QA Manager/FRNP

QAPP Worksheet #34. Data Verification and Validation Inputs
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

This worksheet is used to list the inputs that will be used during data verification and validation. Inputs include planning documents, field records, and laboratory records. 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. Examples of records subject to verification and validation are listed below. The actual inputs required should be based on the graded approach, as defined during project planning.

The Optimized –UFP QAPP guidance provides the following example table for data verification and validation inputs.

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. Data Verification and Validation Inputs (Continued)
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

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 PT 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
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

This worksheet documents procedures that will be used to verify project data. It applies to both field and laboratory records. 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. As illustrated in the following example, verification often is performed at more than one step by more than one person.

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 QA Manager/FRNP—Performs final review at conclusion of field activities

QAPP Worksheet #35. Data Verification Procedures (Continued)
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Chain-of-custody forms	QAPP, Field SOPs	Verify the completeness of chain-of-custody records. Examine entries for consistency with the field logbook. 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 Sample Management Office/FRNP—Performs review as part of data verification and data assessment Data Validator/Wastren Advantage, Inc.—Performs review as part of data validation QA Manager/FRNP—Performs final review at conclusion of field activities

QAPP Worksheet #35. Data Verification Procedures (Continued)
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

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 Sample Management Office/FRNP—Performs review part of data verification and data assessment Data Validator/Wastren Advantage, Inc.—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.	QA Manager/FRNP

QAPP Worksheet #36
Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

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. The example provided below makes use of terminology contained in *Guidance for Labeling Externally Validated Laboratory Data for Superfund Use*, EPA 540-R-08-005 (EPA 2009), which was developed to promote the use of consistent terminology by external data reviewer to describe the scope and content of data review activities. The validation code and label identifier table, as well as any checklists to be used, should be attached to the QAPP. Any data qualifiers to be applied by the data validator must be defined. Of particular importance, third party data validation should NOT include the rejection of data (noted by the designation of the "R" data qualifier). Data validation should note when performance criteria are not met, but the final rejection of any data and their use is a decision reserved specifically for the project team.

Data Validator: Wastren Advantage, Inc..

Analytical Group/Method:	**Volatile Organics–SW-846-8260 (modified)**	**Metals–SW-846-6010**
Data deliverable requirements:	Staged Electronic Data Deliverable Stage 3 plus	Staged Electronic Data Deliverable Stage 3
Analytical specifications:	WS 28-1, SOP VOA-02 (modified)	WS 28-2, SOP Met-03
Measurement performance criteria:	WS 12	WS 12
Percent of data packages to be validated:	100%	100%
Percent of raw data reviewed:	100%	0
Percent of results to be recalculated:	10%	0
Validation procedure:	EPA Region 4 VOA–Level 4	EPA Region 4 Met–Level 3
Validation code (see attached table*):	SV3EM	SV3E
Electronic validation program/version:	TBD	TBD

QAPP Worksheet #37. Data Usability Assessment
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

Usability Assessment

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and, like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

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

Project Director
Project QA Manager
Characterization Manager
Risk Assessor
Data Validator
Sample Management Office
Field Team Leader

Describe how the usability assessment will be documented:

Data usability will be documented through validation reports as well as through the issuance of data quality assessment reports, which will summarize how the data reflect the specific criteria for the data quality indicators assigned to the project.

Summarize the data usability assessment process including statistics, equations, and computer algorithms that will be used to analyze the data:

Step 1. Review the project's objectives and sampling design

Review the key outputs defined during systematic planning (i.e., PQOs or DQOs and MPCs) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.

QAPP Worksheet #37. Data Usability Assessment (Continued)
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

Step 2. Review the data verification and data validation outputs

Review available QA reports, including the data verification, data validation and data assessment, reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.

Step 3. Verify the assumptions of the selected statistical method

Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.

Step 4. Implement the statistical method

Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., “concentrations of lead in groundwater are below the action level”) consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.

Step 5. Document data usability and draw conclusions

Determine if the data can be used as intended, considering implications of deviations and corrective actions, following CP3-ES-5003. Discuss data quality indicators. 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. Assess the performance of the sampling design and identify limitations on data use. Update the CSM and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

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APPENDIX A

COMPARISON OF THE METHOD DETECTION LIMITS FOR WATER AND SOIL TO THE PROJECT ACTION LIMITS DEVELOPED USING 2018 CHILD RESIDENT NO FURTHER ACTION, BACKGROUND, AND MAXIMUM CONTAMINANT LEVEL CONCENTRATIONS

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COMPARISON OF THE METHOD DETECTION LIMITS FOR WATER AND SOIL TO THE PROJECT ACTION LIMITS DEVELOPED USING 2018 CHILD RESIDENT NO FURTHER ACTION, BACKGROUND, AND MAXIMUM CONTAMINANT LEVEL CONCENTRATIONS

The objective of data collection is to support project decision-making. The development of the data quality objectives (DQOs) for a project should include a determination of whether the method detection limits of the planned analytical methods will be sufficient to support the project decision-making. This appendix summarizes a comparison of the typically obtained method detection limits against potential project benchmarks. [This comparison has been updated using GEL Laboratories' method detection limit (MDLs) and the current project action limit (PALs).]

One benchmark for evaluating whether the method detection limit is low enough for a given project is the child resident no action limit (NAL). Analyses that are sensitive enough to detect constituents at or below their NAL often are sufficient to meet project objectives.

As noted in the charts below, most of the GEL MDLs are below the 2018 child resident NALs;[1] thus, they are low enough to support a risk assessment and meet most project DQOs. However, because there are some constituents that have MDLs that are above their respective NALs, the evaluation was extended to include a comparison against background levels (for soils and groundwater) and maximum contaminant levels (MCLs) (for groundwater) to support an evaluation of whether lower MDLs should be pursued for a given project.

The charts in the attachment summarize these comparisons. The comparison found the following.

SOILS

- The MDL was below the respective PAL for metals.

- The MDL was below the respective PAL for the polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and semivolatile organic compounds, except N-nitroso-di-n-propylamine. For most projects, the MDL should be sufficient; however, for projects with N-nitroso-di-n-propylamine as a constituent of concern, lower MDLs may be needed. This issue should be addressed in the project-specific quality assurance project plan (QAPP).

  The minimum detectable activity (MDA) is above the PAL for cesium-137, neptunium-237 uranium-235 and uranium-238. This should be taken into account when developing a project-specific QAPP.

[1] DRAFT *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/R9/V1, U.S. Department of Energy, Paducah, KY, April 2018.

WATER

- Metals (in water): Antimony, arsenic, and thallium have NALs less than MDLs, but the MDLs are below the respective site background concentrations, so the MDLs are considered to be low enough to meet the project DQOs. In addition, the MDLs are below the MCLs for those constituents with MCLs. The NAL for chromium VI is less than the MDL and chromium VI does not have an established background level for the site. It does not have an MCL. California, however, has established an MCL at 0.010 mg/L. The MDL for Chromium VI is below the California MCL; thus, it will be suitable for most projects.

- Uranium-235: The uranium isotope uranium-235 (U-235 has an NAL below the respective PAL and the interpreted MCL (the MCL is 0.030 mg/L total uranium). Because the mobility of uranium is not affected by isotopic composition and because U-235 cannot be separated quantitatively from other uranium isotopes, the standard PAL will be sufficient for many projects.

- PCBs: The Aroclors (except for Aroclor 1016) have PALs that are less than the MDL; however, the MDL is lower than the MCL for Total PCBs. NOTE: Even if all the MDLs were added together for all the Aroclors, the total MDL is less than the MCL for the total PCBs and would meet most project DQOs.

- Radionuclides: Radionuclide PALs are less than MDAs; however, MDAs are below the respective MCLs (except for U-235, calculated based upon normal isotopic composition). In evaluating water-based concentrations of alpha-emitting radionuclides, the alpha activity MCL of 15 pCi/L was evaluated. Thus, for most projects, routinely available MDAs likely will be sufficient.

- VOCs: A few VOCs have PALs less than their MDLs but also have MDLs below their respective MCL except for acrylonitrile (that does not have an MCL). Acrylonitrile is not detected in site groundwater; thus, the need for lower MDLs for acrylonitrile should be considered when setting project DQOs.

- Semivolatile Organic Compounds: Dieldrin, hexachlorobenzene, naphthalene, and N-nitroso-di-n-propylamine have PALs less than the MDL. The need for lower MDLs for these constituents should be considered when setting project DQOs.

In preparing a project-specific QAPP, the expected MDLs should be evaluated against project-specific DQOs (and the related PALs) to identify the need for lower MDLs to meet project objectives.

NOTE: For those constituents that have the PALs below the project quantitation limits, the laboratory will be directed to report to the MDL. Reporting to the MDL may not meet the PALs for some analytes.

ATTACHMENT

ACTION LIMITS VS. METHOD DETECTION LIMITS

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Comparison of Method Detection Limits (MDLs) to Project Action Limits (PALs, Child Resident) and Background (BG) for Soil Samples

Metal	Project Action Limit (mg/kg) Child Resident NAL	Background (mg/kg) Surface	Background (mg/kg) Subsurface	GEL Laboratories		*PAL*	*PAL-MDL*	*Surface BG - MDL*	*Subsurface BG - MDL*
				PQL (mg/kg)	MDL (mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aluminum	7,740	13,000	12,000	10	3	7,740	7737	12997	11997
Antimony	3.13	0.21	0.21	1	0.33	3.13	2.8	-0.12	-0.12
Arsenic	0.356	12	7.9	1	0.2	0.356	0.156	12	7.7
Barium	1,530	200	170	0.4	0.1	1,530	1529.9	200	169.9
Beryllium	15.6	0.67	0.69	0.1	0.02	15.6	15.58	0.65	0.67
Boron	1,560	NA	NA	3	0.8	1,560	1559	NA	NA
Cadmium	5.28	0.21	0.21	0.2	0.02	5.28	5.26	0.19	0.19
Chromium (total)***	16.4	16	43	0.6	0.2	16.4	16.2	15.80	42.8
Chromium VI	0.301	NA	NA	0.4	0.12	0.301	0.181	NA	NA
Cobalt	2.34	14	13	0.2	0.06	2.34	2.28	13.94	12.94
Copper	313	19	25	0.2	0.066	313	312.93	18.93	24.93
Iron	5,480	28,000	28,000	20	6.6	5,480	5473	27993	27993
Lead	400	36	23	0.4	0.1	400	400	36	23
Manganese	183	1,500	820	1	0.2	183	183	1500	820
Mercury	2.35	0.2	0.13	0.01	0.004	2.35	2.346	0.20	0.126
Molybdenum	39.1	NA	NA	0.2	0.06	39.1	39.04	NA	NA
Nickel	155	21	22	0.4	0.1	155	154.9	20.9	21.9
Selenium	39.1	0.8	0.7	1	0.33	39.1	38.77	0.47	0.37
Silver	39.1	2.3	2.7	0.5	0.1	39.1	39	2.20	2.6
Thallium	0.0782	0.21	0.34	0.4	0.06	0.0782	0.0182	0.15	0.28
Uranium	23.4	4.9	4.6	0.04	0.013	23.4	23.4	4.9	4.6
Vanadium	39.3	38	37	0.5	0.1	39.3	39.2	37.9	36.9
Zinc	2,350	65	60	2	0.4	2,350	2349.6	64.6	59.6

