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FEB 15 2018

PPPO-02-4637352-18B

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

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 SCOPING DOCUMENT FOR THE C-400 COMPLEX REMEDIAL INVESTIGATION/FEASIBILITY STUDY AT PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-2424&D1)

Please find enclosed the *Scoping Document for the C-400 Complex Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2424&Dl. This scoping document was developed to be consistent with the Comprehensive Environmental Response, Compensation, and Liability Act; *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA); and the *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* dated August 8, 2017. In accordance with Section XI of the FFA, the scoping document is being provided prior to the D1 Remedial Investigation/Feasibility Study (RI/FS) Work Plan scoping meeting scheduled for March 13, 2018, through March 15, 2018.

The U.S. Department of Energy looks forward to the FFA parties' first scoping meeting to support development of the RI/FS Work Plan.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosure:
Scoping Document for C-400 Complex RI/FS, DOE/LX/07-2424&D1

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DOE/LX/07-2424&D1
Secondary Document

Scoping Document for the C-400 Complex Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-2424&D1
Secondary Document

Scoping Document for the C-400 Complex Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—February 2018

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

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

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PREFACE

This *Scoping Document for the C-400 Complex Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-2424&D1, was prepared in accordance with the requirements under the Federal Facility Agreement (EPA 1998) and the most recently submitted revision of *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2018a).

Specifically, this document provides historical results from environmental media sampling within the C-400 Complex area and proposes data quality objectives to implement for the C-400 Complex Remedial Investigation (RI)/Feasibility Study (FS). Comments to this Scoping Document will be addressed as part of the C-400 Complex RI/FS Work Plan.

This Scoping Document is consistent with the signed *Memorandum of Agreement on the C-400 Complex under the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2017a).

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CONTENTS

FIGURES

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TABLES

ACRONYMS

AL	action level
ARAR	applicable or relevant and appropriate requirement
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical or radionuclide of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
FFA	Federal Facility Agreement
FOD	frequency of detect
FOE	frequency of exceedance
FS	feasibility study
FY	fiscal year
GWOU	Groundwater Operable Unit
HI	hazard index
KDEP	Kentucky Department for Environmental Protection
MCL	maximum contaminant level
MEPAS	Multimedia Environmental Pollutant Assessment System
MIP	membrane interface probe
MOA	Memorandum of Agreement
NAL	no action level
NCP	National Contingency Plan
NSDD	North-South Diversion Ditch
OREIS	Paducah's Oak Ridge Environmental Information System
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PEGASIS	PPPO Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
POC	pathway of concern
PRG	preliminary remediation goal
PTW	principal threat waste
RADS	radionuclides
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDSI	Remedial Design Support Investigation
RESRAD	Residual Radioactive Materials
RGA	Regional Gravel Aquifer
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	record of decision
SESOIL	Seasonal Soil Compartment Model

SMP	Site Management Plan
SPH	six-phase heating
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
UCRS	Upper Continental Recharge System
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	waste area grouping

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an inactive uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). DOE is conducting environmental restoration activities at PGDP in accordance with the requirements of the Kentucky Department for Environmental Protection (KDEP) and the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act. PGDP was placed on the National Priorities List in 1994. DOE, EPA, and KDEP entered into a Federal Facility Agreement (FFA) in 1998 (EPA 1998).

In August 2017, a Memorandum of Agreement (MOA) regarding the C-400 Complex was signed by the FFA parties (DOE 2017a). That MOA included resequencing the approved Fiscal Year (FY) 2015 Site Management Plan (SMP)[1] milestones, established the requirement to conduct a remedial investigation/feasibility study (RI/FS) to support remedy selection for a final remedial action, and required integration of the Phase IIb Interim Action source area into the Final Action for the C-400 Complex with a Remedial Action start date of 2023 (first quarter of FY 2024) (DOE 2017a).

This RI/FS Scoping Document has been developed to assist in preparation of the RI/FS Work Plan for the investigation and subsequent remediation of the C-400 Complex. The C-400 Complex contains numerous solid waste management units (SWMUs) and contaminated environmental media/debris (e.g., groundwater, soils, and slab) and is the largest source of off-site trichloroethene groundwater contamination at PGDP. The C-400 Complex project is intended to evaluate fully and take the necessary actions to address all environmental contamination in order to achieve a final remedial action for the entire C-400 Complex.

This scoping document is based upon a compilation of sampling information collected within the C-400 Complex since 1990.

PROJECT OBJECTIVES AND GOALS

The goals for the C-400 Complex RI/FS are consistent with those established by the MOA, the FFA, and the Paducah SMP negotiated among DOE, EPA, and KDEP. The goals of this RI/FS are discussed within this scoping document.

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[1] Last approved SMP at the time of the MOA (DOE 2015).

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1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located within the Jackson Purchase region of western Kentucky, is an inactive uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). PGDP was owned and managed first by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation (USEC) assumed management and operation of PGDP enrichment facilities under a lease agreement with DOE. PGDP (CERCLIS# KY8-890-008-982) was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE entered into a Federal Facility Agreement (FFA) with the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) on February 13, 1998 (EPA 1998). The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with the Resource Conservation and Recovery Act (RCRA) and CERCLA, including stakeholder involvement. DOE is the lead agency for remedial actions, and EPA and KDEP have regulatory oversight responsibilities. Until 2013, USEC enriched uranium at PGDP to supply nuclear fuel to electric utilities worldwide. In 2014, USEC returned Paducah leased facilities to DOE control.

Source units and areas of contamination at the Paducah Site[2] have been combined into operable units (OUs) for evaluation of remedial alternatives. These OUs include the C-400 Complex OU (C-400 Complex), the Groundwater OU (GWOU), Surface Water OU, the Soils OU, the Burial Grounds OU, the Decontamination and Decommissioning OU, the Lagoons OU, the Depleted Uranium Hexafluoride Footprint Underlying Soils OU, the Dissolved-Phase Plumes OU, and the Comprehensive Site OU. Each OU is designed to remediate contaminated media associated with PGDP (DOE 2018a).

In June 1986, a routine construction excavation along the 11th Street storm sewer revealed trichloroethene (TCE) soil contamination. The cause of the contamination was determined to be a leak in a drain line from the C-400 Cleaning Building's basement sump to the storm sewer. The amount of TCE released is unknown. The area of contamination became known as the C-400 Trichloroethylene Leak Site and was given the designation of Solid Waste Management Unit (SWMU) 11. SWMU 11 and the C-400 area have been the subjects of several investigations since then.

The Phase I and Phase II CERCLA Site Investigations included the C-400 area within their scope, with the installation of soil borings and groundwater monitoring wells (MWs) (CH2M HILL 1991; CH2M HILL 1992). These investigations confirmed that TCE contamination at the southeast corner of C-400 extended from the surface to the base of the Regional Gravel Aquifer (RGA) at 92 ft below ground surface (bgs). TCE use was discontinued at C-400 Cleaning Building in 1993. In 1995, the Phase IV Investigation demonstrated that the C-400 area was a potential major source for the Northwest Plume (DOE 1995a).

The Waste Area Grouping (WAG) 6 Remedial Investigation (RI), as well as other investigations and studies, characterized the nature and extent of contamination around the C-400 Building (DOE 1999).

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[2] References in this Scoping Document to the Paducah Site generally mean the property, programs, and facilities at or near PGDP for which DOE has ultimate responsibility. The Paducah Site is located in a generally rural area of McCracken County, Kentucky, 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River. The plant is on a 3,556-acre DOE site, comprised of the following: 628 acres within a fenced security area, approximately 800 acres located outside the security fence, 133 acres in acquired easements, and the remaining 1,986 acres licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area.

Analytical results from the WAG 6 RI indicate that the primary site-related volatile organic compounds (VOCs) in the subsurface soil and groundwater in the C-400 Cleaning Building area are TCE and its breakdown products [*trans*-1,2-dichloroethene (DCE), *cis*-1,2-DCE, and vinyl chloride] and 1,1-DCE. The WAG 6 RI concluded that there are zones of dense nonaqueous-phase liquid (DNAPL) TCE in the Upper Continental Recharge System (UCRS) and RGA adjacent to and potentially beneath the C-400 Building. The GWOU Feasibility Study (FS), *Feasibility Study far the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1857&D2, presents a summary of the characterization data for the C-400 area DNAPL zones and documents the DNAPL conceptual models for the area (DOE 2001a).

The data from the WAG 6 RI, as well as other investigations and studies, indicate that DNAPL zones in the southeast area of the C-400 area account for the majority of the mass of DNAPL. As part of the WAG 6 RI, UCRS soil was characterized and shown to be a residual source of DNAPL.

Two actions have remediated some of the soil contamination near the southeast corner of the C-400 Cleaning Building. After the discovery of the TCE leak in June 1986, soils were excavated in an attempt to reduce the contamination in the area. Excavation was halted to prevent structural damage to the adjacent TCE storage tank and to 11th Street. Approximately 310 ft^3 of TCE-contaminated soil was drummed and disposed of off-site. The excavation was backfilled with clean soil, and the area was capped with a layer of clay. The amount of released TCE removed by soil excavation is not known.

A treatability study conducted in 2003 was a test of full-scale deployment of electrical resistance heating (ERH) technology in the area adjacent to the southeast corner of the C-400 Cleaning Building. This study included the installation and operation of one six-phase heating (SPH) treatment array and a vapor recovery system. The SPH treatability study began on February 14, 2003, and was discontinued on September 6, 2003. A key operational criterion of the test was to raise the temperature of soil and groundwater within the treatment volume sufficient to drive groundwater and targeted contaminants into their vapor phases. The primary objective was to demonstrate the implementability of the ERH technology in the unsaturated and saturated soils of the UCRS and in the groundwater of the underlying RGA (DOE 2001b). Comparison of pretreatment and post treatment sample results was used to measure treatment efficacy. Approximately 1,900 gal of TCE was removed from the subsurface during SPH. The SPH treatability study achieved a 98% reduction of TCE concentrations in UCRS soils and a 99.1% reduction of TCE concentration in RGA groundwater, which met the removal efficiency criteria. The residual contaminant levels averaged 2,493 µg/kg, with a maximum of 49,200 µg/kg in soil, and averaged 6,394 µg/L, with a maximum of 10,100 µg/L within the RGA and inside the treatment zone (GEO Consultants 2003).

In 2006, a Remedial Design Support Investigation (RDSI) was conducted with the purpose of improving the ERH design by determining the subsurface soil conditions and the presence and relative concentration of VOCs in the UCRS, the RGA, and the RGA/Upper McNairy interface. The initial RDSI was completed in August 2006, using membrane interface probe (MIP) technology (DOE 2005a). During the RDSI, 18 MIP borings were completed through the UCRS to a depth of approximately 55 ft bgs, and 33 MIP borings were completed to the base of the RGA at an approximate depth of 100 ft bgs. The RDSI Characterization Plan optimized location and depth of the MIP borings to complement the characterization data from the WAG 6 RI. Four of the 33 MIP borings completed to the base of the RGA were contingency borings completed to assess uncertainties within the RGA in accordance with the RDSI Characterization Plan. MIP results from the RDSI were used to delineate the extent of TCE soil contamination. The results were used in interpreting the distribution of TCE DNAPL and the topography of the base of the Continental Deposits south of the C-400 Building. These data characterized the three-dimensional aspects of the TCE DNAPL source zones and demonstrated that the residual TCE distribution was consistent with the conceptual model from the WAG 6 RI. Moreover, the data showed that the vertical extent of the DNAPL did not extend downward (beyond 1 ft) into the McNairy Formation below the primary RGA DNAPL pool at the base of the RGA.

Implementation of an interim remedial action for the C-400 Cleaning Building, as part of the *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (ROD) (DOE 2005b), was initiated in December 2008. The selected remedy was ERH to address VOC source mass in the UCRS and the RGA in treatment areas immediately adjacent to the C-400 Cleaning Building.

ERH was implemented in two phases, Phase I and Phase II. The Phase I ERH system consisted of a network of in ground electrodes and vapor extraction wells distributed throughout the east and southwest zones of contamination in a three-phase heating pattern. The east and southwest areas were selected for Phase I because they were the smallest of the source areas near the C-400 Cleaning Building and had contaminants primarily in the UCRS. Phase II was to follow Phase I to treat the southeast area, which was expected to contain a larger amount of source contamination in both the UCRS and the RGA.

Phase I operations were completed in December 2010. Approximately 535 gal of VOCs (primarily TCE) was removed from the subsurface during Phase I. ERH reduced soil TCE concentrations by 95% in the east treatment area and by 99% in the southwest treatment area. The residual contaminant levels averaged 29 µg/kg, with a maximum of 315 µg/kg in the east treatment area, and averaged 15 µg/kg, with a maximum of 228 µg/kg in the southwest treatment area.

An important objective of Phase I was to evaluate the heating performance of the base ERH design through the RGA down to the McNairy Formation interface in the southwest treatment area. During Phase I, temperature goals were not attained in the lower RGA in the southwest treatment area, particularly below 70 ft bgs (refer to the Phase I Technical Performance Report) (DOE 2011a).

In 2011, an additional investigation was completed. Soil and groundwater samples were collected from the Phase II southeast treatment area to provide data for reevaluation of the TCE mass estimate. Two goals of the investigation were as follows:

1. Development of predictive relationships of previous and proposed MIP responses to current TCE concentrations, and

2. Assessment of the TCE DNAPL mass and volume within the C-400 Phase II treatment area.

Additional information regarding the predictive relationships and initial mass volume estimate approaches is included in the C-400 Cleaning Building Remedial Design Report Appendix A (DOE 2012).

Because of the inability of ERH to reach target temperatures in the lower RGA, the FFA parties agreed to divide Phase II into Phase IIa (using ERH to address the UCRS and upper RGA to a depth of 60 ft bgs) and Phase IIb (using a technology to be decided to address the lower RGA). Phase IIb has been incorporated into the C-400 Complex. Phase IIa operations were completed in fall of 2014 and consisted of the implementation of ERH in the UCRS and upper RGA in the southeast treatment area. Phase IIa operations removed approximately 1,137 gal of VOCs (primarily TCE). The median of TCE concentration reductions in collocated preoperational versus post operational soil samples of Phase IIa was 99.8%. The residual contaminant levels averaged 200 µg/kg, with a maximum of 10,000 µg/kg in the Phase IIa treatment area.

In August 2017, a Memorandum of Agreement (MOA) regarding the C-400 Complex was signed by the FFA parties (DOE 2017a). That MOA included resequencing the approved Fiscal Year (FY) 2015 Site Management Plan (SMP)[3] milestones; established the requirement to conduct a comprehensive RI/FS to support remedy selection for a final remedial action; and required integration of the Phase IIb Interim Action source area into the Final Action for the C-400 Complex, with a Remedial Action start date of 2023 (first quarter of FY 2024).

1.1 C-400 COMPLEX OPERABLE UNIT STRATEGY

The C-400 Complex contains numerous SWMUs and is the largest known source of off-site TCE groundwater contamination at PGDP. The C-400 Complex project is intended to evaluate fully and take the necessary actions to address all environmental contamination in order to achieve a final remedial action for the entire C-400 Complex area as shown in Figure 1. The C-400 Complex action will address all sources of contamination within the defined footprint of the C-400 Complex, including, but not limited to, principal threat waste (PTW) (e.g., TCE DNAPL and high concentration TCE contamination). The C-400 Complex CERCLA Final Remedial Action consists of the following (DOE 2018a):

- Conduct a combined RI/FS for the C-400 Complex area that includes an investigation of all remaining building structure(s) (e.g., slab and subsurface structures) and releases of any hazardous substances to soils and groundwater associated with the C-400 Building and C-400 Complex area operations (including, but not limited to, TCE DNAPL areas considered PTW).

- RI characterization to define the full nature and extent of all contamination from the surface down through the RGA and to include the upper McNairy.

- Remedy selection (proposed plan and ROD) to document a final remedial action(s) for all source areas and related contaminants of concern (COCs) requiring remediation for the entire C-400 Complex.

- Post-ROD documents (e.g., remedial design report, remedial action work plan) and implementation of a final remedial action(s) as specified in the ROD.

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[3] Last approved SMP at the time of the MOA.

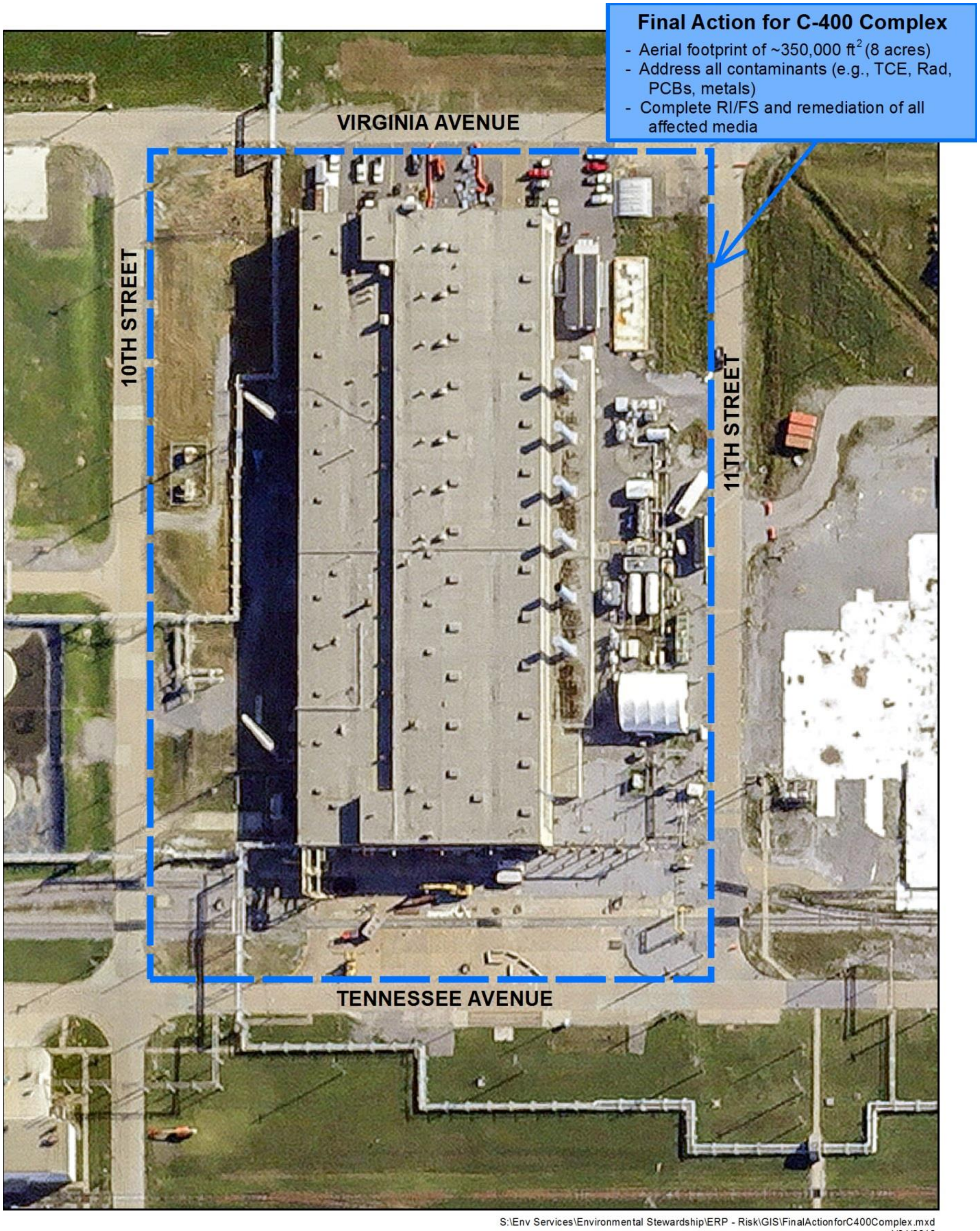

Figure 1. C-400 Complex Remedial Investigation Strategy Area

Within the C-400 Complex area, there have been 22 SWMUs identified. The SWMUs on Table 1 are within the C-400 Complex area and are presented for historical context. Of those SWMUs presented, 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. Figure 2 identifies the locations of these SWMUs requiring action in relation to the C-400 Complex area.

Table 1. SWMUs in the C-400 Complex

SWMU No.	Description
11	C-400 Trichloroethylene Leak Site
40	C-403 Neutralization Tank
47	C-400 Technetium Storage Tank Area
48	***Gold Dissolver Storage Tank (DMSA C400-03)****
49	***C-400-B Waste Solution Storage Tank***
50	***C-400-C Nickel Stripper Evaporation Tank***
51	***C-400-D Lime Precipitation Tank***
52	***C-400 Waste Decontamination Solution Storage Tanks***
53	***C-400 NaOH Precipitation Unit***
54	***C-400 Degreaser Solvent Recovery Unit***
98	C-400 Basement Sump
203	C-400 Discard Waste System
349	***C-400-01***
350	***C-400-04***
351	***C-400-05***
352	***C-400-06***
353	***C-400-07***
383	***G-400-01***
384	***G-400-02***
480	C-402 Lime House Building Slab and Underlying Soils
533	TCE Spill Site from TCE Unloading Operations at C-400
537	***S-400-001***

*SWMUs in ***bold italics*** indicate no further action.

This Scoping Document for the C-400 Complex RI/FS includes the sections outlined below.

- **Chapter 1: Introduction.** This chapter addresses the scope, objectives, and goals for the project, and discusses the data quality objective (DQO) process.

- **Chapter 2: Study Area Investigation.** Chapter 2 contains descriptions of each of the SWMUs of concern and discusses the process history and previous investigations that have been conducted. This chapter also discusses additional sampling that may be required to provide a complete data set needed to make remedial action decisions.

- **Chapter 3: Feasibility Study.** Chapter 3 summarizes the process of a FS.

- **Chapter 4: Applicability of Streamlined Response Actions.** Chapter 4 provides an overview of the potential response actions that may be required as a result of evaluating existing data and obtaining additional characterization data.

- **Chapter 5: References.** Chapter 5 presents the references cited in this document.

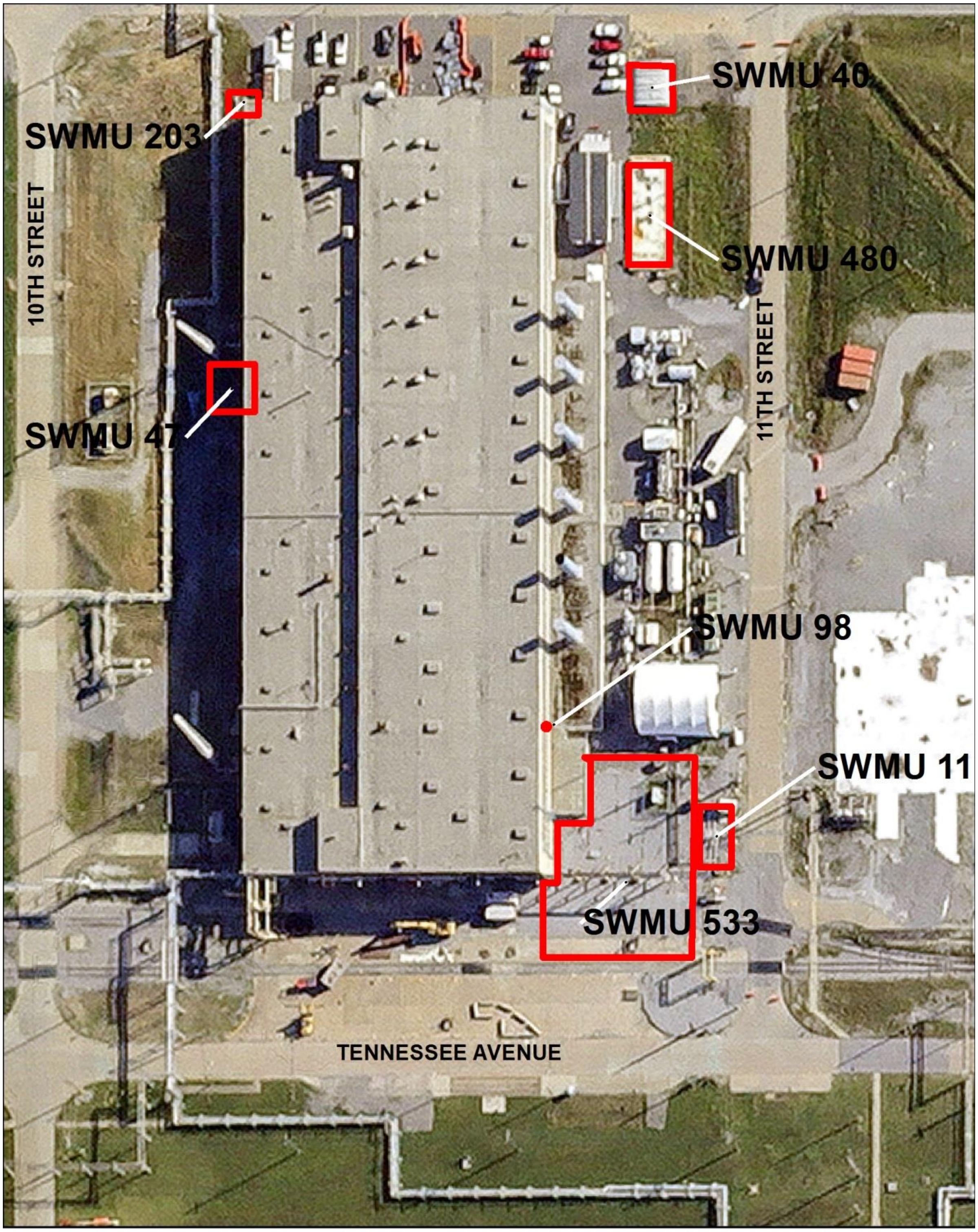

Figure does not show No Further Action SWMUs associated with the C-400 Complex.

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Figure 2. C-400 Complex SWMUs

- **Appendix A: Data Tables and Interactive Maps.** Includes a data download from Paducah's Oak Ridge Environmental Information System (OREIS) in Microsoft Excel and interactive Adobe portable document format (pdf) map. [Information provided in this Appendix also is available on Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS).]

- **Appendix B: Baseline Risk Assessment (GWOU FS).** Includes a reproduction of the Baseline Risk Assessment documented in the GWOU FS (DOE 2001a).

1.2 WORK PLAN SUMMARY

This RI/FS Scoping Document has been prepared to assist in preparation of the RI/FS Work Plan for the investigation and remedial alternative evaluation of the C-400 Complex. The document utilizes a compilation of sampling information collected at and around PGDP. Soil samples collected beginning in 1990 and groundwater samples collected beginning in 2012[4] were utilized. Data were compiled and screened against chemicals or radionuclides of potential concern (COPCs) listed in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Volume 1. Human Health*, consistent with Chapter 2, "Risk Analyses during Scoping Activities," of that document (DOE 2018b). Specific additional data needed, if any, will be identified and documented in the RI/FS Work Plan.

This scoping document utilizes the DQO process as a planning tool to assist in the identification of environmental problems and to define the data collection process needed to support decisions regarding the problems associated with the C-400 Complex.

