Department of Energy

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APR 04 2019

Mr. Brian Begley
Federal Facility Agreement Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

PPPO-02-5432232-19B

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 2019 UPDATE OF THE PADUCAH GASEOUS DIFFUSION PLANT PROGRAMMATIC QUALITY ASSURANCE PROJECT PLAN (DOE/LX/07-2439&D1)

Please find enclosed the 2019 update of the *Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan,* DOE/LX/07-2439&D1 (P-QAPP).

The P-QAPP has been prepared and updated in accordance with the approach discussed in a conference call on October 15, 2018, with Federal Facility Agreement parties who are members of the P-QAPP Plan Group (including U.S. Department of Energy, U.S. Environmental Protection Agency, and Kentucky Department for Environmental Protection personnel) concerning the fiscal year 2019 P-QAPP update. 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.

Revisions to the P-QAPP in response to project-specific or other issues identified since November 20, 2018, including comments on the enclosed document, will be completed as part of the fiscal year 2020 update.

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:
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, DOE/LX/07-2439&D1

General Reference Compendium

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DOE/LX/07-2439&D1
Secondary Document

Paducah Gaseous Diffusion Plant
Programmatic Quality Assurance Project Plan

CLEARED FOR PUBLIC RELEASE

DOE/LX/07-2439&D1
Secondary Document

Paducah Gaseous Diffusion Plant
Programmatic Quality Assurance Project Plan

Date Issued—April 2019

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

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ACRONYMS

A	analytical
AA	atomic absorption
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical (or radionuclide) of potential concern
CPAP	Contractor Performance Assurance Program
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
DQO	data quality objective
ECD	electron capture detector
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
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
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
OREIS	Oak Ridge Environmental Information System
OSWER	EPA Office of Solid Waste and Emergency Response
PAH	polycyclic 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
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RGA	Regional Gravel Aquifer
RMD	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
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 2018a), 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's Portsmouth/Paducah Project Office 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. Additionally, FRNP follows CP2-QA-1000, *Quality Assurance Program Description for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*. This document meets the Quality Assurance (QA) requirements for DOE Order (O) 414.1D, Admin. Chg 1, *Quality Assurance*, as the primary QA criteria.

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 recent project-specific QAPPs or from the Optimized UFP-QAPP Worksheets guidance (IDQTF 2012). Additional analyses (such as perfluorinated chemicals) not previously analyzed will be added in future revisions of this P-QAPP. Lessons learned as part of ongoing project work will be incorporated, as appropriate, into project-specific QAPPs and future revisions of this P-QAPP.

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 2019 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/R10/V1 (DOE 2019a) (RMD). Maximum contaminant levels (MCLs) 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), polycyclic aromatic hydrocarbon (PAH) test kits, 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 (PM), quality assurance/quality control (QA/QC) program 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.

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

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Preparation Date (Month/Year): 4/2019
Document Control Number: DOE/LX/07-2439&D1

FRNP Environmental Services Director	_____ Signature David Hutchison	Date:_____
FRNP Characterization Manager	_____ Signature Pamela Baird	Date:_____
FRNP Environmental Monitoring and Sample Management Office Project Manager	_____ Signature Lisa Crabtree	Date:_____
FRNP Quality Assurance/ Quality Control Program Manager	_____ Signature Jennie Freels	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 2019a).

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&D2/R2 (P–QAPP) (April 2015)	Not Applicable (N/A)
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2402&D1 (P–QAPP) (March 2016)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2409&D1 (P–QAPP) (March 2017)	N/A
Paducah Gaseous Diffusion Plant Programmatic Quality Assurance Project Plan, Paducah, Kentucky, DOE/LX/07-2421&D1 (P–QAPP) (April 2018)	N/A

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 & Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection/Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC Summary	2.3.5	Quality Control Requirements
21	Field SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies, and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, & 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

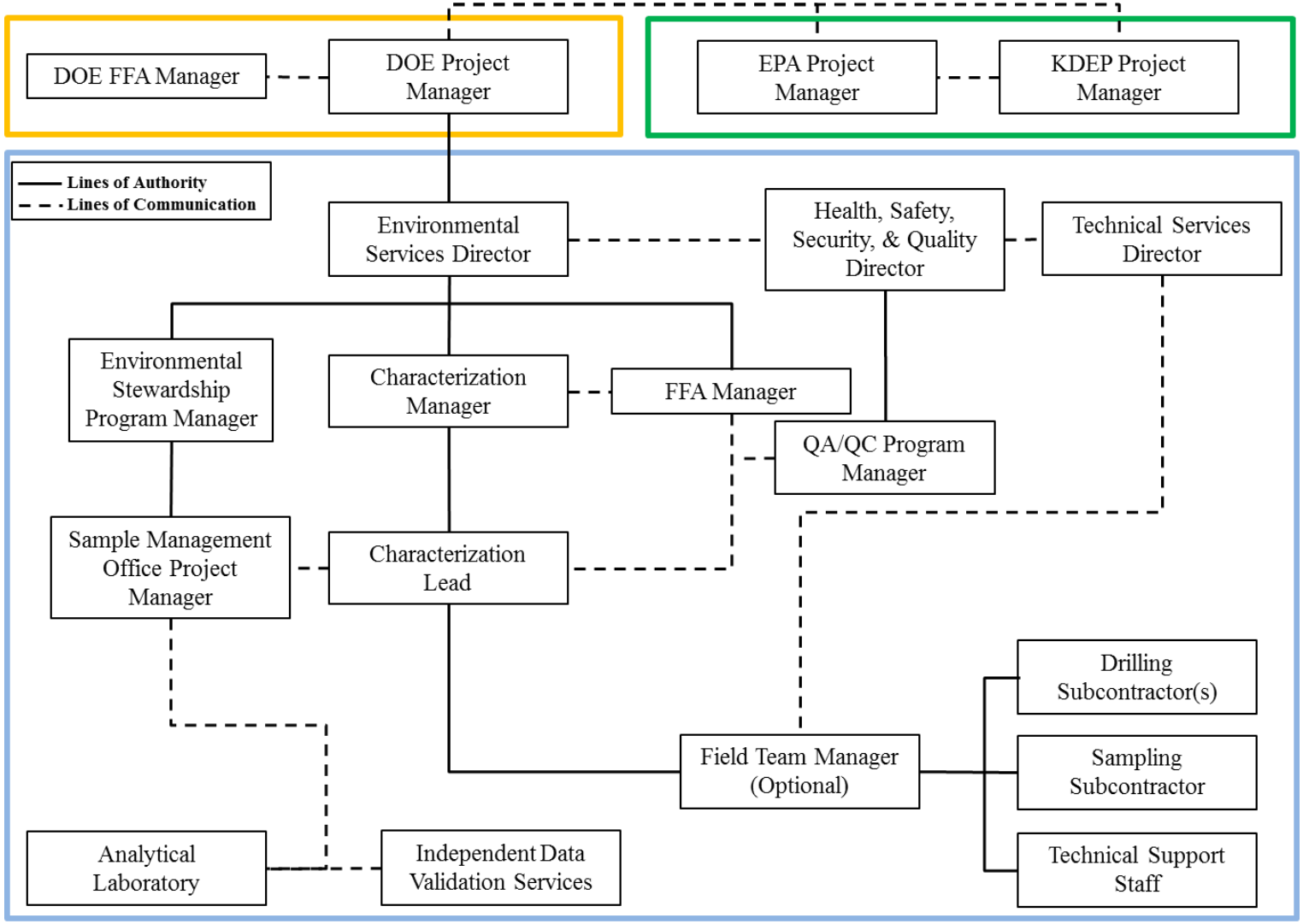
QAPP Worksheets #3 and #5. Project Organization and QAPP Distribution

(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 (Continued)



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

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

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	
FFA Manager	DOE	Tracey Duncan	(270) 441-6862	tracey.duncan@pppo.gov	
PM	DOE	TBD			
Environmental Services Director	FRNP	David Hutchison	(270) 441-5929	dave.hutchison@pad.pppo.gov	
Characterization Manager	FRNP	Pamela Baird	(270) 441-5634	pamela.baird@pad.pppo.gov	
PM	FRNP	TBD			
FFA Manager	KDEP	Brian Begley	(502) 564-6716	brian.begley@ky.gov	
FFA Manager	EPA	Julie Corkran	(404) 562-8547	corkran.julie@epa.gov	
PM	EPA	TBD			
FFA Manager	FRNP	Jana White	(270) 441-5185	jana.white@pad.pppo.gov	
QA/QC Program Manager	FRNP	Jennie Freels	(270) 441-5407	jennie.freels@pad.pppo.gov	
Environmental Monitoring and Sample Management Office (SMO) PM	FRNP	Lisa Crabtree	(270) 441-5135	lisa.crabtree@pad.pppo.gov	
Health, Safety, Support, and Quality (HSS&Q) Director	FRNP	Roland Chretien	(270) 441-6238	roland.chretien@pad.pppo.gov	
SMO	FRNP	Jaime Morrow	(270) 441-5508	jaime.morrow@pad.pppo.gov	

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*
David Hutchison	Environmental Services 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 SMO PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	
Jaime Morrow	SMO	> 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 PM	Analytical Laboratory PM	> 4 years relevant work experience	No specialized training or certification. See TPD.	

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

QAPP Worksheet #6. Communication Pathways

(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 PM: Richard Bonczek, EPA Remedial PM: Julie Corkran, KDEP PM: Brian Begley	rich.bonczek@pppo.gov corkran.julie@epa.gov brian.begley@ky.gov	Formal communication among DOE, EPA, and KDEP.
Field progress reports	FRNP	FRNP Environmental Services Director: David Hutchison	dave.hutchison@pad.pppo.gov	Formal communication among the project staff, the site lead, and the DOE PM.
Stop work due to safety issues	FRNP	FRNP Environmental Services Director: David Hutchison and FRNP HSS&Q: Roland Chretien	dave.hutchison@pad.pppo.gov roland.chretien@pad.pppo.gov	FRNP will communicate work stoppages to DOE PM as required by procedure.
QAPP changes during project execution	FRNP	FRNP Environmental Services Director: David Hutchison and FRNP QA/QC Program Manager: Jennie Freels	dave.hutchison@pad.pppo.gov jennie.freels@pad.pppo.gov	Obtain approval from DOE PM. Submit QAPP amendments to DOE, KDEP, and EPA.