Comparison of Method Detection
Limits (MDLs) to Project Action Limits (PALs, Child Resident), and Background for Soil Samples (Continued)

PCB	Project Action Limit (mg/kg) Child Resident NAL	Background (mg/kg)	Background (mg/kg)	GEL Laboratories		*PAL*	*PAL-MDL*	*Surface BG-MDL*	*Subsurface BG-MDL*
		Surface	Subsurface	PQL (mg/kg)	MDL (mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aroclor 1016	0.206	NA	NA	0.0033	0.0011	0.206	0.2049	NA	NA
Aroclor 1221	0.0752	NA	NA	0.0033	0.0011	0.075	0.0741	NA	NA
Aroclor 1232	0.0708	NA	NA	0.0033	0.0011	0.0708	0.0697	NA	NA
Aroclor 1242	0.0791	NA	NA	0.0033	0.0011	0.0791	0.0780	NA	NA
Aroclor 1248	0.0792	NA	NA	0.0033	0.0011	0.0792	0.0781	NA	NA
Aroclor 1254	0.0588	NA	NA	0.0033	0.0011	0.0588	0.0577	NA	NA
Aroclor 1260	0.0803	NA	NA	0.0033	0.0011	0.0803	0.0792	NA	NA

Radionuclide	Project Action Limit (pCi/g) Child Resident NAL	Background (pCi/g)	Background (pCi/g)	GEL Laboratories	*PAL*	*PAL-MDA*	*Surface BG-MDA*	*Subsurface BG-MDA*
		Surface	Subsurface	MDA (pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Americium-241	1.75	NA	NA	1	1.75	0.75	NA	NA
Cesium-137	0.0402	0.49	0.28	0.1	0.0402	-0.0598	0.39	0.18
Neptunium-237	0.0911	0.1	NA	1	0.0911	-0.9089	-0.90	NA
Plutonium-238	4.26	0.073	NA	1	4.26	3.26	-0.93	NA
Plutonium-239/240	3.77	0.025	NA	1	3.77	2.77	-0.98	NA
Technetium-99	110.0	2.5	2.8	5	110	105	-2.50	-2.2
Thorium-230	4.92	1.5	1.4	1	4.92	3.92	0.50	0.4
Uranium-234	5.77	1.2	1.2	1	5.77	4.77	0.20	0.2
Uranium-235	0.148	0.06	0.06	1	0.148	-0.852	-0.94	-0.94
Uranium-238	0.556	1.2	1.2	1	0.556	-0.444	0.20	0.2

VOC	Project Action Limit (µg/kg) Child Resident NAL	Background (µg/kg)	Background (µg/kg)	GEL Laboratories		*PAL*	*PAL-MDL*	*Surface BG-MDL*	*Subsurface BG-MDL*
		Surface	Subsurface	PQL (µg/kg)	MDL (µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
1,1-Dichloroethene	22,700	NA	NA	1	0.33	22,700	22,700	NA	NA
cis- 1,2-Dichloroethene	15,600	NA	NA	1	0.33	15,600	15,600	NA	NA
trans- 1,2-Dichloroethene	10,200	NA	NA	1	0.33	10,200	10,200	NA	NA
Acrylonitrile	255	NA	NA	5	1.7	255	253	NA	NA
Benzene	1,160	NA	NA	1	0.33	1,160	1,160	NA	NA
Carbon Tetrachloride	653	NA	NA	1	0.33	653	653	NA	NA
Chloroform	316	NA	NA	1	0.33	316	316	NA	NA
Ethylbenzene	5,780	NA	NA	1	0.33	5,780	5,780	NA	NA
Tetrachloroethene	8,100	NA	NA	1	0.33	8,100	8,100	NA	NA
Trichloroethene	412	NA	NA	1	0.33	412	412	NA	NA
Vinyl chloride	59.2	NA	NA	1	0.33	59.2	58.9	NA	NA
Total Xylenes	57,600	NA	NA	3	1.0	57,600	57,599	NA	NA
p-xylene	56,100	NA	NA	2	0.67	56,100	56,099	NA	NA
m-xylene	55,100	NA	NA	2	0.6	55,100	55,099	NA	NA
o-xylene	64,500	NA	NA	1	0.33	64,500	64,500	NA	NA

Comparison of Method Detection Limits (MDLs) to Project Action Limits (PALs, Child Resident), and Background for Soil Samples (Continued)

SVOC	Project Action Limit (µg/kg) Child Resident NAL	Background (µg/kg)	Background (µg/kg)	GEL Laboratories		*PAL*	*PAL-MDL*	*Surface BG-MDL*	*Subsurface BG-MDL*
		Surface	Subsurface	PQL (µg/kg)	MDL (µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Acenaphthene	185,000	NA	NA	33.3	10	185,000	184,990	NA	NA
Acenaphthylene*	185,000	NA	NA	33.3	10	185,000	184,990	NA	NA
Anthracene	923,000	NA	NA	33.3	10	923,000	922,990	NA	NA
Carbazole	10,400	NA	NA	33.3	10	10,400	10,390	NA	NA
Dieldrin**	13.0	NA	NA	1.34	0.33	13.0	12.7	NA	NA
Fluoranthene	123,000	NA	NA	33.3	10	123,000	122,990	NA	NA
Hexachlorobenzene	212	NA	NA	333	100	212	112	NA	NA
Naphthalene	3,830	NA	NA	33.3	10	3,830	3,820	NA	NA
2-nitroaniline	35,600	NA	NA	333	110	35,600	35,490	NA	NA
N-nitroso-di-n-propylamine	29.7	NA	NA	333	100	29.7	-70.3	NA	NA
Phenanthrene*	185,000	NA	NA	33.3	10	185,000	184,990	NA	NA
Pyrene	92,300	NA	NA	33.3	10	92,300	92,290	NA	NA
Total PAHs (carcinogenic)	47.8	NA	NA	NA	NA	47.80	NA	NA	NA

Red numbers used to highlight negative values.

Constituent Name — Constituent MDL higher than considered potentially-applicable benchmarks/PALs

NOTE: Laboratories may not be able to meet PALs. In these cases, the project team will address this issue during scoping.

MDA = Minimum Detectable Activity

*Acenaphthylene and Phenanthrene use values for Acenaphthene as a surrogate

**GEL only reports dieldrin via method SW846-8081, not SW846-8270

***The chromium (III) background value was used

Gray shading indicates calculations used to compare laboratory limits to action limits and background concentrations.

Comparison of Method Detection Limits (MDLs) to Project Action Limits (PALs, Child Resident NAL), Background, and MCLs for Groundwater Samples

Metal	Project Action Limit			RGA Background (mg/L)	MCL (mg/L)	GEL Laboratories		*PAL*	*PAL-MDL*	*BG-MDL*	*MCL-MDL*
	Tapwater RSL or MCL (mg/L)	RSL or MCL	Child Resident NAL (mg/L)			PQL (mg/L)	MDL (mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Aluminum	2.0	RSL	2.00	1.64	NA	0.05	0.015	2.0000	1.985	1.6250	NA
Antimony	0.0060	MCL	0.000779	0.060	0.0060	0.003	0.001	0.000779	-0.00022	0.0590	0.0050
Arsenic	0.010	MCL	0.0000517	0.005	0.010	0.01	0.0017	0.0000517	-0.00165	0.0033	0.0083
Barium	2.0	MCL	0.377	0.202	2.0	0.206	0.0006	0.377	0.3764	0.2014	1.9994
Beryllium	0.0040	MCL	0.00246	0.004	0.0040	0.0005	0.0002	0.00246	0.00226	0.0038	0.0038
Boron	0.40	RSL	0.399	NA	NA	0.015	0.004	0.399	0.395	NA	NA
Cadmium	0.0050	MCL	0.000922	0.010	0.0050	0.001	0.00011	0.000922	0.00081	0.0099	0.0049
Chromium (total)	0.10	MCL	2.25	0.134	0.10	0.01	0.002	0.10	0.098	0.1320	0.0980
Chromium VI	0.000035	RSL	0.0000350	NA	NA	0.01	0.0033	0.0000350	-0.003265	NA	NA
Cobalt	0.0006	RSL	0.000601	0.045	NA	0.001	0.0001	0.000601	0.000501	0.0449	NA
Copper	1.3	MCL	0.0799	0.034	1.3	0.001	0.00035	0.0799	0.07955	0.0337	1.2997
Iron	1.4	RSL	1.40	3.72	NA	0.1	0.033	1.4	1.367	3.6870	NA
Lead	0.015	MCL	0.0150	0.25	0.015	0.002	0.0005	0.015	0.0145	0.2495	0.0145
Manganese	0.043	RSL	0.0434	0.082	NA	0.005	0.001	0.043	0.0424	0.0810	NA
Mercury	0.0020	MCL	0.000566	0.0002	0.0020	0.0002	0.000067	0.000566	0.000499	0.0001	0.0019
Molybdenum	0.01	RSL	0.00998	0.050	NA	0.0005	0.000165	0.00998	0.0098	0.0498	NA
Nickel	0.039	RSL	0.0392	0.530	NA	0.002	0.0005	0.039	0.0387	0.5295	NA
Selenium	0.050	MCL	0.00998	0.005	0.050	0.005	0.0015	0.00998	0.00848	0.0035	0.0485
Silver	0.0094	RSL	0.00941	0.011	NA	0.001	0.0002	0.00941	0.00921	0.0108	NA
Thallium	0.0020	MCL	0.0000200	0.056	0.0020	0.002	0.00045	0.00002	-0.00043	0.0556	0.0016
Uranium	0.030	MCL	0.00399	0.002	0.030	0.0002	0.000067	0.00399	0.0039	0.0019	0.0299
Vanadium	0.01	RSL	0.00864	0.139	NA	0.005	0.001	0.00864	0.0076	0.1380	NA
Zinc	0.60	RSL	0.600	0.025	NA	0.01	0.0035	0.600	0.60	0.0215	NA