The goals for the C-400 Complex RI/FS are consistent with those established in the FFA and the Paducah SMP negotiated among DOE, EPA, and KDEP. The goals of this RI/FS are as follows:

- Goal 1: Characterize Nature of Contamination—characterize the nature of contaminant source materials using existing data and by collecting additional data, as necessary;

- Goal 2: Define Extent of Contamination—define the nature, extent (vertical and lateral), and magnitude of contamination in soils and perform a multimedia evaluation (e.g., groundwater, soil) to ensure that all exposure pathways for the subject units are assessed adequately to support cleanup decisions;

- Goal 3: Determine Surface and Subsurface Transport Mechanisms and Pathways—assess existing data and collect additional data, as necessary, to analyze contaminant transport mechanisms and support an FS;

- Goal 4: Complete a final baseline risk assessment for the C-400 Complex—complete a baseline human health risk assessment (BHHRA) and a screening-level ecological risk assessment (Steps 1 and 2); and

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[4] Groundwater samples collected before 2012 are available in PEGASIS. Data from before 2012 (including angled borings beneath the C-400 Cleaning Building from the WAG 6 RI) are used qualitatively during the RI/FS process. Only groundwater samples collected beginning in 2012 are utilized quantitatively for scoping purposes in order to present the data representative of current conditions.

- Goal 5: Identify, develop, and evaluate remedial alternatives—use historical and newly collected data to identify, develop, and evaluate alternatives that will reduce risk to human health and the environment.

The C-400 Complex RI/FS Work Plan will include the sections outlined below.

Chapter 1: Introduction. Chapter 1 will address the scope of the project, as well as the objectives and goals for the RI/FS investigation, and will discuss the DQO process.

Chapter 2: Project Organization and Management Plan. Chapter 2 will contain a project organization and management plan that details how the project will be organized and managed to collect defensible data within project schedules and budgets. This chapter also will include an integrated schedule for the entire CERCLA investigative process beginning with implementation of the RI/FS and ending with the submittal of the final RI and FS reports.

Chapter 3: Regulatory Setting. Chapter 3 will provide an overview of the regulatory framework at PGDP with primary emphasis on the regulatory drivers for the RI/FS process.

Chapter 4: Environmental Setting and Site Characterization. Chapter 4 will contain a brief discussion of the environmental setting of PGDP including location, history, demography and land use, geology, hydrogeology, ecology, and climatology. This chapter also will include development of a conceptual site model (CSM).

Chapter 5: Characterization of Site/Previous Analytical Data. Chapter 5 will present historical information for each SWMU. Included in this chapter will be the detailed characteristics, summary of previous investigations, and summary of data and/or conclusions from previous investigations.

Chapter 6: Initial Evaluations. Chapter 6 will describe the content of the RI/FS report; the requirements for completion of the baseline risk assessment to include a BHHRA and a screening-level ecological risk assessment (Steps 1 and 2); the use of treatability studies to evaluate potential technologies, associated data requirements, and schedule of the process that will be used to develop and evaluate remedial alternatives; and potential remedial alternatives for the C-400 Complex.

Chapter 7: Treatability Studies. Chapter 7 will provide details on potential treatability studies for these areas.

Chapter 8: Alternatives Development. Chapter 8 will define likely alternatives that will be considered for the C-400 Complex during the FS portion of the RI/FS report.

Chapter 9: Field Sampling Plan. Chapter 9 will provide the general sampling strategy used to develop the field sampling plans for the C-400 Complex, sample collection methods, and field documentation requirements in order to obtain the type, quality, and quantity of data needed. Also included will be general decontamination, waste management, quality assurance and sample analysis procedures, and sample location civil surveys.

Chapter 10: Health and Safety Plan. Chapter 10 will detail how worker health and safety will be maintained during the field activities.

Chapter 11: Quality Assurance Plan. Chapter 11 will define the procedures for ensuring the acquisition of defensible data. This project-specific quality assurance plan will be consistent with the Programmatic Quality Assurance Project Plan (DOE 2017b).

Chapter 12: Data Management Implementation Plan. Chapter 12 will describe the requirements for initiating, managing, compiling, and controlling all documents at the project level pertaining to field, laboratory, and data validation activities. This chapter also will present the mechanism for data input, storage, retrieval, and usage required by the Paducah Site.

Chapter 13: Waste Management Plan. Chapter 13 will discuss the management of all investigation-derived waste generated during implementation of the RI/FS.

Chapter 14: Community Relations Plan. Chapter 14 will define methods for involving the community in PGDP remediation activities and decisions.

Chapter 15: References. Chapter 15 will present the references cited in the work plan.

1.3 PROJECT SCOPE

This scoping document is intended to provide a document identifying the data available and the data required to conduct an RI/FS at the C-400 Complex. The primary focus of the scoping document will be to present existing information about contamination associated with the C-400 Complex and determine what additional data are required to assess site conditions and evaluate alternatives to the extent necessary to select a remedy. The RI/FS scoping process, as it relates to remedial alternatives, is discussed in Section 3.

Remedial or Removal Actions. The RI/FS process is an interactive one in which EPA, KDEP, and DOE evaluate and approve or revise work conducted during various stages of the investigation. To facilitate implementation of the RI/FS work plan, flexibility will be included in the sampling plans for the C-400 Complex to allow some adjustments to be made in the field. For example, unexpected contaminant levels or subsurface conditions may require changes to the plans.

If during the RI/FS, the FFA parties agree that the data and other relevant information support the need for conducting either a CERCLA Time-Critical or Non-Time-Critical Removal Action(s) or an Interim Remedial Action(s) is warranted under the National Contingency Plan (NCP) or FFA, then the decision to undertake such action(s) will be addressed in accordance with the FFA.

The scope of the C-400 Complex project includes a final baseline risk assessment, evaluation of remedial alternatives, remedy selection, and implementation of actions as necessary for protection of human health and the environment from the C-400 Complex. Project uncertainties that could potentially affect the scope and schedule of the RI/FS include the amount and scope of RI characterization needed (e.g., field samples, test pits, borings, etc.). This RI/FS scoping document is the first of a series of documents necessary to meet the C-400 Complex remedial action.

Figure 3 provides key schedule elements and projected implementation dates for the C-400 Complex RI/FS Scoping Document and Work Plan. Project schedules for completion of activities set forth herein are estimates provided for informational purposes only and are not considered to be enforceable elements of the remedial action or this document. The enforceable milestones for performance of activities included as part of the remedial action are set forth in accordance with requirements of the C-400 Complex MOA (DOE 2017a). Any additional milestones, timetables, or deadlines for activities included as part of the remedial action will be identified and established independent of this scoping document, in accordance with existing FFA protocols.

Scoping Team Date	Comments
January 24, 2018	Planning Meeting
February 15, 2018	DOE Submit D1 RI/FS Scoping Document to EPA/KDEP
March 13, 2018	Face to Face in Paducah—Scoping kickoff meetings
March 14, 2018	Face to Face in Paducah—Scoping kickoff meetings
March 15, 2018	Face to Face in Paducah—Scoping kickoff meetings
March 28, 2018	WebEx and/or Conference Call
April 10, 2018	WebEx and/or Conference Call
April 11, 2018	WebEx and/or Conference Call
May 1, 2018	WebEx and/or Conference Call
May 15, 2018	WebEx and/or Conference Call
May 16, 2018	WebEx and/or Conference Call
June 5, 2018	WebEx and/or Conference Call
June 19, 2018	Face to Face in Paducah
June 20, 2018	Face to Face in Paducah
June 21, 2018	Face to Face in Paducah
November 28, 2018	DOE submit D1 RI/FS Work Plan to EPA/KDEP

Figure 3. Project Schedule (C-400 Complex RI/FS Scoping Document and Work Plan)

1.4 PROJECT DQOs

The DQO process will be used to focus the sampling strategy on C-400 Complex-specific media, contamination, and migration pathways. This process also will be used to identify the data requirements for the baseline risk assessment and FS. To facilitate this activity, existing data on SWMU processes, waste management, releases, and environmental site conditions were gathered and are presented in this document. The DQO process is a planning tool, based on the scientific method, that identifies an environmental problem and defines the data collection process needed to support decisions regarding that problem [*Guidance on Systematic Planning Using the Data Quality Objectives Process*, (EPA 2006)]. The steps outlined in the DQO process will be used in the development of the RI/FS work plan. These steps will formulate a set of criteria that will achieve the desired control of uncertainty, allowing the decision to be made with acceptable confidence. In establishing DQOs, it is important to follow the sequence of the stages because the product of each stage forms the foundation for subsequent stages.

The first step in the DQO process is to state the problem to be resolved. Contaminants originating from the C-400 Complex have been released to the environment. The overall problem statement developed for the DQO process is as follows.

> Hazardous substances that have been historically 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.[5] The nature and extent of contamination has been adequately defined for some SWMUs and risk assessments have been prepared. For others, the nature and extent of contamination has not been adequately defined 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.

The subsequent six steps in the process will be completed in accordance with the referenced guidance (EPA 2006) and are listed as follows:

1. Identify the goal(s) of the study,
2. Identify information inputs,
3. Define the boundaries of the study,
4. Develop the analytic approach,
5. Specify performance or acceptance criteria, and
6. Develop the plan for obtaining data.

Figure 4 shows the DQO process chart. In order to facilitate discussion, the seven steps of the DQO process have been initiated, and a preliminary set of decision rules and questions to be answered to complete the DQO process are provided in Table 2. The decision rules were written as if little were known to ensure that the scoping document is a comprehensive evaluation of the C-400 Complex and there is no bias of future data collection efforts.

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[5] Dissolved-phase groundwater contamination will be addressed as part of the Dissolved-Phase Plumes Remedial OU.

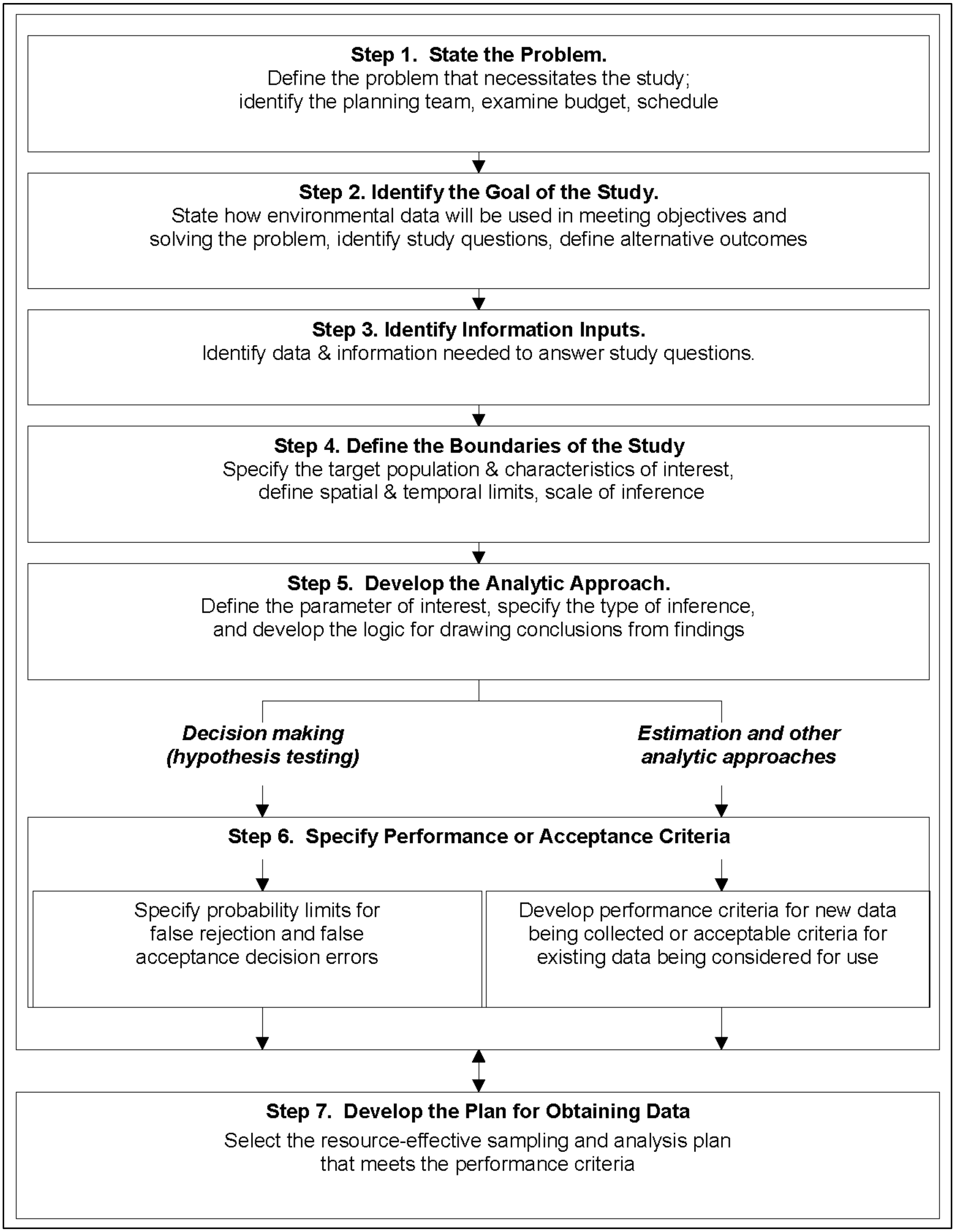

Figure 4. DQO Process Chart

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS

GOAL 1: CHARACTERIZE NATURE OF CONTAMINATION

Decisions and questions

1-1: What are the suspected contaminants?
1-2: What are the plant processes that could have contributed to the contamination? When and over what duration did releases occur?
1-3: What are the concentrations and activities at the source?
1-4: What is the area and volume of the source zone?
1-5: What are the chemical and physical properties of associated material at the source areas?
1-6: Where is the source?

Decision rule	Evaluation method	Data needs
D1a: If the concentration of analytes found could result in a cumulative excess lifetime cancer risk (ELCR) greater than 1×10^{-6} or a cumulative Hazard Index (HI) greater than 1 through contact with contaminated media and/or debris (as applicable), or exceeds a chemical-specific applicable or relevant and appropriate requirement (ARAR), then evaluate remedial alternatives or otherwise pursue a "no further action" decision (see D1b).	<u>Screening</u> Quantitative comparisons by medium between maximum detected concentrations of analytes, background concentrations and preliminary remediation goals (PRGs) Quantitative comparison by medium between maximum detected concentrations of analytes and nonhuman receptor benchmarks <u>Baseline</u> Completion of baseline human health risk assessment and screening-level ecological risk assessment	Results of previous investigations, reports, and treatability studies to target sampling locations and analytical requirements, including the identification of suspected contaminants Sampling data from each medium, including extent of source zone Site use and activity history Procedures and methods for human health and ecological risk assessment Procedures and methods for performing comparisons Current and expected land-use patterns List of ARARs

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

Decision rule	Evaluation method	Data needs
D1b: If contaminants found at the site are known to transform or degrade into chemicals that could lead to increased risks to human health or the environment or into chemicals for which there are any chemical-specific ARARs, **and** if the concentrations of these contaminants could result in risks greater than those defined in D1a or concentrations greater than any chemical-specific ARARs, then evaluate remedial alternatives that will mitigate potential future risk and/or obtain compliance with the impacted chemical-specific ARARs.	Completion of a baseline human health risk assessment that considers transformation and degradation of contaminants found in the source zone Quantitative comparison by medium between analyte concentrations and any ARARs Evaluate if ARAR waiver or other alternative standards are appropriate	Results of previous investigations, reports, and treatability studies to target sampling locations and analytical requirements Sampling data from each medium Site use and activity history Analyte degradation or transformation paths List of ARARs Geochemical and biological parameters that could affect chemical degradation and transformation Procedures and methods for human health and ecological risk assessments and comparison with any ARARs

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

GOAL 2: DEFINE EXTENT OF CONTAMINATION

Decisions and questions

2-1: What are the past, current, and potential future migratory paths?
2-2: What are the past, current, and potential future release mechanisms?
2-3: What are the contaminant concentrations or activity gradients?
2-4: What is the vertical and lateral extent of contamination?
2-5: What is the extent of contamination to integrator units (e.g., groundwater, soil)?

Decision rule	Evaluation method	Data needs
D2a: If secondary[6] sources are found, **and** if the concentration of analytes within the secondary source is found to result in a cumulative ELCR greater than 1×10^{-6} or a cumulative HI greater than 1 through contact with contaminated media and/or debris (as applicable) at the unit, **and** if the concentrations of analytes are greater than those expected to occur naturally in the environment, then evaluate remedial alternatives that will mitigate risk; otherwise do not consider secondary sources when making remedial decisions for the unit.	Screening Quantitative comparisons by medium between maximum detected concentrations of analytes and background concentrations and PRGs Quantitative comparison by medium between maximum detected concentrations of analytes and nonhuman receptor benchmark Baseline Completion of baseline human health and screening-level ecological risk assessments	Results of previous investigations, reports, and treatability studies to target sampling locations and analytical requirements Analytical limits for identification of secondary sources Subsurface characterization information including stratigraphy Current and expected land-use patterns

[6] Secondary sources are those sources of contamination that were not expected, based upon historical information and/or previous site investigations or characterization efforts. Secondary source information is detectable through the analysis of characterization data, where COPCs exist, in sufficient quantities, in addition to the indicator chemicals that were expected.

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

GOAL 3: DETERMINE SURFACE AND SUBSURFACE TRANSPORT MECHANISMS AND PATHWAYS

Decisions and questions

3-1: What are the contaminant migration trends?
3-2: To what area is the dissolved-phase plume migrating?
3-3: What are the effects of underground utilities and plant operations on migration pathways including ditches?
3-4: What is the role of the UCRS in contaminant transport?
3-5: What are the physical and chemical properties of the formations and subsurface matrices?

Decision rule	Evaluation method	Data needs
D3a: If contaminants are found in the source zone, **or** if secondary sources are found, **and** if these contaminants are found to be migrating from the source zone or from secondary sources at concentrations that result in a cumulative ELCR greater than 1×10^{-6} or a cumulative HI greater than 1 through contaminated media and/or debris (as applicable) at downgradient points of exposure, **and** the concentrations of analytes are greater than those expected to occur naturally in the environment, then evaluate remedial alternatives that will mitigate risk (see D3b).	<u>Screening</u> Quantitative comparisons by medium between modeled contaminant concentrations and background concentrations and PRGs <u>Baseline</u> Completion of a baseline human health risk assessment for exposure points located away from the unit to which contaminants may migrate	Results of analyses performed under D1a and D2a Procedures and methods for human health and ecological risk assessment Current and expected land-use patterns Results of models [e.g., Multimedia Environmental Pollutant Assessment System (MEPAS), Residual Radioactive Materials (RESRAD), Seasonal Soil Compartment Model (SESOIL)] that can predict future soil contaminant concentrations at exposure points Modeling parameters including chemical parameters, mineralogy, reduction-oxidation potential, porosity, and stratigraphy

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

Decision rule	Evaluation method	Data needs
D3b: If contaminants are found in the source zone, or if secondary sources are found, and if these contaminants are found to be migrating from the source zone or from the secondary source at concentrations that exceed any chemical-specific ARARs, then evaluate remedial alternatives that will bring migratory concentrations into compliance with any chemical-specific ARARs (see D3a).	Quantitative comparison by medium between modeled analyte concentrations at downgradient exposure points and any chemical-specific ARARs Evaluate if ARAR waiver or other alternative standards are appropriate	Results of analyses performed under D1b List of ARARs Current and expected land-use patterns Results of models (e.g., MEPAS, RESRAD, SESOIL) that can predict future soil contaminant concentrations at exposure points (Geochemical equilibrium will be addressed in the RI report.) Modeling parameters including chemical parameters, mineralogy, reduction-oxidation potential, porosity, and stratigraphy

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

GOAL 4: COMPLETE A FINAL BASELINE RISK ASSESSMENT FOR THE C-400 COMPLEX RI/FS

Decisions and questions

4-1: Where do the contaminant concentrations exceed characterization levels (i.e., detection limits)?
4-2: Are isolated areas of contamination present or is contamination general?
4-3: What are the COCs that define the contamination?
4-4: What are the characterization levels?
4-5: Are SWMUs within the C-400 Complex RI/FS similar enough to be addressed in the same manner?

Decision rule	Evaluation method	Data needs
D4a: Determine if isolated contamination exists or if contamination is general; if isolated contamination exists, determine its extent. Use this information to determine where remedial alternative is required and where no further action is necessary.	Quantitative comparisons by medium between maximum detected concentrations of analytes in the source zone and background concentrations and PRGs Quantitative comparison by medium between maximum detected concentrations of analytes and nonhuman receptor benchmarks Quantitative comparison by medium between analyte concentrations and any ARARs Quantitative comparison by medium between modeled analyte concentrations at downgradient exposure points and any ARARs	Historical data Proposed characterization levels Analytical levels Characterization data Background concentrations and PRGs, Current and expected land-use patterns

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

GOAL 5: IDENTIFY, DEVELOP, AND EVALUATE REMEDIAL ALTERNATIVES

Decisions and questions

What is the nature and extent of contamination?
What are stakeholder's perceptions of contamination at or migrating from source zone or secondary sources?
What are the principal threats?
What media are contaminated to unacceptable levels?
What contaminant groups are present driving the unacceptable risk?
What are the preliminary remedial action objectives (RAOs)?
What is unacceptable risk?
What are the PRGs?
What are the general remedial alternatives/what are the remedial technology types?
What is the schedule of remedial action?
What are the possible remedial technologies applicable for this unit?
Are possible remedial technologies incompatible?
Are cultural impediments present?
What are the process option(s) to be used/what are the representative remedial technologies to be assessed?
What are the physical and chemical properties of media to be remediated?
What treatability studies would be required?
What is the area/volume of affected media?
Are process options innovative or proven?
Are process options applicable to multiple contaminant families?
What would be the impact of a process option on and by other sources?
What would the impact of a process options on the integrator units (e.g., groundwater)?
Are there geologic limitations to the process options?
Are process options acceptable to the community and state?
Are process options reversible?

Table 2. Decision Rules, Evaluation Methods, and Data Needs for C-400 Complex RI/FS (Continued)

Decision rule	Evaluation method	Data needs
D5a: If Decision D1a, D1b, D2a, D3a, or D3b indicates that remedial alternatives are needed, then evaluate remedial alternatives to mitigate risk in the source zone.	Use of results of baseline human health risk assessment and screening-level ecological risk assessment to determine if action is needed Use of results of comparison of contaminant concentrations to any ARARs to determine if action is needed Qualitative (or quantitative) assessment of decrease or increase in risk to human health and the environment as a result of implementation Evaluation of any ARARs Evaluation of existing risk management procedures or activities currently being conducted at the site	Data listed for D1a, D1b, D2a, D3a, and D3b Methods for qualitative (or quantitative) analyses of decrease or increase in risk to human health and the environment as a result of implementation Additional physical parameters including compaction, grain size, cation exchange, thermodynamic conductivity, dielectric constants, chemical oxygen demand, pH, and moisture content of soils List of ARARs

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2. STUDY AREA INVESTIGATION

2.1 EXISTING DATA

Several documents have been produced containing data pertinent to the various SWMUs within the C-400 Complex RI/FS and are listed in Section 2.3. The most comprehensive investigation at the C-400 Complex area was the WAG 6 RI (DOE 1999). WAG 6 was divided into sectors for the investigation, as shown in the schematic in Figure 5.

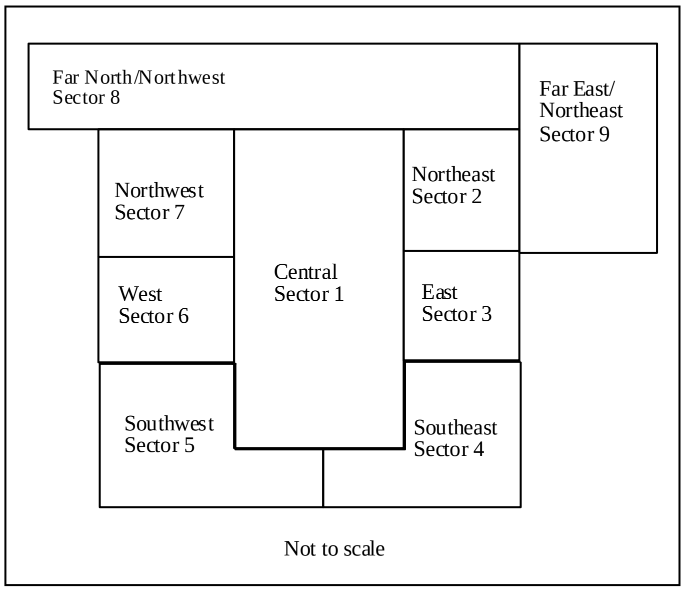

Figure 5. Schematic Diagram of WAG 6 Sectors

Additionally, data were downloaded from the OREIS data base in December 2017 and January 2018. Non-representative data were removed from the dataset (e.g., data collected from remediated areas, data flagged as rejected by validation, etc.). Data representative of current conditions were binned for several statistical comparison scenarios. Those data summaries are presented in this section. Data summaries are for metals, pesticides/polychlorinated biphenyls (PCBs) (PPCB), semivolatile organic compounds (SVOCs), VOCs, and radionuclides (RADS) and include minimum (min), maximum (max), and average (avg) for soil data detected results, min and max for groundwater data, frequencies of detection (FODs), and frequencies of exceedance (FOEs). In accordance with the Risk Methods Document (DOE 2018b), concentrations of total carcinogenic polycyclic aromatic hydrocarbons (PAHs) and Total PCBs have been derived. Total carcinogenic PAHs were derived using toxicity equivalence factors. Individual carcinogenic PAHs and PCB aroclors are not presented in the summaries, but are included in the dataset in the appendix. For soil samples, detections are compared to the following:

- Provisional background values, where available,[7]
- Industrial worker (surface soil) and excavation worker (subsurface soil) no action levels (NALs),[8]
- Industrial worker (surface soil) and excavation worker (subsurface soil) action levels (ALs),[9] and

[7] Background values are reported in the Risk Methods Document, Table A.12 (DOE 2018b).
[8] NALs are the lesser of the excess lifetime cancer risk of 1E-06 and HI of 0.1 from the Risk Methods Document (DOE 2018b).

- Soil screening levels (SSLs) for protection of groundwater (using a dilution attenuation factor of 20).

For this screening, surface soil is defined as 0−1 ft bgs and subsurface soil is defined as > 1 ft bgs.

For the summary tables, only those analyses with detections above background values, where available, and at least one other exceedance of a screening level are included. The appendix includes a summary of all analyses. Table 3 provides a data summary for the soil samples collected over the entire C-400 Complex area from 1990‒2011 (see Figure 6 for sample locations). For screening purposes, a 50-ft buffer area around the C-400 Complex and around the individual SWMUs was used to select historical soil sampling locations. Table 3 provides a list of COPCs in soils (i.e., analytes exceeding screening criteria).

