DOE/LX/07-0030&D1
Primary Document

Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Remedial Investigation Report for the Burial Grounds Operable Unit at Paducah Gaseous Diffusion Plant Paducah, Kentucky

Date Issued—June 2008

Date Revised—September 2008

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06W05001

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ACRONYMS

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
ASB	angled soil boring
AT123D	Analytical Transient 1-,2-,3- Dimensional
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
BHHRA	baseline human health risk assessment
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
COPC	chemical of potential concern
D&D	decontamination and decommissioning
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
EDD	electronic data deliverable
ELCR	excess lifetime cancer risk
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
f_{oc}	organic content
FS	feasibility study
GC	gas chromatograph
HI	hazard index
HQ	hazard quotient
HU	hydrostratigraphic unit
K_d	soil/water distribution coefficient
KEPPC	Kentucky Environmental and Public Protection Cabinet
K_{oc}	organic partition coefficient
KPDES	Kentucky Pollutant Discharge Elimination System
KSNPC	Kentucky State Nature Preserves Commission
MCL	maximum contaminant level
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate
MW	monitoring well
NAL	no action level
NCP	National Contingency Plan
ND	not detected
NFA	no further action
NSDD	North-South Diversion Ditch
OU	operable unit
PaducahOREIS	Paducah Oak Ridge Environmental Information System
PAH	polycyclic aromatic hydrocarbon

PCB	polychlorinated biphenyl
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
pH	negative logarithm of the hydrogen-ion concentration
POC	pathway of concern
POE	point of exposure
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RI	remedial investigation
RPD	relative percent difference
SADA	Statistical Analysis and Decision Assistance
SERA	screening-level ecological risk assessment
SESOIL	Seasonal Soil Compartment Model
SI	site investigation
SMO	Sample Management Office
SMP	site management plan
SOP	standard operating procedure
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UF_6	uranium hexafluoride
USEC	United State Enrichment Corporation
VOC	volatile organic compound
WAG	Waste Area Grouping
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an active 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 Paducah Federal Facility Agreement (FFA). PGDP was placed on the National Priorities List in 1994. DOE, U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky entered into the FFA in 1998 (EPA 1998).

BURIAL GROUNDS OPERABLE UNIT SUMMARY

The Burial Grounds Operable Unit (BGOU) is one of five media-specific operable units (OUs) at PGDP being used to evaluate and implement remedial actions. DOE, EPA, and the Commonwealth of Kentucky have agreed upon five strategic cleanup initiatives as follows (from the Site Management Plan DOE 2007a):

- BGOU Strategic Initiative,
- Decontamination and Decommissioning OU Strategic Initiative,
- Groundwater OU Strategic Initiative,
- Soils OU Strategic Initiative, and
- Surface Water OU Strategic Initiative.

The scope of the BGOU Strategic Initiative includes a remedial investigation (RI), baseline risk assessment, feasibility study (FS), remedy selection, and implementation of actions, as necessary, for protection of human health and the environment.

This BGOU RI assesses contamination associated with eight solid waste management units (SWMUs) that include PGDP's landfills and burial grounds; seven (SWMUs 2, 3, 4, 5, 6, 7, and 30) are located within the main PGDP secure area, and one (SWMU 145) is located within a controlled access area to the north of the main PGDP area. The following are the potential source units addressed by the BGOU RI.

- SWMU 2 — C-749 Uranium Burial Ground
- SWMU 3 — C-404 Low-Level Radioactive Waste Burial Ground
- SWMU 4 — C-747 Contaminated Burial Yard and C-748-B Burial Area
- SWMU 5 — C-746-F Burial Yard
- SWMU 6 — C-747-B Burial Ground
- SWMUs 7 and 30 — C-747-A Burial Ground and Burn Area (which includes the area beneath SWMU 12)
- SWMU 145 — Area P (residential/inert borrow area) and old North-South Diversion Ditch disposal trench (the area for SWMU 145 includes that beneath SWMUs 9 and 10)

Subsequent to development of the BGOU RI/FS Work Plan (DOE 2006a) and concurrent with the field investigation, interviews of former plant personnel identified potential areas of buried metal within the C-746-P and C-746-P1 Scrap Yards (SWMU 13). Assessment and remedial measures, if required, for these potential burial areas fall within the scope of the BGOU Strategic Initiative. The characterization of the potential burial areas of SWMU 13 will be addressed with a Sampling and Analysis Plan addendum to the BGOU RI/FS Work Plan and follow-on field investigation. The results will be documented and assessed in the BGOU FS.

Remedial decisions for sediments within the BGOU SWMUs fall primarily within the scope of the Surface Water OU Strategic Initiative. Ditches of the northwest plant area that drain to the C-613 Sediment Basin will be addressed by the Comprehensive Site OU evaluation, after completion of the other strategic initiatives.[1]

The Groundwater OU Strategic Initiative will address dissolved-phase groundwater contamination in the Regional Gravel Aquifer (RGA) beneath the BGOU SWMUs; however, secondary sources of groundwater contamination that are derived from the BGOU burial grounds, such as the potential dense nonaqueous-phase liquid (DNAPL) source zone beneath SWMU 4, remain within the scope of the BGOU for assessment and remedial action, if required.

The BGOU RI/FS Work Plan (DOE 2006a) identified the following four primary goals for this RI and the follow-up FS:

- Goal 1. Characterize the nature of the source zone;
- Goal 2. Define the extent of the source zone and contamination in soil and other secondary sources at all units;
- Goal 3. Determine surface and subsurface transport mechanisms and pathways; and
- Goal 4. Support the evaluation of remedial technologies.

NATURE AND EXTENT OF CONTAMINATION (GOALS 1 AND 2)

Materials that were disposed of in each of the SWMUs of the BGOU contained hazardous substances. The conceptual model applicable to all of the BGOU SWMUs is that releases from these SWMUs have impacted soils below or adjacent to the source zones and, through vertical infiltration in the soil, have the potential to contaminate the groundwater underlying these sources. Analysis of soil and groundwater from the area of each SWMU documents the presence of metals, organic compounds, and radionuclides above screening levels. Soil and groundwater sampling results are compared with screening levels to identify the list of potential contaminants to be evaluated for the purposes of determining nature and extent of contamination. Section 4 summarizes the characterization of the area of these SWMUs as part of the BGOU RI and previous efforts.

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[1] The BGOU RI risk assessment includes the available surface soils and sediments analyses for samples from within the BGOU SWMUs to complete evaluation of the exposure scenarios specified in the Work Plan (residential, industrial, and recreational).

Metals and radionuclides are the only analytes in subsurface soils (soils deeper than 1 ft) frequently detected[2] above screening criteria[3] used to identify contaminants for the assessment of nature and extent. As shown in Table ES.1, iron and manganese are the most prevalent of the frequently detected contaminants in subsurface soils, detected in more than 50% of samples in six of the eight BGOU SWMUs.

Table ES.1. Subsurface Soil Analytes Frequently Detected above Screening Levels

Source Area	Metals	Organic Compounds	Radionuclides
SWMU 2	Arsenic, Iron, Manganese, Vanadium	--	--
SWMU 3	Arsenic	--	--
SWMU 4	Iron, Manganese, Vanadium	--	^{230}Th, U, ^{234}U, ^{238}U
SWMU 5	Iron, Manganese, Vanadium	--	--
SWMU 6	Iron, Manganese, Vanadium	--	--
SWMU 7	Arsenic, Iron, Manganese	--	$^{235/236}$U
SWMU 30	Iron, Manganese, Vanadium	--	$^{235/236}$U
SWMU 145	Arsenic	--	^{228}Th

-- = none U = uranium

^{228}Th = thorium-228 ^{234}U = uranium-234

^{230}Th = thorium-230 $^{233/236}$U = uranium-235/236

Metals are the most common of the frequently detected contaminants in both Upper Continental Recharge System (UCRS) and RGA groundwater samples.[4] Iron and manganese are commonly present above screening levels and are the predominant contaminants in the UCRS (Table ES.2). Iron is less prevalent in the RGA (Table ES.3).

Principal threat wastes are defined by EPA as “source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.” No threshold level for risk has been established to indicate a principal threat waste; however, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, EPA recommends that treatment alternatives be evaluated (EPA 1991).

The BGOU SWMUs contain two Principal Threat Wastes: TCE DNAPL and uranium wastes at SWMUs 2 and 3. Dissolved contaminant trends in the RGA indicate that SWMU 4 and the adjoining areas of SWMUs 7 and 30 contain trichloroethene (TCE) sources as DNAPL. The mobility and toxicity of DNAPLs make them Principal Threat Waste. Additionally, adsorbed TCE is present in subsurface soil at SWMU 2 at levels that present significant potential risk and will require evaluation of a treatment alternative.

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[2] In this section, “frequently detected” for subsurface soils means detected in 50% or more of the samples at levels above either PGDP background or risk-based excavation worker no action levels, where applicable. For groundwater, “frequently detected” means detected in 50% or more of the samples at levels above all screening criteria.

[3] Screening criteria for subsurface soils for the assessment of nature and extent were PGDP background levels and risk-based excavation worker no action levels. The identification of COPCs for groundwater fate and transport modeling screened the subsurface soils against PGDP-specific Soil Screening Levels.

[4] The screening criteria for UCRS groundwater are maximum contaminant levels (MCLs) and risk-based child resident no action levels. RGA screening criteria include PGDP background levels in addition to MCLs and risk-based child resident no action levels.

The uranium wastes at SWMUs 2 and 3 present potential significant risk that will persist for thousands of years. Remedial actions for large volumes of radioactive wastes, as at SWMUs 2 and 3, are uniquely challenging. The contained uranium constitutes principal threat wastes.

Table ES.2. UCRS Groundwater Analytes Frequently Detected above Screening Level

Source Area	Metals	Organic Compounds	Radionuclides
SWMU 2	Beryllium, Iron, Manganese, Uranium, Vanadium	1,1-DCE; TCE	^{234}U, ^{238}U
SWMU 3	Arsenic, Iron, Manganese	TCE	^{99}Tc, ^{234}U
SWMU 4	Arsenic, Iron, Lead, Manganese	*cis*-1,2-DCE; TCE	^{99}Tc
SWMU 5	Arsenic, Iron, Lead, Manganese, Molybdenum	--	--
SWMU 6	Arsenic, Iron, Lead, Manganese, Molybdenum, Uranium	--	^{99}Tc, ^{234}U, ^{238}U
SWMU 7	Arsenic, Iron, Lead, Manganese, Molybdenum, Nickel	TCE; Vinyl chloride	^{222}Rn, ^{234}U, ^{238}U
SWMU 30	Arsenic, Iron, Lead, Manganese, Molybdenum, Nickel, Uranium, Vanadium	--	^{234}U, ^{238}U
SWMU 145	Iron, Manganese	--	^{222}Rn, ^{238}U

-- = none

DCE = dichloroethene
^{222}Rn = radon-222
TCE = trichloroethene
^{234}U = uranium-234
^{238}U = uranium-238

Table ES.3. RGA Groundwater Analytes Frequently Detected above Screening Level

Source Area	Metals	Organic Compounds	Radionuclides
SWMU 2	Arsenic, Beryllium, Iron, Manganese, Vanadium	1,1-DCE; TCE	^{234}U, ^{238}U
SWMU 3	Manganese	TCE	--
SWMU 4	Arsenic, Manganese, Iron, Lead	1,1-DCE; Carbon Tetrachloride; Chloroform; *cis*-1,2-DCE; TCE; Vinyl Chloride	--
SWMU 5	Iron, Lead, Manganese	--	--
SWMU 6	Lead, Manganese	TCE	--
SWMU 7	Arsenic, Iron, Manganese	TCE	--
SWMU 30	Manganese	TCE	--
SWMU 145	--	--	--

-- = none

DCE = dichloroethene
TCE = trichloroethene

FATE AND TRANSPORT (GOAL 3)

Modeling assessed fate and transport of contaminants for two pathways: (1) dissolved-phase transport through the aquifer and (2) vapor transport to a residential basement.[5] Section 5 and Appendix E document the fate and transport modeling applied to the BGOU RI.

Previous work has shown that the primary pathway for groundwater flow and the site-related contaminants is vertical migration through the UCRS, followed by lateral migration in the RGA. Contaminated groundwater could migrate to the points of exposure (POEs). The PGDP Risk Methods Document (DOE 2001a) identifies the potential POEs for the BGOU SWMUs as the plant boundary, the DOE property boundary, surface seeps at Little Bayou Creek, and near the Ohio River (Figure ES.1). Additionally, the BGOU RI includes a comprehensive evaluation of on-site risk at the SWMU that supports assessment of a SWMU boundary POE (see Table ES.4 for analytes predicted to exceed maximum contaminant limits at POEs). Not all SWMUs have transport pathways to all of the POEs. For example, SWMU 145 is located outside of the plant boundary and does not contribute to the Little Bayou seeps. SWMUs 3, 6, 7, and 30 were determined to be the only SWMUs with groundwater flow paths to the Little Bayou seeps POE.

Table ES.4. Analytes Predicted to Exceed Maximum Contaminant Limits at the Points of Exposure

Source Area	Contaminant	SWMU	Plant Boundary	Property Boundary	Little Bayou seeps	Ohio River
SWMU 2	Arsenic	**Yes**[a]	No[b]	No	N/A[c]	No
	cis-1,2-DCE	**Yes**	**Yes**	**Yes**	N/A	**Yes**
	TCE	**Yes**	**Yes**	**Yes**	N/A	**Yes**
SWMU 3	Arsenic	**Yes**	No	No	No	N/A
	^{99}Tc	**Yes**	**Yes**	**Yes**	No	N/A
	Uranium	**Yes**	No	No	No	N/A
SWMU 4	Arsenic	**Yes**	No	No	N/A	No
	cis-1,2-DCE	**Yes**	**Yes**	**Yes**	N/A	No
	^{99}Tc	**Yes**	**Yes**	**Yes**	N/A	No
	TCE	**Yes**	**Yes**	**Yes**	N/A	No
	Vinyl Chloride	**Yes**	**Yes**	**Yes**	N/A	No
SWMU 5	None					
SWMU 6	None					
SWMU 7	1,1-DCE	**Yes**	**Yes**	No	No	N/A
	Arsenic	**Yes**	**Yes**	No	No	N/A
	^{99}Tc	**Yes**	No	No	No	N/A
	TCE	**Yes**	**Yes**	No	No	N/A
	Vinyl Chloride	**Yes**	**Yes**	No	No	N/A
SWMU 30	Arsenic	**Yes**	**Yes**	No	No	N/A
	TCE	**Yes**	**Yes**	**Yes**	**Yes**	N/A
SWMU 145	Antimony	**Yes**	N/A	No	N/A	No
	Arsenic	**Yes**	N/A	No	N/A	No
	^{99}Tc	**Yes**	N/A	**Yes**	N/A	**Yes**

[a] Yes = The modeled analyte concentration exceeds its maximum contaminant level
[b] No = The modeled analyte concentration does not exceed its maximum contaminant
[c] N/A = Not applicable: the POE does not apply to the SWMU.

DCE = dichloroethene
^{99}Tc = technetium-99

[5] Assessment of surface water runoff and sediments is principally the scope of the Surface Water OU.

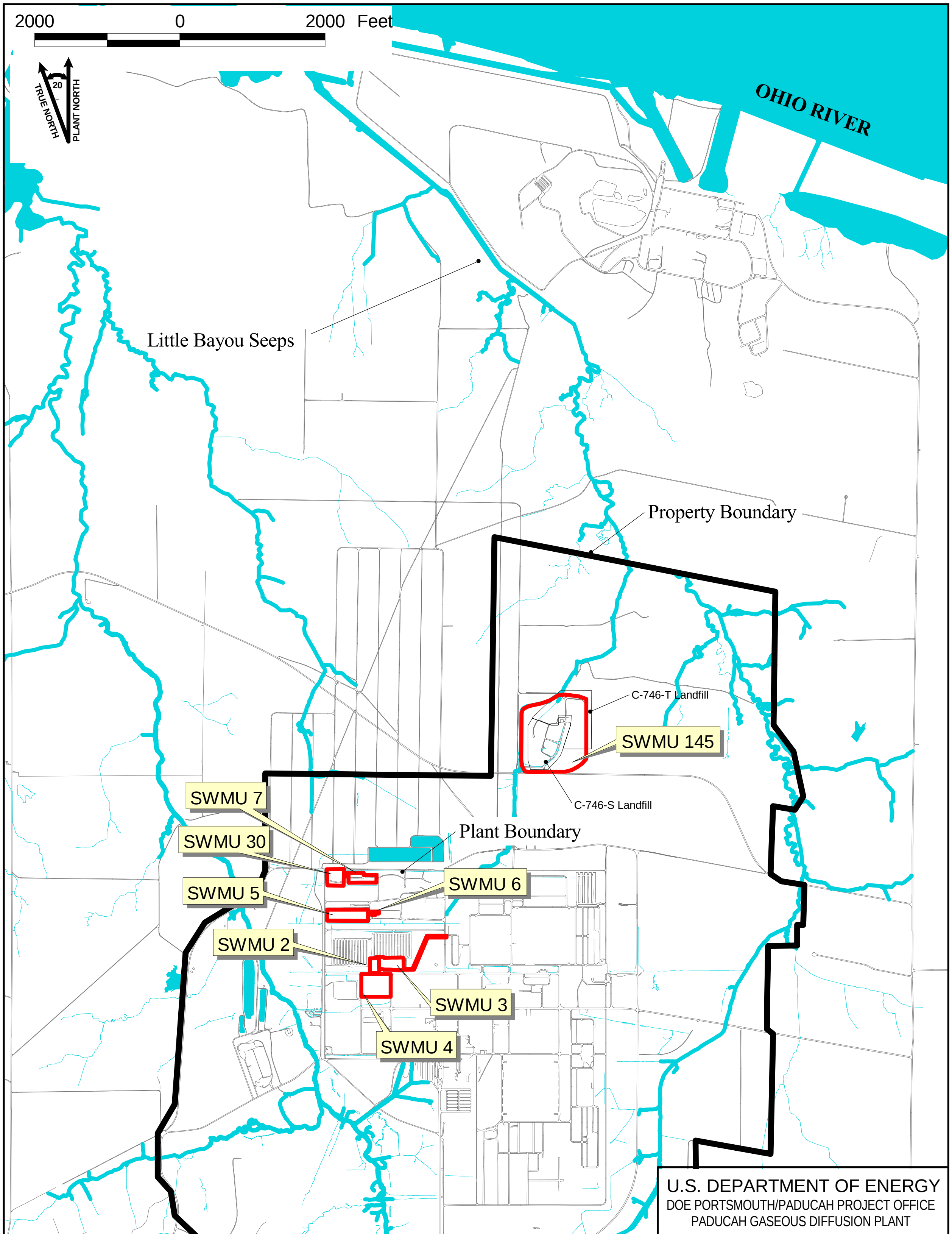

Figure ES.1. Location of BGOU SWMUs and Potential POEs

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A Portage Shaw Joint Venture Company

Figure No. \BGOU\RI.apr
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Vapor transport modeling assessed contaminant concentrations in a hypothetical residential basement at the SWMU and in hypothetical residential basements at the plant boundary and property boundary POEs (Table ES.5).

Table ES.5. Analytes with Basement Air Concentrations of Concern Based on Vapor Transport Modeling Results at the Points of Exposure

Source Area	Contaminant	SWMU Boundary	Plant Boundary	Property Boundary
SWMU 2	TCE	**Yes**[a]	**Yes**	**Yes**
	cis-1,2-DCE	**Yes**	No[b]	No
SWMU 3	TCE	**Yes**	No	No
	Mercury	**Yes**	No	No
SWMU 4	TCE	**Yes**	**Yes**	**Yes**
	Vinyl Chloride	**Yes**	**Yes**	No
	cis-1,2-DCE	**Yes**	No	No
SWMU 5			None	
SWMU 6			None	
SWMU 7	TCE	**Yes**	No	No
	Vinyl Chloride	**Yes**	No	No
	1,1-DCE	**Yes**	**Yes**	No
	Mercury	**Yes**	No	No
SWMU 30	TCE	**Yes**	**Yes**	**Yes**
	1,1-DCE	**Yes**	**Yes**	No
	Mercury	**Yes**	No	No
SWMU 145	Mercury	**Yes**	No	No

DCE = dichloroethene
[a] Yes = Modeled air concentration equals or exceeds 1.0E-06 excess lifetime cancer risk (ELCR) or 0.1 hazard quotient (HQ)
[b] No = Modeled air concentration is less than 1.0E-06 ELCR or 0.1 HQ

RISK ASSESSMENT (GOAL 4)

PGDP is an industrial facility. Land use is expected to remain industrial. The future on-site rural resident is not a likely land-use scenario. Additionally, DOE's excavation-penetration permit process and on-site groundwater use prohibition provide administrative controls that prevent or control some exposure scenarios that are assessed for the current on-site industrial use scenario and future on-site excavation scenario. These factors should be considered in examination of risk information provided in this report.

The risk for the on-site resident for soil exceeds 1E-04 and the hazard index (HI) is greater than 1 at all SWMUs except for SWMU 3 (for which the risk was between 1E-06 and 1E-04) and SWMU 145 (which was not evaluated for soil exposure). The contaminants that are risk drivers for soil are Total Uranium, antimony, arsenic, iron, Total PAHs, uranium-235, cesium-137, and uranium-238.

Residential use of groundwater was evaluated at the SWMU boundary, plant boundary, property boundary, and Ohio River (or seeps) for all SWMUs except SWMU 6. At the SWMU boundary, risks and hazards from groundwater use for all evaluated SWMUs exceeded 1E-04 risk and exceeded an HI of 1. The major contaminants driving the groundwater risks and hazards at these on-site points of exposure are arsenic, antimony (at SWMU 145), naphthalene (at SWMU 5), manganese, uranium, TCE, Total PCBs (at SWMU 7), *cis*-1,2-DCE, vinyl chloride, and 1,1-DCE, and ^{99}Tc. At the plant boundary, risks and hazards from groundwater for SWMUs 2, 3, 4, 5, 7, and 30 exceeded 1E-04 risk or exceeded an HI of

1. At the property boundary, risks and hazards from groundwater for SWMUs 2, 4, 7, 30, and 145 exceeded 1E-04 risk or exceeded an HI of 1. At the Ohio River (or seeps), risks and hazards from groundwater for SWMUs 2, 4, 7, and 30 exceeded 1E-04 risk or exceeded an HI of 1. The major contaminants driving the groundwater risks and hazards at these off-site points of exposure are arsenic, Total PCBs (at SWMU 7), TCE, *cis*-1,2-DCE, 1,1-DCE, and ^{99}Tc.

As mentioned, the on-site residential scenario discussed here is not a realistic future use for these sites. For exposure to soil of at least one of the other on-site receptor scenarios (industrial worker, excavation worker, or recreational user), all SWMUs have an excess lifetime cancer risk (ELCR) ≥ 1.0E-06. For at least one of these scenarios, SWMUs 2, 5, 6, 7, and 30 have HIs > 1. Recreational users had risks exceeding 1E-04 and/or HIs greater than 1 at all SWMUs (except SWMU 3 and SWMU 145), with the majority of the risk coming from uranium and PAHs. Risk and hazard for the recreational receptor are driven primarily by the game ingestion pathway, which is not a realistic scenario for cleanup decisions because it is based on very high exposures of game animals and transfer factors from the site soil to game. Soil exposures of workers are more relevant to the potential future uses of the site.

For the excavation worker who is exposed to both surface soil and subsurface soil, HIs were greater than one at SWMUs 2, 5, 7, and 30. Risks for the excavation worker exceeded 1E-04 at SWMUs 2, 4, 5, 7, 30, and 145. The risk drivers for the excavation worker scenario were antimony (at SWMU 145), arsenic, iron, PAHs, Total PCBs, cesium-137, uranium-235, uranium-238, and uranium.

The most likely future scenario is the industrial worker. The ELCR for the scenario exceeded 1E-04 at SWMUs 2, 5, 7, and 30 primarily due to risk from cesium-137 (SWMU 2 only), PAHs, Total PCBs (at SWMU 7), thorium-228 (at SWMU 7), and uranium-238. The HI exceeds 1 for the industrial worker at SWMUs 2 and 30; arsenic and uranium are the hazard drivers. Risks for the current worker (at 16 days per year of exposure) were much less than those for the future industrial worker; risks for the current worker exceeded 1E-04 only at SWMU 5.

The risk drivers for groundwater use and on-site workers reflect the most likely future uses at and near the site and are the ones that need to be addressed in the FS.

Table ES.6. Exposure Pathways and Contaminants of Concern Associated with Dominant Risk for Each SWMU for Exposure to Subsurface Soil and Groundwater

Source Area	HI	ELCR
SWMU 2	– Ingestion of groundwater and household inhalation of vapors(TCE; *cis*-1,2-DCE) – Ingestion of subsurface soil (uranium)	– Household inhalation of vapors (TCE) – Ingestion of groundwater (TCE) – Ingestion and external exposure to subsurface soil (^{137}Cs, ^{238}U)
SWMU 3	– Ingestion of groundwater (arsenic, uranium)	– Ingestion of groundwater (arsenic, ^{99}Tc) – External exposure to subsurface soil (^{238}U)
SWMU 4	– Ingestion of groundwater (TCE)	– Household inhalation of vapors and dermal exposure (TCE, vinyl chloride) – External exposure to subsurface soil(^{137}Cs)
SWMU 5	– Ingestion of RGA groundwater (arsenic, naphthalene) – Ingestion of subsurface soil (uranium)	– Ingestion of RGA groundwater (arsenic)
SWMU 6	– Ingestion of subsurface soil (uranium)	– Dermal exposure to subsurface soil (PAHs)
SWMU 7	– Ingestion of RGA groundwater (TCE, arsenic, PCB-1254) – Ingestion of subsurface soil (uranium)	– Household inhalation of vapors and ingestion of RGA groundwater (1,1-DCE) – Dermal exposure and ingestion of subsurface soil (PAHs, PCBs, ^{238}U)
SWMU 30	– Ingestion of RGA groundwater (TCE) – Ingestion of subsurface soil (uranium)	– Household inhalation of vapors (TCE) – Dermal exposure and ingestion of subsurface soil (PAHs, PCBs, ^{238}U)
SWMU 145	– Ingestion of RGA groundwater (antimony, arsenic)	– Ingestion of RGA groundwater (arsenic) – Dermal exposure and ingestion of subsurface soil (arsenic, PAHs, PCBs, ^{238}U)

^{99}Tc = technetium-99

The BGOU RI includes a Screening-Level Ecological Risk Assessment (SERA) for SWMUs 2, 3, 4, 5, 6, 7, and 30. (SWMU 145 is located beneath the C-746-S and -T Landfills and has a negligible amount of surface soil.) Comparison of site characterization data against No Further Action screening levels determined that all of the SWMUs have metals and organic compounds (in surface soil) that are chemicals of potential concern (COPCs) for risk to the environment, while only SWMU 7 has a radionuclide COPC (in surface soil).

CONCLUSIONS

The following are the major contaminant distribution findings for sources investigated in the BGOU RI.

- Environmental media, specifically subsurface soil and groundwater, have been impacted by releases of contaminants at all of the BGOU SWMUs.

- TCE trends in the RGA indicate that TCE DNAPL is present at SWMU 4 and in the vicinity of the shared border between SWMUs 7 and 30. (See Section 3.9.4.) Concentrations of TCE at SWMU 4 suggest that TCE DNAPL may be present both in the waste cells and underlying soils of the UCRS and in the matrix of the RGA. TCE trends at SWMUs 7 and 30 indicate that the TCE DNAPL source is likely constrained to the UCRS soils.

- The Baseline Human Health Risk Assessment completed as part of the BGOU RI indicates that excess upper-bound lifetime risk from exposure to contaminated media exists and that response actions may be appropriate for impacted media at each of the sites. For on-site receptor scenarios with soil exposure, all SWMUs have excess upper-bound lifetime risks for hazard (HI $\geq$ 1) and cancer (ELCR $\geq$ 1.0E-06) from some contaminants. All but SWMU 3 have an ELCR $\geq$ 1.0E-04. The metals arsenic and uranium, the organic compounds TCE, PAHs, and PCBs, and the radionuclides ^{238}U and ^{137}Cs are common contaminants that present the dominant risks.

- For on-site groundwater use, all evaluated SWMUs exceeded 1E-04 risk and/or exceeded an HI of 1. The major contaminants driving the groundwater risks at these on-site points of exposure are arsenic, uranium, ^{99}Tc, TCE, *cis*-1,2-DCE, and 1,1-DCE.

- For off-site groundwater use scenarios, SWMUs 2, 4, 7, and 30 have a cumulative HI $\geq$1 and/or ELCR $\geq$ 1.0E-04. (SWMU 145 also has ELCR $\geq$ 1.0E-04.) SWMUs 3 and 5 have ELCR $\geq$ 1.0E-06. The organic compound TCE is a major risk driver.

- The SERA retained a number of COPCs at each of the sites. Each SWMU requires further ecological evaluation.

The BGOU RI/FS Work Plan developed decision rules for the BGOU Strategic Initiative. Table ES.7 presents the decision rules (DOE 2006a).

The risk levels associated with contamination at all of the SWMUs and associated with groundwater contamination derived from all of the SWMUs meet the criteria of the decision rules to progress to evaluate actions that will mitigate risk and to achieve applicable or relevant and appropriate requirements (ARARs); to seek an ARAR waiver in accordance with EPA guidance; or to propose alternative standards. The following are the BGOU remedial action objectives:

- Contribute to protection of current and future residential receptors from exposure to contaminated groundwater by reducing/controlling sources of groundwater contamination;

- Protect industrial workers from exposure to waste and contaminated soils; and

- Treat or remove principal threat wastes wherever practicable, consistent with 40 *CFR* § 300.430 (a)(iii)(A).

A follow-on FS will develop and evaluate remedial action alternatives for the BGOU.

Table ES.7. Decision Rules for the BGOU Strategic Initiative

GOAL	DECISION RULE		
		***If* statement**	***Then* statement**
Nature of Contamination	1a	If the concentration of analytes found in the source zone could result in a cumulative ELCR greater than 1×10^{-6} or a cumulative HI greater than 1 through contact with contaminated media, **or** if the concentration of analytes in the source zone could result in detrimental impacts to nonhuman receptors through contact with contaminated media as indicated by exceeding ecological screening criteria, **and** if the concentrations of analytes in the source zone are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise pursue a "no further action" decision (see D1b and D1c)
	1b	If concentrations of analytes found in the source zone exceed ARARs,	then evaluate actions that will bring contamination within the source zone into compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards
	1c	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 ARARs, **and** if the concentrations of these contaminants could result in risks greater than those defined in D1a or concentrations greater than ARARs,	then evaluate actions that will mitigate potential future risk or obtain compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards
Extent of Contamination	2a	If secondary contamination sources are found, **and** if the concentration of analytes within the secondary contamination source is found to potentially result in a cumulative ELCR greater than 1×10^{-6} or a cumulative HI greater than 1 through contact with contaminated media at the unit, **and** if the concentrations of analytes are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise, do not consider secondary contamination sources when making remedial decisions for the unit

Table ES.7. Decision Rules for the BGOU Strategic Initiative (Continued)

GOAL	**DECISION RULE**	***If* statement**	***Then* statement**
Fate and Transport	3a	If contaminants are found in the source zone, **or** if secondary contamination sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from secondary contamination sources at concentrations that may potentially result in a cumulative ELCR greater than 1×10^{-6} or a cumulative HI greater than 1 through use of contaminated media at downgradient points of exposure, **and** the concentrations of analytes are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise, do not consider risk posed by migratory pathways when evaluating remedial alternatives for the unit (see D3b)
	3b	If contaminants are found in the source zone, **or** if secondary contamination sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from the secondary contamination source at concentrations that exceed ARARs,	then evaluate actions that will bring migratory concentrations into compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards; otherwise, do not consider ARARs when examining migratory pathways during the evaluation of remedial actions (see D3a)
Risk Assessment	4a	If Decision D1a, D1b, D1c, D2a, D3a, or D3b indicate that response actions are needed,	then evaluate response actions to mitigate risk in the source zone

UNCERTAINTIES/ASSUMPTIONS

The BGOU RI used the Observational Approach[1] to optimize the location of soil borings in relation to areas of interest (buried waste). While the BGOU RI field investigation sampled directly beneath the waste units using angled borings, one key uncertainty associated with the sampling approach (and common to burial ground investigations) is that the samples do not characterize the waste directly. It remains possible that the buried waste contains hazard that current sample results do not characterize. Upcoming remedial decisions must consider the available documentation of the buried waste in addition to the soil and groundwater characterization data to limit this uncertainty. A related uncertainty is that the field investigation was unable to sample to the middle of a few of the larger SWMUs[2] (SWMUs 5 and 145, particularly); thus, these SWMUs remain incompletely characterized.

The BGOU RI uses a combination of historical and current sample results of soil and groundwater to characterize the nature and extent of contamination. The associated samples were collected and analyzed over several previous and continuing investigations, as well as the BGOU RI, using several methods. Quality control/quality assurance practices at PGDP, now and previously, limit the uncertainty associated with the sampling and analysis process. Another related concern is the “age” of some of the data; older data may not reflect current conditions and should not be assessed in concert with the sample results of the BGOU RI. To minimize the potential for “age” to bias the analysis of the data, the historical sample analyses used in the BGOU RI are limited to water samples collected in January 1995 and later and soil samples collected in June 1996 and later. This criterion maximizes the number of historical sample analyses available to the RI while providing a reasonable assurance of the comparability of the data.

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[1] The BGOU RI/FS Work Plan located sampling points primarily based on historical information. Where merited, the field investigation adjusted locations, after approval of participants to the BGOU RI/FS scoping process, based on surface radiological and geophysical surveys and reviews of historical aerial photography.

[2] Soil samples that best characterize releases from the SWMUs are limited to the UCRS (the shallowest 50 to 60 ft of soils). The shallowest angle of drilling/sampling that could be achieved in the deeper soil borings was 45 degrees from vertical; thus, the furthest distance under the burial grounds that could be sampled was approximately 60 ft.

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1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County, is an active uranium enrichment facility owned by the U.S. Department of Energy (DOE). Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation on which is located the electricity generating Shawnee Steam Plant (Figure 1.1).

PGDP was owned and managed first by the Atomic Energy Commission and then the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, Martin Marietta Utility Services and later the United States Enrichment Corporation (USEC) assumed management and operation of the PGDP enrichment facilities under a lease agreement with DOE. DOE still owns the enrichment complex and is responsible for environmental management activities associated with past operation of PGDP (CERCLIS# KY8-890-008-982). DOE is the lead agency for remedial actions in accordance with the Paducah Federal Facility Agreement (FFA), and the U.S. Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet (KEPPC) are regulatory oversight agencies (EPA 1998).

The Burial Grounds Operable Unit (BGOU) consists of contamination associated with PGDP's landfills and burial grounds and additional disposal areas that might exist beneath the scrap yards. Burial grounds addressed by this remedial investigation (RI) are listed below and shown in Figure 1.2 (DOE 2006a).

- Solid Waste Management Unit (SWMU) 2—C-749 Uranium Burial Ground
- SWMU 3—C-404 Low-Level Radioactive Waste Burial Ground
- SWMU 4—C-747 Contaminated Burial Yard and C-748-B Burial Area
- SWMU 5—C-746-F Burial Yard
- SWMU 6—C-747-B Burial Ground
- SWMUs 7 and 30—C-747-A Burial Ground and Burn Area (which includes the area beneath SWMU 12);
- SWMU 145—Area P (the residential/inert borrow area) and old North-South Diversion Ditch (NSDD) disposal trench (the area for SWMU 145 includes that beneath SWMUs 9 and 10)

Subsequent to development of the BGOU RI/Feasibility Study (FS) Work Plan (DOE 2006a) and concurrent with the field investigation, interviews of former plant personnel identified potential areas of buried metal within the C-746-P and C-746-P1 Scrap Yards (SWMU 13). Assessment and remedial measures, if required, for these potential burial areas fall within the scope of the BGOU Strategic Initiative, but are in addition to the scope defined in the BGOU RI/FS Work Plan. The characterization of the potential burial areas of SWMU 13 will be addressed with a Sampling and Analysis Plan addendum to the BGOU RI/FS Work Plan and follow-on field investigation. The results will be documented and assessed in the BGOU FS.

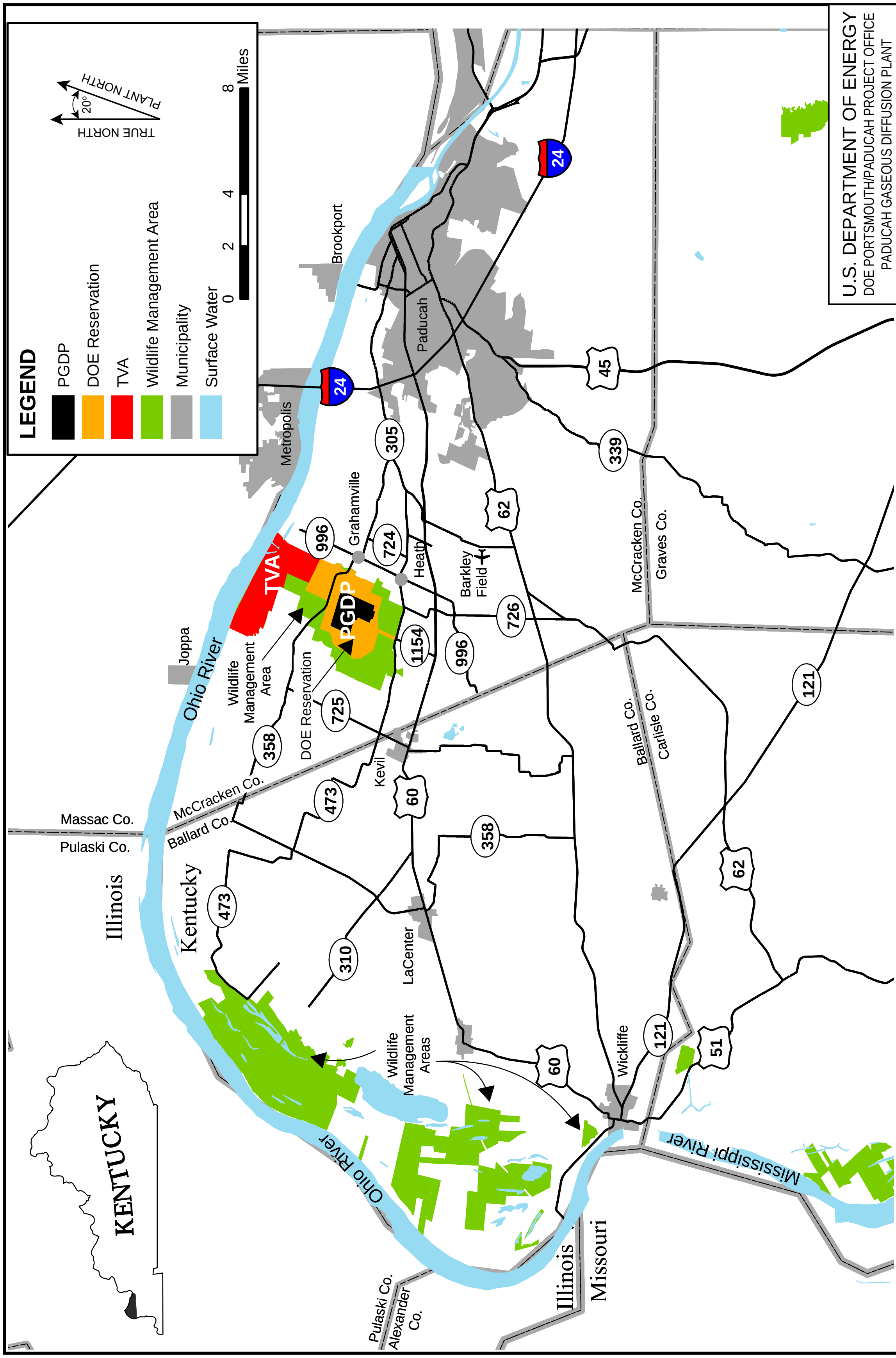

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Figure 1.1 PGDP Site Location

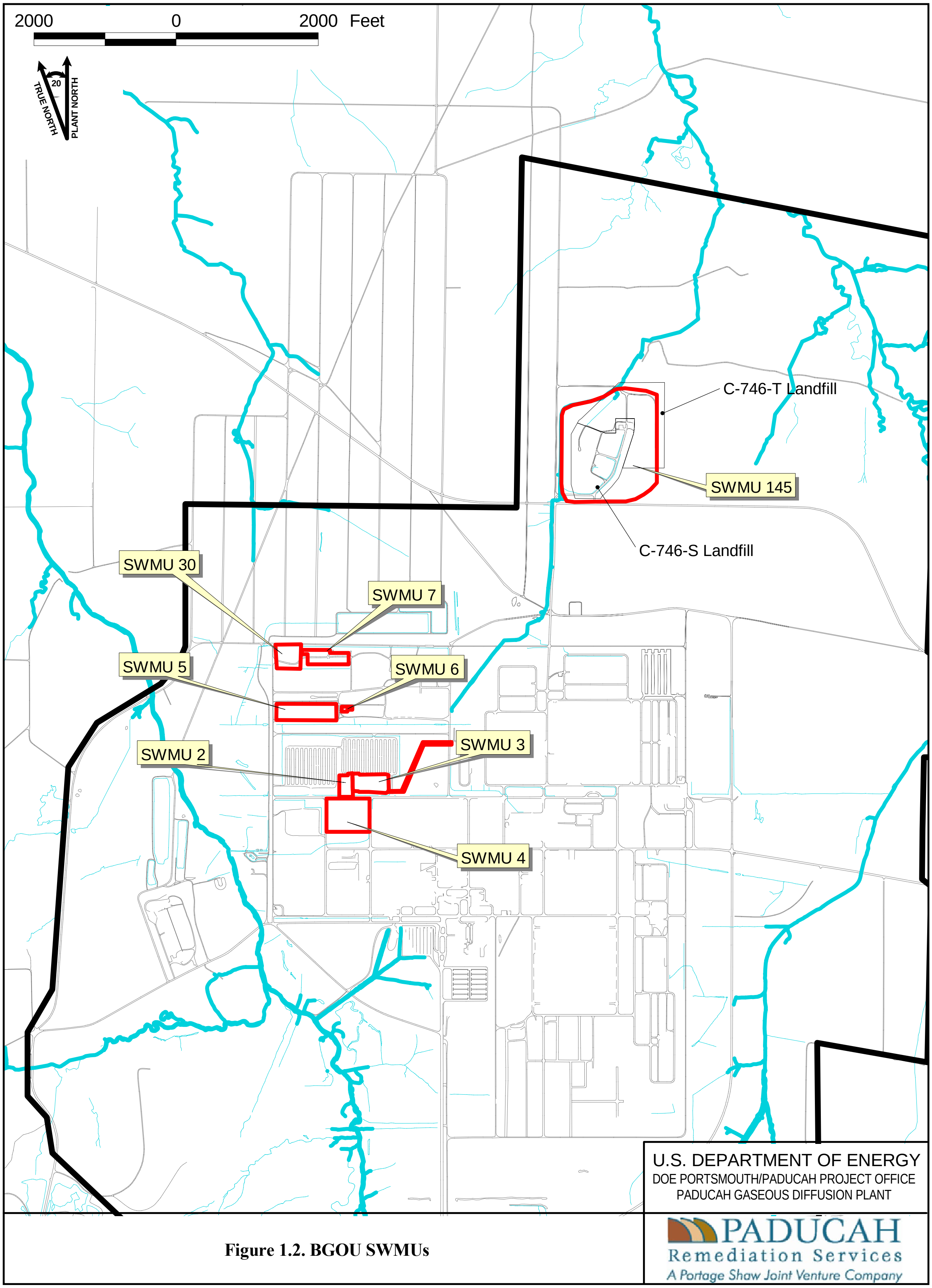

Figure 1.2. BGOU SWMUs

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1.1 PURPOSE OF REPORT

The BGOU RI followed the investigation outlined in the BGOU RI/FS Work Plan (DOE 2006a). The work plan utilized the data quality objective (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 problem statement developed through the DQO process and documented in the BGOU RI/FS Work Plan:

> Hazardous substances that have been contained in, or passed through, the BGOU SWMUs may have been released to surface water or into surrounding soil or are contained in burial cell materials. These substances may have infiltrated into groundwater below the unit and been transported through subsurface pathways. The nature and extent of contamination have been adequately defined for some SWMUs, and risk assessments have been prepared. For others, the nature and extent of contamination have not been adequately defined to assess whether potential contaminants pose unacceptable risks to human health and the environment at the SWMUs and at downgradient exposure points. Data gaps should be identified, and "closed," so that a comprehensive RI/FS report can be prepared for the eight SWMUs within the BGOU.

The objectives of the RI included characterization of nature, extent, and magnitude of source zones and secondary sources (such as contaminated soil) at the locations listed above. Additionally, the purpose of the RI is to determine surface and subsurface transport mechanisms and to support an evaluation of remedial technologies. These goals (DOE 2006a) are listed specifically in Table 1.1.

This report documents the results of the RI and Baseline Risk Assessment (BRA). Recommended remedial action objectives will be presented in the forthcoming FS.

1.2 PROJECT SCOPE

The BGOU RI primarily consisted of a field investigation of the following burial grounds: C-749 (SWMU 2); C-404 (SWMU 3); C-747 (SWMU 4); C-746-F (SWMU 5); C-747-B (SWMU 6); C-747-A (SWMUs 7 and 30, which includes the area beneath SWMU 12); and the residential/inert borrow area and old NSDD disposal trench (SWMU 145).

1.2.1 Scope

The BGOU RI focused on the burial grounds listed previously and the immediately affected areas adjacent to and beneath the burial cells down to the Regional Gravel Aquifer (RGA) interface to determine if the cells are contributing to groundwater contamination. As stated in the Site Management Plan (SMP), a primary objective for this project is to contribute to the protection of off-site residents by addressing sources of groundwater contamination (DOE 2007a).

The Groundwater Operable Unit (OU) Strategic Initiative will address dissolved-phase groundwater contamination in the RGA beneath the BGOU SWMUs; however, secondary sources of groundwater contamination that are derived from the BGOU burial grounds, such as the potential dense nonaqueous-phase liquid (DNAPL) source zone beneath SWMU 4, remain within the scope of the BGOU for assessment and remedial action, if required.

Table 1.1. Goals Identified for the BGOU RI

GOAL 1: CHARACTERIZE NATURE OF SOURCE ZONE
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?
GOAL 2: DEFINE EXTENT OF SOURCE ZONE AND CONTAMINATION IN SOIL AND OTHER SECONDARY SOURCES AT ALL UNITS
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 relationship of the UCRS gradient to the source, to surface water bodies, and to the RGA?
GOAL 3: DETERMINE SURFACE AND SUBSURFACE TRANSPORT MECHANISMS AND PATHWAYS
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?
GOAL 4: SUPPORT EVALUATION OF REMEDIAL ALTERNATIVES
4-1: What are the possible remedial technologies applicable for this unit?
4-2: What are the physical and chemical properties of media to be remediated?
4-3: Are cultural impediments present?
4-4: What is the extent of contamination (geologic limitations presented by the source zone or secondary contamination source)?
4-5: What would be the impact of action on and by other sources?
4-6: What would the impact of an action at the source be on the integrator units?
4-7: What are stakeholders’ perceptions of contamination at or migrating from source zone or secondary contamination sources?

UCRS = Upper Continental Recharge System

The DQO process was used to focus the sampling strategy on SWMU-specific media, contamination, and migration pathways, and identifying data needs. Data collected during the BGOU RI, together with historical data presented in the BGOU RI/FS Work Plan (DOE 2006a), are used within this RI Report.

The following list summarizes the activities that were conducted as part of the RI:

- Collection of geophysical data;
- Collection of surface soil, subsurface soil, and groundwater samples;
- Laboratory analysis of the samples;
- Evaluation of nature and extent of contamination related to each source unit;

- Numeric modeling of contaminant fate and transport and estimation of future exposure point concentrations at the DOE property boundary; and

- Determination of ecological and human health risks associated with each site.

Consistent with the BGOU RI/FS Work Plan, the nature and extent of surface soils (0–1 ft bgs) and sediments within the BGOU SWMUs are not included in the BGOU RI/FS.[1] Surface soils within two of the BGOU SWMUs (SWMUs 3[2] and 7), however, were sampled during this RI, as specified in the BGOU RI/FS Work Plan (DOE 2006a), to provide additional information. Results from these surface soil samples are presented with the BGOU analytical data.

Further, the BGOU RI sought to identify additional disposal areas that might exist beneath the scrap yards, consistent with the scope of the BGOU, as described in the SMP (DOE 2007a). One such potential area, within the existing SWMU 13, was identified by employee interviews and confirmed by a geophysics survey. The results of the geophysics survey are presented within this report in Section 2; however, this geophysical information and data available for this area will be evaluated under the BGOU FS.

To deal with uncertainties identified in the BGOU, the observational approach was used in the design of the sampling strategy for the BGOU RI/FS. The key concepts are as follows:

- The RI strategy is based on a specified “most probable site condition,” which, for the BGOU RI/FS, assumes that contamination is potentially adversely impacting human health and welfare or an impact on the environment has occurred.

- Reasonable deviations from the most probable site condition are identified. The reasonable deviation for the BGOU RI/FS is that no contamination is adversely impacting human health and welfare or the environment. Site conditions should not differ significantly from the postulated conditions shown in the conceptual models.