PCB	Project Action Limit			RGA Background (µg/L)	MCL (µg/L)	GEL Laboratories		*PAL*	*PAL-MDL*	*BG-MDL*	*MCL-MDL**
	Tapwater RSL or MCL (µg/L)	RSL or MCL	Child Resident NAL (µg/L)			PQL (µg/L)	MDL (µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Aroclor 1016	0.5	MCL	0.140	NA	0.5	0.1	0.033	0.140	0.1067	NA	0.47
Aroclor 1221	0.5	MCL	0.00471	NA	0.5	0.1	0.033	0.00471	-0.0286	NA	0.47
Aroclor 1232	0.5	MCL	0.00471	NA	0.5	0.1	0.033	0.00471	-0.0286	NA	0.47
Aroclor 1242	0.5	MCL	0.00785	NA	0.5	0.1	0.033	0.00785	-0.02545	NA	0.47
Aroclor 1248	0.5	MCL	0.00785	NA	0.5	0.1	0.033	0.00785	-0.02545	NA	0.47
Aroclor 1254	0.5	MCL	0.00785	NA	0.5	0.1	0.033	0.00785	-0.02545	NA	0.47
Aroclor 1260	0.5	MCL	0.00785	NA	0.5	0.1	0.033	0.00785	-0.02545	NA	0.47
Total (0.5 µg/L MCL total PCBs	0.5	MCL	0.0436	NA	0.5	NA	0.233	0.0436	-0.1895	NA	0.27

Comparison of Method Detection Limits (MDLs) to Project Action Limits (PALs, Child Resident), Background, and MCLs for Groundwater Samples (Continued)

Radionuclide	Project Action Limit			RGA Background (pCi/L)	MCL** (pCi/L)	GEL Laboratories	*PAL*	*PAL-MDA*	*BG-MDA*	*MCL-MDA*
	Tapwater RSL or MCL (pCi/L)	RSL or MCL	Child Resident NAL (pCi/L)			MDA (pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
Americium-241	15	MCL	0.504	NA	15	1	0.504	-0.50	NA	14
Cesium-137	4 mRem/year-dose	MCL	1.71	NA	200	10	1.71	-8.29	NA	190
Neptunium-237	15	MCL	0.763	0.21	15	1	0.763	-0.24	-0.79	14
Plutonium-238	15	MCL	0.398	NA	15	1	0.398	-0.60	NA	14
Plutonium-239/240	15	MCL	0.387	0.03	15	1	0.387	-0.61	-0.97	14
Technetium-99	4 mRem/year-dose	MCL	19	10.8	900	25	19	-6.00	-14.2	875
Thorium-230	15	MCL	0.572	0.54	15	1	0.572	-0.43	-0.46	14
Uranium-234	10.24	MCL	0.739	0.7	10.24	1	0.739	-0.26	-0.3	9.24
Uranium-235	0.466	MCL	0.728	0.3	0.466	1	0.728	-0.27	-0.7	-0.534
Uranium-238	9.99	MCL	0.601	0.7	9.99	1	0.601	-0.40	-0.3	8.99

VOC	Project Action Limit			RGA Background (µg/L)	MCL	GEL Laboratories		*PAL*	*PAL-MDA*	*BG-MDA*	*MCL-MDA*
	Tapwater RSL or MCL (µg/L)	RSL or MCL	Child Resident NAL (µg/L)		(µg/L)	PQL (µg/L)	MDL (µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Acrylonitrile	0.052	RSL	0.0523	NA	NA	5	1.5	0.0520	-1.448	NA	NA
Benzene	5.0	MCL	0.455	NA	5.0	1	0.3	0.455	0.155	NA	4.7
Carbon tetrachloride	5.0	MCL	0.455	NA	5.0	1	0.3	0.455	0.155	NA	4.7
Chloroform	80	MCL	0.221	NA	80	1	0.3	0.221	-0.079	NA	79.7
1,1-Dichloroethene	7.0	MCL	28.5	NA	7.0	1	0.3	7.0	6.7	NA	6.7
cis- 1,2-Dichloroethene	70	MCL	3.61	NA	70	2	0.3	3.61	3.31	NA	69.7
trans -1,2-Dichloroethene	100	MCL	9.29	NA	100	1	0.3	9.29	8.99	NA	99.7
Ethylbenzene	700	MCL	1.50	NA	700	1	0.3	1.50	1.2	NA	699.7
Tetrachloroethene	5.0	MCL	4.06	NA	5.0	1	0.3	4.06	3.76	NA	4.7
Trichloroethene	5.0	MCL	0.283	NA	5.0	1	0.3	0.283	-0.017	NA	4.7
Vinyl Chloride	2.0	MCL	0.0188	NA	2.0	1	0.3	0.0188	-0.281	NA	1.7
Total Xylenes	10,000	MCL	19.3	NA	10,000	3	0.3	19.3	19	NA	9999.7
Xylene-o	19	RSL	19.3	NA	NA	1	0.3	19.3	19	NA	NA
Xylene-m	19	RSL	19.3	NA	NA	2	0.3	19.3	19	NA	NA
Xylene-p	19	RSL	19.3	NA	NA	2	0.3	19.3	19	NA	NA

Comparison of Method Detection Limits (MDLs) to Project Action Limits (PALs, Child Resident), Background, and MCLs for Groundwater Samples (Continued)

SVOC	Project Action Limit			RGA Background (µg/L)	MCL (µg/L)	GEL Laboratories		*PAL* (µg/L)	*PAL-MDL* (µg/L)	*BG-MDL* (µg/L)	*MCL-MDL* (µg/L)
	Tapwater RSL or MCL (µg/L)	RSL or MCL	Child Resident NAL (µg/L)			PQL (µg/L)	MDL (µg/L)				
Acenaphthene	53	RSL	53.5	NA	NA	1	0.3	53.5	53.2	NA	NA
Acenaphthylene***	53	RSL	53.5	NA	NA	1	0.3	53.5	53.2	NA	NA
Anthracene	180	RSL	177	NA	NA	1	0.3	177	176.7	NA	NA
Carbazole	NA	RSL	2.03	NA	NA	1	0.3	2.03	1.73	NA	NA
Dieldrin****	0.0018	RSL	0.00175	NA	NA	0.04	0.0125	0.00175	-0.011	NA	NA
Fluoranthene	80	RSL	80.2	NA	NA	1	0.3	80	79.7	NA	NA
Hexachlorobenzene	1.0	MCL	0.00976	NA	1.0	10	3	0.0	-2.99	NA	-2.00
Naphthalene	0.17	RSL	0.165	NA	NA	1	0.3	0.17	-0.135	NA	NA
2-nitroaniline	19	RSL	18.9	NA	NA	10	3	18.9	15.9	NA	NA
N-nitroso-di-n-propylamine	0.011	RSL	0.0108	NA	NA	10	3	0.011	-2.99	NA	NA
Phenanthrene***	53	RSL	53.5	NA	NA	1	0.3	54	53.2	NA	NA
Pyrene	12	RSL	12.1	NA	NA	1	0.3	12	11.7	NA	NA
Total PAHs (carcinogenic)	0.20	RSL	0.0251	NA	0.20	NA	NA	0.0251	NA	NA	NA

Red numbers used to highlight negative values — Negative values mean that the PAL is less than the benchmark

Constituent Name — Constituent MDL higher than all considered potentially-applicable benchmarks/PALs

NOTE: Laboratories may not be able to meet PALs. In these cases, the project team will address this issue during scoping.

MCL = U.S.EPA Drinking Water Standard Maximum Contaminant Level

NAL = No Action Level

RGA = Regional Gravel Aquifer

RSL= Regional Screening Level

*Even if EVERY Aroclor present at MDL, Total PCB concentration < MCL

**Gross Alpha MCL = 15 pCi/L

attributed uranium MCL — uranium MCL converted from 0.030 mg/L to pCi/L based upon natural composition and activity factors

U-235 not seen alone (i.e., w/o U-238). Uranium-238 MDA < MCL (i.e., uranium issues in water will be detected at PAL with current isotopic MDAs).

***Acenaphthylene and Phenanthrene use values for Acenaphthene as surrogate

****GEL only reports dieldrin via method SW846-8081, not SW846-8270

2016 RSLs from EPA regional screening levels (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2017

Gray shading indicates calculations used to compare laboratory limits to action limits and background concentrations.

APPENDIX B

THE ROLE OF INDEPENDENT THIRD PARTY DATA VALIDATION IN MEETING DATA QUALITY OBJECTIVES AT PADUCAH GASEOUS DIFFUSION PLANT

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THE ROLE OF INDEPENDENT THIRD PARTY DATA VALIDATION IN MEETING DATA QUALITY OBJECTIVES

ISSUE

A balance must be struck and the associated uncertainties acknowledged over the appropriate level of independent third-party data validation that should be conducted for various types of Paducah Gaseous Diffusion Plant (PGDP) projects. In addition, there is uncertainty over how best to ensure that the appropriate level of independent third-party data validation is conducted.

Collected data are evaluated for usability by the project team. In addition, a fraction of these data is subjected to independent third-party validation. This briefing discusses the process by which the fraction of data subjected to independent third-party validation is specified. *As noted in EPA guidance, the principal use of independent third-party validation is to supplement the data assessment process and minimize the potential for fraud.*

BACKGROUND

Collected data are reviewed by the project team as part of a data assessment to ensure that collected data are usable for their intended purpose. This project-team assessment includes elements of data validation. This effort is supplemented further by subjecting a fraction of the data to independent third-party validation. All of the assessment and validation efforts are used to support the data usability assessment.

The cost of higher levels of independent third-party validation should be balanced against the incremental value in meeting project and programmatic data quality objectives (DQOs). Programmatic DQOs are related to the likelihood that collected data may be used to support issues that go beyond the needs of the individual project.