Table 4 provides a data summary for groundwater samples collected over the C-400 Complex area from 2012‒2017 where at least one screening level was exceeded (see Figure 7 for sample locations). For groundwater samples, detections are compared to the following:

- Provisional background values, where available,[10]
- Resident NALs,[11]
- Resident ALs,[12] and
- Maximum contaminant levels (MCLs).

WAG 6 RI analytical data and other groundwater samples collected prior to 2012 will be used to inform the C-400 Complex RI/FS. Groundwater data from beneath the C-400 Cleaning Building structure are available for two vertical borings drilled into the UCRS (maximum TCE soil detect of 2,900 µg/kg) and two angled borings drilled through the RGA (maximum TCE groundwater detect of 126,012 µg/L). Although the WAG 6 RI groundwater analyses are unrepresentative of current conditions, these data are important evidence of DNAPL presence in the lower RGA.

Additionally, vapor intrusion studies are being performed at the C-400 Cleaning Building (DOE 2017c). Information from these studies will be used to inform the C-400 Complex RI/FS when the data are available.

Table 4 provides a list of COPCs in groundwater (i.e., analytes exceeding residential screening criteria).

Data used for these summaries will be flagged for project use in PEGASIS. Appendix A contains interactive maps and data summaries for each SWMU and for the complex as a whole.

The seven SWMUs requiring action are discussed in the following subsections. Each of these subsections includes area description, process history, previous investigation results, baseline risk assessment summary, and additional data needs. The baseline risk assessment summaries are taken from Core Team Summaries in 2001.

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[9] ALs are the lesser of the excess lifetime cancer risk of 1E-04 and HI of 3 from the Risk Methods Document (DOE 2018b).
[10] RGA and McNairy background values are reported in the Risk Methods Document, Table A.13, and are taken from the "Over All Observations" values from DOE 2018b.
[11] NALs are the lesser of the combined adult and child excess lifetime cancer risk of 1E-06 and child HI of 0.1 from the Risk Methods Document (DOE 2018b).
[12] ALs are the lesser of the combined adult and child excess lifetime cancer risk of 1E-04 and child HI of 3 from the Risk Methods Document (DOE 2018b).

Table 3. Soil Data Summary: C-400 Complex

SURFACE SOIL (0–1 ft bgs)														
			Detected Results				Background (Bkgd)		Industrial Worker		Industrial Worker		Protection of Groundwater	
Type	Analysis	Unit	Min	Max	Avg	FOD	FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Arsenic	mg/kg	1.80E+00	4.63E+01	9.67E+00	37/37	5/37	1.20E+01	37/37	1.60E+00	0/37	1.60E+02	15/37	5.84E+00
METAL	Cadmium	mg/kg	4.00E-02	1.75E+01	3.13E+00	26/37	20/37	2.10E-01	0/37	6.05E+01	0/37	1.82E+03	4/37	7.52E+00
METAL	Chromium	mg/kg	7.85E+00	6.60E+01	1.99E+01	37/37	20/37	1.60E+01	29/37	1.23E+01	0/37	1.23E+03	0/37	3.60E+06
METAL	Cobalt	mg/kg	2.60E+00	1.85E+01	7.76E+00	27/27	3/27	1.40E+01	0/27	6.87E+01	0/27	2.06E+03	27/27	5.43E-01
METAL	Copper	mg/kg	5.90E+00	5.92E+01	1.86E+01	27/27	8/27	1.90E+01	0/27	9.34E+03	0/27	1.00E+05	2/27	9.15E+02
METAL	Iron	mg/kg	7.76E+03	3.70E+04	1.91E+04	27/27	2/27	2.80E+04	0/27	1.00E+05	0/27	1.00E+05	27/27	7.04E+02
METAL	Mercury	mg/kg	1.65E-02	1.61E+00	1.37E-01	24/37	3/37	2.00E-01	0/37	7.01E+01	0/37	2.10E+03	1/37	5.91E-01
METAL	Nickel	mg/kg	5.70E+00	6.84E+01	2.16E+01	37/37	16/37	2.10E+01	0/37	4.30E+03	0/37	1.00E+05	1/37	5.12E+01
METAL	Silver	mg/kg	1.30E-01	2.56E+01	6.37E+00	10/37	4/37	2.30E+00	0/37	1.17E+03	0/37	3.51E+04	5/37	1.60E+00
METAL	Thallium	mg/kg	9.00E-01	6.52E+01	1.32E+01	14/37	14/37	2.10E-01	8/37	2.34E+00	0/37	7.02E+01	8/37	2.85E+00
METAL	Uranium	mg/kg	1.50E+03	3.00E+03	2.12E+03	5/5	5/5	4.90E+00	5/5	6.81E+02	5/5	2.04E+04	5/5	2.70E+02
PPCB	Polychlorinated biphenyl	mg/kg	3.00E-03	1.10E+01	2.61E+00	14/29	N/A	N/A	7/29	2.93E-01	0/29	2.93E+01	7/29	1.56E+00
SVOA	Acenaphthene	mg/kg	6.10E-03	1.70E+01	3.04E+00	12/25	N/A	N/A	0/25	1.38E+03	0/25	4.14E+04	1/25	1.10E+01
SVOA	Fluorene	mg/kg	4.80E-03	1.70E+01	2.80E+00	10/25	N/A	N/A	0/25	9.19E+02	0/25	2.76E+04	1/25	1.09E+01
SVOA	Phenanthrene	mg/kg	4.60E-02	7.75E+01	1.45E+01	18/25	N/A	N/A	0/25	1.38E+03	0/25	4.14E+04	7/25	1.10E+01
SVOA	Pyrene	mg/kg	4.10E-02	1.11E+02	1.52E+01	20/25	N/A	N/A	0/25	6.89E+02	0/25	2.07E+04	4/25	2.63E+01
SVOA	Total PAH	mg/kg	1.95E-03	5.41E+01	9.04E+00	21/25	N/A	N/A	12/25	6.43E-01	0/25	6.43E+01	9/25	4.70E+00
RADS	Cesium-137	pCi/g	2.00E-01	1.50E+00	4.10E-01	10/17	3/17	4.90E-01	10/17	1.08E-01	0/17	1.08E+01	0/17	9.58E+00
RADS	Neptunium-237	pCi/g	2.00E-01	3.00E+00	6.79E-01	15/23	15/23	1.00E-01	14/23	2.49E-01	0/23	2.49E+01	1/23	1.07E+00
RADS	Technetium-99	pCi/g	1.50E+00	1.40E+02	2.52E+01	22/23	19/23	2.50E+00	0/23	1.27E+03	0/23	1.00E+05	22/23	1.52E-01
RADS	Uranium-234	pCi/g	5.00E-01	3.11E+01	5.59E+00	21/21	19/21	1.20E+00	0/21	5.01E+01	0/21	5.01E+03	20/21	9.90E-01
RADS	Uranium-235	pCi/g	1.80E-01	1.90E+00	4.38E-01	13/21	13/21	6.00E-02	4/21	4.08E-01	0/21	4.08E+01	1/21	9.76E-01
RADS	Uranium-238	pCi/g	5.00E-01	3.95E+01	7.57E+00	21/21	19/21	1.20E+00	19/21	1.66E+00	0/21	1.66E+02	20/21	8.05E-01

Table 3. Soil Data Summary: C-400 Complex (Continued)

SUBSURFACE SOIL (> 1 ft bgs)														
			Detected Results				Background (Bkgd)		Excavation Worker		Excavation Worker		Protection of Groundwater	
Type	Analysis	Unit	Min	Max	Avg	FOD	FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	6.00E-03	1.94E+01	1.83E+00	79/374	78/374	2.10E-01	1/374	1.32E+01	0/374	3.96E+02	6/374	5.42E+00
METAL	Arsenic	mg/kg	1.69E-02	2.58E+01	3.45E+00	370/389	21/389	7.90E+00	131/389	3.74E+00	0/389	3.60E+02	55/389	5.84E+00
METAL	Cadmium	mg/kg	1.30E-03	1.28E+01	3.87E-01	167/387	51/387	2.10E-01	0/387	2.53E+01	0/387	7.59E+02	1/387	7.52E+00
METAL	Chromium	mg/kg	1.22E-01	5.60E+01	1.54E+01	381/389	6/389	4.30E+01	278/389	9.14E+00	0/389	9.14E+02	0/389	3.60E+06
METAL	Cobalt	mg/kg	4.40E-02	1.26E+02	5.51E+00	373/389	17/389	1.30E+01	27/389	9.84E+00	0/389	2.95E+02	368/389	5.43E-01
METAL	Iron	mg/kg	1.50E+02	3.80E+05	1.66E+04	389/389	12/389	2.80E+04	43/389	2.30E+04	2/389	1.00E+05	388/389	7.04E+02
METAL	Manganese	mg/kg	2.19E+00	7.24E+03	2.53E+02	388/389	13/389	8.20E+02	15/389	7.74E+02	0/389	2.32E+04	254/389	5.65E+01
METAL	Mercury	mg/kg	9.30E-03	8.30E+00	6.98E-02	177/389	2/389	1.30E-01	0/389	9.86E+00	0/389	2.96E+02	1/389	5.91E-01
METAL	Silver	mg/kg	7.00E-03	2.51E+01	1.42E+00	55/389	5/389	2.70E+00	0/389	1.64E+02	0/389	4.92E+03	8/389	1.60E+00
METAL	Thallium	mg/kg	7.00E-03	2.30E+00	7.73E-01	26/389	23/389	3.40E-01	23/389	3.29E-01	0/389	9.87E+00	25/389	2.85E+00
SVOC	N-Nitroso-di-n-propylamine	mg/kg	4.80E-02	6.34E-01	4.55E-01	8/444	N/A	N/A	6/444	3.79E-01	0/444	3.79E+01	8/444	1.62E-04
SVOC	Total PAH	mg/kg	7.90E-03	5.71E+00	9.90E-01	29/444	N/A	N/A	3/444	2.35E+00	0/444	1.51E+02	2/444	4.70E+00
VOC	*cis*-1,2-Dichloroethene	mg/kg	1.40E-03	2.40E+00	1.71E-01	71/400	N/A	N/A	0/400	6.58E+01	0/400	1.97E+03	8/400	4.12E-01
VOC	*trans*-1,2-Dichloroethene	mg/kg	1.40E+00	3.40E+01	7.84E+00	19/400	N/A	N/A	0/400	5.67E+01	0/400	1.70E+03	19/400	6.27E-01
VOC	Trichloroethene	mg/kg	3.00E-04	8.21E+03	6.19E+01	178/471	N/A	N/A	50/471	2.26E+00	3/471	6.78E+01	92/471	3.57E-02
VOC	Vinyl chloride	mg/kg	1.90E-03	1.30E-01	2.23E-02	16/468	N/A	N/A	0/468	4.72E+00	0/468	4.72E+02	5/468	1.38E-02
RADS	Cesium-137	pCi/g	2.00E-01	6.00E-01	3.02E-01	89/324	56/324	2.80E-01	2/324	5.82E-01	0/324	5.82E+01	7/324	9.58E+00
RADS	Technetium-99	pCi/g	2.00E-01	4.33E+01	9.64E-01	224/339	12/339	2.80E+00	0/339	1.55E+03	0/339	1.00E+05	224/339	1.52E-01
RADS	Uranium-234	pCi/g	1.90E-02	4.17E+01	9.44E-01	331/336	23/336	1.20E+00	0/336	4.30E+01	0/336	4.30E+03	32/336	9.90E-01
RADS	Uranium-235	pCi/g	2.10E-02	2.20E+00	4.56E-01	12/336	10/336	6.00E-02	0/336	2.62E+00	0/336	2.62E+02	1/336	9.76E-01
RADS	Uranium-238	pCi/g	1.30E-01	4.28E+01	9.92E-01	329/336	22/336	1.20E+00	4/336	8.98E+00	0/336	8.98E+02	50/336	8.05E-01

Legend:

One or more samples exceed background value

One or more samples exceed NAL value

One or more samples exceed AL value

One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.

Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).

Field replicates or separate samples are counted independently.

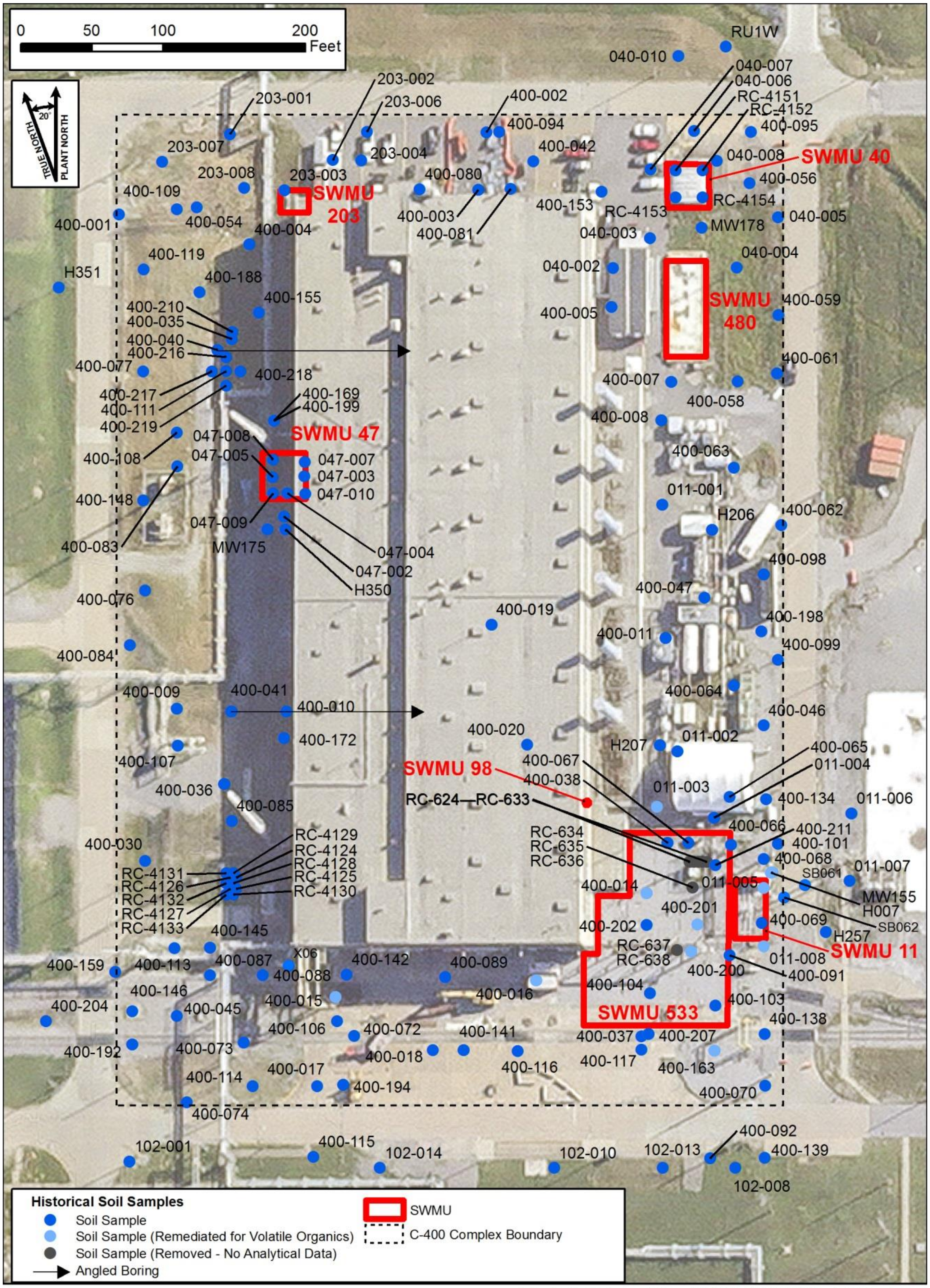

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Figure 6. C-400 Complex Historical Soil Sampling Locations

Table 4. Groundwater Data Summary: C-400 Complex

			Detected Results			Background (Bkgd)		Resident		Resident		MCL	
Type	**Analysis**	**Unit**	**Min**	**Max**	**FOD**	**FOE**	**Bkgd**	**FOE**	**NAL**	**FOE**	**AL**	**FOE**	**MCL**
SVOC	Naphthalene	µg/L	9.70E+01	1.10E+02	2/26	N/A	N/A	2/26	1.65E-01	2/26	1.65E+01	N/A	N/A
VOC	1,1-Dichloroethene	µg/L	4.40E-01	1.70E+02	16/283	0/283	N/A	16/283	1.71E-01	5/283	1.71E+01	10/283	7.00E+00
VOC	Chloroform	µg/L	7.30E+00	8.10E+00	2/34	0/34	N/A	2/34	2.21E-01	0/34	2.21E+01	0/34	8.00E+01
VOC	*cis*-1,2-Dichloroethene	µg/L	4.10E-01	7.50E+04	244/280	0/280	N/A	231/280	3.61E+00	122/280	1.08E+02	162/280	7.00E+01
VOC	Trichloroethene	µg/L	9.70E+00	1.40E+06	283/283	0/283	N/A	283/283	2.83E-01	283/283	8.49E+00	283/283	5.00E+00
VOC	Vinyl chloride	µg/L	6.00E-01	5.43E+01	4/280	0/280	N/A	4/280	1.88E-02	3/280	1.88E+00	3/280	2.00E+00
RADS	Alpha activity	pCi/L	1.69E+00	1.16E+02	25/58	13/58	5.80E+00	N/A	N/A	N/A	N/A	8/58	1.50E+01
RADS	Beta activity	pCi/L	5.57E+00	5.95E+03	54/58	48/58	1.38E+01	N/A	N/A	N/A	N/A	N/A	N/A
RADS	Technetium-99	pCi/L	2.09E+01	1.03E+04	191/256	190/256	2.23E+01	191/256	1.90E+01	67/256	1.90E+03	77/256	9.00E+02

Legend:

One or more samples exceed background value
One or more samples exceed NAL value
One or more samples exceed AL value
One or more samples exceed MCL

NOTE: Data were downloaded from the OREIS database in January 2018. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates or separate samples are counted independently.

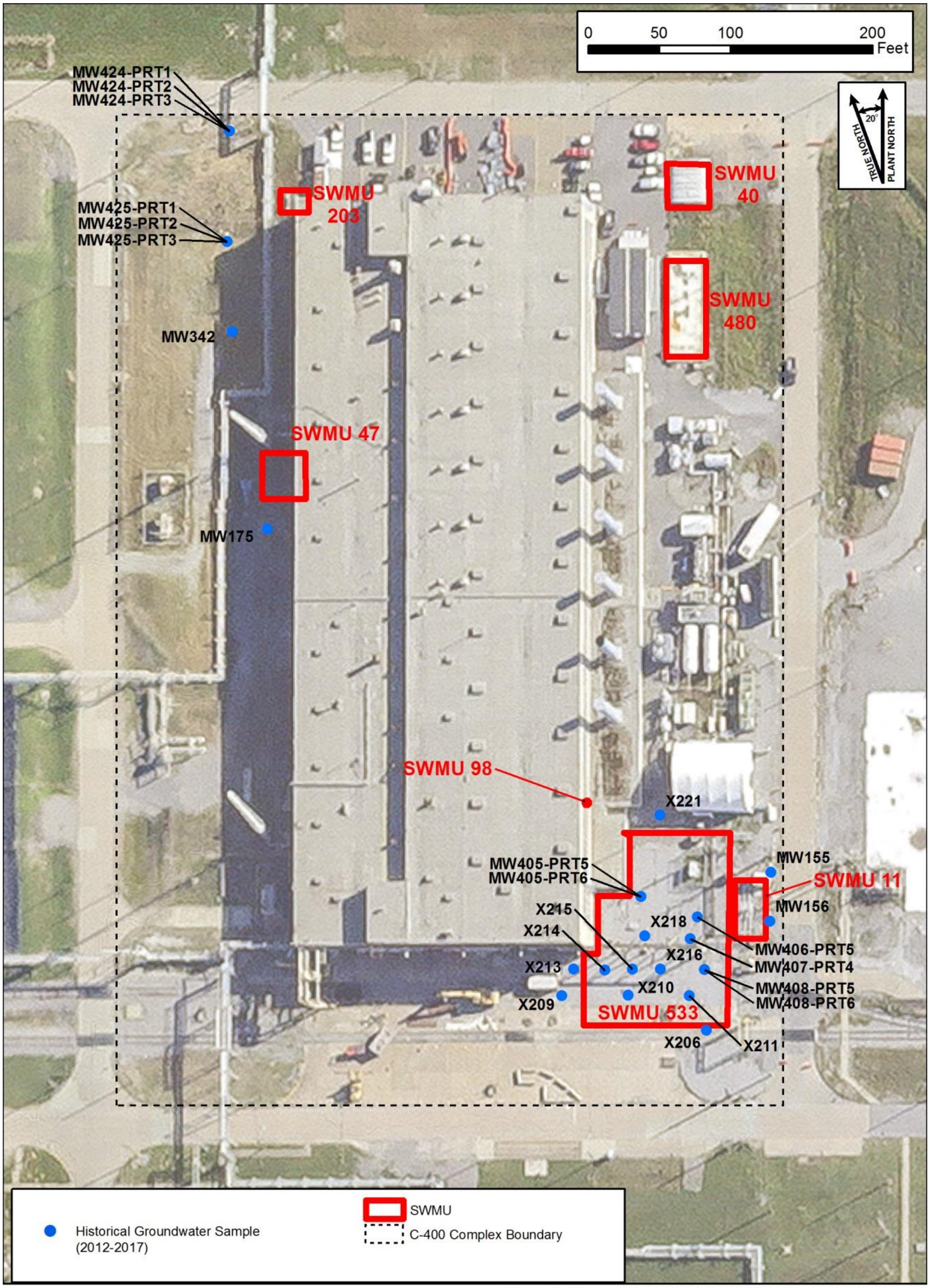

Figure 7. C-400 Complex Historical Groundwater Sampling Locations

2.1.1 C-400 Trichloroethylene Leak Site (SWMU 11)

2.1.1.1 Area description

The C-400 TCE Leak Site (SWMU 11) is located at the southeast corner of the C-400 Cleaning Building, as shown in Figure 8.

2.1.1.2 Process history

A leak of TCE from the sump in the C-400 degreaser area to the storm sewer was discovered in 1986. TCE was released at various times through broken pipes and joints in a leaking underground storm sewer pipe from the C-400 Cleaning Building. It had not been known previously that the sump discharged to the sewer. After the leak was discovered, discharge lines from the sump in the basement of the C-400 Cleaning Building were disconnected from the storm sewer. TCE-contaminated soils were excavated from the area of the leak.

2.1.1.3 Previous investigation results

TCE concentrations as high as 7,000,000 μg/kg were reported in soil samples collected adjacent to and below the storm sewer line during removal of the contaminated soil in 1986 (EDGe 1988). Approximately 9,200 ft^3 of contaminated soil and bedding material were excavated, containerized, and stored as hazardous waste for treatment and disposal. Some of the contaminated soil is known to have been left in place because of concerns about the structural integrity of 11th Street and the TCE Tank Pad, located to the west between the spill site and the C-400 Cleaning Building (CH2M HILL 1992). The excavated area was backfilled with clean fill material and capped with a layer of clay after excavation activities were completed.

The Trichloroethylene Leak Site (SWMU 11) was investigated under the Phase I and Phase II SIs completed between 1989 and 1991 (CH2M HILL 1991; CH2M HILL 1992). The field activities for Phase I consisted of drilling a deep boring within the leak area and collecting groundwater samples from MW68 through MW71. All samples were analyzed for VOCs, SVOCs, PPCBs, metals, and selected RADs, including uranium-238, uranium-235, technetium-99, thorium-230, plutonium-239, as well as gross alpha activity and gross beta activity. The analytical results for the soil samples collected from the deep boring showed that TCE was detected in the soils at concentrations throughout the interval sampled (4 to 93 ft bgs) and that the highest concentration was from the sample collected at approximately 55–60 ft bgs. Technetium-99 was detected at 10–15 ft bgs (at 6.6 pCi/g). No other compounds or analytes were detected in any of the samples analyzed (DOE 1999). Phase II SI installed wells clusters in the area and detected TCE at 360,000 μg/L.

SWMU 11 was investigated with Sector 4 of the WAG 6 RI (DOE 1999). The WAG 6 RI found a widespread TCE-impacted area located primarily between the C-400 Cleaning Building and 11th Street and north of Tennessee Avenue (see Figure 2). In that area, a large zone of shallow soil contained greater than 225,000 μg/kg TCE, indicating that the chlorinated solvent was present as a DNAPL in UCRS soil. TCE and its degradation products were found in soils throughout the UCRS.

The highest concentrations were found below the backfilled excavation at SWMU 11 (8,208,600 μg/kg) and adjacent to the TCE off-loading pumps (11,055,000 μg/kg), now known as SWMU 533. The location of the 11,055,000 μg/kg result was remediated as part of SPH.