1.2.2 Rationale for Field Sampling

Sampling activities focused on the soils and groundwater beneath the burial pits to a depth of 60 ft bgs. Angled soil borings were utilized to collect samples for this objective. Surface[1] and subsurface soils adjacent to but not beneath the burial pits were not part of this investigation and will be evaluated through the Soils OU. Likewise, the RGA was not part of this investigation and will be evaluated through the Groundwater OU (with the exception of borings advanced to the RGA to evaluate upgradient and downgradient contaminant levels at SWMUs 3 and 7). Borings adjacent to the NSDD were advanced to a depth of 15 ft bgs to evaluate impacts from the pipeline that once discharged leachate from SWMU 3 into the NSDD. Figure 1.3 illustrates the conceptual design of the soil borings to collect these samples.

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[1] A discussion of nature and extent of surface soils and sediment is discussed in previous investigations (DOE 1994; 1997a; 1998c; 2000a). The BGOU RI risk assessment includes the available surface soils and sediments analyses for samples from within the BGOU SWMUs to complete evaluation of the exposure scenarios specified in the Work Plan (residential, industrial, and recreational).

[2] The SWMU 3 surface soils characterized by the BGOU RI are associated with a former pipeline located to the east of C-404.

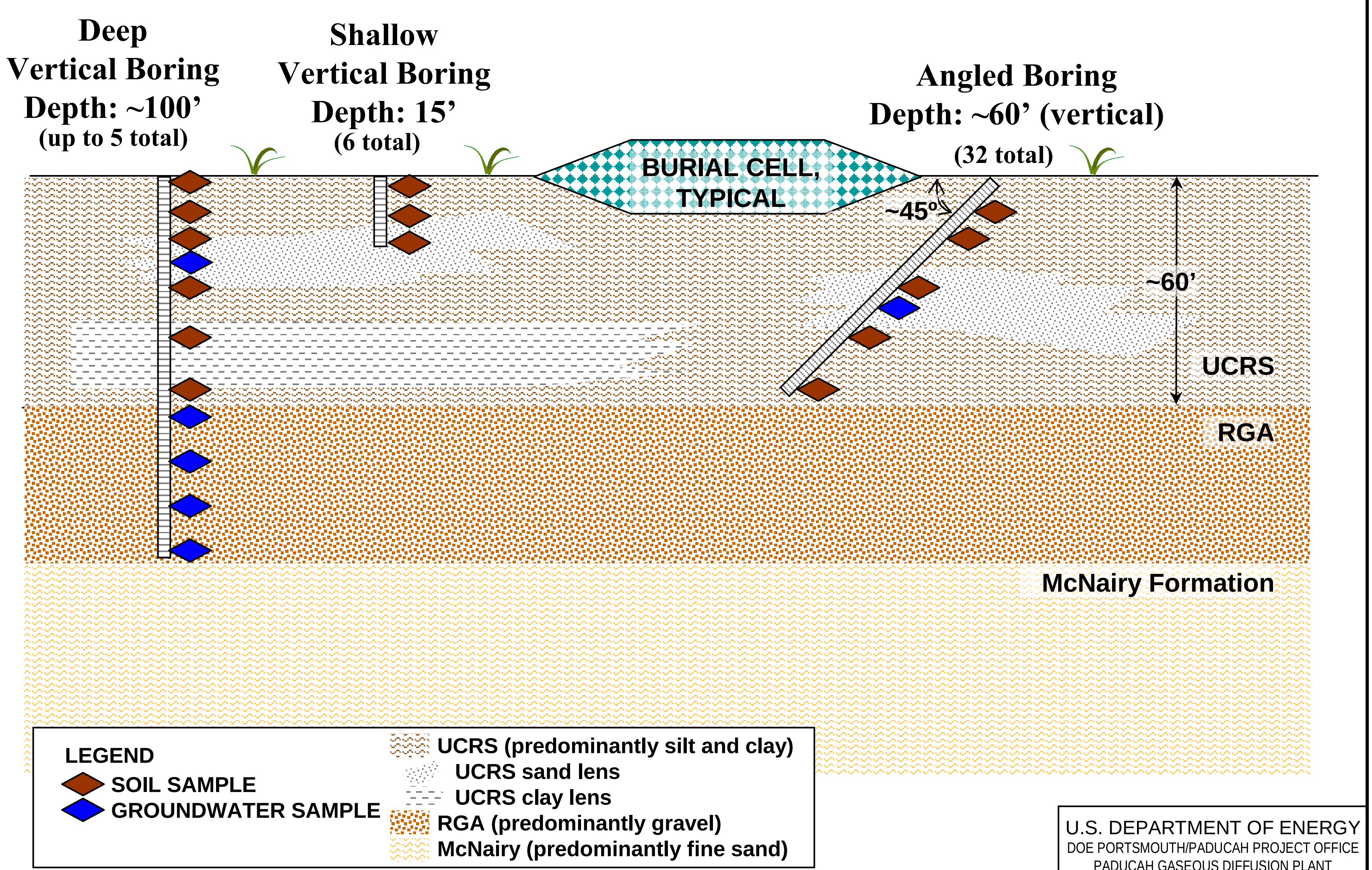

Figure 1.3. BGOU Drilling

1.3 SITE BACKGROUND

The burial grounds addressed by this RI are discussed in detail in the following sections. Table 1.2 summarizes this information.

Table 1.2. Summary of BGOU SWMUs

Sub Unit	Dates of Operation	Area of Waste	Cap	Known or Expected Contents (Special Hazards)
SWMU 2 C-749 Uranium Burial Ground				
	1951 – 1977	32,000 ft^2	6-inch clay 18-inch soil	Uranium (pyrophoric uranium)
SWMU 3 C-404 Low-Level Radioactive Waste Burial Ground				
	1952 –1986	53,000 ft^2	RCRA multilayered cap	Uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, degreasing sludge, and radioactively contaminated trash
SWMU 4 C-747 Burial Yard and C-748-B Burial Area				
C-747	1951 to 1958	8,300 ft^2	2 to 3 ft soil 6-inch clay	Debris (radiologically contaminated) from uranium hexafluoride feed plant
C-748-B	potentially 1973 – 1987	278,400 ft^2	2 to 3 ft soil 6-inch clay	Proposed chemical landfill
SWMU 5 C-746-F Burial Yard				
	1965 – 1987	197,400 ft^2	2 to 3 ft soil	Radionuclide-contaminated scrap metal, slag from nickel and aluminum smelters
SWMU 6 C-747-B Burial Ground				
Area H	1971	180 ft^2 (6 ft deep)	3 ft soil	Magnesium scrap
Area I	1966	200 ft^2 (8 ft deep)	5 ft soil	Exhaust fan
Area J	Early 1960s	4,000 ft^2 (6 ft deep)	3 ft soil	Contaminated aluminum
Area K	1968 – 1969	180 ft^2 (6 ft deep)	3 ft soil	Magnesium scrap
Area L	1969	600 ft^2 (6 ft deep)	3 ft soil	Modine trap
SWMU 7 C-747-A Burial Ground				
Pit B		10,320 ft^2 (6 – 7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment
Pit C		10,320 ft^2 (6 – 7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment,
Pit D		1,485 ft^2 (6 – 7 ft deep)	3 ft soil	Uranium-contaminated concrete pieces of reactor tray bases from fluorination process of uranium tetrafluoride to uranium hexafluoride
Pit E		2,145 ft^2 (6 – 7 ft deep)	3 ft soil	Uranium-contaminated concrete pieces of reactor tray bases
Pits F1–F5		1,600 ft^2 (6 – 7 ft deep)	3 ft soil	Uranium-contaminated scrap metal, equipment, empty uranium/magnesium powder drums
Pit G		3,294 ft^2 (6 – 7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment
SWMU 30 C-747-A Burn Area				
Pit A	1951 – 1970	128,000 ft^2 (12 ft deep)	4 ft soil	Ash and debris from combustible trash, possibly uranium-contaminated
SWMU 145 Area P				
	1950 – 1980	44 acres		Construction debris

Several documents have been produced containing data pertinent to the various SWMUs within the BGOU. In most cases, the previously prepared documents grouped several SWMUs together and did not study one particular SWMU. These documents and the various monitoring wells (MWs) installed throughout PGDP provide considerable usable historical data in addition to that generated during the BGOU RI. Historical data to be used for the BGOU is documented in the BGOU RI/FS Work Plan (DOE 2006a). Additionally, the historical data set was updated to include measurements collected from monitoring wells between the periods of work plan development and RI development.

Table 1.3 identifies the previously completed reports and/or investigations primarily used.

Table 1.3. Summary of Previous Investigations of BGOU

Dates	Title	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30	SWMU 145
1989	Post Closure Permit Application C-404 Low-Level Radioactive Waste Burial Ground		✓						
1990-1992	Phase II Site Investigation	✓	✓	✓	✓	✓	✓	✓	
1996	Closure Plan C-404 Low-Level Radioactive Waste Burial Ground		✓						
1996–1997	WAG 22 SWMUs 2 and 3 Remedial Investigation and Addendum (including SWMU 2 Data Summary Report)	✓	✓						
1996–1998	WAG 22 SWMUs 7 and 30 RI/FS						✓	✓	
1998–2001	WAG 3 RI/FS			✓	✓	✓			
1999–2001	Data Gaps Investigation			✓	✓		✓	✓	✓
2000–2001	Old NSDD Sampling								✓
2002–2003	Scrap Yards Site Characterization				✓	✓	✓	✓	
2003–2004	C-746-S and -T Landfill Site Investigation								✓
2004	Southwest Plume Site Investigation			✓					

In addition to the reports of previous investigations, the following documents provide significant information on the content and volume of the burial grounds:

- *The Discard of Scrap Materials by Burial at the Paducah Plant* (Union Carbide 1973) and
- *The Disposal of Solid Waste at the Paducah Gaseous Diffusion Plant* (Union Carbide 1978).

1.3.1 C-749 Uranium Burial Ground (SWMU 2)

1.3.1.1 Site description

The C-749 Uranium Burial Ground (SWMU 2) is located within the west-central portion of the plant. SWMU 2 encompasses an area of approximately 32,000 ft^2, with approximate dimensions of 160 ft by 200 ft. Records indicate that when the burial ground was in use, pits were excavated to an estimated depth of 7 to 17 ft. After the burial ground no longer was in use, the area was covered with a 6-inch thick clay cap and an 18-inch thick soil layer covered with vegetation (DOE 1995a). Figure 1.4 illustrates the burial ground, showing the historical grid layout as documented.

1.3.1.2 Site history

SWMU 2 was used from 1951 to 1977 for the disposal of uranium and uranium-contaminated wastes. Disposal records for SWMU 2 indicate that 270 tons of uranium, 59,000 gal of oils, and 450 gal of trichloroethene (TCE) were disposed of in the unit (DOE 1999a). Disposal records also indicate that drummed wastes buried in the unit consist primarily of uranium metal from machine shop turnings, shavings, and sawdust. Other wastes at the unit consist of drummed uranyl fluoride and TCE. Because small pieces of uranium metal may be pyrophoric (spontaneously burn in air), operating practices of that time required placing the material in drums and submerging the material in petroleum-based oil and synthetic oil to avoid contact with air.

Most of the waste in the unit is believed to consist of pyrophoric uranium metal in the form of machine shop turnings, shavings, and sawdust. Pyrophoric uranium metal usually was placed in 20-, 30-, or 55-gal drums. Occasionally, underground fires were reported as a result of oxidation of pyrophoric uranium metal, but no documentation of these fires is available. No subsidence has been observed as a result of volume reductions due to the fires. It is possible that the oils used may have included some polychlorinated biphenyl (PCB)-contaminated oils. Other forms of uranium, including oxides of uranium (solid and dissolved in aqueous solutions), uranyl-fluoride solutions, uranium-zirconium alloy, slag, and uranium tetrafluoride, were buried in small quantities (DOE 1996).

The most likely scenario is that the uranium buried at PGDP is in the metallic state or is coated with uranium (IV) oxide. Neither of these forms of uranium is very susceptible to leaching. The kinetics of dissolution of the buried metal and uranium (IV) oxide is controlled by the amount of oxygen and carbon dioxide that leaches through the waste. Site records show that much of the metal was coated with oil, possibly PCB oil. Such oils are resistant to chemical and biological degradation and from leaching by percolating waters. In addition, oils, as they slowly degrade, consume oxygen, which lowers the oxidation-reduction potential. Under such conditions, uranium dissolution is negligible (ORNL 1998).

No documentation of technetium-99 (^{99}Tc) disposal at SWMU 2 exists; however, during the years of feed plant operation from 1953 to 1964 and from 1968 intermittently through 1977, recycled uranium feed material from nuclear reactors was reprocessed through the feed plant, resulting in the introduction of reactor-produced radioactive impurities, such as ^{99}Tc, into the enrichment process. It is possible that a portion of the uranium-contaminated wastes disposed of in burial grounds at PGDP contains ^{99}Tc from reprocessing activities (DOE 1994).

Materials contaminated with TCE also are known to have been disposed of at SWMU 2. In August 1984, the western portion of the area designated as containing uranyl fluoride solution and contaminated TCE on Figure 1.4 was excavated with the intent of removing TCE in the soil or drums due to concern about the integrity of TCE-containing drums (15 30-gal drums) reportedly disposed of in this area. It is reported that during excavation, four 30-gal drums (one of these drums contained a uranium and TCE sludge and the others were of such poor integrity that the contents could not be ascertained) and 35 55-gal drums (30 of these drums contained uranium sludges, not TCE, one drum contained TCE, and the rest were of such poor integrity their contents could not be ascertained) were recovered. The drums containing TCE were placed in overpacks for proper disposal. Additionally, the liquid portion of the uranium solutions found in the other drums was transferred to new drums for proper disposal (Ashburn 1984). The remaining material was left within the SWMU and re-covered.

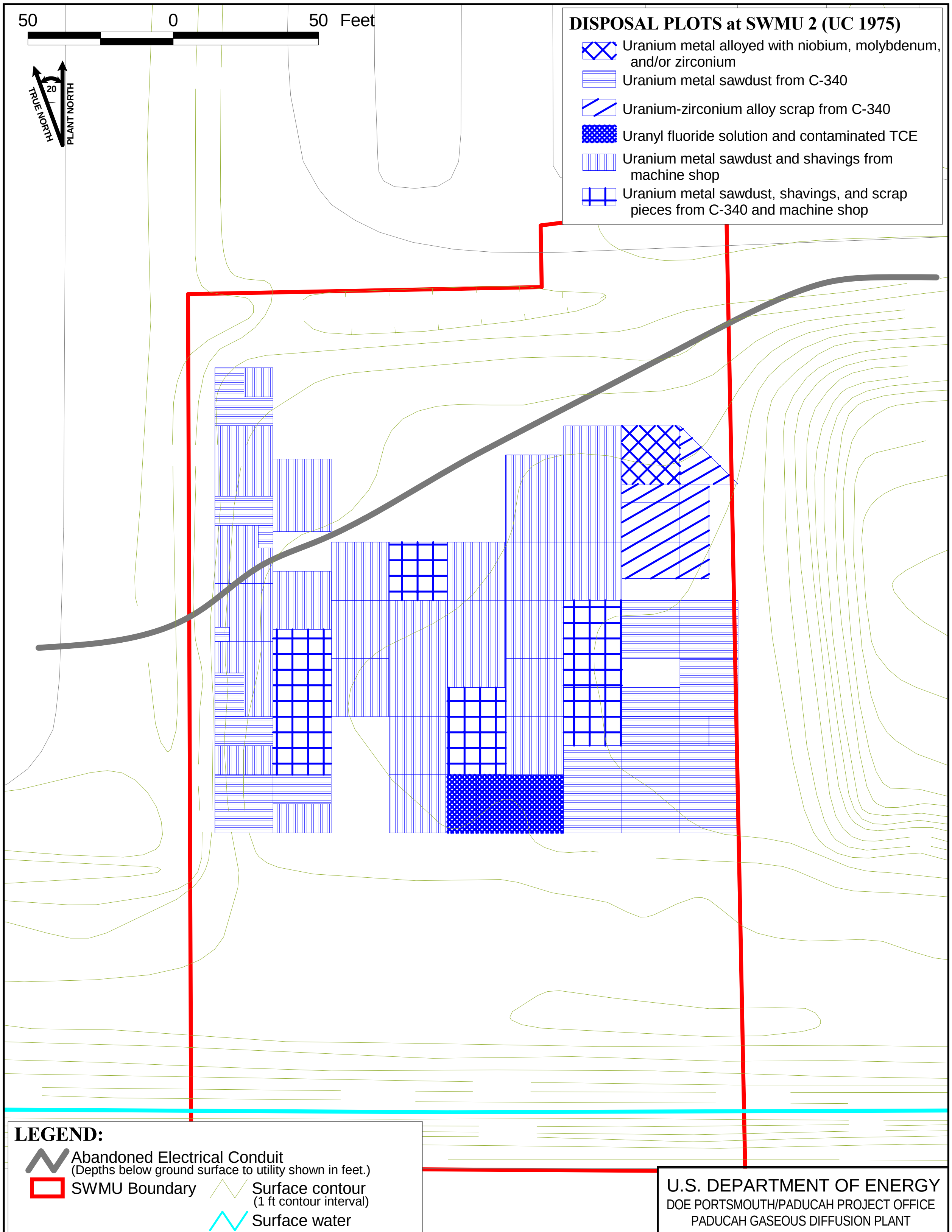

Figure 1.4. SWMU 2 Historical Layout

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1.3.2 C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3)

1.3.2.1 Site description

The C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3) is 1.2 acres located in the west-central portion of the secured area. The unit originally was constructed as a rectangular, aboveground surface impoundment measuring 387 ft by 137 ft, with a floor area of approximately 53,000 ft^2. The floor of the surface impoundment was constructed of well-tamped earth and clay dikes to a height of 6 ft. The C-404 impoundment was designed with an overflow weir at its southwest corner. From the weir, the surface impoundment effluent flowed west in a ditch (not the NSDD) and eventually discharged through what is nowKentucky Pollutant Discharge Elimination System (KPDES) Outfall 015. Figure 1.5 shows C-404 along with a schematic of this design. Historic effluent/leachate discharges later were rerouted to the NSDD via what is now an abandoned pipeline leading from the northeast corner of the landfill.

1.3.2.2 Site history

SWMU 3 operated as a surface impoundment from approximately 1952 until early 1957. During this time, all influents to the impoundment originated from C-400. In 1957, the C-404 surface impoundment was converted to a solid waste disposal facility for solid uranium-contaminated wastes. The waste consists of uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, degreasing sludge, and radioactively contaminated trash. There are no records documenting the cleanout of sludges and sediments from the pond when it was converted to a landfill. When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. Leachate was pumped from the sump through an underground transfer line. The transfer line discharged into a northeast-southwest ditch just east of C-404. From this ditch, the leachate flowed into the NSDD. NSDD historically carried PGDP effluents north to Little Bayou Creek. The date of termination of the leachate discharge through the underground transfer line into the NSDD has not been determined. It is known that, prior to landfill closure in 1986, this underground transfer line to the NSDD was not in operation, and leachate from the C-404 Landfill was being collected in the sump for treatment at the C-400-D Lime Precipitation Unit in the C-400 Facility. At some time following closure of the C-404 Landfill, treatment of leachate from C-404 at C-400 was discontinued, and treatment of the leachate was transferred to the C-752 Remedial Action Waste Holding Facility.

The upper tier of waste within C-404 contains drummed waste similar to that collected in the impoundment plus smelter furnace liners and drums of extraction-procedure, characteristically hazardous, waste [Resource Conservation and Recovery Act (RCRA) waste codes D006 (for cadmium), D008 (for lead), and D010 (for selenium)]. A partial clay cap was installed on the eastern end of the landfill in 1982 (DOE 1987).

Approximately 6,615,000 lb of uranium-contaminated wastes were disposed of at SWMU 3. The total volume is approximately 260,000 ft^3. Some uranium contaminated waste also is contaminated with TCE, radionuclides, and metals. In 1986, the disposal of waste at C-404 Landfill was halted, and a portion of the disposed waste was found to be RCRA-hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987. It currently is regulated under RCRA as a land disposal unit and compliance is required by a RCRA postclosure permit issued in 1992. The closure plan required continued groundwater monitoring (DOE 1989). A permit modification was submitted in May 2008, revising the MW network for the unit (DOE 2008).

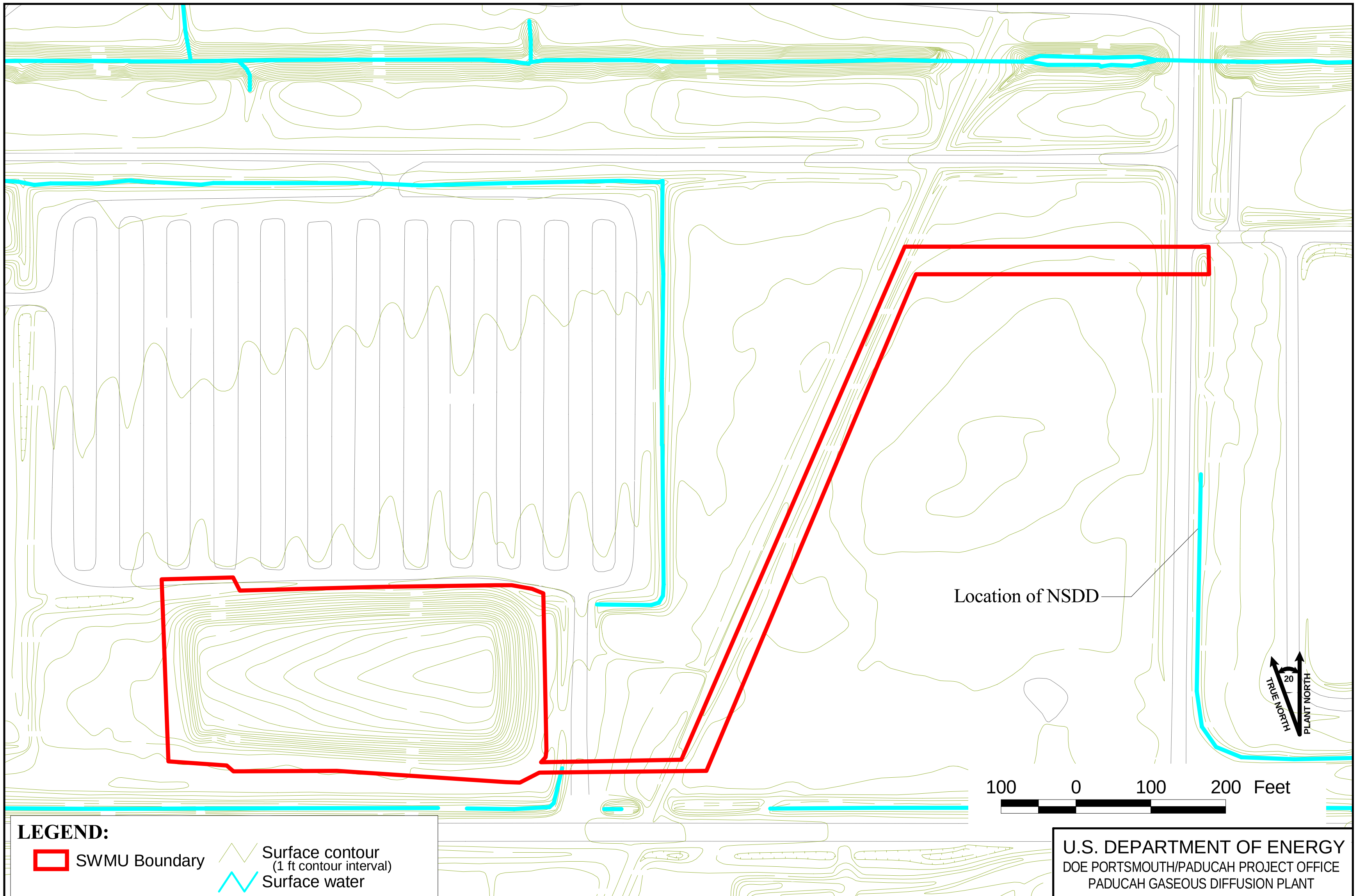

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Figure 1.5. SWMU 3 Historical Layout

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1.3.3 C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4)

1.3.3.1 Site description

The C-747 Contaminated Burial Yard and the C-748-B Burial Area (SWMU 4) is located in the western section of the plant area. SWMU 4 (which covers an area of approximately 286,700 ft^2) is bounded on the north, east, and west by plant roads and on the south by an active railroad spur (Figure 1.6). This SWMU is an open field that, at one time, was used for the burial and disposal of various waste materials in designated burial cells. A short, narrow, gravel road that enters from the west is nearly completely grass-covered. Except for this rarely used road, the entire site is covered with a variety of field grasses and clovers. The site typically is mowed once a month from April through September. SWMU 4 is bounded on three sides (north, east, and west) by shallow drainage swales that direct surface runoff to the northwest corner of the site. There is an elevation difference of approximately 10 ft between the highest point in the SWMU to the adjacent drainage swales. The entire burial yard was covered with 2 to 3 ft of soil material and a 6-inch clay cap was placed over the area in 1982 (DOE 1998a).

1.3.3.2 Site history

The C-747 Burial Yard was in operation from 1951 to 1958 for the disposal of radiologically contaminated and uncontaminated debris originating from the C-410 uranium hexafluoride (UF_6) feed plant. The area originally consisted of two pits covering an area of approximately 8,300 ft^2 (50 ft by 15 ft and 50 ft by 150 ft) (Union Carbide 1978).

Some of the trash was burned before burial. According to PGDP personnel, a majority of the contaminated metal was buried in the northern part of the yard. When the yard was closed, a smaller pit was reported to have been excavated for the disposal of radiologically contaminated scrap metal that could not be sold.

The C-748-B Burial Area, located on the west side of C-747, is identified as a Proposed Chemical Landfill Site in the 1973 Union Carbide document on waste disposal. The original SWMU Assessment Report dated August 24, 1987, for SWMU 4 included only the C-747 Contaminated Burial Yard. The C-748-B Burial Area was incorporated into various descriptions of SWMU 4 starting in the mid-1990s as a result of a geophysical survey. As a result of this addition, the area of the SWMU was changed from 8,300 ft^2 to 286,700 ft^2 (DOE 2007b).

SWMU 4 also may have received sludges designated for disposal at the C-404 Burial Ground. The source of these sludges is unknown, but the Waste Area Grouping (WAG) 3 RI Work Plan (DOE 1998a) indicated that the sludges potentially included uranium-contaminated solid waste and ^{99}Tc-contaminated magnesium fluoride. The total volume of material disposed at this site is unknown. Potential contaminants associated with this SWMU include uranium, ^{99}Tc, metals, and TCE.

During the summer of 1996, a small sinkhole (approximately 3 ft across and 3 ft deep) developed in the southern burial cell, apparently from settling of material within the SWMU. The sinkhole was backfilled with soil. This hole previously had been reported in the WAG 3 RI Report and the BGOU Work Plan as having developed in the fall of 1999.

In the fall of 1999, employee interviews led to designating the C-747 Burial Yard as a classified area. Access subsequently was restricted based on security considerations.

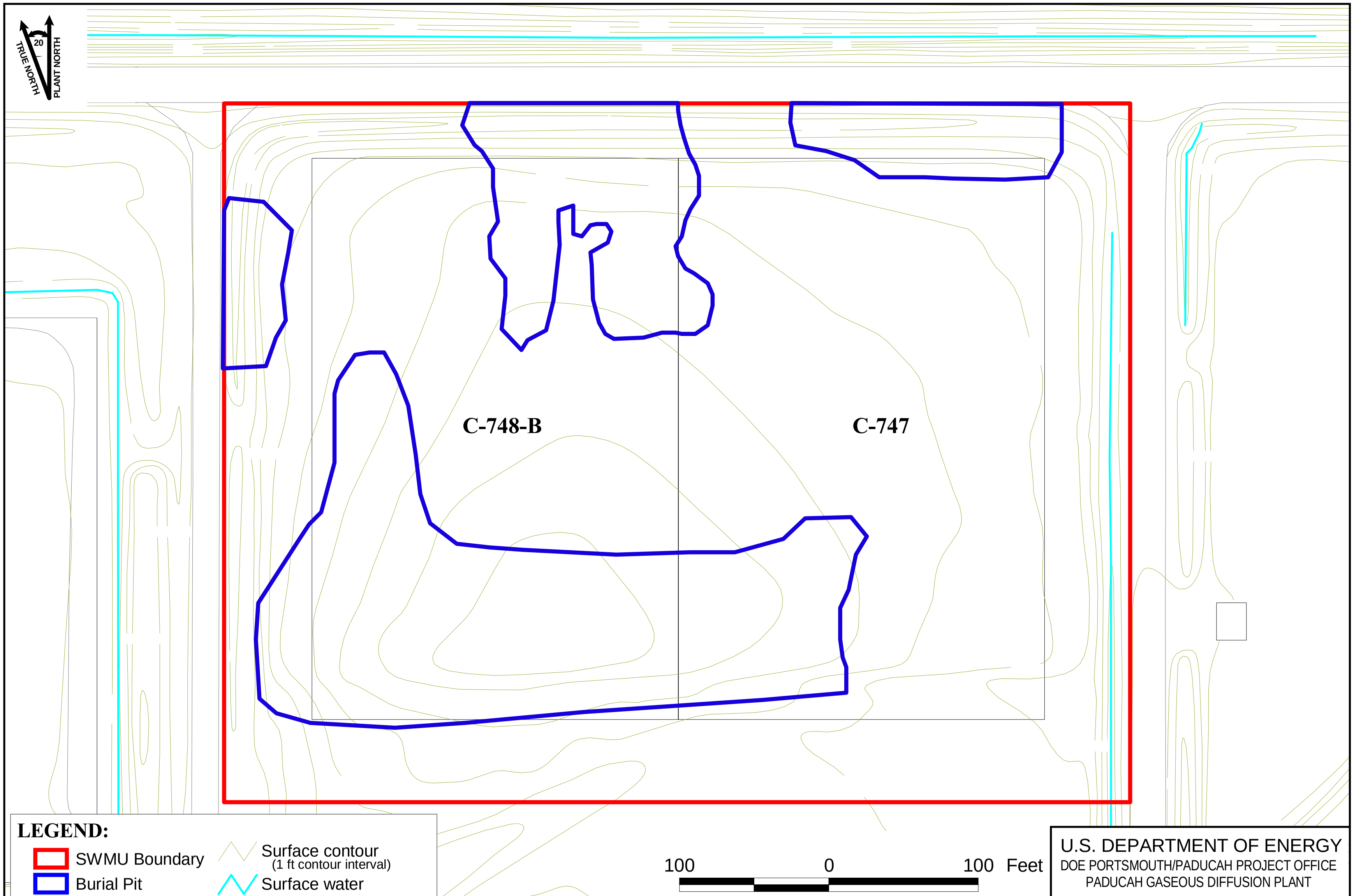

Figure 1.6. SWMU 4 Historical Layout

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1.3.4 C-746-F Burial Yard (SWMU 5)

1.3.4.1 Site description

The C-746-F Burial Yard is located in the northwestern section of the PGDP secured area. SWMU 5 (which covers an area of approximately 197,400 ft^2) is located adjacent to a scrap yard to the north and SWMU 6 to the east. Disposal pits were located on a grid system. Documentation of the size of these grids ranges from 10 by 10 ft cells to 20 by 20 ft cells excavated to a depth of 6 to 15 ft bgs. Figure 1.7 shows these cells as 20 by 20 ft. Worker interviews indicate this spacing is roughly accurate; however, historical aerial photographs indicate the earliest grid spacing may have been smaller.

Waste placed in the yard disposal pits was covered with 2 to 3 ft of soil. SWMU 5 is fenced to limit access to authorized personnel only. The ground surface is covered with short grasses and various flowering herbaceous plants (DOE 1998a).

1.3.4.2 Site history

SWMU 5 was in operation from 1965 to 1987. The burial pits were used for the burial of components from the "Work for Others" activities, some radionuclide-contaminated scrap metal, and slag from the nickel and aluminum smelters. Metals and radioisotopes are the primary potential contaminants of interest at this SWMU. The total quantity of wastes buried at the yard could be up to 896,000 ft^3, assuming an average quantity of 2,800 ft^3 waste placed in each cell and 320 cells receiving waste. Chemically unstable or incompatible compound/metal wastes are thought to have been placed here also. This conclusion is supported by the occurrence of an underground fire (thought to have occurred circa 1975–1976) in the southeast corner of the yard. This fire burned for several weeks, and individuals observing the fire reported that the ground surface appeared to become unstable. The source and/or cause were never determined; however, subsequent worker interviews indicate the fire was thought to be a reaction from hot slag in contact with water, producing acetylene gas. The fire extinguished itself without intervention, and no testing was performed to prove or disprove this theory. Common practice following this incident was to allow slag to cool before placing it in the burial yard. No data are available related to contaminant releases from the fire.

1.3.5 C-747-B Burial Ground (SWMU 6)

1.3.5.1 Site description

The C-747-B Burial Ground is located in the northwestern section of the plant area east of SWMU 5. The entire burial area covers an area of approximately 13,500 ft^2, which is divided into five separate burial cells (Figure 1.8). The following are the dimensions of each of the cells.

- Area H—This disposal site covers an area of about 12 by 15 ft and is about 6 ft deep. A 3 ft cover of soil was placed on top of the buried drums.

- Area I—This discard pit is approximately 8 by 35 ft and is about 8 ft deep. The waste was covered with about 5 ft of soil.

- Area J—This burial site is about 4,000 ft^2 (37 by 110 ft) and was excavated to a depth of about 6 ft. The area was covered with about 3 ft of soil.

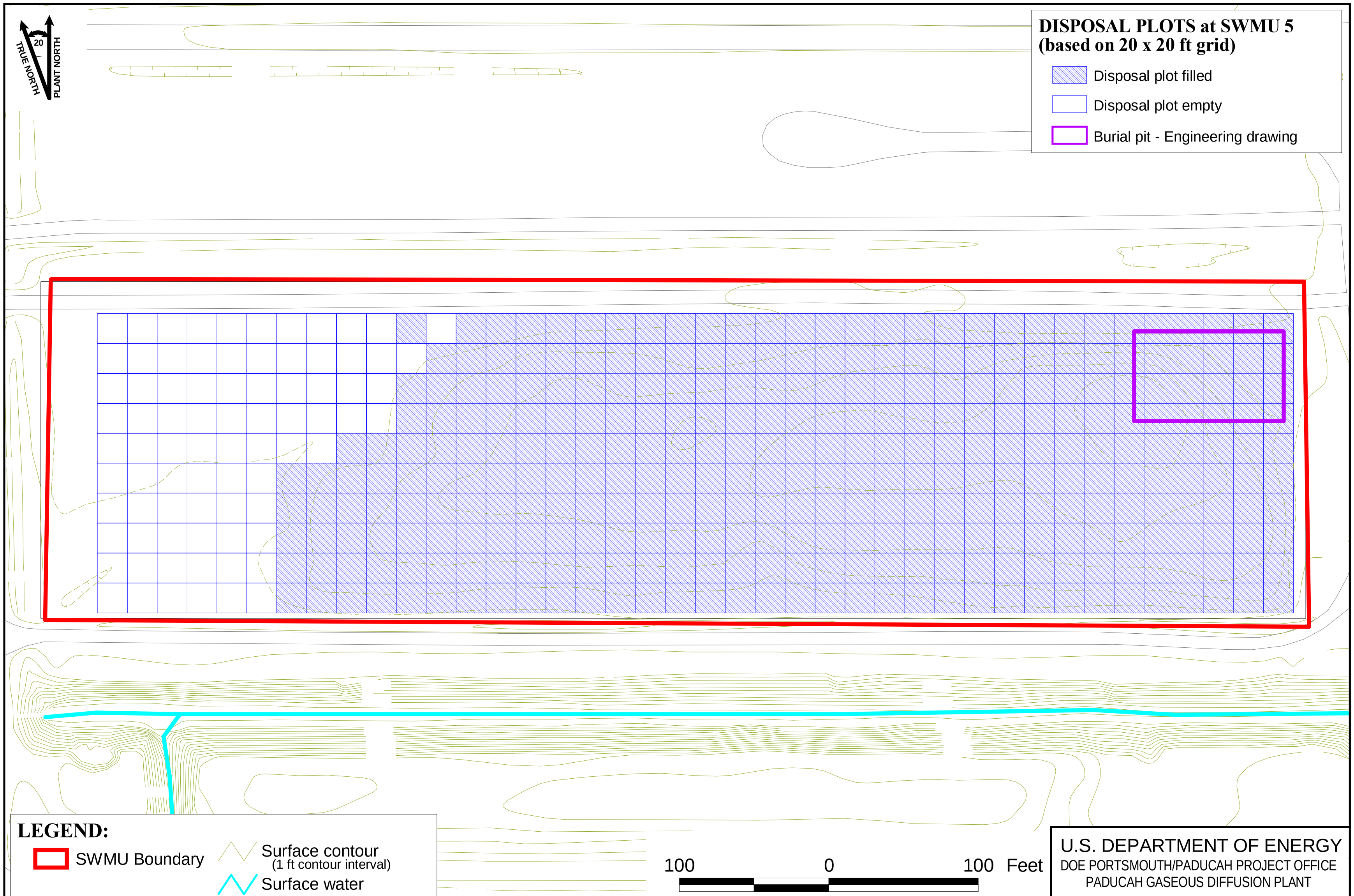

Figure 1.7. SWMU 5 Historical Layout

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- Area K—This disposal site consists of an area of about 12 by 15 ft and is about 6 ft deep. A 3 ft cover of soil was placed on top of the buried drums.

- Area L—This burial area is about 20 by 30 ft and about 6 ft deep. The disposed waste was covered with about 3 ft of soil.

This area is relatively flat and is bounded to the north by a set of abandoned railroad tracks, to the east by a 5-ft wide by 4-ft deep drainage ditch that drains into Ditch 001, and unnamed gravel roads to the west and south. The ground surface is medium to tall grasses (up to 3 ft high) with occasional pockets of young trees and shrubs (DOE 1998a).

1.3.5.2 Site history

SWMU 6 was in operation from 1960 to 1976. Each of the burial cells was used for the disposal of a different waste. Each cell and its contents were identified in the WAG 3 RI Report (DOE 2000a) as follows:

- Area H—Magnesium Scrap Burial Area. The scrap buried at this location is magnesium, in various shapes, generated in the machine shop. A total of about ten drums of scrap was buried during midsummer 1971.

- Area I—Exhaust Fan Burial Area. Eight exhaust hood blowers removed from C-710 were discarded to this pit. These blowers, which were about 15 inch in diameter and weighed about 100 lb each, were discarded in 1966 because of contamination with perchloric acid. Each blower was spaced about 4 ft apart in the hole.

- Area J—Contaminated Aluminum Burial Area. The contaminated scrap buried in this hole involved about 100 to 150 drums of aluminum scrap in the form of nuts, bolts, plates, trimmings, etc., that were generated in the converter and compressor shop. This scrap was buried in the early 1960s.

- Area K—Magnesium Scrap Burial Area. The scrap buried at this location is magnesium in various shapes generated in the machine shop. A total of about 20 drums of scrap was buried on September 3, 1968, and December 23, 1969.

- Area L—Modine Trap Burial Area. A single contaminated modine trap was buried in this area. The cold trap was about 4 ft in diameter, approximately 15 ft long, and weighed about 5,000 lb. This equipment was buried on March 5, 1969.

The WAG 3 RI Report (DOE 2000a), stated that approximately 50% of the surface area of SWMU 6 was used to store radioactively contaminated equipment and materials. These items include industrial forklifts and transport carts, flatbed trailers, generators, concrete pipes, and other miscellaneous items. This stored equipment has been removed. The area no longer is used for storage (DOE 2007c).

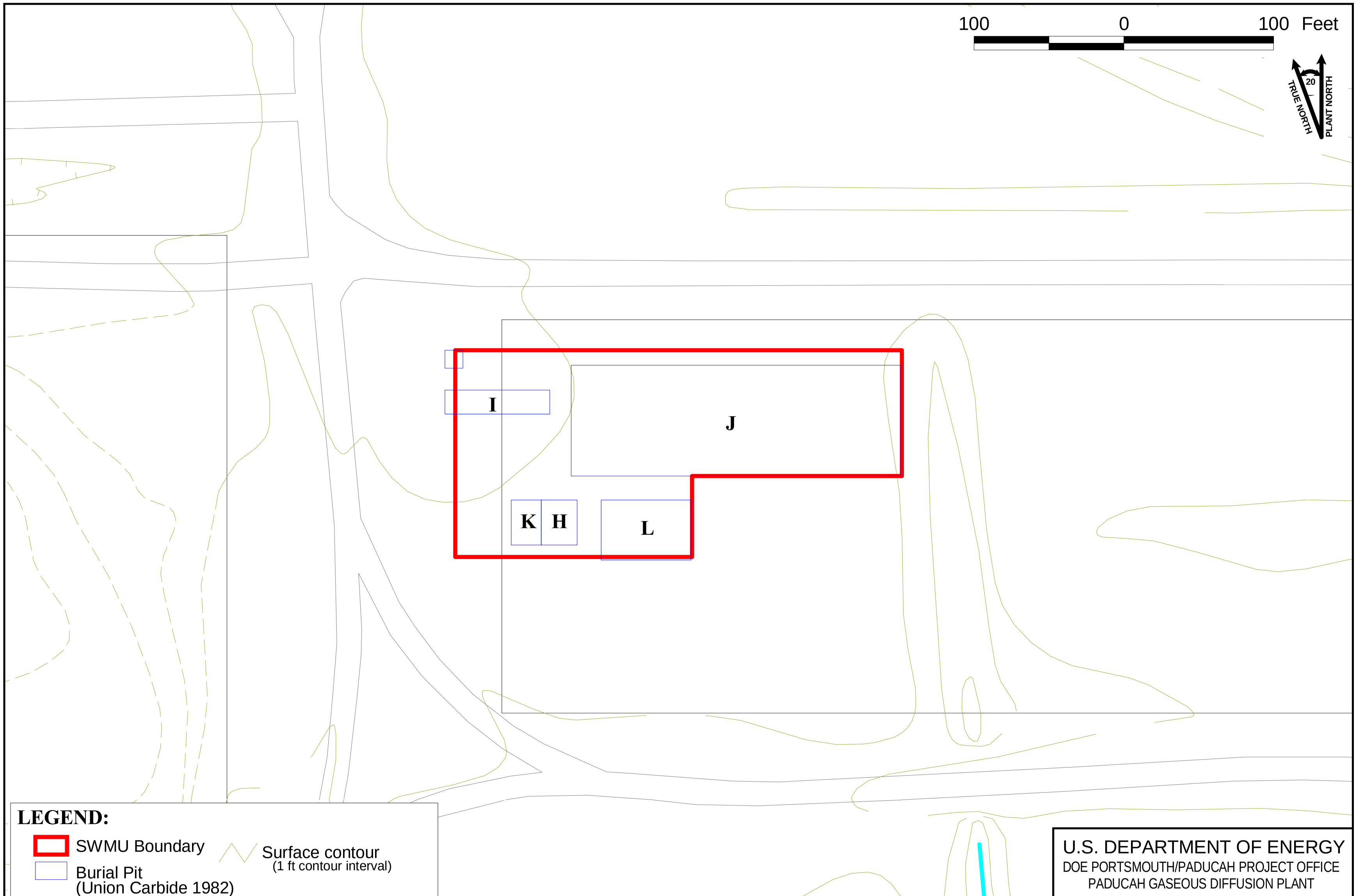

Figure 1.8. SWMU 6 Historical Layout

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1.3.6 C-747-A Burial Ground (SWMU 7)

1.3.6.1 Site description

The C-747-A area is located in the northwest corner of the PGDP secured area. SWMU 7 comprises the eastern two-thirds of C-747-A. The SWMU is bounded on the north and south sides by perimeter ditches, on the west side by the C-747-A Burn Area (SWMU 30), and on the east side by the C-746-E Contaminated Scrap Yard. SWMU 7 covers approximately 240,900 ft^2 and includes six discrete burial pit areas described below and illustrated in Figure 1.9 (DOE 1998b).

- Pit B—This pit is approximately 60 by 172 ft. According to the Phase II Site Investigation (SI) geophysical survey, the actual excavation extends beyond the designated boundaries and may connect with the adjacent burial pit (Pit C).

- Pit C—This pit is approximately the same size as Pit B. Based on the Phase II geophysical survey, Pit C and Pit B may be one continuous pit.

- Pit D—This pit is approximately 15 by 99 ft.

- Pit E (outside the eastern boundary of SWMU 7 and within the C-746-E Contaminated Scrap Yard)—This pit is approximately 15 by 143 ft.

- Pits F1–F5—These five pits are all small (approximately 20 by 80 ft).

- Pit G—This pit was documented as approximately 27 by 122 ft.

Records indicate the burial pits were excavated to a depth of 6 to 7 ft bgs, filled with wastes, and covered with approximately 3 ft of earth (Union Carbide 1978); however, the Phase II SI discovered waste in pits to a depth of 8-15 ft (CH2M Hill 1992).

A stockpile of radiologically contaminated scrap drums, locally known as Drum Mountain, formerly was located on the southeast corner covering Pit G. Interviews with a former operator who worked in the SWMU 7 area indicate Drum Mountain was created only after the area between the F Pits and Pit G had been filled with similar material. This interview was corroborated by geophysical evidence (see Section 2.1).

The land surface slopes within SWMU 7. Burial Pits B and C form a slight hill on the north side of SWMU 7, and Burial Pit F forms a lesser mound on the south side of the SWMU. Pit D underlies a level area north of where Drum Mountain once was located. Shallow drainage swales occur on the west side of Burial Pit B, between Burial Pits C and D. The ground surface of the west half of the SWMU is covered by grassy vegetation, except where gravel roads extend through the site. A PGDP scrap metal project covered the west half of the SWMU with 1 to 2 ft of gravel as a working base for truck and tractor traffic. This gravel also prevents exposure to contaminated soils resulting from the earlier removal of scrap material in Drum Mountain.

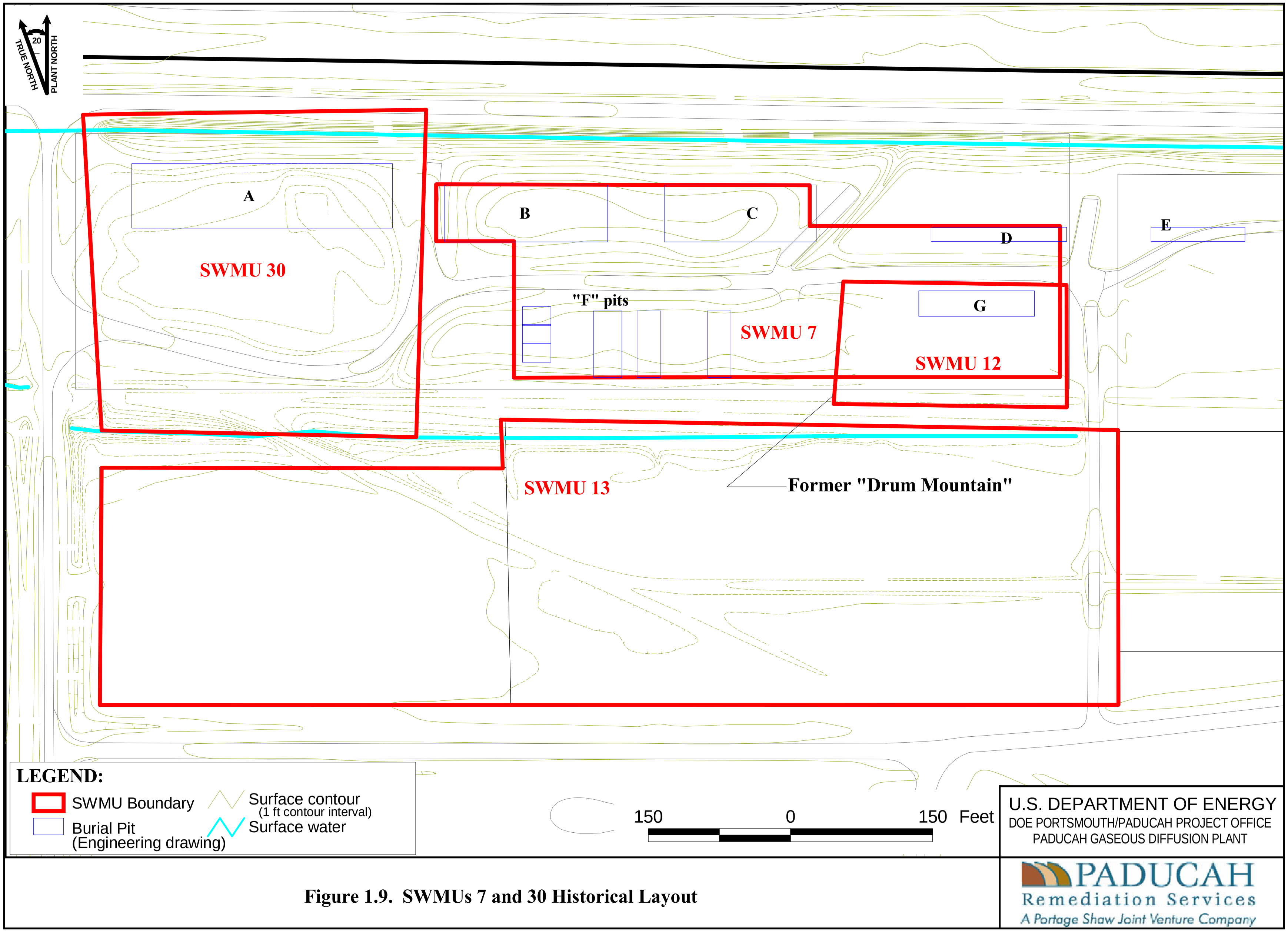

Figure 1.9. SWMUs 7 and 30 Historical Layout

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Infrastructure has been placed in the area in support of the Scrap Metal Removal Action project. This infrastructure includes an extensive gravel pad constructed to support a truck scale in the area of Burial Pit G.