HISTORY

The level of independent third-party validation of data for a given PGDP project is set as part of developing DQOs for that project. This level has varied appropriately for different types of PGDP projects. The following discusses the role of independent third-party validation in the data quality process and discusses how project and programmatic considerations should be evaluated in setting the appropriate level of independent third-party validation for a given project.

FINDINGS

1. The level of independent third-party validation should be set for each project as part of the DQO process;

2. The project DQO process should anticipate (and incorporate where appropriate) programmatic considerations in setting the level of independent third-party validation;

3. Incorporation of programmatic considerations is required by the in-place Quality Assurance Program; this approach is consistent with the approach used at the Portsmouth Gaseous Diffusion Plant (PORTS);

4. Independent third-party validation, by design, duplicates many elements of the Four Rivers Nuclear Partnership, LLC, (FRNP) data assessment/verification/validation process;

5. The FRNP's *Quality Assured Data* procedure (CP2-ES-0063) identifies 5% as a minimum of definitive data that typically should be subjected to independent third-party validation;

6. Most PGDP data collection activities generate usable, valid, high-quality data with this approach;

7. There are a few data collection activities [e.g., supporting property transfer for unrestricted use under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120h guidance] where a higher percentage of independent third-party validation may be appropriate (i.e., PORTS has identified some property transfer projects where 100% independent third-party validation is considered appropriate); and

8. Additional independent third-party data validation may be able to be performed at a later time should the DQOs of the project change.

DISCUSSION

Independent third-party validation is one tool used as part of an over-arching program to assure data quality. Per the current *Quality Assured Data* procedure, developed to be consistent with U.S. Environmental Protection Agency (EPA) guidance, 100% of collected definitive (i.e., not screening level) data are subjected to data assessment and verification (which includes elements of data validation) by the project team. However, only a fraction (minimum of 5%) of the definitive data collected for projects at PGDP are subjected to independent third-party validation that uses an external third party to repeat the data validation steps. As noted in EPA guidance, the principal use of independent third-party validation is to support the data assessment process and minimize the potential for fraud by providing detailed review of the data collection and analysis process. NOTE: Because this independent third-party validation does not introduce any additional data or information, this process does not increase the quality of the data.

Per the *Quality Assured Data* procedure, each project establishes a level of independent third-party validation needed to ensure project DQOs are met. The principal goal of a data collection process is to ensure that collected data meet the DQOs for the individual project, which helps assure the data will be considered usable to support decision-making. To support its Quality Assurance Program, FRNP has been subjecting landfill groundwater data to 100% independent third-party validation in support of the Environmental Monitoring Data Quality Program. By performing 100% independent third-party validation, these landfill groundwater data become a benchmark against which other groundwater data can be compared reliably.

For most other projects, independent third-party validation rates range from 5% to 20%. These levels are set in the project scoping process at levels that are considered sufficient to support the project data quality

process. As noted above, the level of independent third-party data validation is a project-specific decision that should evaluate all data quality needs, including incorporating programmatic considerations. Attached is a White Paper that discusses in more detail the considerations that may drive the determination of the appropriate level of independent third-party data validation.

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ATTACHMENT

WHITE PAPER ON THE USE OF INDEPENDENT THIRD-PARTY VALIDATION TO SUPPORT DATA QUALITY ASSURANCE AT PGDP

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WHITE PAPER ON THE USE OF INDEPENDENT THIRD-PARTY VALIDATION TO SUPPORT DATA QUALITY ASSURANCE AT PGDP

ISSUE

Independent third-party validation of laboratory data is one of the tools used to support the data quality assurance program at the Paducah Gaseous Diffusion Plant (PGDP), the Portsmouth Gaseous Diffusion Plant (PORTS), and other Superfund sites. Because there are multiple procedures that are used routinely to evaluate laboratory data quality; the manner in which these reviews are communicated to decision-makers may also vary. Because of this potential variability, and because of the complex nature of commonly used analytical data verification and validation procedures, it is important to minimize ambiguity in communicating the nature of these procedures to data users. This White Paper seeks to summarize the tools Four Rivers Nuclear Partnership, LLC, (FRNP) uses to ensure data quality and its approach to the use of independent third-party validation to support its Quality Assurance Program.

BACKGROUND

There are several considerations that factor into the use of independent third-party validation as well as other tools used in the quality assurance program with the overall goal to ensure that the data meet the data quality objectives (DQOs) of the individual project. The data should be of sufficient quality as to ensure data usability to support environmental decision-making. The different objectives of that decision-making (e.g., ranging from simple survey sampling to property transfer) are the largest considerations driving the application of independent third-party validation.

Summary of the FRNP Data Quality Assurance Program

FRNP maintains a graduated program to ensure data quality assurance and usability, as described by *Quality Assured Data*, CP2-ES-0063, which is as follows.

Data Verification is performed on 100% of laboratory data. Data verification is the process for comparing a data set against a standard or contractual requirement. Data verification includes ***laboratory contractual screening***, which is the process of evaluating a set of data against the requirements in the analytical Statement of Work (SOW) to ensure that all requested information is received. The SOW requirements include required analytes, methods, units, and required reporting limits. Data verification includes comparison of newly received data to historical results, permit limits, maximum contaminant levels (MCLs), background values, and evaluates the results of field quality control samples, etc. The goal of data verification is to identify if submitted samples were analyzed appropriately, properly reported, and the results are consistent with historical information.

Data Assessment is performed on 100% of the data to ensure data meet the DQOs of the project and to ensure that data are usable for their intended purpose. Data assessment is used to determine if the data are suitable to make a decision with the desired level of confidence. Data assessment follows data verification/validation. Data qualifiers are taken into consideration during data assessment.

Data Validation is a data review process performed by a qualified individual, independent from sampling, laboratory, project management, or other decision-making personnel. Data validation evaluates the laboratory adherence to analytical method requirements. The percentage and level of data validation for a given project is defined in project work plans and Quality Assurance Project Plans and is performed

in conjunction with data assessment. There are several levels of data validation that are performed by review of data packages as defined below:

- **Level I data packages** are comprised of sample results, methods, and data qualifiers.

- **Level II data packages** include the Level I information plus quality control (QC) information and surrogate results when applicable.

- **Level III data packages** include the Level II information plus calibration information, internal standard results, special instrumentation analysis requirements (i.e., bromofluorobenzene tune data or post digestion spike results).

- **Level IV data packages** include the Level III information plus all the raw data and certificates for standards.

An excerpt from EPA 2009 is reproduced below to clarify how the guidance defines the terms *verification and validation.*

> **5.1 Analytical Data Verification and Validation Stages**
>
> (1) A verification and validation based only on completeness and compliance of sample receipt condition checks should be called a Stage 1 Validation.
>
> (2) A verification and validation based on completeness and compliance checks of sample receipt conditions and ONLY sample-related QC results should be called a Stage 2A Validation.
>
> (3) A verification and validation based on completeness and compliance checks of sample receipt conditions and BOTH sample-related and instrument-related QC results should be called a Stage 2B Validation.
>
> (4) A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, AND recalculation checks should be called a Stage 3 Validation.
>
> (5) A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, recalculation checks, AND the review of actual instrument outputs should be called a Stage 4 Validation.
>
> The recommended minimum baseline checks conducted for each stage of analytical data verification and validation are described in more detail in Appendix A of the EPA 2009 guidance.

Independent Third-Party Data Validation is a data validation process performed by a party that is independent of sampling, the laboratory analyzing the sample, and other project decision-making personnel. The principal purpose for an independent third-party validation is to minimize the potential for fraud (EPA 2002). With that as its purpose, a random (5%) check may be as effective as greater levels of independent validation for many projects [think 5% validation of random drug test results compared to 100% validation of random drug test results; you achieve your goal (for the independent evaluation) of evaluating the performance of the drug-testing laboratory]. Note: EPA 2002 states that independent

third-party validation alone is not sufficient to meet this goal (of combatting fraud); rather laboratory audits, etc. should be used with validation to identify and correct fraud.

As noted in EPA 2009:

> Note: Using higher stages of analytical verification and validation does not typically result in higher data quality. However, the quality of the analytical data becomes more transparent as more stages of verification and validation are conducted.

Appropriateness of Independent Third-Party Validation. Although the use of 100% independent third-party validation may be appropriate for a few types of data collection efforts at PGDP, the majority of the collected data will meet the project and programmatic DQOs with only a percentage of the results subjected to independent third-party validation. One example of a situation where 100% independent third-party validation may be appropriate would be if DOE were collecting data to support transfer of a parcel of property for unrestricted use and each of the samples (depending upon the sampling protocol) would be uniquely representative of a portion of that land. In that case, independent third-party validation of all the data is prudent to ensure that the data support the land transfer, given that DOE will have no recourse if the data were in error.

Similarly, if a project were collecting data in support of litigation and each of these data points were to be evaluated alone, having every data point subjected to independent third-party validation may have value even though the DQOs would have been met without the additional third-party validation.

Most PGDP data collection efforts will meet project DQOs with only a fraction of the data subjected to independent third-party validation, as follows:

- Time-series groundwater monitoring is conducted at PGDP to identify adverse impacts to groundwater. This type of monitoring typically requires several sample results to identify a trend. Thus, any individual sample does not need to be subjected to independent third-party validation as long as the Quality Assurance Program can confirm the quality and data usability of the groundwater data set to a reasonable certainty.

- Site investigation results often are grouped for evaluation and used to support risk assessments. Thus, any individual result is not uniquely important; rather, the mean and range of results are used to identify unacceptable risks requiring remedial action. Thus, if sufficient independent third-party validation is used to minimize the potential for fraud, the entire data set will be usable for its intended purpose. Note: Post-remedy ***confirmation samples*** may properly be subjected to a greater percentage of independent third-party validation if the decision rules for the site future use depend upon individual results. But even confirmation sampling results may be aggregated to support calculation of an exposure point concentration used in decision-making and thus, less independent third-party validation would be defensible.

The appropriate level of independent third-party validation should be established in the project-specific QAPP for each project and developed to ensure that the DQOs of the project will be met and the data will be considered usable. However, the degree of independent third-party validation should consider the entire PGDP Quality Assurance Program efforts.

In general, 100% independent third party validation should not be considered necessary for CERCLA projects or solid waste projects where:

The entire data set is evaluated to support decision-making;

1. The analyses can be repeated (or are part of a continuing monitoring program to identify trends);

2. The decision is not dependent upon a single result at a single well at a single time [but rather some different form of evaluation (e.g., upgradient versus downgradient results)]; or

3. The decision is not dependent upon a single result at a location at a single time (but rather from combining multiple results [e.g., an exposure point concentration]).