SWMU 11 Surface Soil (0–1 ft bgs) Data Summary (Samples Collected 1991)

Type	Analysis	Unit	Detected Results			FOD	Background		Industrial Worker		Industrial Worker		Protection of Groundwater	
			Min	Max	Avg	FOD	FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Arsenic	mg/kg	1.80E+00	2.20E+00	2.00E+00	2/2	0/2	1.20E+01	2/2	1.60E+00	0/2	1.60E+02	0/2	5.84E+00
METAL	Cadmium	mg/kg	8.70E-01	1.20E+00	1.04E+00	2/2	2/2	2.10E-01	0/2	6.05E+01	0/2	1.82E+03	0/2	7.52E+00
METAL	Chromium	mg/kg	9.50E+00	1.84E+01	1.40E+01	2/2	1/2	1.60E+01	1/2	1.23E+01	0/2	1.23E+03	0/2	3.60E+06
SVOC	Acenaphthene	mg/kg	9.30E+00	1.70E+01	1.32E+01	2/2	N/A	N/A	0/2	1.38E+03	0/2	4.14E+04	1/2	1.10E+01
SVOC	Fluorene	mg/kg	8.70E+00	1.70E+01	1.29E+01	2/2	N/A	N/A	0/2	9.19E+02	0/2	2.76E+04	1/2	1.09E+01
SVOC	Phenanthrene	mg/kg	4.70E+01	6.30E+01	5.50E+01	2/2	N/A	N/A	0/2	1.38E+03	0/2	4.14E+04	2/2	1.10E+01
SVOC	Pyrene	mg/kg	3.60E+01	4.10E+01	3.85E+01	2/2	N/A	N/A	0/2	6.89E+02	0/2	2.07E+04	2/2	2.63E+01
SVOC	Total PAH	mg/kg	2.05E+01	3.91E+01	2.98E+01	2/2	N/A	N/A	2/2	6.43E-01	0/2	6.43E+01	2/2	4.70E+00
RADS	Neptunium-237	pCi/g	2.50E-01	5.40E-01	3.95E-01	2/2	2/2	1.00E-01	2/2	2.49E-01	0/2	2.49E+01	0/2	1.07E+00
RADS	Technetium-99	pCi/g	4.30E+01	6.50E+01	5.40E+01	2/2	2/2	2.50E+00	0/2	1.27E+03	0/2	1.00E+05	2/2	1.52E-01
RADS	Uranium-234	pCi/g	1.00E+01	1.00E+01	1.00E+01	1/1	1/1	1.20E+00	0/1	5.01E+01	0/1	5.01E+03	1/1	9.90E-01
RADS	Uranium-235	pCi/g	4.20E-01	4.20E-01	4.20E-01	1/1	1/1	6.00E-02	1/1	4.08E-01	0/1	4.08E+01	0/1	9.76E-01
RADS	Uranium-238	pCi/g	1.40E+01	1.40E+01	1.40E+01	1/1	1/1	1.20E+00	1/1	1.66E+00	0/1	1.66E+02	1/1	8.05E-01

SWMU 11 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1990–2011)

Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
			Min	Max	Avg	FOD	FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	6.00E-01	7.00E+00	1.53E+00	18/60	18/60	2.10E-01	0/60	1.32E+01	0/60	3.96E+02	2/60	5.42E+00
METAL	Arsenic	mg/kg	2.70E-01	1.09E+01	3.06E+00	69/70	3/70	7.90E+00	23/70	3.74E+00	0/70	3.60E+02	7/70	5.84E+00
METAL	Chromium	mg/kg	2.97E+00	4.31E+01	1.64E+01	70/70	1/70	4.30E+01	51/70	9.14E+00	0/70	9.14E+02	0/70	3.60E+06
METAL	Cobalt	mg/kg	4.90E-01	1.61E+01	4.26E+00	69/70	2/70	1.30E+01	4/70	9.84E+00	0/70	2.95E+02	68/70	5.43E-01
METAL	Iron	mg/kg	3.45E+03	3.48E+04	1.45E+04	70/70	1/70	2.80E+04	7/70	2.30E+04	0/70	1.00E+05	70/70	7.04E+02
METAL	Manganese	mg/kg	6.58E+00	1.47E+03	1.74E+02	69/70	1/70	8.20E+02	2/70	7.74E+02	0/70	2.32E+04	39/70	5.65E+01
METAL	Thallium	mg/kg	1.80E-01	1.10E+00	5.97E-01	6/70	4/70	3.40E-01	4/70	3.29E-01	0/70	9.87E+00	0/70	2.85E+00
SVOC	N-Nitroso-di-n-propylamine	mg/kg	4.47E-01	4.47E-01	4.47E-01	1/91	N/A	N/A	1/91	3.79E-01	0/91	3.79E+01	1/91	1.62E-04
SVOC	Total PAH	mg/kg	5.56E-02	3.50E+00	9.64E-01	4/91	N/A	N/A	1/91	2.35E+00	0/91	1.51E+02	0/91	4.70E+00
VOC	cis-1,2-Dichloroethene	mg/kg	1.40E-03	1.20E+00	1.54E-01	19/49	N/A	N/A	0/49	6.58E+01	0/49	1.97E+03	2/49	4.12E-01
VOC	trans-1,2-Dichloroethene	mg/kg	2.10E+00	1.25E+01	6.17E+00	3/49	N/A	N/A	0/49	5.67E+01	0/49	1.70E+03	3/49	6.27E-01
VOC	Trichloroethene	mg/kg	6.00E-04	8.21E+03	2.29E+02	42/61	N/A	N/A	8/61	2.26E+00	1/61	6.78E+01	13/61	3.57E-02
VOC	Vinyl chloride	mg/kg	3.40E-03	1.10E-01	2.76E-02	5/61	N/A	N/A	0/61	4.72E+00	0/61	4.72E+02	2/61	1.38E-02
RADS	Technetium-99	pCi/g	2.00E-01	6.60E+00	8.78E-01	37/64	3/64	2.80E+00	0/64	1.55E+03	0/64	1.00E+05	37/64	1.52E-01
RADS	Uranium-234	pCi/g	4.00E-01	3.50E+00	7.60E-01	62/62	5/62	1.20E+00	0/62	4.30E+01	0/62	4.30E+03	5/62	9.90E-01
RADS	Uranium-238	pCi/g	2.00E-01	4.30E+00	7.77E-01	62/62	5/62	1.20E+00	0/62	8.98E+00	0/62	8.98E+02	8/62	8.05E-01

Legend:

- (orange) One or more samples exceed background value
- (green) One or more samples exceed NAL value
- (red) One or more samples exceed AL value
- (blue) One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Historical Depiction of SWMU 11

Map of SWMU 11 Soil Samples

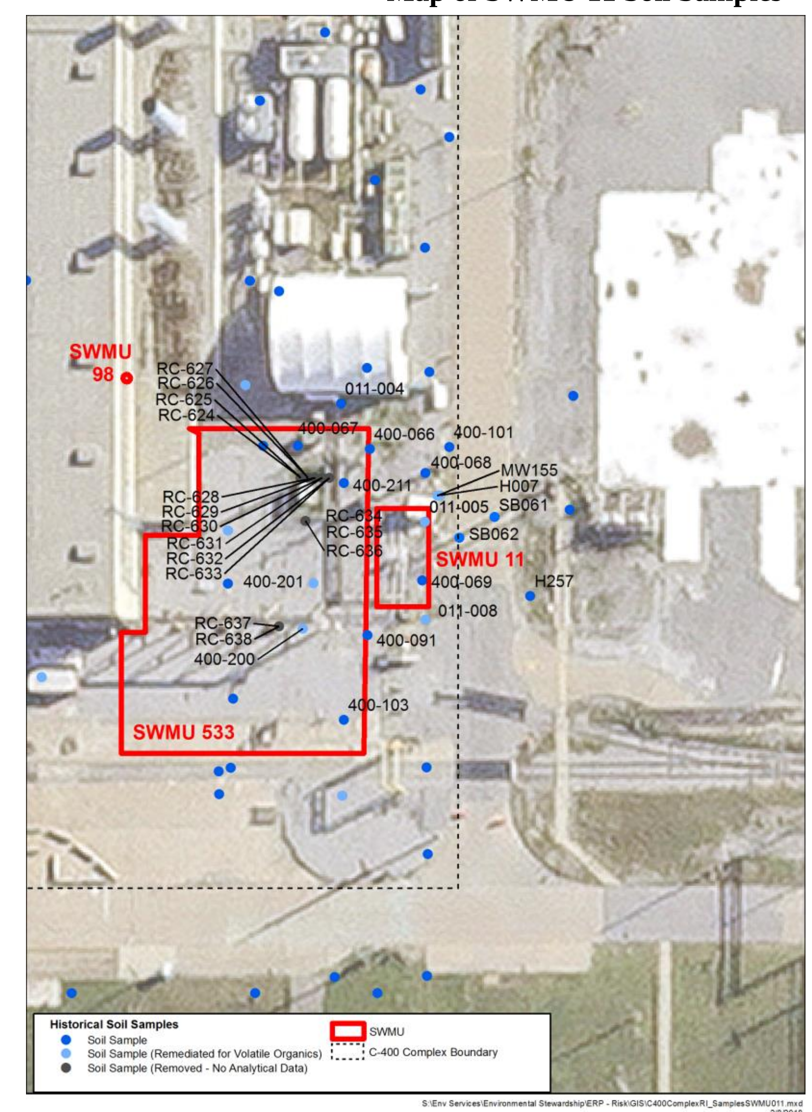

Figure 8. SWMU 11 Existing Data Summary (Soil)

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2.1.1.4 Baseline risk assessment summary

Human Health Risk Assessment Summary. The direct contact risks for the SWMU 11 area were assessed following the procedures presented in the 1996 revision of *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant* (DOE 1996). The data evaluation for the risk assessment identified several COPCs for the data aggregates constructed. A listing of the number of COPCs identified by class is in Table 5. Of these COPCs, several were identified in only a few samples or were identified above screening levels. A summary of the data evaluation leading to this list is in Table 6.

Table 5. Number of COPCs by Class Identified for the SWMU 11 Area

		Analyte Type		
Location	**Medium**	**Organics**	**Inorganics**	**RADs**
SWMU 11	Surface Soil	10	4	2
	Subsurface Soil	28	16	6
	RGA Groundwater*	14	23	14
	McNairy Groundwater*	12	19	17

*The results for RGA Groundwater and McNairy Groundwater are for the entire WAG 6 area.

The exposure assessment of the risk assessment evaluated several scenarios that encompassed both current use and several hypothetical future uses of the SWMU 11 area. These are as follows.

- Current on-site industrial—direct contact with surface soil (soil found 0−1 ft bgs).
- Future on-site industrial—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area.
- Future on-site excavation scenario—direct contact with surface and subsurface soil (soil found 1−16 ft bgs).
- Future on-site recreational user—consumption of game exposed to contaminated surface soil.
- Future off-site recreational user—direct contact with surface water impacted by contaminants migrating from sources and consumption of game exposed to this surface water.
- Future on-site rural resident—direct contact with surface soil at SWMU 11 and use of groundwater drawn from aquifers below the WAG 6 area, including consumption of vegetables that were posited to be raised in this area.
- Future off-site rural resident—use in the home of groundwater drawn from the RGA at the DOE property boundary.

The risk characterization performed for the SWMU 11 area followed the guidance in the 1996 revision of the Risk Methods Document (DOE 1996). The results of the risk characterization are shown in Table 6. Because lead was treated as a special case in the WAG 6 RI (as indicated by the title of Table 6), Table 7 presents a risk characterization for lead alone.

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR Pathways of Concern (POCs)	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	3.7E-06	PAHs	95	Dermal contact with soil	96	1.0	None	--	None	--
Future industrial worker at current concentrations	3.7E-06	PAHs	95	Dermal contact with soil	96	1.0	None	--	None	--
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	1.5E-07	NE	NE	NE	NE	< 0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	24.8	Aluminum Antimony Cadmium Chromium	59 9 2 29	Ingestion of soil Dermal contact with soil Ingestion of vegetables	1 23 76
Future adult rural resident at current concentrations	1.9E-04	PAHs PCBs	83 17	Ingestion of soil Dermal contact with soil Ingestion of vegetables	< 1 5 94	7.1	Aluminum Antimony Cadmium Chromium	62 9 2 27	Dermal contact with soil Ingestion of vegetables	16 84
Future excavation worker at current concentrations	3.6E-04	Arsenic Beryllium 1,1-Dichloroethene PAHs PCBs Trichloroethene Vinyl chloride Cesium-137	3 22 1 11 < 1 < 1 61 < 1	Ingestion of soil Dermal contact with soil Inhalation of vapors and particles External exposure	6 32 62 < 1	1.6	Aluminum Antimony Chromium Iron Manganese Vanadium	7 6 10 29 12 20	Ingestion of soil Dermal contact with soil	15 85

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future industrial worker at	2.7E-03	Arsenic	6	Ingestion of groundwater	85	37.7	Aluminum	1	Ingestion of groundwater	82
current concentrations		Beryllium	8	Dermal contact with	8		Antimony	1	Dermal contact with	16
(RGA groundwater only		1,1-Dichloroethene	1	groundwater			Arsenic	3	groundwater	
from below the WAG 6		Carbon tetrachloride	2	Inhalation while showering	7		Chromium	< 1	Inhalation while showering	2
area)		Chloroform	< 1				Iron	34		
		N-nitroso-di-n-propylamine	< 1				Manganese	2		
		Tetrachloroethene	< 1				Nitrate	< 1		
		Trichloroethene	20				Vanadium	< 1		
		Vinyl chloride	37				Carbon tetrachloride	5		
		Americium-241	< 1				Trichloroethene	49		
		Cesium-137	< 1				*cis*-1,2-Dichloroethene	1		
		Lead-210	24							
		Neptunium-237	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Uranium-238	< 1							
Future industrial worker at	4.5E-03	Arsenic	31	Ingestion of groundwater	98	20.6	Aluminum	4	Ingestion of groundwater	94
current concentrations		Beryllium	4	Dermal contact with			Arsenic	42	Dermal contact with	6
(McNairy Formation		1,1-Dichloroethene	< 1	groundwater	1		Chromium	3	groundwater	
groundwater only from		Bromodichloromethane	< 1	Inhalation while showering	< 1		Iron	35		
below the WAG 6 area)		Chloroform	< 1				Manganese	2		
		Dibromochloromethane	< 1				Vanadium	9		
		Tetrachloroethene	< 1				Zinc	1		
		Trichloroethene	< 1				Di-N-octylphthalate	1		
		Vinyl chloride	2							
		Cesium-137	< 1							
		Lead -210	59							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Thorium-234	2							
		Uranium-235	< 1							

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (McNairy Formation groundwater only from below the WAG 6 area)	NA	NA	NA	NA	NA	224	Aluminum	4	Ingestion of groundwater	58
							Arsenic	44	Dermal contact with groundwater	2
							Barium	< 1	Consumption of vegetables	40
							Beryllium	< 1	Inhalation from household use	< 1
							Cadmium	< 1		
							Chromium	3		
							Cobalt	< 1		
							Iron	36		
							Manganese	1		
							Nickel	< 1		
							Selenium	< 1		
							Vanadium	8		
							Zinc	2		
							1,1-Dichloroethene	< 1		
							1,2-Dichloroethane	< 1		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Trichloroethene	< 1		
							cis-1,2-Dichloroethene	< 1		

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident	3.5E-02	Arsenic	33	Ingestion of groundwater	57	84.4	Aluminum	4	Ingestion of groundwater	64
at current concentrations		Beryllium	3	Dermal contact with	< 1		Arsenic	44	Dermal contact with	2
(McNairy Formation		1,1-Dichloroethene	3	groundwater			Barium	< 1	groundwater	
groundwater only from		1,2-Dichloroethane	< 1	Inhalation while showering	< 1		Cadmium	< 1	Consumption of vegetables	34
below WAG 6 area)		Bis(2-ethylhexyl)phthalate	< 1	Consumption of vegetables	40		Chromium	3		
		Bromodichloromethane	< 1				Iron	36		
		Chloroform	< 1				Manganese	1		
		Dibromochloromethane	< 1				Nickel	< 1		
		Tetrachloroethene	< 1				Selenium	< 1		
		Trichloroethene	< 1				Vanadium	8		
		Vinyl chloride	6				Zinc	2		
		Actinium-228	< 1				Di-N-octylphthalate	< 1		
		Cesium-137	< 1				Trichloroethene	< 1		
		Lead-210	43							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	10							
		Thorium-228	< 1							
		Thorium-230	< 1							
		Thorium-234	1							
		Uranium-234	< 1							
		Uranium-235	< 1							
		Uranium-238	< 1							

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	475	Aluminum	1	Ingestion of groundwater	44
							Antimony	< 1	Dermal contact with groundwater	3
							Arsenic	2		
							Barium	< 1	Consumption of vegetables	41
							Beryllium	< 1	Inhalation while showering	< 1
							Cadmium	< 1	Inhalation from household use	10
							Chromium	< 1		
							Cobalt	< 1		
							Copper	< 1		
							Iron	30		
							Manganese	1		
							Nickel	< 1		
							Nitrate	< 1		
							Silver	< 1		
							Uranium	< 1		
							Vanadium	< 1		
							Zinc	< 1		
							1,1-Dichloroethene	< 1		
							Carbon tetrachloride	14		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Toluene	< 1		
							Trichloroethene	46		
							cis-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Table 6. Summary Human Health Risk Characterization for SWMU 11 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	6.4E-02	Arsenic	2	Ingestion of groundwater	17	169	Aluminum	2	Ingestion of groundwater	52
		Beryllium	2	Dermal contact with groundwater	< 1		Antimony	< 1	Dermal contact with groundwater	5
		1,1-Dichloroethene	1				Arsenic	2		
		Bromodichloromethane	< 1	Inhalation while showering	1		Barium	< 1	Consumption of vegetables	37
		Carbon tetrachloride	< 1	Consumption of vegetables	69		Cadmium	< 1	Inhalation while showering	< 1
		Chloroform	< 1				Chromium	< 1	Inhalation from household use	6
		N-nitroso-di-n-propylamine	< 1				Copper	< 1		
		Tetrachloroethene	< 1				Iron	32		
		Trichloroethene	12				Manganese	1		
		Vinyl chloride	30				Nickel	< 1		
		Americium-241	< 1				Nitrate	< 1		
		Cesium-137	< 1				Silver	< 1		
		Lead-210	6				Vanadium	< 1		
		Neptunium-237	< 1				Zinc	< 1		
		Technetium-99	45				Carbon tetrachloride	10		
		Thorium-228	< 1				Chloroform	< 1		
		Thorium-230	< 1				Tetrachloroethene	< 1		
		Uranium-234	< 1				Trichloroethene	48		
		Uranium-238	< 1				*cis*-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern.
*Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77, without lead included, from the WAG 6 BHHRA (DOE 1999).

Table 7. Comparison of Representative Concentrations[a] of Lead at SWMU 11 against Regulatory Screening Values

Location	Representative Concentration	KDEP Screening Value	Exceed?	EPA Screening Value	Exceed?
Groundwater (μg/L)[b]					
WAG 6 RGA	32.7	4	Yes	15	Yes
WAG 6 McNairy	114	4	Yes	15	Yes
Surface Soil (mg/kg)[c]					
SWMU 11 area	x	20	x	400	x
Subsurface Soil (mg/kg)[d]					
SWMU 11 area	5.53	20	No	400	No

x indicates that lead was not a COPC for that location; therefore, a representative concentration is not available.
[a] As shown in Subsection 1.2.3.1 of the WAG 6 BHHRA, the representative concentration is the lesser of the maximum detected concentration and the upper 95% confidence level on the mean concentration (DOE 1999).
[b] As discussed in the WAG 6 BHHRA, groundwater was evaluated on an area basis because all locations within WAG 6 are contiguous (DOE 1999).
[c] Surface soil is soil collected from 0–1 ft bgs.
[d] Subsurface soil is soil collected from 0–16 ft bgs.

The following are significant results in the risk characterization.

- The overall cancer risk to the current and future industrial worker from exposure to soil in the SWMU 11 area exceeds the PGDP *de minimis* level (i.e., 1.0E-06), but is within EPA's generally acceptable risk range of 1.0E-04 and 1.0E-06 (ELCR = 3.7E-06). The overall HI essentially was equal to the PGDP *de minimis* level of 1 (HI = 1.0). The COC for cancer risk to the industrial worker is PAHs (95% of total). The driving exposure route for cancer risk was dermal contact with soil (96% of total). There were no COCs for hazard to the industrial worker. Lead in surface soil does not exceed screening levels.

- The overall cancer risk to the excavation worker from exposure to soil in SWMU 11 area exceeds the PGDP *de minimis* level and EPA generally acceptable risk range (ELCR = 3.6E-04). The overall hazard also exceeds the *de minimis* level (HI = 1.6). The COCs for cancer risk to the excavation worker were beryllium (22% of total), PAHs (11% of total), arsenic (3% of total), and 1,1-dichloroethene (1% of total). The driving exposure routes for cancer risk were inhalation of vapors and particles (62% of total) and dermal contact with soil (32% of total). The COCs for hazard were iron (29% of total), vanadium (20% of total), manganese (12% of total), chromium (10% of total), aluminum (7% of total), and antimony (6% of total). The driving exposure routes and their percentage of total hazard were dermal contact (85%) and ingestion (15%). Lead in subsurface soil does not exceed screening levels.

- The overall cancer risk to the hypothetical residential groundwater user in the WAG 6 area exceeded both the PGDP *de minimis* level and EPA's generally acceptable risk range for both the RGA and McNairy Formation (6.4E-02 and 3.5E-02, respectively). The overall HIs also were greater than the *de minimis* level for water drawn from the two water sources (475 and 224, respectively, for the child resident). The primary COCs for cancer risk for water drawn from the RGA are technetium-99 (45% of total), vinyl chloride (30% of total), TCE (12% of total), and lead-210 (6% of total). The primary COCs for hazard for water drawn from the RGA are TCE (46% of total), iron (30% of total), and carbon tetrachloride (14% of total). The primary COCs for cancer risk for water drawn from the McNairy Formation are lead-210 (43% of total), arsenic (33% of total), technetium-99 (10% of total), and vinyl chloride (6% of total). The primary COCs for hazard for water drawn from the McNairy Formation are arsenic (44% of total), iron (36% of total), and vanadium (8% of total). The driving exposure routes for both cancer risk and hazard for both the water sources were ingestion of water and consumption of vegetables from irrigated gardens. Additionally, lead is a COC for both water sources.

Several uncertainties were determined to affect the risk characterization results. The effect of the some important uncertainties on the risk characterization for the industrial worker is shown in Tables 8a and 8b. As shown there, the lower bound cancer risk and hazard can be shown to be less than the respective *de minimis* levels if alternative methods and parameters are used.

Table 8a. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 11—ELCR

Location	Default ELCR[a]	Site-specific ELCR[b]	Default ELCR Minus Common Laboratory Contaminants	Default ELCR Calculated using EPA Default Dermal Absorption Values[c]	Default ELCR Minus Analytes Infrequently Detected	Lower-bound ELCR[d]
SWMU 11	3.7E-06	2.3E-07	3.7E-06	5.9E-07	3.7E-06	3.8E-08

[a] These values were derived using the default exposure rates for the reasonable maximum exposure (RME) scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. [See Subsection 1.6.2.5 of WAG 6 BHHRA (DOE 1999).]
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. [See Subsection 1.6.2.4 of WAG 6 BHHRA (DOE 1999).]
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Table 8b. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 11—Systemic Toxicity

Location	Default HI[a]	Default HI without Lead	Site-specific HI without Lead[b]	Default HI Minus Common Laboratory Contaminants without Lead	Default HI Calculated EPA Default Dermal Absorption Values without Lead[c]	Default HI Minus Analytes Infrequently Detected without Lead	Lower-bound HI[d]
SWMU 11	< 1	< 1	< 1	< 1	< 1	< 1	< 1

< 1 indicates that the HI is less than the *de minimis* level.
[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. [See Subsection 1.6.2.5 of WAG 6 BHHRA (DOE 1999).]
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. [See Subsection 1.6.2.4 of WAG 6 BHHRA (DOE 1999).]
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Ecological Risk Assessment Summary. The primary purpose of the ecological assessment was to determine whether any credible risks to ecological receptors exist in the SWMU 11 area. Because only abiotic data were available, the assessment was limited to the evaluation of these data. Additional lines of evidence (e.g., media toxicity testing and biological surveys) were not collected.

Table 9 lists the contaminants identified as chemicals of potential ecological concern (COPECs) for soil at SWMU 11. As shown there, aluminum and chromium were COPECs for one or more receptors. Additionally, the assessment determined that each receptor considered had one or more COPECs.

Table 9. Summary of Chemicals[a] Posing Potential Future Risks[b] to Nonhuman Receptors at SWMU 11

		Chemicals of Potential Ecological Concern									
Location	**Receptor**	**Al**	**As**	**Cd**	**Cr**	**Fe**	**Tl**	**U**	**V**	**Zn**	**PCBs**
SWMU 11	Microbe	23.7	--	--	2.4	--		nb	--	--	nb
	Plant	284.0	--	--	23.6	nb		--	--	--	--
	Worm	nb	--	--	59.0	nb		nb	nb	--	nb
	Shrew	92.1	--	--	4.2	nb		--	--	--	--
	Mouse	8.8	--	--	--	nb		--	--	--	--
	Deer	6.0	--	--	--	nb		--	--	--	--

Al = aluminum; As = arsenic; Cd = cadmium; Cr = chromium; Fe = iron; Tl = thallium; U = uranium; V = vanadium; Zn = zinc.
-- indicates that the hazard quotient for the chemical/receptor combination did not exceed 1 or the chemical was below background in that sector.
nb indicates that no toxicological benchmark was available for the chemical/receptor combination.
Blank cells indicate that the analyte was not detected in surface soil in the sector.
[a] The table includes values for those chemicals with a maximum concentration above background (or no background available) and a hazard quotient > 1.0. Analytes for which ecological benchmarks were not available are shown in Tables 2.1 and 2.2 of Volume 3 of the WAG 6 BHHRA (DOE 1999).
[b] Values in this table are hazard quotients estimated by dividing the dose to the receptor by the benchmark dose.

2.1.1.5 Additional data needs

SWMU 11 has been placed in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to subsurface soil contamination. Additional sampling is required to determine if the concentration of analytes other than TCE poses a risk, as defined in the DQOs, and to determine the nature and extent of contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

2.1.2 C-403 Neutralization Tank (SWMU 40)

2.1.2.1 Area description

The C-403 Neutralization Tank (SWMU 40) is an in-ground, concrete, open-top tank lined with two layers of acid bricks and located northeast of the C-400 Cleaning Building (Figure 9). The tank is approximately 25-ft square by 26-ft deep.

2.1.2.2 Process history

The C-403 Neutralization Tank received influent from the C-400 Cleaning Building for the storage and treatment (i.e., neutralization) of acidic, uranium-bearing waste solutions generated during cleaning operations. During treatment, lime slurry was added to the wastewater from the C-402 Lime House to raise the pH and precipitate out the uranium in the form of a low-level radioactive sludge. Once the pH was raised to the proper level (10 to 12), the effluent was discharged to the C-404 Holding Pond where the sludge was allowed to settle out of the solution.

In 1957, the discharge from the C-403 Neutralization Tank was routed to the North-South Diversion Ditch (NSDD), where it flowed to the Little Bayou Creek. In the late 1970s, flow from the NSDD was routed into the C-616-F Full Flow Lagoon, and direct discharge to Little Bayou Creek subsequently was discontinued. Although neutralization no longer was carried out at C-403 after 1957, low-level, uranium-bearing wastewater continued to be discharged to C-403 until 1990. These discharges included

SWMU 40 Surface Soil (0–1 ft bgs) Data Summary (Samples Collected 1990)

Type	Analysis	Unit	Detected Results			FOD	Background		Industrial Worker		Industrial Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Uranium	mg/kg	1.50E+03	3.00E+03	2.12E+03	5/5	5/5	4.90E+00	5/5	4.66E+01	5/5	1.40E+03	5/5	2.70E+02
PPCB	Polychlorinated biphenyl	mg/kg	3.40E+00	1.10E+01	6.44E+00	5/5	0/5	N/A	5/5	2.93E-01	0/5	2.93E+01	5/5	1.56E+00

SWMU 40 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1991–1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Arsenic	mg/kg	5.60E-01	8.83E+00	3.14E+00	16/16	1/16	7.90E+00	5/16	3.74E+00	0/16	3.60E+02	1/16	5.84E+00
METAL	Thallium	mg/kg	6.00E-01	6.00E-01	6.00E-01	1/16	1/16	3.40E-01	1/16	3.29E-01	0/16	9.87E+00	0/16	2.85E+00
SVOC	N-Nitroso-di-n-propylamine	mg/kg	4.84E-01	4.84E-01	4.84E-01	1/16	N/A	N/A	1/16	3.79E-01	0/16	3.79E+01	1/16	1.62E-04
RADS	Technetium-99	pCi/g	4.00E-01	4.00E+00	1.60E+00	3/6	1/6	2.80E+00	0/6	1.55E+03	0/6	1.00E+05	3/6	1.52E-01
RADS	Uranium-234	pCi/g	1.90E-02	1.30E+01	3.02E+00	6/6	2/6	1.20E+00	0/6	4.30E+01	0/6	4.30E+03	2/6	9.90E-01
RADS	Uranium-238	pCi/g	4.00E-01	1.34E+01	3.76E+00	5/6	2/6	1.20E+00	1/6	8.98E+00	0/6	8.98E+02	2/6	8.05E-01

Legend:

- (orange) One or more samples exceed background value
- (green) One or more samples exceed NAL value
- (red) One or more samples exceed AL value
- (blue) One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Historical Depiction of SWMU 40

Map of SWMU 40 Soil Samples

Figure 9. SWMU 40 Existing Data Summary (Soil)

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uranium hexafluoride cylinder hydrostatic-test water, overflow, and runoff from cleaning tanks; discharge from floor drains; and other unknown sources. After 1990, the C- 403 Neutralization Tank was removed from service.