The upper 20 ft of soils at SWMU 7 consist of surface soil, fill, and loess, alternatively described as silt or clay, in the area boreholes. Surface soils, to a depth of 6 inches, were sampled and described during the Phase II SI. Soil textures range from sand with gravel to lean clay with gravel. During the Phase II SI, double-ring infiltrometer tests were conducted on surface soils at SWMU 7. Average long-term infiltration rates ranged less than 5.7 ft/day (CH2M Hill 1992). Logs of deeper soil borings demonstrate that coarse textures generally are limited to the upper 2 ft, with the exception of the burial pits that are now known to be as much as 10 ft deep.

The surface water that drains from SWMU 7 into the surrounding ditches is carried west through Outfall 001 into Bayou Creek. In 2002, a sedimentation basin was constructed to contain runoff from PGDP scrap yards. Runoff now flows into the sedimentation basin and is released periodically into Outfall 001.

1.3.6.2 Site history

PGDP used the burial pits for disposal of wastes from 1957 to 1979. Burial Pits B, C, and G were used for disposal of noncombustible, contaminated and uncontaminated trash, material, and equipment. Contaminated concrete removed from the C-410 Feed Plant during May and June 1960 was placed in Burial Pits D and E. Burial Pit F was used for disposal of uranium-contaminated scrap metal and equipment. Empty uranium and magnesium powder drums also were reported to have been buried in Burial Pit F (Union Carbide 1978).

The following summarizes what is known about the disposed waste in the burial pits.

- Pit B—Buried material includes noncombustible trash and contaminated and noncombustible material and equipment.

- Pit C—Historic records indicate that both Pit B and C received the same material.

- Pit D—Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases from C-410 used during the fluorination process of uranium tetrafluoride to uranium hexafluoride.

- Pit E—Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases.

- Pits F1–F5—Documented buried material consists of uranium-contaminated scrap metal and equipment and empty uranium and magnesium powder drums.

- Pit G—Documented buried material consists of noncombustible trash and contaminated and noncombustible material and equipment.

In addition to these burial pits, the Phase II SI geophysical investigation also identified another anomaly in the shape of a rough circular area (15 ft diameter) between SWMU 30 and SWMU 7, west of the F-4 and F-5 Pits (see Section 2). There is no information confirming the presence or the nature of any buried wastes associated with this anomaly.

1.3.7 C-747-A Burn Area (SWMU 30)

1.3.7.1 Site description

SWMU 30 includes the western one-third of C-747-A. It consists of an historical burn-and-burial pit (Burial Pit A) and the location of a former incinerator. The SWMU is bounded on the north and south sides by ditches, on the west side by a plant road, and on the east side by SWMU 7 (Figure 1.9). The unit encompasses approximately 128,000 ft^2. The pit is reported to have been excavated to a depth of 12 ft and covered with 4 ft of earth. The land surface slopes gently, and a slight mound rises over Burial Pit A. SWMU 30 is bordered by drainage ditches on the north and south side. Grassy vegetation covers the ground, except where gravel roads extend through the site.

Phase II SI surface soil sample sites H-361 through H-366, H-370, and H-373 provide characterization of surface soil texture from eight locations across SWMU 30. The upper 6 inches of soil ranges from lean clay to sand. Surface soil samples from the Burial Pit A area tend to be lean clay with gravel, whereas surface soil textures from the south side of SWMU 7 range from lean clay to silty sand with gravel (DOE 1998b). The Phase II SI included double-ring infiltrometer tests on surface soils at three locations. Average long-term infiltration rates were less than 6×10^{-3} ft/day for two of the tests. All deeper soil borings, including Phase II SI borings H-211 and H-212, MW 66, and boring S-2, encountered surficial fill materials to depths of 2 to 12 ft.

1.3.7.2 Site history

SWMU 30 was used from 1951 to 1970 to burn combustible trash, which may have contained uranium contamination. Ash and debris were buried below ground in Burial Pit A beginning in 1962, when use of an on-site incinerator was discontinued. Site maps and a surface electromagnetic geophysical survey of the Phase II SI identify the location of Burial Pit A. Prior to identification by Phase II SI surface geophysics testing; it was believed that remnants of the former incinerator were not present. Further research identified images of the incinerator at the location. This disposal site covers an area of about 250 ft by 50 ft. Geophysical data from the Phase II SI indicate that the actual area of excavation does not exactly match the rectangular outline and extends beyond the rectangular outline to the north and east. Material disposed in Pit A included contaminated and uncontaminated trash, ash, and debris.

In addition to Pit A, the Phase II SI geophysical investigation also identified another anomaly in the shape of a rough circle approximately 43 ft in diameter (see Section 2). The SWMUs 7 and 30 RI confirmed this anomaly likely was the metal reinforcement within the footer and retaining walls of the former incinerator and/or parts of the unit buried there upon decommissioning (DOE 1998c).

1.3.8 Area P (SWMU 145)

1.3.8.1 Site description

Area P (SWMU 145) is located north of the PGDP security area and is defined by encompassing the area underneath SWMUs 9 and 10 (the C-746-S and -T Landfills, respectively). The SWMU is approximately 44 acres and began operation in the early 1950s. Currently, the C-746-S and -T Landfills are located on top of SWMU 145, but are not included in SWMU 145 (DOE 1999b), as illustrated in the conceptual drawing, Figure 1.10. The boundaries of the area previously had not been well defined outside of the area utilized by the C-746-S and -T Landfills.

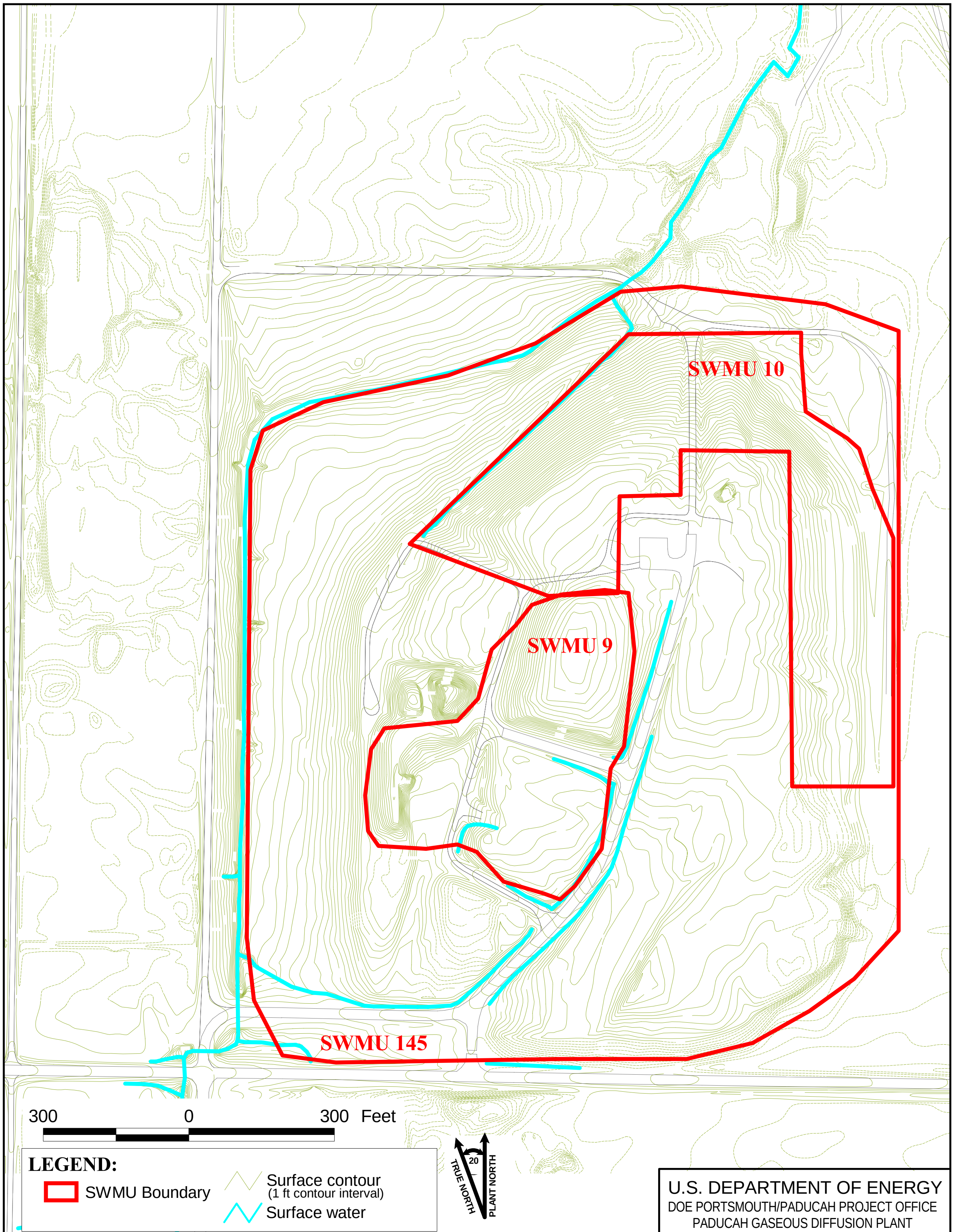

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Figure 1.10. SWMU 145 Historical Layout

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1.3.8.2 Site history

SWMU 145 began operation in the early 1950s. A 1973 document *The Discard of Scrap Materials by Burial at the Paducah Plant* (Union Carbide 1973), states this area was used by the contractor during the construction of PGDP to discard all types of scrap and waste materials. Use of the area for discarding of scrap and waste by subcontractors was continued until the early 1980s. Construction debris, such as concrete, roofing materials, wire, wood, shingles with asbestos, and welding rods, are expected to have been disposed of in the area. Approximately once a year, the accumulated scrap piles were moved by plant personnel into piles or earth depressions and, whenever practicable, covered with dirt. The area was later permitted for the construction and operation of the C-746-S and -T Landfills (BJC 2001a). Figure 1.11 shows historical aerial photographs of the area and depicts evident ground scarring, likely indicating areas of discard.

Several monitoring wells are present in the area for permit-related monitoring. Since 2003, these wells have indicated the presence of PCBs in the RGA (see Section 4).

1.4 REPORT ORGANIZATION

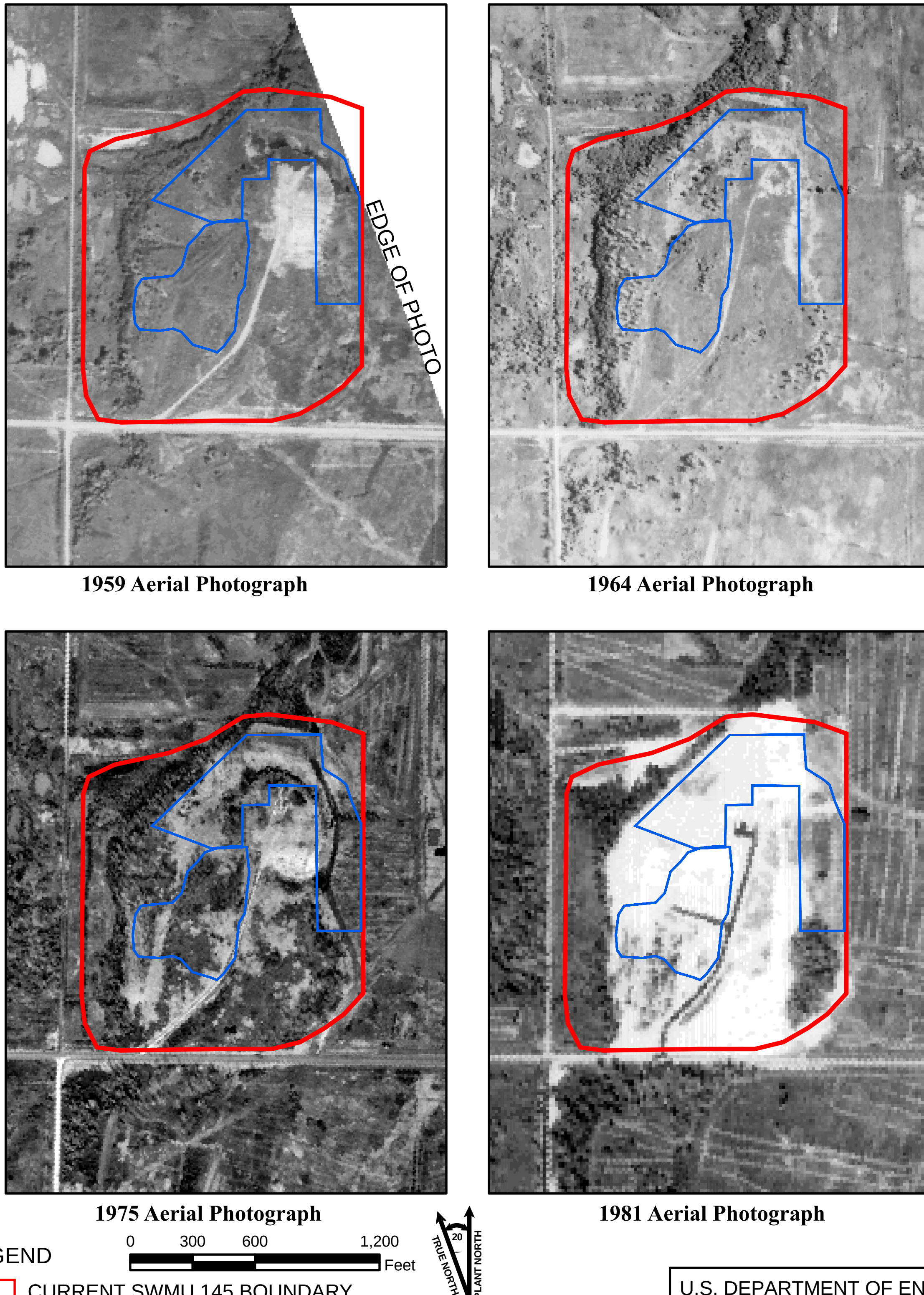
This RI report was prepared following the guidance found in Appendix D of the FFA for PGDP (EPA 1998). The outline of this report followed the guidance presented in Appendix D of the *Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2006a).

These sections are consistent with the FFA. The following are their locations within this report.

- Chapter 1—Introduction
- Chapter 2—Study Area Investigation
- Chapter 3—Physical Characteristics of the Study Area
- Chapter 4—Nature and Extent of Contamination
- Chapter 5—Fate and Transport
- Chapter 6—Baseline Risk Assessment
- Chapter 7—Summary and Conclusions
- Chapter 8—References

Additionally, the following appendices are included to support the information presented in the text.

- Appendix A—Technical Memorandum for Field Activities
- Appendix B—Lithologic Logs and Well Construction Diagrams, Groundwater Stabilization Logs, and Well Development Logs
- Appendix C—Analytical Data and Quality Assurance (QA)/Quality Control (QC) Evaluation Results
- Appendix D—Three-Dimensional Visualization Figures
- Appendix E—Fate and Transport Modeling
- Appendix F—Baseline Human Health Risk Assessment
- Appendix G—Ecological Risk Assessment



1959 Aerial Photograph

1964 Aerial Photograph

1975 Aerial Photograph

1981 Aerial Photograph

LEGEND

CURRENT SWMU 145 BOUNDARY

CURRENT SWMUs 9 and 10 BOUNDARIES

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Figure 1.11. Historical Aerial Photographs of SWMU 145

2. STUDY AREA INVESTIGATION

Section 2 includes all field activities associated with site characterization of the BGOU. Technical memoranda documenting details of field activities are included in Appendix A.

2.1 GEOPHYSICAL INVESTIGATIONS

Current geophysical investigations were combined with historical geophysical information to create a more complete picture of the burial area.

Geophysical surveys of SWMUs 2, 5, 7, 30, and 145, were conducted prior to sampling activities. The BGOU represented a difficult target for geophysical characterization because the SWMUs contain a heterogeneous collection of wastes and backfill soils, and some of these SWMUs consist of multiple burial pits of various depths.

An electromagnetic (EM)-61 magnetometer survey was conducted at the surface of these SWMUs to delineate the location and extent of the burial pits. The EM-61 survey was implemented for the most part along continuous lines primarily spaced 5 ft apart in a grid layout. A data logger was employed for data acquisition, and resultant geophysical anomalies were marked in the field and plotted using plant coordinates to an electronic overlay.

In addition to the current geophysical surveys, historical geophysical information is available for SWMUs 2, 4, 5, 6, 7, and 30. Results of the geophysical surveys conducted for the BGOU RI and historical information gathered during this RI is presented on Figures 2.1 through 2.6.

The area within SWMU 13 identified by an employee interview was confirmed by a geophysics survey. The results of this survey are presented in Figure 2.7. This geophysical information and data available for this area will be evaluated under the BGOU FS.

2.2 CONTAMINANT SOURCE INVESTIGATIONS

In order to evaluate contaminant sources, angled soil borings were utilized to collect samples from the soils and groundwater beneath the burial pits. Available information from aerial photographs, historical and current geophysics, engineering drawings, and previous RIs was used to determine the most probable location of the burial pit. Angled soil borings then were placed to collect samples from beneath the burial pits and/or cells. Figures 2.8 through 2.14 show the locations of these angled borings.

The locations of the angled soil borings and deep vertical soil borings were determined in order to avoid drilling into any burial cells. Set-back calculations, the use of geophysics, and historical process knowledge were utilized to determine pit boundaries and depths. During the drilling of Boring 104 at SWMU 145, the field effort was stopped when a safety meter detected a gas coming from the drill stem near the lower explosive limit. According to the recollection of a landfill operator who had worked at the site for several years, roofing material had been disposed of and covered with soil in the area, though not expected to be the source of the gas. Gas samples were collected and analyzed immediately by the USEC laboratory. The gas was determined to be methane. It is believed the methane was migrating from buried

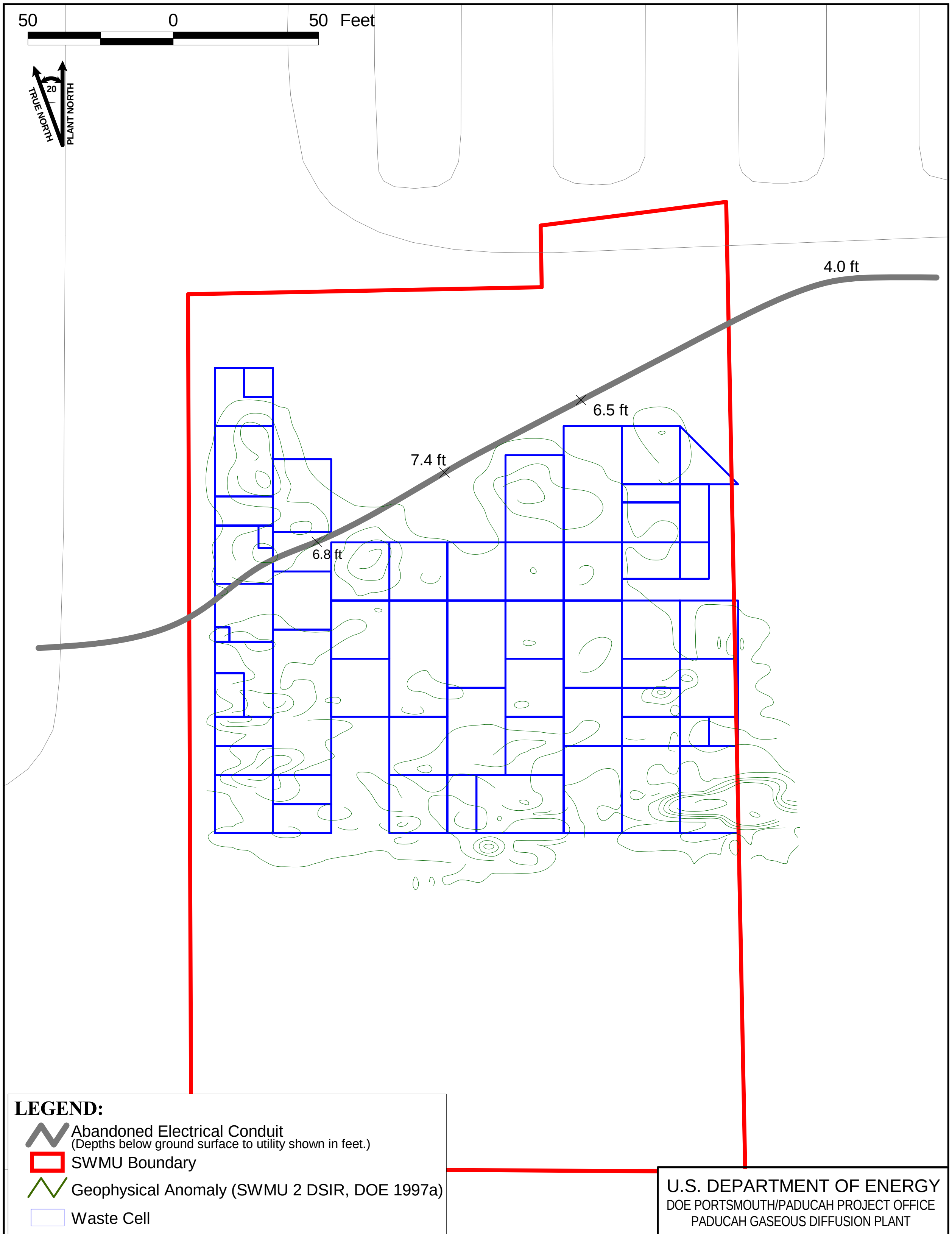

Figure 2.1. SWMU 2 Geophysics

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Figure 2.2. SWMU 4 Geophysics

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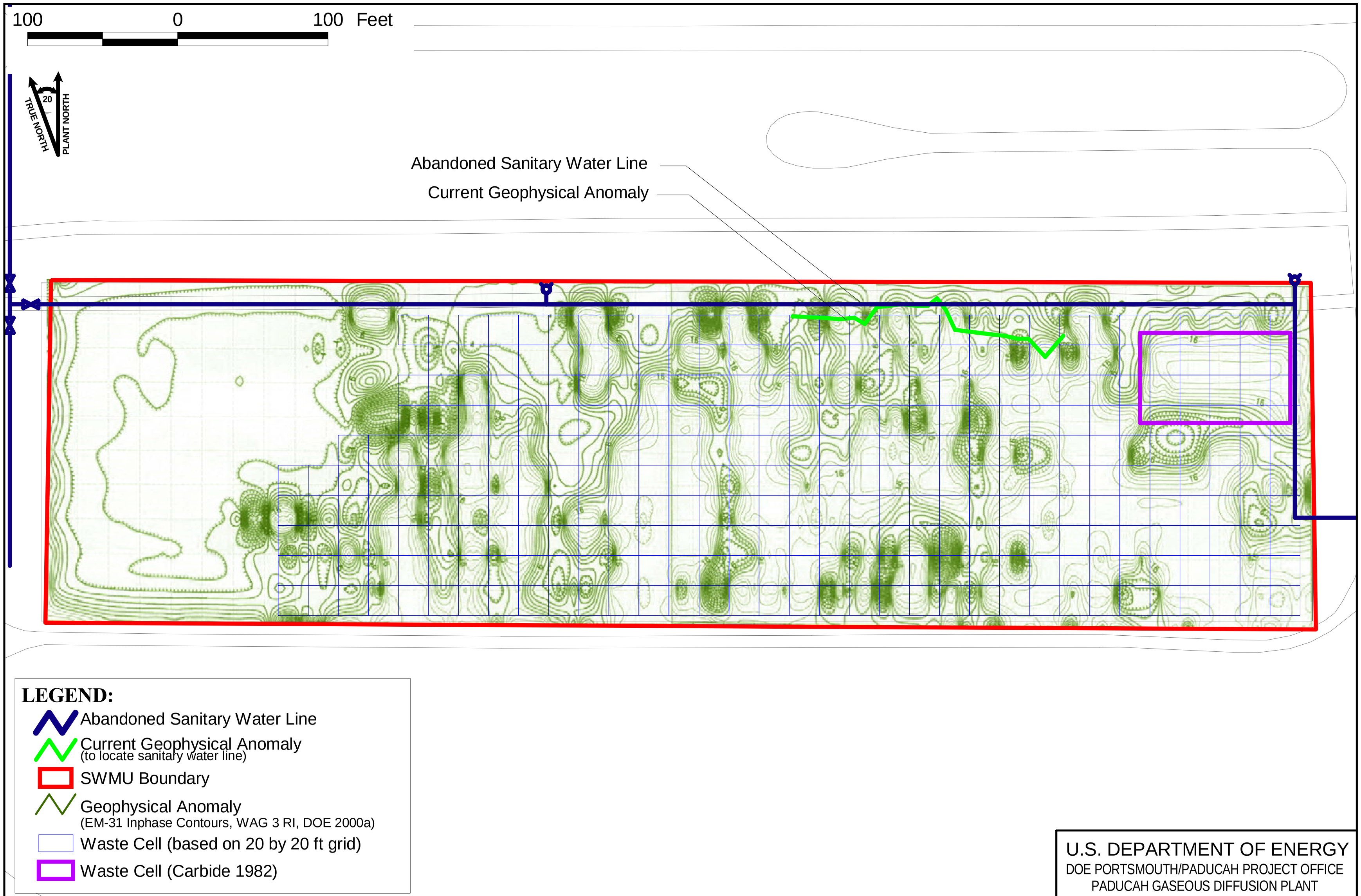

Figure 2.3. SWMU 5 Geophysics

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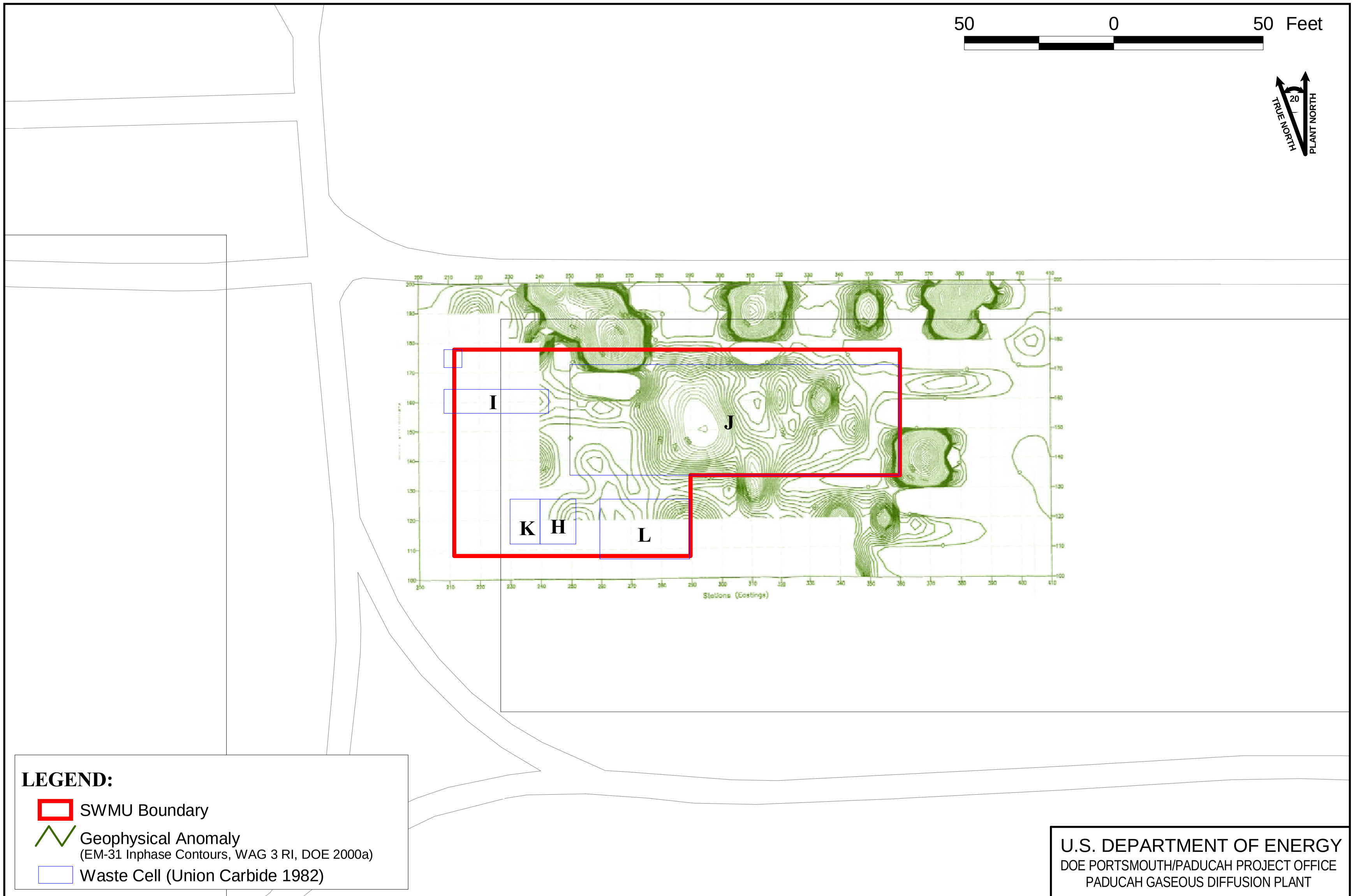

Figure 2.4. SWMU 6 Geophysics

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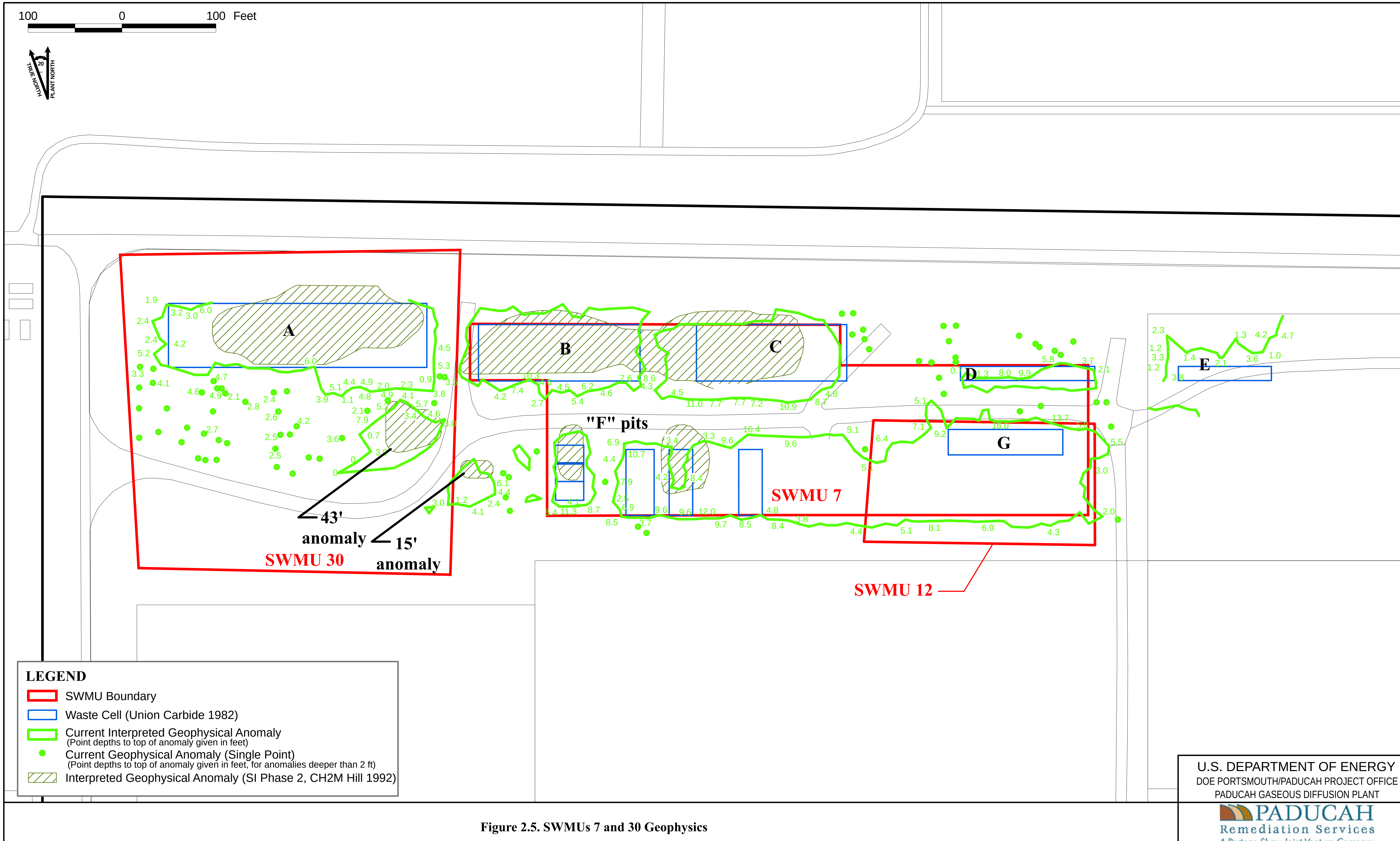

Figure 2.5. SWMUs 7 and 30 Geophysics

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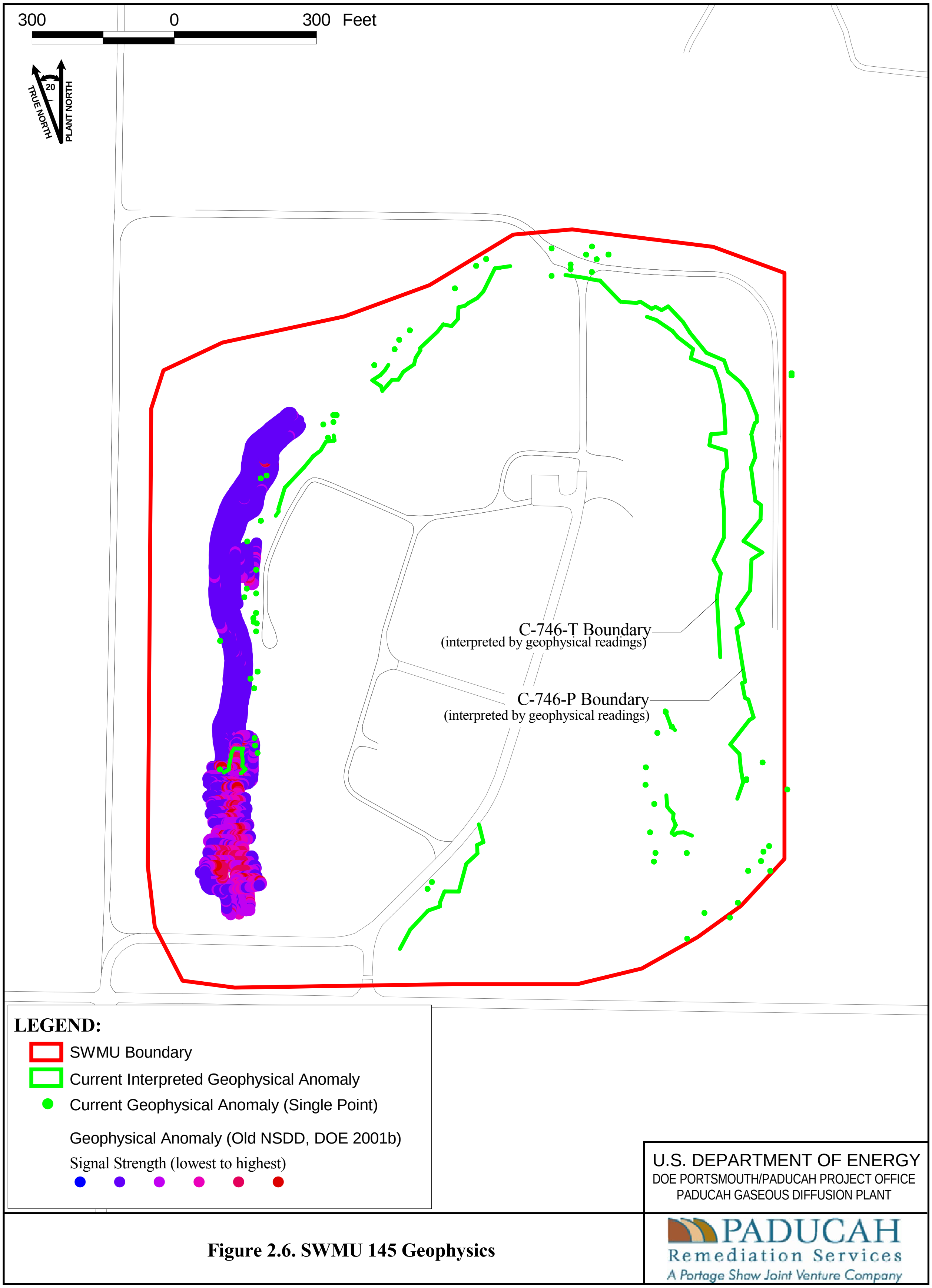

Figure 2.6. SWMU 145 Geophysics

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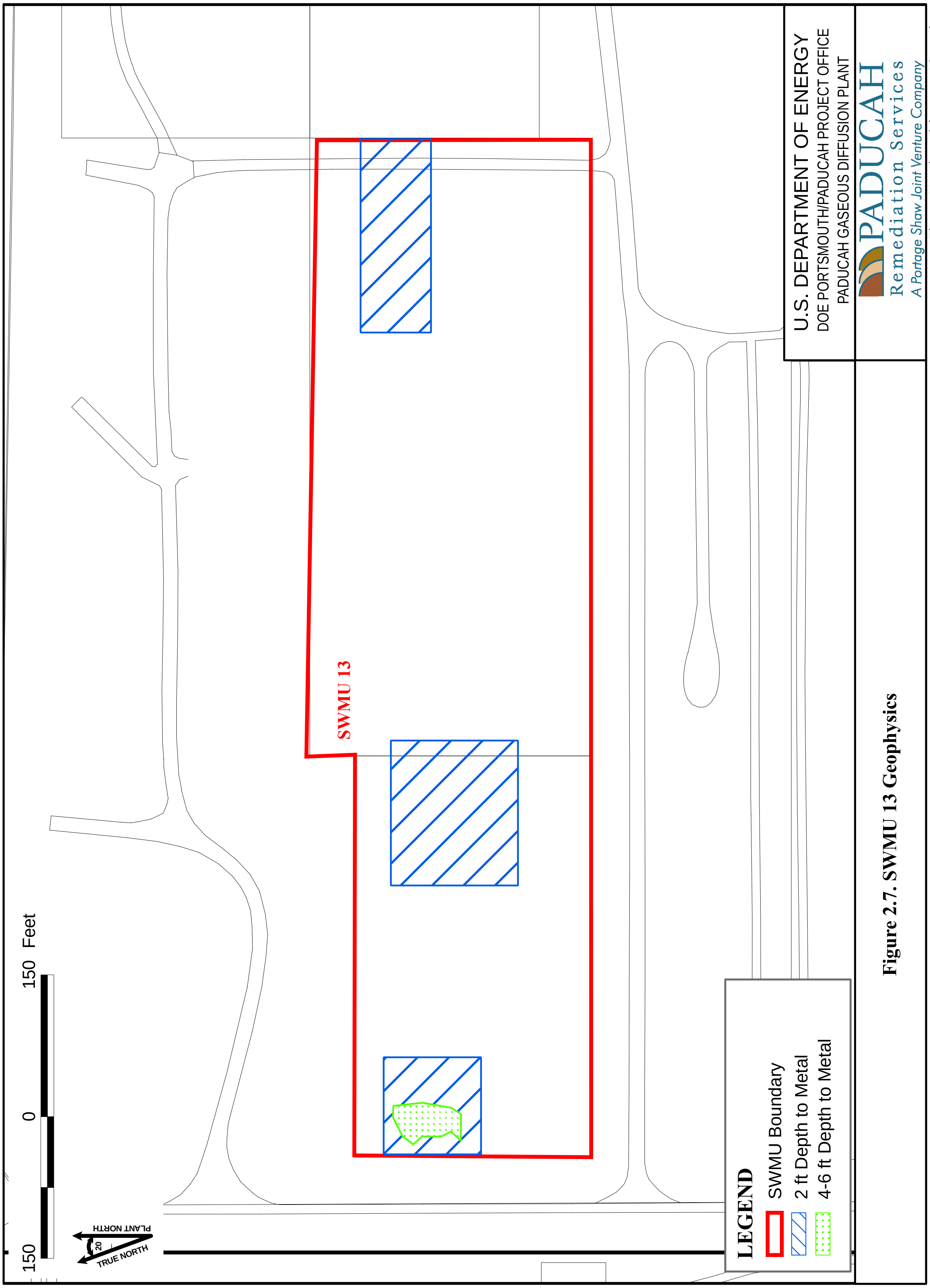


Figure 2.7. SWMU 13 Geophysics

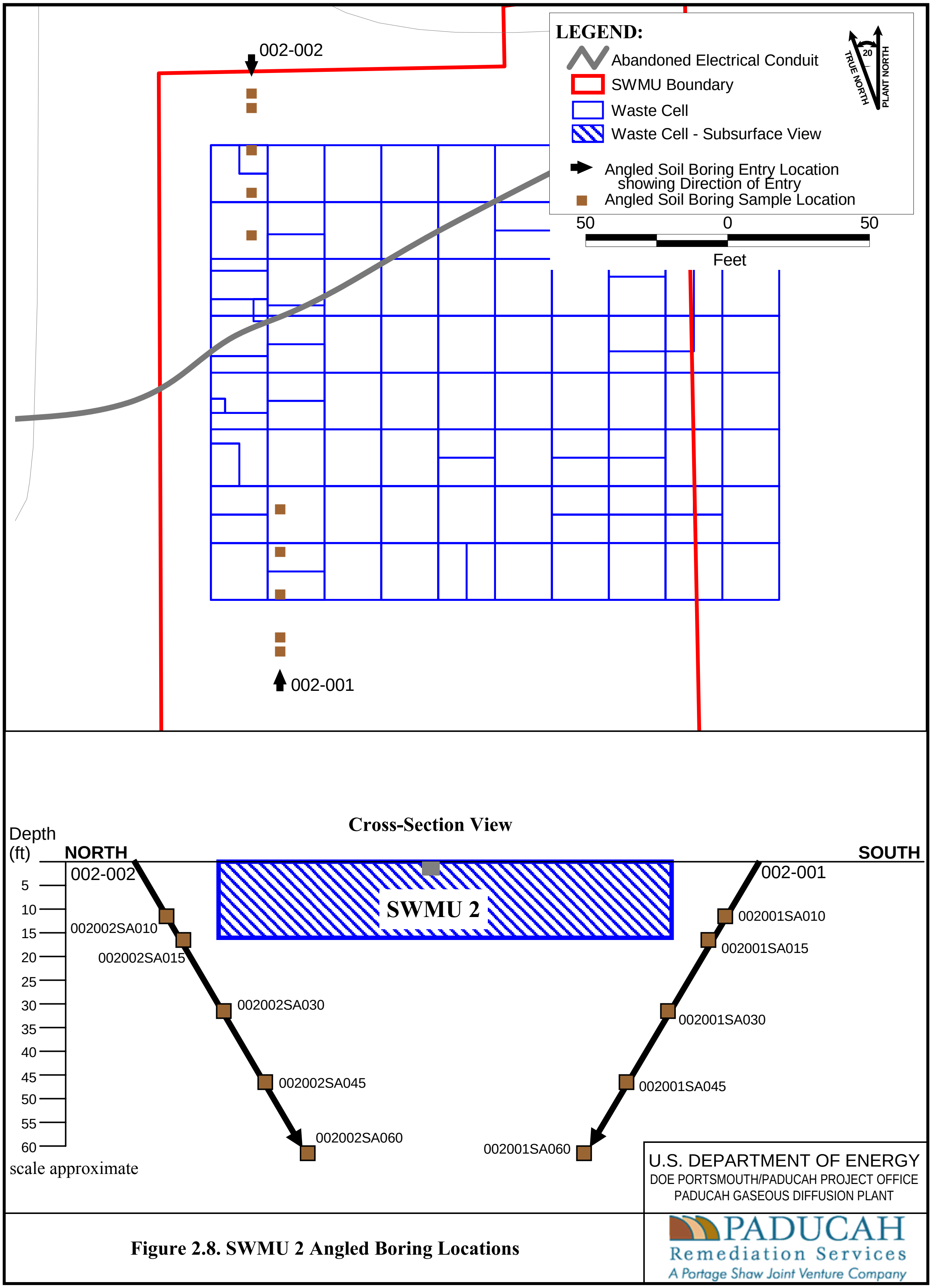


Figure 2.8. SWMU 2 Angled Boring Locations

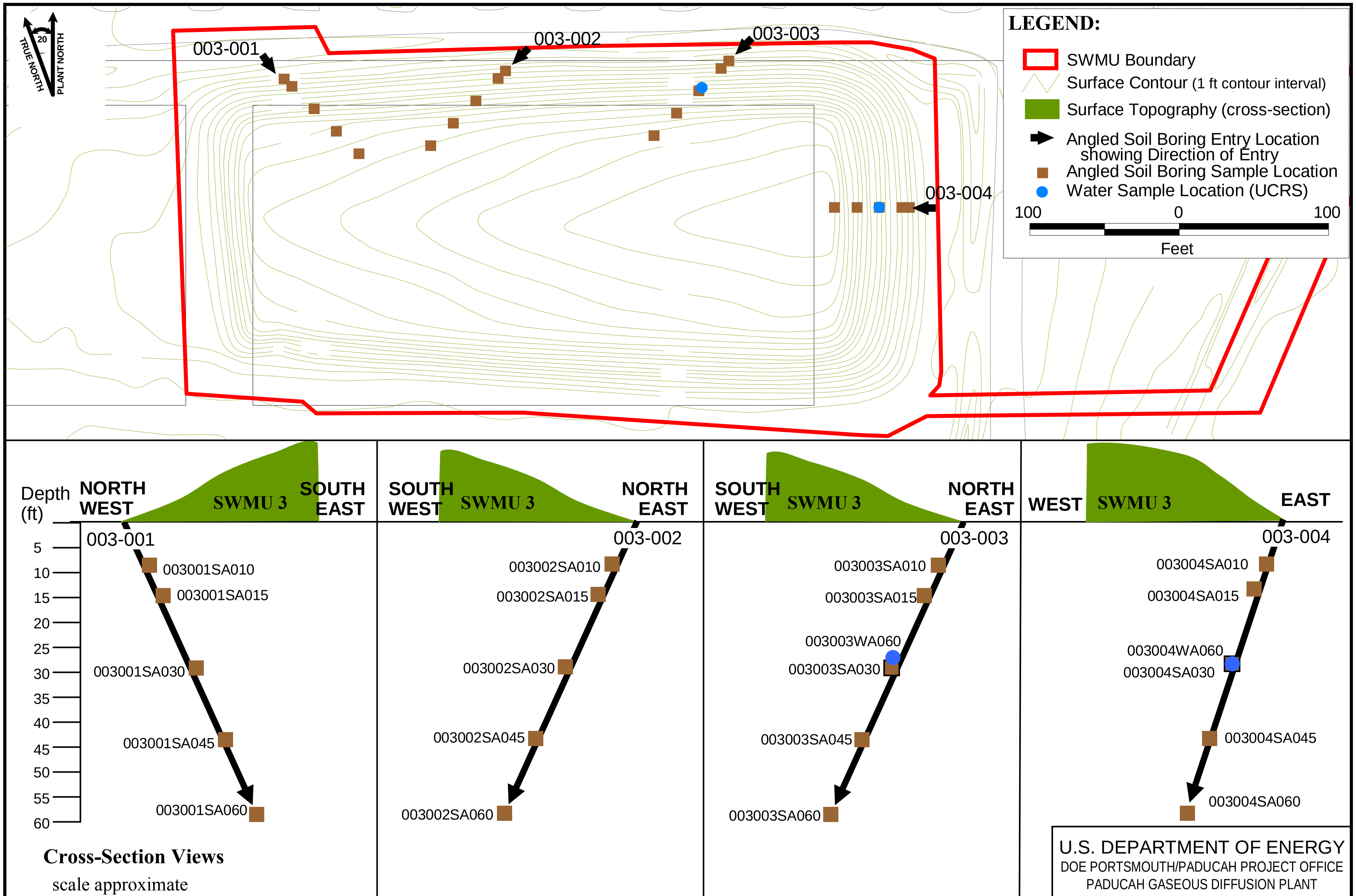
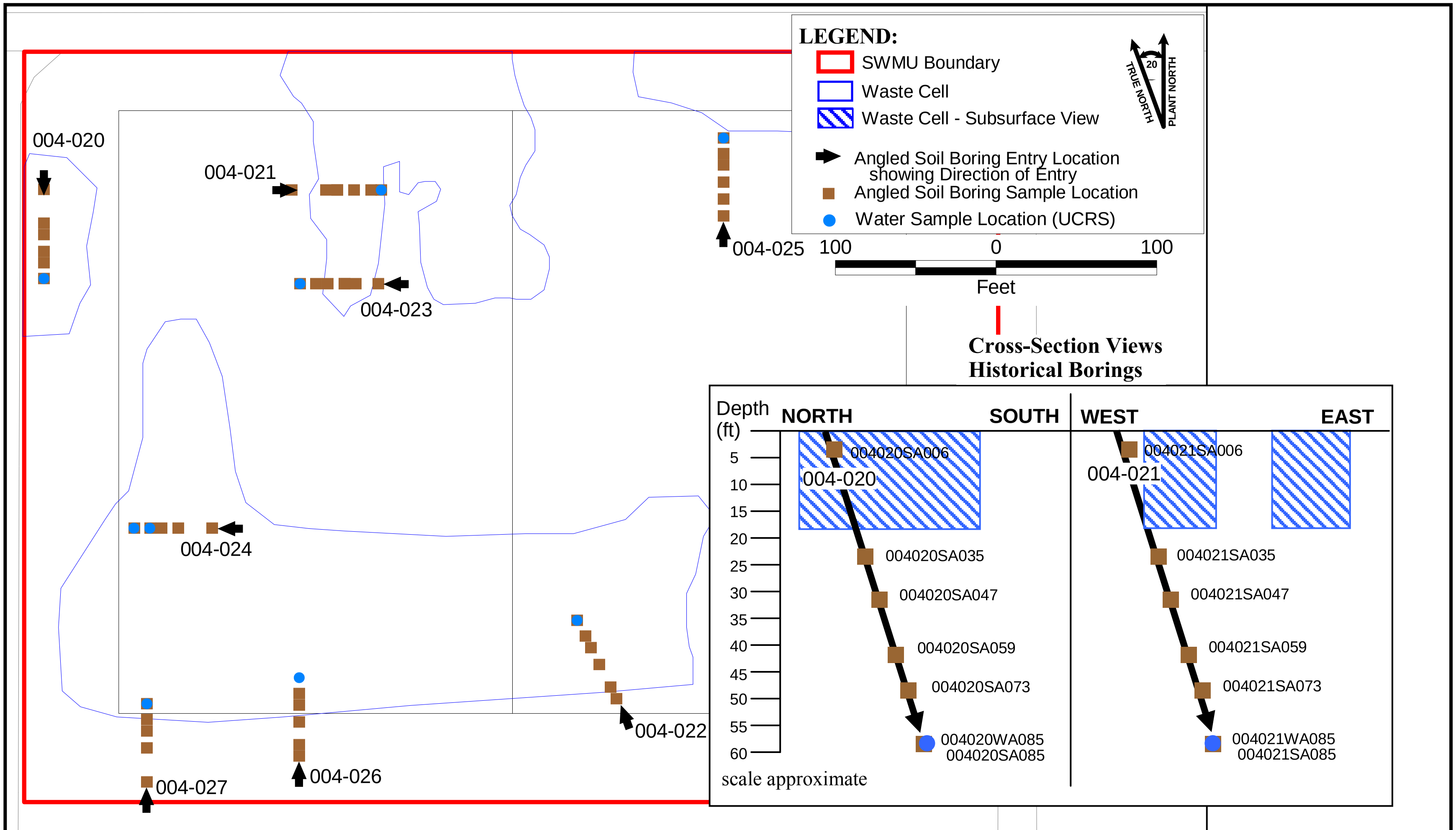


Figure 2.9. SWMU 3 Angled Borings



Cross-Section Views of Historical Borings continued on the following page.