QAPP Worksheet #6. Communication Pathways (Continued)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Field corrective actions	FRNP	FRNP Environmental Services Director: David Hutchison	dave.hutchison@pad.pppo.gov	Field corrective actions will need to be approved by FRNP Project Director and communicated to the DOE, EPA, and KDEP PMs.
Analytical laboratory interface	FRNP	FRNP Environmental Monitoring and SMO PM: Lisa Crabtree	lisa.crabtree@pad.pppo.gov	Communication between FRNP and analytical laboratory.
Laboratory quality control variances	Contracted Laboratory	Laboratory PM	TBD	Notify FRNP SMO. SMO will notify FRNP PM to determine corrective actions.
Analytical corrective actions	Contracted Laboratory, FRNP	Laboratory PM, FRNP Environmental Monitoring and SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Notify FRNP SMO. SMO will notify the project.
Data verification issues (e.g., incomplete records)	Veolia Nuclear Solutions Federal Services	Data Validator, FRNP Environmental Monitoring and SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Data verification issues will be reported to the FRNP SMO.
Data validation issues (e.g. noncompliance with procedures)	Veolia Nuclear Solutions Federal Services	Data Validator, FRNP Environmental Monitoring and SMO PM: Lisa Crabtree	TBD lisa.crabtree@pad.pppo.gov	Issues with data quality will be reported to the FRNP SMO.

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

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)

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 C-400 Complex Remedial Investigation/Feasibility Study (RI/FS) sampling.

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

Scoping meetings were held concerning the C-400 Complex RI/FS sampling 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: C-400 Complex RI/FS Sampling
Date of Session: March 13–15, 2018
Scoping Session Purpose: DOE and its contractors, EPA and its contractors, and KDEP met to scope the C-400 Complex OU RI/FS and develop DQOs.

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Project Manager	DOE	David Dollins	270-441-6819	dave.dollins@pppo.gov	Project management
Project Manager	FRNP	Todd Powers	270-441-5791	todd.power@pad.pppo.gov	Project management
FFA Manager and Project Manager	EPA	Julie Corkran	404-562-8547	corkran.julie@epa.gov	Project management
FFA Manager	KDEP	Brian Begley	502-782-6317	brian.begley@ky.gov	Project management
Project Manager	KDEP	Gaye Brewer	270-898-8468	gaye.brewer@ky.gov	Technical support
Technical Advisor	EPA	Noman Ahsanuzzaman	404-562-8047	ahsanuzzaman.noman@epa.gov	Technical support
Technical support	FRNP	Baker, Cheryl	270-441-6288	cheryl.baker@pad.pppo.gov	Technical support
Technical support	EPA	Bentkowski, Ben	404-562-8507	bentkowski.ben@epa.gov	Technical support
Technical support	DOE	Bonczek, Richard	859-219-4051	richard.bonczek@lex.doe.gov	Technical support
Technical support	CHFS	Brock, Stephanie	502-564-8390	stephaniec.brock@ky.gov	Technical support
Technical support	Pro2Serve	Butterworth, George	270-441-6803	george.butterworthiii@pppo.gov	Technical support
Technical support	DOE	Clauberg, Martin	865-259-7155	martin.clauberg@pppo.gov	Technical support
Technical support	FRNP	Clayton, Bryan	270-441-5412	bryan.clayton@pad.pppo.gov	Technical support
Technical support	EPA	Davis, Eva	580-436-8548	davis.eva@epa.gov	Technical support
Technical support	FRNP	Davis, Ken	270-441-5049	ken.davis@pad.pppo.gov	Technical support
Technical support	TechLaw	Dawson, Jana	703-627-0821	jdawson@techlawinc.com	Technical support
Technical support	FRNP	Flynn, Robert	270-441-5171	robert.flynn@pad.pppo.gov	Technical support
Technical support	FRNP	Ford, Bruce	270-441-5357	bruce.ford@pad.pppo.gov	Technical support
Technical support	FRNP	Fountain, Stefanie	270-441-5722	stefanie.fountain@pad.pppo.gov	Technical support
Technical support	FRNP	Garner, LeAnne	270-441-5436	leanne.garner@pad.pppo.gov	Technical support
Technical support	CHFS	Garner, Nathan	502-564-8390	nathan.garner@ky.gov	Technical support
Technical support	KDEP	Guffey, Mike	502-330-4454	mike.guffey@ky.gov	Technical support
Technical support	KDEP	Higginbotham, Jeri	502-782-6654	jeri.higginbotham@ky.gov	Technical support
Technical support	KDEP	Jung, Christopher	502-782-6391	christopher.jung@ky.gov	Technical support
Technical support	Sapere	Kytola, Kevin	509-524-2343	kkytola@sapereconsulting.com	Technical support

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

Position Title	Affiliation	Name	Phone #	E-mail Address	Project Role
Technical support	DOE	Ladd, April	270-441-6843	ladd.april@pppo.gov	Technical support
Technical support	KDEP	Lainhart, Brian	270-898-8468	brian.lainhart@ky.gov	Technical support
Technical support	FRNP	Layne, Kelly	270-441-5206	kelly.layne@pad.pppo.gov	Technical support
Technical support	TechLaw	McRae, Mac	678-493-1247	mmcrae@techlawinc.com	Technical support
Technical support	FRNP	Morgan, John	270-441-5206	john.morgan@pad.pppo.gov	Technical support
Technical support	KDEP	Newton, Aaron	502-523-8023	aaron.newton@ky.gov	Technical support
Technical support	Sapere	Parsons, Christopher	509-524-2345	cparsons@sapereconsulting.com	Technical support
Technical support	FRNP	Powers, Todd	270-441-5206	todd.powers@pad.pppo.gov	Technical support
Technical support	Techlaw	Rapal, Kristen	312-345-8929	kristen.rapal@techlawinc.com	Technical support
Technical support	Pro2Serve	Taylor, Tracy	270-441-6866	tracy.taylor@pppo.gov	Technical support
Technical support	FRNP	Walker, Curt	270-441-5226	curt.walker@pad.pppo.gov	Technical support
Technical support	FRNP	White, Jana	270-441-5206	jana.white@pad.pppo.gov	Technical support

CHFS = Cabinet for Health and Family Services

Notes/comments:

Consensus decisions made:

- One hundred nine boring locations agreed upon by FFA parties.
- Analytical compounds chosen by the FFA parties.
- During the scoping process, progress was made in defining sample locations, clarifying concepts and identifying data needs, exchanging ideas on investigation methods, and identifying and resolving concerns/issues related to the RI/FS Work Plan development.

Action items:

Action	Responsible Party	Due Date
Action items were identified and resolved during scoping activities by the FFA parties and incorporated into the work plan as appropriate.	FRNP Project Manager	November 19, 2018

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 is taken from the RI/FS Work Plan for the C-400 Complex Operable Unit (DOE 2018b) and is found in 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)

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)

5. Develop the Analytic Approach. Define the parameter(s) of interest; specify the type of inference [e.g., "samples from groundwater monitoring wells (MWs) 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)

[Example taken from RI/FS Work Plan for the C-400 Complex Operable Unit (DOE 2018)]

Step 1. State the Problem:

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

Problem Description: Within the C-400 Complex area, there have been 22 SWMUs identified. Of the SWMUs present, 15 have been identified as requiring no further action. The remaining seven SWMUs requiring action include, SWMUs 11, 40, 47, 98, 203, 480, and 533. In addition numerous potential and known spill areas (stained areas) have been identified requiring further investigation. The chemicals or radionuclides of potential concern (COPCs) included radionuclides, metals, inorganic compounds, volatile organic compounds, semivolatile compounds, and PCBs. The C-400 Complex area also is the suspected source zone for trichloroethene (TCE) contamination associated with the Northeast and Northwest Groundwater Plumes and likely the source zone for technetium-99 (Tc-99) contamination associated with the Northwest Groundwater Plume.

Problem Approach: The planning team determined that it will be best to divide the C-400 Complex into seven sectors: six of these sectors surround the C-400 Cleaning Building; and the seventh sector is the C-400 Cleaning Building, which is divided further into four subsectors. The sampling strategy for the C-400 Complex will focus on concrete slabs, surface soils, subsurface soils, and groundwater.

Planning Team: FFA parties, FRNP

- Conceptual Model: See Section 4.10 of this work plan.
- Determine Resources:
  - Schedule: See Worksheets #14 and #16
  - Budget: Based upon final scope of work
  - Personnel: FRNP

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

Step 2: Identify the Goals of the Study

- Characterize nature of source zone(s).
- Define extent of source and contamination in soil and remaining structures in the OU area.
- Evaluate potential for surface and subsurface transport mechanisms and pathways.
- Complete a risk assessment for the C-400 Complex.
- Identify, develop, and evaluate remedial alternatives.

Step 3. Identify Information Inputs:

Concrete, soil, and groundwater sample results for quantitative use in determining contamination contained within the footprint of the C-400 Complex area.

Step 4. Identify the Boundaries of the Study:

Boundary of the study area is defined by the outer edges of the surrounding roadways (Virginia Street to the north, 11th Street to the east, Tennessee Street to the south, and 10th Street to the west) that encompass the C-400 Cleaning Building footprint.

Step 5. Develop the Analytical Approach:

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

Step 6. Specify Performance or Acceptance Criteria:

- Analytical sample results must successfully undergo assessment and validation to be used to support the C-400 Complex RI/FS and to support CERCLA analysis.

Step 7. Develop the Detailed Plan for Obtaining Data:

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

QAPP Worksheet #11. Project/Data Quality Objectives (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.
- The addition of perfluorinated chemicals and other constituents that are not COPCs (as listed in Table 2.1 of the RMD) should be considered.

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. Example MPC include relative percent difference (RPD) comparisons and no target compounds greater than practical quantitation limit (PQL) or minimum detectable activity (MDA). 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.