2.1.2.3 Previous investigation results

There have been no previous response actions for the C-403 Neutralization Tank; however, in 1993, nine water and three sediment samples were collected from the C-403 Neutralization Tank. Analytical results indicated that TCE concentrations in the nine water samples ranged from 17 to 1,300 μg/L, and TCE concentrations in the three sediment samples ranged from 35 to 6,700 ppb (DOE 1999). During the WAG 6 RI, a water line located near the C-403 tank broke, and subsurface water flowed into the tank from one of the remaining fill lines. Approximately 7,000 ft^3 of water accumulated in the tank. Samples of the water from the tank were analyzed in November 1997 and were found to contain TCE at a concentration of 21,000 μg/L. Resampling in January 1998 indicated that TCE concentrations in water were 5,600 μg/L (DOE 1999), which exceeds the risk-based ALs for the hypothetical industrial worker exposure scenario. In addition, soil boring and groundwater samples were obtained during the Phase II SI. Results of this sampling indicate the potential for radiological, PCB, and PAH contamination. SWMU 40 was investigated with Sector 2 of the WAG 6 RI (DOE 1999).

An Engineering Evaluation/Cost Analysis and Action Memo were prepared to support removal as part of an early action for the Soils Inactive Facilities (DOE 2008a; DOE 2008b). Because a 30-inch water line located adjacent to SWMU 40 required rerouting prior to removal and this rerouting would have interfered with USEC facility operations, a change in schedule for the C-403 Neutralization Tank (SWMU 40) was determined to be necessary during development of the Removal Action Work Plan (DOE 2009). The removal action will be implemented and coordinated with the other anticipated response actions associated with cleanup of the C-400 Complex.

2.1.2.4 Baseline risk assessment summary

Human Health Risk Assessment Summary. The direct contact risks for the SWMU 40 area (Sector 2 in the WAG 6 RI) were assessed following the procedures presented in the 1996 revision of *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant* (DOE 1996). The data evaluation for the risk assessment identified several COPCs for the data aggregates constructed. A listing of the number of COPCs identified by class is in Table 10. Of these COPCs, several were identified in only a few samples or were only slightly above screening values. A summary of the data evaluation leading to this list is in Table 11.

Table 10. Number of COPCs by Class Identified for the SWMU 40 Area

		Analyte Type		
Location	**Medium**	**Organics**	**Inorganics**	**RADs**
SWMU 40	Surface Soil	14	3	4
	Subsurface Soil	22	13	6
	RGA Groundwater*	14	23	14
	McNairy Groundwater*	12	19	17

*The results for RGA Groundwater and McNairy Groundwater are for the entire WAG 6 area.

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.7E-05	PAHs Uranium-238	88 9	Dermal contact with soil External exposure	86 10	0.4	NE	NE	NE	NE
Future industrial worker at current concentrations	1.7E-05	PAHs Uranium-238	88 9	Dermal contact with soil External exposure	86 10	0.4	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	10.6	Chromium Uranium Zinc	55 40 4	Ingestion of soil Dermal contact with soil Consumption of vegetables	1 23 76
Future adult rural resident at current concentrations	8.1E-04	PAHs PCBs Uranium-235 Uranium-238	84 5 < 1 11	Ingestion of soil Dermal contact with soil External exposure	< 1 5 93	3.0	Chromium Uranium Zinc	51 44 5	Dermal contact with soil Consumption of vegetables	16 84
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	4.7E-07	NE	NE	NE	NE	< 0.1	NE	NE	NE	NE
Future excavation worker at current concentrations	1.6E-04	Arsenic Beryllium PAHs N-nitroso-di-n-propylamine Uranium-234 Uranium-238	6 44 35 10 < 1 3	Ingestion of soil Dermal contact with soil External exposure	17 81 2	1.2	Aluminum Antimony Chromium Manganese Vanadium	10 20 14 16 28	Ingestion of soil Dermal contact with soil	11 88

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future industrial worker at	2.7E-03	Arsenic	6	Ingestion of groundwater	85	37.7	Aluminum	1	Ingestion of groundwater	82
current concentrations		Beryllium	8	Dermal contact with	8		Antimony	1	Dermal contact with	16
(RGA groundwater only		1,1-Dichloroethene	1	groundwater			Arsenic	3	groundwater	
from below the WAG 6		Carbon tetrachloride	2	Inhalation while showering	7		Chromium	< 1	Inhalation while showering	2
area)		Chloroform	< 1				Iron	34		
		N-nitroso-di-n-propylamine	< 1				Manganese	2		
		Tetrachloroethene	< 1				Nitrate	< 1		
		Trichloroethene	20				Vanadium	< 1		
		Vinyl chloride	37				Carbon tetrachloride	5		
		Americium-241	< 1				Trichloroethene	49		
		Cesium-137	< 1				*cis*-1,2-Dichloroethene	1		
		Lead-210	24							
		Neptunium-237	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Uranium-238	< 1							
Future industrial worker at	4.5E-03	Arsenic	31	Ingestion of groundwater	98	20.6	Aluminum	4	Ingestion of groundwater	94
current concentrations		Beryllium	4	Dermal contact with			Arsenic	42	Dermal contact with	6
(McNairy Formation		1,1-Dichloroethene	< 1	groundwater	1		Chromium	3	groundwater	
groundwater only from		Bromodichloromethane	< 1	Inhalation while showering	< 1		Iron	35		
below the WAG 6 area)		Chloroform	< 1				Manganese	2		
		Dibromochloromethane	< 1				Vanadium	9		
		Tetrachloroethene	< 1				Zinc	1		
		Trichloroethene	< 1				Di-N-octylphthalate	1		
		Vinyl chloride	2							
		Cesium-137	< 1							
		Lead -210	59							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Thorium-234	2							
		Uranium-235	< 1							

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (McNairy Formation groundwater only from below the WAG 6 area)	NA	NA	NA	NA	NA	224	Aluminum	4	Ingestion of groundwater	58
							Arsenic	44	Dermal contact with groundwater	2
							Barium	< 1		
							Beryllium	< 1	Consumption of vegetables	40
							Cadmium	< 1	Inhalation from household use	< 1
							Chromium	3		
							Cobalt	< 1		
							Iron	36		
							Manganese	1		
							Nickel	< 1		
							Selenium	< 1		
							Vanadium	8		
							Zinc	2		
							1,1-Dichloroethene	< 1		
							1,2-Dichloroethane	< 1		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Trichloroethene	< 1		
							cis-1,2-Dichloroethene	< 1		

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident	3.5E-02	Arsenic	33	Ingestion of groundwater	57	84.4	Aluminum	4	Ingestion of groundwater	64
at current concentrations		Beryllium	3	Dermal contact with	< 1		Arsenic	44	Dermal contact with	2
(McNairy Formation		1,1-Dichloroethene	3	groundwater			Barium	< 1	groundwater	
groundwater only from		1,2-Dichloroethane	< 1	Inhalation while showering	< 1		Cadmium	< 1	Consumption of vegetables	34
below WAG 6 area)		Bis(2-ethylhexyl)phthalate	< 1	Consumption of vegetables	40		Chromium	3		
		Bromodichloromethane	< 1				Iron	36		
		Chloroform	< 1				Manganese	1		
		Dibromochloromethane	< 1				Nickel	< 1		
		Tetrachloroethene	< 1				Selenium	< 1		
		Trichloroethene	< 1				Vanadium	8		
		Vinyl chloride	6				Zinc	2		
		Actinium-228	< 1				Di-N-octylphthalate	< 1		
		Cesium-137	< 1				Trichloroethene	< 1		
		Lead-210	43							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	10							
		Thorium-228	< 1							
		Thorium-230	< 1							
		Thorium-234	1							
		Uranium-234	< 1							
		Uranium-235	< 1							
		Uranium-238	< 1							

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	475	Aluminum	1	Ingestion of groundwater	44
							Antimony	< 1	Dermal contact with groundwater	3
							Arsenic	2		
							Barium	< 1	Consumption of vegetables	41
							Beryllium	< 1	Inhalation while showering	< 1
							Cadmium	< 1	Inhalation from household use	10
							Chromium	< 1		
							Cobalt	< 1		
							Copper	< 1		
							Iron	30		
							Manganese	1		
							Nickel	< 1		
							Nitrate	< 1		
							Silver	< 1		
							Uranium	< 1		
							Vanadium	< 1		
							Zinc	< 1		
							1,1-Dichloroethene	< 1		
							Carbon tetrachloride	14		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Toluene	< 1		
							Trichloroethene	46		
							cis-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Table 11. Summary Human Health Risk Characterization for SWMU 40 Area without Lead as a COC (Continued)

Receptor	Total ELCR*	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI*	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	6.4E-02	Arsenic	2	Ingestion of groundwater	17	169	Aluminum	2	Ingestion of groundwater	52
		Beryllium	2	Dermal contact with groundwater	< 1		Antimony	< 1	Dermal contact with groundwater	5
		1,1-Dichloroethene	1				Arsenic	2		
		Bromodichloromethane	< 1	Inhalation while showering	1		Barium	< 1	Consumption of vegetables	37
		Carbon tetrachloride	< 1	Consumption of vegetables	69		Cadmium	< 1	Inhalation while showering	< 1
		Chloroform	< 1				Chromium	< 1	Inhalation from household use	6
		N-nitroso-di-n-propylamine	< 1				Copper	< 1		
		Tetrachloroethene	< 1				Iron	32		
		Trichloroethene	12				Manganese	1		
		Vinyl chloride	30				Nickel	< 1		
		Americium-241	< 1				Nitrate	< 1		
		Cesium-137	< 1				Silver	< 1		
		Lead-210	6				Vanadium	< 1		
		Neptunium-237	< 1				Zinc	< 1		
		Technetium-99	45				Carbon tetrachloride	10		
		Thorium-228	< 1				Chloroform	< 1		
		Thorium-230	< 1				Tetrachloroethene	< 1		
		Uranium-234	< 1				Trichloroethene	48		
		Uranium-238	< 1				*cis*-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern.
*Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77, without lead included, from the WAG 6 BHHRA (DOE 1999).

The exposure assessment of the risk assessment evaluated several scenarios that encompassed both current use and several hypothetical future uses of the SWMU 40 area. These are as follows.

- Current on-site industrial—direct contact with surface soil (soil found 0−1 ft bgs).
- Future on-site industrial—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area.
- Future on-site excavation scenario—direct contact with surface and subsurface soil (soil found 1−15 ft bgs).
- Future on-site recreational user—consumption of game exposed to contaminated surface soil.
- Future off-site recreational user—direct contact with surface water impacted by contaminants migrating from sources and consumption of game exposed to this surface water.
- Future on-site rural resident—direct contact with surface soil at SWMU 40 and use of groundwater drawn from aquifers below the WAG 6 area, including consumption of vegetables that were posited to be raised in this area.
- Future off-site rural resident—use in the home of groundwater drawn from the RGA at the DOE property boundary.

The risk characterization performed for the SWMU 40 area followed the guidance in the 1996 revision of the Risk Methods Document (DOE 1996). The results of the risk characterization are shown in Table 11. Because lead was treated as a special case in the WAG 6 RI (as indicated by the title of Table 11), Table 12 presents a risk characterization for lead alone.

Table 12. Comparison of Representative Concentrations[a] of Lead at SWMU 40 against Regulatory Screening Values

Location	Representative Concentration	KDEP Screening Value	Exceed?	EPA Screening Value	Exceed?
Groundwater (μg/L)[b]					
WAG 6 RGA	32.7	4	Yes	15	Yes
WAG 6 McNairy	114	4	Yes	15	Yes
Surface Soil (mg/kg)[c]					
SWMU 40 area	x	20	x	400	x
Subsurface Soil (mg/kg)[d]					
SWMU 40 area	-	20	-	400	-

Notes: x indicates that lead was not a COPC for that location; therefore, a representative concentration is not available.
[a] As shown in Subsection 1.2.3.1 of the WAG 6 BHHRA, the representative concentration is the lesser of the maximum detected concentration and the upper 95% confidence level on the mean concentration (DOE 1999).
[b] As discussed in the WAG 6 BHHRA, groundwater was evaluated on an area basis because all locations within WAG 6 are contiguous (DOE 1999).
[c] Surface soil is soil collected from 0−1 ft bgs.
[d] Subsurface soil is soil collected from 0−16 ft bgs.

The following are significant results in the risk characterization.

- The overall cancer risk to the current and future industrial worker from exposure to soil in the SWMU 40 area exceeds the PGDP *de minimis* level (i.e., 1.0E-06) but is within EPA's generally acceptable risk range of 1.0E-04 and 1.0E-06 (ELCR = 1.7E-05). The overall HI was below the PGDP *de minimis level* (HI < 1). The COCs for cancer risk to the industrial worker are PAHs (88% of total) and uranium-238 (9% of total). The driving exposure routes for cancer risk to the industrial worker are dermal contact with soil (86% of total) and external exposure (10% of total).

- The overall cancer risk to the excavation worker from exposure to soil in the SWMU 40 area exceeds both the PGDP *de minimis* level and EPA's generally acceptable risk range (ELCR = 1.6E-04). The overall HI essentially is equal to the *de minimis* level (HI = 1.2). The primary COCs for cancer risk to the excavation worker are beryllium (44% of total), PAHs (35% of total), N-nitroso-di-n-propylamine (10% of total), and arsenic (6% of total). The driving exposure routes for cancer risk to the excavation worker are dermal contact (81% of total), ingestion (17% of total), and external exposure (2% of total).

- The overall cancer risk to the hypothetical residential groundwater user in the WAG 6 area exceeded both the PGDP *de minimis* level and EPA's generally acceptable risk range for both the RGA and McNairy Formation (6.4E-02 and 3.5E-02, respectively). The overall HIs also were greater than the *de minimis* level for water drawn from the two water sources (475 and 224, respectively, for the child resident). The primary COCs for cancer risk for water drawn from the RGA are technetium-99 (45% of total), vinyl chloride (30% of total), TCE (12% of total), and lead-210 (6% of total). The primary COCs for hazard for water drawn from the RGA are TCE (46% of total), iron (30% of total), and carbon tetrachloride (14% of total). The primary COCs for cancer risk for water drawn from the McNairy Formation are lead-210 (43% of total), arsenic (33% of total), technetium-99 (10% of total), and vinyl chloride (6% of total). The primary COCs for hazards for water drawn from the McNairy Formation are arsenic (44% of total), iron (36% of total), and vanadium (8% of total). The driving exposure routes for both cancer risk and hazard for both the water sources were ingestion of water and consumption of vegetables from irrigated gardens. Additionally, lead is a COC for both water sources.

Several uncertainties were determined to affect the risk characterization results. The effect of some important uncertainties on the risk characterization for the industrial worker is shown in Tables 13a and 13b. As shown there, the lower bound cancer risk and hazard can be shown to be less than the respective *de minimis* levels if alternative methods and parameters are used.

Table 13a. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 40—ELCR

Location	Default ELCR[a]	Site-specific ELCR[b]	Default ELCR Minus Common Laboratory Contaminants	Default ELCR Calculated using EPA Default Dermal Absorption Values[c]	Default ELCR Minus Analytes Infrequently Detected	Lower-bound ELCR[d]
SWMU 40	1.7E-05	1.1E-06	1.7E-05	3.8E-06	1.7E-05	2.4E-07

[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. (See Subsection 1.6.2.5 of the WAG 6 RI.)
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. (See Subsection 1.6.2.4 of the WAG 6 RI.)
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at SWMU 40.

Table 13b. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 40—Systemic Toxicity

Location	Default HI[a]	Default HI without Lead	Site-specific HI without Lead[b]	Default HI Minus Common Laboratory Contaminants without Lead	Default HI Calculated EPA Default Dermal Absorption Values without Lead[c]	Default HI Minus Analytes Infrequently Detected without Lead	Lower-bound HI[d]
SWMU 40	< 1	< 1	< 1	< 1	< 1	< 1	< 1

Notes: < 1 indicates that the HI is less than the *de minimis* level.
[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. (See Subsection 1.6.2.5 in the WAG 6 RI.)
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. (See Subsection 1.6.2.4 in the WAG 6 RI.)
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Ecological Risk Assessment Summary. The primary purpose of the ecological assessment was to determine whether any credible risks to ecological receptors exist in the SWMU 40 area. Because only abiotic data were available, the assessment was limited to the evaluation of this data. Additional lines of evidence (e.g., media toxicity testing and biological surveys) were not collected.

Table 14 lists the contaminants identified as COPECs for soil at SWMU 40. As shown there, chromium, uranium and zinc were COPECs for one or more receptors. Additionally, the assessment determined that each receptor considered, except the mouse and deer, had one or more COPECs.

Table 14. Summary of Chemicals[a] Posing Potential Future Risks[b] to Nonhuman Receptors at SWMU 40

		Chemicals of Potential Ecological Concern									
Location	**Receptor**	**Al**	**As**	**Cd**	**Cr**	**Fe**	**Tl**	**U**	**V**	**Zn**	**PCBs**
SWMU 40	Microbe	x	x		1.9	x		nb	x	x	nb
	Plant	x	x		19.3	nb		2.8	x	1.4	x
	Worm	nb	x		48.3	nb		nb	nb	x	nb
	Shrew	x	x		3.4	nb		x	x	x	x
	Mouse	x	x		x	nb		x	x	x	x
	Deer	x	x		x	nb		x	x	x	x

Notes: Al = aluminum; As = arsenic; Cd = cadmium; Cr = chromium; Fe = iron; Tl = thallium; U = uranium; V = vanadium; Zn = zinc
x indicates that the hazard quotient for the chemical/receptor combination did not exceed 1 or the chemical was below background in that sector.
nb indicates that no toxicological benchmark was available for the chemical/receptor combination.
Blank cells indicate that the analyte was not detected in surface soil in the sector.
[a] The table includes values for those chemicals with a maximum concentration above background (or no background available) and a hazard quotient > 1.0. Analytes for which ecological benchmarks were not available are shown in Tables 2.1 and 2.2 of Volume 3 of the WAG 6 BHHRA (DOE 1999).
[b] Values in this table are hazard quotients estimated by dividing the dose to the receptor by the benchmark dose.

2.1.2.5 Additional data needs

SWMU 40 is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

2.1.3 C-400 Technetium Storage Tank Area (SWMU 47)

2.1.3.1 Area description

The C-400 Technetium Storage Tank Area (SWMU 47) is located west of the C-400 Cleaning Building as shown in Figure 10. Prior to dismantling and disposal, the 4,000 gal tank was located on a concrete pad on the west side of the C-400 Cleaning Building.

2.1.3.2 Process history

From the early 1960s to 1986, the C-400 Technetium Storage Tank was used in the technetium recovery process to store a waste solution of chromium and technetium-99.

The technetium recovery process consisted of dissolution of technetium-bearing material, precipitation of uranium and impurities from the solution, and the recovery of the technetium via ion exchange. The tank contained extracted liquid from process operations in the C-400 Cleaning Building.

2.1.3.3 Previous investigation results

The tank was emptied of liquids (approximately 200 gal of solution) and removed in 1986, as part of RCRA-permitting activities. The remaining two inches of sludge was sampled in 1999 for RCRA constituents in order to determine if the sludge was hazardous. Total concentrations indicated that the sludge should be considered RCRA-hazardous for chromium and mercury.

Soil boring and groundwater samples were obtained during the WAG 6 RI. SWMU 47 was investigated with Sector 6 of the WAG 6 RI (DOE 1999). Results of this sampling indicate the potential for radiological, chomium, and PAH contamination.

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SWMU 47 Surface Soil (0–1 ft bgs) Data Summary (Samples Collected 1991–1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Industrial Worker		Industrial Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Arsenic	mg/kg	5.46E+00	4.52E+01	1.60E+01	9/9	3/9	1.20E+01	9/9	1.60E+00	0/9	1.60E+02	7/9	5.84E+00
METAL	Chromium	mg/kg	1.27E+01	4.58E+01	2.00E+01	9/9	6/9	1.60E+01	9/9	1.23E+01	0/9	1.23E+03	0/9	3.60E+06
METAL	Cobalt	mg/kg	3.00E+00	1.43E+01	7.39E+00	9/9	1/9	1.40E+01	0/9	6.87E+01	0/9	2.06E+03	9/9	5.43E-01
METAL	Iron	mg/kg	1.50E+04	2.49E+04	2.00E+04	9/9	0/9	2.80E+04	0/9	1.00E+05	0/9	1.00E+05	9/9	7.04E+02
PPCB	Polychlorinated biphenyl	mg/kg	7.70E-02	9.60E-01	3.86E-01	3/9	N/A	N/A	1/9	2.93E-01	0/9	2.93E+01	0/9	1.56E+00
SVOC	Phenanthrene	mg/kg	2.30E-01	7.75E+01	2.00E+01	8/9	N/A	N/A	0/9	1.38E+03	0/9	4.14E+04	4/9	1.10E+01
SVOC	Pyrene	mg/kg	2.90E-01	1.11E+02	2.44E+01	8/9	N/A	N/A	0/9	6.89E+02	0/9	2.07E+04	2/9	2.63E+01
SVOC	Total PAH	mg/kg	1.95E-03	5.41E+01	1.32E+01	8/9	N/A	N/A	5/9	6.43E-01	0/9	6.43E+01	4/9	4.70E+00
RADS	Cesium-137	pCi/g	2.00E-01	1.50E+00	5.00E-01	6/9	2/9	4.90E-01	6/9	1.08E-01	0/9	1.08E+01	0/9	9.58E+00
RADS	Neptunium-237	pCi/g	2.00E-01	3.00E+00	7.90E-01	11/11	11/11	1.00E-01	10/11	2.49E-01	0/11	2.49E+01	1/11	1.07E+00
RADS	Technetium-99	pCi/g	4.50E+00	1.40E+02	3.40E+01	11/11	11/11	2.50E+00	0/11	1.27E+03	0/11	1.00E+05	11/11	1.52E-01
RADS	Uranium-234	pCi/g	2.40E+00	3.11E+01	6.22E+00	10/10	10/10	1.20E+00	0/10	5.01E+01	0/10	5.01E+03	10/10	9.90E-01
RADS	Uranium-235	pCi/g	1.80E-01	1.90E+00	4.83E-01	7/10	7/10	6.00E-02	2/10	4.08E-01	0/10	4.08E+01	1/10	9.76E-01
RADS	Uranium-238	pCi/g	2.60E+00	3.95E+01	7.75E+00	10/10	10/10	1.20E+00	10/10	1.66E+00	0/10	1.66E+02	10/10	8.05E-01

SWMU 47 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1991–1997)

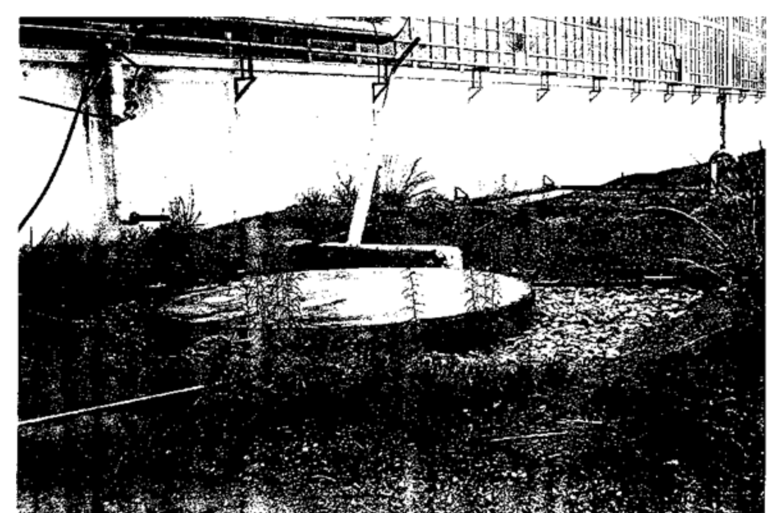
Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	6.00E-01	1.94E+01	5.40E+00	4/11	4/11	2.10E-01	1/11	1.32E+01	0/11	3.96E+02	1/11	5.42E+00
METAL	Arsenic	mg/kg	4.56E-02	8.35E+00	2.94E+00	15/15	1/15	7.90E+00	4/15	3.74E+00	0/15	3.60E+02	2/15	5.84E+00
METAL	Cadmium	mg/kg	5.00E-02	1.28E+01	3.39E+00	5/13	4/13	2.10E-01	0/13	2.53E+01	0/13	7.59E+02	1/13	7.52E+00
METAL	Chromium	mg/kg	3.30E+00	5.19E+01	1.82E+01	15/15	1/15	4.30E+01	12/15	9.14E+00	0/15	9.14E+02	0/15	3.60E+06
VOC	trans-1,2-Dichloroethene	mg/kg	2.30E+00	2.50E+00	2.40E+00	2/6	0/6	N/A	0/6	5.67E+01	0/6	1.70E+03	2/6	6.27E-01
VOC	Trichloroethene	mg/kg	9.00E-03	1.70E+00	1.15E+00	5/15	0/15	N/A	0/15	2.26E+00	0/15	6.78E+01	3/15	3.57E-02
RADS	Technetium-99	pCi/g	4.00E-01	8.20E+00	3.88E+00	5/8	2/8	2.80E+00	0/8	1.55E+03	0/8	1.00E+05	5/8	1.52E-01
RADS	Uranium-234	pCi/g	6.00E-01	4.17E+01	6.80E+00	7/7	2/7	1.20E+00	0/7	4.30E+01	0/7	4.30E+03	3/7	9.90E-01
RADS	Uranium-235	pCi/g	5.40E-02	2.20E+00	1.13E+00	2/7	1/7	6.00E-02	0/7	2.62E+00	0/7	2.62E+02	1/7	9.76E-01
RADS	Uranium-238	pCi/g	6.00E-01	4.28E+01	6.99E+00	7/7	2/7	1.20E+00	1/7	8.98E+00	0/7	8.98E+02	4/7	8.05E-01

Legend:

- (orange) One or more samples exceed background value
- (green) One or more samples exceed NAL value
- (red) One or more samples exceed AL value
- (blue) One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Map of SWMU 47 Soil Samples



Historical Depiction of SWMU 47

Figure 10. SWMU 47 Existing Data Summary (Soil)

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2.1.3.4 Baseline risk assessment summary

Human Health Risk Assessment Summary. The direct contact risks for the SWMU 47 area were assessed following the procedures presented in the 1996 revision of *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant*. The data evaluation for the risk assessment identified several COPCs for the data aggregates constructed. A listing of the number of COPCs identified by class is in Table 15. Of these COPCs, several were identified in only a few samples or were identified above screening levels. A summary of the data evaluation leading to this list is in Table 16.