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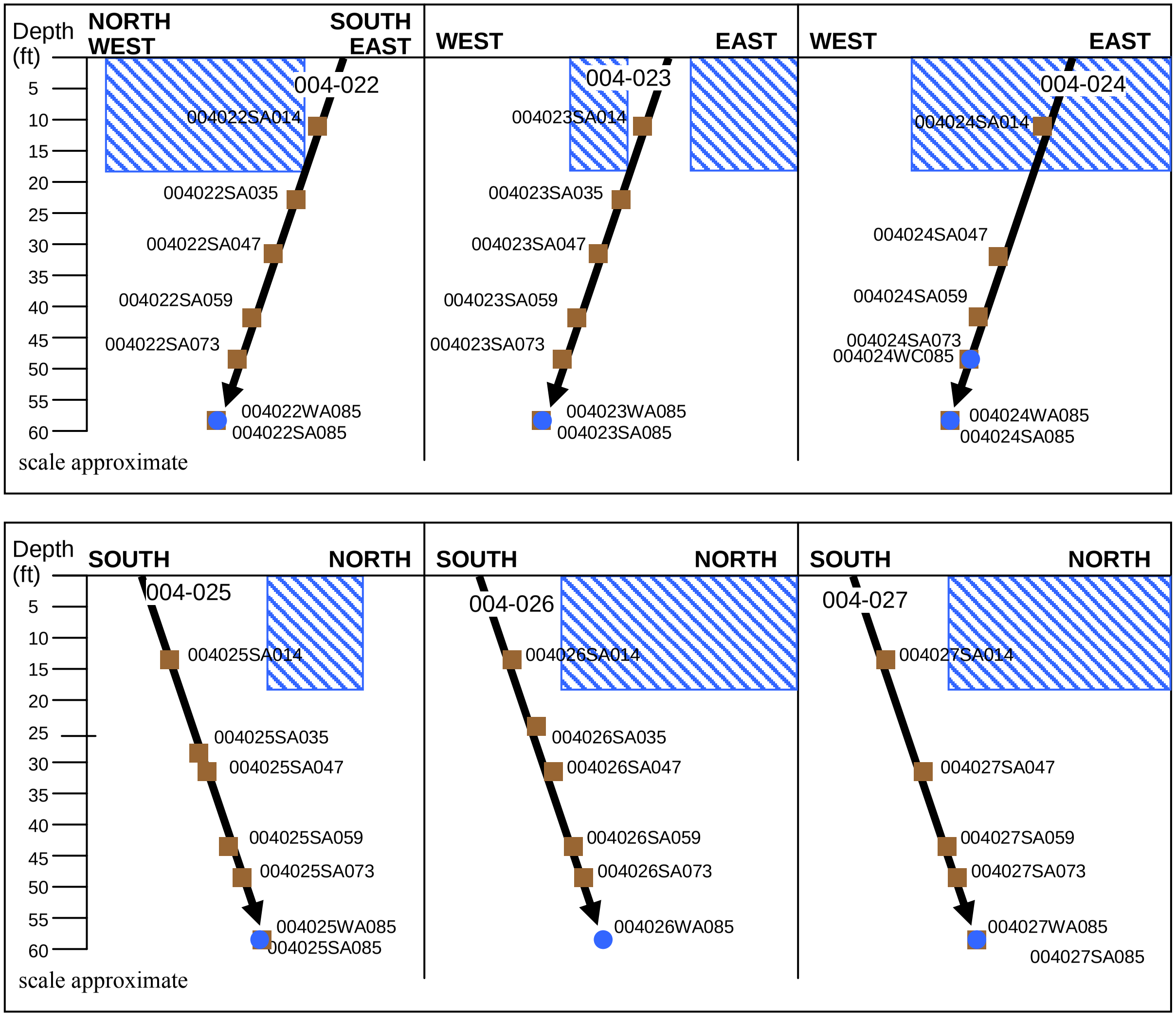
Figure 2.10. SWMU 4 Angled Borings



Cross-Section Views
Historical Borings

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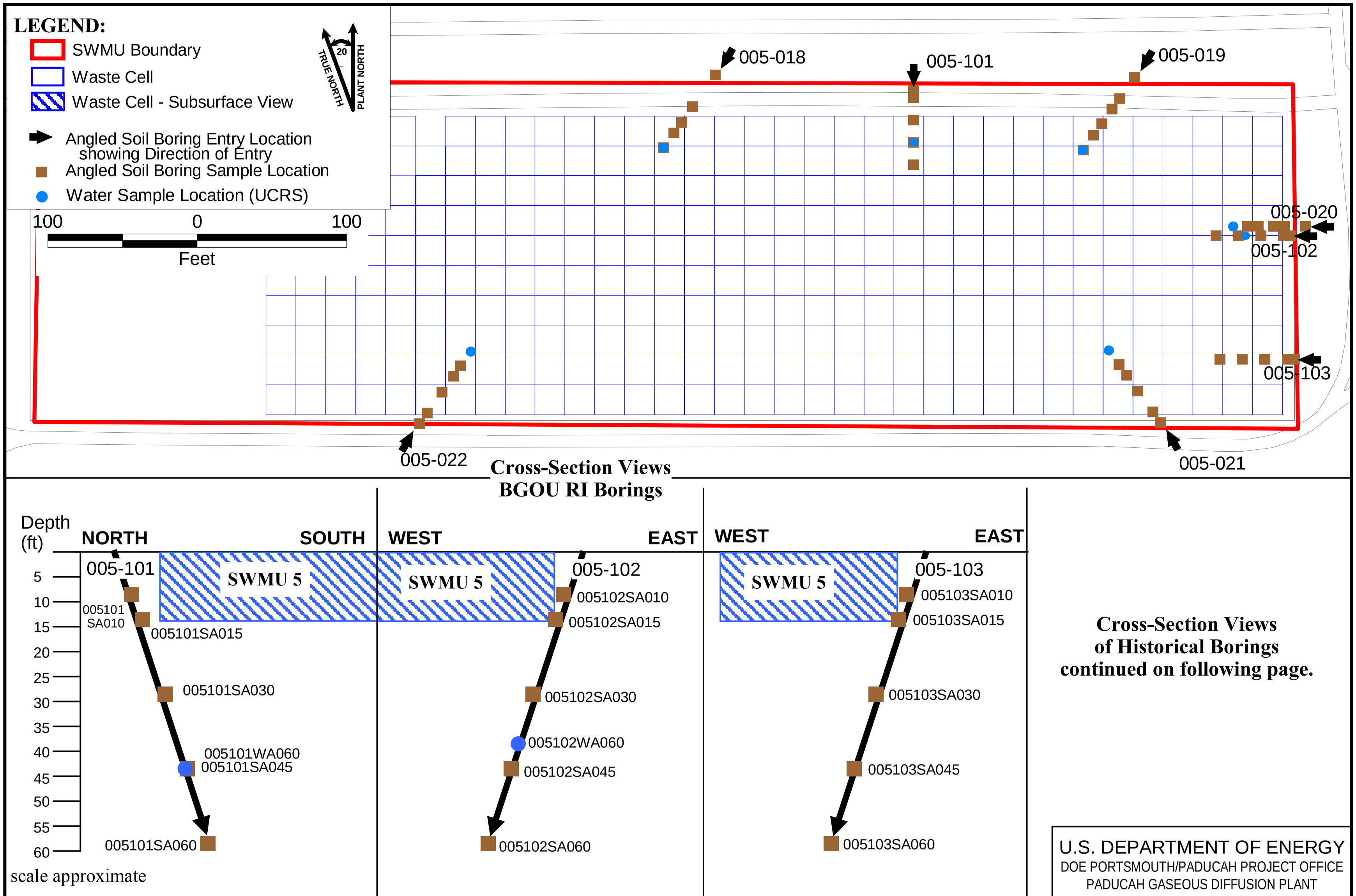
Figure 2.10. (Continued)



Cross-Section Views of Historical Borings continued on following page.

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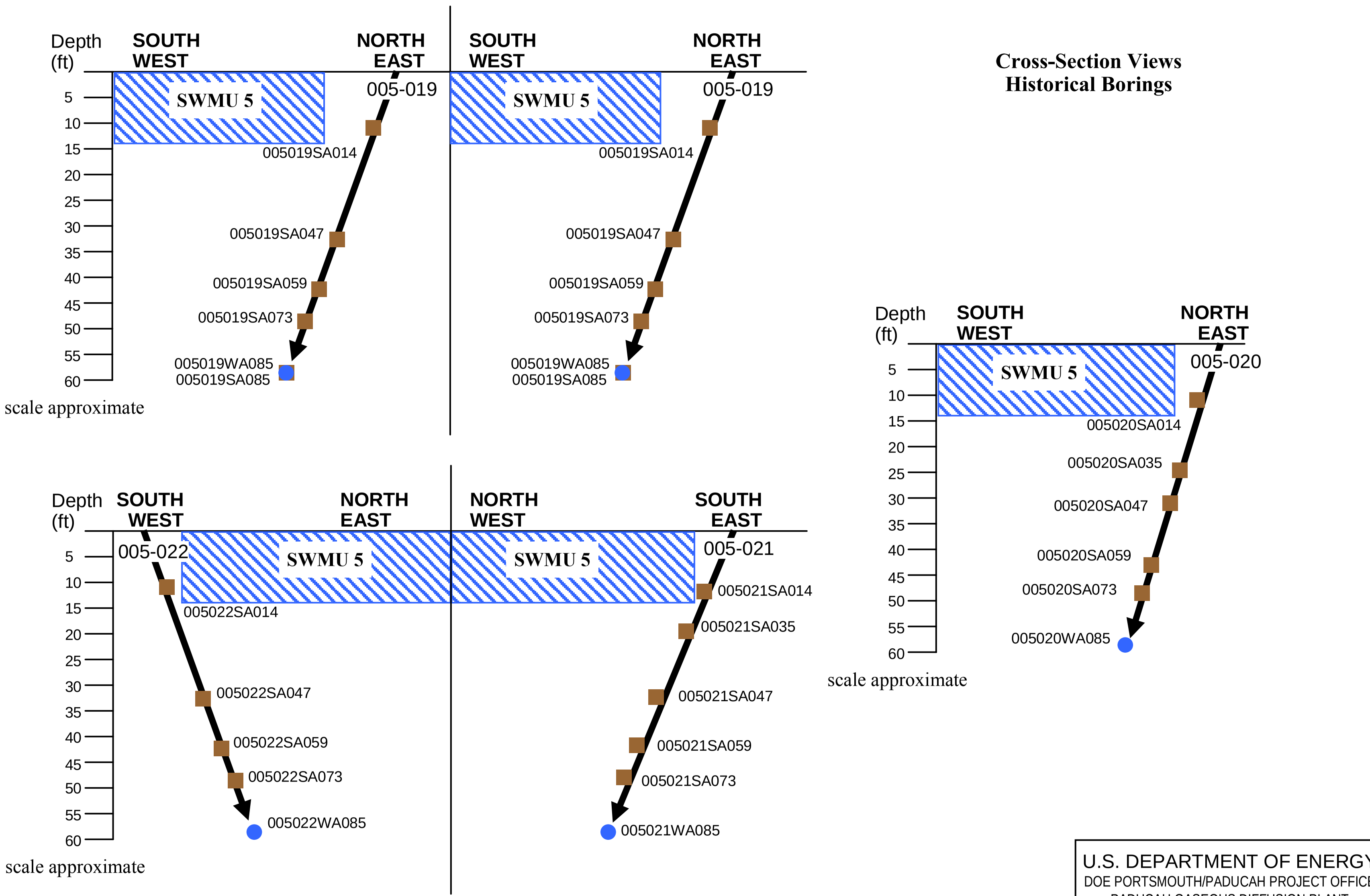
Figure 2.11. SWMU 5 Angled Borings



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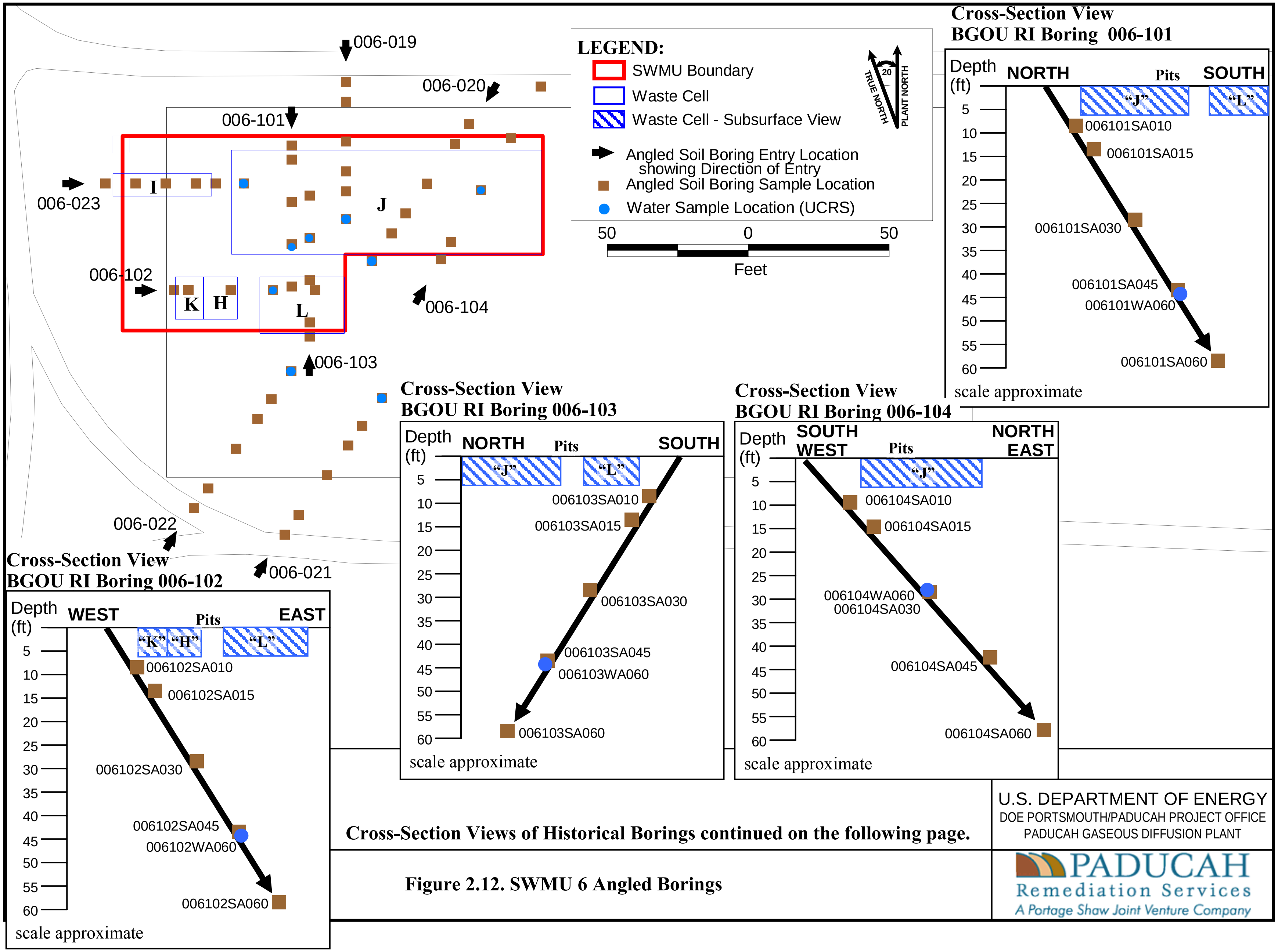

Cross-Section Views of Historical Borings continued on the following page.

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PADUCAH GASEOUS DIFFUSION PLANT

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Figure 2.12. SWMU 6 Angled Borings

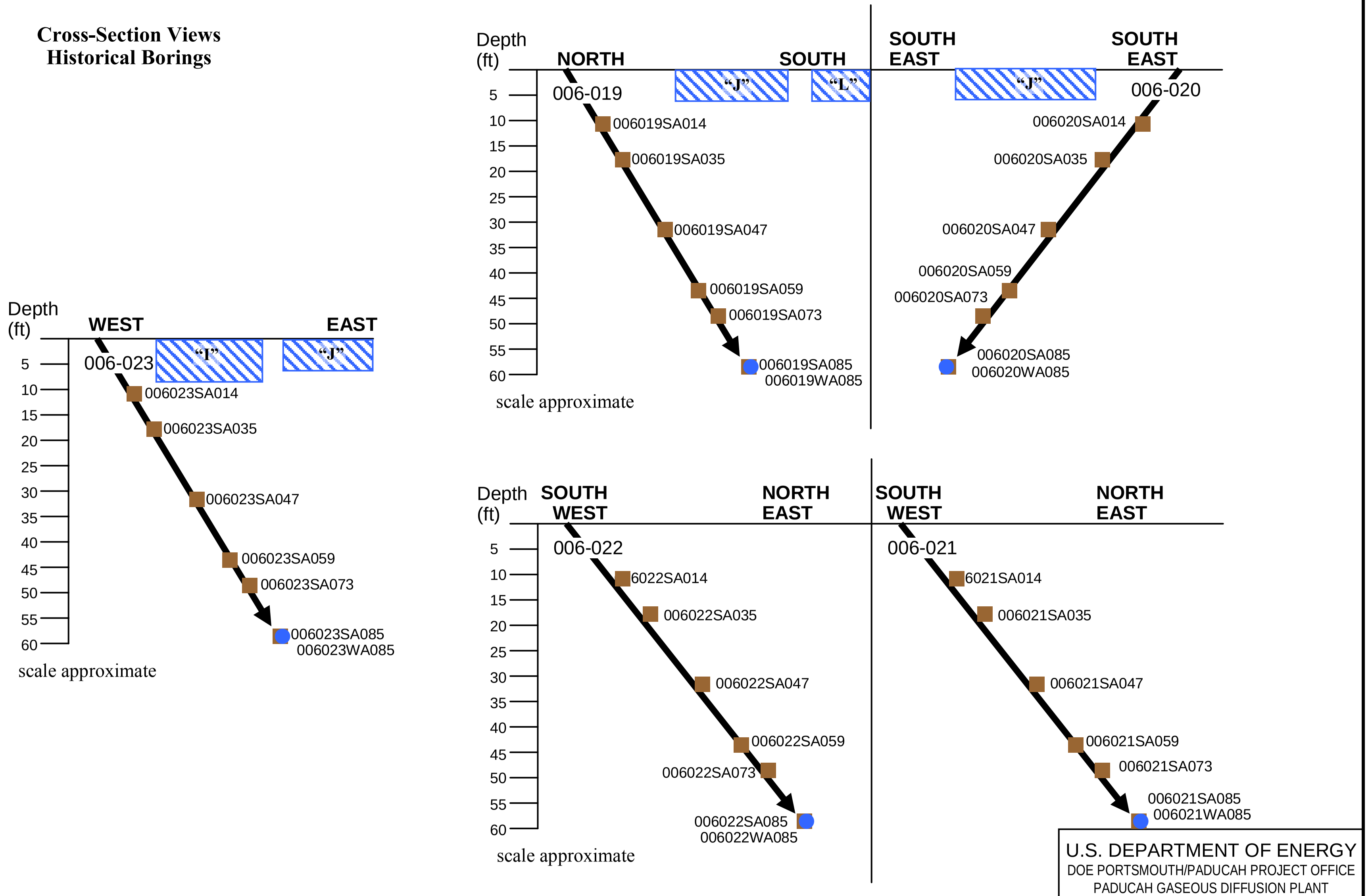

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Figure 2.12. (Continued)

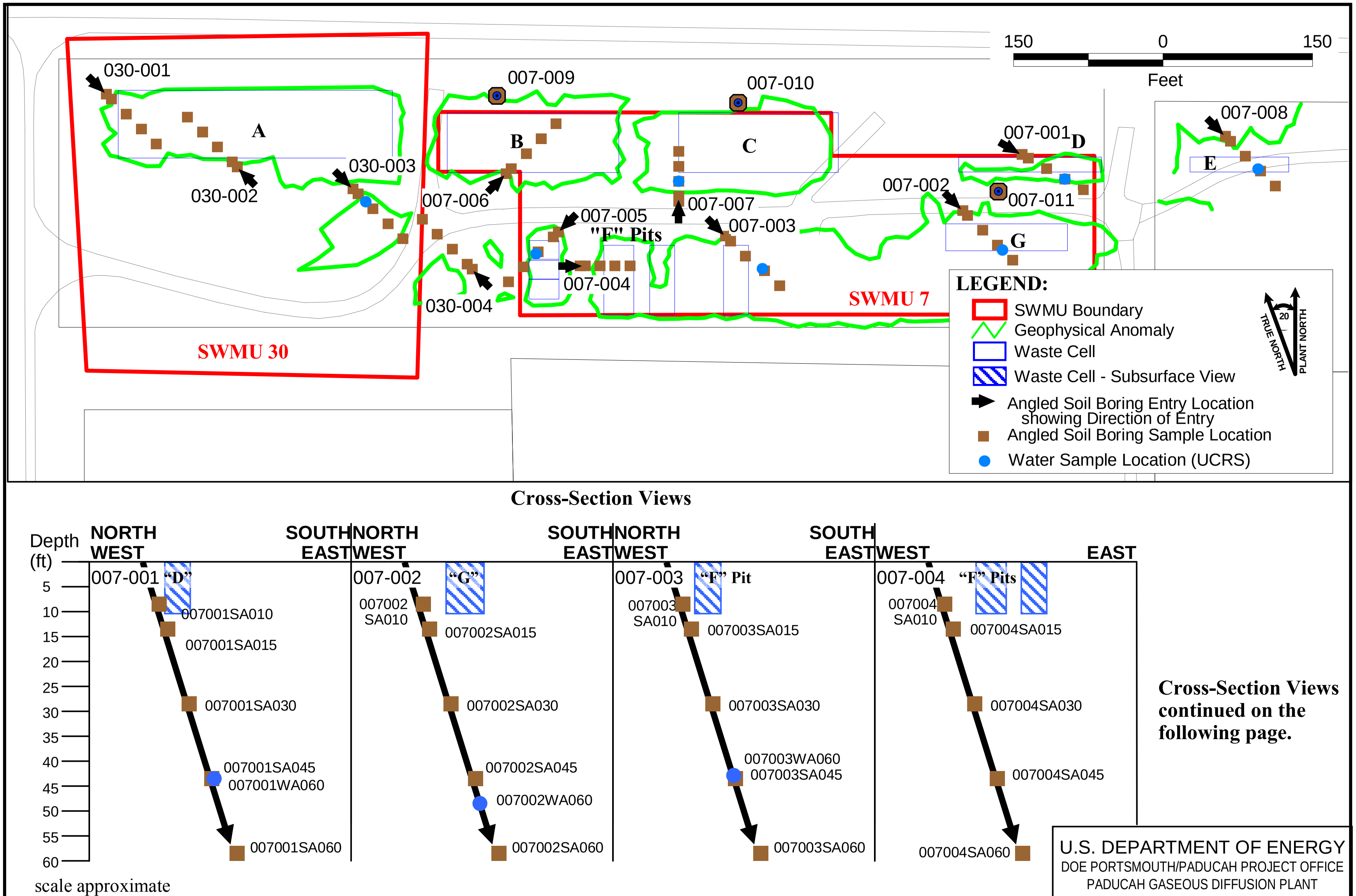

Figure 2.13. SWMUs 7 and 30 Angled Borings

Cross-Section Views

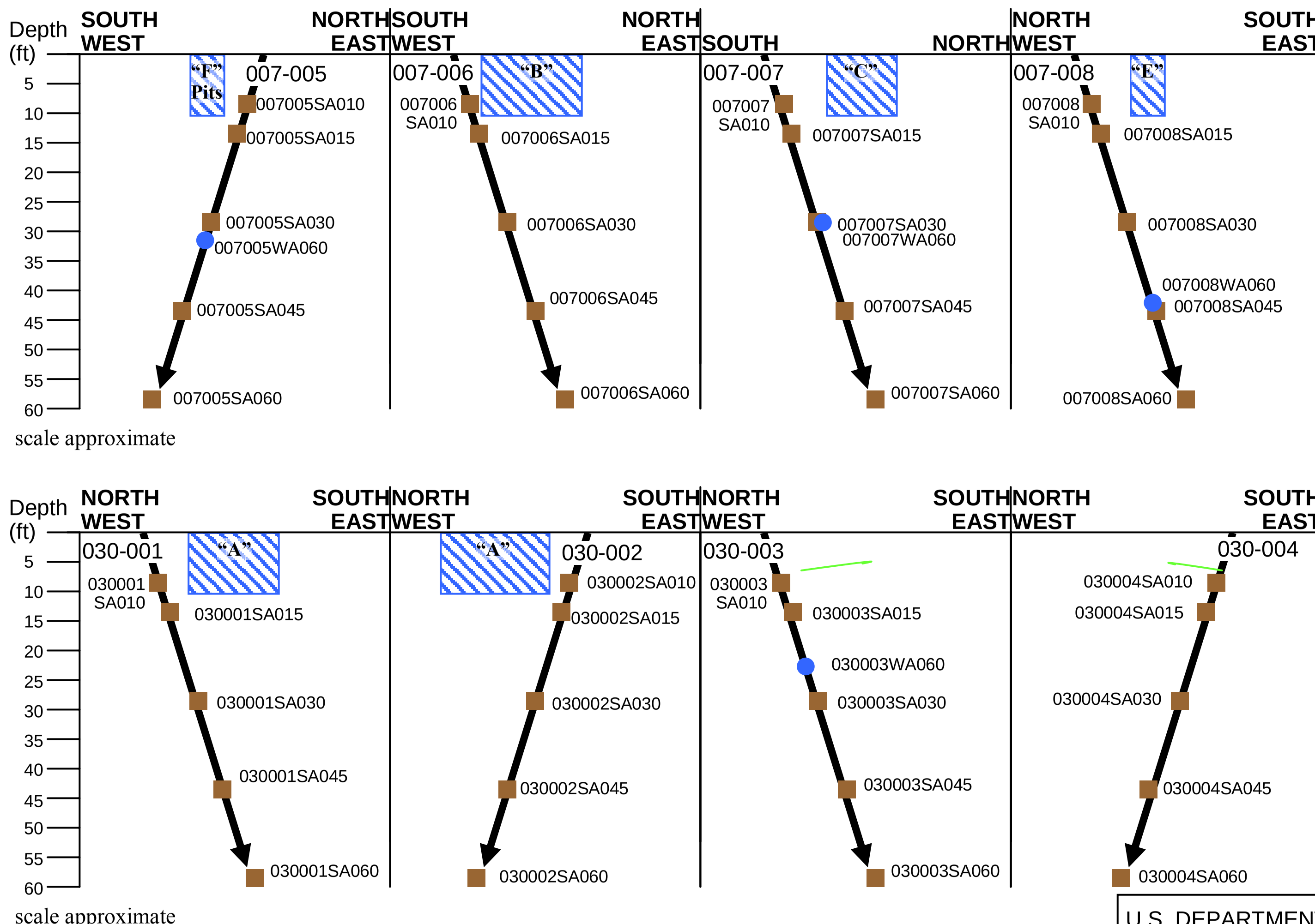

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Figure 2.13. (Continued)

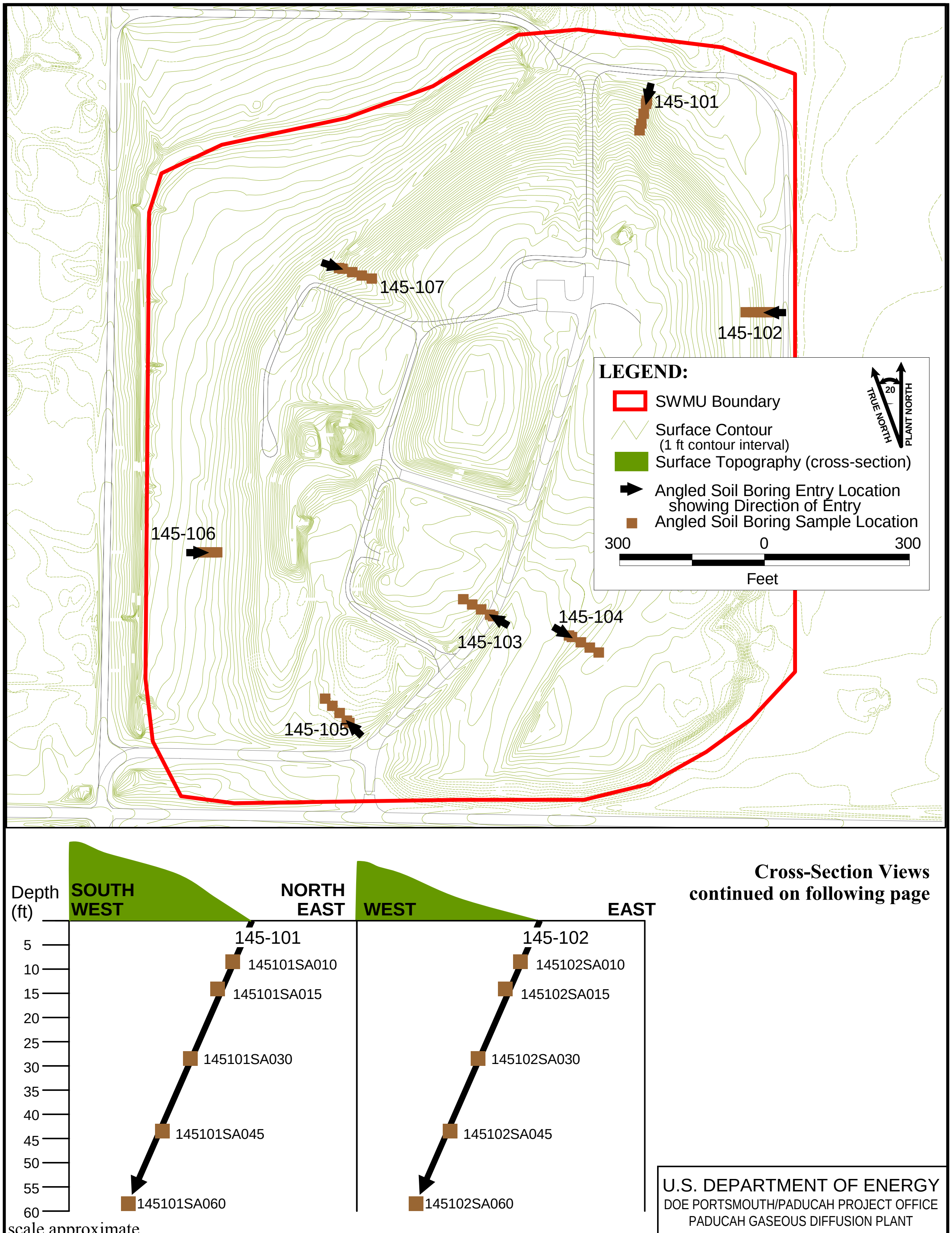

Figure 2.14. SWMU 145 Angled Boring Locations

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Cross-Section Views

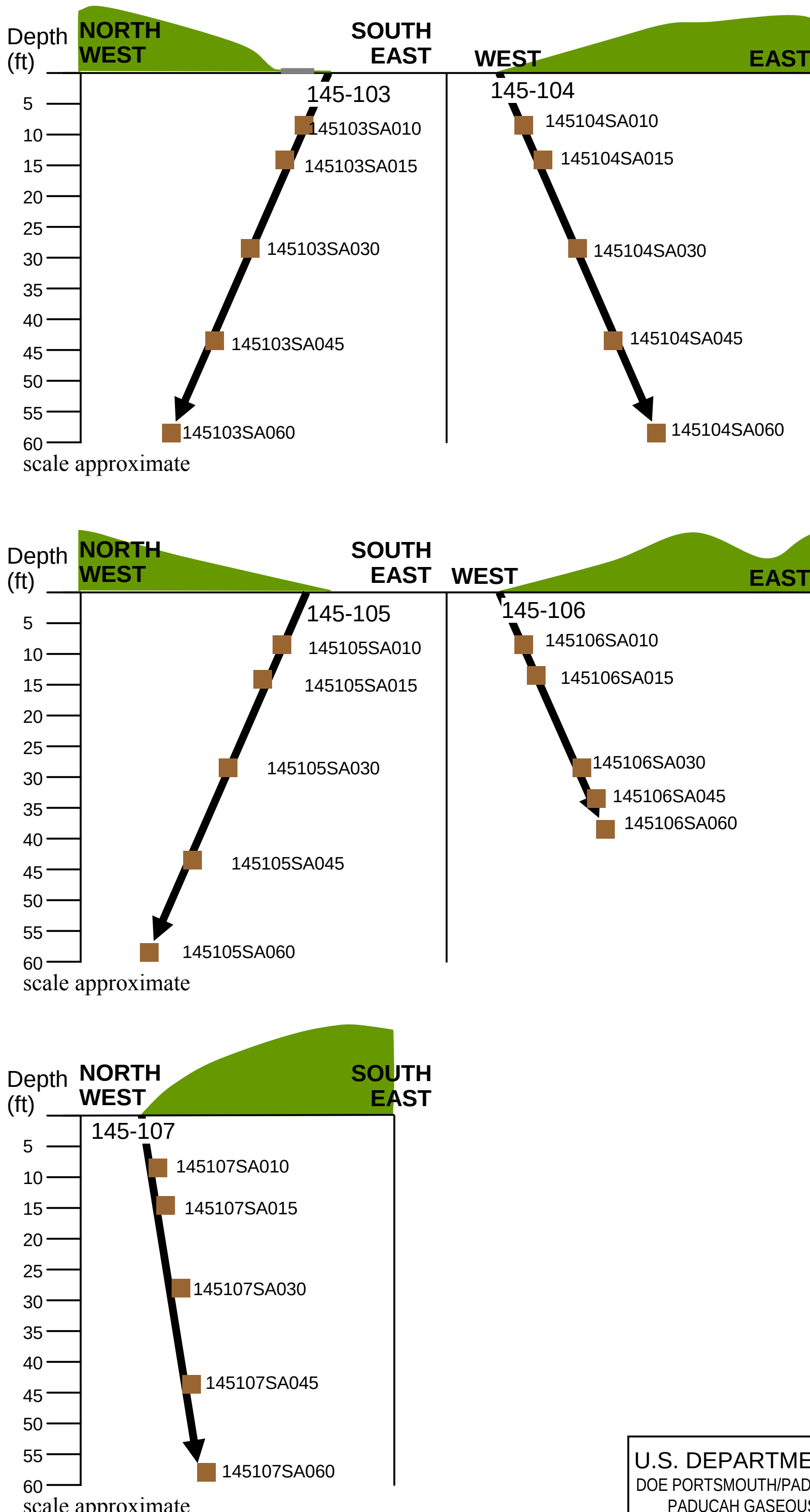

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Figure 2.14. (Continued)

material in the area. The borehole was allowed to vent and sampling was completed during the next two weeks.

2.3 SOIL INVESTIGATIONS

Subsurface soil samples from the angled borings were collected generally from 7 to 11 ft, 11 to 14 ft, 28 to 32 ft, 42 to 46 ft, and 57 to 60 ft bgs (a total of five sets of soil samples per boring) in order to effectively identify probable and potential contaminant migration and exposure pathways, as directed by the BGOU Work Plan (DOE 2006a). Soil samples were not collected at or near the surface in angled borings because these borings were installed at a given distance from the burial cell, outside the influence of a burial pit. Locations of these soil samples, relative to their surface penetration, are shown in Figures 2.8 through 2.14. Table 2.1 summarizes soil sampling and analysis from the BGOU RI. Appendix D provides the soil and groundwater analytical results in a searchable database on compact disk.

In addition to the angled borings, subsurface soil samples were collected from both shallow and deep vertical borings (see Figures 2.8 through 2.14). Ten shallow borings were installed along a former drainage ditch that connected the C-404 Landfill and the NSDD. Samples from these borings were collected at the surface and from 1 to 5 ft, 5 to 10 ft, and 10 to 15 ft. Three deep vertical borings were installed within SWMU 7. Samples from these borings were collected at the surface and from 3 to 5 ft, 8 to 10 ft, 13 to 15 ft, 28 to 30 ft, 43 to 45 ft, and 58 to 60 ft.

Table 2.1. Summary of BGOU RI Soil Sampling and Analysis

Location	Activity	Number of Borings	Sampling Interval (ft bgs)[a]	Analyses per Sampling Interval	Sampling Rationale
SWMU 2	Angled Borings	2	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides VOCs	Sampling intended to characterize soils beneath typical waste cell.
SWMU 3	Angled Borings	4	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides VOCs	Sampling intended to characterize soils beneath waste cell.
	Shallow Vertical Borings	10	0-1 1-5 5-10 10-15	Metals PCBs Radionuclides	Sampling intended to characterize soils along former discharge ditch.
SWMU 5	Angled Borings	3	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides	Sampling intended to characterize soils beneath typical waste cell.

Table 2.1. Summary of BGOU RI Soil Sampling and Analysis (Continued)

Location	Activity	Number of Borings	Sampling Interval (ft bgs)[a]	Analyses per Sampling Interval	Sampling Rationale
SWMU 6	Angled Borings	4	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides	Sampling intended to characterize soils beneath typical waste cell.
SWMU 7	Angled Borings	8	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides SVOCs VOCs	Sampling intended to characterize soils beneath geophysics-defined waste cells.
	Deep Vertical Borings	3	0-1 3-5 8-10 13-15 28-30 43-45 58-60	Metals PCBs Radionuclides SVOCs VOCs	Sampling intended to characterize soils downgradient of typical waste cell.
SWMU 30	Angled Borings	4	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides SVOCs VOCs	Sampling intended to characterize soils beneath geophysics-defined waste cells.
SWMU 145	Angled Borings	7	7-11 11-14 28-32 42-46 57-60	Metals PCBs Radionuclides VOCs	Sampling intended to characterize soils beneath geophysics-defined waste cell boundary and areas of disturbance defined in historical photos.

[a] Sampling Interval reported in vertical depth.
SVOC = semivolatile organic compound
VOC = volatile organic compound

2.4 GROUNDWATER INVESTIGATIONS

Collection of an Upper Continental Recharge System (UCRS) groundwater sample was attempted for each angled boring. Of the 32 attempts, 17 boring locations provided enough groundwater to collect a sample. Locations of these samples are shown in Figures 2.8 through 2.14.

RGA groundwater samples in addition to UCRS groundwater samples were collected from the deep vertical borings. Generally, UCRS samples were collected from 30 to 45 ft bgs; while RGA samples were collected at 10 ft intervals beginning at 60 ft bgs to the base of the RGA. Table 2.2 summarizes groundwater sampling and analysis from the BGOU RI.

Table 2.2. Summary of BGOU RI Groundwater Sampling and Analysis

Location	Activity	Boring	Sampling Interval (ft bgs)[a]	Analyses per Sampling Interval	Comments
SWMU 2	Angled Borings	002-001 002-002	None collected None collected	Metals PCBs, VOCs Radionuclides	Groundwater not present in sufficient quantity for samples.
SWMU 3	Angled Borings	003-001 003-002 003-003 003-004	None collected None collected 28 30	Metals PCBs Radionuclides VOCs	Groundwater present in two of four borings in sufficient quantity for samples.
SWMU 5	Angled Borings	005-101 005-102 005-103	45 40 None collected	Metals PCBs Radionuclides	Groundwater present in two of three borings in sufficient quantity for samples.
SWMU 6	Angled Borings	006-101 006-102 006-103 006-104	46 45 45 45	Metals PCBs Radionuclides	Groundwater present in all four borings in sufficient quantity for samples.
SWMU 7	Angled Borings	007-001 007-002 007-003 007-004 007-005 007-006 007-007 007-008	45 50 43 None collected 45 None collected 45 43	Metals PCBs Radionuclides SVOCs VOCs	Groundwater present in six of eight borings in sufficient quantity for samples.
	Deep Vertical Borings	007-009 007-010 007-011	50 69[b] 80[b] 90[b] 45 60[b] 66[c] 80[b] 90[b] 100[c] 45 60[b] 70[b] 80[b] 90[b]	Metals PCBs Radionuclides SVOCs VOCs	Groundwater samples collected in UCRS and at 10 ft intervals within the RGA.
SWMU 30	Angled Borings	030-001 030-002 030-003 030-004	None collected None collected 23 None collected	Metals PCBs Radionuclides SVOCs, VOCs	Groundwater present in one of four borings in sufficient quantity for samples.
SWMU 145	Angled Borings	145-101 145-102 145-103 145-104 145-105 145-106 145-107	None collected None collected None collected None collected None collected None collected None collected	Metals PCBs Radionuclides VOCs	Groundwater not present in sufficient quantity for samples.

[a] Sampling interval reported in vertical depth, not drilled length.
[b] RGA
[c] Suspected McNairy
SVOC = semivolatile organic compound
VOC = volatile organic compound

Groundwater-productive intervals are uncommon in the UCRS. The following steps were followed to identify target sample depths and ensure the quality of the groundwater samples.

(1) Prior to drilling, identify likely depths of saturated, permeable horizons in the UCRS (typically a sand unit or soil unit containing appreciable sand content) from soil boring logs of area boreholes.

(2) As drilling proceeds, examine soil samples to determine the presence of saturated, permeable soils and monitor indications of water [i.e., drilling progress, drill cuttings (when using augers), and indications of water within the borehole (e.g., wet center rods)] to identify target horizons for UCRS groundwater samples.

(3) Upon drilling into a target groundwater-producing horizon in the UCRS, pull back the drill string several ft to expose the walls of the borehole and allow groundwater to flow into the open drill string.

(4) Measure depth to groundwater to determine the presence of water and the rate of rise of water within the drill string.

(5) If the target soils are water-productive, lower a clean sampling pump within the drill string. Position the sampling pump at least five ft above the base of the drill string, if possible, to minimize the potential of "sand locking" the pump inside the drill string.[1]

(6) Purge up to two to three gallons[2] of water, as necessary, to reduce the turbidity of the discharge water.

(7) Upon completion of the purge of initial, turbid water, route the discharge water through a flow-through cell equipped with a water quality monitor and document the stability of water quality criteria over time.

(8) Upon documenting stable water quality in the discharge stream, route the discharge stream through a sampling port, isolating the water in the sample stream from the flow-through cell.

(9) Collect the water sample. Because the discharge water often remained turbid and the analytical laboratory was not able to analyze volatile organic and semivolatile organic samples containing excessive turbidity, the field crew often filled bottles for these analyses last in an attempt to collect water samples with less turbidity.

(10) After collecting the UCRS groundwater sample and recovery of the sample pump, measure the depth to water in the borehole and then resume drilling and collection of soil samples. For the three vertical boreholes at SWMU 7, continue the borehole into the RGA, collecting groundwater samples at 10 ft depth intervals.

[1] Field experience revealed that sand settling out of the water column, as the soil borings were pumped, often accumulated in the base of the drill string. Later attempts to recover the pump could wedge the pump inside the drill string.

[2] For most soil borings that did not produce clear water, two to three gallons of initial purge water was adequate to assess the potential of producing a better quality water sample.

2.5 DEVIATIONS FROM ORIGINALLY PLANNED SAMPLE LOCATIONS

To deal with uncertainties identified in the BGOU, the observational approach was used in the design of the sampling strategy for the BGOU RI/FS. Site conditions and results of the geophysical investigation necessitated movement of some of the RI borings from their originally planned location. Movement of these locations was communicated among the parties and agreed to beforehand.

2.5.1 SWMU 2

Site conditions, results of a geophysical investigation, and a historical records search necessitated moving final placement of both SWMU 2 borings.

The angled boring 002-002 was formerly proposed at the center, northern edge of the unit. The boring was moved in order to place it north of burial areas (see Figure 2.8), which reportedly contain uranium sawdust and shavings from routine C-340 operations and machining operations. Buried material in this area is expected to be representative of other waste buried at C-749 (DOE 1995b).

The angled boring 002-001 initially was proposed to be moved slightly south to avoid penetrating the abandoned electrical conduit; however, the setup location for the drilling was too close to the cylinder yard to the west of SWMU 2. Historical sampling of the waste itself is available in this area [boring location SWMU2-12 of the SWMU 2 Interim Remedial Design Investigation (DOE 1997a)]; therefore, 002-001 was moved to the southern edge of the unit, angling to the north.

2.5.2 SWMU 3

Movement of planned boring locations to their final placement varied only slightly to allow for set-back to avoid penetrating the C-404 cap or the bottom of the burial cell.

2.5.3 SWMU 5

Final locations of these borings were moved only slightly in consultation with KEPPC personnel.

2.5.4 SWMU 6

Site conditions and results of the geophysical investigation necessitated movement of two borings as described below.

The originally planned location for Boring 006-101 was adjacent to Burial Area I, angling to the west, beneath Burial Area J. Area I is reported to contain exhaust fans contaminated with perchloric acid buried in 1966. Since perchloric acid presents a serious explosion hazard, “Danger” signs had been placed at the edges of the burial pit. In order to avoid disturbance of the acid, 006-101 was relocated to the north, angling to the southeast under the corner of Area J.

Boring 006-102 was adjusted southward slightly to better intersect the center of Burial Areas K, H, and L. The location of the burial areas as indicated on the engineering drawing compared favorably to the areas delineated by geophysics in the field.

2.5.5 SWMUs 7 and 30

Site conditions and results of the geophysical investigation necessitated moving final placement of several of these borings.

Boring 030-001 was impossible to complete as originally planned under the current site conditions. The ditch to the north of the planned boring location is wide and filled with water. Between the ditch and the "Pit A" is a silt fence placed as part of an interim corrective measure, preventing the drill rig from setting up in the planned location. Boring 030-001 was moved approximately 62 ft west and angled under the pit to the southeast.

Although the previous geophysical survey did not indicate buried items in the originally planned location, the current survey showed Boring 030-002 within the boundary of buried material. Boring 030-002 was moved approximately 50 ft south and 70 ft west. The revised location was adequate to provide equivalent information regarding potential contamination leaching from Pit A.

Borings 007-012 (45 ft north and 15 ft west) and 007-002 (10 ft east and 60 ft north) were moved from the originally planned location because the previous geophysical survey did not indicate the apparent large burial area, connecting the F Pit area and Pit G. When the previous geophysical survey took place, SWMU 12 (Drum Mountain) had not been removed and electromagnetic survey near the area was not possible. The new location provided equivalent information regarding potential contamination migrating from Pit G.

Boring 007-003-ASB (angled soil boring) was moved 50 ft north. The previous geophysical survey did not indicate the apparent large burial area, connecting the F Pit area and Pit G. When the previous geophysical survey took place, SWMU 12 (Drum Mountain) had not been removed and electromagnetic survey near the area was not possible. The new location provided equivalent information regarding potential contamination leaching from the F Pits.

Boring 007-005-ASB was moved 25 ft east and 80 ft north to the opposite side of the pits, allowing the boring to be closer to the geophysical anomalies.