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

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

Matrix	Water
Analytical Group[1]	Volatile Organic Compounds (VOCs)
Concentration Level	Low

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-8260 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

[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 the laboratory is accredited to perform 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 (SVOCs, Water)

Matrix	Water				
Analytical Group[1]	Semivolatile Organic Compounds (SVOCs)				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-8270 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

[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 the laboratory is accredited to perform 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 (Metals, Water)

Matrix	Water
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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	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	RPD—80-120%	Interference Check Sample	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

[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 the laboratory is accredited to perform 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 (Mercury, Water)

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-7470 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

[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 the laboratory is accredited to perform 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 (Fluoride, Water)

Matrix	Water				
Analytical Group[1]	Fluoride				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-9056 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

[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 the laboratory is accredited to perform 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 (PCBs, Water)

Matrix	Water
Analytical Group[1]	PCBs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8082 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 25%	Field Duplicates	S
		Accuracy	RPD—≤ 40%	Dual column analysis	A
		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

[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 the laboratory is accredited to perform 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, Water)

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 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

[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 the laboratory is accredited to perform 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-H. Measurement Performance Criteria (Radionuclides, Water)

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Gamma spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 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

[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 the laboratory is accredited to perform 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-I. Measurement Performance Criteria (Radionuclides, Water)

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Liquid scintillation See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 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

[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 the laboratory is accredited to perform 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 (VOCs, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete
Analytical Group[1]	VOCs
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8260 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

[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 the laboratory is accredited to perform 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 (SVOCs, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete				
Analytical Group[1]	SVOCs				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-8270 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

[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 the laboratory is accredited to perform 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, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete
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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	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	RPD—80-120%	Interference Check Sample	A
		Accuracy/Bias Contamination	No target compounds > PQL	Method Blanks/Instrument Blanks	A
		Accuracy/Bias Contamination	No target compounds > PQL	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > PQL	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

[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 the laboratory is accredited to perform 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, Soil/Sediment, or Concrete)

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

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-7471 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

[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 the laboratory is accredited to perform 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 (Fluoride, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete
Analytical Group[1]	Fluoride
Concentration Level	Low

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-9056 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

[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 the laboratory is accredited to perform 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 (PCBs, Soil/Sediment, or Concrete)

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

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	SW-846-8082 See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy	RPD—≤ 40%	Dual column analysis	A
		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

[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 the laboratory is accredited to perform 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, Soil/Sediment, or Concrete)

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

Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[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

[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 the laboratory is accredited to perform 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-Q. Measurement Performance Criteria (Radionuclides, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete
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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Alpha spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[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

[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 the laboratory is accredited to perform 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 (Radionuclides, Soil/Sediment, or Concrete)

Matrix	Soil/Sediment or Concrete				
Analytical Group[1]	Radionuclides (cesium-137)				
Concentration Level	Low				
Sampling Procedure[2]	**Analytical Method/SOP**[3, 4]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	Gamma spectroscopy See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias Contamination	No target compounds > MDA	Field Blanks	S
		Accuracy/Bias Contamination	No target compounds > MDA	Equipment Rinseates	S
		Completeness[5]	90%	Data Completeness Check	S&A

[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 the laboratory is accredited to perform 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 (Radionuclides, Soil/Sediment, or Concrete)

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

Sampling Procedure[2]	Analytical Method/SOP[3, 4]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
See Worksheet #21	Liquid scintillation See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 50%	Field Duplicates	S
		Accuracy/Bias	% recovery[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

[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 the laboratory is accredited to perform 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-T. 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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
See Worksheet #21	SW-846-6200 (XRF) See Worksheet #23	Precision	RPD—≤ 35%	Field Duplicates	S
		Precision—Lab	Duplicate result within 95% confidence interval of original reading	Laboratory Duplicates	A
		Accuracy/Bias Contamination	No target compounds > quantitation limit	Method Blanks/Instrument Blanks	A
		Completeness[5]	90%	Data Completeness Check	S&A

[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-U. 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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
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

[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-V. 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**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
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

[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-W. 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**	**Measurement Performance Criteria**[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 gas chromatography/mass spectrometry (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

[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 the laboratory is accredited to perform 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.

QAPP Worksheet #12-X. Measurement Performance Criteria (PCBs, Wipe)

Matrix	Wipe
Analytical Group[1]	PCBs (GC/ECD)
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: 3541/8082 3541/8082A See Worksheet #23	Precision—Lab	RPD—≤ 25%	Laboratory Duplicates	A
		Precision	RPD—≤ 35%	Field Duplicates	S
		Accuracy	RPD—≤ 40%	Dual column analysis	A
		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-Y. Measurement Performance Criteria (Radionuclides, Wipe)

Matrix	Wipe
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-Z. Measurement Performance Criteria (Radionuclides, Wipe)

Matrix	Wipe
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-AA. Measurement Performance Criteria (Radionuclides, Wipe)

Matrix	Wipe
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.

QAPP Worksheet #12-BB. Measurement Performance Criteria (Radionuclides, Wipe)

Matrix	Wipe
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—≤ 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 #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 (Continued)

(Example taken from C-400 Complex RI/FS 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 whether the concrete slab is a potential secondary source of contamination. The data will be used in conjunction with RI/FS data to be collected at a later date.	Data have been verified, assessed, and validated (if validation is required). Rejected data will not be used.
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. DOE 1995. *C-400 Process and Structure Review*, KY/ERWM-38, U.S. Department of Energy, Paducah, KY, May. DOE 1999. *Remedial Investigation Report for Waste Area Grouping 6 (C-400) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1727&D2.	DOE contractors, soil and aqueous, 1992–1999 Various	Information will be used in conjunction with newly collected data to determine chemical or radionuclide of potential concern are present in the concrete slabs. 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; Oak Ridge Environmental Information System (OREIS) is the repository for environmental and waste characterization analytical results. OREIS is a limited access database. Most of the results in OREIS are downloaded to Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS) periodically (usually on a quarterly basis). The general public can access data in PEGASIS.

QAPP Worksheets #14 and 16. Project Tasks & Schedule

(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

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.

Example from C-400 Complex RI/FS Project

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization/demobilization	FRNP	October 1, 2019	May 30, 2020	Field notes	September 1, 2020
Sample collection	FRNP	October 1, 2019	May 30, 2020	Field notes	September 1, 2020
Analysis	Contract Lab	November 1, 2019	September 30, 2020	Report of analysis	September 30, 2020
Validation	Veolia Nuclear Solutions Federal Services	June 1, 2019	September 30, 2020	Validation summary	September 30, 2020
Data Report	Project Team	May 2019	December 30, 2020	Data Report	December 30, 2020

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 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.

Consideration also should be given to ecological values found in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 2. Ecological*, DOE/LX/07-0107&D2/R3/V2 (DOE 2019b).

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

Matrix: Water
Analytical Group: VOCs

Analyte	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
Bromodichloromethane	75-27-4	80/0.134	MCL[f]/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
1,2-Dichloroethane	107-06-2	5.0/0.171	MCL/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
1,1,1-Trichloroethane	71-55-6	200/801	MCL/NAL	Yes	1	0.3
1,1,2-Trichloroethane	79-00-5	5.0/0.0415	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
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,p-Xylene	179601-23-1	19/19.3[g]	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.

[a] This QAPP references the NALs established by the RMD for the child resident scenario 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 contaminants of concern (COCs) in risk assessments previously performed at PGDP.
[c] The analytical laboratory may not be able to meet the NALs established by the RMD and MCLs reproduced in the RMD. For cases where the PQL is above the 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 2018 (EPA 2018).
[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.
[g] Project action limit for m-Xylene used.

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

Matrix: Water
Analytical Group: SVOCs

Analyte	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	208-96-8	53.5	NAL	Yes	1	0.3
Anthracene	120-12-7	180/177	Tapwater/NAL	Yes	1	0.3
Benz[a]anthracene	56-55-3	0.03/0.0298	Tapwater /NAL	Yes	1	0.3
Benzo[a]pyrene	50-32-8	0.2/0.0251	MCL/NAL	Yes	1	0.3
Benzo[b]fluoranthene	205-99-2	0.25/0.251	Tapwater /NAL	Yes	1	0.3
Benzo[k]fluoranthene	207-08-9	2.5/2.51	Tapwater /NAL	Yes	1	0.3
Carbazole	86-74-8	2.03	NAL	Yes	1	0.3
Chrysene	218-01-9	25/25.1	Tapwater /NAL	Yes	1	0.3
Dibenz[a,h]anthracene	53-70-3	0.025/0.0251	Tapwater /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
Fluorene	86-73-7	29/29.4	Tapwater /NAL	Yes	1	0.3
Hexachlorobenzene	118-74-1	1.0/0.00976	MCL/NAL	Yes	10	3
Indeno[1,2,3-cd]pyrene	193-39-5	0.25/0.251	Tapwater /NAL	Yes	1	0.3
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
Pentachlorophenol	87-86-5	1.00/0.0413	MCL/NAL	Yes	TBD	TBD
Phenanthrene	85-01-8	53.5	NAL	Yes	1	0.3
Pyrene	129-00-0	12/12.1	Tapwater/NAL	Yes	1	0.3

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
[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 for the child resident scenario 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 2018 (EPA 2018).
[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.

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

Matrix: Water
Analytical Group: Metals

Analyte	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
Fluoride	16984-48-8	4.0/0.0799	MCL/NAL	Yes	0.1	0.033
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
Mercury	7439-97-6	0.0020/0.000566[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	7440-02-0	0.039/0.0392[i]	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	7440-28-0	0.0020/0.000020[i]	MCL/NAL	Yes	0.002	0.00045
Uranium	7440-61-1	0.030/0.000399[i]	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.
*SW-846 Method 7196.

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

[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 for the child resident scenario 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 2018 (EPA 2018).
[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 were derived for metal salts; the CAS number is presented for the elemental form.
[i] The PAL/NAL values were derived for metal soluble salts.

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

Matrix: Water
Analytical Group: PCBs

Analyte	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)
Total PCBs	1336-36-3	0.50/0.0436	MCL/NAL	Yes	0.1	0.0333
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.

[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 for the child resident scenario 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-E. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Water)

Matrix: Water
Analytical Group: Radionuclides

Analyte	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[e]	10045-97-3	1.71	NAL	Yes	10
Neptunium-237[e]	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[f], 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[e]	15117-96-1	0.466/0.728	MCL[e]/NAL	Yes	1
Uranium-238[e]	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.

[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 for the child resident scenario 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] PAL/NAL was derived considering the contribution from short-lived decay products.
[f] 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-F. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (VOCs, Soil/Sediment, or Concrete)

Matrix: Soil/Sediment or Concrete
Analytical Group: VOCs

Analyte	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)
1,2-Dichloroethane	107-06-2	464	NAL	Yes	1	0.33
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
Bromodichloromethane	75-27-4	293	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
1,1,1-Trichloroethane	71-55-6	815,000	NAL	Yes	1	0.33
1,1,2-Trichloroethane	79-00-5	150	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
m,p-Xylene	179601-23-1	55,100[e]	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.