For these types of projects, independent third-party validation would not increase data usability; however, the cost of collecting the data would increase markedly.

FRNP's Quality Assurance Program's Use of Independent Third-Party Validation. As noted above, all of FRNP's laboratory data are subjected to data verification and data assessment that includes elements of data validation. These processes typically are sufficient to ensure data usability for most projects. FRNP's program also subjects some data for independent third-party validation to support its Quality Assurance Program.

For example, all the groundwater monitoring data collected for the C-746-S&T, C-746-U, and C-404 Landfills are subjected to 100% independent third-party validation (at a Stage 3 Level), because FRNP believes that these samples are representative of the broad range of analyses conducted at PGDP. Performing 100% independent third-party validation of these samples effectively supports the FRNP Environmental Monitoring Quality Assurance Program by evaluating laboratory results from a broad spectrum of analyses. Independent third-party validation of groundwater samples is also more appropriate because these types of samples are not subject to as many heterogeneity issues as other sample matrices.

For most other projects, independent third-party validation rates range from 5% to 20%. These levels are set in the project scoping process at levels that are considered sufficient to support the project data quality process. As noted above, the level of independent third party data validation to be conducted is a project-specific decision that should evaluate all data quality needs, including incorporating programmatic considerations.

FRNP recognizes that should DQOs for a project change, additional third-party data validation could be conducted on the project data. The value of this additional third-party validation will depend, in part, on how old are the collected data. Although there is no theoretical limit on the time that can elapse before independent third-party validation is conducted, the representativeness and usability of any data may be called into question after several years (whether or not those data were subjected to independent third-party validation).

REFERENCES

EPA (U.S. Environmental Protection Agency) 2002. *Guidance on Environmental Data Verification and Data Validation*, EPA/240/R-02/004, U.S. Environmental Protection Agency, Washington, DC, November.

EPA 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*, OSWER No. 9200.1-85, EPA 540-R-08-005, U.S. Environmental Protection Agency, Washington, DC, January.

APPENDIX C

DISCUSSION OF THE QUALITY ASSURANCE CRITERIA TO BE APPLIED TO FIELD ANALYTICAL METHODS

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QUALITY ASSURANCE CRITERIA TO BE APPLIED TO FIELD ANALYTICAL METHODS

Field analytical methods, like X-ray fluorescence (XRF) spectroscopy are used at Paducah Gaseous Diffusion Plant. These methods typically are performed in accordance with a procedure that includes quality assurance criteria associated with instrument calibration and standard result reproducibility, often based upon manufacturer's specifications. In addition, the quality of the results from field analyses may be further confirmed by subjecting a fraction of the samples to analysis at a fixed-based laboratory.

Although XRF and other field methods typically are used for screening or semiquantitative evaluation, under certain, well-defined circumstances, their use may be extended and used in a definitive analysis if the results can be shown to meet the project data quality objectives. In order to meet project data quality objectives, some data verification or validation may be needed in addition to the comparison of the field data to laboratory analyses.

As part of planning for a project that includes the use of a field method, the quality assurance requirements needed to support the data quality objective should be outlined in the plan or procedure, including a description of how calibration and field data will be collected, logged, and recorded. This process should also anticipate the steps that will be taken as part of the data verification/validation process. For example, the procedure may identify what data/information will be presented in the report, including logbook pages, etc. An example of this approach is presented in *The Standard Operating Procedure for Elemental Analysis Using the X-Met 920 Field X-Ray Fluorescence Analyzer* (EPA 1996).

Depending upon the types of data that are collected and the forms in which these data are recorded, a data review and validation process may be developed for use by the project team and/or an independent third party validator. The *Standard Operating Procedure for the X-Ray Fluorescence Analysis of Particulate Matter Deposits on Teflon Filters* (RTI International 2009) has an outline of the types of activities that could be included to support quality control activities. This type of verification process, when coupled with the comparability evaluation of the field data to laboratory analyses, can bound the range of results and provide verification of whether the results meet the project data quality objectives. Sections 10 and 11 of the RTI report are reproduced in the attachment to this appendix.

REFERENCES

EPA (U.S. Environmental Protection Agency) 1996. *Standard Operating Procedure for Elemental Analysis Using the X-MET 920 Field X-ray Fluorescence Analyzer*, SOP #: X-MET 920, U.S. Environmental Protection Agency, Region I—New England, Boston, MA, October.

RTI International 2009. *Standard Operating Procedure for the X-Ray Fluorescence Analysis of Particulate matter Deposits on Teflon Filters*, RTI International, Environmental and Industrial measurements Division, research Triangle Park, NC, August 19.

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ATTACHMENT

SECTIONS 10 AND 11 OF
STANDARD OPERATING PROCEDURE FOR THE X-RAY FLUORESCENCE ANALYSIS OF PARTICULATE MATTER DEPOSITS ON TEFLON FILTERS

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10.0 Quality Control

Several different QC activities are performed as part of the analysis procedure. These activities, their frequency, the measures of acceptable performance, and action if the item fails performance standards are provided in Table 5.

Table 5. Quality Control Procedures

Item	Inspection Frequency	Inspection Parameter	Action If Item Fails Inspection	Documentation Required
Energy calibration	Daily	Wavelength alignment of the instrument	This is an automated process	Document in the instrument's run logbook
Calibration verification	Monthly	Percentage of recovery of seven elements on thin-film National Institutes of Standards and Technology reference materials	Adjust instrument calibration factors	Document in the instrument's run logbook; results stored in XRF database
	Monthly	90% to 110% recovery analyzing the PM2.5 calibration standards as unknowns		Results stored in instrument's method file
Ongoing calibration verification	Run with every tray of samples	90% to 110% recovery using a multi-element sample containing Ti, Fe, Cd, Se, Pb, and SiO deposits of 5–10 $\mu g/cm^2$	Re-check instrument calibration and adjust if necessary; re-analyze samples	Document in the instrument's run log book

11.0 Data Review and Validation

The analytical dataset undergoes Level 0 and Level 1 validations. These levels of validation will ensure that the dataset being reported will be of good quality.

11.1 Level 0 Validation

A Level 0 validation begins with the analyst, who identifies any problems related to the chain-of-custody, the filter, or any mechanical or software problems that might have occurred during the analysis of the filters. If such items are identified, the analyst notes any problems in the instrument logbook, which is reviewed by the Technical Area Supervisor.

11.2 Level 1 Validation

A Level 1 validation is a more technical review of the analytical data. This review starts with the analyst, but it will primarily be performed by the Technical Area Supervisor. Using the review criteria developed by the QA Manager, the responsibilities of the analyst and the Technical Area Supervisor are provided in Table 6.

If any discrepancies are noted by the analyst or the Technical Area Supervisor, they will be reported on their respective checklist (Figure 1 and Figure 2).

Table 6. Level 1 Validation Responsibilities

Analyst	Technical Area Supervisor
Verify proper custody documentation is provided in batch folder	Ensure analytical dataset is complete and the proper procedures were followed to analyze the filters
Check sample identifications against COC forms and proper number of samples match given COC	Check that proper paperwork is provided in the batch folder and for any notations regarding the analysis of the batch or flaws with the filters that were analyzed
Confirm mass values for each sample are present on final report	Review precision, accuracy, and replicate data for acceptable limits
Make sure sample identifications are consistent between final report versus pre-attenuation report	Check data for any inconsistencies or trends and report to QA Manager
Review pre and post attenuation reports for disparity with attenuated data	Apply flags to data, if applicable

After two levels of review have been performed on the analytical dataset, it is ready to be submitted for upload into the CSN database.

Batch Creation Date:_____ Batch ID Number:_____

Number of Samples:_____

(circle one, if no leave comment why)

Item #1: Custody Documentation

Chain-of-Custody form present Yes No

Signed By:_____

Dated:_____

Sample Identification

No. of samples matches number on COC form Yes No

ID#s on COC match Id #s on samples Yes No

Item #2: Attenuation Correction

Sample IDs consistent with pre-attenuation report Yes No

Mass values present on report Yes No

Item #3: Data Comparison Pre-attenuation vs Attenuated Data

Results consistent between pre and post attenuation Yes No

Comments Regarding Data:_____

_____

_____

_____

Reviewer Signature: _____ Date Signed: _____

Figure 1. EDXRF Analysis Analyst Checklist.

COC Form No. _____ Report Date: _____

Data Review:

Sample Filter No. _____ Comments: _____

Sample Filter No. _____ Comments: _____

Sample Filter No. _____ Comments: _____

Sample Filter No. _____ Comments: _____

Sample Filter No. _____ Comments: _____

Sample Filter No. _____ Comments: _____

Quality Control Review:

Precision Data Acceptable? Yes ____ No_____ Notes: _____

Accuracy Data Acceptable? Yes ____ No_____ Notes: _____

Replicate Data Acceptable? Yes ____ No_____ Notes: _____

Chain-of-Custody Data Letter Yes ____ No_____ Notes: _____

Filter-Loading Masses: Yes ____ No_____ Notes: _____

_____

_____

_____

Reviewer by: _____ _____

Date

Figure 2. EDXRF Analysis Technical Area Supervisor Checklist.

APPENDIX D

CONCEPTUAL SITE MODEL

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Information in this appendix is taken primarily from the C-400 Vapor Intrusion Work Plan (DOE 2017). This information provides an example conceptual site model.

D.1. OVERVIEW OF THE SITE-SPECIFIC VAPOR INTRUSION CONCEPTUAL SITE MODEL

U.S. Environmental Protection Agency's (EPA's) Vapor Intrusion Guide (EPA 2015) recommends using available site data to develop a vapor intrusion (VI) conceptual site model (CSM) that addresses, at a minimum, the nature, location, and spatial extent of the vapor sources in the subsurface as well as location, use, occupancy, and construction of the existing buildings. EPA also recommends the CSM portray the current understanding of the hydrologic and geologic setting and its influence on vapor migration and attenuation in the vadose zone. To address these needs, a VI CSM generally includes descriptions of the following:

- Site operations and activities—The types of site operations and activities that occurred on or near the site that could have released volatile organic compounds (VOCs) to the subsurface;
- Chemicals of interest—The types of VOCs that may have been used or disposed at the site;
- Land and facility use—Current and reasonably anticipated land and building use and occupancy;
- Building characteristics—Such as layout; type and integrity of the building foundation, and heating, ventilating, and air conditioning operations;
- Potential residual subsurface sources—Types, locations, and concentrations of vapor-forming sources under or near the building; and
- Potential vapor migration pathways—Descriptions of vadose zone features conducive to vapor transport and potential vapor entry points into the building, including potential preferential pathways, such as subsurface utility corridors.