2.5.6 SWMU 145

Sampling locations for SWMU 145 were better defined in a revision to the Work Plan (DOE 2006b) issued in November 2006. Site conditions and results of the geophysical investigation necessitated movement of these borings' final placement only slightly.

Boring 145-101 encountered a shallower than expected RGA. (The planned samples for SWMU 145 were limited to UCRS soil and groundwater.) Adjustments were made to soil sample intervals at 145-106 and 145-107 to account for the shallow RGA at this location.

2.6 QUALITY ASSURANCE/QUALITY CONTROL

QC was monitored throughout the RI process. QC included field sampling, laboratory analysis, and data management.

2.6.1 Field QC

Field QC samples were collected to assess data quality. Appendix D provides the data from the field QC samples in a searchable database on compact disk. Table 2.3 lists the QC samples collected for each SWMU. The target frequency of collection for QC samples was 1 in 20 for equipment rinseates, field blanks, and field duplicates. Overall, this target was met for the project. Trip blanks were collected at a frequency of one per sample cooler containing VOC samples.

Table 2.3. Summary of BGOU RI QC Sampling

Location	QC Sample Type	Frequency of Collection[a]
SWMU 2	Equipment Rinseates	1/10
	Trip Blanks	4/10
	Field Blanks	1/10
	Field Duplicates	1/10
SWMU 3	Equipment Rinseates	3/46
	Trip Blanks	10/46
	Field Blanks	3/46
	Field Duplicates	2/46
SWMU 5	Equipment Rinseates	1/18
	Trip Blanks	N/A
	Field Blanks	1/18
	Field Duplicates	1/18
SWMU 6	Equipment Rinseates	2/24
	Trip Blanks	N/A
	Field Blanks	2/24
	Field Duplicates	2/24
SWMU 7	Equipment Rinseates	4/82
	Trip Blanks	24/82
	Field Blanks	4/82
	Field Duplicates	5/82
SWMU 30	Equipment Rinseates	1/21
	Trip Blanks	5/21
	Field Blanks	1/21
	Field Duplicates	1/21
SWMU 145	Equipment Rinseates	2/35
	Trip Blanks	10/35
	Field Blanks	2/35
	Field Duplicates	2/35

N/A = not applicable (no VOCs collected)
[a] Frequency of collection is the number of QA samples collected per number of regular samples collected.

2.6.2 Laboratory QC

The USEC Paducah laboratory performed all of the laboratory analyses of soil and groundwater samples for the BGOU RI. The laboratory was contracted through the DOE Sample Management Office (SMO) and is DOE-approved and Nuclear Regulatory Commission licensed. Approved SW-846 methods were used for all samples, except those parameters for which other methods are necessary. The analysis followed SW-846 protocols, and Level C and Level D data packages were provided along with electronic data deliverables (EDDs). Filtered and unfiltered analyses were performed on metals and uranium isotopes. All other analyses were performed using unfiltered samples.

The following data qualifiers were used for reporting fixed-base laboratory results:

Inorganic Analysis

B	This flag is used when the analyte is found in the associated blank as well as in the sample.
U	The analyte was analyzed for, but not detected.
J	Indicates an estimated value.
E	The reported value is estimated because of the presence of interference. An explanatory note must be included under comments on the cover page (if the problem applies to all samples) or on the specific Form I (if it is an isolated problem).
M	Duplicate injection precision was not met.
N	Spiked sample recovery was not within control limits.
S	The reported value was determined by the method of standard additions (MSA).
W	Postdigestion spike for furnace atomic absorption analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.
X	Other specific flags may be required to properly define the results.
*	Duplicate analysis was not within control limits.
+	Correlation coefficient for the MSA is less than 0.995.

Organic Analysis

U	Indicates compound was analyzed for, but not detected.
J	Indicates an estimated value. This flag is used under the following circumstances: (1) when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed and (2) when the mass spectral and retention time data indicate the presence of a compound that meets the pesticide/PCB identification criteria, and the result is less than the contract-required quantitation limit, but greater than zero.
P	This flag is used for a pesticide/PCB target analyte when there is greater than 25% difference for detected concentrations between the two gas chromatograph (GC) columns.
C	This flag applies to pesticide results where the identification has been confirmed by gas chromatograph/mass spectrometer (GC/MS).
B	This flag is used when the analyte is found in the associated blank as well as in the sample.
E	This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis.
D	This flag identifies all compounds identified in an analysis at a secondary dilution factor.
X	Other specific flags may be required to properly define the results.
Y	Indicates matrix spike (MS)/matrix spike duplicate (MSD) recovery and/or relative percent difference (RPD) failed to meet acceptance criteria.

Radionuclide Analysis

B	Method blank not statistically different from sample at 95% level of confidence.
D	Sample is statistically different from duplicate at 95% level of confidence.
L	Expected and measured value for LCS is statistically different at 95% level of confidence.
M	Expected and measured value for MS is statistically different at 95% level of confidence.
T	Tracer recovery is < 20% or > 105%.
U	Indicates compound was analyzed for, but not detected.
X	Other specific flags may be required to properly define the results.

Precision, accuracy, and completeness objectives were presented in the RI Work Plan (DOE 2006a). An assessment of these objectives for laboratory analytical data was performed. The results of this assessment are provided in Table 2.4.

Precision refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions. To determine the precision of the laboratory analysis, a routine program of replicate analyses is performed. The absolute difference between the two values calculated is referred to as the relative percent difference (RPD). Precision was determined for this RI by reviewing laboratory-applied qualifiers that pertain to laboratory duplicates (i.e., "M" and "*" for inorganic analyses, "Y" for organic analyses, and "D" for radionuclide analyses) over all analyses. QA objectives for precision given in the RI Work Plan are performance based, with RPDs that ranged from 13 to 50%. These objectives were met by the data collected during this RI.

Table 2.4. QA Assessment for Laboratory Measurements of RI Data

Parameter	Method	Matrix		Precision	Accuracy	Completeness[c]
TCL volatiles	SW-846[a] 8260	Soil	Work Plan Criteria:	22%	80–100%	90%
			RI Data:	99%	99%	99%[d]
		Water	Work Plan Criteria:	13%	80–100%	90%
			RI Data:	99%	99%	100%[d]
TCL semivolatiles	SW-846 8270	Soil	Work Plan Criteria:	38%	80–100%	90%
			RI Data:	99%	99%	99%
		Water	Work Plan Criteria:	n/a	n/a	n/a
			RI Data:	100%	100%	100%
TAL metals	SW-846 6010, 6020, and 7000 series	Soil	Work Plan Criteria:	35%	80–100%	90%
			RI Data:	95%	92%	94%[e]
		Water	Work Plan Criteria:	n/a	n/a	n/a
			RI Data:	94%	81%	97%[f]
TCL PCBs	SW-846 8082	Soil	Work Plan Criteria:	43%	80–100%	90%
			RI Data:	97%	97%	99%
		Water	Work Plan Criteria:	21%	80–100%	90%
			RI Data:	100%	100%	68%[g]
Gross alpha	SW-846 9310	Soil	Work Plan Criteria:	30%	80–100%	90%
			RI Data:	100%	100%	99%
Gross beta	SW-846 9310	Soil	Work Plan Criteria:	25%	80–100%	90%
			RI Data:	100%	100%	99%
^{234}U, ^{235}U, and ^{238}U	RL-7128[b]	Soil	Work Plan Criteria:	20%	80–100%	90%
			RI Data:	100%	100%	99%
		Water	Work Plan Criteria:	20%	80–100%	90%
			RI Data:	100%	100%	100%
^{99}Tc, ^{230}Th, ^{239}Pu, ^{137}Cs, and ^{237}Np	RL-7100, RL-7124, and RL-7128[b]	Soil	Work Plan Criteria:	50%	80–100%	90%
			RI Data:	100%	100%	99%
		Water	Work Plan Criteria:	n/a	n/a	n/a
			RI Data:	96%	88%	93%

[a]EPA 1996. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition, SW-846, December.
[b]Laboratory-specific method, derived from DOE guidance.
[c]Completeness for groundwater samples calculated based on locations where groundwater was available for sampling.
[d]Completeness for acrolein analysis in soil samples was 45% and 77% in groundwater samples.
[e]Completeness for silver analysis in soil samples was 80%.
[f]Completeness for antimony, chromium, and nickel analyses in groundwater samples was 77%, 84%, and 87%, respectively.
[g]Completeness for PCBs in groundwater was less than the 90% objective due to ten samples being rejected by validation. Of the ten samples, eight were from SWMU 7 and two were from SWMU 6. Section 2.6.4 contains additional discussion.

TAL = Target Analyte List
TCL = Target Compound List
^{137}Cs = cesium-137
^{237}Np = neptunium-237
^{239}Pu = plutonium-239
^{230}Th = thorium-230
^{234}U = uranium-234
^{235}U = uranium-235
^{238}U = uranium-238

Accuracy refers to the nearness of a measurement to an accepted reference or true value. To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted. Accuracy for this RI was determined by reviewing laboratory-applied qualifiers that pertain to laboratory spikes over all analyses (i.e., "N" and "W" for inorganic analyses; "Y" for organic analyses;

and "B," "M," and "L" for radionuclide analyses). The accuracy range objective specified in the RI Work Plan was 80–100%. These objectives were met by the data collected during this RI.

Representativeness is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites, drilling sites, drilling depths, and analytical parameters and through the proper collection and handling of samples to avoid interference and minimize contamination and sample loss.

Completeness is a measure of the percentage of valid, viable data obtained from a measurement system compared with the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs.

For this project, the completeness objective for laboratory measurements was 90%. This objective was met as intended by the RI data with the exception of PCBs in groundwater. Completeness for PCBs in groundwater was less than the 90% objective due to ten samples being rejected by validation. Of the ten samples, eight were from SWMU 7 and two were from SWMU 6. Section 2.6.4 contains additional discussion. These measurements were not used for decision calculations in this RI Report.[3]

Completeness also is a measure of samples collected during the field effort with respect to those targeted for collection in the work plan. All soil samples targeted for collection during this RI were collected with the exception of one surface soil sample at SWMU 7. Additionally, a sufficient volume of soils was not available from three intended locations for all analyses planned (metals were not analyzed from location 145-104 at 15 ft bgs and radionuclides were not analyzed from locations 007-001 and 007-006 at 60 ft bgs and 45 ft bgs, respectively)

Groundwater sample objectives were fulfilled. The Work Plan (DOE 2006a) strategy for sampling groundwater in the UCRS was to sample water-bearing zones as they were available. Where sand and gravel zones were encountered in the UCRS that would yield sufficient water for the collection of a quality water sample, the field crew collected water samples for analysis. Of the 35 soil borings of the BGOU RI deeper than 15 ft (those targeted for groundwater sampling in the Work Plan), the RI collected UCRS groundwater samples from 18. Because the UCRS water samples only supplement the characterization of the BGOU SWMUs (the analysis of subsurface soil samples is the primary measure that supports the assessment of nature and extent and risk), the lack of UCRS water samples from all soil borings does not limit the planned assessment of the SWMUs.

For those borings that extended through the RGA, water samples were collected as scheduled in 10-ft depth increments throughout the thickness of the RGA. Table 2.5 summarizes the water samples that were collected and analyzed for the BGOU RI/FS. Of all of the water samples, the only sample to be partially collected was the UCRS sample from soil boring 006-103-ASB. This boring provided insufficient water for the collection of samples for analysis of dissolved metals and dissolved radionuclides levels.

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[3] UCRS groundwater analyses of the BGOU RI soil borings are used primarily to supplement the assessment of soil analyses to identify significant sources of groundwater contamination. The BGOU RI risk assessment uses only analyses of UCRS groundwater collected from MWs within and adjacent to the SWMUs to calculate a conservative reasonable maximum risk estimate (see Attachment F2 of Appendix F). The low completion rate of UCRS groundwater PCB analyses does not limit significantly the nature and extent and risk assessments for the BGOU RI.

Table 2.5 Summary of BGOU RI Water Samples

Location	Soil Boring	Water Sample Depth Interval (ft)
UCRS Groundwater Samples		
SWMU 2	--[1]	NA[2]
SWMU 3	003-003-ASB	28-32
	003-004-ASB	28-32
SWMU 4	none planned	NA
SWMU 5	005-101-ASB	42-46
	005-102-ASB	40-41
SWMU 6	006-101-ASB	42-46
	006-102-ASB	18-19
	006-103-ASB	50-51
	006-104-ASB	42-46
SWMU 7	007-001-ASB	42-46
	007-002-ASB	50-51
	007-003-ASB	42-46
	007-005-ASB	42-46
	007-007-ASB	42-46[3]
	007-008-ASB	42-46
	007-009-VSB	45-55
	007-010-VSB	40-45 and 55-60
	007-011-VSB	40-45 and 55-60
SWMU 30	030-003-ASB	57-60
SWMU 145	--[1]	NA[2]
RGA Groundwater Samples		
SWMU 7	007-009-VSB	69, 80, 90[3]
	007-010-VSB	66, 80, 90, 100
	007-011-VSB	70, 80, 90

[1] None of the soil borings at this SWMU yielded UCRS water samples.
[2] No water sample was collected.
[3] A duplicate water sample was collected from this depth interval.

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability will be assessed in terms of field standard operating procedures (SOPs), analytical methods, QC, and data reporting. In addition, data validation assesses the processes employed by the laboratory that affect data comparability.

Historical data also was evaluated for precision and accuracy as described previously. This assessment was performed over all measurements for the projects associated with the BGOU SWMUs. Multiple laboratories analyzed samples for these projects. The comparison for the precision and accuracy of historical results encompassed the entire historical data set and did not differentiate between projects or laboratories. A summary of this assessment is provided in Table 2.6.

Table 2.6. Assessment for Laboratory Measurements of Historical Data Used in RI

Parameter	Method	Matrix	Precision[a]	Accuracy[a]
TCL volatiles	SW-846 8260	Soil	94%	94%
		Water	99%	99%
TCL semivolatiles	SW-846 8270	Soil	99%	99%
		Water	99%	99%
TAL metals	SW-846 6010, 6020,	Soil	81%	48%
	and 7000 series	Water	99%	83%
TCL PCBs	SW-846 8082	Soil	100%	100%
		Water	100%	100%
^{234}U, ^{235}U, and ^{238}U	Various methods	Soil	100%	100%
		Water	100%	100%
^{99}Tc, ^{230}Th, ^{239}Pu,	Various methods	Soil	99%	100%
^{137}Cs, and ^{237}Np		Water	99%	99%

[a] Values indicated are for the percent of valid values.
^{137}Cs = cesium-137
^{237}Np = neptunium-237
^{239}Pu = plutonium-239
^{234}U = uranium-234
^{235}U = uranium-235
^{238}U = uranium-238

All historical analyses were within the criteria established by the RI Work Plan for RI data, with the exception of accuracy of metals analyses in soil.

2.6.3 Surveillances

A surveillance was completed during fieldwork to verify adherence to project specific plans and procedures. Surveillance results are documented and filed in the Document Management Center. The DOE SMO conducts routine laboratory surveillances of the laboratory through the Consolidated Audit Program. These surveillances of the BGOU laboratory were conducted in February 2006 and February 2007.

2.6.4 Data Management

The BGOU Project Environmental Measurements System (PEMS) was used to manage field-generated data; import laboratory-generated data; add data qualifiers based on data verification, validation, and assessment; and transfer data to the Paducah Oak Ridge Environmental Information System (Paducah OREIS). PEMS included a tracking system to identify, track, and monitor each sample and associated data from point of collection through final data reporting. The system included field measurements, chain-of-custody information, and a tracking system for tracking hard-copy data packages and EDDs. PEMS also included information for field planning and data evaluation.

All data packages and EDDs received from the laboratory were tracked, reviewed, and maintained in a secure environment. When first received, data packages were assigned a document control number and then logged into a tracking system. The following information was tracked: sample delivery group numbers, date received, document control number, number of samples, sample analyses, receipt of EDDs, and comments.

The data verification processes for laboratory data were implemented for both hard-copy data and EDDs. The data packages were reviewed to confirm that all samples had been analyzed for the requested parameters. Discrepancies were reported to the laboratory and the data validators. As part of a series of internal integrity checks within PEMS, a check was run to identify which of the requested samples and analyses were not received in an EDD. Hard copy data packages were checked to confirm agreement with the associated EDD. Integrity checks in PEMS also were used to check the list of compounds generated by the laboratory to confirm that data were provided for all requested analytes. Discrepancies were reported to the laboratories for responses and/or correction and to the data validators.

Data verification within PEMS included standardization of analytical methods, chemical names and units, as well as checks for holding time violations and detections above background values.

PEMS system requirements included backups, security, change control, and interfacing with other data management systems. PEMS was housed on the Paducah network. System backups were performed nightly following standard Paducah network protocol. Updates made to the files were copied to a computer backup tape each night, and an entire backup was performed each week.

Security of PEMS and data used for the data management effort was considered essential to the success of the project. The security protocol followed by the data management team was consistent with that of the Paducah network. Access to the network is password-protected. Access to PEMS was limited, on an as-needed basis, to the data management personnel. Read-write, graded access to PEMS was limited to the data management team, which consisted of the PEMS Coordinator and the supporting data entry staff. The data management staff assisted other project members with data needs from PEMS by running requested queries.

A large volume of data was generated during the BGOU RI. To confirm that the data set could be used in the decision making process, the RI team performed various checks and reviews during and after the fieldwork to maintain data consistency and identify problem areas. These checks and reviews included electronic verification and manual assessments by the RI team, as well as independent validation of fixed-base laboratory data. Approximately 36,000 records were reviewed during the BGOU RI data assessment.

Data validation is a process performed for a data set by a qualified individual independent from sampling, laboratory, project management, and other decision making personnel for the project. Data validation is performed in accordance with EPA guidance. In the data validation process, the laboratory adherence to analytical method requirements is evaluated. Portage Environmental, Inc., validated data collected for this RI at a frequency of 100%.

As part of the data review process, findings were qualified as necessary to reflect data validation results. The following qualifiers were assigned by the data validators:

U	Analyte or compound considered not detected above the reported detection limit.
J	Analyte or compound identified; the associated numerical value is approximated.
UJ	Analyte or compound not detected above the reported detection limit, and the reported detection limit is approximated due to quality deficiency.
R	Result is not usable for its intended purpose, so data are of "information only" quality and should be supplemented with additional data for decision-making.
=	Data were validated; however, no qualifier was added.

The majority of the data rejected by validation was acrolein analyses in soil (101 of the 177 samples collected) due to initial and continuing calibration relative response factors less than 0.05. Also rejected by validation in soil were silver and vanadium analyses (46 and 10 of 216 samples, respectively). These analyses were rejected due to the interference check sample, the MS and/or MSD, lab control sample, and post digestion spike recoveries being below the lower control limit and the MS/MSD pair exceeding the RPD limit.

The risk assessment does not identify either acrolein or silver as a chemical of potential concern (COPC) for the BGOU RI (nor have they been recognized commonly as site-related contaminants); thus, the rejection of these sample results likely has little importance. In contrast, vanadium is a COPC at several BGOU SWMUs. All soil samples with rejected vanadium analyses were collected from SWMU 145. A significant percentage of the vanadium analyses of subsurface soils at SWMU 145 was rejected (10 of 34). Although the risk assessment does not identify vanadium as a COPC for SWMU 145, some uncertainty remains. There are 576 analyses of vanadium (non-rejected) among the historical data and RI data for the BGOU SWMUs. Comparison of these data with PGDP background values (37 mg/kg for subsurface soil and 38 mg/kg for surface soil) demonstrates that the vanadium is naturally occurring; 94% of the vanadium analyses are equal or less to the PGDP background values. Thus, the rejected data have little impact on remedial decisions to be made for the BGOU SWMUs.

Analyses of groundwater samples resulted in the following number of rejections: 7 of 26 acrolein samples; 7 antimony results, 5 chromium results, 1 mercury result, and 4 nickel results of 31 samples; 2 of 31 ^{99}Tc samples; and 11 of 31 PCB (total) and congeners samples. Acrolein was rejected because initial and continuing calibration relative response factors were <0.05. Metals were rejected for recoveries being below the lower control limits on one or more of the following controls: continuing calibration verification, interference check sample, lab control sample, the MS and/or MSD, and/or post digestion spike. Additionally, in some cases, the MS/MSD pair exceeded the RPD limit. Technetium-99 was rejected for unacceptable laboratory control sample bias, significant difference between the sample and the duplicate, and the MS and/or MSD recovery being below the lower control limit. PCBs were rejected because the decachlorobyphenyl surrogate was recovered at lower than acceptable QC limits and the results were nondetect; however, the tetrachloro-m-xylene surrogate also was used and recovered within acceptable QC limits.

The presence of the metals antimony, chromium, mercury, and nickel largely are naturally occurring in the PGDP groundwater. [All antimony analyses (617 analyses), 85% (1,755 of 2,070) of chromium analyses, 95% (1,640 of 1,720) of the mercury analyses, and 96% (1,294 of 1,352) of the nickel analyses are equal or below RGA background levels.] Thus, remedial decisions for the BGOU SWMUs should not be impacted by the rejected metals analyses. Because the water samples are used primarily to supplement the characterization of the BGOU SWMUs (the analysis of subsurface soil samples is the primary measure that supports the assessment of nature and extent and risk), the importance of the rejected data is minimal.

3. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This chapter presents the physical and ecological characteristics of PGDP, in general, and of the BGOU SWMUs, in particular, that bear on contaminant release and migration. The discussion focuses from region- and PGDP-wide characteristics to SWMU-specific characteristics in sufficient detail to support subsequent evaluations of the nature and extent and the fate and transport of contaminants exiting the SWMUs and entering the external environment.

Numerous investigations detail physical characteristics of PGDP that are pertinent to the BGOU. In addition to the BGOU SWMU investigations identified in Table 1.2, the primary references include the following:

- *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1991)
- *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1992)
- *Report of the Paducah Gaseous Diffusion Plant Groundwater Investigation Phase III*
- (Clausen, et al. 1992)
- *Environmental Investigations at the Paducah Gaseous Diffusion Plant, and Surrounding Area, McCracken County, Kentucky* (COE 1994)
- *Groundwater Monitoring Plan for the C-746-S Residential Landfill, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (BJC 2001b)

This RI field effort focused on collection and analysis of soil and groundwater samples to address deficiencies in the existing characterization of the nature and extent of contamination. These field activities yielded additional analyses of the subsurface soils and groundwater that are incorporated into the SWMU-specific discussions. Other than the area of the previous ditch that routed effluent from SWMU 3 to the NSDD and the vertical borehole locations of SWMU 7, the BGOU RI did not include additional characterization of surface soils (see Section 1.2.1).

3.1 SURFACE FEATURES

PGDP is located on a 3,556-acre DOE site approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County (Figure 1.1). The PGDP industrial area occupies 748 acres of the DOE site, surrounded by an additional 689-acre buffer zone. DOE licenses most of the remaining acreage to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA). TVA’s Shawnee Steam Plant borders the DOE site to the northeast, between the plant and the Ohio River.

Three small communities are situated within three miles of the DOE property boundary: Heath and Grahamville to the east and Kevil to the southwest. The next closest municipality is Metropolis, Illinois, five miles to the northeast of PGDP on the north side of the Ohio River.

The dominant topographic features in the area of PGDP are nearly level to gently sloping dissected plains and the flood plain of the Ohio River. Local elevations range from 290 ft above mean sea level (amsl) along the Ohio River to 450 ft amsl southwest of PGDP. Ground surface elevations vary from

360 to 390 ft amsl within the PGDP plant boundary, where most of the BGOU SWMUs are located, and from 360 to 410 ft at SWMU 145. Generally, the topography in the PGDP area slopes toward the Ohio River at an approximate gradient of 27 ft per mile (CH2M Hill 1992).

3.2 METEOROLOGY

The National Weather Service office at Barkley Regional Airport (located four miles to the southeast of PGDP) documents hourly meteorological measurements. Current and historical meteorological information regarding temperature, precipitation, and wind speed/direction are available from the National Oceanic and Atmospheric Administration's National Climatic Data Center.

The climate of the PGDP region is humid-continental. Summers are warm (July averages 79 °F) and winters are moderately cold (January averages 35 °F). PGDP experiences a yearly surplus of precipitation versus evapotranspiration. The 30-year average monthly precipitation for the period 1961 through 1990 is 4.11 inches,[1] varying from an average of 3.00 inches in October (the monthly average low) to an average of 5.01 inches in April (the monthly average high). Monthly estimates of evapotranspiration using the Thornthwaite method (Thornthwaite and Mather 1957) equal or exceed average rainfall for the period May through September (season of no net infiltration).

Heavy rainfall associated with thunderstorms or low-pressure systems occurs occasionally at PGDP. Table 3.1 presents the predicted storm recurrence intervals for PGDP (Hershfield 1963; Johnson et al. 1993; DOE 1997a).

Table 3.1. Precipitation as a Function of Recurrence Interval and Storm Duration for the Site

Recurrence Interval (years)	Storm Duration (hours)						
	0.5	1	2	3	6	12	24
	Precipitation (inches)						
1	1.08	1.30	1.66	1.85	2.23	2.65	3.06
2	1.26	1.56	1.91	2.14	2.61	3.08	3.53
5	1.55	1.98	2.38	2.67	3.20	3.69	4.38
10	1.80	2.23	2.75	3.02	3.66	4.33	4.97
25	1.99	2.57	3.13	3.44	4.18	4.83	5.71
50	2.23	2.83	3.46	3.83	4.62	5.53	6.42
100	2.45	3.13	3.83	4.24	5.02	5.97	6.88
10,000*	3.80	4.94	5.99	6.59	7.85	9.32	10.85

* Extrapolated values calculated using least-squares methodology

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

3.3 SURFACE WATER HYDROLOGY

PGDP is situated in the western portion of the Ohio River basin, 15 miles downstream of the confluence of the Ohio River with the Tennessee River and 35 miles upstream of the confluence of the Ohio River with the Mississippi River. The Ohio River is located approximately 3.5 miles north of PGDP. It is the

[1] For the recent five-year period June 2002 through May 2007, average monthly precipitation was slightly less (3.90 inches), ranging from 3.25 inches in October (monthly average low) to 4.94 inches in September (monthly average high).

most significant surface-water feature in the region, carrying over 25 billion gal/day of water through its channel. A U. S. Geological Survey gauging station at Metropolis, Illinois, monitors the Ohio River stage near PGDP. River stage typically varies between 290 and 328 ft amsl over the course of a year. Water levels on the lower Ohio River generally are highest in winter and early spring and lowest in late summer and early fall. The entire PGDP is above the historical high water floodplain of the Ohio River (CH2M Hill 1991) and above the local 100-year flood elevation of the Ohio River (333 ft). [The highest Ohio River stage recorded at Metropolis, Illinois (February 2, 1937) was 343 ft.]

The plant overlies the divide between Little Bayou and Bayou Creeks (Figure 3.1). Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River along a 9 mile course. Little Bayou Creek is an intermittent stream located on the eastern boundary of the plant; its drainage originates within WKWMA and extends northward along a 6.5 mile course, which joins Bayou Creek near the Ohio River. Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from PGDP. Networks of ditches discharge effluent and surface water runoff from PGDP to the creeks. Contributions from PGDP comprise approximately 85% of the base flow within Bayou Creek and 100% of the base flow within Little Bayou Creek.

Multiple groundwater aquifers underlie PGDP. (See Section 3.6 for a discussion of PGDP hydrogeology.) The shallowest aquifers occur in the Continental Deposits and the McNairy Formation, both of which discharge into the Ohio River north of PGDP. A large, downward, vertical hydraulic gradient within the Upper Continental Deposits typically limits the amount of groundwater discharge to the ditches of PGDP and adjacent creeks. Gaining reaches in the creeks are found on Bayou Creek south of PGDP and on Little Bayou Creek to the north of PGDP where it meets the Ohio River flood plain. Both creeks have gaining reaches adjacent to the Ohio River.

Other surface water bodies in the vicinity of PGDP include several small ponds, inactive clay and gravel pits, and settling basins scattered throughout the PGDP plant area; a marshy area just south of the confluence of Bayou Creek and Little Bayou Creek; ash settling ponds of the Shawnee Steam Plant; and Metropolis Lake, located east of the Shawnee Steam Plant.

3.4 GEOLOGY

PGDP lies within the Jackson Purchase region of western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain Province. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock (Figure 3.2). Following sections describe the primary geologic units of the PGDP region. Section 3.9 presents the shallow geology specific to each of the BGOU SWMUs.

3.4.1 Bedrock

Mississippian carbonates, composed of dark gray limestone, with some interbedded chert and shale underlie the entire PGDP area at an approximate depth of 300 to 340 ft.

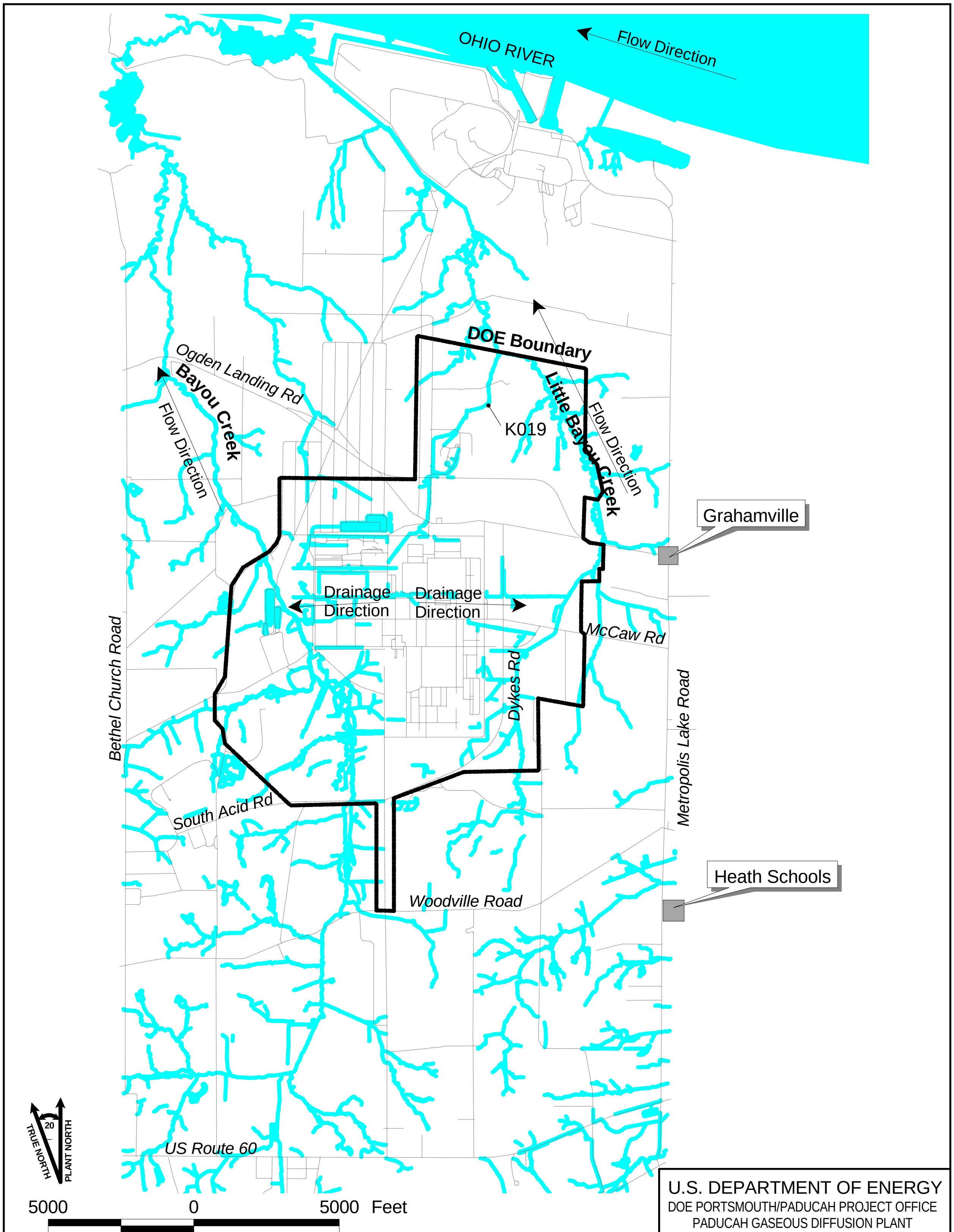

Figure 3.1 Surface Water Features in the Vicinity of the DOE Site

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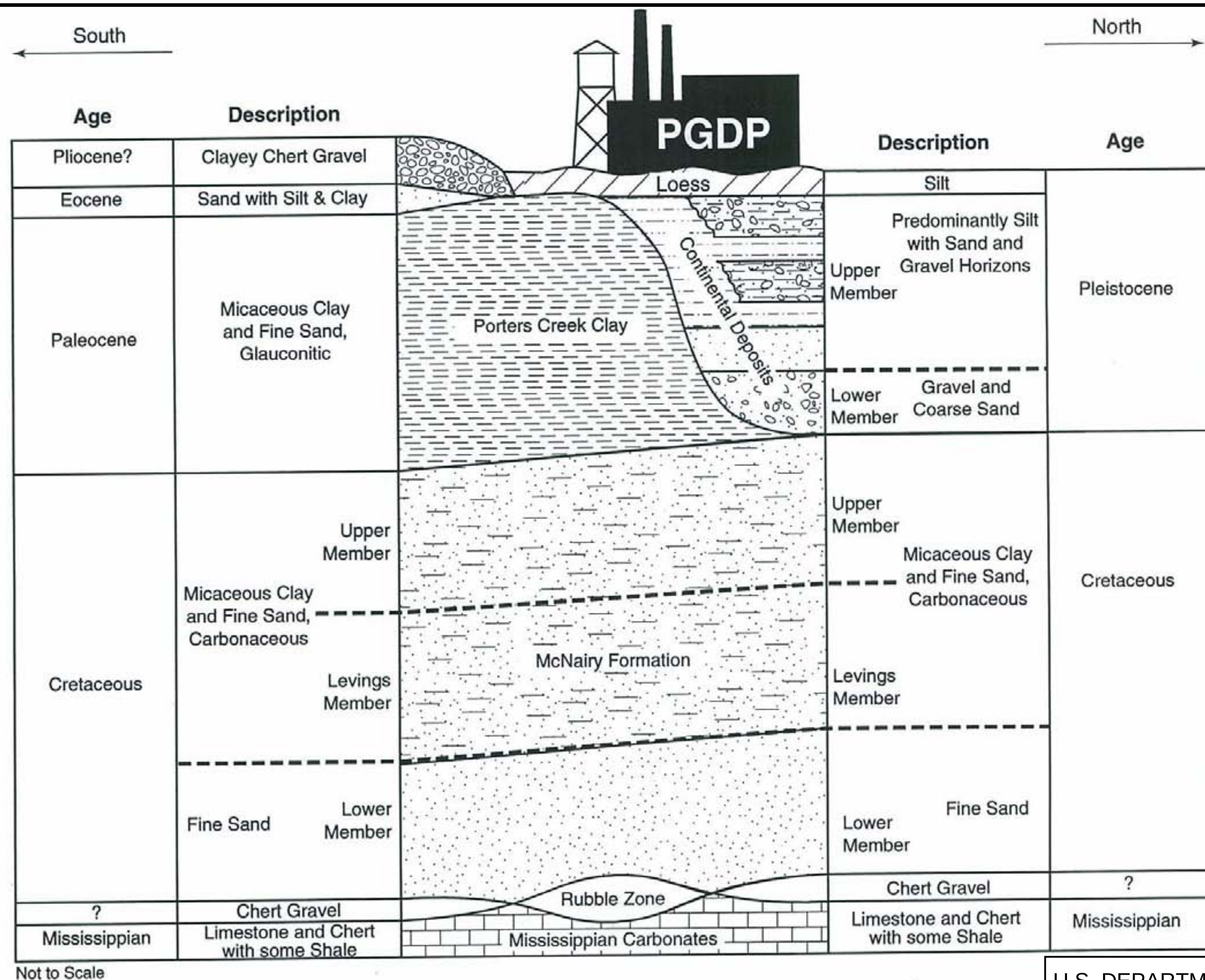

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Figure 3.2. PGDP Stratigraphic Sections

3.4.2 Rubble Zone

Deep soil borings at PGDP commonly encounter a rubble zone of chert gravel at the top of the bedrock. The age and continuity of the rubble zone remain undetermined.

3.4.3 McNairy Formation

The McNairy Formation consists of Upper Cretaceous, fine clastic sediments. At PGDP the upper and middle members of the McNairy Formation are typically grayish-white to dark-gray, micaceous silt and clay interbedded with gray to yellow, very fine- to fine-grained sand. The middle (Levings) member tends to contain fewer sand interbeds. The basal McNairy member at PGDP is primarily a light gray, very fine to fine sand.

3.4.4 Porters Creek Clay/Porters Creek Terrace Slope

Paleocene age Porters Creek Clay underlies the southern portions of the DOE site and consists of dark gray to black silt with varying amounts of clay and fine-grained, micaceous, commonly glauconitic, sand. The Porters Creek Clay subcrops along a buried terrace slope that extends east–west under the south end of the PGDP industrial area. This subcrop is the northern limit of Porters Creek Clay and the southern limit of the Pleistocene Lower Continental Deposits under PGDP.

3.4.5 Eocene Sands

Eocene sands occur south of PGDP above the Porters Creek Clay. This unit includes undifferentiated quartz sands and interbedded and interlensing silts and clays of the Claiborne Group and Wilcox Formation (Olive 1980). The Eocene sands thicken to the south of PGDP.

3.4.6 Continental Deposits

Continental sediments [Pliocene (?)[2] to Pleistocene age] unconformably overlie the Cretaceous through Eocene strata throughout the area. These continental sediments were deposited on an irregular erosional surface consisting of several terraces. The thicker Continental Deposits sections represent Pleistocene valley fill sediments that comprise a fining-upward cycle. The continental sediments have been divided into the two distinct facies described below.

(1) Lower Continental Deposits. The Lower Continental Deposits is a gravel facies consisting of chert, ranging from pebbles to cobbles, in a matrix of poorly sorted sand and silt. Gravels of the Lower Continental Deposits overlie three distinct terraces in the PGDP area.

- The upper terrace Lower Continental Deposits consists of Pliocene (?) gravel units, ranging in thickness from near 0 to 30 ft, occurring in the southern portion of the DOE site at elevations greater than 350 ft amsl. This gravel unit overlies the Eocene sands and Porters Creek Clay (where the Eocene sands are missing).

- Pliocene (?) gravels of the Lower Continental Deposits also occur on an intermediate terrace eroded into the Porters Creek Clay at an elevation of approximately 320 to 345 ft amsl in the southeastern and eastern portions of the DOE site. The thickness of this unit typically ranges from 15 to 20 ft.

---

[2] A question mark indicates uncertain age.

- The Lower Continental Deposits of the upper and intermediate terraces are collectively referred to as the Terrace Gravel.

- The third and most prominent of the three Lower Continental Deposits members consists of a Pleistocene gravel deposit resting on an erosional surface at an elevation of approximately 280 ft amsl. This gravel underlies most of the plant area and the region to the north, but pinches out under the south side of PGDP along the subcrop of the Porters Creek Clay. The Pleistocene member of the Lower Continental Deposits averages approximately 30 ft in thickness. Trends of greater thickness, as much as 50 ft, fill deeper scour channels that trend east–west beneath the site.

(2) Upper Continental Deposits. The Upper Continental Deposits is a Pleistocene age, fine-grained clastics facies that commonly overlies the Lower Continental Deposits. This unit ranges in thickness from 15 to 55 ft. The Upper Continental Deposits includes three general horizons beneath PGDP: (1) an upper silt and clay interval, (2) an intermediate interval of common sand and gravel lenses (sand and gravel content generally diminishes northward), and (3) a lower silt and clay interval. The upper silt and clay interval consists of the Peoria Loess and Roxana Silt (DOE 2003 and WLA 2006). The Peoria Loess and Roxana Silt blanket the entire PGDP area.

3.5 SOILS

The surficial deposits found in the vicinity of PGDP are Pleistocene loess and Holocene alluvium. Both units commonly consist of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult. The general soil map for Ballard and McCracken Counties delineates three soil associations within the vicinity of PGDP: the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association (USDA 1976).

In the immediate PGDP area, the predominant soil is the Henry soil series of the Calloway-Henry association, which consists of nearly level, somewhat poorly- to poorly-drained, medium-textured soils on upland positions. The Henry soil series contains poorly drained, acidic soils that have a fragipan. Henry soils typically have moderate permeability above the fragipan and low permeability within the fragipan. Permeability in the fragipan is less than 0.4 ft/day (DOE 1998b).

Several other soil groups also occur in limited areas of the region, including the Grenada, Falaya-Collins, Waverly, Vicksburg, and Loring.

The soils in the vicinity of PGDP tend to have a low buffering capacity, with a pH ranging from 4.5 to 5.5. Measurements of the cation exchange capacity of site soils range from 8.92 to 69.8 milliequivalents per liter (DOE 1999c). Under background conditions, the cation exchange capacity is sufficient to bind metals in the soils; however, acidic leachate will significantly increase metal solubility and mobility.

3.6 HYDROGEOLOGY

The significant geologic units relative to shallow groundwater flow at PGDP include the Terrace Gravel and Porters Creek Clay (south sector of the DOE site) and the Pleistocene Continental Deposits and McNairy Formation (underlying PGDP and adjacent areas to the north). Groundwater flow in the Pleistocene Continental Deposits is a primary pathway for transport of dissolved contamination from PGDP. The following paragraphs provide the framework of the shallow groundwater flow system at PGDP.

(1) Terrace Gravel Flow System. The Porters Creek Clay is a confining unit to downward groundwater flow south of PGDP. A shallow water table flow system is developed in the Terrace Gravel, where it overlies the Porters Creek Clay south of PGDP. Discharge from this water table flow system provides baseflow to Bayou Creek and underflow to the Pleistocene Continental Deposits to the east of PGDP.

The elevation of the top of the Porters Creek Clay is an important control to the area's groundwater flow trends. A distinct groundwater divide is centered in hills located approximately 9,000 ft southwest of PGDP, where the Terrace Gravel and Eocene sands overlie a "high" on the top of the Porters Creek Clay. In adjacent areas where the top of the Porters Creek Clay approaches land surface, as it does south of PGDP and near the subcrop of the Porters Creek Clay to the west of the industrial complex, the majority of groundwater flow is forced to discharge into surface streams (gaining reaches) and little underflow occurs into the Pleistocene Continental Deposits. To the east of PGDP, the Terrace Gravel overlies a lower terrace eroded into the top of the Porters Creek Clay. In this area, a thick sequence of Terrace Gravel occurs adjacent to the Pleistocene Continental Deposits, allowing significant underflow from the Terrace Gravel. Surface drainages in this area are typically loosing reaches. Figure 3.3 presents hydraulic potential trends for the Terrace Gravel flow system.

(2) UCRS. The infiltration of water in the Upper Continental Deposits, beneath PGDP and the contiguous land to the north, is called the UCRS. Groundwater flow is primarily downward in the Upper Continental Deposits. A plot of elevation of water level versus midpoint of well screen for UCRS wells at PGDP (Figure 3.4) demonstrates that steep vertical hydraulic gradients are characteristic of the UCRS. Vertical hydraulic gradients generally range from 0.5 to 1 ft/ft where measured by wells completed at different depths in the UCRS.

Direct measurements of the UCRS water table elevation are available only for the south-central PGDP industrial area, where water levels commonly occur in the screen interval of the wells, and the location of two source unit investigations (the SWMU 2 Interim Remedial Design Investigation and the SWMUs 7 and 30 RI) in the west PGDP industrial area. All other well measurements, where water levels occur above the well screen interval, provide lower bounds to the elevation of the water table. Figure 3.5 illustrates the general features of the UCRS water table for the PGDP industrial area (DOE 1997b). The main features of the water table are a broad trough in the northeast and central areas, a linear discharge area associated with a ditch in the northwest, and a lateral hydraulic gradient toward Bayou Creek on the west side. In general, the water table is less than 20 ft deep in the western half of PGDP and as much as 40 ft deep in the northeastern corner.

The infiltration rate for the PGDP area is approximately 6.6 inches/yr based on site-specific groundwater modeling. This 6.6 inches/yr applied over the area of the industrial area of the plant yields approximately 0.4 mgd of recharge to the shallow groundwater system. Leakage from plant water utilities is suspected to be another important source of infiltration at PGDP. Water use for PGDP for calendar year 2006 averaged 13 mgd. Municipal water systems lose as much as 24% of their daily conveyance (Jowitt and Xu 1990). A similar loss of the PGDP system would equal 3.1 mgd.

(3) RGA. Vertically infiltrating water from the UCRS moves downward into a basal sand member of the Upper Continental Deposits and the Pleistocene gravel member of the Lower Continental Deposits and then laterally north toward the Ohio River. This lateral flow system is called the RGA. The RGA is the shallow aquifer beneath PGDP and contiguous lands to the north. Groundwater of the RGA meets requirements of a Class II groundwater as delineated in *Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy* (EPA 1988).