Table 15. Number of COPCs by Class Identified for the SWMU 47 Area

		Analyte Type		
Location	**Medium**	**Organics**	**Inorganics**	**RADs**
SWMU 47	Surface Soil	21	9	7
	Subsurface Soil	22	11	7
	RGA Groundwater	14	23	14
	McNairy Groundwater	12	19	17

Note: The results for RGA Groundwater and McNairy Groundwater are for the entire WAG 6 area.

The exposure assessment of the risk assessment evaluated several scenarios that encompassed both current use and several hypothetical future uses of the SWMU 47 area. These are as follows.

- Current on-site industrial—direct contact with surface soil (soil found 0–1 ft bgs).
- Future on-site industrial—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area.
- Future on-site excavation scenario—direct contact with surface and subsurface soil (soil found 1–16 ft bgs).
- Future on-site recreational user—consumption of game exposed to contaminated surface soil.
- Future off-site recreational user—direct contact with surface water impacted by contaminants migrating from sources and consumption of game exposed to this surface water.
- Future on-site rural resident—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area, including consumption of vegetables that were posited to be raised in this area.
- Future off-site rural resident—use in the home of groundwater drawn from the RGA at the DOE property boundary.

The risk characterization performed for the SWMU 47 area followed the guidance in the 1996 revision of the Risk Methods Document (DOE 1996). The results of the risk characterization are shown in Table 16. Because lead was treated as a special case in the WAG 6 RI (as indicated by the title of Table 16), Table 17 presents a risk characterization for lead alone.

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.1E-03	Arsenic Beryllium PAHs PCBs Cesium-137 Neptunium-237 Uranium-238	3 9 86 < 1 < 1 < 1 < 1	Ingestion of soil Dermal contact with soil External exposure	3 95 1	1.2	Aluminum Antimony Arsenic Chromium PCBs	13 22 20 22 13	Dermal contact with soil	95
Future industrial worker at current concentrations	1.1E-03	Arsenic Beryllium PAHs PCBs Cesium-137 Neptunium-237 Uranium-238	3 9 86 < 1 < 1 < 1 < 1	Ingestion of soil Dermal contact with soil External exposure	3 95 1	1.2	Aluminum Antimony Arsenic Chromium PCBs	13 22 20 22 13	Dermal contact with soil	95
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	3.2E-03	PAHs	98	Ingestion of deer Ingestion of rabbit Ingestion of quail	9 81 10	< 0.1	NE	NE	NE	NE

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	119	Aluminum	6	Ingestion of soil	1
							Antimony	3	Dermal contact with soil	6
							Arsenic	36	Ingestion of vegetables	93
							Beryllium	< 1		
							Cadmium	1		
							Chromium	3		
							Uranium	9		
							Zinc	< 1		
							PAHs	2		
							PCBs	38		
Future adult rural resident at current concentrations	5.0E-02	Arsenic	9	Ingestion of soil	< 1	36.4	Aluminum	6	Ingestion of soil	< 1
		Beryllium	1	Dermal contact with soil	6		Antimony	3	Dermal contact with soil	4
		PAHs	88	Ingestion of vegetables	93		Arsenic	36	Ingestion of vegetables	96
		PCBs	1	External exposure	< 1		Cadmium	1		
		Cesium-137	< 1				Chromium	3		
		Neptunium-237	< 1				Uranium	10		
		Uranium-234	< 1				PAHs	2		
		Uranium-235	< 1				PCBs	38		
		Uranium-238	< 1							
Future excavation worker at current concentrations	5.5E-04	Arsenic	31	Ingestion of soil	29	2.1	Aluminum	7	Ingestion of soil	31
		Beryllium	14	Dermal contact with soil	69		Antimony	8	Dermal contact with soil	69
		PAHs	52	External exposure	2		Arsenic	50		
		PCBs	< 1				Chromium	9		
		Cesium-137	< 1				Vanadium	16		
		Neptunium-237	< 1							
		Uranium-234	< 1							
		Uranium-238	1							

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future industrial worker at	2.7E-03	Arsenic	6	Ingestion of groundwater	85	37.7	Aluminum	1	Ingestion of groundwater	82
current concentrations		Beryllium	8	Dermal contact with	8		Antimony	1	Dermal contact with	16
(RGA groundwater only		1,1-Dichloroethene	1	groundwater			Arsenic	3	groundwater	
from below the WAG 6		Carbon tetrachloride	2	Inhalation while showering	7		Chromium	< 1	Inhalation while showering	2
area)		Chloroform	< 1				Iron	34		
		N-nitroso-di-n-propylamine	< 1				Manganese	2		
		Tetrachloroethene	< 1				Nitrate	< 1		
		Trichloroethene	20				Vanadium	< 1		
		Vinyl chloride	37				Carbon tetrachloride	5		
		Americium-241	< 1				Trichloroethene	49		
		Cesium-137	< 1				*cis*-1,2-Dichloroethene	1		
		Lead-210	24							
		Neptunium-237	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Uranium-238	< 1							
Future industrial worker at	4.5E-03	Arsenic	31	Ingestion of groundwater	98	20.6	Aluminum	4	Ingestion of groundwater	94
current concentrations		Beryllium	4	Dermal contact with			Arsenic	42	Dermal contact with	6
(McNairy Formation		1,1-Dichloroethene	< 1	groundwater	1		Chromium	3	groundwater	
groundwater only from		Bromodichloromethane	< 1	Inhalation while showering	< 1		Iron	35		
below the WAG 6 area)		Chloroform	< 1				Manganese	2		
		Dibromochloromethane	< 1				Vanadium	9		
		Tetrachloroethene	< 1				Zinc	1		
		Trichloroethene	< 1				Di-N-octylphthalate	1		
		Vinyl chloride	2							
		Cesium-137	< 1							
		Lead -210	59							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	< 1							
		Thorium-228	< 1							
		Thorium-234	2							
		Uranium-235	< 1							

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (McNairy Formation groundwater only from below the WAG 6 area)	NA	NA	NA	NA	NA	224	Aluminum	4	Ingestion of groundwater	58
							Arsenic	44	Dermal contact with groundwater	2
							Barium	< 1		
							Beryllium	< 1	Consumption of vegetables	40
							Cadmium	< 1	Inhalation from household use	< 1
							Chromium	3		
							Cobalt	< 1		
							Iron	36		
							Manganese	1		
							Nickel	< 1		
							Selenium	< 1		
							Vanadium	8		
							Zinc	2		
							1,1-Dichloroethene	< 1		
							1,2-Dichloroethane	< 1		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Trichloroethene	< 1		
							cis-1,2-Dichloroethene	< 1		

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (McNairy Formation groundwater only from below WAG 6 area)	3.5E-02	Arsenic	33	Ingestion of groundwater	57	84.4	Aluminum	4	Ingestion of groundwater	64
		Beryllium	3	Dermal contact with groundwater	< 1		Arsenic	44	Dermal contact with groundwater	2
		1,1-Dichloroethene	3	Inhalation while showering	< 1		Barium	< 1	Consumption of vegetables	34
		1,2-Dichloroethane	< 1	Consumption of vegetables	40		Cadmium	< 1		
		Bis(2-ethylhexyl)phthalate	< 1				Chromium	3		
		Bromodichloromethane	< 1				Iron	36		
		Chloroform	< 1				Manganese	1		
		Dibromochloromethane	< 1				Nickel	< 1		
		Tetrachloroethene	< 1				Selenium	< 1		
		Trichloroethene	< 1				Vanadium	8		
		Vinyl chloride	6				Zinc	2		
		Actinium-228	< 1				Di-N-octylphthalate	< 1		
		Cesium-137	< 1				Trichloroethene	< 1		
		Lead-210	43							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	10							
		Thorium-228	< 1							
		Thorium-230	< 1							
		Thorium-234	1							
		Uranium-234	< 1							
		Uranium-235	< 1							
		Uranium-238	< 1							

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	475	Aluminum	1	Ingestion of groundwater	44
							Antimony	< 1	Dermal contact with groundwater	3
							Arsenic	2		
							Barium	< 1	Consumption of vegetables	41
							Beryllium	< 1	Inhalation while showering	< 1
							Cadmium	< 1	Inhalation from household use	10
							Chromium	< 1		
							Cobalt	< 1		
							Copper	< 1		
							Iron	30		
							Manganese	1		
							Nickel	< 1		
							Nitrate	< 1		
							Silver	< 1		
							Uranium	< 1		
							Vanadium	< 1		
							Zinc	< 1		
							1,1-Dichloroethene	< 1		
							Carbon tetrachloride	14		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Toluene	< 1		
							Trichloroethene	46		
							cis-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Table 16. Summary Human Health Risk Characterization for SWMU 47 Area without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident	6.4E-02	Arsenic	2	Ingestion of groundwater	17	169	Aluminum	2	Ingestion of groundwater	52
at current concentrations		Beryllium	2	Dermal contact with	< 1		Antimony	< 1	Dermal contact with	5
(RGA groundwater only)		1,1-Dichloroethene	1	groundwater			Arsenic	2	groundwater	
		Bromodichloromethane	< 1	Inhalation while showering	1		Barium	< 1	Consumption of vegetables	37
		Carbon tetrachloride	< 1	Consumption of vegetables	69		Cadmium	< 1	Inhalation while showering	< 1
		Chloroform	< 1				Chromium	< 1	Inhalation from household	6
		N-nitroso-di-n-propylamine	< 1				Copper	< 1	use	
		Tetrachloroethene	< 1				Iron	32		
		Trichloroethene	12				Manganese	1		
		Vinyl chloride	30				Nickel	< 1		
		Americium-241	< 1				Nitrate	< 1		
		Cesium-137	< 1				Silver	< 1		
		Lead-210	6				Vanadium	< 1		
		Neptunium-237	< 1				Zinc	< 1		
		Technetium-99	45				Carbon tetrachloride	10		
		Thorium-228	< 1				Chloroform	< 1		
		Thorium-230	< 1				Tetrachloroethene	< 1		
		Uranium-234	< 1				Trichloroethene	48		
		Uranium-238	< 1				*cis*-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Note:NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern.
[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77, without lead included, from the WAG 6 BHHRA (DOE 1999).

Table 17. Comparison of Representative Concentrations[a] of Lead at SWMU 47 against Regulatory Screening Values

Location	Representative Concentration	KDEP Screening Value	Exceed?	EPA Screening Value	Exceed?
Groundwater (µg/L)[b]					
WAG 6 RGA	32.7	4	Yes	15	Yes
WAG 6 McNairy	114	4	Yes	15	Yes
Surface Soil (mg/kg)[c]					
SWMU 47 Area	x	20	x	400	x
Subsurface Soil (mg/kg)[d]					
SWMU 47 Area	x	20	x	400	x

Notes: x indicates that lead was not a COPC for that location; therefore, a representative concentration is not available.
[a] As shown in Subsection 1.2.3.1 of the WAG 6 BHHRA, the representative concentration is the lesser of the maximum detected concentration and the upper 95% confidence level on the mean concentration (DOE 1999).
[b] As discussed in the WAG 6 BHHRA, groundwater was evaluated on an area basis because all locations within WAG 6 are contiguous.
[c] Surface soil is soil collected from 0−1 ft bgs (DOE 1999).
[d] Subsurface soil is soil collected from 0−16 ft bgs.

The following are significant results in the risk characterization.

- The overall cancer risk to the current and future industrial worker from exposure to soil in the SWMU 47 area exceeds the PGDP *de minimis* level (i.e., 1.0E-06) and EPA's generally acceptable risk range of 1.0E-04 and 1.0E-06 (ELCR = 1.1E-03). The overall HI was similar to the PGDP *de minimis* level of 1 (HI = 1.2). The COCs for cancer risk to the industrial worker were PAHs (86% of total) and beryllium (9% of total). The driving exposure route for cancer risk was dermal contact with soil (95% of total). The COCs for hazard to the industrial worker were antimony (22% of total), chromium (22% of total), arsenic (20% of total), aluminum (13% of total), and PCBs (13% of total). The driving exposure route for hazard was dermal contact with soil (95% of total). Lead in surface soil does not exceed screening levels.

- The overall cancer risk to the excavation worker from exposure to soil in SWMU 47 area exceeds the PGDP *de minimis* level and EPA generally acceptable risk range (ELCR = 5.5E-04). The overall hazard also exceeds the *de minimis* level (HI = 2.1). The COCs for cancer risk to the excavation worker were PAHs (52% of total), arsenic (31% of total), and beryllium (14% of total). The driving exposure routes for cancer risk were dermal contact with soil (69% of total) and ingestion of soil (29% of total). The COCs for hazard were arsenic (50% of total), vanadium (16% of total), chromium (9% of total), antimony (8% of total), and aluminum (7% of total). The driving exposure routes and their percentage of total hazard were dermal contact (69%) and ingestion (31%). Lead in subsurface soil does not exceed screening levels.

- The overall cancer risk to the hypothetical residential groundwater user in the WAG 6 area exceeded both the PGDP *de minimis* level and EPA's generally acceptable risk range for both the RGA and McNairy Formation (6.4E-02 and 3.5E-02, respectively). The overall HIs also were greater than the *de minimis* level for water drawn from the two water sources (475 and 224, respectively, for the child resident). The primary COCs for cancer risk for water drawn from the RGA are technetium-99 (45% of total), vinyl chloride (30% of total), TCE (12% of total), and lead-210 (6% of total). The primary COCs for hazard for water drawn from the RGA are TCE (46% of total), iron (30% of total), and carbon tetrachloride (14% of total). The primary COCs for cancer risk for water drawn from the

McNairy Formation are lead-210 (43% of total), arsenic (33% of total), technetium-99 (10% of total), and vinyl chloride (6% of total). The primary COCs for hazard for water drawn from the McNairy Formation are arsenic (44% of total), iron (36% of total), and vanadium (8% of total). The driving exposure routes for both cancer risk and hazard for both the water sources were ingestion of water and consumption of vegetables from irrigated gardens. Additionally, lead is a COC for both water sources.

Several uncertainties were determined to affect the risk characterization results. The effects of some important uncertainties on the risk characterization for the industrial worker are shown in Tables 18a and 18b. As shown there, the lower bound cancer risk falls within the EPA generally acceptable risk range (ELCR = 9.8E-06) and hazard can be shown to be less than its *de minimis* level if alternative methods and parameters are used.

Table 18a. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 47—ELCR

Location	Default ELCR[a]	Site-specific ELCR[b]	Default ELCR Minus Common Laboratory Contaminants	Default ELCR Calculated using EPA Default Dermal Absorption Values[c]	Default ELCR Minus Analytes Infrequently Detected	Lower-bound ELCR[d]
SWMU 47	1.1E-03	7.3E-05	1.1E-03	1.5E-04	1.1E-03	9.8E-06

[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. [See Subsection 1.6.2.5 of WAG 6 BHHRA (DOE 1999).]
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. [See Subsection 1.6.2.4 of WAG 6 BHHRA (DOE 1999).]
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Table 18b. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 47—Systemic Toxicity

Location	Default HI[a]	Default HI without Lead	Site-specific HI without Lead[b]	Default HI Minus Common Laboratory Contaminants without Lead	Default HI Calculated EPA Default Dermal Absorption Values without Lead[c]	Default HI Minus Analytes Infrequently Detected without Lead	Lower-bound HI[d]
Sector 6	1.2	1.2	< 1	1.2	< 1	1.2	< 1

< 1 indicates that the HI is less than the *de minimis* level.
[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. [See Subsection 1.6.2.5 of WAG 6 BHHRA (DOE 1999).]
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. [See Subsection 1.6.2.4 of WAG 6 BHHRA (DOE 1999).]
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Ecological Risk Assessment Summary. The primary purpose of the ecological assessment was to determine whether any credible risks to ecological receptors exist in the SWMU 47 area. Because only abiotic data were available, the assessment was limited to the evaluation of this data. Additional lines of evidence (e.g., media toxicity testing and biological surveys) were not collected.

Table 19 lists the contaminants identified as COPECs for soil at SWMU 47. As shown there, aluminum, arsenic, cadmium, chromium, uranium, and zinc were COPECs for one or more receptors. Additionally, the assessment determined that each receptor considered had one or more COPECs.

Table 19. Summary of Chemicals[a] Posing Potential Future Risks[b] to Nonhuman Receptors at SWMU 47

		Chemicals of Potential Ecological Concern									
Location	**Receptor**	**Al**	**As**	**Cd**	**Cr**	**Fe**	**Tl**	**U**	**V**	**Zn**	**PCBs**
SWMU 47	Microbe	29.5	X	X	4.6	X		nb	X	X	nb
	Plant	354.0	4.5	1.4	45.8	nb		23.8	X	1.5	X
	Worm	nb	X	X	115.0	nb		nb	nb	X	nb
	Shrew	47.2	5.0	X	2.2	nb		X	X	X	X
	Mouse	4.5	X	X	X	nb		X	X	X	X
	Deer	3.1	X	X	X	nb		X	X	X	X

Notes: Al = aluminum; As = arsenic; Cd = cadmium; Cr = chromium; Fe = iron; Tl = thallium; U = uranium; V = vanadium; Zn = zinc
X indicates that the hazard quotient for the chemical/receptor combination did not exceed 1 or the chemical was below background in that sector.
nb indicates that no toxicological benchmark was available for the chemical/receptor combination.
Blank cells indicate that the analyte was not detected in surface soil in the sector.
[a] The table includes values for those chemicals with a maximum concentration above background (or no background available) and a hazard quotient > 1.0. Analytes for which ecological benchmarks were not available are shown in Tables 2.1 and 2.2 of Volume 3 of the WAG 6 BHHRA (DOE 1999).
[b] Values in this table are hazard quotients estimated by dividing the dose to the receptor by the benchmark dose.

2.1.3.5 Additional data needs

SWMU 47 is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

2.1.4 C-400 Basement Sump (SWMU 98)

2.1.4.1 Area description

The C-400 Basement Sump (SWMU 98) is a 2-ft diameter sump located in the basement, as shown in Figure 11.

2.1.4.2 Process history

The C-400 Basement Sump was used to collect TCE spilled from the C-400 degreaser inside the basement. The sump inadvertently released TCE, along with wastewater, to the storm sewer line east of the C-400 Cleaning Building. Before discovery of the leak, it was not known that the basement sump discharged directly to the storm sewer. The sump was thought to discharge to the C-403 Neutralization Tank (SWMU 40). The leak was discovered during construction of a discharge line from the truck unloading dock containment sump to the 11th Street storm sewer line. During excavation, TCE was discovered leaking from the joints of the storm sewer line. Although the actual duration of the leak is unknown, it is believed that TCE may have been discharged to the storm sewer as early as the 1950s.

Once the leak was discovered, the discharge line from the basement sump was disconnected from the storm sewer, material from the sump was routed to 55-gal drums, and TCE-contaminated soil was excavated from the area of the leak.

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No SWMU 98 Surface Soil (0–1 ft bgs) Samples Available

SWMU 98 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1997)

			Detected Results				Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
Type	Analysis	Unit	Min	Max	Avg	FOD	FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	8.00E-01	1.40E+00	1.10E+00	2/10	2/10	2.10E-01	0/10	1.32E+01	0/10	3.96E+02	0/10	5.42E+00
METAL	Manganese	mg/kg	7.87E+00	8.28E+02	1.29E+02	10/10	1/10	8.20E+02	1/10	7.74E+02	0/10	2.32E+04	3/10	5.65E+01

Legend:

- (orange) One or more samples exceed background value
- (green) One or more samples exceed NAL value
- (red) One or more samples exceed AL value
- (blue) One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Historical Depiction of SWMU 98

Map of SWMU 98 Soil Samples

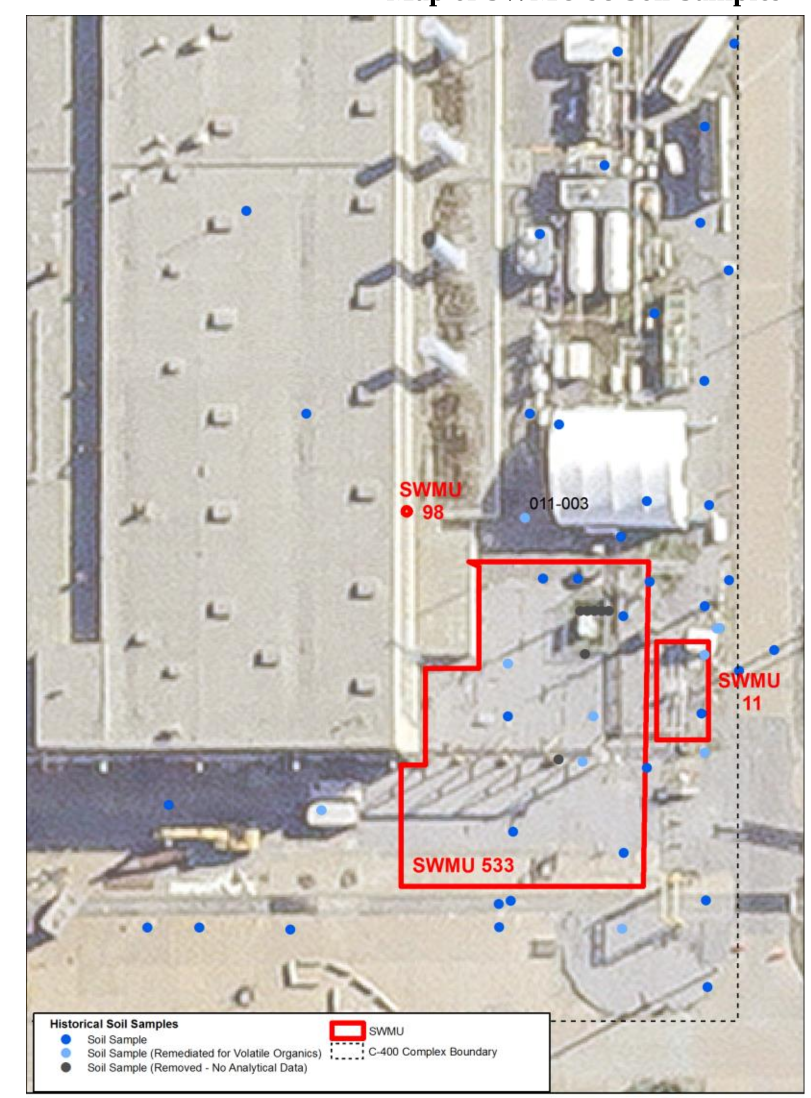

Figure 11. SWMU 98 Existing Data Summary (Soil)

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2.1.4.3 Previous investigation results

During the Phase I and Phase II SI field activities, three deep soil borings (H007, H206, and H207) were drilled near SWMU 11, near SWMU 98, and halfway between SWMU 11 and SWMU 40. These borings were installed to depths as great as 110 ft, with analytical sampling throughout the depth. The purpose was to assess the depth and lateral extent to which contamination may have migrated within the Continental Deposits and to identify which units appeared to be contributing the most contamination.

Samples from the three deep soil borings indicated the area near the building north of the leak site (H207) contained TCE up to 3,000 μg/kg and PAHs up to 640.55 μg/kg. No PAHs were found in H007 at the leak site, and the soil TCE levels (up to 220 μg/kg) were more than an order of magnitude lower than those found in H207. [Note: The TCE result of 220 μg/kg is not included in this scoping document because it is considered nonrepresentative data (i.e., collected from a remediated area).] TCE soil contamination (up to 560 μg/kg) in H206, even further north of the leak site than H207, also was at levels greater than those found in H007. These results suggested in the Phase II SI Report that (1) the primary source of TCE was closer to or in the building, (2) TCE was migrating in a free phase to the north if the bedding of the sand and clay lenses dips in that direction, or (3) most of the contamination directly attributable to the leak was removed. Over 300 ft^3 of contaminated soil was removed below the sewer when the leak was discovered.

2.1.4.4 Baseline risk assessment summary

See Section 2.1.1.4 for the baseline risk assessment summary.

2.1.4.5 Additional data needs

SWMU 98 is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional sampling is required to determine if the concentration of analytes other than TCE poses a risk, as defined in the DQOs, and to determine the nature and extent of contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

2.1.5 C-400 Discard Waste System Slab and Underlying Soils (SWMU 203)

2.1.5.1 Area description

The C-400 Discard Waste System slab and underlying soils (SWMU 203) is located northwest of the C-400 Cleaning Building, as shown in Figure 12.

2.1.5.2 Process history

The Waste Discard Sump located at the northwest corner of the building was a convergence point for effluent from the C-400 Cleaning Building (primarily from the west side). The unit is a 6-ft wide × 11-ft long × 6-ft deep concrete pit that includes a 4-ft diameter × 4-½-ft deep sump in the floor. The concrete walls of the sump are lined with acid-proof brick. Influent to the system was discharged directly into the sump, which emptied into the NSDD.