The U.S. Department of Energy's (DOE's) compilation of available historical data has identified considerable existing information relevant to the assessment of VI at C-400. The following sections present a compilation of the data relevant to the VI pathway, and the use of that data to develop a site-specific VI CSM, evaluate the completeness of the VI pathway, and identify data gaps that need to be addressed.

In compiling the existing data, the following rules were used to determine the usability of historical data:

- Historical data that have been qualified as rejected by data validation or by data assessment were not included in the historical data evaluated for use.
- Historical data that contain units inconsistent with the sampled media or with the analysis were not included in the historical data evaluated for use (e.g., a soil sample with analytical units reported in mg/L would not be considered usable).
- Historical data with no reported result and no recorded detection limit were not included in the historical data evaluated for use.

- Data assessment qualifiers previously placed on the data were noted and applied as appropriate.

- A result was considered to be a nondetect if it was qualified by the reporting laboratory with a "U" qualifier or a "<" qualifier.

- A result was considered a nondetect if it has a "U" validation code or a "U" data assessment code.

- Historical data that are no longer representative of the current site conditions being evaluated were excluded (e.g., where site conditions were changed substantially as a result of remedial activities).

- Historical practical quantitation limits were compared to current screening levels to evaluate the usability of the data in the current context and the reliability of conclusions about presence or absence of contaminants.

- Historical analyses derived from an on-site laboratory were not included in historical data evaluated when analyses for duplicate samples were available from a fixed-base laboratory.

This appendix contains 11 figures that are presented at the end of text. Figure 1 provides a map of the trichloroethene (TCE) plume in the Regional Gravel Aquifer (RGA). Figure 2 is a contour map of maximum historical TCE concentration detected in Upper Continental Recharge System (UCRS) soil. Figure 3 shows historical C-400 TCE sources. Figure 4 is an approximate perspective from the northeast corner of the C-400 Cleaning Building CSM. Figure 5 shows TCE degradation pathways, while Figure 6 shows trichloroacetic acid (TCA) degradation pathways. Figure 7 is a cross section through the C-400 Building. Figure 8 illustrates that many buried utilities service the C-400 Building. Figure 9 illustrates the hydrogeology of the C-400 area. Figure 10 is the 2014 TCE Plume Map. Figure 11 shows the location of Phase 1 electrical resistance heating (ERH) soil borings.

D.2. SITE OPERATIONS THAT COULD HAVE RELEASED VOLATILE ORGANIC COMPOUNDS

Operations at C-400 began in 1952. Cleaning metal parts and equipment with degreasing solvents (primarily TCE) was one of the principal operations performed in the building and resulted in releases of VOCs inside and outside the building.

D.2.1 TCE RELEASES INSIDE C-400

Historically, some of the primary activities associated with C-400 have included cleaning machinery parts. Degreasing solvents were used on metallic items that were contaminated with oil and grease. Due to the efficient cleaning abilities of TCE, it reportedly was used throughout C-400 and at a variety of locations across the plant (MMES 1995). Originally there were three vapor degreasers that used industrial grade TCE as the solvent. After degreasing was complete, the cleaned item was shifted to the side of the degreasing unit and excess solvents were allowed to drain into a collection basin connected to the degreaser. The item then was placed either on the floor next to the degreasers or into one of the cleaning tanks. Items placed on the floor may have been returned directly to service or cleaned in the spray booth (large items) or on the hand tables (small items). Floor drains were located throughout the building to direct spills and overflow into interior and exterior sumps or directly into storm sewer lines.

Each of the degreasers was equipped with a spray hose that could be used to direct a stream of TCE at difficult to clean areas on items within the degreaser or to fill containers (5-gal buckets) used in remote cleaning operations. The TCE tank loading facility was equipped with a hose that also could be used to fill small containers (drums).

Average usages of TCE in C-400 over the decades of plant operation are shown in Table 1.

Table 1. Average Rate of TCE Consumption in the C-400 Cleaning Building by Decade (CH2M HILL 1992)

Decade	TCE Use at the C-400 Cleaning Building
1960s	500 to 2,000 gal/month
1970s	> 15,000 gal/month
1980s	1,000 to 2,000 gal/month
1990s	600 to 700 gal/month

Areas of C-400 where historical TCE leaks and spills are known or suspected may include all areas of the building especially (1) degreaser and cleaning tank pits (see Figure 3); (2) drains and sewers (see Figure 6); (3) the east side basement (see Figure 3); (4) tanks and sumps outside the building (see Section 4.2), including underground piping running from tanks (see Figure 6); and (5) various first-floor processes (see Figure 3). These sources have resulted in the development of a source zone comprised of VOCs (primarily TCE and its breakdown products) at the C-400 area.

For an undetermined period of time, 1,1,1-TCA was used as a solvent for at least some of the degreasing activities. Commercial 1,1,1-TCA is stabilized with 1,4-dioxane and may have also contained impurities such as 1,1,2-TCA. Thus, there is a potential for 1,1,1-TCA, 1,1,2-TCA, 1,4-dioxane and TCA breakdown products to pose a VI threat. When discussing the historical releases of solvents from the C-400 Building, the statements concerning TCE also should be considered as referring to 1,1,1-TCA.

Vapor degreaser solvent use was discontinued at C-400 on July 1, 1993, and the identified TCE sources within C-400 were addressed. There is some potential for historically TCE-contaminated flooring (concrete) to be a current source of vapors; and other historical TCE releases from leaks in the floor drains and piping may remain under the floor slab where they have the potential to contribute to vapor sources in the interior of the building.

D.2.2 TCE RELEASES TO THE VICINITY OF C-400

Historical operations released TCE dense nonaqueous-phase liquid (DNAPL) to the subsurface, which contaminated UCRS soils and RGA groundwater in the vicinity of C-400, as shown in Figures 1 and 2. To address TCE-contaminated soils located outside C-400, DOE performed a treatability study of ERH near the southeast corner of the building in 2003 to determine its applicability at PGDP as a remedial approach to remove TCE contamination from soil and groundwater. The treatability study results supported development of the record of decision (DOE 2005).

DOE implemented ERH between 2008 and 2010 to address TCE soil contamination east and near the southwest corner of C-400 in Phase I of the IRA and approximately 535 gal of VOCs (primarily TCE) were removed from the subsurface during Phase I. In Phase IIa, ERH was used to address TCE contamination in the UCRS and the upper RGA in the southeast area treatment area, which contained a

larger amount of source contamination. Phase IIa operations were completed in fall of 2014 and approximately 1,137 gal of VOCs (primarily TCE) were removed from the subsurface. However, residual TCE remains in soil at concentrations ranging up to ~ 10,000 µg/kg in the vicinity of C-400 and has the potential to migrate as vapor into the building.

D.3. CHEMICALS OF INTEREST

As noted above, large volumes of TCE were used in historical operations at the site, and releases of TCE inside and outside of C-400 have contaminated site media. The VOCs of interest are TCE; its breakdown products [*cis*-1,2-dichloroethene (DCE), *trans*-1,2-DCE, and vinyl chloride (VC)]; and 1,1-DCE. As part of the vapor intrusion screening level (VISL) calculator, EPA has not assigned inhalation toxicity values for *cis*-1,2-DCE and *trans*-1,2-DCE; thus, these chemicals do not have VISLs. EPA has provided provisional values to use on this project as listed in Table 1.

Degradation pathways for TCE are well understood [see Figure 5 (Figure 12.3.1 from Morrison et al. 2006), http://announce.exponent.com/practice/environmental/ef/morrison_murphy.pdf]. TCE degrades faster in a reducing environment to DCE isomers and then DCE degrades in a reducing environment to VC. However, as shown in the figure, once DCE or VC is present, it may degrade at significant rates via either a reductive or oxidative path. At PGDP, the RGA is not a reducing environment; thus, TCE will tend to persist in the RGA, but DCE and VC typically will be degraded via the oxidizing environment present there.

There is evidence that 1,1,1-TCA was used in the building; thus, TCA and a common TCA-stabilizer, 1,4-dioxane, are included in the list of contaminants of interest. In addition, TCA degradation products and impurities not identified above are also included as chemicals of interest, including 1,1-DCE and 1,2-DCE. Please see Table 1 for the list of chemicals of interest and associated VISLs.

TCA degradation also is well understood [see Figure 6 (Figure 12.3.2 from Morrison et al. 2006), http://announce.exponent.com/practice/environmental/ef/morrison_murphy.pdf] and occurs much more rapidly in the environment than TCE degradation. TCA degradation products also degrade rapidly. Often, the only evidence of TCA migration to the environment is the detection of the presence of 1,4-dioxane. 1,4-dioxane is miscible with water and thus provides an essentially unattenuated plume front indicator of historical TCA contamination. However, its miscibility also allows effective transport downward and away from the source via a groundwater pathway.

D.4. LAND AND FACILITY USE

Current and reasonably foreseeable future land uses at and adjacent to PGDP are industrial for areas located primarily inside the security fence, industrial or recreational for areas located outside the security fence, and residential for areas beyond the DOE property (DOE 2005). This land use determination was made after consideration of (1) existing lease agreements, (2) the nature of contamination currently present at the facility, and (3) stakeholder input. Data used to determine land uses were obtained through a land use survey performed in 1995 and future land use public workshops conducted in 1994 and 1995. Additionally, the subject has been discussed with a number of organizations, including city and county officials and the Citizens Advisory Board.

The Kentucky Research Consortium for Energy and Environment worked with federal, commonwealth, and local government representatives and community stakeholders to complete a risk-based end state vision for the site in 2011 (KRCEE 2011). The process included structured public involvement and technology integration. This end state vision informs DOE of current community preferences for future use of the PGDP site.