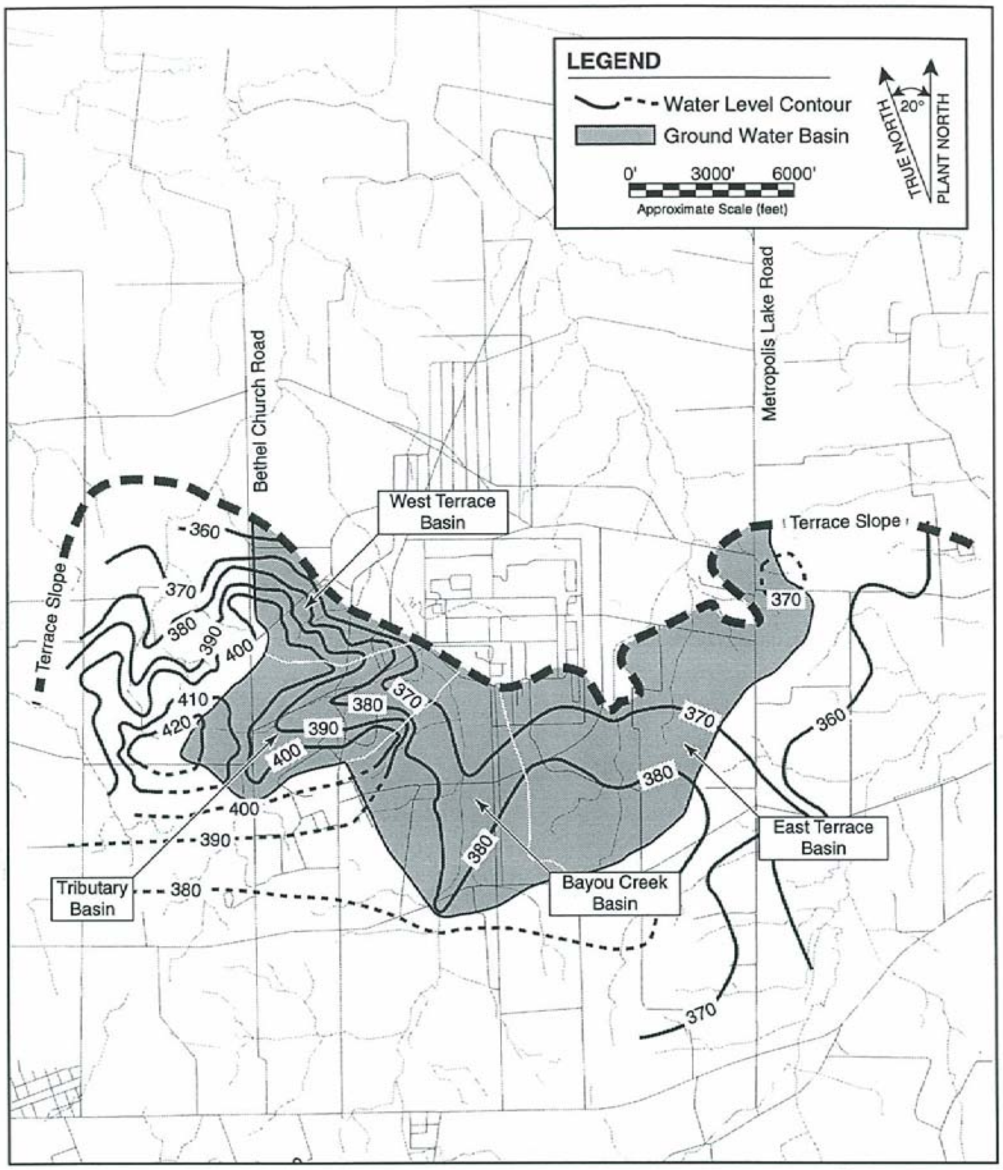

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Figure 3.3. Water Table Trends in the Terrace Deposits South of the PGDP

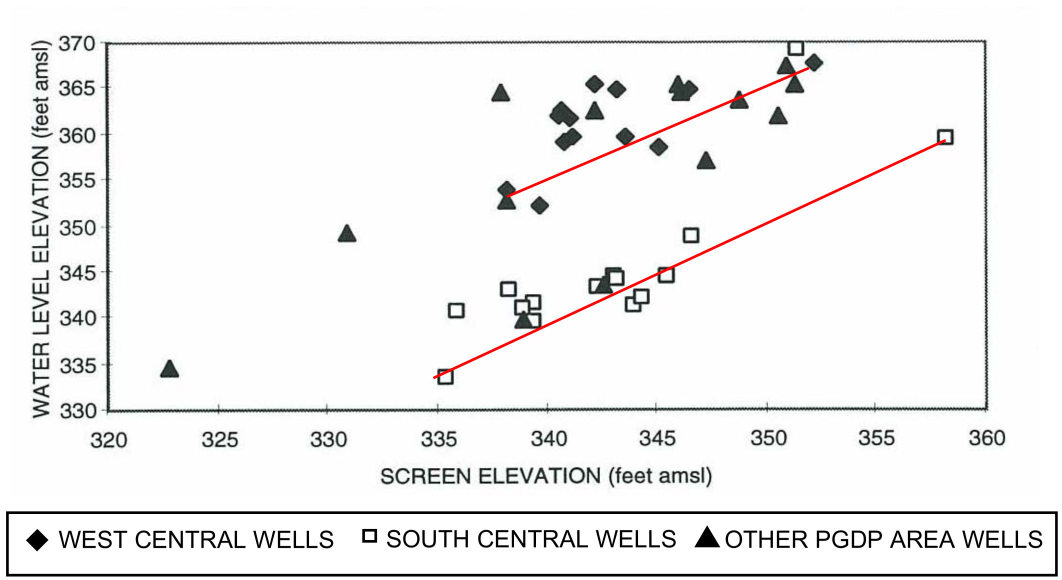

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Figure 3.4. Plot of Water Level versus Well Screen for Upper Continental Recharge System Wells

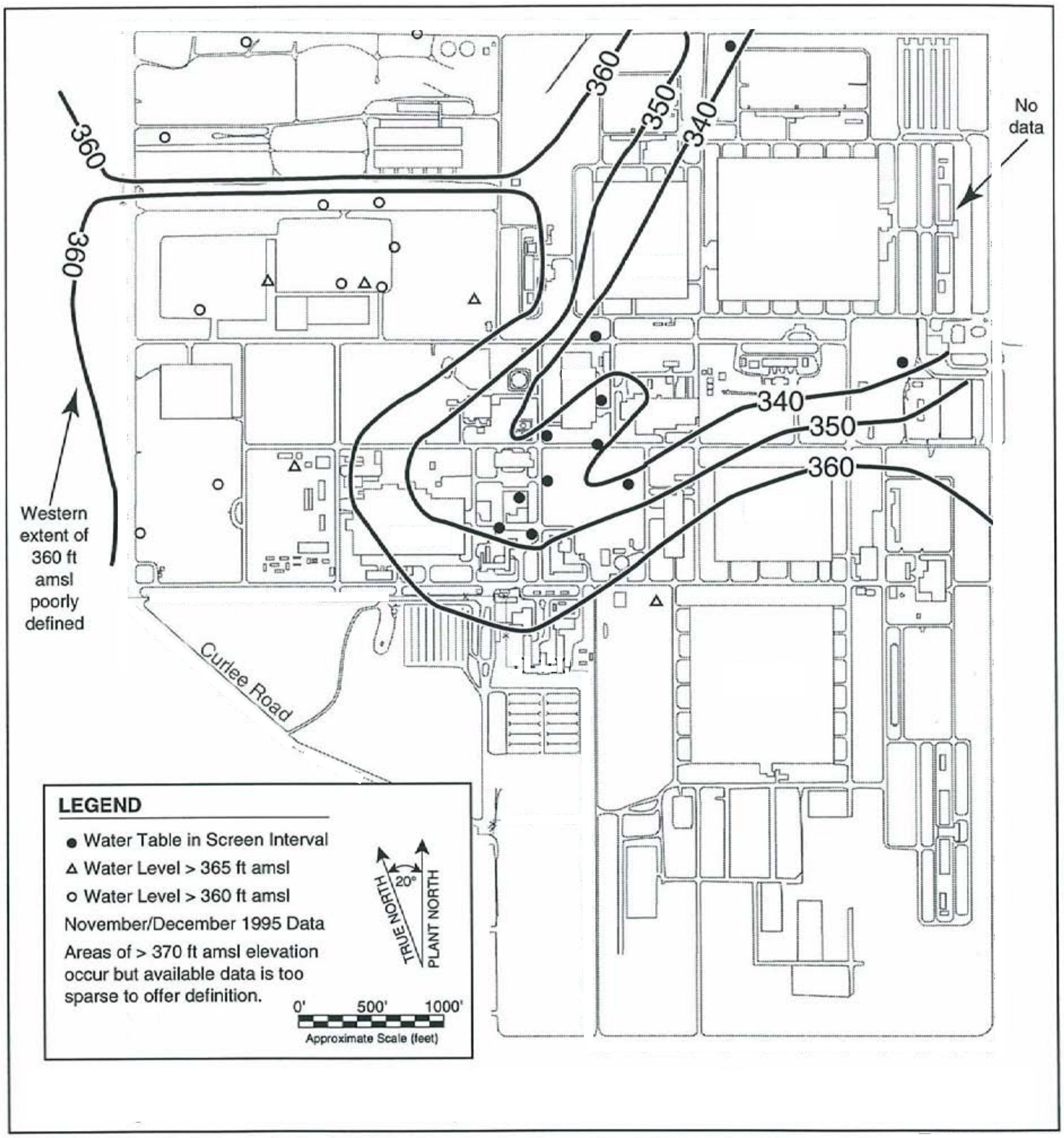

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Figure 3.5. Conceptual Water Table for PGDP

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Hydraulic potential in the RGA declines toward the Ohio River, which is the control of base level of the region's surface water and groundwater systems. The RGA potentiometric surface gradient beneath PGDP is commonly 10^{-4} ft/ft, but increases by an order of magnitude near the Ohio River. (Vertical gradients are not well documented, but small.)

The hydraulic conductivity of the RGA varies spatially. Pumping tests have documented the hydraulic conductivity of the RGA ranges from 53 ft/day to 5,700 ft/day. East-to-west flow of the ancestral Tennessee River, which laid down the Pleistocene Continental Deposits gravel member, tended to orient permeable gravel and sand lenses east-west. Thus, overall flow in the RGA is northward to the Ohio River, but trends to the northeast and northwest from PGDP in response to the anisotropy of the hydraulic conductivity. Ambient groundwater flow rates in the more permeable pathways of the RGA commonly range from 1 to 3 ft/day.

(4) McNairy Flow System. Groundwater flow in the fine sands and silts of the McNairy Formation is called the McNairy Flow System. The overall McNairy groundwater flow direction in the area of PGDP is northward to the Ohio River, similar to that of the RGA. Hydraulic potential is greater in the RGA than in the McNairy Flow System beneath PGDP. Area monitoring well clusters document an average downward vertical gradient of 0.03 ft/ft. Because the RGA has a steeper hydraulic potential slope toward the Ohio River than does the McNairy Flow System, the vertical gradient reverses nearer the Ohio River. [The "hinge line," where the vertical hydraulic gradient between the RGA and McNairy Flow System is near zero, parallels the Ohio River near the northern DOE property boundary (LMES 1996a).]

The contact between the Lower Continental Deposits and the McNairy Formation is a marked hydraulic properties boundary. Representative lateral and vertical hydraulic conductivities of the upper McNairy Formation in the area of PGDP are approximately 0.02 ft/day and 0.0005 ft/day, respectively. Vertical infiltration of groundwater into the McNairy Formation beneath PGDP is on the order of 0.1 inch per year. (Lateral flow in the McNairy Formation beneath PGDP is on the order of 0.03 inch per year.) As a result, little interchange occurs between the RGA and McNairy Flow System.

3.6.1 Hydrogeologic Units

Five hydrogeologic units (HUs) are commonly used to discuss the shallow groundwater flow system beneath the DOE site and the contiguous lands to the north (Figure 3.6). In descending order, the HUs are described below:

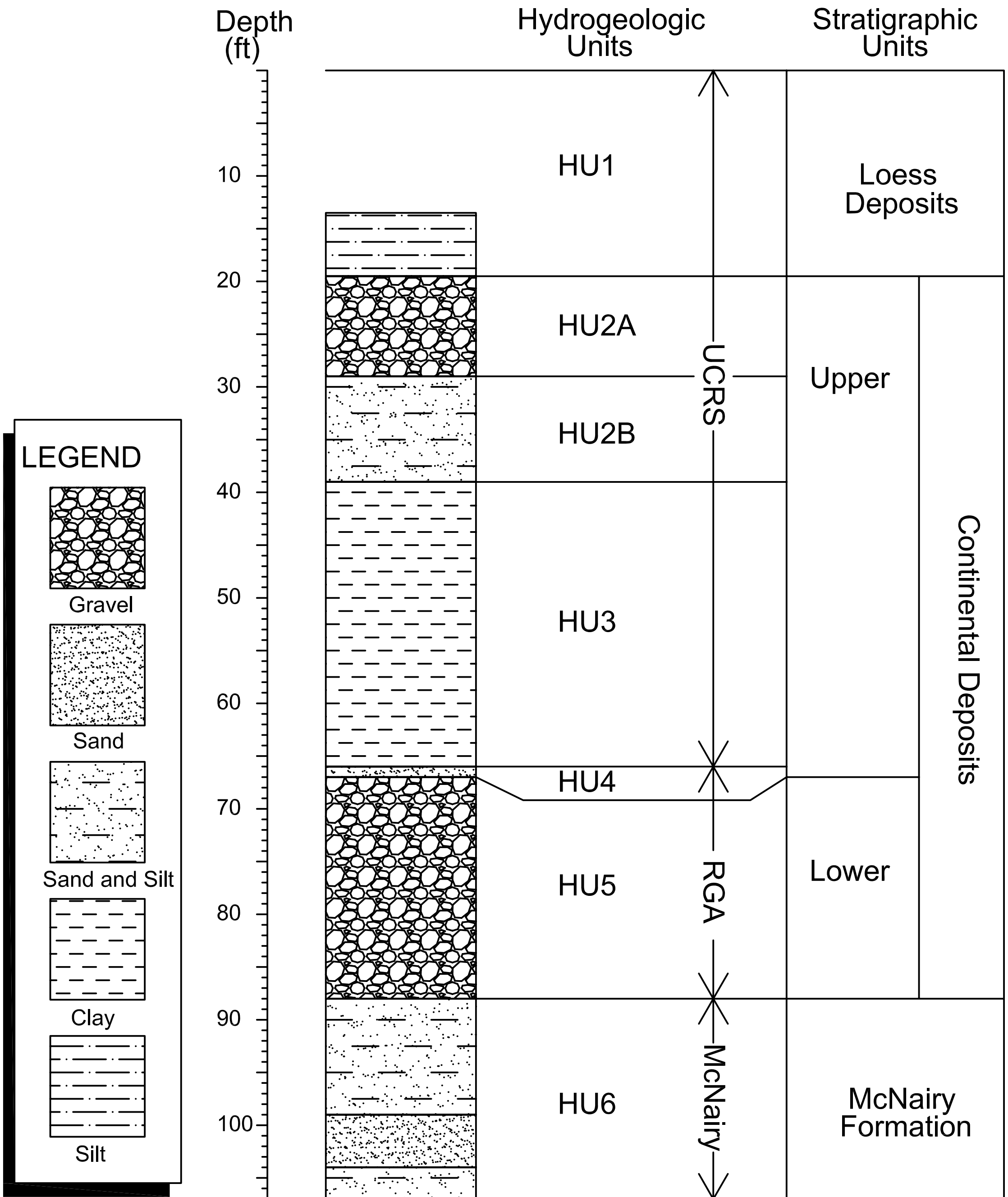
- Upper Continental Deposits

  - HU 1 (UCRS): Loess that covers the entire site.

  - HU 2 (UCRS): Discontinuous, sand and gravel lenses in a clayey silt matrix. In some areas of the plant, the HU2 interval consists of an upper sand and gravel member (HU2A) and a lower sand and gravel member (HU2B) separated by a thin silt unit.

  - HU 3 (UCRS): Relatively impermeable unit that acts as the upper semiconfining-to-confining layer for the RGA. The lithologic composition of HU3 varies from clay to fine sand, but is predominantly silt and clay.

  - HU 4 (RGA): Near-continuous sand unit with a clayey silt matrix that forms the top of the RGA.



Geology based on SI Phase 1 Boring H007.
Actual depths of hydrogeologic units and stratigraphic units vary across the site.

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Figure 3.6. Example Stratigraphic and Hydrogeologic Units

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- Lower Continental Deposits

  — HU 5 (RGA): Gravel, sand, and silt.

3.7 DEMOGRAPHY AND LAND USE

The WKWMA and some sparsely populated agricultural lands surround PGDP. Historically, the economy of western Kentucky has been based on agriculture, although there has been increased industrial development in recent years. PGDP's operations contractor, USEC, employs approximately 1,400 people, while the TVA Shawnee Steam Plant employs an additional 260 people. According to the 2000 U.S. Census, the total population within the 32 counties that lie within a 50-mile radius of PGDP is approximately 731,500; and approximately 88,500 people live within the three counties that contain the 10 mile radius of the plant (Massac County, Illinois and Ballard and McCracken Counties, Kentucky). The estimated population of Paducah, Kentucky, (2006) is approximately 25,600. Metropolis, Illinois, has an estimated population (2006) of approximately 6,400 (U.S Census Bureau 2007).

In addition to the residential population surrounding the plant, WKWMA draws thousands of visitors each year for recreational purposes. Visitors primarily use the area for hunting and fishing, but other activities include horseback riding, hiking, and bird watching. An estimated 5,000 fishermen visit the area each year.

3.8 ECOLOGY

The following sections give a brief overview of the terrestrial and aquatic systems at PGDP. A more detailed description, including identification and discussion of sensitive habitats and threatened/ endangered species, is contained in the *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CDM Federal 1994) and *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume V: Floodplain Investigation, Part A: Results of Field Survey* (COE 1994).

3.8.1 Terrestrial Systems

The terrestrial component of the PGDP ecosystem includes the plants and animals that use the upland habitats for food, reproduction, and protection. Upland vegetative communities in the vicinity of PGDP consist primarily of grassland, forest, and thicket habitats with agricultural areas. The main crops grown in the PGDP area include soybeans, corn, tobacco, and sorghum.

Most of the area in the vicinity of PGDP has been cleared of vegetation at some time. PGDP mows much of the grassland habitat adjacent to the plant. The Kentucky Department of Fish and Wildlife Resources manages a large percentage of the adjacent WKWMA to promote native prairie vegetation by burning, mowing, and various other techniques.

Dominant overstory species of the forested areas include oaks, hickories, maples, elms, and sweetgum. Understory species include snowberry, poison ivy, trumpet creeper, Virginia creeper, and Solomon's seal. Thicket areas consist predominantly of maples, black locust, sumac, persimmon, and forest species in the sapling stage with herbaceous ground cover similar to that of the forest understory.

Wildlife commonly found in the PGDP area consists of species indigenous to open grassland, thicket, and forest habitats. Small mammal surveys conducted on WKWMA documented the presence of southern short-tailed shrew, prairie vole, house mouse, rice rat, and deer mouse (KSNPC 1991). Large mammals commonly present in the area include coyote, eastern cottontail, opossum, groundhog, whitetail deer, raccoon, and gray squirrel. Mist netting activities in the area have captured red bat, little brown bat, Indiana bat, northern long-eared bat, evening bat, and eastern pipistrelle (KSNPC 1991).

The typical birds of the area are European starling, cardinal, red-winged blackbird, mourning dove, bobwhite quail, turkey, killdeer, American robin, eastern meadowlark, eastern bluebird, bluejay, red-tail hawk, and great horned owl.

Amphibians and reptiles present in the PGDP area include cricket frog, Fowler's toad, common snapping turtle, green tree frog, chorus frog, southern leopard frog, eastern fence lizard, and red-eared slider (KSNPC 1991).

3.8.2 Aquatic Systems

The aquatic communities in and around the PGDP area that could be impacted by plant discharges include two perennial streams (Bayou Creek and Little Bayou Creek), the NSDD (a former ditch for the discharge of plant effluents to Little Bayou Creek), a marsh located at the confluence of Bayou Creek and Little Bayou Creek, and other smaller drainage areas. The dominant taxa in all surface waters include several species of sunfish, especially bluegill and green sunfish, as well as bass and catfish. Shallow streams, characteristic of the two main area creeks, are commonly dominated by bluegill, green and longear sunfish, and stonerollers.

3.8.3 Wetlands and Floodplains

The wetlands of the PGDP vicinity include a swamp covering 165 acres immediately south of the confluence of Bayou and Little Bayou Creeks. A 1994 study of the PGDP area by the U.S. Corps of Engineers (COE) (1994) groups the area wetlands into 16 vegetative cover types encompassing forested, scrub/shrub, and emergent wetlands. Wetland vegetation consists of species such as sedges, rushes, spikerushes, and various other grasses and forbs in the emergent portions; red maple, sweet gum, oaks, and hickories in the forested portions; and black willow and various other saplings of forested species in the thicket portions. Wetlands inside the plant security fence are confined to portions of drainage ditches traversing the site (CDM Federal 1994).

At PGDP, three bodies of water cause most area flooding: the Ohio River, Bayou Creek, and Little Bayou Creek. The floodplain analysis performed by the COE (COE 1994) found that much of the built-up portions of the plant lie outside the 100- and 500-year floodplains of these streams. In addition, this analysis determined that ditches within the plant area can contain the expected 100- and 500-year discharges.

3.9 BGOU PHYSICAL CHARACTERISTICS

The following sections present the settings and physical characteristics of the BGOU SWMUs that govern contaminant migration.

3.9.1 BGOU Surface Features

The PGDP facility generally consists of three land uses, (1) areas of permanent structures and paved roads that are engineered to promote drainage, (2) UF_6 cylinder storage yards and scarp yards, and (3) former burial grounds and aboveground landfills. All of the SWMUs for the BGOU are former burial grounds or aboveground landfills. Drainage ditches that discharge into KPDES outfalls and then to Bayou Creek west of the plant skirt all of the BGOU SWMUs, except SWMU 145 (Figure 3.7). Runoff from SWMU 145 flows through the NSDD to Little Bayou Creek.

SWMU 2 is a uranium burial ground located immediately west of SWMU 3, in the west-central portion of the plant (Figure 1.4). Graveled storage yards bound SWMU 2, to the north and west, respectively. The main drainage ditch to KPDES Outfall 015 passes between SWMU 2 and Virginia Avenue, to the south. SWMU 2 is grass covered. The land surface at SWMU 2 is relatively flat (with a slight mound on the east side); surface elevations range from 370 to 375 ft amsl. PGDP maintains SWMU 2 as a Radioactive Materials Area, with applicable boundary access controls.

SWMU 3 (Figure 1.5) consists of an aboveground surface impoundment that was converted to a solid waste disposal facility (C-404) and a field to the east where a northeast-southwest ditch drained the C-404 surface impoundment to the NSDD. C-404 is a grass covered mound with steep, 10-ft high sides and a gently sloping cap (highest on the east side). Elevations at C-404 range from 375 to 392 ft amsl. A graveled storage yard borders C-404 to the north. The same main drainage ditch to KPDES Outfall 015 passes between C-404 and Virginia Avenue, to the south. Gravel roads provide limited access to the east and south sides of C-404. PGDP maintains C-404 as a Radioactive Materials Area.

SWMU 4 is an open grass field that was used for the burial and disposal of waste materials. This SWMU is bounded on the north by Virginia Avenue, on the east by 6th Street, on the west by 4th Street, and on the south by an active railroad spur (Figure 1.6). Shallow drainage swales that direct surface runoff to the northwest corner of the site bound SWMU 4 on three sides (north, east, and west). Surface runoff passes beneath Virginia Avenue through a drainage culvert where it discharges into the main drainage ditch to KPDES Outfall 015. The ground surface of the burial area is graded so that surface runoff is directed toward the surrounding drainage swales. There is an elevation difference of approximately 10 ft between the highest point in the SWMU to the adjacent drainage swales. PGDP maintains a fence around SWMU 4 to control access.

SWMU 5 is a burial area in the northwest quadrant of the plant (Figure 1.7). Unnamed gravel roads parallel the north, south, and east sides, while a paved road lies to the west. Shallow drainage swales bordering the SWMU direct surface runoff to a settling pond (C-613) and then to KPDES Outfall 001. The ground surface is grass-covered with no significant surface structures. Approximately five ft of topographic relief exists between the mound of the burial area, which is offset to the east, and the sides of the SWMU. The SWMU is fenced to limit access to authorized personnel only.

The SWMU 6 burial plots (Figure 1.8) are located due east of SWMU 5. This area is relatively flat and is bounded by unnamed gravel roads to the west and south and to the north by a ditch that drains through the C-613 settling pond to KPDES Outfall 001. PGDP maintains the area as a grassed field with occasional shrubs. SWMU 6 is a Radioactive Materials Area with boundary chains to mark limited access.

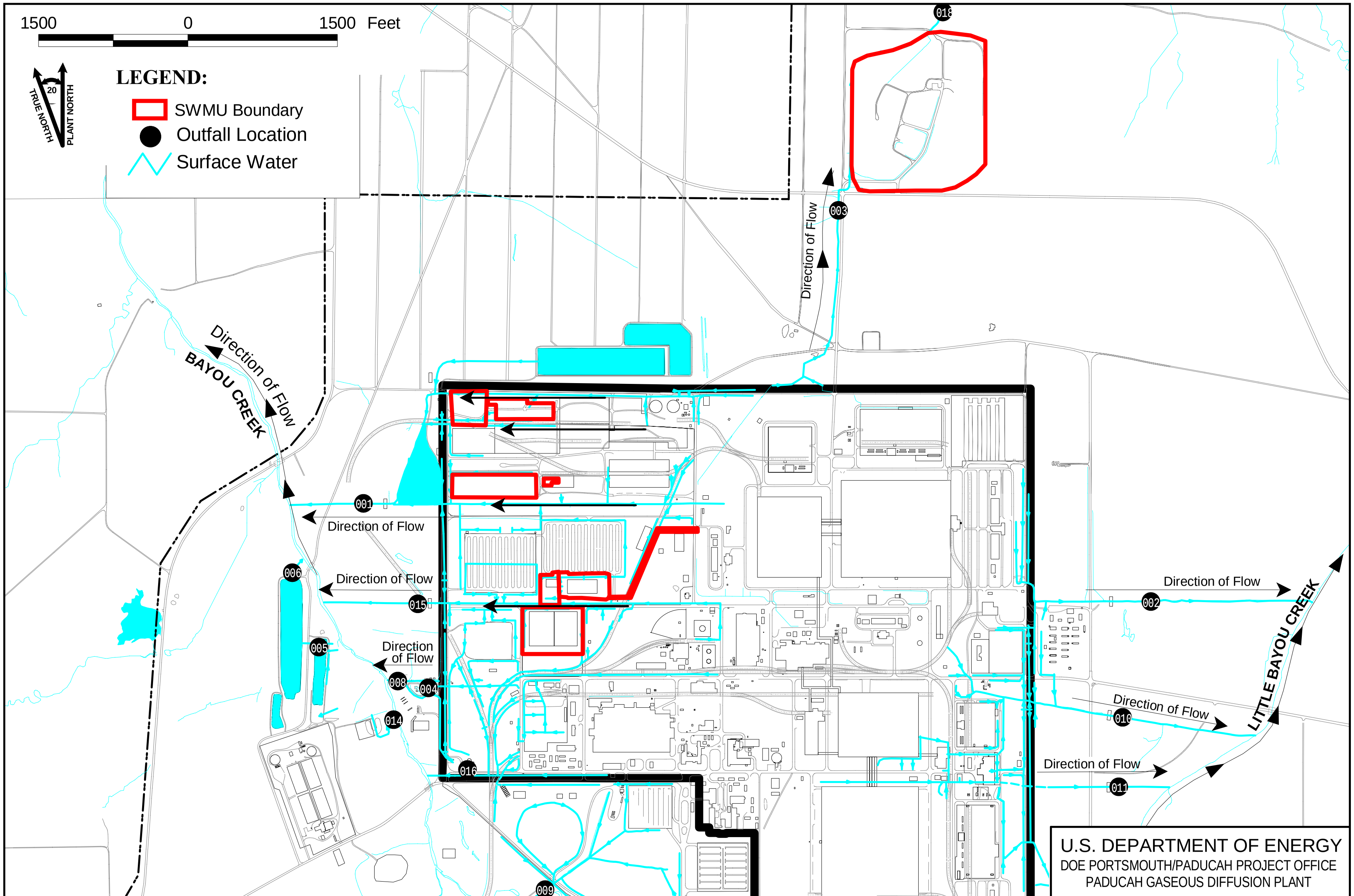

Figure 3.7. Drainage Ditch Systems at the BGOU SWMUs

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SWMU 7 is a burial pit area in the northwest corner of the plant (Figure 1.9). Ditches of the KPDES Outfall 001 drainage system border SWMU 7 to the north and south. A scrap yard lies to the east. SWMU 30 adjoins SWMU 7 to the west. The earthen cover over the burial pits form slight hills (two ft high) on the north and south sides of SWMU 7. A gravel pad covers the east end of SWMU 7. PGDP maintains grass cover over the west burial pits. Boundary chains limit access to the west burial pits, which are delimited Radioactive Materials Areas and High Radioactive Materials Areas.

The same KPDES Outfall 001 drainage ditches bound SWMU 30 on the north and south sides. A paved road borders SWMU 30 on the west side. The surface of the SWMU 30 earthen cover ranges from an elevation of 375 ft at it highest point near the northeast corner of the SWMU to 371 ft near the edges of the burial pit. As at SWMU 7, PGDP maintains a grass cover over the burial pit and boundary chains limit access (Radioactive Materials Area).

SWMU 145 (Figure 1.10) is located to the north of the plant, beneath the C-746-S and -T Landfills. Boundaries of the waste fill are not well defined. The BGOU RI used review of historical aerial photography and geophysical surveys to delineate areas for characterization of the historic waste fill (see Section 2.1). Ogden Landing Road (Kentucky Highway 358) borders the south side of SWMU 145. PGDP's currently operating landfill (C-746-U) lies to the north of SWMU 145. The present trace of the NSDD passes on the west and north sides. Grasslands of the WKWMA adjoin SWMU 145 to the east. Area runoff drains through the NSDD. Fencing for the C-746-S and -T Landfills limits access to SWMU 145.

3.9.2 Underground Utilities and Plant Operations

Underground utilities are sparse in the area of the BGOU SWMUs and appear to have had no impact on contaminant migration from or into the SWMU areas. Plant operations subsequent to waste operations at each of the SWMUs have contaminated surface soils. The common presence of polycyclic aromatic hydrocarbons (PAHs) and uranium in surface soil are related directly to past and on-going plant operation. Ditches bound all of the BGOU SWMUs and provide a potential pathway for contaminant migration. The SWOU SI assesses the nature and extent of this contamination in most areas addressed by the BGOU RI. Ditches of the northwest plant area that drain to the C-613 Sedimentation Basin will be addressed by the Comprehensive Site OU evaluation, after completion of the other strategic initiatives.

3.9.3 BGOU Hydrogeology

The scope of the BGOU RI focused on contaminant migration in the soils of the Pleistocene Continental Deposits and in the groundwater of the UCRS and RGA flow systems. Appendix B provides the lithologic logs of the boreholes drilled for the BGOU RI. The following sections summarize the general characteristics of the UCRS and RGA and present hydrogeologic data for each SWMU based on field information obtained during the BGOU RI and previous studies. This presentation of the site hydrogeology uses the framework of the five HUs as summarized in Section 3.6.1.

Sorption. Cation exchange capacity and total organic carbon content are common measures of the sorption capacity of soils. The SWMU 2 Interim Remedial Design Investigation (DOE 1997a) characterized cation exchange capacity and total organic carbon content for each HU. Table 3.2 presents the data. Cation exchange capacity values for UCRS soils range from 15 to 26 milliequivalents per 100 g (meq/100 g). These values are typical of silty soils with some clay. Only three values are available for the RGA HU5 interval. The two lowest values of 9 and 10 meq/100 g are most representative of the overall RGA.

Total organic carbon content for the SWMU 2 data is similar for the UCRS and RGA. Values range from 0.05 to 0.24% (with a median value of 0.08%) for the UCRS measurements and 0.02 to 0.25% (with a median value of 0.05%) for the RGA measurements. The WAG 6 RI (DOE 1999c) also measured total organic carbon content of UCRS and RGA soils. Total organic carbon content measurements ranged from 0.002 to 0.2% (median of 0.04% for 20 measurements) in UCRS samples and from 0.003 to 0.3% (median of 0.02% for 38 measurements) in RGA samples.

The SWMUs 7 and 30 Remedial Investigation (DOE 1998c) and SWMU 2 Interim Remedial Design Investigation also characterized the uranium distribution ratio for all HUs because of the significance of potential uranium transport from the burial cells (Table 3.2). All measurements of the uranium distribution ratio are greater than 1, which means that uranium will preferentially partition from groundwater to the soils. The magnitude of the UCRS values (253 to 93,900 mL/g) indicates that common forms of uranium leachate are not likely to migrate from the burial grounds to the RGA. Even the sands and gravel units of the RGA would provide significant retention of uranium [uranium distribution coefficient (K_d) of 66.8 mL/g]. The fate and transport modeling for this RI, as documented in Appendix E, uses a K_d of 66.8 mL/g to minimize the potential of eliminating uranium as a contaminant of concern (COC) so that it can be properly addressed in the BGOU FS.

Table 3.2. Sorption Measurements from SWMUs 7 and 30 Remedial Investigation Report and the SWMU 2 Interim Remedial Design Investigation

	SWMUs 7 and 30	**SWMU 2**			
HU	**Uranium Distribution Ratio (mL/g)**	**Sample ID**	**Uranium Distribution Ratio (mL/g)**	**Cation Exchange Capacity (meq/100 g)**	**Total Organic Carbon Content (%)**
HU1	253 ± 10.0	S03211	3,200	NA	NA
		S05211	1,530	17.54	0.1020
		S17211	NA	20.80	0.0819
HU2 Sand	1,170 ± 264	S03212	9,080	NA	0.0701
		S05212	8,070	15.11	0.0869
		S13211	NA	17.87	0.2400
HU2 Silt		S03213	13,100	17.78	0.0465
		S05213	72,200	21.04	0.0968
		S17212	NA	18.18	0.0566
HU3	3,640 ± 2,060	S03214	93,900	NA	NA
		S05214	7,020	21.94	0.0862
		S09213	NA	23.02	0.0807
		S17213	NA	25.63	0.0720
HU4	761 ± 172	S13212	NA	23.80	0.1060
		S17214	NA	NA	0.0464
HU5	66.8 ± 3.82	S03215	4,950	NA	0.2530
		S05215	49,900	9.98	0.0453
		S09215	NA	NA	0.0394
		S13214	NA	23.72	0.0796
		S13215	NA	9.40	0.0321
		S17215	NA	NA	0.0199

NA = not available (not measured)

Groundwater Geochemistry. In areas that are not heavily influenced by dissolved contaminants, both UCRS and RGA groundwater tends to be mildly acidic and well buffered. As the groundwater migrates through the UCRS, bicarbonate replaces sulfate as the dominant anion (Clausen, et al. 1992; DOE 1997a) with depth. The dominant cations in both UCRS and RGA water are commonly sodium followed by calcium.

Sufficient UCRS and RGA monitoring well data are available to document the nature of dissolved oxygen levels and oxidation/reduction potential that are applicable to the BGOU SWMUs. Table 3.3 summarizes the available analyses for UCRS groundwater samples (collected from wells and temporary borings) for the BGOU SWMUs. The majority of dissolved oxygen measurements (collected *ex situ*) from UCRS wells range from near zero to four mg/L (Figure 3.8) and oxidation/reduction potential commonly ranges from -100 to 300 microVolts, with the majority of measurements greater than zero. The line plots of Figure 3.9 further demonstrate trends of dissolved oxygen (517 measurements) and oxidation/reduction potential (136 measurements) in the UCRS at the BGOU SWMUs. Plots of the data for each SWMU (as available), overlaid on the cumulative trend plots, (Figures 3.10 and 3.11) illustrate the relative abundance of measurements for each SWMU and demonstrate that the cumulative trend is representative of conditions at each SWMU.

Previous investigations of SWMU 2 (DOE 1997a) and SWMUs 7 and 30 (DOE 1998c) identified high levels of reductive dechlorination byproducts of TCE within and below some waste disposal areas. These byproducts [principally *cis*-1,2-dichloroethene (DCE) and vinyl chloride] are evidence that reducing conditions (little to no dissolved oxygen) have been present, and may continue to be present, locally within some of the burial cells where other organic wastes, such as oils, have been co-located.

The range of dissolved oxygen and oxidation/reduction potential is similar for the RGA beneath the BGOU SWMUs. Dissolved oxygen measurements commonly fall between near 0 mg/L and 6 mg/L (Figure 3.12). Oxidation/reduction potential of the RGA is confined in the 100 to 300 microvolts range. Line plots of the data (Figure 3.13) illustrate the trends of dissolved oxygen (1,799 measurements) and oxidation/reduction potential (574 measurements) in the RGA at the BGOU SWMUs. Plots of the data for each SWMU (as available), overlaid on the cumulative trend plot, (Figures 3.14 and 3.15) reveal that the dissolved oxygen and oxidation/reduction potential measurements at each SWMU are generally well distributed through the cumulative range.

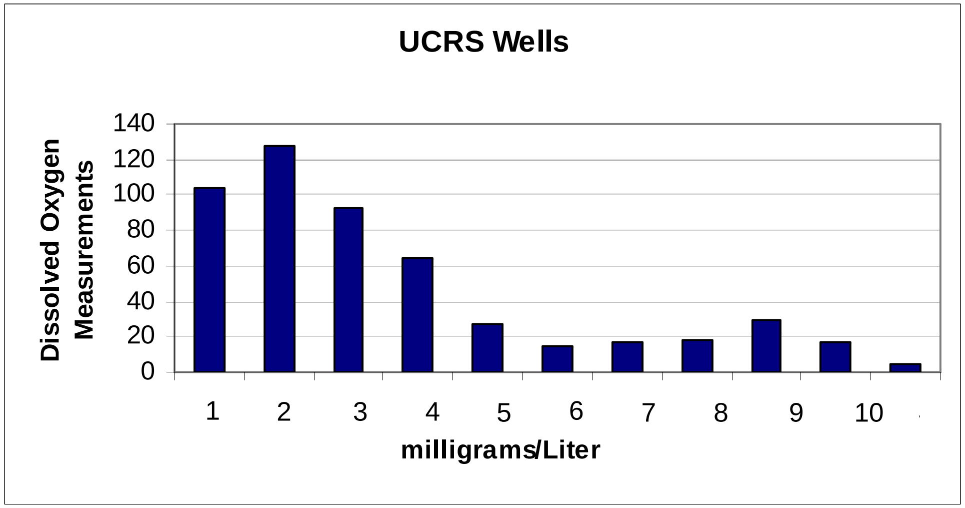
RGA Hydraulic Potential. The potentiometric surface of the RGA trends north-northeast toward the regional hydraulic base level represented by the Ohio River. Representative values for hydraulic gradient at PGDP and to the north commonly range between 10^{-4} ft/ft and 10^{-3} ft/ft. In the area of the plant, the potentiometric surface remains relatively flat throughout the year. The area north of the DOE property boundary tends to be an area of higher hydraulic gradient, except following an extended rise in the Ohio River stage.

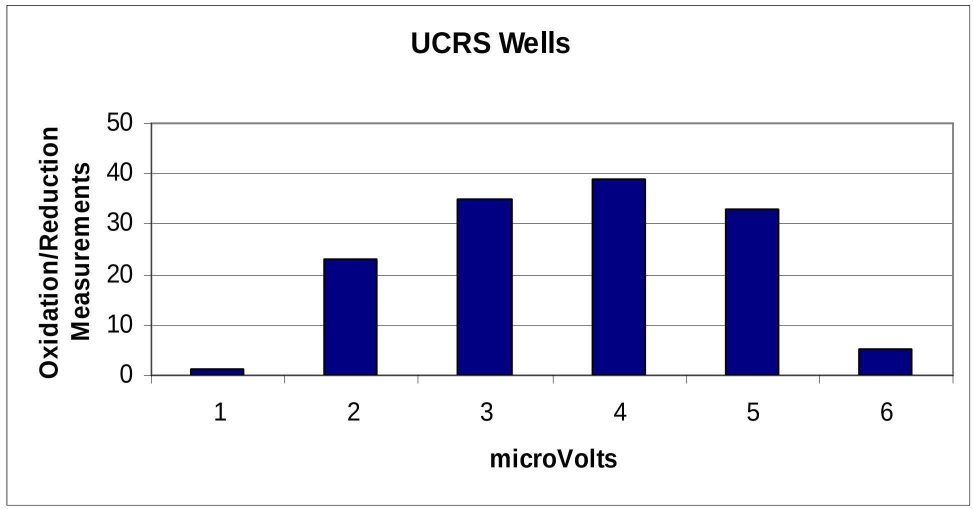
The hydraulic potential of the RGA near the center of the plant averages 328 ft amsl and commonly fluctuates five ft over a yearly high-and-low cycle. RGA water levels near the Ohio River are often 10 ft lower. Low pool elevation of the Ohio River north of PGDP is 290 ft amsl.

Table 3.3. Summary of Dissolved Oxygen and Oxidation/Reduction Potential Data of the UCRS (Samples from 64 ft depth or less) for the BGOU RI

SWMU	Sample Location	Sample Depth (ft)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Data Type	Oxidation /Reduction Potential (mV)	Oxidation /Reduction Potential Data Type
2	SWMU 2-3	63	6.3	C	112	C
	SWMU 2-9	24	11.5	C	174	C
		43	9.4	C	--	--
	SWMU 2-10	22	3.0	C	--	--
	SWMU 2-17	22	7.8	C	46	C
	PZ74	32 – 42	5.0	B	240	B
	MW154	16 - 18	4.5	A	303	C
	PZ334	8 - 10	5.7	A	224	B
	PZ335	8 - 10	2.8	B	254	B
	PZ336	8 - 10	5.5	B	244	B
3	MW85	30 – 40	8.2	A	225	A
	MW88	29 – 40	2.0	A	228	A
	MW91	29 – 39	6.8	A	223	A
	MW94	29 – 39	2.5	A	192	A
4	004-020	60	--	--	156	C
	004-021	60	--	--	183	C
	004-022	60	--	--	241	C
	004-105	64	--	--	144	C
	004-107	64	--	--	168	C
	004-108	64	--	--	84	C
	004-110	64	--	--	134	C
5	005-015	55 – 60	--	--	179	C
	005-018	60	--	--	220	C
	MW190	18 – 22	2.9	A	--	--
6	006-016	32 – 37	--	--	171	C
	006-018	22 – 27	--	--	175	C
	006-019	60	--	--	207	C
7	WBP-9A	11	1.6	B	164	B
	WBP-12A	9	2.3	B	64*	B
	MW186	18 – 23	0.8	A	157	A
30	WBP-4A	8	2.6	B	7*	B
	MW64	28 – 33	6.3	A	--	--
	MW187	22 – 26	2.0	A	198	A
145	145-021	59	--	A	24	A
	MW16	20 – 40	5.8	A	--	A
	MW18	35 – 55	0.7	A	--	A
	MW180	22 – 27	2.3	A	179	A
	MW182	15 – 20	1.5	A	-7*	A
	MW386	20 - 30	1.3	A	21	A
	MW390	28 - 38	2.7	A	197	A
	MW393	28 - 38	1.2	A	-13	A
	MW396	34 - 44	1.0	A	36	A

Data Type:
A = median of measurements of four or more sample events
B = average of measurements of two or three sample events
C = single value available
* Range includes negative and positive oxidation/reduction potential values
-- indicates no data available.





NOTE: Table 3.3 identifies the sample locations.

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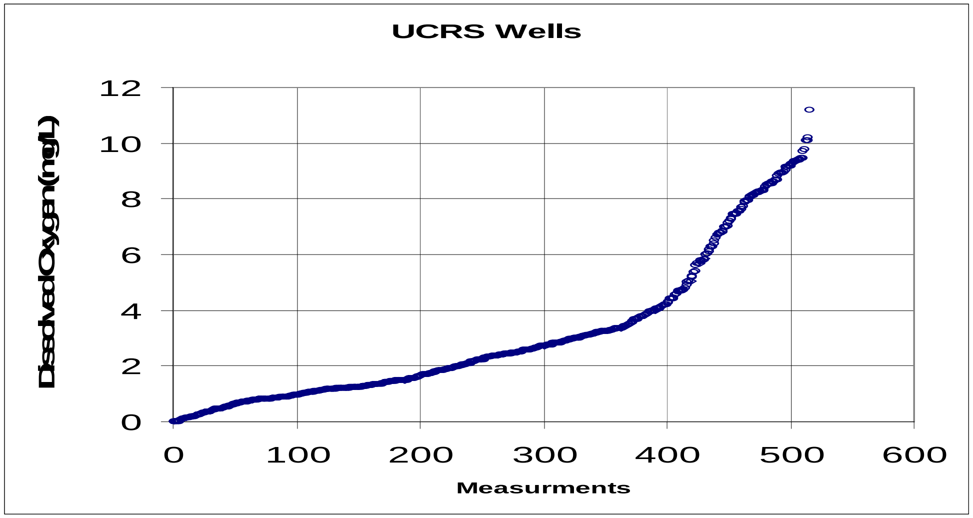
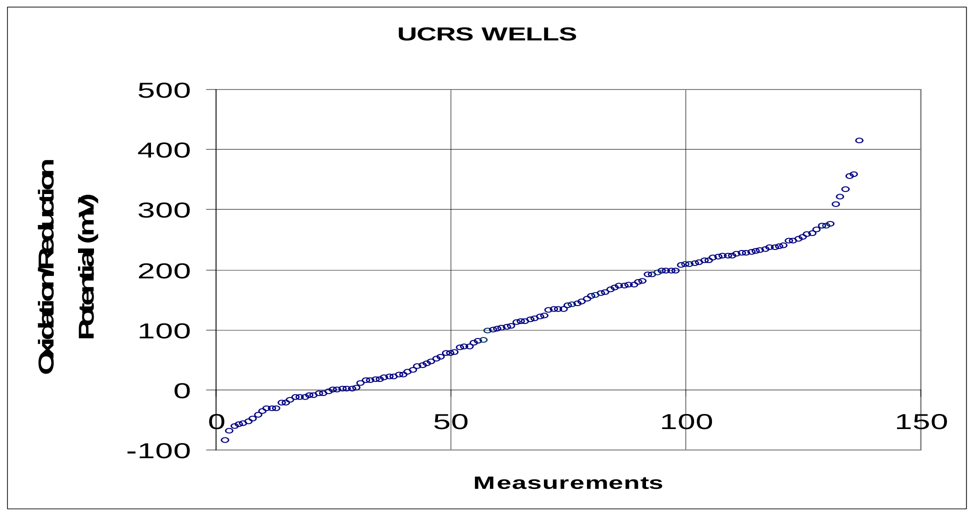
Figure 3.8. Distribution of Dissolved Oxygen and Oxidation/Reduction Potential Measurements in the UCRS for the BGOU SWMUs





NOTE: Table 3.3 identifies the sample locations.

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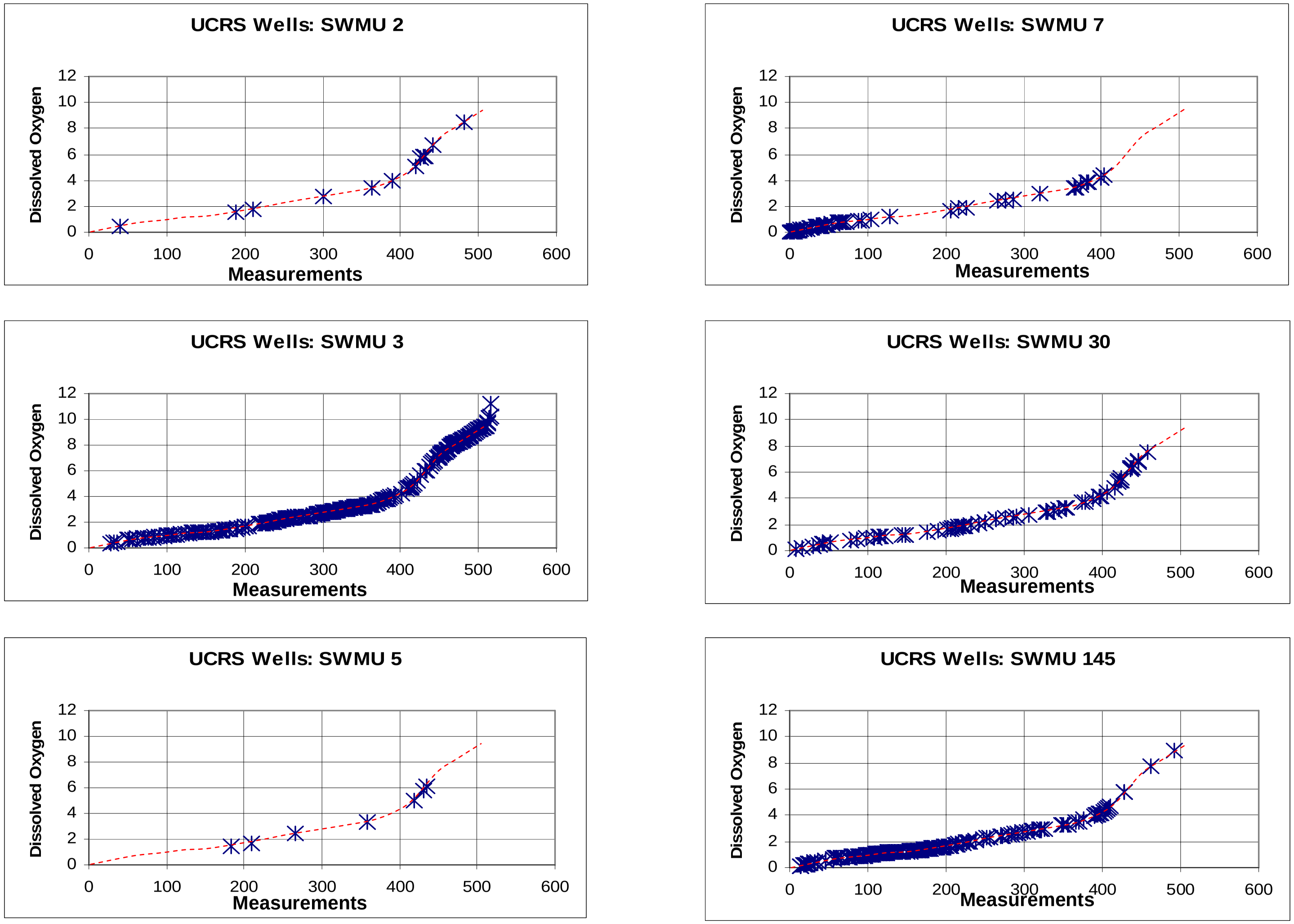
Figure 3.9. Dissolved Oxygen and Oxidation/Reduction Potential Measurements in the UCRS for the BGOU SWMUs



NOTE: Table 3.3 identifies the sample locations.

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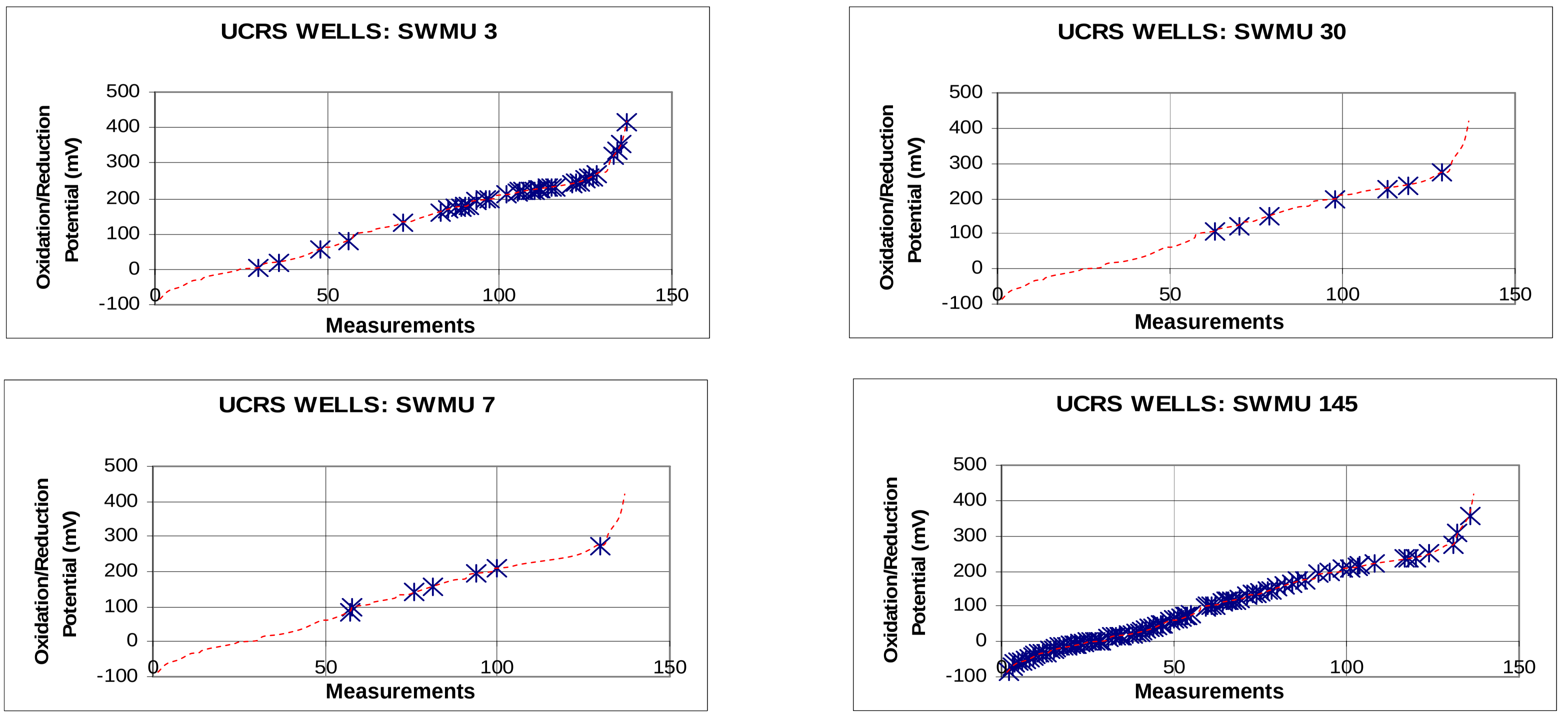
Figure 3.10. Dissolved Oxygen Measurements in the UCRS for Each BGOU SWMU



NOTE: Table 3.3 identifies the sample locations.