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No SWMU 203 Surface Soil (0–1 ft bgs) Samples Available

SWMU 203 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater*	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	6.00E-01	9.40E+00	2.56E+00	5/14	5/14	2.10E-01	0/14	1.32E+01	0/14	3.96E+02	1/14	5.42E+00
METAL	Arsenic	mg/kg	4.80E-01	5.29E+00	3.47E+00	14/14	0/14	7.90E+00	7/14	3.74E+00	0/14	3.60E+02	0/14	5.84E+00
METAL	Chromium	mg/kg	6.31E+00	3.29E+01	1.91E+01	14/14	0/14	4.30E+01	12/14	9.14E+00	0/14	9.14E+02	0/14	3.60E+06
METAL	Cobalt	mg/kg	1.40E+00	1.77E+01	6.84E+00	14/14	1/14	1.30E+01	2/14	9.84E+00	0/14	2.95E+02	14/14	5.43E-01
METAL	Iron	mg/kg	4.67E+03	2.72E+04	1.65E+04	14/14	0/14	2.80E+04	2/14	2.30E+04	0/14	1.00E+05	14/14	7.04E+02
METAL	Manganese	mg/kg	3.72E+01	8.87E+02	2.55E+02	14/14	1/14	8.20E+02	1/14	7.74E+02	0/14	2.32E+04	13/14	5.65E+01
METAL	Mercury	mg/kg	1.47E-02	8.30E+00	1.06E+00	8/14	1/14	1.30E-01	0/14	9.86E+00	0/14	2.96E+02	1/14	5.91E-01
SVOC	N-Nitroso-di-n-propylamine	mg/kg	5.22E-01	5.22E-01	5.22E-01	1/14	0/14	N/A	1/14	3.79E-01	0/14	3.79E+01	1/14	1.62E-04
VOC	Trichloroethene	mg/kg	4.00E-03	4.50E+00	2.25E+00	2/10	0/10	N/A	1/10	2.26E+00	0/10	6.78E+01	1/10	3.57E-02
RADS	Technetium-99	pCi/g	2.00E-01	4.33E+01	8.00E+00	6/7	2/7	2.80E+00	0/7	1.55E+03	0/7	1.00E+05	6/7	1.52E-01
RADS	Uranium-234	pCi/g	5.00E-01	7.40E+00	1.60E+00	7/7	1/7	1.20E+00	0/7	4.30E+01	0/7	4.30E+03	1/7	9.90E-01
RADS	Uranium-238	pCi/g	6.00E-01	1.48E+01	2.66E+00	7/7	1/7	1.20E+00	1/7	8.98E+00	0/7	8.98E+02	1/7	8.05E-01

Legend:

One or more samples exceed background value
One or more samples exceed NAL value
One or more samples exceed AL value
One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Historical Depiction of SWMU 203

Map of SWMU 203 Soil Samples

Figure 12. SWMU 203 Existing Data Summary (Soil)

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2.1.5.3 Previous investigation results

The WAG 6 RI found surface and subsurface soils contamination in one area associated with the Waste Discard Sump. SWMU 203 was investigated with Sector 7 of the WAG 6 RI (DOE 1999). A surface soil sample collected in the area surrounding the Waste Discard Sump contained mercury at a concentration that exceeded PGDP background level by a factor of 41. The same sample exhibited high radioactivity from technetium-99. While mercury was not detected in subsurface samples collected from approximately 15 and 32 ft bgs at this location, technetium-99 activity slightly exceeded the background value at 15 ft bgs. The WAG 6 RI concluded that both mercury and technetium-99 were probably related to surface spills and releases of C-400 Cleaning Building effluent to the Waste Discard Sump. TCE also was detected at 4,500 mg/kg at a depth of 28.5–32 ft bgs in the same boring that contained elevated metals and radioactivity. The RI report stated that the source for the TCE may have been the Waste Discard Sump, but the lack of TCE at shallow depths near the sump suggested a different source. A subsurface spill or release from the northwest corner of the C-400 Cleaning Building, which is located approximately 25 ft to the southeast, may have been the source of the TCE.

2.1.5.4 Baseline risk assessment summary

Human Health Risk Assessment Summary. The direct contact risks for the SWMU 203 area were assessed following the procedures presented in the 1996 revision of *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant* (DOE 1996). The data evaluation for the risk assessment identified several COPCs for the data aggregates constructed. A listing of the number of COPCs identified by class is in Table 20. Of these COPCs, several were identified in only a few samples or were identified above screening levels. A summary of the data evaluation leading to this list is in Table 21.

Table 20. Number of COPCs by Class Identified for the SWMU 203 Area

		Analyte Type		
Location	**Medium**	**Organics**	**Inorganics**	**RADs**
SWMU 203	Surface Soil	7	7	3
	Subsurface Soil	12	14	5
	RGA Groundwater	14	23	14
	McNairy Groundwater	12	19	17

Note: The results for RGA Groundwater and McNairy Groundwater are for the entire WAG 6 area.

The exposure assessment of the risk assessment evaluated several scenarios that encompassed both current use and several hypothetical future uses of the SWMU 203 area. These are as follows.

- Current on-site industrial—direct contact with surface soil (soil found 0–1 ft bgs).
- Future on-site industrial—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area.
- Future on-site excavation scenario—direct contact with surface and subsurface soil (soil found 1–16 ft bgs).
- Future on-site recreational user—consumption of game exposed to contaminated surface soil.
- Future off-site recreational user—direct contact with surface water impacted by contaminants migrating from sources and consumption of game exposed to this surface water.

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	1.2E-04	Beryllium PAHs Uranium-238	85 14 < 1	Dermal contact with soil	98	1.6	Antimony Chromium Iron Vanadium	6 26 36 30	Dermal contact with soil	99
Future industrial worker at current concentrations	1.2E-04	Beryllium PAHs Uranium-238	85 14 < 1	Dermal contact with soil	98	1.6	Antimony Chromium Iron Vanadium	6 26 36 30	Dermal contact with soil	99
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	< 0.1	NE	NE	NE	NE
Future adult recreational user at current concentrations	5.1E-07	NE	NE	NE	NE	< 0.1	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	53.6	Antimony Beryllium Cadmium Chromium Iron Vanadium	3 < 1 < 1 12 75 9	Ingestion of soil Dermal contact with soil Ingestion of vegetables	1 18 81
Future adult rural resident at current concentrations	1.5E-03	Beryllium PAHs Uranium-238	41 55 4	Ingestion of soil Dermal contact with soil Ingestion of vegetables External exposure	< 1 24 75 < 1	15.7	Antimony Chromium Iron Vanadium	3 10 78 8	Dermal contact with soil Ingestion of vegetables	12 88
Future excavation worker at current concentrations	1.3E-04	Arsenic Beryllium PAHs n-nitroso-di-n-propylamine PCBs Uranium-238	8 62 12 14 1 < 1	Ingestion of soil Dermal contact with soil External exposure	13 86 1	1.7	Aluminum Antimony Chromium Iron Manganese Vanadium	7 12 11 29 12 22	Ingestion of soil Dermal contact with soil	14 86

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future industrial worker at current concentrations (RGA groundwater only from below the WAG 6 area)	2.7E-03	Arsenic Beryllium 1,1-Dichloroethene Carbon tetrachloride Chloroform N-nitroso-di-n-propylamine Tetrachloroethene Trichloroethene Vinyl chloride Americium-241 Cesium-137 Lead-210 Neptunium-237 Technetium-99 Thorium-228 Uranium-238	6 8 1 2 < 1 < 1 < 1 20 37 < 1 < 1 24 < 1 < 1 < 1 < 1	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering	85 8 7	37.7	Aluminum Antimony Arsenic Chromium Iron Manganese Nitrate Vanadium Carbon tetrachloride Trichloroethene *cis*-1,2-Dichloroethene	1 1 3 < 1 34 2 < 1 < 1 5 49 1	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering	82 16 2
Future industrial worker at current concentrations (McNairy Formation groundwater only from below the WAG 6 area)	4.5E-03	Arsenic Beryllium 1,1-Dichloroethene Bromodichloromethane Chloroform Dibromochloromethane Tetrachloroethene Trichloroethene Vinyl chloride Cesium-137 Lead -210 Lead-212 Neptunium-237 Plutonium-239 Potassium-40 Technetium-99 Thorium-228 Thorium-234 Uranium-235	31 4 < 1 < 1 < 1 < 1 < 1 < 1 2 < 1 59 < 1 < 1 < 1 < 1 < 1 < 1 2 < 1	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering	98 1 < 1	20.6	Aluminum Arsenic Chromium Iron Manganese Vanadium Zinc Di-N-octylphthalate	4 42 3 35 2 9 1 1	Ingestion of groundwater Dermal contact with groundwater	94 6

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (McNairy Formation groundwater only from below the WAG 6 area)	NA	NA	NA	NA	NA	224	Aluminum	4	Ingestion of groundwater	58
							Arsenic	44	Dermal contact with groundwater	2
							Barium	< 1		
							Beryllium	< 1	Consumption of vegetables	40
							Cadmium	< 1	Inhalation from household use	< 1
							Chromium	3		
							Cobalt	< 1		
							Iron	36		
							Manganese	1		
							Nickel	< 1		
							Selenium	< 1		
							Vanadium	8		
							Zinc	2		
							1,1-Dichloroethene	< 1		
							1,2-Dichloroethane	< 1		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Trichloroethene	< 1		
							cis-1,2-Dichloroethene	< 1		

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident	3.5E-02	Arsenic	33	Ingestion of groundwater	57	84.4	Aluminum	4	Ingestion of groundwater	64
at current concentrations		Beryllium	3	Dermal contact with	< 1		Arsenic	44	Dermal contact with	2
(McNairy Formation		1,1-Dichloroethene	3	groundwater			Barium	< 1	groundwater	
groundwater only from		1,2-Dichloroethane	< 1	Inhalation while showering	< 1		Cadmium	< 1	Consumption of vegetables	34
below WAG 6 area)		Bis(2-ethylhexyl)phthalate	< 1	Consumption of vegetables	40		Chromium	3		
		Bromodichloromethane	< 1				Iron	36		
		Chloroform	< 1				Manganese	1		
		Dibromochloromethane	< 1				Nickel	< 1		
		Tetrachloroethene	< 1				Selenium	< 1		
		Trichloroethene	< 1				Vanadium	8		
		Vinyl chloride	6				Zinc	2		
		Actinium-228	< 1				Di-N-octylphthalate	< 1		
		Cesium-137	< 1				Trichloroethene	< 1		
		Lead-210	43							
		Lead-212	< 1							
		Neptunium-237	< 1							
		Plutonium-239	< 1							
		Potassium-40	< 1							
		Technetium-99	10							
		Thorium-228	< 1							
		Thorium-230	< 1							
		Thorium-234	1							
		Uranium-234	< 1							
		Uranium-235	< 1							
		Uranium-238	< 1							

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	475	Aluminum	1	Ingestion of groundwater	44
							Antimony	< 1	Dermal contact with groundwater	3
							Arsenic	2		
							Barium	< 1	Consumption of vegetables	41
							Beryllium	< 1	Inhalation while showering	< 1
							Cadmium	< 1	Inhalation from household use	10
							Chromium	< 1		
							Cobalt	< 1		
							Copper	< 1		
							Iron	30		
							Manganese	1		
							Nickel	< 1		
							Nitrate	< 1		
							Silver	< 1		
							Uranium	< 1		
							Vanadium	< 1		
							Zinc	< 1		
							1,1-Dichloroethene	< 1		
							Carbon tetrachloride	14		
							Chloroform	< 1		
							Di-N-octylphthalate	< 1		
							Tetrachloroethene	< 1		
							Toluene	< 1		
							Trichloroethene	46		
							cis-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Table 21. Summary of Human Health Risk Characterization for Sector 7 (including SWMU 203) without Lead as a COC (Continued)

Receptor	Total ELCR[a]	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI [a]	Systemic Toxicity COCs	% Total HI	Systemic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	6.4E-02	Arsenic	2	Ingestion of groundwater	17	169	Aluminum	2	Ingestion of groundwater	52
		Beryllium	2	Dermal contact with groundwater	< 1		Antimony	< 1	Dermal contact with groundwater	5
		1,1-Dichloroethene	1				Arsenic	2		
		Bromodichloromethane	< 1	Inhalation while showering	1		Barium	< 1	Consumption of vegetables	37
		Carbon tetrachloride	< 1	Consumption of vegetables	69		Cadmium	< 1	Inhalation while showering	< 1
		Chloroform	< 1				Chromium	< 1	Inhalation from household use	6
		N-nitroso-di-n-propylamine	< 1				Copper	< 1		
		Tetrachloroethene	< 1				Iron	32		
		Trichloroethene	12				Manganese	1		
		Vinyl chloride	30				Nickel	< 1		
		Americium-241	< 1				Nitrate	< 1		
		Cesium-137	< 1				Silver	< 1		
		Lead-210	6				Vanadium	< 1		
		Neptunium-237	< 1				Zinc	< 1		
		Technetium-99	45				Carbon tetrachloride	10		
		Thorium-228	< 1				Chloroform	< 1		
		Thorium-230	< 1				Tetrachloroethene	< 1		
		Uranium-234	< 1				Trichloroethene	48		
		Uranium-238	< 1				*cis*-1,2-Dichloroethene	1		
							trans-1,2-Dichloroethene	< 1		

Note: NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario not of concern.
[a] Total ELCR and total HI columns reflect values from Tables 1.68 to 1.77, without lead included, from the WAG 6 BHHRA (DOE 1999).

- Future on-site rural resident—direct contact with surface soil at and use of groundwater drawn from aquifers below the WAG 6 area, including consumption of vegetables that were posited to be raised in this area.

- Future off-site rural resident—use in the home of groundwater drawn from the RGA at the DOE property boundary.

The risk characterization performed for the SWMU 203 area followed the guidance in the 1996 revision of the Risk Methods Document (DOE 1996). The results of the risk characterization are shown in Table 21. Because lead was treated as a special case in the WAG 6 RI (as indicated by the title of Table 21), Table 22 presents a risk characterization for lead alone.

Table 22. Comparison of Representative Concentrations[a] of Lead against Regulatory Screening Values

Location	Representative Concentration	KDEP Screening Value	Exceed?	EPA Screening Value	Exceed?
Groundwater (μg/L)[b]					
WAG 6 RGA	32.7	4	Yes	15	Yes
WAG 6 McNairy	114	4	Yes	15	Yes
Surface Soil (mg/kg)[c]					
SWMU 203 area	13.0	20	No	400	No
Subsurface Soil (mg/kg)[d]					
SWMU 203 area	6.22	20	No	400	No

Notes: – indicates that lead was not a COPC for that location; therefore, a representative concentration is not available.
[a] As shown in Subsection 1.2.3.1 of the WAG 6 BHHRA, the representative concentration is the lesser of the maximum detected concentration and the upper 95% confidence level on the mean concentration (DOE 1999).
[b] As discussed elsewhere in the WAG 6 BHHRA, groundwater was evaluated on an area basis because all locations are contiguous.
[c] Surface soil is soil collected from 0–1 ft bgs (DOE 1999).
[d] Subsurface soil is soil collected from 0–16 ft bgs.

The following are significant results in the risk characterization.

- The overall cancer risk to the current and future industrial worker from exposure to soil in the SWMU 203 area exceeds the PGDP *de minimis* level (i.e., 1.0E-06) and EPA's generally acceptable risk range of 1.0E-04 and 1.0E-06 (ELCR = 1.2E-04). The overall HI was similar to the PGDP *de minimis* level of 1 (HI = 1.6). The COCs for cancer risk to the industrial worker were beryllium (85% of total) and PAHs (14% of total). The driving exposure route for cancer risk was dermal contact with soil (98% of total). The COCs for hazard to the industrial worker were iron (36% of total), vanadium (30% of total), chromium (26% of total), and antimony (6% of total). The driving exposure route for hazard was dermal contact with soil (99% of total). Lead in surface soil does not exceed screening levels.

- The overall cancer risk to the excavation worker from exposure to soil in SWMU 203 area exceeds the PGDP *de minimis* level and EPA generally acceptable risk range (ELCR = 1.3E-04). The overall hazard also exceeds the *de minimis* level (HI = 1.7). The COCs for cancer risk to the excavation worker were beryllium (62% of total), n-nitroso-di-n-propylamine (14% of total), PAHs (12% of total), and arsenic (8% of total). The driving exposure routes for cancer risk were dermal contact with soil (86% of total) and ingestion of soil (13% of total). The COCs for hazard were iron (29% of total), vanadium (22% of total), antimony (12% of total), manganese (12% of total), chromium (11% of total), and aluminum (7% of total). The driving exposure routes and their percentage of total hazard were dermal contact (86%) and ingestion (14%). Lead in subsurface soil does not exceed screening levels.

- The overall cancer risk to the hypothetical residential groundwater user in the WAG 6 area exceeded both the PGDP *de minimis* level and EPA's generally acceptable risk range for both the RGA and McNairy Formation (6.4E-02 and 3.5E-02, respectively). The overall HIs also were greater than the *de minimis* level for water drawn from the two water sources (475 and 224, respectively, for the child resident). The primary COCs for cancer risk for water drawn from the RGA are technetium-99 (45% of total), vinyl chloride (30% of total), TCE (12% of total), and lead-210 (6% of total). The primary COCs for hazard for water drawn from the RGA are TCE (46% of total), iron (30% of total), and carbon tetrachloride (14% of total). The primary COCs for cancer risk for water drawn from the McNairy Formation are lead-210 (43% of total), arsenic (33% of total), technetium-99 (10% of total), and vinyl chloride (6% of total). The primary COCs for hazard for water drawn from the McNairy Formation are arsenic (44% of total), iron (36% of total), and vanadium (8% of total). The driving exposure routes for both cancer risk and hazard for both the water sources were ingestion of water and consumption of vegetables from irrigated gardens. Additionally, lead is a COC for both water sources.

Several uncertainties were determined to affect the risk characterization results. The effects of some important uncertainties on the risk characterization for the industrial worker are shown in Tables 23a and 23b. As shown there, both the lower bound cancer risk and hazard can be shown to be less than their *de minimis* levels if alternative methods and parameters are used.

Table 23a. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 203—ELCR

Location	Default ELCR[a]	Site-specific ELCR[b]	Default ELCR Minus Common Laboratory Contaminants	Default ELCR Calculated using EPA Default Dermal Absorption Values[c]	Default ELCR Minus Analytes Infrequently Detected	Lower-bound ELCR[d]
SWMU 203 area	1.2E-04	7.9E-06	1.2E-04	5.7E-06	1.2E-04	3.7E-07

Notes: NV indicates that a value is not available because the sector encompasses the area below the C-400 Cleaning Building.
[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. (See Subsection 1.6.2.5.)
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. (See Subsection 1.6.2.4.)
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Table 23b. Quantitative Summary of Uncertainties for the Current Industrial Worker at SWMU 203—Systemic Toxicity

Location	Default HI[a]	Default HI without Lead	Site-specific HI without Lead[b]	Default HI Minus Common Laboratory Contaminants without Lead	Default HI Calculated EPA Default Dermal Absorption Values without Lead[c]	Default HI Minus Analytes Infrequently Detected without Lead	Lower-bound HI[d]
SWMU 203 area	1,890	1.6	< 1	1.6	< 1	1.6	< 1

Notes:
< 1 indicates that the HI is less than the *de minimis* level.
[a] These values were derived using the default exposure rates for the RME scenario approved by regulatory agencies.
[b] These values were derived using site-specific exposure rates for general maintenance workers at PGDP. [See Subsection 1.6.2.5 of WAG 6 BHHRA (DOE 1999).]
[c] The values were calculated using the soil dermal absorption rates suggested by EPA. [See Subsection 1.6.2.4 of WAG 6 BHHRA (DOE 1999).]
[d] These values were derived using site-specific exposure rates for general maintenance workers at PGDP and EPA default dermal absorption values and omitting contributions from common laboratory contaminants and infrequently detected analytes. The values should be used as a lower-bound estimates of risk when considering the appropriate actions to address contamination at WAG 6.

Ecological Risk Assessment Summary. The primary purpose of the ecological assessment was to determine whether any credible risks to ecological receptors exist in the SWMU 203 area. Because only abiotic data were available, the assessment was limited to the evaluation of this data. Additional lines of evidence (e.g., media toxicity testing and biological surveys) were not collected.

Table 24 lists the contaminants identified as COPECs for soil at SWMU 203. As shown there, chromium, iron, uranium, and vanadium were COPECs for one or more receptors. Additionally, the assessment determined that all receptors, except mice and deer, had one or more COPECs.

Table 24. Summary of Chemicals[a] Posing Potential Future Risks[b] to Nonhuman Receptors at SWMU 203

		Chemicals of Potential Ecological Concern									
Location	**Receptor**	**Al**	**As**	**Cd**	**Cr**	**Fe**	**Tl**	**U**	**V**	**Zn**	**PCBs**
SWMU 203 Area	Microbe	X	X	X	6.6	153.0		nb	2.1	X	
	Plant	X	X	X	66.0	nb		1.9	21.2	X	
	Worm	nb	X	X	165.0	nb		nb	nb	X	
	Shrew	X	X	X	3.6	nb		X	X	X	
	Mouse	X	X	X	X	nb		X	X	X	
	Deer	X	X	X	X	nb		X	X	X	

Notes: Al = aluminum; As = arsenic; Cd = cadmium; Cr = chromium; Fe = iron; Tl = thallium; U = uranium; V = vanadium; Zn = zinc;
X indicates that the hazard quotient for the chemical/receptor combination did not exceed 1 or the chemical was below background in that sector.
nb indicates no toxicological benchmark was available for the chemical/receptor combination.
A blank cell indicates that the analyte was not detected in surface soil in the sector.
[a] The table includes values for those chemicals with a maximum concentration above background (or no background available) and a hazard quotient > 1.0. Analytes for which ecological benchmarks were not available are shown in Tables 2.1 and 2.2 of Appendix A of the WAG 6 BHHRA (DOE 1999).
[b] Values in this table are hazard quotients estimated by dividing the dose to the receptor by the benchmark dose.

2.1.5.5 Additional data needs

The C-400 Discard Waste System slab and underlying soils is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional sampling is required to determine if the concentration of analytes other than TCE poses a risk, as defined in the DQOs, and to determine the nature and extent of contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

2.1.6 C-402 Lime House Building Slab and Underlying Soils (SWMU 480)

2.1.6.1 Area description

SWMU 480, the C-402 Lime House Building Slab and Underlying Soils, is located northeast of the C-400 Cleaning Building, as shown in Figure 13.

2.1.6.2 Process history

The facility was used to neutralize acids, produce magnesium fluoride pellets, and later as a storage facility, according to the SWMU Assessment Report. The C-402 Lime House is a 1,742 ft^2 reinforced concrete building with a ground floor and partial basement. The facility was used to supply lime slurry to the C-403 Neutralization Pit. The building also housed palletizing units and associated vent systems and was used for drummed chemical storage.

The building was radiologically contaminated, and potential asbestos-containing material also was present. In 2006, the C-402 facility structure was demolished to the first floor concrete slab (DOE 2007).

2.1.6.3 Previous investigation results

During the WAG 6 RI, three sampling sites were collected on the west and south side of the C-402 Limehouse. SWMU 480 is located within Sector 2 of the WAG 6 RI (DOE 1999). A small area of surface soil between the C-402 Building and the C-400 Cleaning Building was found to be impacted with moderate concentrations of several common PAH compounds. The extent of contamination appears to be confined both vertically and horizontally to the surface soil surrounding Boring 400-005. The source of the identified PAH contaminants is unknown, but these compounds could have been derived from any number of one-time surface releases associated with the operation of an industrial facility.

2.1.6.4 Additional data needs

SWMU 480 is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional sampling is required to determine if the concentration of analytes poses a risk, as defined in the DQOs, and to determine the nature and extent of contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

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SWMU 480 Surface Soil (0–1 ft bgs) Data Summary (Samples Collected 1990–1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Industrial Worker		Industrial Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Chromium	mg/kg	1.93E+01	1.93E+01	1.93E+01	1/1	1/1	1.60E+01	1/1	1.23E+01	0/1	1.23E+03	0/1	3.60E+06
METAL	Cobalt	mg/kg	9.76E+00	9.76E+00	9.76E+00	1/1	0/1	1.40E+01	0/1	6.87E+01	0/1	2.06E+03	1/1	5.43E-01
METAL	Iron	mg/kg	2.60E+04	2.60E+04	2.60E+04	1/1	0/1	2.80E+04	0/1	1.00E+05	0/1	1.00E+05	1/1	7.04E+02
METAL	Manganese	mg/kg	5.20E+02	5.20E+02	5.20E+02	1/1	0/1	1.50E+03	0/1	4.72E+03	0/1	1.00E+05	1/1	5.65E+01
METAL	Uranium	mg/kg	1.60E+03	2.20E+03	1.90E+03	2/2	2/2	4.90E+00	2/2	6.81E+02	2/2	2.04E+04	2/2	2.70E+02
PPCB	Polychlorinated biphenyl	mg/kg	4.30E-02	6.30E+00	2.92E+00	3/3	0/3	N/A	2/3	2.93E-01	0/3	2.93E+01	2/3	1.56E+00
RADS	Technetium-99	pCi/g	3.60E+00	3.60E+00	3.60E+00	1/1	1/1	2.50E+00	0/1	1.27E+03	0/1	1.00E+05	1/1	1.52E-01
RADS	Uranium-234	pCi/g	3.40E+00	3.40E+00	3.40E+00	1/1	1/1	1.20E+00	0/1	5.01E+01	0/1	5.01E+03	1/1	9.90E-01
RADS	Uranium-238	pCi/g	4.60E+00	4.60E+00	4.60E+00	1/1	1/1	1.20E+00	1/1	1.66E+00	0/1	1.66E+02	1/1	8.05E-01

Historical Depiction of SWMU 480

SWMU 480 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1991–1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	8.00E-01	5.50E+00	2.20E+00	4/23	4/23	2.10E-01	0/23	1.32E+01	0/23	3.96E+02	1/23	5.42E+00
METAL	Arsenic	mg/kg	9.70E-01	9.20E+00	2.97E+00	24/24	1/24	7.90E+00	7/24	3.74E+00	0/24	3.60E+02	1/24	5.84E+00
METAL	Chromium	mg/kg	5.50E+00	5.43E+01	1.92E+01	24/24	1/24	4.30E+01	20/24	9.14E+00	0/24	9.14E+02	0/24	3.60E+06
METAL	Thallium	mg/kg	6.00E-01	9.00E-01	7.60E-01	5/24	5/24	3.40E-01	5/24	3.29E-01	0/24	9.87E+00	0/24	2.85E+00
SVOC	N-Nitroso-di-n-propylamine	mg/kg	3.85E-01	6.34E-01	5.01E-01	3/24	N/A	N/A	3/24	3.79E-01	0/24	3.79E+01	3/24	1.62E-04
SVOC	Total PAH	mg/kg	4.74E+00	4.74E+00	4.74E+00	1/24	N/A	N/A	1/24	2.35E+00	0/24	1.51E+02	1/24	4.70E+00
RADS	Uranium-234	pCi/g	1.90E-02	2.00E+00	7.53E-01	6/6	1/6	1.20E+00	0/6	4.30E+01	0/6	4.30E+03	1/6	9.90E-01
RADS	Uranium-238	pCi/g	5.00E-01	2.50E+00	1.00E+00	5/6	1/6	1.20E+00	0/6	8.98E+00	0/6	8.98E+02	1/6	8.05E-01

Map of SWMU 480 Soil Samples

Legend:

- One or more samples exceed background value (orange)
- One or more samples exceed NAL value (green)
- One or more samples exceed AL value (red)
- One or more samples exceed SSL for Groundwater value (blue)

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Figure 13. SWMU 480 Existing Data Summary (Soil)

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2.1.7 TCE Spill Site from TCE Unloading Operations at C-400 (SWMU 533)

2.1.7.1 Area description

The TCE Spill Site from TCE Unloading Operations at C-400 (SWMU 533) is located southeast of the C-400 Cleaning Building, as shown in Figure 14.

2.1.7.2 Process history

The area where SWMU 533 is located was used for unloading or off-loading TCE from rail cars or tankers. SWMU 533 was composed of a concrete pad, the pumping station, and an aboveground storage tank for TCE. The off-loading pump station and associated piping were used to transfer or off-load TCE from railroad tank cars or tank trucks into an aboveground storage tank. All infrastructure associated with SWMU 533 has been removed.

2.1.7.3 Previous investigation results

Environmental sampling of soils and groundwater was completed as a part of the characterization of WAG 6 and is documented in the WAG 6 RI Report (DOE 1999). SWMU 533 is located within Sector 4 of the WAG 6 RI (DOE1999). The maximum TCE concentration, 8,208,600 μg/kg was found at a depth of approximately 30 ft bgs. The highest concentrations were found adjacent to the TCE off-loading pumps (up to 11,055,000 μg/kg). The area was addressed as part of the SPH Treatability Study. See Section 1 for additional information.