[a] This QAPP references the NALs established by the RMD for the child resident scenario 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.
[e] Project action limit for m-Xylene used.

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

Matrix: Soil/Sediment or Concrete
Analytical Group: SVOCs

Analyte	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	NAL	Yes	33.3	10
Anthracene	120-12-7	923,000	NAL	Yes	33.3	10
Benz[a]anthracene	56-55-3	475	NAL	Yes	33.3	10
Benzo[a]pyrene	50-32-8	47.8	NAL	Yes	33.3	10
Benzo[b]fluoranthene	205-99-2	478	NAL	Yes	33.3	10
Benzo[k]fluoranthene	207-08-9	4,780	NAL	Yes	33.3	10
Carbazole	86-74-8	10,400	NAL	Yes	33.3	10
Chrysene	218-01-9	47,800	NAL	Yes	33.3	10
Dibenz[a,h]anthracene	53-70-3	47.8	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
Fluorene	86-73-7	123,000	NAL	Yes	33.3	10
Hexachlorobenzene	118-74-1	212	NAL	Yes	333	100
Indeno[1,2,3-cd]pyrene	193-39-5	478	NAL	Yes	33.3	10
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
Pentachlorophenol	87-86-5	254	NAL	Yes	333	100
Phenanthrene	85-01-8	185,000	NAL	Yes	33.3	10
Pyrene	129-00-0	92,300	NAL	Yes	33.3	10

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
[a] This QAPP references the NALs established by the RMD for the child resident scenario 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 2019a) 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-H. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Metals, Soil/Sediment, or Concrete)

Matrix: Soil/Sediment or Concrete
Analytical Group: Metals

Analyte	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 (total)	7440-47-3	11,700[e]	NAL	Yes	0.6	0.2
Chromium VI*	18540-29-9	0.301	NAL	Yes	0.4	0.16
Cobalt	7440-48-4	2.34	NAL	Yes	0.2	0.06
Copper	7440-50-8	313	NAL	Yes	0.2	0.066
Fluoride	16984-48-8	313	NAL	Yes	1	0.34
Iron	7439-89-6	5,480	NAL	Yes	20	6.6
Lead	7439-92-1	400	NAL	Yes	0.4	0.1
Manganese	7439-96-5	183	NAL	Yes	1	0.2
Mercury[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[g]	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[g]	7440-28-0	0.0782	NAL	Yes	0.4	0.06
Uranium[g]	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.
*SW-846 Method 7196.

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

[a] This QAPP references the NALs established by the RMD for the child resident scenario 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.
[g] The PAL/NAL values were derived for metal soluble salts.

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

Matrix: Soil/Sediment or Concrete
Analytical Group: PCBs

Analyte	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)
Total PCBs	1336-36-3	0.0788	NAL	Yes	0.0033	0.001099
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.

[a] This QAPP references the NALs established by the RMD for the child resident scenario 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-J. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (Radionuclides, Soil/Sediment, or Concrete)

Matrix: Soil/Sediment or Concrete
Analytical Group: Radionuclides

Analyte	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[e]	10045-97-3	0.0402	NAL	Yes	0.1
Neptunium-237[e]	13994-20-2	0.0911	NAL	Yes	1
Plutonium-238	13981-16-3	4.27	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	4.93	NAL	Yes	1
Uranium-234	13966-29-5	5.77	NAL	Yes	1
Uranium-235[e]	15117-96-1	0.148	NAL	Yes	1
Uranium-238[e]	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.

[a] This programmatic QAPP references the NALs established by the RMD for the child resident scenario 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.
[e] PAL/NAL was derived considering the contribution from short-lived decay products.

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)

Analyte	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

[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 for uranium (insoluble compounds) (DOE 2019a). 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 (Total PCBs, Soil/Sediment)

Matrix: Soil/Sediment
Analytical Group: Total PCBs

Analyte	CAS Number	Project Action Limit (mg/kg)	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific	
					PQL (mg/kg)	MDL (mg/kg)
Total PCBs	1336-36-3	1[b]	Project scoping	Yes	N/A	1

[a] Analytes marked with COPC are from Table 2.1 of the RMD.
[b] The PAL for Total PCBs was set to ensure the DQOs agreed to by the FFA parties were met using the immunoassay test kit.

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

Matrix: Soil/Sediment
Analytical Group: PAHs

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

[a] Analytes marked with COPC are from Table 2.1 of the RMD.
[b] The PAL for PAHs was set to ensure the DQOs agreed to by the FFA parties were met using the immunoassay test kit.

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

Matrix: Air
Analytical Group: VOCs

Analyte	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

[a] VISL = Vapor Intrusion Screening Level, Version 3.5.2 (EPA 2017) (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-N. 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-N. 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-N. 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 #15-O. Project Action Limits and Laboratory-Specific Detection/Quantitation Limits (PCBs, Wipe)

Matrix: Wipe
Analytical Group: PCBs

PCB	CAS Number	Project Action Limit	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific[b]	
					PQL (µg/sample)	MDL[c] (µg/sample)
Aroclor 1016	12674-11-2	N/A	N/A	Yes	0.1	0.0333
Aroclor 1221	11104-28-2	N/A	N/A	Yes	0.1	0.0333
Aroclor 1232	11141-16-5	N/A	N/A	Yes	0.1	0.0333
Aroclor 1242	53469-21-9	N/A	N/A	Yes	0.1	0.0333
Aroclor 1248	12672-29-6	N/A	N/A	Yes	0.1	0.0333
Aroclor 1254	11097-69-1	N/A	N/A	Yes	0.1	0.0333
Aroclor 1260	11096-82-5	N/A	N/A	Yes	0.1	0.0333
Aroclor Total	1336-36-3	N/A	N/A	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.

[a] 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 contaminants of concern in risk assessments previously performed at PGDP.
[b] Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[c] This QAPP will be used to solicit laboratories to perform the work. Should the laboratory not be able to meet the MDLs and PQLs identified in the Worksheets, the laboratory will submit documentation of its actual MDLs and PQLs, and this information will be appended to the QAPP.

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

Matrix: Wipe
Analytical Group: Radionuclides

Radionuclide	CAS Number	Project Action Limit	Project Action Limit Reference	Site COPC?[a]	Laboratory-Specific[b] MDA[c] (pCi/sample)
Americium-241	14596-10-2	N/A	N/A	Yes	1
Cesium-137	10045-97-3	N/A	N/A	Yes	25
Neptunium-237	13994-20-2	N/A	N/A	Yes	1
Plutonium-238	13981-16-3	N/A	N/A	Yes	1
Plutonium-239/240	15117-48-3/ 14119-33-6	N/A	N/A	Yes	1
Technetium-99	14133-76-7	N/A	N/A	Yes	10
Thorium-230	14269-63-7	N/A	N/A	Yes	1
Uranium-234	13966-29-5	N/A	N/A	Yes	1
Uranium-235	15117-96-1	N/A	N/A	Yes	1
Uranium-238	24678-82-8	N/A	N/A	Yes	1

[a] 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 contaminants of concern in risk assessments previously performed at PGDP.
[b] Standard practices for qualifying data will apply for any result reported below the laboratory PQL.
[c] 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 MDAs and this information will be appended to the QAPP.

QAPP Worksheet #17. Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

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.

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-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 Solid Waste Management Unit (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.

Example taken primarily 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) Upper Continental Recharge System (UCRS) MWs; 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 Regional Gravel Aquifer (RGA).

Phase V will include installation of five additional RGA MWs. 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 VOC 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; SVOC 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)

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.

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

QAPP Worksheet #18. Sampling Locations and Methods (Continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group[a]	Number of Samples (Identify Field Duplicate %)[b]	Sampling SOP Reference[c]	Rationale for Sampling Location
TBD	Soil	0–20 ft (5 ft intervals)	VOC, SVOCs, PCBs, Radiological, Metals	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	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	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	27 (1 sample from each of 27, 60 ft borings) (minimum of 5%)	See Worksheet #21	See Worksheet #17
TBD	Soil	0–1 ft	PCBs test kits, XRF Metals analysis (performed in field lab); PCBs, Metals SVOCs, radiological (performed in fixed-base lab)	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	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	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	8 samples taken for grain size and air permeability (no duplicates)	See Worksheet #21	See Worksheet #17
TBD	Soil gas	0–1 ft	VOCs	48	See Worksheet #21	See Worksheet #17

[a] See Analytical SOP References Table (Worksheet #23).
[b] Contingency locations not included.
[c] See Field SOP References Table (Worksheet #21).

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. Example from C-400 Complex RI/FS Project

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

List any required accreditations/certifications: DOE Consolidated Audit Program (DOECAP), if applicable

Back-up Laboratory: N/A

Sample Delivery Method: Overnight delivery

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	Solid (Concrete)/Soil	EPA Methods SW-846-8260	TBD	Soil cores— 3 × 5-g Encore Samplers Concrete and other solids— 1 2-oz wide mouth glass jar	0–6˚C	N/A	Soil cores— 48 hours (EnCore™ Sampler) Concrete and other solids— 14 day hold time	28 days
SVOCs	Solid (Concrete)/Soil	EPA Method SW-846-8270	TBD	1 × 250 ml wide mouth amber glass	0–6˚C	14 days	40 days	28 days

QAPP Worksheet #19 and 30. Sample Containers, Preservation, and Hold Times (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	Solid (Concrete)/Soil	SW-846-8082	TBD	1 × 250 ml wide mouth amber glass	0–6˚C	N/A	N/A*	28 days
Metals	Solid (Concrete)/Soil	EPA Method SW-846-6020	TBD	1 × 4 oz. wide mouth glass	N/A	N/A	180 days	28 days
Radionuclides	Solid (Concrete)/Soil	Alpha Spec, Gamma Spec, Liquid Scintillation	TBD	1 × 16 oz. wide mouth poly/plastic jar	N/A	N/A	180 days	28 days
Mercury	Solid (Concrete)/Soil	EPA Method SW-846-7471	TBD	1 × 4 oz. wide mouth glass	0–6˚C	N/A	28 days	28 days
Dioxins and Furans	Soil	EPA Method SW-846-8290	TBD	125 ml wide mouth amber glass	0–6˚C	30 days	45 days	28 days
Dieldrin	Solid (Concrete)/Soil	EPA Method SW-846-8061	TBD	1 × 250 ml wide mouth amber glass	0–6˚C	14 days	40 days	28 days
VOCs	Groundwater	EPA Methods SW-846-8260	TBD	3 × 40 ml VOA vials jar	HCl-hydrochloric acid to pH < 2; 0–6˚C	N/A	14 days	28 days
SVOCs	Groundwater	EPA Method SW-846-8270	TBD	2 × 1,000 ml amber glass	0–6˚C	7 days	40 days	28 days
PCBs	Groundwater	EPA Method SW-846-8082	TBD	2 × 1,000 ml amber glass	0–6˚C	N/A	N/A*	28 days

QAPP Worksheet #19 and 30. Sample Containers, Preservation, and Hold Times (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
Metals	Groundwater	EPA Method SW-846-6010/6020	TBD	1 × 500 ml glass	HCl to pH < 2	N/A	180 days	28 days
Radionuclides	Groundwater	Alpha Spec, Gamma Spec, Liquid Scintillation, EPA-903.1-M, EPA-905.0-M	TBD	2 × 1,000 ml amber glass	HCl to pH < 2	N/A	180 days	28 days
Mercury	Groundwater	EPA Method SW-846-7470	TBD	1 × 250 ml amber glass	HCl to pH < 2	N/A	28 days	28 days
Dieldrin	Groundwater	EPA Method SW-84-8081	TBD	2 × 1,000 ml amber glass	0–6˚C	7 days	40 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.