TCE and other VOCs in soil and groundwater originate in an area where current and expected future land use is industrial. There are no current exposures to on-site groundwater by nonremediation workers or the general public because of existing on-site restrictions and controls (e.g., the current excavation/penetration permit program). A Land Use Control Implementation Plan (DOE 2008) identifies specific controls and mechanisms to ensure four objectives:

1. Maintain the integrity of any current or future remedial or monitoring system;

2. Prohibit the development and use of the C-400 area for residential housing, elementary and secondary schools, child care facilities, and playgrounds;

3. Prevent exposure of current and future on-site industrial workers to groundwater/soils and prevent use of the groundwater at the C-400 area through institutional controls (e.g., access controls, Excavation/Penetration Permits Program) and through deed restrictions; and

4. Provide notice in property records regarding contamination and response actions at the C-400 area.

There is a potential for TCE vapors from subsurface (and potentially indoor) sources to impact indoor air in C-400; therefore, both the remediation workers currently deactivating the building in anticipation of eventual demolition and nonremediation workers working in the building may come in contact with these vapors.

D.5. C-400 CLEANING BUILDING CHARACTERISTICS

Figure 3 presents the layout of the building with approximate locations of building features. C-400 rests on a 16-inch, on grade concrete slab in most areas, although there are four pits/sumps and an east-side basement area that are up to 15 to 20 ft below grade. Figure 7 shows a typical cross section through C-400. Construction photographs and soil boring logs suggest that the building floor overlies approximately 10 ft of gravel backfill. The east-side basement includes a plenum and fan room system to ventilate the building. Within the east-side fan room, two fans were connected to each of five stacks for a total of ten fans. All of the fans were of similar design and capacity. Currently, two of the ten fans are operational. At least one ventilation fan currently operates continuously to ventilate the building. The fans that are not in use have been removed and their stacks have been capped.

Figure 8 shows many buried utilities service C-400, including sanitary water lines, return circulating water lines, storm sewers, sanitary sewers, and electrical lines and ducts. Floor drains found throughout the building have been sealed with epoxy (or equivalently closed) to prevent further releases from the building. These floor drains previously emptied into interior and exterior building sumps or directly into storm sewer lines. Sumps for wastewater treatment and disposal were located northeast (C-403 Neutralization Pit) and northwest (waste discard sump) of C-400.

Historical industrial hygiene (IH) sampling and analysis of indoor air in C-400 is summarized in Table A.1 of Appendix A. The IH sampling has generally resulted in no detectable TCE or VC, although two

indoor air samples collected in 2003 in the C-400 basement as part of the ERH Treatability Study (DOE 2004) had TCE concentrations 900 and 5,000 times higher than the commercial TCE VISL screening level of 3 µg/m^3 (0.56 ppbv) [although the levels were below the American Conference of Governmental Industrial Hygienists (ACGIH) value of 50 ppm]. These samples were considered to have originated from seep water in a sump associated with an abandoned TCE storage tank located in the C-400 basement and not from other indoor sources. This sump [Solid Waste Management Unit (SWMU) 98] remains and had been noted to contain water only once, and the source was unknown. The sump bottom is located approximately 7 ft to 12 ft above the water table. TCE concentrations in subsequent IH samples, including IH samples collected in 2015, were below detection (at a detection limit of ~ 500 ppbv). Because the IH detection limits for TCE are greater than EPA's commercial TCE VISL value of 3 µg/m^3 (0.56 ppbv), it is not known if indoor air concentrations in C-400 currently exceed the TCE VISL value.

Recent walkthroughs of C-400 indicate the integrity of the floor slab appears to be generally good, but did identify deteriorated concrete in the central west portion of the building that may serve as a conduit to subsurface vapors. Due to the size (approximately 144,000 ft^2) and complexity of C-400, identifying the specific locations of other potential VI conduits is not practicable. Instead, DOE assumes that both a subsurface source of TCE and preferential pathways for VI exist at C-400, and, for risk assessment and risk management purposes, assumes that any measured indoor air exceedances of the TCE VISL value are attributable to VI.

D.5.1 POTENTIAL SOURCES OF CHEMICALS OF INTEREST

The 1997 WAG 6 RI identified areas of soil and groundwater contaminated with VOCs, primarily TCE, outside of C-400. Similar levels of contamination, as discussed in the previous section, may be present beneath the building. Soil sampling conducted in 1997 at two locations beneath the building, 400-019 and 400-020, documented the presence of TCE in vadose zone soils at concentrations ranging up to 130 µg/kg.

D.5.1.1 Subsurface Sources

As described in Section 5, leaks and spills from past operations at PGDP have affected soil and groundwater at the site with TCE as both dissolved-phase contamination and DNAPL at locations through the UCRS and down to the base of the RGA. This section presents analytical data documenting the presence of TCE in subsurface media adjacent to and under C-400 with the potential to pose an unacceptable risk to human health via the VI pathway.

D.5.1.2 Groundwater

In the C-400 area, groundwater is encountered at approximately 30 to 35 ft bgs in the UCRS. The sands and gravels of the RGA are encountered at about 50 ft bgs. The sands and gravels of the RGA are highly permeable, and groundwater velocity is thought to be on the order of 0.1 to 0.3 ft per day around C-400. Groundwater flow in the RGA is generally to the north. Figure 9 illustrates the hydrogeology of the C-400 area.

The RGA TCE Plume concentrations are evaluated sitewide every two years and summarized as updates to the site plume maps. Dissolved TCE trends in the vicinity of C-400 continue to indicate the presence of DNAPL in the RGA below the building (i.e., dissolved concentrations in some wells are greater than 1% of TCE's aqueous solubility or approximately 13,000 µg/L.) The most recent plume map

[calendar year 2014 (DOE 2015a)] is shown in Figure 10. Appendix A contains a compilation of the groundwater results collected over the past 10 years from wells located in the vicinity of C-400.

Upper and middle RGA wells nearest C-400 include MW156; MW178; and the upper sampled ports of wells MW406, MW407, MW408, MW421, MW422, MW423, MW424, and MW425. TCE concentrations for these wells from the latest round of sampling (EPA 2014) are tabulated in Appendix A. TCE Plume concentrations underlying the northwest corner of C-400 currently are higher than concentrations toward the southeast corner, but previously, the reverse was the case. All concentrations are substantially higher than the commercial groundwater TCE VISL of 7.4 µg/L. In the southeast area of C-400 (i.e., the upgradient end), TCE concentrations have been shown to be decreasing. For example, TCE concentrations in MW156 have decreased from previous levels of 56,500 µg/L to 925 µg/L in 2014. Similarly, concentrations in MW408-PRT5 and MW405-PRT5 have decreased from 2012 highs of 1,400,000 µg/L (MW408-PRT5) and 97,000 µg/L (MW405-PRT5) to values of 37.6 and 481 µg/L, respectively, in 2014. Concentrations in monitoring wells near the northwest corner of C-400 (i.e., the downgradient end) still exhibit high levels, generally above 10,000 µg/L. For example, the TCE concentration in MW421-PRT3 was 62,800 µg/L in 2014. These levels are several thousand times higher than the groundwater TCE VISL of 7.4 µg/L.

These data support the conclusion that TCE is present in groundwater surrounding and potentially below C-400 at aqueous concentrations with the potential to result in TCE soil vapor concentrations under C-400 that are likely to exceed EPA's soil gas TCE VISL of 100 µg/m^3.

D.5.1.3 Vadose Zone

In the C-400 area, the vadose zone generally is comprised of fine-grained sediments (mostly silt and fine sand) of the UCRS, which overlies the RGA (Figure 9). Locally, however, at the south end of C-400, more intervals of sand and gravelly sand are noted (Figure 11). These sandy zones would be more amenable to vapor migration. The UCRS at C-400 is typically unsaturated for approximately the first 35 ft bgs.

Historical TCE contamination in unremediated UCRS soils adjacent to the southern end of C-400 initially exceeded 1,000,000 µg/kg and was interpreted to exceed 100,000 µg/kg under the southeast end of the building (Figure 2). These soil concentrations in the areas surrounding the building have been reduced by 95% to 99% through Phase I (DOE 2011) and Phase IIa of the ERH IRA (DOE 2015b), but residual TCE remains in the soil. Concentrations in the east and southwest remediated areas average 29 µg/kg and 15 µg/kg, respectively, with maximums of 315 µg/kg and 228 µg/kg, respectively. In the southeast remediated area, TCE soil concentrations average 225 µg/kg with a maximum of ~ 10,100 µg/kg. These levels exceed EPA's VISL of 7.4 µg/L for groundwater. The TCE concentrations remaining in soil after the Phase I and Phase IIa IRAs are summarized in Appendix A.

Historical sampling of sub-slab soil from two borings completed within the footprint of the building was conducted as part of the WAG 6 RI (DOE 1999). A total of 18 sub-slab soil samples was collected at regular depth intervals of 4 to 8 ft down to 48 ft. Analytical results from these samples are presented in Table 2. Of the 18 samples collected, 16 samples had detectable TCE concentrations, ranging from 1.6 to 130 µg/kg with a median of 22.5 µg/kg. These data are considerably older than the post-remediation data described above, but nevertheless provide insight as to the extent of contamination around and under C-400 (in the vadose zone) because the soils directly under the building have not been subjected to remedial activities.