Figure 3.11. Oxidation/Reduction Potential Measurements in the UCRS for Each BGOU SWMU

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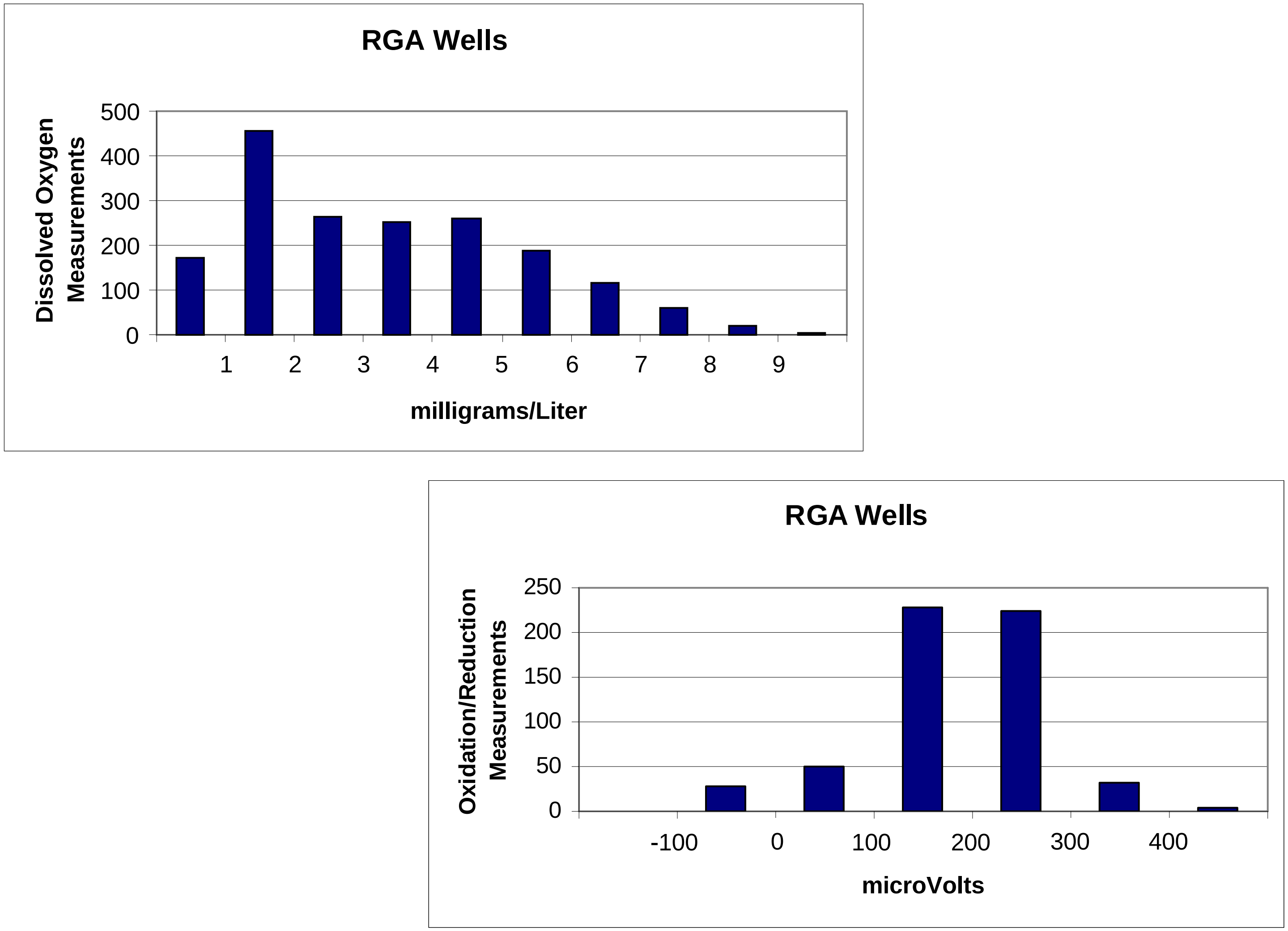

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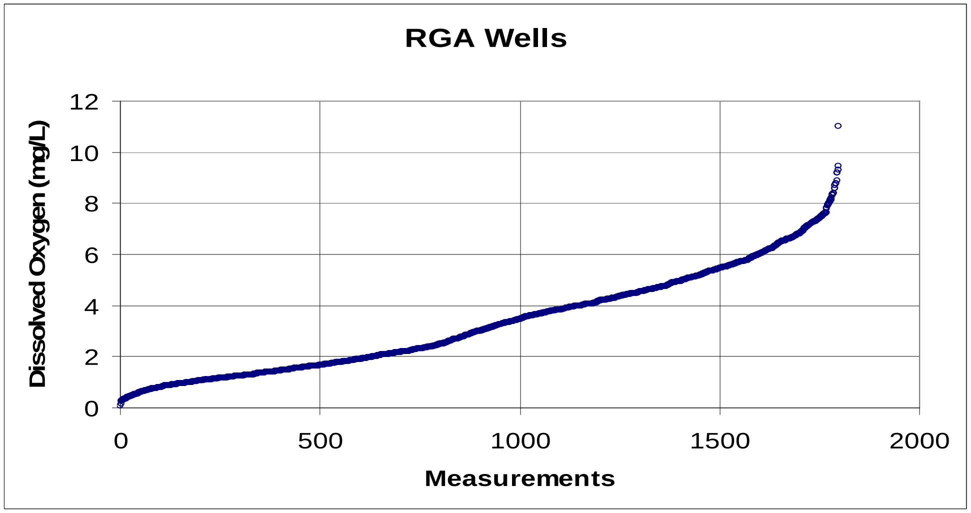
Figure 3.12. Distribution of Dissolved Oxygen and Oxidation/Reduction Potential Measurements in the RGA for the BGOU SWMUs



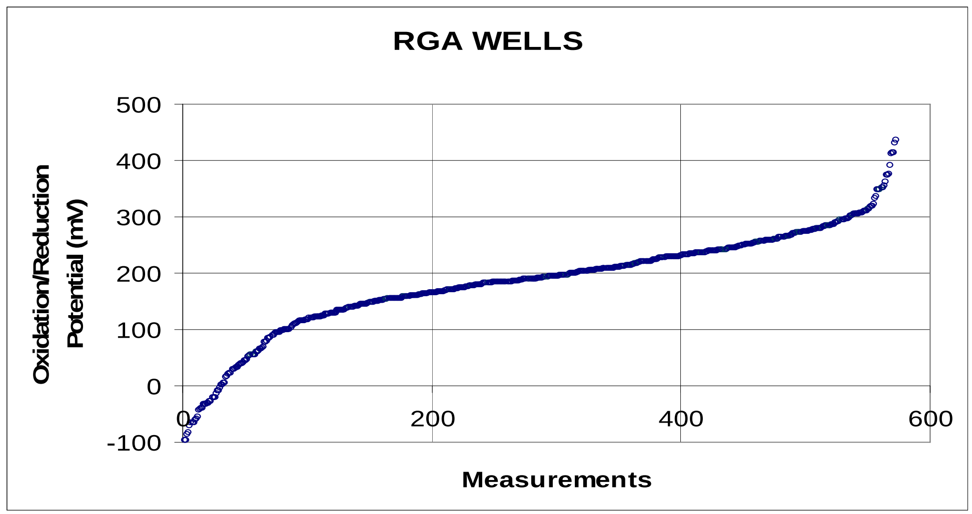


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Figure 3.13. Dissolved Oxygen and Oxidation/Reduction Potential Measurements in the RGA for the BGOU SWMUs

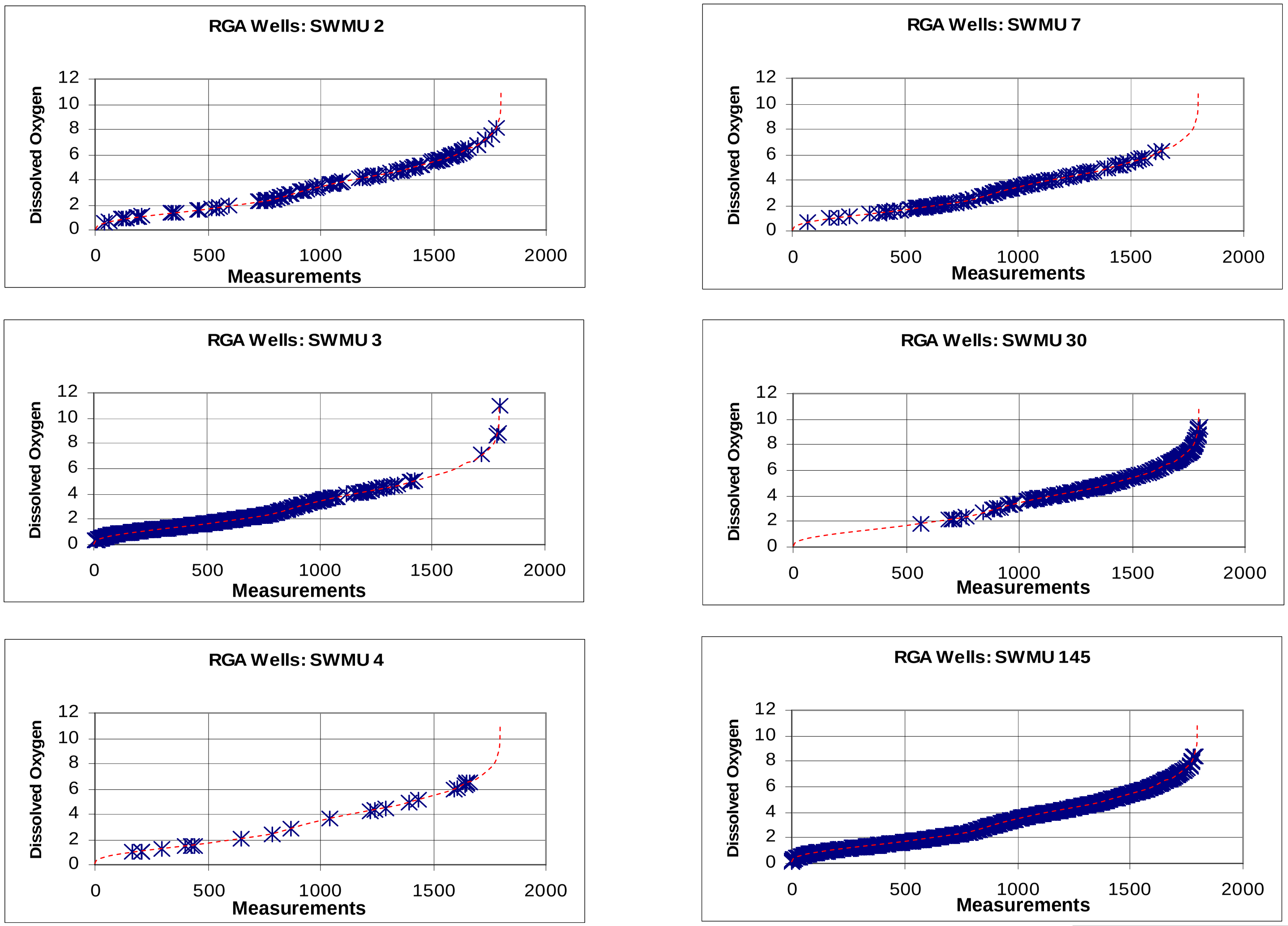

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Figure 3.14. Dissolved Oxygen Measurements in the RGA for Each BGOU SWMU

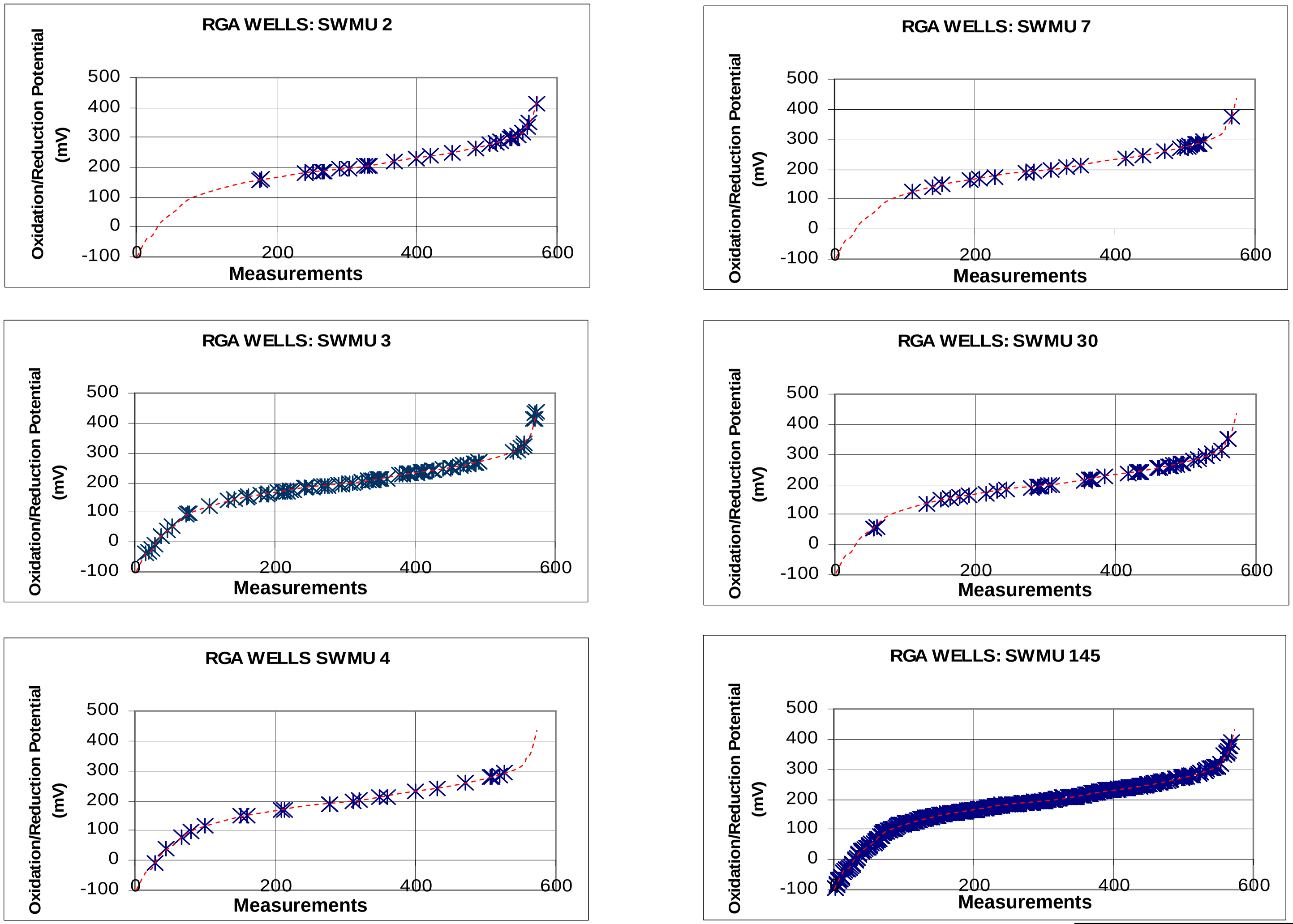

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Figure 3.15. Oxidation/Reduction Potential Measurements in the RGA for Each BGOU SWMU

3.9.3.1 SWMUs 2 and 3 hydrogeologic interpretation

Waste Disposal Background. SWMUs 2 and 3 are adjacent waste disposal facilities located in the west-central portion of the plant. PGDP buried uranium and uranium-contaminated waste in cells excavated to depths of 7 to 17 ft at SWMU 2. SWMU 3 (C-404) operated as a rectangular, aboveground, surface impoundment from approximately 1952 until 1957, when PGDP converted the surface impoundment to a solid waste disposal facility for uranium-contaminated wastes. (See Sections 1.3.1 and 1.3.2)

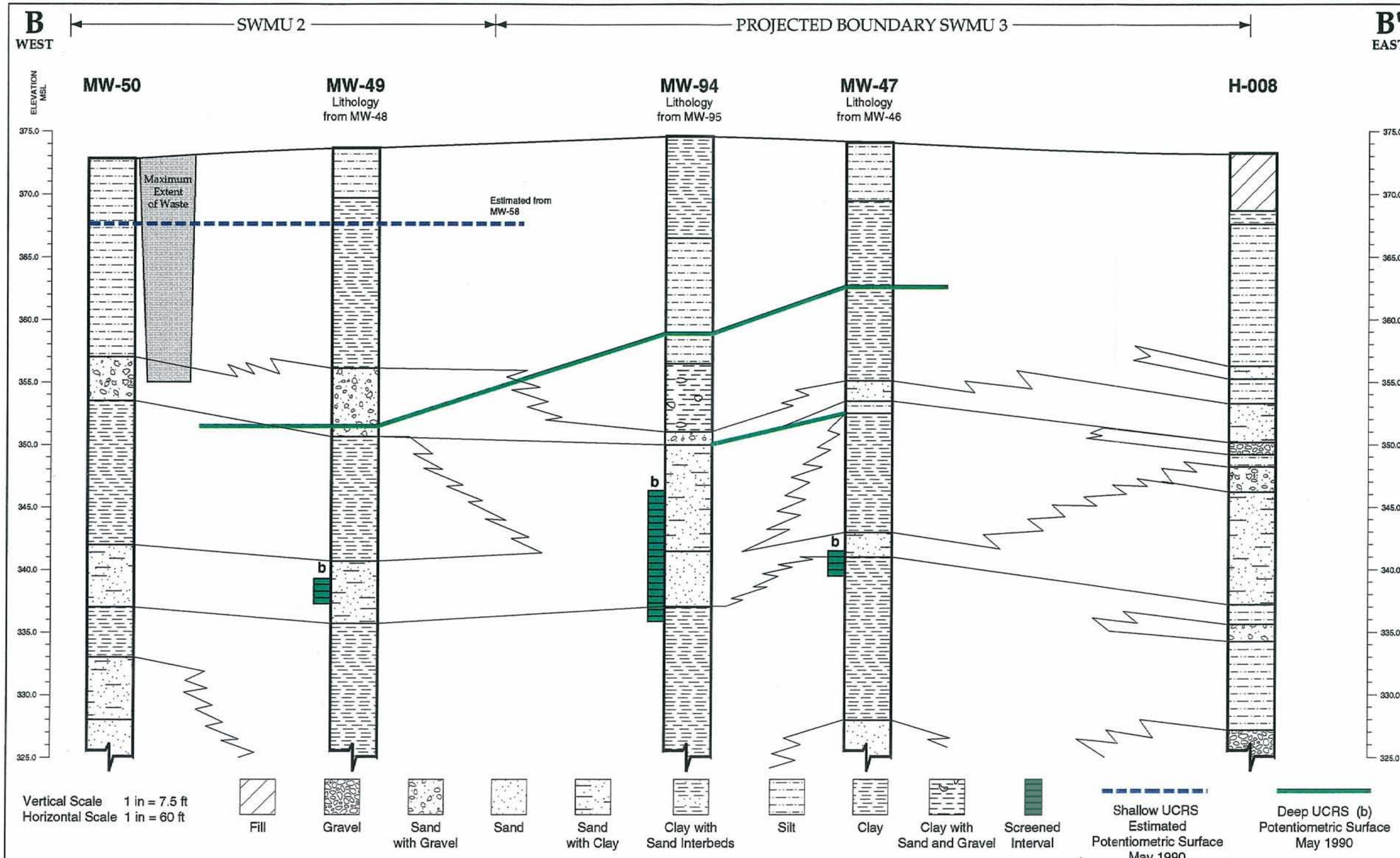
Stratigraphy. The burial cells of SWMU 2 are excavated into the HU1 loess member (silt with some clay) of the Upper Continental Deposits. Some waste cells likely extend to near the base of the HU1 unit, at a depth of 18.5 ft. The underlying HU2 interval consists of upper and lower sand and gravel horizons, separated by an intervening clayey silt unit, to a depth of 40 ft. A nine-ft-thick silty clay interval (HU3) separates the HU2 sand and gravel horizons from the basal HU4 sand and the sands and gravels of the Lower Continental Deposits (HU5). SWMU 3 rests upon the top of the Upper Continental Deposits. East-west cross sections of the stratigraphy below SWMUs 2 and 3 (Figure 3.16, DOE 1995b) demonstrate the relative continuity of the HU2 sand and gravel intervals.

UCRS Groundwater Flow and Hydraulic Potential. Figure 3.17 (DOE 1997a) summarizes the key hydrogeologic parameters that govern groundwater flow through the UCRS below SWMUs 2 and 3. The SWMU 2 Interim Remedial Design Investigation Report (DOE 1997a) documents the depth and gradient of the water table using measurements from shallow monitoring wells and piezometers. Four rounds of measurements of water level during a one-week period in August, 1996 consistently demonstrate that the water table occurred within 10 ft of land surface, sloping toward a ditch on the west side. Most of the buried waste at SWMU 2 is saturated. The westward slope of the water table below SWMU 2 indicates that the water table must be equally shallow beneath SWMU 3. Because SWMU 3 is an above-ground facility with a RCRA multi-layered cap, all but the base of the landfill wastes are likely unsaturated.[3]

RGA Groundwater Flow and Hydraulic Potential. The BGOU RI includes a hydrogeological assessment of SWMU 3 (PRS 2007a), which documents the primary groundwater pathways in the area RGA (Figure 3.18). Contaminant trends associated with the Southwest Plume demonstrate convincingly that the dominant groundwater pathway immediately south of SWMU 3 is to the northwest, in agreement with the larger Southwest Plume trend, which passes beneath the south end of SWMU 2. Beneath SWMU 3, the groundwater pathway veers northward.

The governing parameters determining the groundwater flow paths are the higher hydraulic conductivity corridors in the RGA marked by the Southwest Plume and the Northwest Plume to the south and north of SWMU 3, respectively, and the RGA potentiometric surface, which declines to the north. Edges of the Southwest Plume and Northwest Plume approximate boundaries of higher hydraulic conductivity in the HU5 sediments, through which the majority of groundwater flow occurs. Pumping tests of the RGA in the area of the main contaminant plumes on-site (Terran 1992; LMES 1996b) have determined the representative hydraulic conductivity to be 1,200 to 1,300 ft/day, which contrasts with the hydraulic conductivity of the RGA beneath SWMU 3, measured as 100 ft/day in a previous pumping test (Terran 1990).

[3] The continuing recovery of leachate from the facility indicates that some infiltration occurs and the base of the disposal cell must be saturated.



REFERENCE: DOE 1995b

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Figure 3.16. East-West Cross-Section of SWMUs 2 and 3

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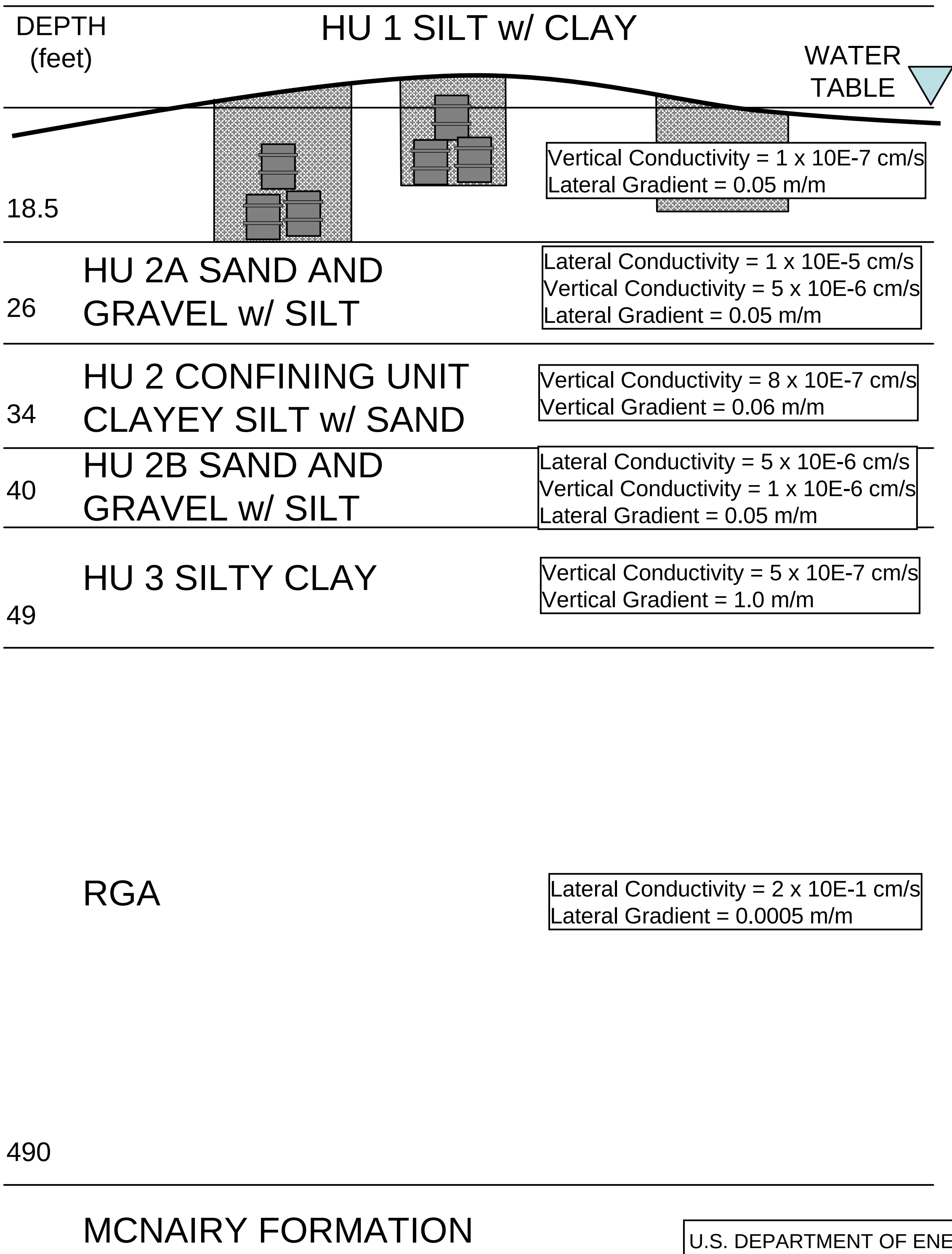

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Figure 3.17. Geologic Setting

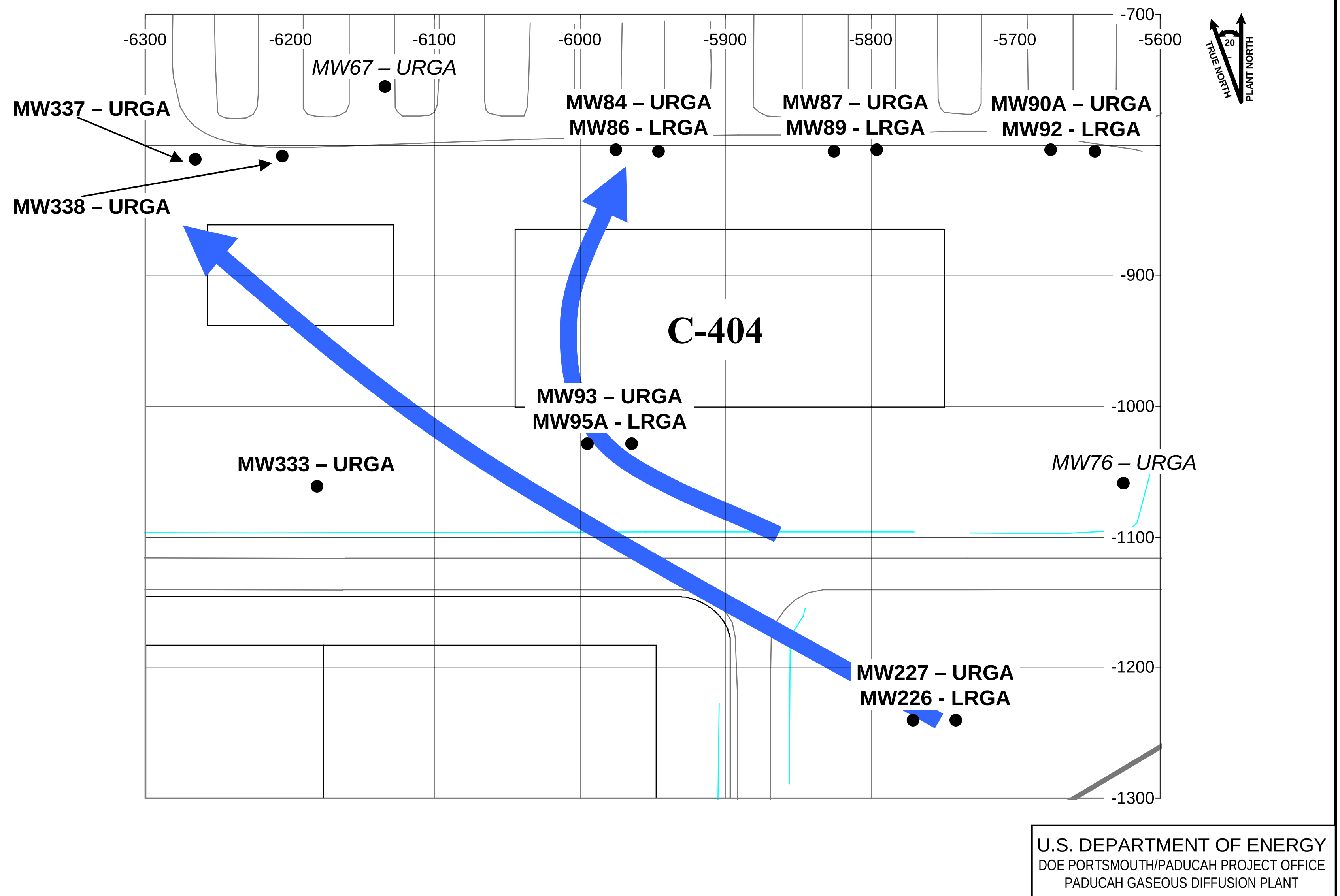

Figure 3.18. Prevailing Groundwater Flow Directions in the RGA

Groundwater flow paths at the interface with a media of lower hydraulic conductivity will deflect into the lower conductivity material. The north flow beneath SWMU 3 is an intermediate flow path between the hydraulic conductivity “expressways” delineated by the Southwest Plume (to the south of SWMU 3) and the Northwest Plume (to the north of SWMU 3).

RGA groundwater flow in the areas of the contaminant plumes is commonly 1 to 3 ft/day. Hydraulic potential gradients to the north and to the west are commonly similar in the SWMU 3 area. The northward groundwater flow rate beneath SWMU 3 is likely 0.1 to 0.3 ft/day, in step with the order-of-magnitude reduction in hydraulic conductivity beneath SWMU 3.

3.9.3.2 SWMU 4 hydrogeologic interpretation

Waste Disposal Background. SWMU 4 includes four burial pit areas to the south of SWMUs 2 and 3, excavated to a depth of approximately 15 ft for the disposal of various wastes (Section 1.3.3).

Stratigraphy. Like SWMU 2, the burial cells of SWMU 4 penetrate into the HU1 loess member (predominately silt) of the Upper Continental Deposits. These burial cells likely extend to near the base of HU1, at a depth of 15 to 20 ft. Lithologic logs of wells MW415 and MW417 document the presence of an upper and lower HU2 sand horizon, separated by an intervening silt member beneath SWMU 4. The HU2 occurs over the approximate depths of 20 to 40 ft. This, in turn, is underlain by the HU3 silt interval down to a depth of 50 ft. The HU4 sand is approximately 15 ft thick at SWMU4. Sand and gravelly sand members of the Lower Continental Deposits (HU5) extend down to a depth of approximately 100 ft. The underlying McNairy Formation consists of fine sands and clays. Cross sections based on the numerous soil borings of the WAG 3 RI demonstrate the lateral continuity of these units beneath SWMU 4 (Figure 3.19, taken from DOE 2000a).

UCRS Groundwater Flow and Hydraulic Potential. There are no direct measurements of the depth of the water table beneath SWMU 4. The stratigraphy is comparable to that of SWMUs 2 and 3. It appears that the hydrogeologic setting is similar, and the water table likely extends up into the waste burial pits.

RGA Groundwater Flow and Hydraulic Potential. The northwest flow direction demonstrated for the immediate area to the south of SWMU 3 and the general west-northwest trend of the Southwest Plume define the dominant flow paths in the RGA beneath SWMU 4. It is anticipated that the hydraulic conductivity of the RGA is similar to that of other on-site areas containing the main contaminant plumes, 1,200 to 1,300 ft/day. RGA groundwater flow in the areas of the contaminant plumes is commonly 1 to 3 ft/day.

3.9.3.3 SWMUs 5 and 6 hydrogeologic interpretation

Waste Disposal Background. SWMUs 5 and 6 are adjacent waste disposal facilities near the northwest corner of the PGDP industrial area. Both are burial grounds. The disposal pits of SWMU 5 extend 6 to 15 ft deep (Section 1.3.4). Those of SWMU 6 range from 6 to 8 ft deep (Section 1.3.5).

Stratigraphy. The burial cells of SWMUs 5 and 6 are excavated into the HU1 loess member (silt with some clay) of the Upper Continental Deposits. Only the deeper SWMU 5 pits likely extend to near the base of the HU1 unit, at a depth of 18 to 20 ft. Soil borings of the WAG 3 RI (Figure 3.20, taken from DOE 2000a) document that the HU2 interval in this area is a silty clay with sand and gravel lenses, to a depth of 30 ft below SWMU 6 and 40 ft below SWMU 5. The bottom of the HU3 interval, clay with variable amounts of silt and sand, occurs uniformly at depths of 58 to 60 ft. Soil borings infrequently identified a thin (5 to 7 ft thick) sand interval at the top of the RGA (HU4). In most soil borings, the RGA is a mix of sand and gravel deposits. In the area of SWMUs 5 and 6, the upper McNairy consists primarily of clay, beginning at depths of 100 to 105 ft.

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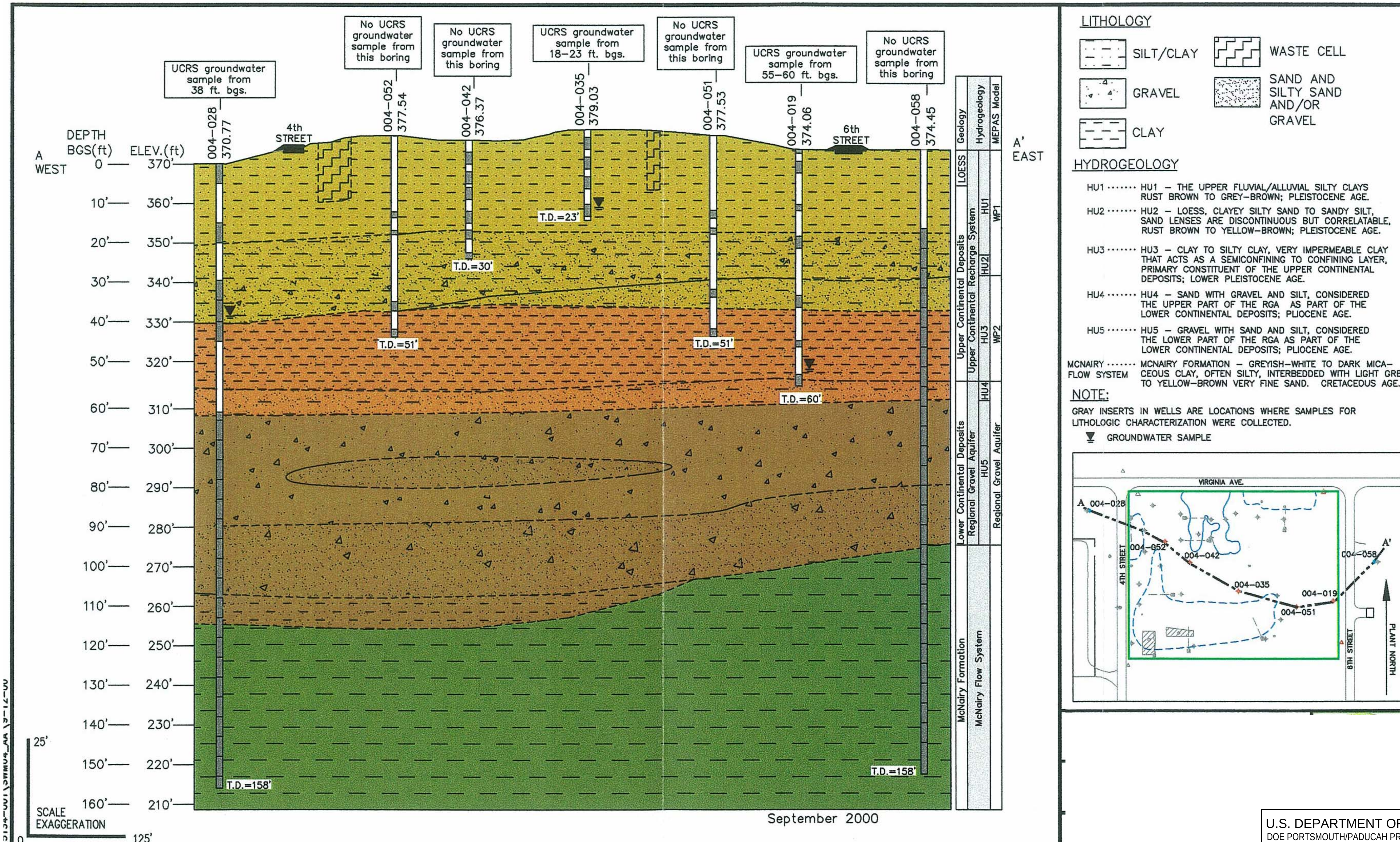

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Figure 3.19.WAG 3, SWMU 4 Lithologic Cross-Section A-A'

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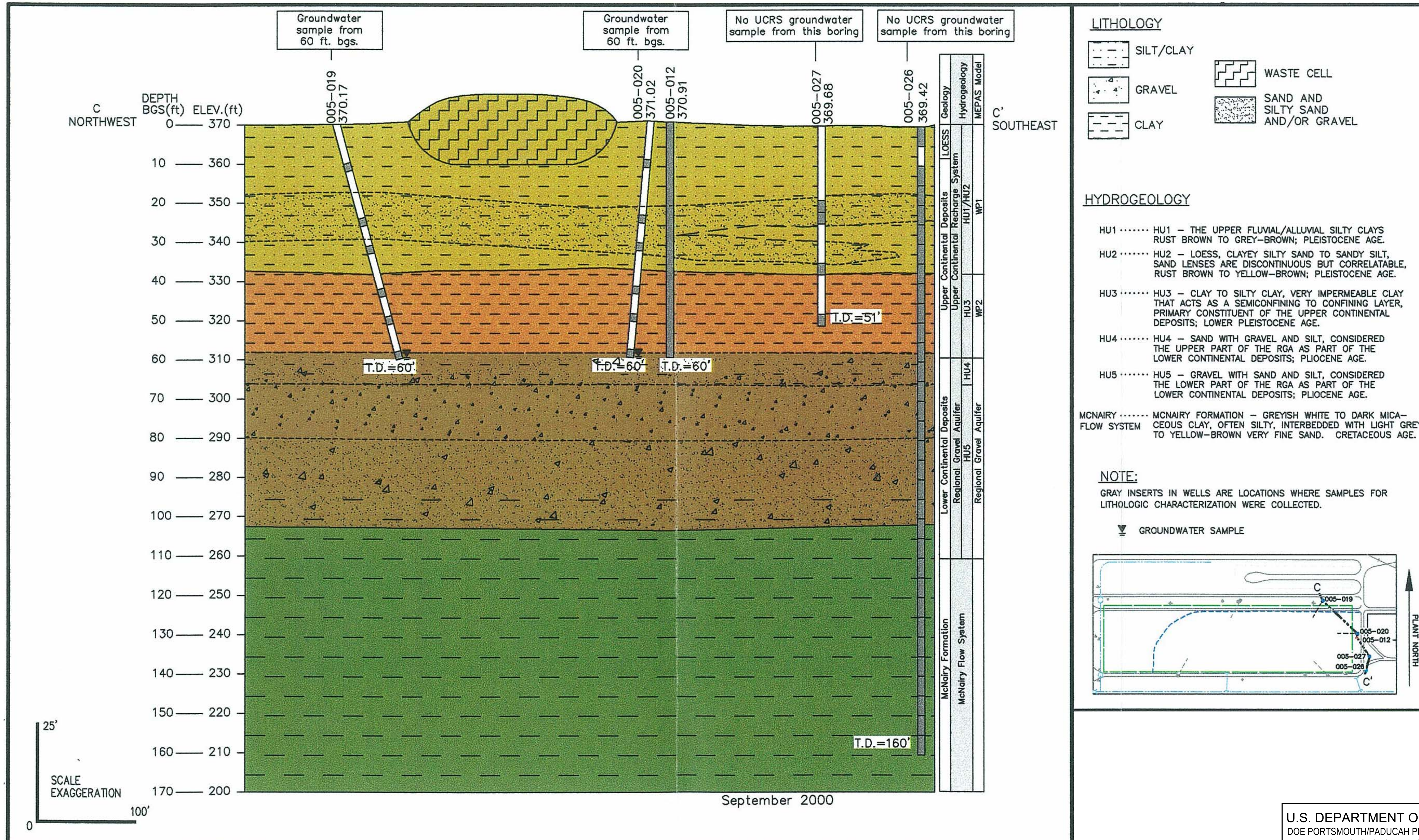

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Figure 3.20.WAG 3, SWMU 4 Lithologic Cross-Section C-C'

Figure No. \BGOU\RI_4.apr
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UCRS Groundwater Flow and Hydraulic Potential. Well MW190, screened over the depth interval 17.5 to 22.5 ft bgs (elevation of 348.6 to 353.6 amsl) provides a direct measure of the hydraulic potential in HU2 on the north side of SWMU 5 and an approximation of the elevation of the water table in HU1. The average elevation of measured water levels in MW190 is 367.0 ft (4.1 ft bgs).

The base of the ditch on the south side of SWMUs 5 and 6, with a local elevation of 358 ft amsl, is a primary control on the elevation of the water table in the area. Because the ditch is a linear east-west discharge feature, the area shallow groundwater flow is likely oriented north-south. The north-south distance between MW190 and the ditch is 350 ft. The difference in elevation of the average MW190 water level and the base of the ditch is 9 ft; thus, the gradient of the water table across SWMU 5 (and similar to that of SWMU 6) is oriented southward with an approximate value of 9/350 ft/ft (0.03 ft/ft). Because HU1 has low transmissivity, the gradient of the water table will tend to be less on the north side of SWU 5 (although still southward) and significantly greater on the south side of SWMU 5 adjacent to the ditch.

The shallow depth to water in well MW190 (average of 4.1 ft) determines that the vertical hydraulic gradient within the HU1/HU2 hydrogeologic system must be negligible; thus, groundwater flow in HU1 in the area of SWMUs 5 and 6 has a south-oriented vector with a minimal vertical component. The limited shallow groundwater flow beneath SWMU 5 must discharge to the ditch.

Waste was buried to depths of 15 ft (approximate elevation of 355 ft) in SWMU 5; thus, at a minimum, the deepest buried waste cells are saturated over the bottom 3 ft of depth (358 ft amsl/base of ditch – 355 ft amsl/base of waste). Assuming a minimal southward gradient of the water table across most of SWMUs 5 and 6, even the shallowest wastes (with top near 365 ft amsl) are likely buried below the water table (at an elevation of approximately 367 ft amsl on the north side of SWMU 5).

RGA Groundwater Flow and Hydraulic Potential. The high-concentration core of the Northwest Plume passes immediately to the east of SWMU 6 in the RGA. This plume vector defines the direction of RGA groundwater flow below SWMUs 5 and 6. It is anticipated that the hydraulic conductivity of the RGA beneath SWMUs 5 and 6 is similar to that of other on-site areas containing the main contaminant plumes, 1,200 to 1,300 ft/day. RGA groundwater flow in the areas of the contaminant plumes is commonly 1 to 3 ft/day.

3.9.3.4 SWMUs 7 and 30 hydrogeologic interpretation

Waste Disposal Background. SWMUs 7 and 30 (C-747-A) are located in the extreme northwest corner of the industrial area of the plant. Both SWMUs are burial grounds. SWMU 7 consists of five distinct burial pit areas that range from 6 to 10 ft deep. (See Section 1.3.6) PGDP buried waste to 12 ft deep at SWMU 30. (See Section 1.3.7)

Stratigraphy. Like all other on-site BGOU SWMUs, the HU1 silt interval contains the burial cells of SWMUs 7 and 30. The base of HU1 is at a depth of 20 ft, approximately 8 ft below the deepest of the burial cells (SWMU 30). A single sand and gravel horizon, in a clay matrix, defines the underlying HU2 interval. The sand and gravel deposits commonly range between 5 and 10 ft thick. Silt and clay members, with a cumulative thickness of 20 to 35 ft, comprise the HU3 interval below SWMUs 7 and 30.

In the area of SWMUs 7 and 30, the RGA consists of an intermittent HU4 sand overlying 20 to 40 ft of the HU5 sand with gravel layers. The top of the RGA commonly occurs at depths of 45 to 60 ft (Figure 3.21, taken from DOE 1998c).

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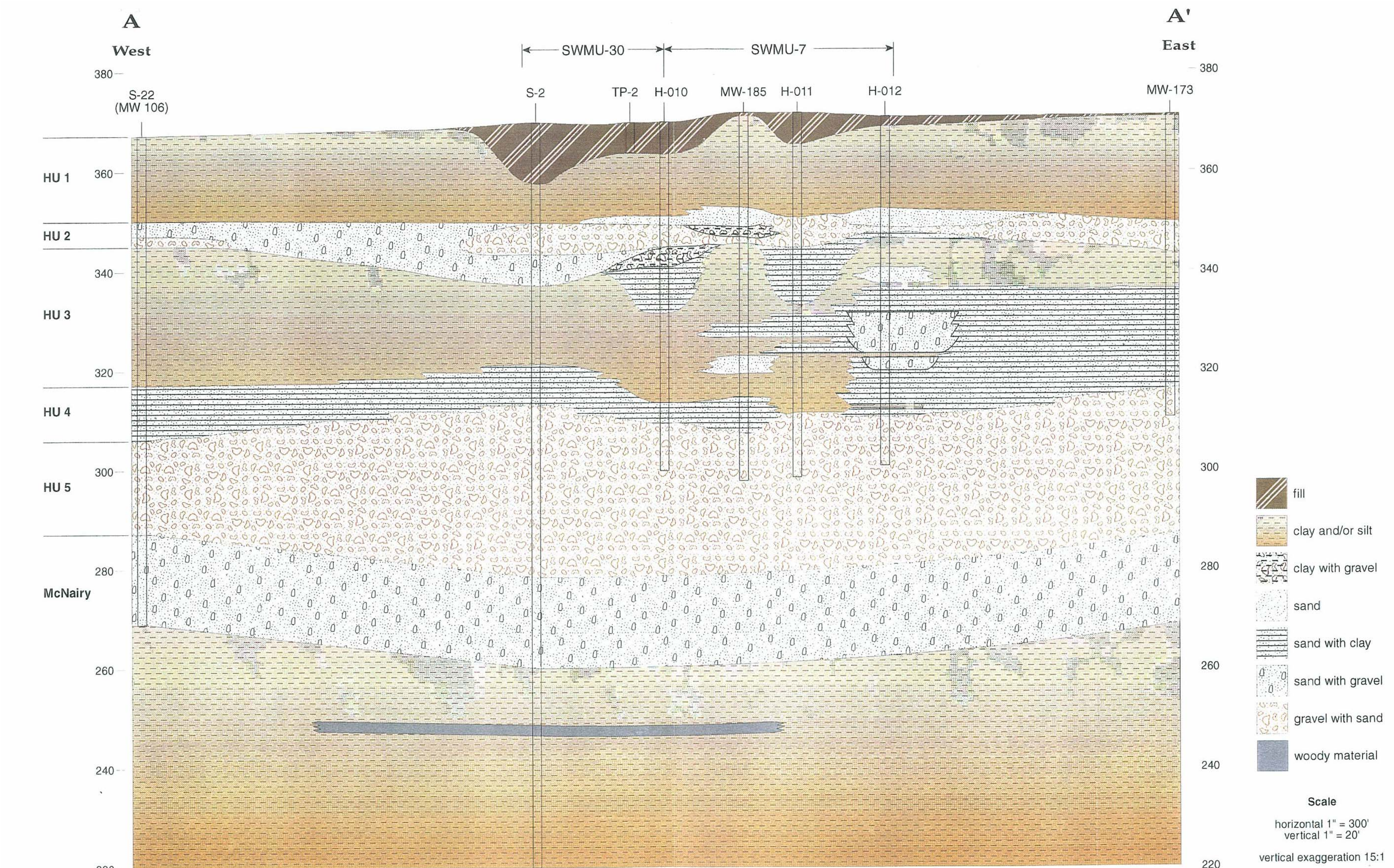

REFERENCE: DOE 1998c

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Figure 3.21. SWMUs 7 and 30 Lithologic Cross-Section A-A'

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UCRS Groundwater Flow and Hydraulic Potential. The SWMUs 7 and 30 RI (DOE 1998c) determined that a shallow water table exists approximately 5 ft bgs (Figure 3.22) and within the burial cells. UCRS piezometer and well measurements documented a strong downward gradient within the area UCRS. These trends determine that dissolved contaminants from the burial grounds have potential to migrate into the RGA.