QAPP Worksheet #20. Field QC Summary

(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

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 (PT) 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.

Example from C-400 Complex RI/FS Project

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Solid (Concrete)/Soil	VOCs	773	39	39	39	39	39	1 per day or 1 per cooler	N/A	1007
Solid (Concrete)/Soil	Metals	773	39	39	39	39	39	N/A	N/A	968
Solid (Concrete)/Soil	SVOCs	773	39	39	39	39	39	N/A	N/A	968
Solid (Concrete)/Soil	PCBs	773	39	39	39	39	39	N/A	N/A	968
Solid (Concrete)/Soil	Radionuclides	779	39	39	39	39	39	N/A	N/A	974
Solid (Concrete)/Soil	Dioxins	60	4	4	4	4	4	N/A	N/A	80

QAPP Worksheet #20. Field QC Summary (Continued)

Matrix	Analyte/ Analytical Group	Field Samples	Field Duplicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # of Analyses
Solid (Concrete)/Soil	Additional Radionuclides (thorium-228, thorium-232, actinium-227, cobalt-60, lead-210, protactinium-231, radium-226, strontium-90)	8	1	1	1	1	1	N/A	N/A	13
Groundwater	VOCs	284	15	15	15	15	15	l per day or 1 per cooler	N/A	374
Groundwater	Metals	284	15	15	15	15	15	N/A	N/A	359
Groundwater	SVOCs	284	15	15	15	15	15	N/A	N/A	359
Groundwater	PCBs	284	15	15	15	15	15	N/A	N/A	359
Groundwater	Radionuclides	284	15	15	15	15	15	N/A	N/A	359

QAPP Worksheet #21. Field SOPs

(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

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.

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

QAPP Worksheet #21. Field SOPs (Continued)

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
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
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

QAPP Worksheet #21. Field SOPs (Continued)

Reference Number	Title and Number[a] Revision Date	Originating Organization[b]	Equipment Type	Modified for Project Work? (Y/N)	Comments
26	CP2-HS-2040, *Asbestos Controls Program at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (3/18/2018)	Contractor	N/A	N	N/A
27	CP4-ES-0036, *Asbestos Waste Sampling* (12/28/2017)	Contractor	N/A	N	N/A
28	SI-ES-0006 R0, *Obtaining Concrete Core Samples and Access Port Installation at C-400* (7/31/2018)	Contractor	N/A	N	N/A
29	CP3-RP-1109, *Radioactive Contamination Control and Monitoring* (8/16/2018)	Contractor	N/A	N	N/A
30	CP4-RP-1309, *Setup for Operability Tests of Portable Field Instruments* (1/8/2018)	Contractor	N/A	N	N/A
31	CP4-RP-1336, *Radiological Instrumentation Field Operability Tests* (10/20/2017)	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.

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)

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.

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 (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
Pressure Transducer	Precalibrated by manufacturer	As needed	Measure against water level meter	Upon receipt, successful operation	Weekly as needed	With range of manufacturer's specifications	Service by manufacturer	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 (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
RCT = radiological control technician

QAPP Worksheet #23. Analytical SOPs

(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

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.

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 GC/MS	Definitive	VOAs/Soil and Water	GC/MS	TBD	No
8082	PCBs by Gas Chromatography (GC)	Definitive	PCBs/ Soil and Water	GC	TBD	No
6010	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	Definitive	Metals/Soil	ICP	TBD	No
6020	Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)	Definitive	Metals/ Water	ICP-MS	TBD	No
8270[1]	SVOCs by GC/MS	Definitive	SVOCs/ Water	GC/MS	TBD	No
7470/7471	Cold vapor Atomic Absorption (AA)	Definitive	Mercury/ Soil and Water	AA	TBD	No
4035	Soil Screening for Polynuclear Aromatic Hydrocarbons by Immunoassay	Screening	PAHs/ Soil	Field Test Kit	FRNP	No

QAPP Worksheet #23. Analytical SOPs (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)
4020	Screening for Polychlorinated Biphenyls by Immunoassay	Screening	PAHs/ Soil	Field Test Kit	FRNP	No
TO-15	Determination Of VOCs In Air Collected In Specially-Prepared Canisters And Analyzed by GC/MS	Definitive	VOCs/ Air	GC/MS	TBD	No
Gas Flow Proportional***	Gas Flow Proportional	Definitive	Rads/Soil and Water	Gas flow proportional counter	TBD	No
Alpha Spec***	Alpha Spectrometry	Definitive	Rads/Soil and Water	Alpha Spectrometry	TBD	No
Gamma Spec***	Gamma Spectrometry	Definitive	Rads/Soil and Water	Gamma Spectrometry	TBD	No
Liquid Scintillation***	Tc-99 by Liquid Scintillation	Definitive	Rads/Soil and Water	Liquid Scintillation	TBD	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.
[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.

Laboratories used by the DOE Prime Contractor are participants in DOE Consolidated Audit Program (DOECAP). In the fall of 2017, DOECAP began implementing accreditation of environmental laboratories through third party organizations. If not in DOECAP, laboratories are audited by contractors for compliance with DOECAP program requirements. As such, laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program as summarized in the SOPs. The laboratory is responsible for maintaining instrument calibration information per its QA Plan, including control charts established for instrumentation.

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

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

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

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

(UFP-QAPP Manual Section 3.2.3)
(EPA 2106-G-05 Section 2.3.6)

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.

Laboratories used by the DOE Prime Contractor are participants in DOECAP. In the fall of 2017, DOECAP began implementing accreditation of environmental laboratories through third party organizations. If not in DOECAP, laboratories are audited by contractors for compliance with DOECAP program requirements. As such, laboratory equipment and instruments used for quantitative measurements are calibrated in accordance with the laboratory's formal calibration program as summarized in the SOPs. The laboratory is responsible for maintaining instrument calibration information per its QA Plan, including control charts established for instrumentation. 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.

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 (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 (Continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference*
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	
Cold Vapor Atomic Absorption (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

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

QAPP 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.

Example from C-400 Complex RI/FS Project.

Sampling Organization: TBD
Laboratory: TBD
Method of sample delivery (shipper/carrier): Overnight
Number of day from reporting until sample disposal: Six months (182 days)

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	Sampling Teams/DOE Prime Contractor and Subcontractors	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	SMO/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	TBD
Sample custody and storage	Sample Management/Contracted Laboratory	TBD
Sample disposal	Sample Management/Contracted Laboratory	TBD

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-A. Analytical Quality Control and Corrective Action (Aqueous)

Matrix: Aqueous Samples
Analytical Group/Concentration Level: VOC, Metals, PCBs, Rads, SVOCs
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: TBD
No. of Sample Locations: TBD

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	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 (matrix spike and/or matrix spike duplicate)	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 (laboratory control sample)	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. Analytical Quality Control and Corrective Action (Aqueous) (Continued)

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	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 samples, blanks and QA samples	See data validation plans CP2-ES-0811, -5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All samples and standards	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	See data validation plans
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, ≤ contract-required quantitation limit (CRQL).

QAPP Worksheet #28-B. Analytical Quality Control and Corrective Action (Soil/Sediment)

Matrix: Soils/Sediments
Analytical Group/Concentration Level: VOC, Metals, PCBs, Radionuclides, SVOCs
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: TBD
No. of Sample Locations: TBD

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	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 (matrix spike and/or matrix spike duplicate)	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 (laboratory control sample)	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. Analytical Quality Control and Corrective Action (Soil/Sediment) (Continued)

QC Sample	Frequency/Number*	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	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-0811, -5105	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Internal standards	All sample blanks and QA samples	See data validation plans CP2-ES-5102, -5107	Check calculations and instrument; reanalyze affected samples		Accuracy	See procedure CP3-ES-5003, *Quality Assured Data*
Field duplicate	Minimum 5%	See data validation plans CP2-ES-0026, -0811, -5102, -5105, -5107	Data reviewer will place qualifiers on samples affected	Project	Homogeneity/ Precision	See data validation plans
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.

QAPP Worksheet #28-C. Analytical Quality Control and Corrective Action (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: TBD
No. of Sample Locations: TBD

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Field duplicate	Minimum 5%	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

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.

Example from C-400 Complex RI/FS Project.