2.1.7.4 Baseline risk assessment summary

See Section 2.1.1.4 for the baseline risk assessment summary.

2.1.7.5 Additional data needs

The TCE Spill Site from TCE Unloading Operations at C-400 is included in the C-400 Complex RI/FS for further evaluation and/or remediation as a potential contributor to soil and groundwater contamination. Additional sampling is required to determine if the concentration of analytes other than TCE poses a risk, as defined in the DQOs, and to determine the nature and extent of contamination. Additional information is needed to complete the DQOs and to evaluate remedial alternatives. See Table 2 for additional information.

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SWMU 533 Surface Soil Data (0–1 ft bgs) Summary (Sample Collected 1997)

Type	Analysis	Unit	Detected Results			FOD	Background		Industrial Worker		Industrial Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Chromium	mg/kg	2.36E+01	2.36E+01	2.36E+01	1/1	1/1	1.60E+01	1/1	1.23E+01	0/1	1.23E+03	0/1	3.60E+06

SWMU 533 Subsurface Soil (> 1 ft bgs) Data Summary (Samples Collected 1990–2011)

Type	Analysis	Unit	Detected Results			FOD	Background		Excavation Worker		Excavation Worker		Protection of Groundwater	
			Min	Max	Avg		FOE	Bkgd	FOE	NAL	FOE	AL	FOE	SSL
METAL	Antimony	mg/kg	6.00E-01	7.00E+00	1.44E+00	33/116	33/116	2.10E-01	0/116	1.32E+01	0/116	3.96E+02	2/116	5.42E+00
METAL	Arsenic	mg/kg	2.70E-01	1.48E+01	3.21E+00	125/126	6/126	7.90E+00	39/126	3.74E+00	0/126	3.60E+02	15/126	5.84E+00
METAL	Chromium	mg/kg	2.77E+00	5.16E+01	1.57E+01	126/126	2/126	4.30E+01	91/126	9.14E+00	0/126	9.14E+02	0/126	3.60E+06
METAL	Cobalt	mg/kg	4.90E-01	1.96E+01	4.47E+00	125/126	3/126	1.30E+01	8/126	9.84E+00	0/126	2.95E+02	123/126	5.43E-01
METAL	Iron	mg/kg	3.45E+03	3.48E+04	1.47E+04	126/126	3/126	2.80E+04	14/126	2.30E+04	0/126	1.00E+05	126/126	7.04E+02
METAL	Manganese	mg/kg	6.21E+00	1.02E+03	1.89E+02	125/126	3/126	8.20E+02	4/126	7.74E+02	0/126	2.32E+04	71/126	5.65E+01
METAL	Thallium	mg/kg	1.80E-01	1.10E+00	5.97E-01	7/126	5/126	3.40E-01	5/126	3.29E-01	0/126	9.87E+00	0/126	2.85E+00
SVOC	N-Nitroso-di-n-propylamine	mg/kg	4.47E-01	4.47E-01	4.47E-01	1/143	N/A	N/A	1/143	3.79E-01	0/143	3.79E+01	1/143	1.62E-04
SVOC	Total PAH	mg/kg	5.56E-02	3.50E+00	7.92E-01	11/143	N/A	N/A	1/143	2.35E+00	0/143	1.51E+02	0/143	4.70E+00
VOC	cis-1,2-Dichloroethene	mg/kg	1.40E-03	2.40E+00	2.07E-01	37/97	N/A	N/A	0/97	6.58E+01	0/97	1.97E+03	4/97	4.12E-01
VOC	trans-1,2-Dichloroethene	mg/kg	1.40E+00	3.40E+01	9.49E+00	10/97	N/A	N/A	0/97	5.67E+01	0/97	1.70E+03	10/97	6.27E-01
VOC	Trichloroethene	mg/kg	1.50E-03	8.21E+03	1.47E+02	68/106	N/A	N/A	26/106	2.26E+00	3/106	6.78E+01	38/106	3.57E-02
VOC	Vinyl chloride	mg/kg	1.90E-03	1.30E-01	2.82E-02	10/107	N/A	N/A	0/107	4.72E+00	0/107	4.72E+02	3/107	1.38E-02
RADS	Cesium-137	pCi/g	2.00E-01	6.00E-01	3.13E-01	32/121	22/121	2.80E-01	1/121	5.82E-01	0/121	5.82E+01	0/121	9.58E+00
RADS	Technetium-99	pCi/g	2.00E-01	6.60E+00	7.75E-01	63/123	4/123	2.80E+00	0/123	1.55E+03	0/123	1.00E+05	63/123	1.52E-01
RADS	Uranium-234	pCi/g	2.00E-01	3.50E+00	7.49E-01	121/121	9/121	1.20E+00	0/121	4.30E+01	0/121	4.30E+03	11/121	9.90E-01
RADS	Uranium-238	pCi/g	2.00E-01	4.30E+00	7.52E-01	120/121	9/121	1.20E+00	0/121	8.98E+00	0/121	8.98E+02	18/121	8.05E-01

Legend:

- (orange) One or more samples exceed background value
- (green) One or more samples exceed NAL value
- (red) One or more samples exceed AL value
- (blue) One or more samples exceed SSL for Groundwater value

NOTE: Data were downloaded from the OREIS data base in December 2017. See Section 2.1 for additional information.
Counts of analyses are based on the maximum detected result from a sample (i.e., if a sample has analytical results from two different labs, only the maximum value is counted).
Field replicates, or separate samples are counted independently.

Historical Depiction of SWMU 533

Map of SWMU 533 Soil Samples

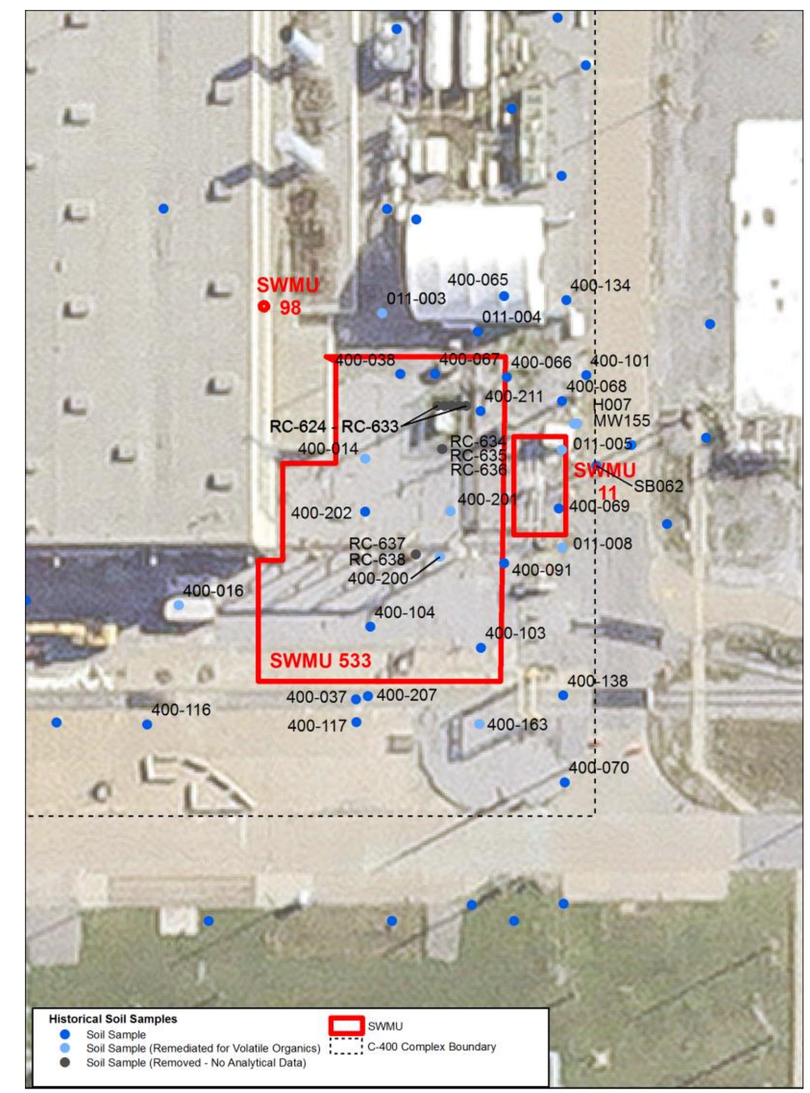

Figure 14. SWMU 533 Existing Data Summary (Soil)

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2.2 PREVIOUS INVESTIGATIONS

Historical data used in this scoping includes data from several sources as discussed in Section 2.1. Table 25 shows a summary of the major investigation data collected and documents with historical information pertinent to the C-400 Complex. Documents for each of the noted investigations are located in the DOE Environmental Information Center, accessible at www.paducaheic.com. Information is maintained in the Administrative Record for the C-400 Complex. Additionally, a website has been established as a repository for C-400 Complex RI/FS Scoping information until the D1 C-400 Complex RI/FS Work Plan is submitted for review. That website is accessible using a project-specific password at http://fourriversnuclearpartnership.com/scoping.

2.3 CONCEPTUAL MODEL OF RELEASE

The following information describes the CSM for exposure to contaminants at the C-400 Complex (see Figure 15).

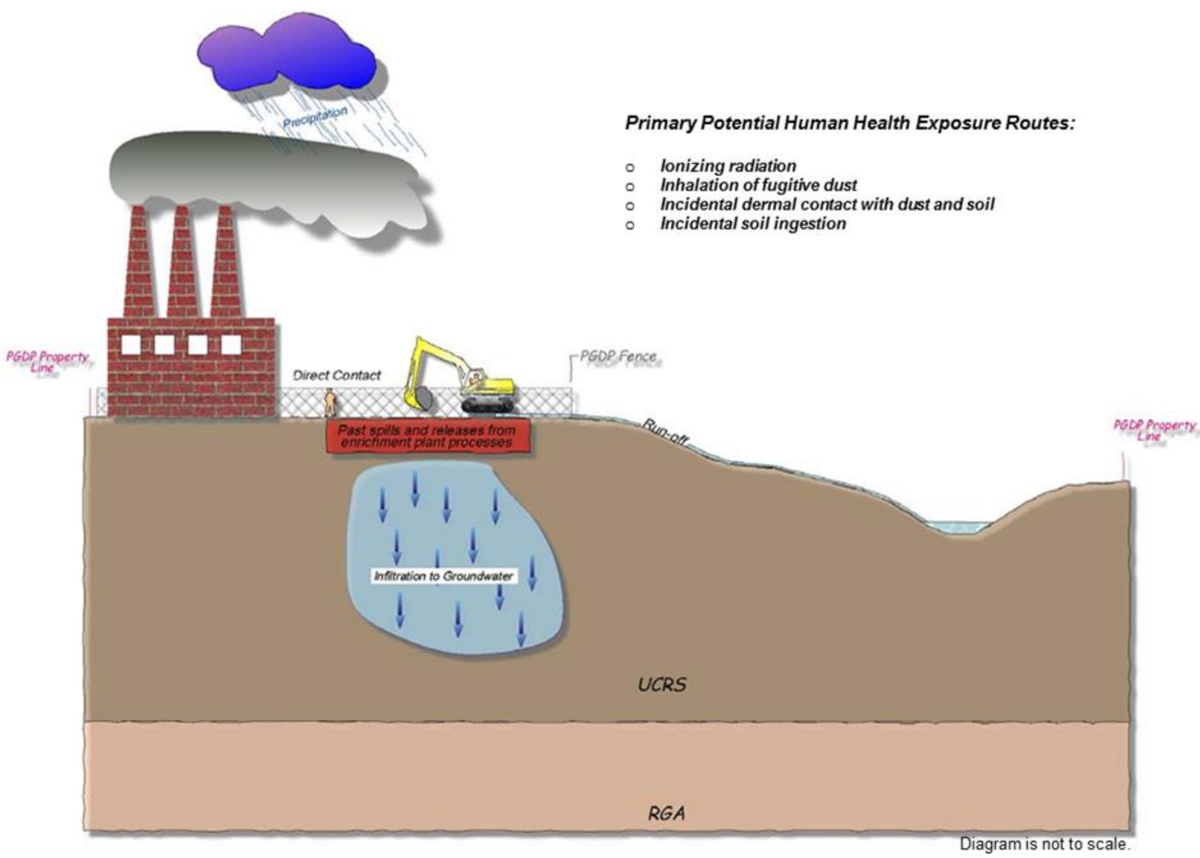

Figure 15. Industrial Worker Conceptual Site Model

Table 25. C-400 Complex Previous Investigations and Historical Information

Year	Title
1982	Final Environmental Impact Assessment (DOE 1982) http://paducaheic.com/Search.aspx?accession=LB09905-0307
1991	Results of the Site Investigation, Phase I (CH2M HILL 1991)
1992	Results of the Site Investigation, Phase II (CH2M HILL 1992)
1994	ROD for Source Control at NSDD (DOE 1994) http://paducaheic.com/Search.aspx?accession=I-01913-0009
1995	C-400 Process and Structure Review (DOE 1995b) http://paducaheic.com/Search.aspx?accession=I-00809-0045
1995	Northeast Plume Preliminary Characterization Summary Report (DOE 1995a)
1999	RI Report for WAG 6 (DOE 1999) http://paducaheic.com/Search.aspx?accession=I-00810-0050
2001	GWOU FS, DOE/OR/07-1857&D2 (DOE 2001a) http://paducaheic.com/Search.aspx?accession=I-04611-0127(Volume 1) http://paducaheic.com/Search.aspx?accession=I-04611-0128 (Volume 2) http://paducaheic.com/Search.aspx?accession=I-04611-0129 (Volume 3) http://paducaheic.com/Search.aspx?accession=I-04611-0130 (Volume 4) http://paducaheic.com/Search.aspx?accession=I-04611-0131 (Volume 5)
2001	Process Knowledge Review of Historic Discharges to the NSDD (DOE 2001c) http://paducaheic.com/Search.aspx?accession=I-04802-0055
2004	Six-Phase Final Report (DOE 2004) http://paducaheic.com/Search.aspx?accession=I-04611-0265
2005	ROD for Interim Remedial Action for the GWOU for the VOC Contamination at the C-400 Cleaning Building (DOE 2005b) http://paducaheic.com/Search.aspx?accession=I-04613-0075
2005	EE/CA for the C-402 Lime House, C-405 Incinerator, and C-746-A West End Smelter (DOE 2005c) http://paducaheic.com/Search.aspx?accession=I-05112-0045
2007	Removal Action Report C-402 Lime House (DOE 2007) http://paducaheic.com/Search.aspx?accession=env 1.A-00345
2008	C-400 Remedial Design Support Investigation (DOE 2008c) http://paducaheic.com/Search.aspx?accession=I-04615-0052
2008	EE/CA for Soils OU Inactive Facilities (includes C-403) (DOE 2008a) http://paducaheic.com/Search.aspx?accession=I-04912-0016
2011	Remedial Action Work Plan for Interim Remedial Action at C-400 (DOE 2011b)
2017	MOA on the C-400 Complex (DOE 2017a) http://paducaheic.com/Search.aspx?accession=ENV 1.A-01430
2017	C-400 Vapor Intrusion Work Plan (DOE 2017c) http://paducaheic.com/Search.aspx?accession=ENV 1.A-01428
2018	Remedial Action Completion Report for Interim Remedial Action at C-400 (DOE 2018c)
	Final Inventory/Characterization Reports for C-400 Area DMSAs C-400-06: http://paducaheic.com/Search.aspx?accession=D-18106-0003 C-400-05: http://paducaheic.com/Search.aspx?accession=D-18105-0008 and http://paducaheic.com/Search.aspx?accession=D-18105-0015 C-400-04: http://paducaheic.com/Search.aspx?accession=D-18104-0022 and http://paducaheic.com/Search.aspx?accession=D-18104-0046 C-400-03: http://paducaheic.com/Search.aspx?accession=D-18103-0001 C-400-01: http://paducaheic.com/Search.aspx?accession=D-18101-0001
	SWMU Assessment Reports SWMU 11: http://paducaheic.com/Search.aspx?accession=I-04607-0011 SWMU 40: http://paducaheic.com/Search.aspx?accession=I-04607-0013 SWMU 47: http://paducaheic.com/Search.aspx?accession=I-04607-0014 SWMU 51: http://paducaheic.com/Search.aspx?accession=ENV 1.J.1-01206 SWMU 98: currently not available online SWMU 203: http://paducaheic.com/Search.aspx?accession=I-04607-0015 SWMU 480: http://paducaheic.com/Search.aspx?accession=I-05106-0004 SWMU 533: http://paducaheic.com/Search.aspx?accession=I-04602-0117

The CSM presented in Figure 15 identifies the probable and potential contaminant migration and exposure pathways at C-400 Complex SWMUs for the industrial worker (the most likely receptor). From the source, four probable pathways are identified: (1) a probable pathway to the adjacent soils; (2) a probable pathway to groundwater due to leaching and dissolution of contaminants; (3) a probable pathway to surface water due to run-off; and (4) a probable pathway via air due to fugitive dust emissions. These are the primary pathways and will be the focus of the investigation activities.

The DQO process will be used to focus the sampling strategy on SWMU-specific media, contamination, and migration pathways. The DQO process also will be used to identify the data requirements for the baseline risk assessment and FS. The overall sampling strategy for the C-400 Complex will focus on surface soils, subsurface soils, and groundwater (UCRS, RGA, and McNairy). Sampling at these SWMUs also will investigate known or suspected release mechanisms and will define the migration routes of contaminants and the methods of migration. Of particular interest will be the determination if the SWMUs and potentially related secondary sources are contributing to contamination of the RGA.

2.4 LIKELY RESPONSE SCENARIOS

See Section 3.

2.5 NEED FOR DATA COLLECTION

To perform the screening analyses during site scoping, available data must be deemed sufficient to determine the potential contamination at a site. Therefore, data used during site scoping are from samples collected using approved, documented collection techniques and analyzed using approved, documented analytical techniques.

2.6 TYPE, QUALITY, AND QUANTITY OF DATA

Various sample collection methods will be utilized during this investigation. A combination of field measurements, and fixed-base analytical methods, will be utilized to meet the specific DQOs for the C-400 Complex. Sampling and analysis will be in accordance with SW-846 or other approved methodology.

2.6.1 Concrete Sampling

Samples will be collected from the C-400 concrete slabs when necessary. Concrete sampling will be conducted in accordance with contractor procedures.

2.6.2 Surface Radiological Screening Survey

A radiation screening walkover survey will be conducted for some surface areas using a sodium iodide detector in accordance with contractor procedures.

2.6.3 Surface Soil Sampling

Surface soil samples (0–1 ft bgs) will be collected in accordance with contractor procedures.

2.6.4 Subsurface Soil Sampling

Subsurface soil samples (> 1 ft bgs) from soil borings will be collected in accordance with contractor procedures. The specific sample equipment selected will be appropriate to the drilling technology being used.

Soil will be collected from vertical, horizontal, and/or angled soil borings wherever specified. Some vertical soil borings will be advanced with soil samples collected at discrete intervals determined by preset depths. In addition, angled soil borings may be advanced under the building slab at designated locations. Soil samples may be collected from the RGA and McNairy Formation.

Subsurface Soil

For analytical data screening within this document and for sampling, subsurface soil is considered > 1 ft bgs.

For risk assessment, subsurface soil will include 0–16 ft bgs. Deep soil will include soils > 16 ft bgs.

2.6.5 Geotechnical Sampling

Geotechnical samples may be collected from multiple discrete depths using temporary borings in accordance with contractor procedures.

2.6.6 Groundwater Sampling

Groundwater samples may be collected from multiple discrete depths within the UCRS, RGA, or McNairy Formation using temporary borings at several locations. The borings will be drilled using methods that allow collection of discrete-depth water samples with minimum vertical cross-contamination.

2.6.7 Drilling Methods

Example drilling methods suggested for use for the C-400 Complex RI include the following.

- Dual-wall reverse circulation
- Rotary sonic
- Hollow stem auger/direct push combination

2.7 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of the CERCLA and 40 *CFR* § 300.430(f)(1)(ii)(B) of the NCP require that remedial actions at CERCLA sites attain ARARs or provide grounds for invoking a CERCLA waiver. ARARs include the substantive requirements of federal or more stringent state environmental or facility siting laws/regulations. Additionally, per 40 *CFR* § 300.400(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (to be considered category). CERCLA § 121(d)(4) provides several ARAR waiver options that may be invoked, provided that human health and the environment are protected. ARARs do not include occupational safety or worker protection requirements. On-site activities must comply with the substantive, but not administrative, requirements. Administrative requirements include applying for permits, recordkeeping, consultation, and reporting. Activities conducted off-site must comply with both the substantive and administrative requirements of applicable laws.

ARARs typically are divided into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific. “Chemical-specific ARARs usually are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values” [53 *FR* 51394, 51437 (December 21, 1988)]. (In the absence of chemical-specific ARARs, cleanup criteria are based upon risk calculations.) Location-specific ARARs generally are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations [53 *FR* 51394, 51437 (December 21, 1988)]. Action-specific ARARs usually are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes or requirements to conduct certain actions to address particular circumstances at a site [53 *FR* 51394, 51437 (December 21, 1988)].

ARARs identification is an iterative process, and potential ARARs will be developed and refined throughout the RI/FS processes until they are finalized in the ROD.

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3. FEASIBILITY STUDY

The FS will consist of the following: alternatives development, alternatives screening, and the detailed analysis of alternatives. Each will be described in the work plan. Additional details for conducting the FS are found in EPA and DOE guidance (EPA 1988; DOE 1993).

According to the FFA, the FS will satisfy the requirements for a RCRA corrective measures study. DOE will rely on the FS to address National Environmental Policy Act values, as appropriate. As remedial alternatives are developed, screened, and analyzed, the presumptive response strategy contained in *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites* (EPA 1996) will be considered.

Table 26 shows the hierarchy of general remedial alternatives, technology types, and process options. Table 27 summarizes criteria for evaluation of process options.

Table 26. Relationship of Example General Remedial Alternatives, Technology Types, and Process Options

General Remedial Alternatives	Technology Types	Process Options
Soil, Sediment, and Sludge		
In Situ Treatment	Biological Treatment	Bioventing Enhanced Bioremediation Phytoremediation
	Physical/Chemical Treatment	Chemical Oxidation Electrokinetic Separation Fracturing Soil Flushing Soil Vapor Extraction Solidification/Stabilization
	Thermal Treatment	Thermal Treatment
Ex Situ Treatment	Biological Treatment (Assuming Excavation)	Biopiles Composting Landfarming Slurry Phase Biological Treatment
	Physical/Chemical Treatment (Assuming Excavation)	Chemical Extraction Chemical Reduction/Oxidation Dehalogenation Separation Soil Washing Solidification/Stabilization
	Thermal Treatment (Assuming Excavation)	Hot Gas Decontamination Incineration Open Burn/Open Detonation Pyrolysis Thermal Desorption
Containment	Containment	Landfill Cap Landfill Cap Enhancements/Alternatives
Other Treatment	Other Treatment	Excavation, Retrieval, Off-Site Disposal

Table 26. Relationship of Example General Remedial Alternatives, Technology Types, and Process Options (Continued)

General Remedial Alternatives	Technology Types	Process Options
Groundwater Sources		
In Situ Treatment	Biological Treatment	Enhanced Bioremediation Monitored Natural Attenuation Phytoremediation
	Physical/Chemical Treatment	Air Sparging Bioslurping Chemical Oxidation Directional Wells (Enhancement) Dual-Phase Extraction Thermal Treatment Hydrofracturing Enhancements In-Well Air Stripping Passive/Reactive Treatment Walls
Ex Situ Treatment	Biological Treatment	Bioreactors Constructed Wetlands
	Physical/Chemical Treatment (Assuming Pumping)	Adsorption/Absorption Advanced Oxidation Processes Air Stripping (Granulated Activated Carbon/Liquid Phase Carbon Adsorption) Groundwater Pumping/Pump-and-Treat Ion Exchange (Precipitation/Coagulation/ Flocculation) Separation Sprinkler Irrigation
Containment	Containment	Physical Barriers Deep Well Injection
Air Emissions/Off-Gas Treatment	Air Emissions/Off-Gas Treatment	Biofiltration High Energy Destruction Membrane Separation Oxidation Scrubbers Vapor Phase Carbon Adsorption

Table 27. Summary of Criteria for Evaluation of Process Options

Criteria	Summary Explanation
Effectiveness	The effectiveness evaluation, which is of primary concern, will include consideration of these factors: • The potential effectiveness in handling the estimated areas or volumes of media and in meeting the RAOs; • The potential impacts to human health and the environment during construction and implementation; and • How proven and reliable the process option is with respect to the contaminants and conditions at the site.
Implementability	The implementability evaluation will consider the technical and administrative feasibility of implementing the process option.
Cost	The cost evaluation will be limited to relative capital and operations and maintenance costs, as opposed to detailed estimates.

4. APPLICABILITY OF STREAMLINED RESPONSE ACTIONS

4.1 EARLY/LIMITED DATA COLLECTION

Preliminary data collection may be utilized to support development of the RI/FS work plan and to support any necessary early actions, as provided by Section X (Removal Actions) and Section XIV.2.B (Expediting Actions under Remedial Authority) of the FFA (EPA 1998). This early data collection may include passive soil vapor sampling, soil sampling, and concrete sampling.

4.2 REMOVALS

Throughout the RI/FS process, DOE will evaluate continuously whether risks posed by site conditions warrant the need to implement removal actions to abate, minimize, stabilize, mitigate, or eliminate the release or threat of releases of hazardous substances, pollutants or constituents, or hazardous wastes and hazardous constituents. The FFA and NCP provide for implementing the following three types of removal actions, distinguished by the nature of the risks and urgency of the situation:

- Emergency Removal Actions
- Time-Critical Removal Actions
- Non-Time-Critical Removal Actions

In selecting an appropriate type of removal action, the factors outlined in Section 300.415(b)(2) of the NCP shall be considered.

Section X.A of the FFA indicates removal actions generally shall be low-cost response actions that deal with situations requiring a short-term response. Removal activity is not intended to supplant, compromise, or foreclose removal actions, including interim remedial actions, at the site. If a long-term remedy is planned, removal actions at the site may be used to mitigate the threat to human health and the environment until the remedial actions can be implemented. Removal actions shall, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action with respect to the release concerned.

4.3 EARLY REMEDIAL ACTIONS

The need for early remedial actions will be evaluated as information is collected during the investigation activities.

Early remedial actions would be considered for response to an immediate site threat or for rapidly achieving significant risk reduction; therefore, all early remedial actions will be implemented on an expedited basis. Any early remedial actions implemented at PGDP must be consistent with the requirements of CERCLA and the NCP and will be conducted in accordance with the objectives and process outlined in Section X.IV.B of the FFA.

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CD DATA

Appendix A: C-400 Complex Maps and Data

Appendix B: Baseline Risk Assessment (GWOU FS)

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