Table 2. Waste Area Grouping 6 Remedial Investigation
Volatile Organic Compound Analyses of Sub-Slab Soil Samples

STATION	Depth (ft)	TCE (µg/kg)	*cis*-1,2-DCE (µg/kg)	*trans*-1,2-DCE (µg/kg)	1,1-DCE (µg/kg)
400-019	0–4	1.6	< 6	< 6	< 6
400-019	8–12	11	< 6	< 6	< 6
400-019	16–20	6.3	< 5	< 5	< 5
400-019	24–28	13	< 6	< 6	< 6
400-019	28–32	< 5	< 5	< 5	< 5
400-019	32–36	7.1	< 6	< 6	< 6
400-019	36–40	< 5	< 5	< 5	< 5
400-019	40–44	< 6	< 6	< 6	< 6
400-020	0–4	< 6	< 6	< 6	< 6
400-020	8–12	17	< 6	< 6	< 6
400-020	16–20	130	< 6	< 6	< 6
400-020	16–20 (duplicate)	75	< 6	< 6	< 6
400-020	20–24	5.6	< 5	< 5	< 5
400-020	28–32	70	< 6	< 6	< 6
400-020	32–36	34	< 6	< 6	< 6
400-020	36–40	28	< 5	< 5	< 5
400-020	40–44	42	< 6	< 6	< 6
400-020	44–48	53	< 6	< 6	< 6

The EPA VI Guide (EPA 2015) generally recommends against using soil concentrations for VI assessment, because of the likelihood of VOC losses during sampling and analysis, but notes that soil samples are useful for delineating soil source areas with the potential to pose a VI concern. EPA summarizes the challenges in soil sampling and analysis for VI screening of soil and discusses appropriate uses of soil data for VI assessment, which include using soil data to delineate sources (EPA 2014). The report provides bulk soil concentrations corresponding to the target VISL levels for sub-slab soil gas. For TCE, the target soil level for residential settings is 0.02 µg/kg; the equivalent value for commercial settings is approximately 6 times higher or 0.12 µg/kg. The measured residual TCE concentrations in the remediated soil adjacent to C-400 (described above) are orders of magnitude higher than the target commercial TCE soil concentration (~ 0.1 µg/kg) corresponding to the commercial sub-slab VISL of 100 µg/m^3. Therefore, vapor concentrations associated with the residual TCE in the remediated soils as well as the TCE in soils under C-400 are likely to have been (and continue to be) many orders of magnitude higher than the commercial TCE sub-slab VISL of 100 µg/m^3. VOC losses upon soil sampling, the primary concern noted by EPA regarding the use of soil data for VI assessment, would simply mean the soil concentrations and associated soil vapor concentrations were actually higher.

These data support the conclusion that soil vapor concentrations adjacent to and directly under the C-400 floor slab are likely to be higher than the sub-slab TCE VISL value of 100 µg/m^3. The presence of approximately 10 ft of gravel fill under the slab is expected to allow the transport and accumulation of these vapors under the floor slab, under at least a portion of the footprint of the building. It should be noted that, while the 10-ft gravel layer thickness is based upon two vertical borings where the gravel thickness ranges from 8–12 ft, it is possible that the gravel thickness will vary and, as a result, there is some uncertainty associated with the variability of the gravel thickness.

The WAG 6 RI also included collection of exterior soil gas samples, but soil air permeabilities were so low that most soil samples reportedly were compromised by ambient air that leaked through joints in the aboveground drill pipe. Under these types of conditions, the primary route of vapor migration is likely to be along preferential conduits, such as utility lines. Of the 145 attempted samples, 10 (9 of which are on the south side of C-400) contained detectable TCE concentrations that were considered to represent some contribution from soil gas. The detected TCE soil gas concentrations from the south side of C-400 ranged from 1.5 to 1,678 µg/L (1,678,000 µg/m^3) with a median of 4.9 µg/L (4,900 µg/m^3). These values support the conclusion derived above, based on soil sampling, that vapor concentrations arising from TCE contamination under and adjacent to C-400 are orders of magnitude greater than the commercial TCE sub-slab VISL of 100 µg/m^3.

There are several lines of evidence that point to the likely continued presence of TCE in the soil under and adjacent to C-400 at levels that exceed VI screening values. Prior to remediation (by the ERH IRA), some of the UCRS soils were interpreted to contain DNAPL, with derived DNAPL saturations up to 4%. Additionally, membrane interface probe logs of historical area soil borings suggested that zones of DNAPL saturation were present. It is possible these zones extended under the building (and outside the remediated areas) as interpreted in Figure 2. The ERH IRA removed approximately 3,500 gal of VOCs from the UCRS and upper RGA soils exterior to the building and reduced soil concentrations, but residual soil concentrations still are higher than bulk soil concentrations corresponding to the target VISL levels for sub-slab soil gas (EPA 2014). In addition, ERH was not implemented below the building.

Additionally, leaks from building drains and sewers are known to have contaminated utility trenches and adjacent soils in the vicinity of C-400, as directly evidenced by the SWMU 11 (TCE Leak Site). Other utilities lines and bedding material around the drain pipes leading from the floor drains or other utilities entering or leaving the building have not been investigated because of the presence of building equipment and infrastructure and uncertainties in utility locations (leading to operations and health risks). Given the lines of evidence described above, it is reasonable to conclude that TCE is present under C-400 in the UCRS soil, utility lines (and their bedding materials), and the gravel layer under the C-400 slab at concentrations sufficient to generate soil vapor concentrations higher than the commercial TCE sub-slab VISL of 100 µg/m^3.

D.5.2 POTENTIAL INDOOR SOURCES

As described above, historical operations associated with C-400 resulted in TCE leaks and spills in areas such as the degreaser and cleaning tank pits, drains and sewers, and tanks and sumps outside the building, including underground piping running from tanks. Although the historical operations were terminated and the identified source areas were closed in 1993, potential indoor sources of TCE may remain in the building, such as TCE in concrete that may continue to off-gas. Additionally, there may have been other sources not identified at the time operations ceased. Nevertheless, DOE considers VI from subsurface sources of TCE under and adjacent to the building likely to be the primary source of any TCE detected in indoor air, because the subsurface sources have totaled thousands of gal of TCE and residual TCE contamination has been documented to be present, and the indoor source areas have been closed and have been subject to the ongoing building ventilation since 1993.

D.5.3 SUMMARY OF POTENTIAL VAPOR SOURCES AND MIGRATION PATHWAYS

The VI CSM uses site-specific information collected during characterization studies and IRAs to describe the nature, location, spatial extent of the vapor sources in the subsurface, as well as the uses (including those that could have the potential to serve as indoor vapor sources), occupancy, and construction of

C-400. The VI CSM also portrays the hydrologic, hydrogeologic, and geologic setting and its influence on vapor migration and attenuation in the vadose zone.

As described above, TCE contaminated groundwater and soil adjacent to and under C-400 are considered potential sources of vapors that may impact C-400. Subsurface conditions in the C-400 area are considered to allow vapor transport toward the building. Although RGA concentrations in the vicinity of C-400 have decreased, groundwater concentrations still exceed EPA's groundwater VISLs. Similarly, remedial actions have achieved greater than 95% reduction in soil concentrations, but post remedial residual concentrations still exceed levels considered capable of generating soil gas concentrations above EPA's soil gas VISLs. Vapor concentrations associated with the remaining TCE contamination in groundwater and soil are expected to be many orders of magnitude higher than the commercial soil gas and sub-slab TCE VISL screening level of 100 $\mu g/m^3$ and, therefore, have the potential to pose an unacceptable health risk to workers in C-400.

Vapor migration from subsurface groundwater and soil sources through the vadose zone is promoted by the presence of sand in the UCRS in the vicinity of C-400, as well as the presence of gravel immediately beneath the building. The large number of utilities present in the vicinity of the building also may serve as preferential pathways for vapor migration. The presence of deteriorated concrete in the building slab and other potential, but unidentified VI conduits may provide potential pathways for vapor migration into the building.

The building includes an exhaust system (plenum with fans) constructed to induce intake of fresh air into the building and exhaust building air from C-400 to limit the potential for worker exposure to vapors. At least one fan continues to operate. The plenum is designed to enable air flow downward through the floor from the main portion of the building and exhaust it through the stack. The plenum also will induce flow of soil gas through conduits or other potential pathways and exhaust this induced flow. The work plan investigation is designed to determine whether the plenum exhaust system is sufficient to control VI in C-400, irrespective of which of the potential sources and conduits may be contributing vapors to the C-400 indoor air.

D.5.4 EVALUATION OF VI PATHWAY COMPLETENESS

As described earlier in Section 5, EPA's VI Guide states that a potential VI pathway should be considered complete when the following five key conditions are present:

1. A subsurface source of vapor-forming chemicals exists;
2. There is a route for the vapors to migrate;
3. The building is susceptible to VI;
4. Vapors are present in the indoor environment; and
5. People are in the indoor environment.

The VI CSM documents the presence of sources of TCE immediately under and adjacent to C-400 in the form of dissolved-phase groundwater contamination and residual or adsorbed TCE in soil. Additionally, leaks from building drains and sewers are known to have historically contaminated utility trenches and adjacent soils with TCE DNAPL. TCE concentrations in groundwater underlying C-400 exceed the groundwater screening levels for TCE in EPA's VISL calculator (EPA 2017). The post-remediation, residual TCE concentrations in soil adjacent to the building and those measured under the building are at levels sufficient to yield soil vapor concentrations exceeding the sub-slab VISLs. Where TCE DNAPL may be present (e.g., in abandoned drain lines and utility bedding material) under C-400 due to past

practices, the associated vapor concentrations are expected to be greater (by orders of magnitude) than the sub-slab VISLs.

Known subsurface conditions, including the presence of sandy material in the vadose zone and gravel under the slab, favor vapor migration. There are no impediments (e.g., no laterally continuous clay layers) considered to inhibit vapor transport between the sources and the building sufficient to limit the intrusion to below VISL levels. The presence of deteriorated concrete flooring in the building and potentially unidentified VI conduits in the building may provide pathways for vapor migration into the building. DOE, therefore, considers that vapors may be migrating from the documented source materials under and adjacent to C-400 and through the sand and gravel into the building.

Openings exist in the building's foundation—openings such as perimeter cracks, stress relief seams, and perforations for utility conduits and structural supports—that could serve as a pathway for vapor entry into the building. Additionally, DOE has noted cracking in the basement area slabs, though the degree to which vapor migrates through cracks in the 16-inch slab is unknown.

These factors have led DOE to conclude that four of EPA's (2015) five conditions regarding completeness of the VI pathway are present and documented with site-specific data, which are (1) subsurface sources of vapor are present in soil and groundwater underneath or near C-400; (2) routes exist for vapor transport to the underside of C-400 and vapor sources are immediately adjacent to the building slab; (3) C-400 is susceptible to VI; and (4) the building had been occupied by nonremediation workers.

Indoor air sampling is needed to evaluate the remaining condition regarding completeness of the VI pathway (i.e., one or more of the chemicals in the sub-slab soil gas also are present in the indoor environment and, if present, pose an unacceptable health risk). DOE considers addressing this data gap to be the appropriate next step for a VI investigation. This approach is supported by EPA's 2015 VI Guide, which states that "if reliable pre-existing sampling data are available and an adequate CSM has been developed (i.e., sufficient subsurface characterization information exists to adequately characterize the locations, forms, and extent of site-specific vapor-forming chemicals and general subsurface conditions [e.g., hydrologic and geologic setting in and around the source(s) and the buildings)], then a risk-based screening may be useful to obtain some preliminary insights about the potential level of exposure and risk posed by vapor intrusion."

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