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Field logbook or data sheets	Field Team	Field Team Leader	Project File
Chain-of –Custody Forms	Field Team	Field Team Leader	Project File
Air Bills	Contract Laboratory	Contract Laboratory	Project File
Equipment Calibration Forms	Field Team	Field Team Leader	Project File
Deviations	Project Manager	Project Director	Project File
Corrective Action Reports	Project Manager	Project Director	Project File
Correspondence	Project Manager	Project Director	Project File

Project Assessments			
Record	**Generation**	**Verification**	**Storage location/archival**
Data verification checklists	SMO/Data Validator	SMO	Project File
Data validation report	Data Validator	SMO	Project File
Data usability assessment report	Data Validator	SMO	Project File

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

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

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)

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
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]	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-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]	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*
Offsite Laboratory Technical Systems Audit	Laboratory Manager/Technical Director	Annually	Annually/Ongoing	Internal Audit Repot	Per Individual Laboratory QA Manual
Management Assessment	Project Director/ FRNP	Interim management review following site mobilization; final management review upon completion of fieldwork	[fill in planned dates]	As described in CP3-QA-1003, *Management and Self-Assessment*	As described in CP3-QA-1003, *Management and Self-Assessment*
Independent Assessment	Contractor Performance Assurance Program (CPAP) Manager	As needed	[fill in planned dates]	As described in CP3-QA-1004, *Independent Assessment Program*	As described in CP3-QA-1004, *Independent Assessment Program*

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

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
Field Sampling TSA	Field Team Leader/FRNP	Field Sampling Corrective Action Response (following CP3-QA-3001, *Issues Management*)	24 hours from receipt of memorandum	Field Team Leader/FRNP	CPAP Manager/FRNP
On-site analytical TSA	Field Team Leader/ FRNP	On-site Analytical Corrective Action Response (following CP3-QA-3001, *Issues Management*)	48 hours from receipt of memorandum and before further analyses can be conducted.	Field Team Leader/ FRNP	CPAP Manager/FRNP
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/QC Program Manager/FRNP
Management Assessment	Project Director/ FRNP	Management Response	As described in CP3-QA-1003, *Management and Self-Assessment*	As assigned in Management Response	CPAP Manager/FRNP
Independent Assessment	Director/Manager of the Assessed Organization	As required by CP3-QA-1004, *Independent Assessment Program*)	As required by CP3-QA-1004, *Independent Assessment Program*)	Field Team Leader/ FRNP	CPAP Manager/FRNP

QAPP Worksheet #34. Data Verification and Validation Inputs

(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	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs	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)

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.

Example from C-400 Complex RI/FS Project

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— SMO/FRNP
Data deliverables, analytes, and holding times	QAPP, contract, and procedures	The documentation from the contractual screening will be included in the data assessment packages, per DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*.	Laboratory PM/Contract Laboratory SMO/FRNP

QAPP Worksheet #35. Data Verification Procedures (Continued)

Records Reviewed	Requirement Documents	Process Description	Responsible Person/Organization
Chain-of-custody, sample handling, sampling methods and procedures, and field transcription	QAPP, contract, and procedures	These items will be validated during the data assessment process as required by DOE Prime Contractor procedure CP3-ES-5003, *Quality Assured Data*, and CP3-ES-1003, *Developing, Implementing, and Maintaining Data Management Plans*. The documentation of this validation will be included in the data assessment packages.	SMO/FRNP
Analytical methods and procedures, laboratory data qualifiers, and standards	QAPP, contract, and procedures	These items will be reviewed during the data validation process as required by DOE Prime Contractor data validation procedures. Data validation will be performed in parallel with data assessment. The data validation report and data validation qualifiers will be considered when the data assessment process is being finalized.	Data Validation Subcontractor and SMO/FRNP
Audit reports, corrective action reports	QAPP and procedures	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	CPAP Manager/FRNP
Deviations and qualifiers	QAPP and procedures	Any deviations and qualifiers resulting from process will be documented in the data assessment packages.	SMO/FRNP

QAPP Worksheet #36. Data Validation Procedures

(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.

Data Validator: Veolia Nuclear Solutions Federal Services

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)

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
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)

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 2019 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 2019 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 2019 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. MDLs also are compared to background (BG) values.

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 (SVOCs), 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/R10/V1, U.S. Department of Energy, Paducah, KY, April 2019.

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 and 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.

- SVOCs: Benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, dieldrin, hexachlorobenzene, indeno[1,2,3-cd]pyrene, naphthalene, and N-nitroso-di-n-propylamine have PALs less than the MDLs. 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 to Project Action Limits and Background for Soil Samples

Metal	Project Action Limit (mg/kg) Child Resident NAL	Background (mg/kg) Surface	Background (mg/kg) Subsurface	GEL Laboratories PQL (mg/kg)	GEL Laboratories MDL (mg/kg)	*PAL* (mg/kg)	*PAL-MDL* (mg/kg)	*Surface BG - MDL* (mg/kg)	*Subsurface BG - MDL* (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)***	11,700	16	43	0.6	0.2	11,700.0	11699.8	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
Fluoride	313	NA	NA	TBD	TBD	313	TBD	TBD	TBD
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	1.56	4.9	4.6	0.04	0.013	1.6	1.5	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

PCB	Project Action Limit (mg/kg) Child Resident NAL	Background (mg/kg) Surface	Background (mg/kg) Subsurface	GEL Laboratories PQL (mg/kg)	GEL Laboratories MDL (mg/kg)	*PAL* (mg/kg)	*PAL-MDL* (mg/kg)	*Surface BG-MDL* (mg/kg)	*Subsurface BG-MDL* (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
Total PCBs	0.0788	NA	NA	0.0033	0.0011	0.0803	0.0792	NA	NA

Comparison of Method Detection Limits to Project Action Limits and Background for Soil Samples (Continued)

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	4.27	0.073	NA	1	4.27	3.27	-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	4.93	1.5	1.4	1	4.93	3.93	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)
1,2-Dichloroethane	464	NA	NA	1	0.33	464	464	NA	NA
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
Bromodichloromethane	293	NA	NA	1	0.33	293	293	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
1,1,1-Trichloroethane	815,000	NA	NA	1	0.33	815,000	815,000	NA	NA
1,1,2-Trichloroethane	150	NA	NA	1	0.33	150	150	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 to Project Action Limits and Background for Soil Samples (Continued)

SVOC	Project Action Limit (µg/kg) Child Resident NAL	Background (µg/kg) Surface	Background (µg/kg) Subsurface	GEL Laboratories PQL (µg/kg)	GEL Laboratories MDL (µg/kg)	*PAL* (µg/kg)	*PAL-MDL* (µg/kg)	*Surface BG-MDL* (µg/kg)	*Subsurface BG-MDL* (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
Benz[a]anthracene	475	NA	NA	33.3	10	475	465	NA	NA
Benzo[a]pyrene	47.8	NA	NA	33.3	10	48	38	NA	NA
Benzo[b]fluoranthene	478	NA	NA	33.3	10	478	468	NA	NA
Benzo[k]fluoranthene	4,780	NA	NA	33.3	10	4,780	4,770	NA	NA
Carbazole	10,400	NA	NA	33.3	10	10,400	10,390	NA	NA
Chrysene	47,800	NA	NA	33.3	10	47,800	47,790	NA	NA
Dibenz[a,h]anthracene	47.8	NA	NA	33.3	10	48	38	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
Fluorene	123,000	NA	NA	33.3	10	123,000	122,990	NA	NA
Hexachlorobenzene	212	NA	NA	333	100	212	112	NA	NA
Indeno[1,2,3-cd]pyrene	478	NA	NA	33.3	10	478	468	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	30	-70	NA	NA
Pentachlorophenol	254	NA	NA	333	100	254	154	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 to Project Action Limits, 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
Fluoride	4	MCL	0.0799	0.245	4	0.1	0.033	0.0799	0.0469	0.2120	3.97
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	0.0086	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	0.1	0.033	0.0436	0.0106	NA	0.47

Comparison of Method Detection Limits to Project Action Limits, 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-MDL*
	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
Bromodichloromethane	80.0	MCL	0.134	NA	80.0	1	0.3	0.134	-0.166	NA	79.7
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
1,2-Dichloroethane	5.0	MCL	0.171	NA	5	1	0.3	0.171	-0.129	NA	4.7
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
1,1,1-Trichloroethane	200.0	MCL	801	NA	200.0	1	0.3	801.00	800.7	NA	199.7
1,1,2-Trichloroethane	5.0	MCL	0.0415	NA	5.0	1	0.3	0.04	-0.2585	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 to Project Action Limits, Background, and MCLs for Groundwater Samples (Continued)

SVOC	Project Action Limit			RGA Background (µg/L)	MCL	GEL Laboratories		*PAL*	*PAL-MDL*	*BG-MDL*	*MCL-MDL*
	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)
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
Benz[a]anthracene	0.03	RSL	0.0298	NA	NA	1	0.3	0.0298	-0.2702	NA	NA
Benzo[a]pyrene	0.2	MCL	0.0251	NA	0.2	1	0.3	0	-0.2749	NA	-0.10
Benzo[b]fluoranthene	0.250	RSL	0.251	NA	NA	1	0.3	0.251	-0.049	NA	NA
Benzo[k]fluoranthene	2.5	RSL	2.51	NA	NA	1	0.3	3	2.21	NA	NA
Carbazole	NA	RSL	2.03	NA	NA	1	0.3	2.03	1.73	NA	NA
Chrysene	25	RSL	25.1	NA	NA	1	0.3	25	24.8	NA	NA
Dibenz[a,h]anthracene	0.025	RSL	0.0251	NA	NA	1	0.3	0.0251	-0.2749	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
Fluorene	29	RSL	29.4	NA	NA	1	0.3	29	28.7	NA	NA
Hexachlorobenzene	1.0	MCL	0.00976	NA	1.0	10	3	1	-2	NA	NA
Indeno[1,2,3-cd]pyrene	0.25	RSL	0.251	NA	NA	1	0.3	0.25	-0.05	NA	NA
Naphthalene	0.17	RSL	0.165	NA	NA	1	0.3	0.17	-0.13	NA	NA
2-nitroaniline	19	RSL	18.9	NA	NA	10	3	19	16	NA	NA
N-nitroso-di-n-propylamine	0.011	RSL	0.0108	NA	NA	10	3	0.011	-2.989	NA	NA
Pentachlorophenol	1.0	MCL	0.0413	NA	0.0413	TBD	TBD	1	NA	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

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.

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

2018 RSLs from EPA regional screening levels (Target Risk = 1E-6, Hazard Quotient = 0.1) November 2018

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.

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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APPENDIX D

CONCEPTUAL SITE MODEL

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Information in this appendix is taken primarily from the Remedial Investigation/Feasibility Study Work Plan for the C-400 Complex Unit (DOE 2018). This information provides an example conceptual site model.

D.1 CONCEPTUAL SITE MODEL

In general, the C-400 Cleaning Building rests on an approximate 16-inch concrete slab floor designed with four main pits and sumps and an east-side basement area that is 15 to 20 ft below grade. The east-side basement includes a plenum and fan room system to ventilate the building (Figure D.1). Some parts of the concrete slab in the basement and pits were constructed with a base slab and an overlying finished slab of differing construction materials.

Cleaning (clothes laundry and machinery parts), disassembly, and testing of cascade components are the primary activities the building was designed to support. The building also has housed many other activities, including recovery of precious metals and treatment of radiological waste streams.

Potential contaminant source areas include a TCE off-loading pump station, spills, overfill from sumps, and releases from tanks or underground piping. Releases from these sources would directly impact soils below or adjacent to the source and/or sediments and surface water in nearby drainage ways. Continuing transport processes also may result in secondary releases that may impact larger areas or affect additional environmental media. Transport processes likely to be active at the site include vertical infiltration in soil, lateral and vertical migration in groundwater, soil erosion and surface runoff, volatilization, and mobilization of dust particles. Figure D.2 illustrates the hydrogeologic setting for the conceptual site model (CSM).

D.1.1 CONTAMINANT SOURCES, RELEASE MECHANISMS, AND MIGRATION PATHWAYS

In accordance with historical process knowledge and the findings of sampling and analysis performed during the WAG 6 RI, several contaminant sources have been identified. Detections of chemicals in soil and groundwater confirm potential for media-specific chemical transport. The following migration pathways discussed appear to be the most viable exposure routes.

- Leaching of contaminants through soil to groundwater
- Migration of groundwater to downgradient receptors
- Migration of vapors to on-site receptors

The C-400 Complex is the source of many types of potential contaminants, including VOCs, semivolatile organic compounds (SVOCs), metals, and radionuclides. Examples of contaminant sources, release mechanisms, and pathways for migration are illustrated in Figure D.3. In this example, primary sources are related to the following processes:

- TCE: truck and railroad delivery and pump and transfer system, storage tank systems, and vapor degreasers;

- PCBs: leaks of electrical transformers, leaks of gaskets and degradation of building wiring, and wall and floor coatings;

- Tc-99: radionuclide recovery and storage and spray booth and degreasing operations; and

- Uranium: pulverizing and screening of the diffusion process heels and hydrostatic testing of product cylinders.

Extensive areas of soil surrounding the C-400 Cleaning Building have been impacted by releases of TCE and other contaminants into the shallow subsurface soil. Due to the DNAPL characteristics of TCE, the dominant dispersal pattern through the vadose soil to the top of the RGA is gravity-driven. Within the RGA, where spill volumes were sufficiently large, vertical DNAPL migration has penetrated to the base of the RGA. Lateral transport of dissolved-phase contaminants within the RGA follows groundwater flow paths established by the regional groundwater gradient. Releases of TCE at the C-400 Complex are the source for the downgradient, off-site Northwest Plume and may be related to the Northeast Plume.

D.1.2 MIGRATION PATHWAYS

D.1.2.1 Soil to Groundwater Pathway—UCRS

Contaminants present in surface and subsurface soils may leach to the underlying aquifer. Several factors influence the dissolution of COPCs in soils and the rate of contaminant movement through soils. These include the physical/chemical properties of the contaminants [e.g., solubility, density, viscosity, distribution coefficient (K_d)] and the physical/chemical properties of the environment (e.g., rainfall, percolation rate, soil permeability, porosity, particle size, and amount of organic carbon). Contaminants migrate to groundwater through infiltration, leaching, and the movement of subsurface water within the capillary fringe.

Generally, the groundwater is relatively deep at the C-400 Complex, and many of the potential source areas have been present for a long time; therefore, leaching potential is indicated by the observed groundwater concentrations. The depth to the water table in many areas is approximately 50 ft, suggesting a long travel time from the surface to the water table. In areas beneath pavement or other low permeability zones, less infiltration would occur. Adjacent to paved areas, higher rates of recharge may occur as runoff increases infiltration in localized areas. It is obvious that vertical migration has occurred at a much higher rate than indicated by advection/leaching, primarily because of diffusion. Diffusion can increase the rate of contaminant migration significantly as the chemical moves to counteract concentration gradients, which are estimated to be quite significant at the C-400 Complex. It appears that the dominant driving force for chemical migration in the UCRS is diffusion.

Chemicals can attenuate in the vadose zone. Chemicals that strongly sorb to soils, including most polycyclic aromatic hydrocarbon (PAH) compounds, tend to remain in or near the point of release. The retardation factors for these constituents indicate that they would be expected to migrate much more slowly than water in some instances. In addition to their strong tendency to adsorb, these compounds biodegrade during the slow transport, limiting the impacted area. Other constituents such as VOCs tend to volatilize in the unsaturated zone, decreasing their persistence in that medium.

The cosolvent effect may apply where there are two types of organic contaminants present in the waste: one type that is hydrophobic and sparingly soluble, (e.g., PAHs and PCBs), and another type that may function as a cosolvent for the sparingly soluble contaminant or moderately to highly soluble in water (Huling 1989). In order for a substance to behave as a cosolvent, it must be miscible with water, even to a small degree. The cosolvent effect is such that the solubility of the hydrophobic compounds increases due to co-mixing with the organic cosolvent, particularly if the latter is fully miscible with water (e.g., ethanol

or methanol) (Suresh et al. 1990; Li and Andren 1994). Nonspecific hydrophobic partitioning to solid phase materials also is understood to decline in the presence of an organic cosolvent.

The main cosolvency effect at the C-400 Complex is anticipated to be PCBs and/or PAHs in TCE. If DNAPL is present or if a small amount of DNAPL is captured in a sample, a "nugget effect" in the concentration levels of PAHs, PCBs, or other cosolved constituents may be observed in the analytical data—this would be evidenced by a higher than expected concentration of the cosolved constituent. Conversely, a higher than expected concentration of a constituent that could be cosolved may be the result of several factors, but could indicate that a small amount of DNAPL was captured in the sample. Cosolvency also may be evidenced during DNAPL remediation, where PCB or PAH concentrations in water and air may increase as the DNAPL is removed/remediated. Raoult's Law can be used to predict this effect. There is some anecdotal evidence that Tc-99 also may experience some cosolvency.

D.1.2.2 Groundwater Migration—RGA

The COCs from the WAG 6 RI reported in RGA groundwater include arsenic, beryllium, iron, chromium, lead, manganese, thallium, silver, TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, vinyl chloride, 1,1-DCE, 1,1,1- trichloroethane (TCA), 1,1,2-TCA, and several radionuclides. VOCs are the most widespread of the COCs. The highest concentrations of VOCs were reported in the southeast area of the C-400 Complex. DCE is formed from anaerobic biodegradation of TCE, TCA, or the DCE intermediates. It subsequently degrades to ethene and/or ethane. The current data indicate that anaerobic biodegradation (e.g., TCE to DCE) is not a major process in the hydrogeological/geochemical environment at the C-400 Complex.

Once in the groundwater, COCs generally move through the RGA via advection. COCs spread both horizontally and vertically due to the process of dispersion, while adsorption retards the movement of chemicals in groundwater. Dispersion generally causes chemicals to migrate from 10 to 20% farther than migration caused by advection alone. Adsorption, which retards the movement of chemicals, counteracts the advection and dispersion processes. Adsorption generally is described by a chemical's K_d.

In accordance with the COCs identified in the WAG 6 RI, the most mobile constituents include the chlorinated VOCs. Other constituents, including PAHs and metals (such as lead and vanadium), are not readily transported in groundwater. Consistent with these properties, PAHs were not detected in the groundwater. The widespread occurrence of unfiltered metals in the WAG 6 RI groundwater samples, 4-28 such as iron, is the result of highly turbid groundwater samples and is not a result of migration or site-related activities.

D.1.3 VAPOR INTRUSION

TCE-contaminated groundwater and soil adjacent to and under the C-400 Cleaning Building are considered sources of vapors. Subslab vapor sampling at the C-400 Cleaning Building detected primarily TCE, but also detected *cis*-1,2-DCE. Subsurface conditions in the C-400 Complex are considered to allow vapor transport toward the building. Although TCE concentrations in the RGA near the C-400 Cleaning Building have decreased, groundwater concentrations still exceed EPA's groundwater Vapor Intrusion Screening Level (VISL). Similarly, remedial actions have achieved greater than 95% reduction in soil concentrations, though post remedial residual concentrations remain. Vapor concentrations associated with the remaining TCE contamination in groundwater and soil are expected to be orders of magnitude higher than the commercial soil gas and subslab TCE VISL screening level of 100 $\mu g/m^3$ (micrograms per m^3).

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 the C-400 Complex, 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.

A vapor intrusion (VI) study was conducted for the C-400 Cleaning Building, and the report was submitted to EPA and KDEP for review and approval on May 29, 2018 (*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1/A3.

The conclusion from this study was that VOC concentrations in the C-400 Cleaning Building do not pose an unacceptable risk to workers. The spatial association between elevated indoor air and sub-slab soil gas concentrations is consistent with a conclusion that the VI pathway is complete, particularly in the southern portion of the building. The presence of *cis*-1,2 DCE in sub-slab vapor in some locations shows there is an underlying groundwater source of TCE. The absence of TCE in sub-slab vapor in other locations shows there also are vadose zone soil sources of TCE. The low-level detections of TCE in the outdoor air would not constitute a significant source of TCE to indoor air. These observations are consistent with the preliminary VI CSM presented in the *C-400 Vapor Intrusion Study Work Plan to Support the Additional Actions for the CERCLA Five-Year Review at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2403&D2/R1.

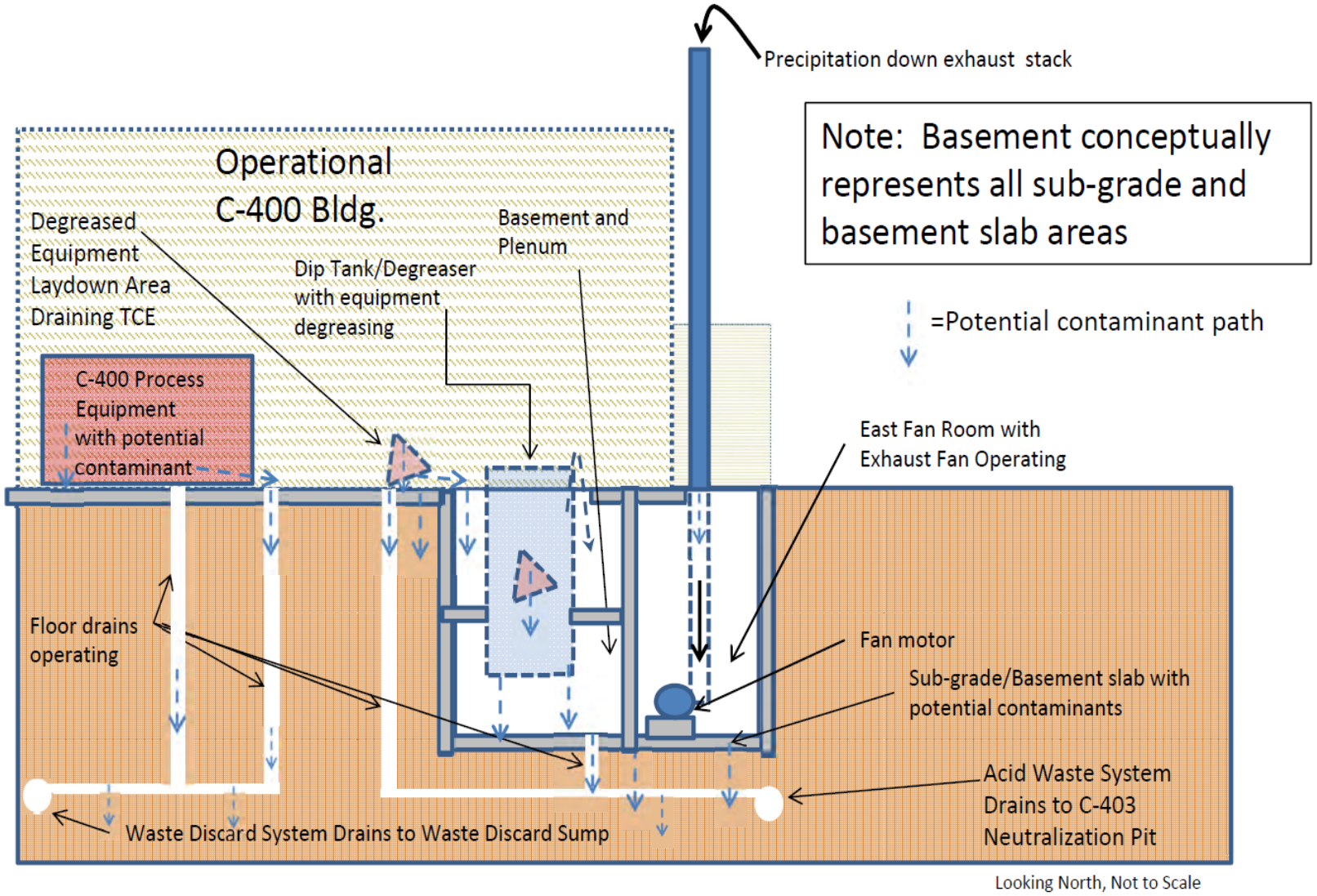

Figure D.1. Historical C-400 Building Operational CSM (prior to approximately 1986)

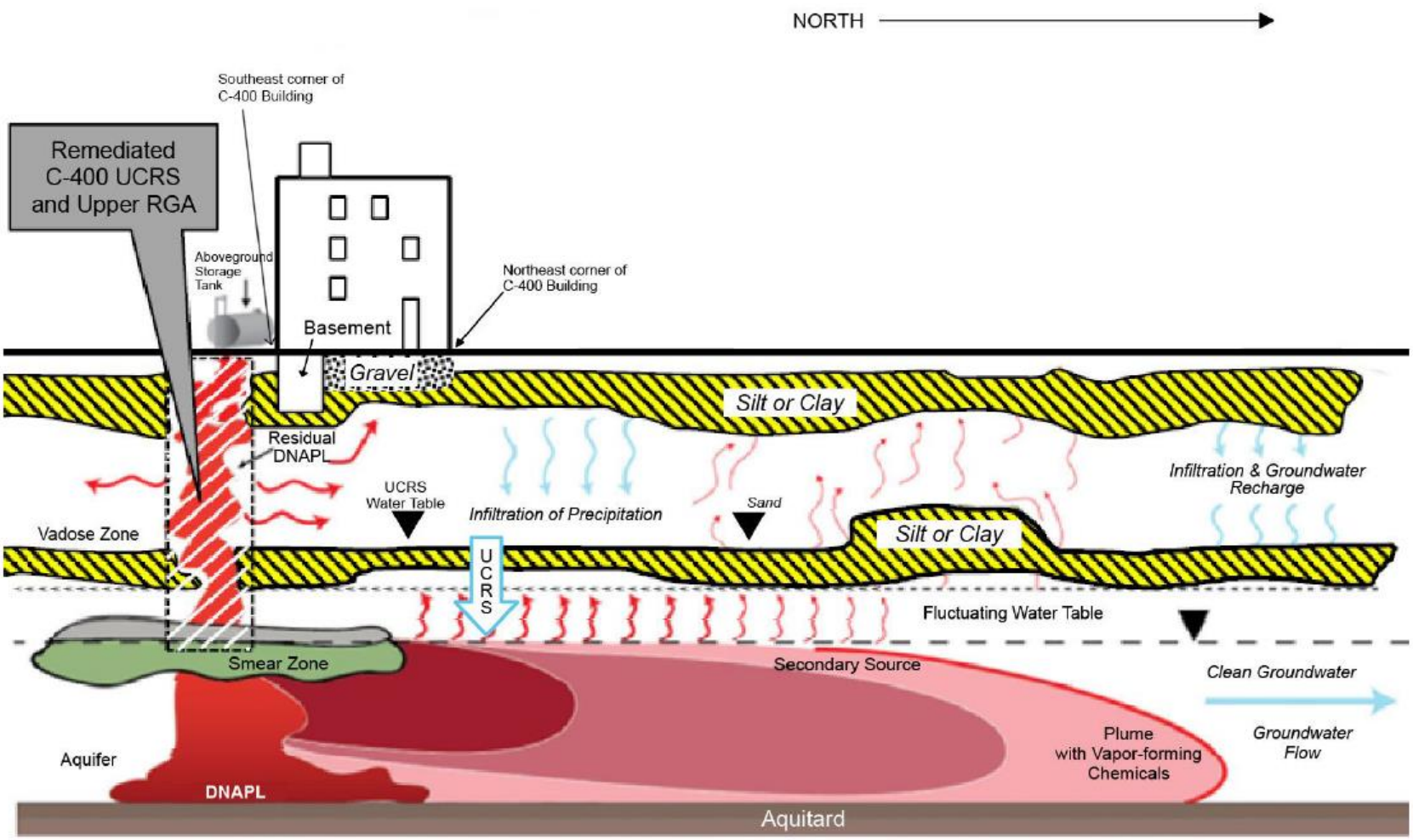

Figure D.2. Hydrogeologic Setting for Conceptual Site Model

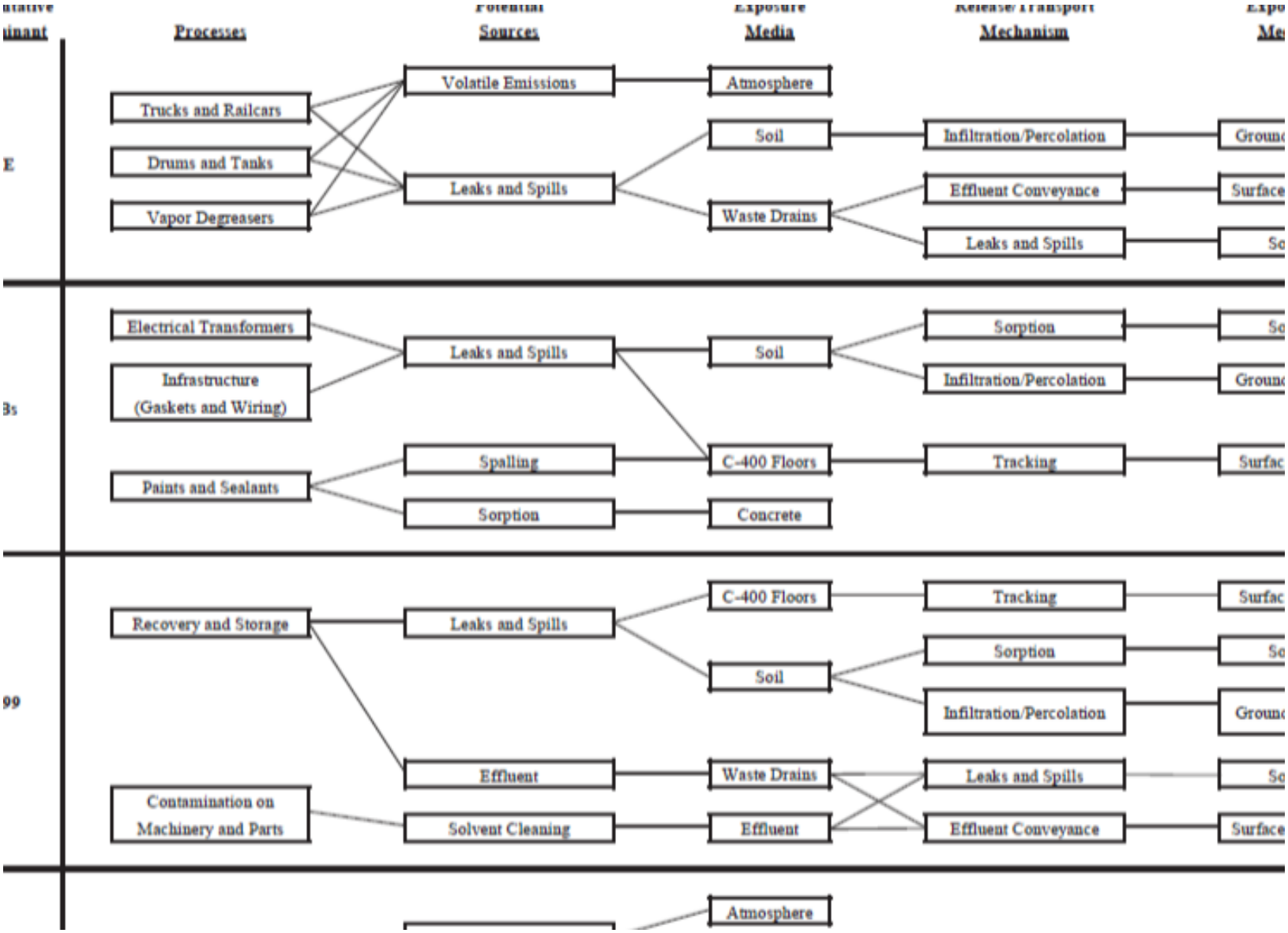

Figure D.3. Pathway Network Diagram for Representative Contaminants

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