The elevation of the water table is above the elevation of the ditches that bound SWMUs 7 and 30 on the north and south sides;[4] however, neither ditch gains significant flow along the reaches adjacent to SWMUs 7 and 30. These observations indicate that the UCRS groundwater flow vector must be oriented steeply downward and that the area contributing infiltration to the ditches typically is limited to a thin border along the ditches.

RGA Groundwater Flow and Hydraulic Potential. The high-contamination core of the Northwest Plume passes beneath the west end of SWMU 7 in the RGA. All RGA flow in SWMUs 7 and 30 is to the northwest, as defined by the plume orientation. The south well field of the Northwest Plume containment system is located approximately 650 ft to the northwest of SWMU 7. A pumping test of EW231, an extraction well of the south well field, determines the hydraulic conductivity of the area RGA to be approximately 1,300 ft/day.

The TCE trend in MW66, located near the boundary between SWMUs 7 and 30, exhibits spikes that can be correlated with similar TCE spikes at MW248 in the south well field. The distance between the wells (650 ft) divided by the time lag between TCE "events" in MW66 and MW248 (6 months) defines the local groundwater flow rate to be 3.5 ft/d (Figure 3.23). Typical groundwater flow rates in the Northwest Plume are thought to range from 1 to 3 ft/day. The RGA groundwater flow rate beneath SWMUs 7 and 30 is accelerated by groundwater extraction in the south well field.

3.9.3.5 SWMU 145 hydrogeologic interpretation

Waste Disposal Background. The waste disposal practices of SWMU 145 (Area P) remain largely undocumented. Anecdotal evidence and historical aerial photographs are sufficient to show that PGDP contractors used the area for disposal of site-related construction debris as early as the construction period of the plant (circa 1952), continuing into the early 1980s. Approximately once a year, plant personnel moved the accumulated scrap into consolidated piles or earth depressions and, wherever practicable, covered them with dirt (Section 1.3.8). By 1973, the disposal area covered approximately 23 acres. Today the area underlies the C-746-S and -T Landfills complex, an area of 44 acres. Area P and the overlying C-746-S and -T Landfills complex form an isolated hill that rises 20 to 40 ft above the surrounding countryside, located 0.25 mile north of the PGDP industrial area.

Stratigraphy. The UCRS beneath SWMU 145 typically consists of a near continuous sequence of silt members down to the top of the RGA at depths of 40 to 60 ft. A thin (commonly less than 1 ft thick), intermittent, sand horizon at a depth of approximately 20 ft is the only vestige of the HU2 interval. The C-746-S and -T Landfills SI (DOE 2006c) determined that the top of the RGA has approximately 20 ft of relief (elevations of 310 to 330 ft) beneath SWMU 145. Where the RGA is deepest, the UCRS grades downward into a series of fine sand layers with silt interbeds overlying the RGA.

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[4] The bottom elevation of the ditches on the north and south sides of SWMUs 7 and 30, as well as well and piezometer measurements within SWMUs 7 and 30 provided definitive control of the water table in those areas. The trends of the water table on the east and west ends of SWMUs 7 and 30 were assumed to resemble the land topography.

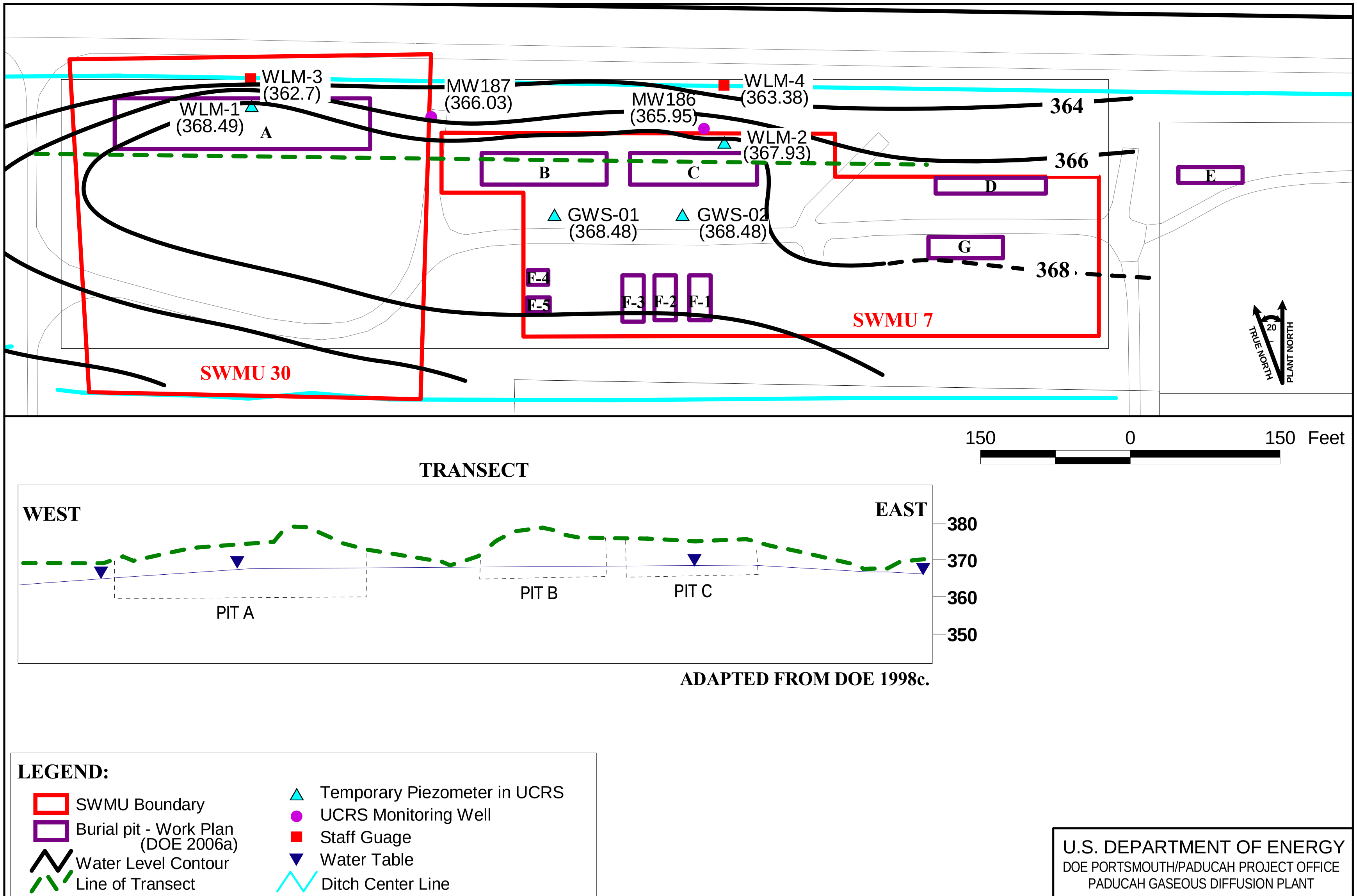

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Figure 3.22. Plan View and Cross-section View of SWMUs 7 and 30 Illustrating the Relationship of the Water Table to the Waste Pits

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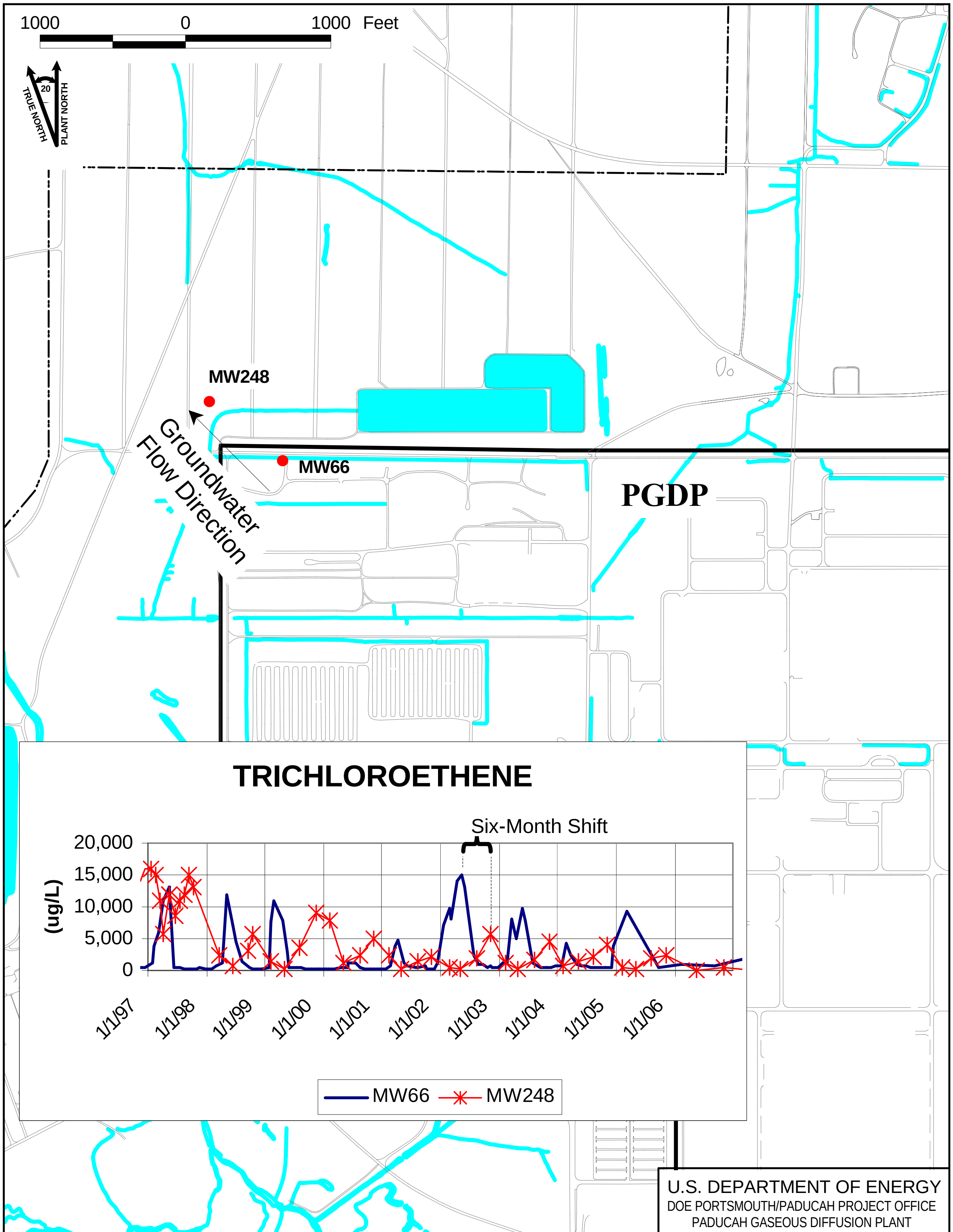

Figure 3.23. Relationship of TCE levels in MW66 and MW248

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An HU4 sand, averaging 5 ft thick, forms the top of the RGA. This, in turn, overlies 20 to 40 ft of gravely sand, made up of individual sand and gravel layers that range from 0.2 to 3.4 ft thick (Figure 3.24). The underlying McNairy Formation (top at an elevation of approximately 280 ft) consists of interbedded units of silt and fine sand.

UCRS Groundwater Flow and Hydraulic Potential. Water level elevations of shallow wells at SWMU 145 determine that a vertical hydraulic gradient of approximately 1 ft/ft is characteristic of the local UCRS (Figure 3.25). The area SI developed a conceptual water table map for the SWMU 145 area (Figure 3.26).[5] Lateral hydraulic gradients range from 0.03 to 0.12 ft/ft horizontally, as measured from the water table. The area SI analysis determined that lateral UCRS flow may be important where the horizontal hydraulic gradients are steepest, but that vertical flow predominates in the UCRS under most of SWMU 145.

RGA Groundwater Flow and Hydraulic Potential. The regional hydraulic gradient of the RGA in the SWMU 145 area is northward with a typical slope of 10^{-3} ft/ft. Water level measurements of RGA wells for the area SI documented the presence of a hydraulic potential mound beneath SWMU 145. The inferred groundwater flow directions, extending radially from SWMU 145 in the immediate vicinity of the burial ground, were consistent with trends of the direction of dissolved TCE contamination associated with the burial ground.

Groundwater modeling indicates that the hydraulic conductivity of the RGA in the area of SWMU 145 ranges between 200 to 500 ft/d. With the regional hydraulic gradient, groundwater flow velocity in the RGA should range between 1 and 2 ft/d.

3.9.4 BGOU Hydrogeologic Conceptual Model

Observations from the BGOU RI are consistent with the following conceptual model of the flow system north of the Porters Creek Clay subcrop (Figure 3.27). A shallow water table exists in the area of the on-site BGOU SWMUs. The UCRS is saturated from the water table down. Groundwater flow through the UCRS (HU1, HU2, and HU3) is primarily downward to the top of the RGA (HU4 and HU5). Limited lateral dispersion results as groundwater and contaminants migrate vertically through the UCRS. The rate of vertical and horizontal movement (migration) is influenced by the physical properties of a particular contaminant including solubility, specific gravity, and the individual contaminant's affinity to adsorb to the surrounding soils and by the lithology of the individual HUs, most notably the HU1 interval, which contains the burial cells, and the HU3 interval, which serves as the upper semiconfining unit between the UCRS and the RGA. Once groundwater reaches the RGA, then the predominant flow is horizontal. The RGA serves as the primary exit pathway for groundwater from within the PGDP property boundary.

The previously known burial pits and waste cells are the sources of contamination identified in the shallow soils and UCRS groundwater of the BGOU SWMUs. Contaminants are migrating from the waste cells as a result of water infiltrating through the cells into the underlying soils and as a result of water migrating through secondary DNAPL sources at SWMU 4 (DOE 2007d) and SWMUs 7 and 30 (DOE 1998c). Once the contaminants reach the RGA, the rate of migration increases as a result of the higher hydraulic conductivity of the RGA sands and gravels. Regional groundwater flow is generally north to northwest in the RGA beneath the BGOU SWMUs.

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[5] The elevation of the water table remains poorly documented at SWMU 145. Some buried waste at SWMU 145 is likely saturated.

MW418

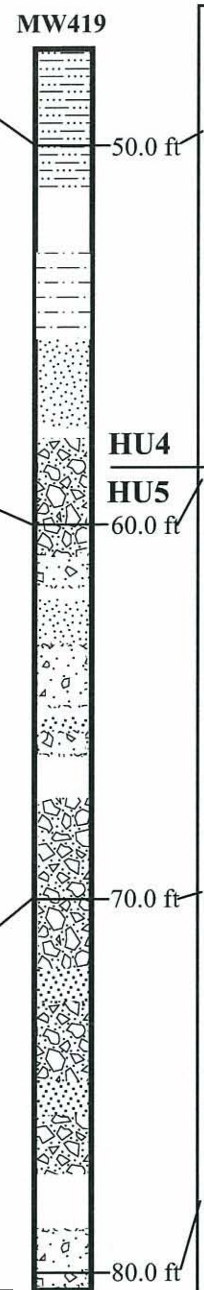
49.0-50.4': SILT with fine sand, sand content increasing downward (10-40%), massive, brownish yellow (10YR6/8), nonplastic, moderately hard, moist.
50.4-52.0': Silty, fine SAND, massive, brownish yellow (10YR6/8), with some light gray (10YR7/1) mottling, nonplastic, moderately hard to soft, moist.
52.0-54.3': SILT, massive, brownish yellow (10YR6/8) with some light gray (10YR7/1) mottling, slightly plastic, moderately hard, moist.
54.3-57.2': SAND, fine grained, GRADING DOWNWARD TO SAND, fine grained, with gravel (up to 25%); gravel diameter increases downward from 0.4 to 1.5 inches, rounded chert; massive, brownish yellow (10YR6/8), loose, wet.

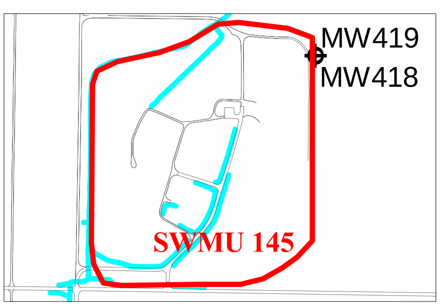
59.0-60.2': Sandy GRAVEL; bimodal sand (40%), ~1/2 is fine, quartz and ~1/2 is coarse-to-very-coarse, subrounded to subangular, chert; gravel (60%) is predominately 0.3-1.0" dia., rounded, chert but some 2" dia., rounded chert is present; massive, brownish yellow (10YR6/8), loose, wet.
60.2-63.0': Gravelly SAND, bimodal sand (60%) as above; gravel (40%) is 0.3-1" dia., rounded, chert; brownish yellow (10YR6/8), loose, wet.
63.0-64.1': SAND, fine, well sorted, quartz, massive, v pale brown (10YR7/3), loose, wet.
64.1-64.9': Gravelly SAND as at 60.2-63.0'.
64.9-65.1': GRAVEL, coarsening downward (0.3" to 0.5" dia.), rounded, chert, massive, yellowish brown (10YR5/6), loose, wet.
65.1-66.4": Sandy GRAVEL as at 59.0-60.2' but grayish brown (10YR5/2).
66.4-68.0': Sandy GRAVEL; sand (30%) is coarse-to-very-coarse, subrounded, chert; gravel (70%) ranges 0.3-1.0" dia., subangular, chert; massive, brownish yellow (10YR6/8), loose, wet.

69.0-70.8': GRAVEL (90%) with some sand (10%); Gravel ranges 0.3-1.0" dia., well rounded, chert; sand is carse-to-very-coarse, rounded, chert; massive, yellowish brown (10YR5/8), loose, wet

70.8-73.0': Sandy GRAVEL; gravel (60%) is 0.3-2.0" dia., subangular to subrounded, chert; bimodal sand, fine to medium quartz (30%), coarse-to-very-coarse, subrounded chert (10%);massive, yellowish brown (10YR5/6), loose, wet.

Total Depth





MW419

49.0-49.3': Very fine SAND with trace mica (muscovite?), massive, brownish yellow (10YR6/8), loose, soft, wet.
49.3-50.6': Silty, very fine SAND, massive, brownish yellow (10YR6/8), nonplastic, moderately hard, moist.
50.6-51.5': Very fine SAND with some silt, brownish yellow (10YR6/8), nonplastic, soft, very moist.
51.5-52.7': Very fine SAND, light gray (10YR7/1) inaterlayered with yellow (10YR7/6), loose, moderately hard, very moist.
52.7-54.3': Clayey SILT, massive, brownish yellow (10YR6/8), moderately plastic, soft-to-moderately hard, moist.
54.3-56.8': Fine SAND, very well sorted, massive, brownish yellow (10YR6/8), loose, soft, wet.

59.0-62.4': Gravelly SAND; gravel (40%) ranges from 0.3-to-2-inch diameter, rounded-to-subrounded, chert; bimodal sand, 40% fine, quartz and 20% coarse-to-very-coarse, well rounded-to-subangular, chert and quartz/feldspar; brownish yellow (10YR6/8), loose, wet.
62.4-63.0': Fine SAND, well sorted, massive, brownish yellow (10YR6/8), loose, soft, wet.
63.0-64.0': Gravelly SAND as at 59.0-62.4'.
64.0-64.9':Very fine SAND, very well sorted, massive, pale brown (10YR6/3), loose, soft, wet.
64.9-66.8': Gravelly SAND as at 59.0-62.4'.
66.8-67.0': Silty, very fine SAND with some gravel; gravel (20%) is 0.3-inch diameter, well rounded, chert; light yellowish brown (10YR6/4), semi-consolidated, hard, wet.
67.0-67.3': Gravelly SAND as at 59.0-62.4'.
69.0-71.7': Gravelly SAND as at 59.0-62.4'.
71.7-72.8': Fine SAND, well sorted, massive, brownish yellow (10YR6/8), loose, wet.
72.8-74.7': Gravelly SAND; gravel (40%) is 0.3-2.0" dia., dominantly rounded with some subangular, chert; bimodal sand, fine (30%) quartz, coarse-to-very-coarse (30%) rounded chert; massive, brownish yellow (10YR6/8), loose, wet.
74.7-75.7': Fine SAND, very well sorted, massive, brownish yellow (10YR6/8), loose, wet.
75.7-77.1': Gravelly SAND as at 72.8-74.7' except that gravel diameter ranges up to 3".
79.0-80.3': Gravelly SAND; gravel (40%) is 0.3-4" dia., well rounded to subangular, chert; sand (60%) is poorly sorted, fine to very coarse grained, quartz (fine and medium sand) and chert (coarse and very coarse sand), typically rounded; massive, brownish yellow (10YR6/6), loose, wet.
80.3-81.5': Poorly sorted SAND, fine to very coarse grained (fine and medium sand are rounded quartz – coarse and very coarse are subangular chert), massive, yellowish brown (10YR5/6), loose, wet.

Lower Continental Deposits/McNairy Formation contact at 81.5'.

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Figure 3.24. Lower Continental Deposits Interval of Lithologic Logs for MW418 and MW419

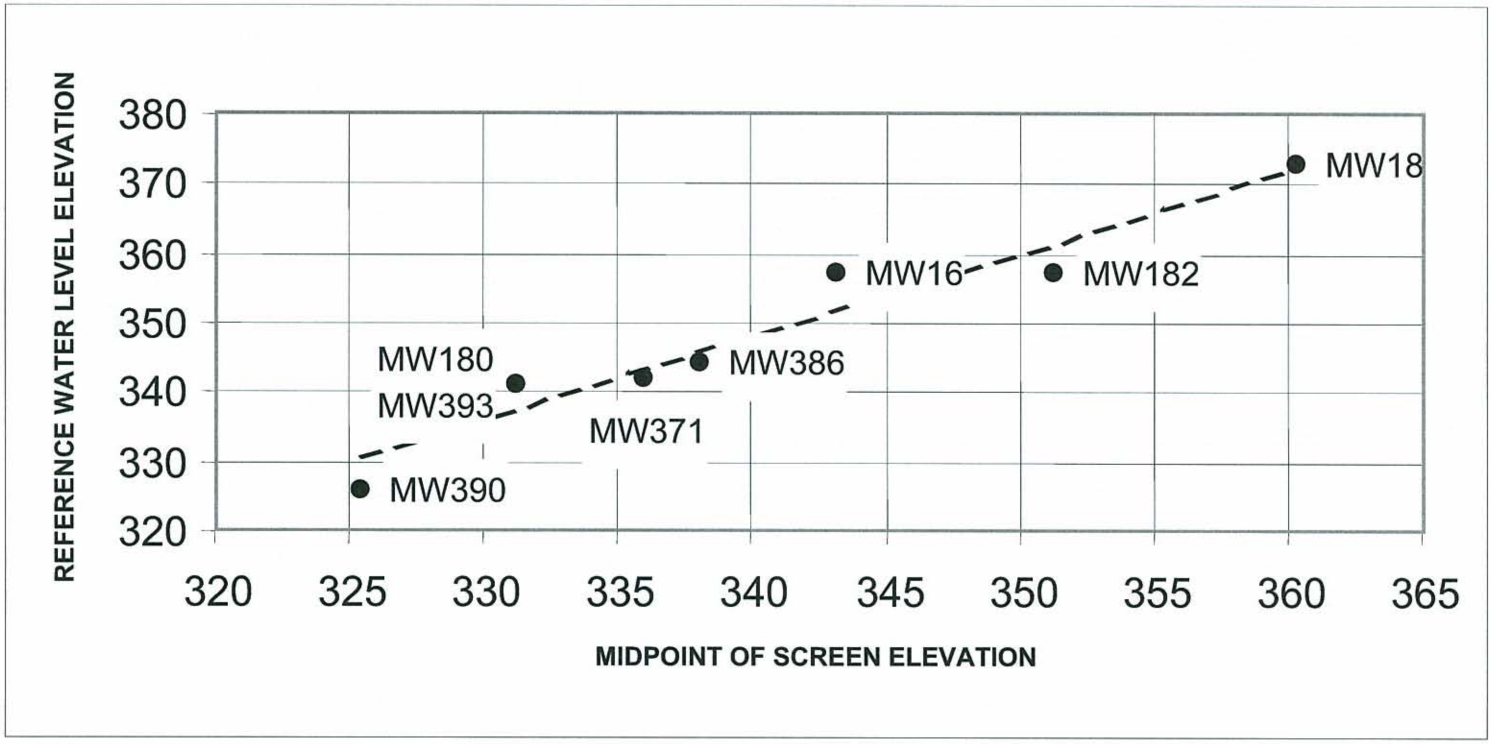

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Figure 3.25. UCRS Vertical Gradient

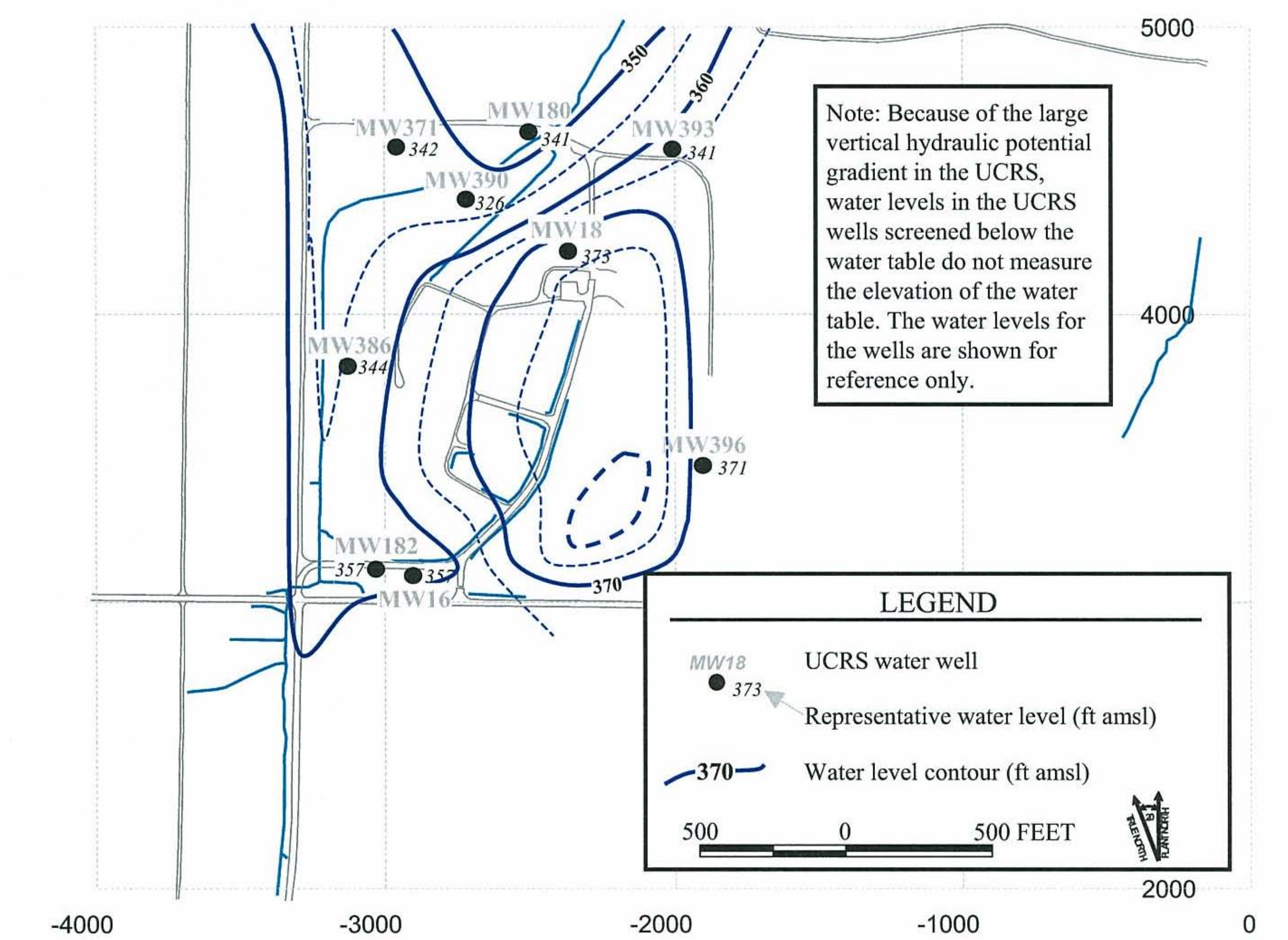

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Figure 3.26. Conceptual Water Table Map in the Area of the C-746-S&-T Landfills Complex

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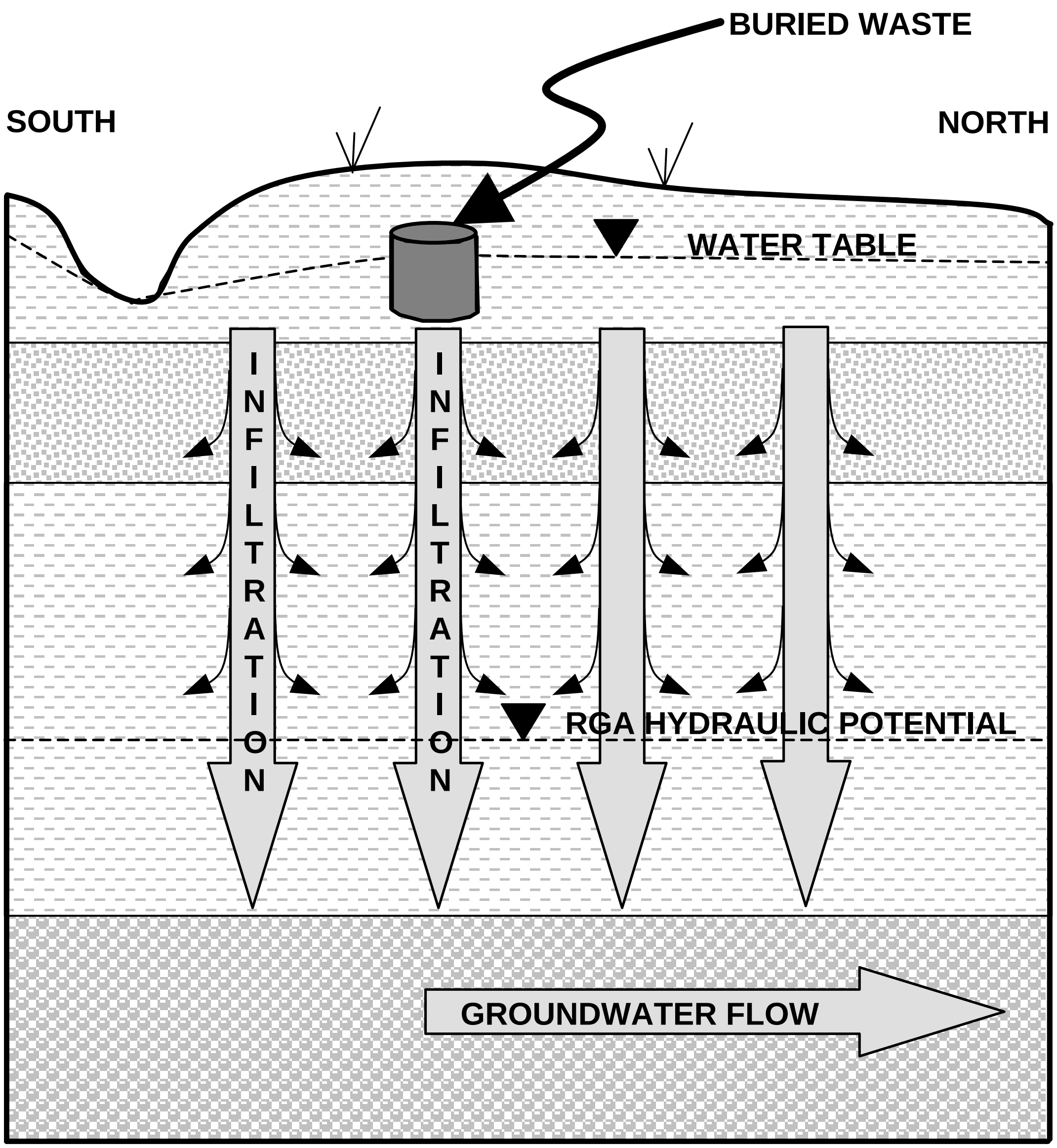

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Figure 3.27. Conceptual Model of the Groundwater Flow System

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For SWMU 4, the evidence of DNAPL presence is markedly higher dissolved TCE levels (commonly 1,000 to 4,000 µg/L) in the RGA on the west (downgradient) side of the SWMU. The area of higher TCE levels spans the entire west side of SWMU 4, suggestive of a diffuse source of DNAPL contamination in the UCRS soils underlying the burial grounds. A discrete area of 10,000 µg/L in the lower RGA implies the presence of a small pool of DNAPL (zone of higher DNAPL saturation) at the base of the RGA. Figure 3.28, taken from the Southwest Plume SI (DOE 2007d), summarizes the dissolved TCE levels in the RGA on the west side of SWMU 4.

MW66 is an upper RGA well[6] located near the shared boundary of SWMUs 7 and 30. The analyses of groundwater samples from MW66 reveal abrupt rises of dissolved TCE (Figure 3.29) that commonly occur in the first half of the calendar year, when RGA water levels are highest. (TCE spikes often exceed 10,000 µg/L.) These high-TCE events typically are limited to years where RGA water level exceeds 324 ft amsl.

In MW66, the contact of the RGA and the overlying UCRS soils occurs at an approximate elevation of 318 ft amsl. The relationship between abrupt rises in TCE levels and high RGA water levels indicates the presence of a DNAPL source zone near the boundary of SWMUs 7 and 30 at an elevation of 324 ft amsl, in the silt/clay horizon that overlies the RGA.

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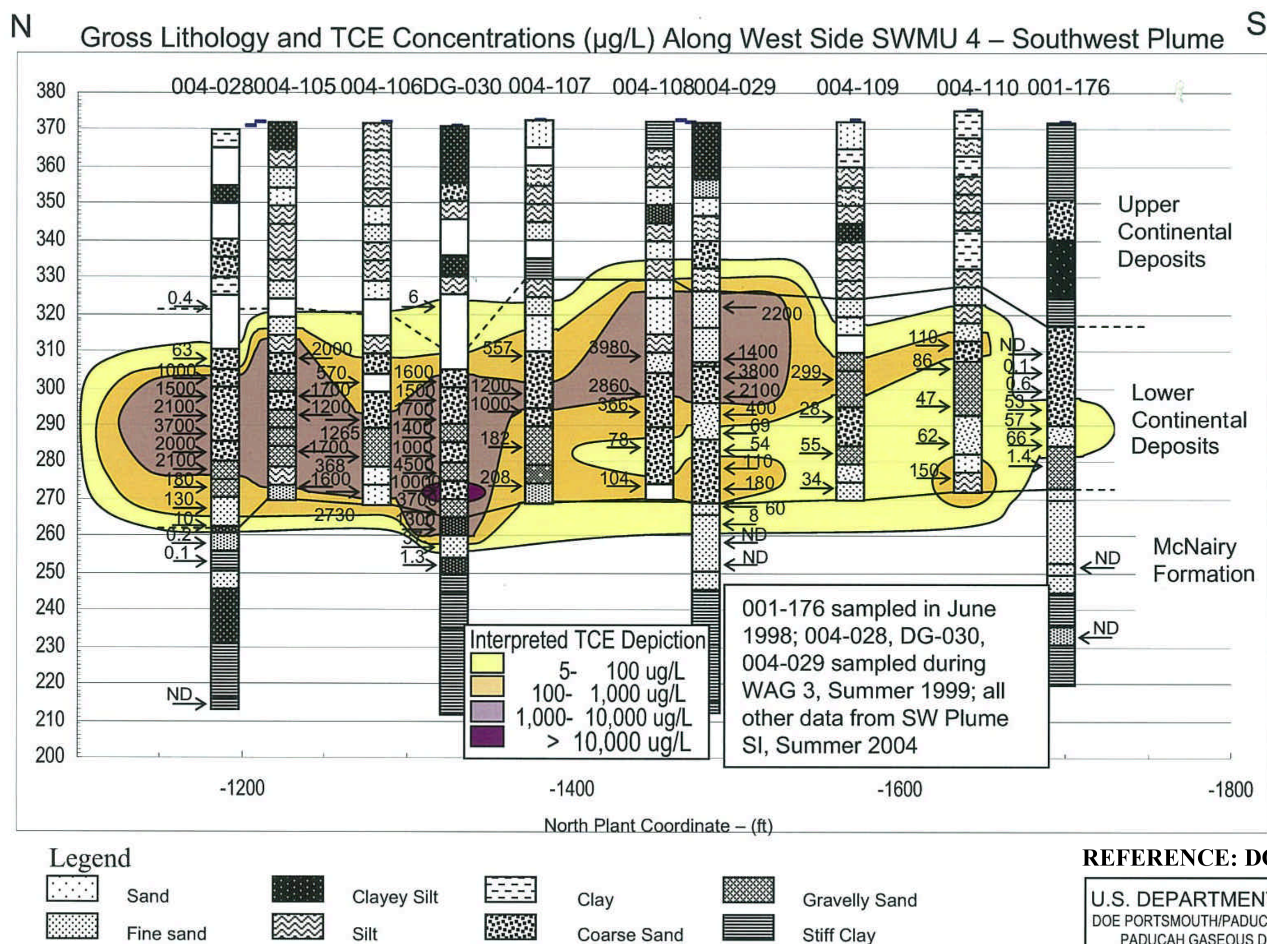
[6] MW66 is constructed with a 5-ft length well screen installed over the interval 308 to 313 ft amsl.



REFERENCE: DOE 2007d

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Figure 3.28. TCE Distribution within the RGA Downgradient of SWMU 4

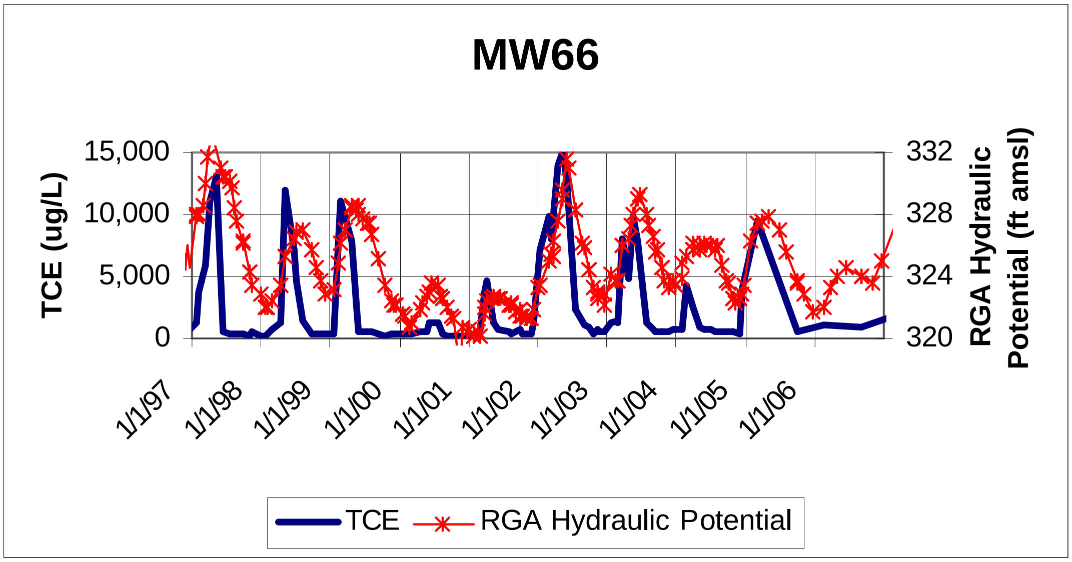

Figure 3.29. TCE Trends in MW66

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4. NATURE AND EXTENT OF CONTAMINATION

The SWMUs comprising the BGOU consist primarily of landfills and below ground burial cells in which various PGDP wastes have been placed. Infiltration descending through the buried waste could mobilize contaminants within the waste. Once mobilized, the most likely pathway of the contaminants would be downward through the UCRS soils, ultimately reaching the RGA (based on the hydrogeologic conceptual model presented in Chapter 3). Some lateral movement of contaminants would occur in the UCRS, but these pathways appear limited.

Based on this conceptual model, any contamination resulting from buried waste found at the BGOU SWMUs would be expected to be found concentrated in the UCRS soils and groundwater immediately within and under the burial cells and landfills, with a lesser amount of contamination dispersed laterally from the cells. The emphasis of the BGOU RI was the evaluation of samples collected from angled soil borings to characterize the potential contaminants leaking from the bottoms of the cells. This chapter provides an assessment of data from the BGOU RI along with data from historical investigations to evaluate the nature and extent of contamination (vertical and lateral) associated with the BGOU SWMUs.

Environmental data from the BGOU RI field activities were merged with the historical data set used for development of the BGOU RI Work Plan (DOE 2006a). These data have been compiled and screened to identify COPCs to be addressed in the evaluation of the nature and extent of contaminants. This chapter presents summary tables containing analytical results for each of the sites and figures depicting the locations of the samples. Appendix D provides a complete report of analytical results for all samples collected during this investigation and the historical data set in a searchable database on compact disk.

This report assesses the extent of contamination based on the presence of contaminants in subsurface soils (below 1 ft bgs) and UCRS and RGA groundwater. Samples from these media were analyzed for suites of constituents and reported as the following analytical groups: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), PCBs, metals, and radionuclides. [The BGOU risk assessment includes an assessment of extent of surface soil COPCs within the BGOU SWMUs (see Attachment F4) to complete the evaluation of exposure scenarios specified in the Work Plan.] The pathway for surface water contamination will be addressed further, as needed, in the FS.

An understanding of the potential releases is key to the rationale behind the sampling that was performed during the BGOU RI. Section 1.3 presents descriptions of the known processes and possible releases from each site that may have contributed to the nature and extent of contaminants.

4.1 DATA PROCESSING AND SCREENING

One objective of the data processing and screening of this RI was to identify potential site-related contaminants and delineate the vertical and horizontal extent of these potential contaminants. To achieve this goal, the RI compared the analytical results of this RI and historical data to PGDP media-specific background concentrations[1, 2] and applicable screening values.[3] Where more than one screening value

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[1] PGDP background levels for water drawn from the RGA and McNairy Formation are provisional values that are subject to change. Potential concerns regarding the background levels are the data set from which these values were derived and the statistical methods that were used to analyze the data set.

[2] Background values were unavailable for UCRS groundwater.

existed for groundwater analytes, the maximum screening value was used to limit the number of contaminants presented in the nature and extent assessment while remaining inclusive of risk-based criteria. Those analytes with no applicable screening value are not discussed in this section. Seven analytes known to be essential nutrients and known to be toxic only at extremely high concentrations were removed from the selection of contaminants in the groundwater data set. These analytes were calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium.

Data processing and screening for the BGOU were conducted as a multiphase process. First, data were screened to eliminate those sample results that were less than the minimum detection limit (or, in the case of radionuclides, did not exceed the total propagation error). These data then were compared with screening levels.[4] Screening levels for subsurface soil consisted of background levels at PGDP and risk-based no action levels (NALs) for the excavation worker as compiled from the Risk Methods Document (DOE 2001a). (The COPC screening for groundwater fate and transport modeling compared analyte levels in subsurface soil against PGDP-specific Soil Screening Levels.) Groundwater samples with analytes above detection limits were compared to maximum contaminant levels (MCLs), if available, for specific chemicals. Risk-based child resident NALs were used to screen compounds or analytes that did not have an MCL. Additionally, background groundwater values for RGA and McNairy samples were used for screening, as applicable. The combined data set of soil and groundwater analyses of the BGOU RI and related historical data is sufficient to address the goals of the BGOU RI (see Table 7.1).

Tables 4.1 through 4.4 contain the soil and groundwater standards used to screen BGOU data for the nature and extent assessment. If an analyte was detected at a level higher than these screening values, it was considered a contaminant for evaluation of nature and extent. (Section 6, Baseline Risk Assessment, continues the assessment of hazard associated with the COPCs. Appendix F explains the more thorough COPC screening process used in the risk assessment.) The following sections in this chapter discuss the contaminants found in the BGOU, using both historical and RI data.

Table 4.1. Background Values[a] for Subsurface Soils (DOE 2001a)

Analytical Compound	Subsurface Soil Background Data (mg/kg or pCi/g)
Aluminum	12,000
Antimony	0.21
Arsenic	7.9
Barium	170
Beryllium	0.69
Boron	NA
Cadmium	0.21
Calcium	6,100
Chromium	43
Chromium, hexavalent	NA

[3] For UCRS and RGA groundwater, the applicable screening criteria were PGDP Significant COPCs, MCLs, and child residence No Action Levels (Table 4.2). For subsurface soils, the applicable screening criteria were PGDP Significant COPCs (DOE 2001a) and excavation worker No Action Levels (Table 4.3). The identification of COPCS for groundwater fate and transport modeling (Section 5) screened the subsurface soils against PGDP-specific Soil Screening Levels.

[4] The data used to define COPCs for the assessment of nature and extent (this section) and the risk assessment (Section 6 and Appendix E) differ. The nature and extent assessment includes all available subsurface soil (>1 ft depth) analyses within a SWMU while the risk assessment addresses soils of 10 ft depth or less (the excavation worker receptor). For groundwater, the nature and extent assessment is based on groundwater analyses within a SWMU while the risk assessment is based on modeled groundwater contaminant levels at the SWMU and at downgradient points of exposure.

Table 4.1. Background Values[a] for Subsurface Soils (DOE 2001a) (Continued)

Analytical Compound	Subsurface Soil Background Data (mg/kg or pCi/g)
Cobalt	13
Copper	25
Cyanide	NA
Iron	28,000
Lead	23
Lithium	NA
Magnesium	2,100
Manganese	820
Mercury	0.13
Molybdenum	NA
Nickel	22
Potassium	950
Selenium	0.7
Silica	NA
Silver	2.7
Sodium	340
Strontium	NA
Thallium	0.34
Uranium (metal)	4.6
Vanadium	37
Zinc	60
Americium-241	NA
Cesium-137	0.28
Cobalt-60	NA
Neptunium-237	NA
Neptunium-237/Protactinium-233*	NA
Plutonium-238	NA
Plutonium-239	NA
Plutonium-239/240*	NA
Potassium-40	16
Protactinium-234m	NA
Radium	NA
Radium-226	1.5
Radon-222	NA
Strontium-90	NA
Technetium-99	2.8
Thorium-230	1.4
Thorium-234	NA
Uranium (total)	NA
Uranium-233/234*	2.4
Uranium-234	2.4
Uranium-235	0.14
Uranium-235/236*	0.14
Uranium-238	1.2

[a]The PGDP studies of background levels for soils are *Background Concentrations and Human Health Risk-based Screening Criteria for Metals in Soil at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1417&D1 (DOE 1995c) and *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1586&D2 (DOE 1997c).

*NOTE: Data for the undifferentiated isotopes Neptunium-237/Protactinium-233, Plutonium-239/240, Uranium-233/234, and Uranium-235/236 were compared to the background values for Neptunium-237, Plutonium-239, Uranium-234, and Uranium-235, respectively.

NA = not available

Table 4.2. Risk-Based No Action Levels Used in BGOU Soil Screening

Chemical	No Action Level	Chemical	No Action Level
Inorganics (mg/kg)		***Radionuclides (pCi/g)***	
Antimony	0.492	Americium-241	1.74
Arsenic	0.324	Cobalt-60	0.0238
Beryllium	1.26	Cesium-137+Daughters	0.0858
Cadmium (Diet)	15.2	Neptunium-237+Daughters	0.271
Chromium (III) (Insoluble Salts)	476	Plutonium-238	11.7
Chromium (Total)	476	Plutonium -239	11.5
Chromium VI (particulates)	3.69	Plutonium -240	11.5
Copper	427	Radium-226+Daughters	0.0256
Iron	2170	Radon-222+Daughters	33900000
Lead	50	Strontium-90+Daughters	7.44
Manganese	56.6	Technetium-99	362
Mercury	1.17	Thorium-228+Daughters	0.028
Molybdenum	66	Thorium -230	14.9
Nickel Soluble Salts	216	Thorium -232	13.5
Selenium	71.3	Uranium-234	19.8
Silver	41.2	Uranium -235+Daughters	0.395
Thallium (Thallium Chloride)	0.711	Uranium -238+Daughters	1.71
Uranium	11.3	Plutonium-239/240	11.5
Vanadium	4.4	Uranium-235/236	0.395
Zinc	2660		
Organics (mg/kg)			
Acenaphthene	350	Fluorene	338
Acrylonitrile	0.248	HpCDD, 2,3,7,8-	0.000349
Anthracene	3340	HpCDF, 2,3,7,8-	0.000349
PCB-1016	0.168	HxCDD, 2,3,7,8-	0.0000349
PCB-1221	0.168	HxCDF, 2,3,7,8-	0.0000349
PCB-1232	0.168	Indeno[1,2,3-cd]pyrene	0.232
PCB-1242	0.168	Naphthalene	30.4
PCB-1248	0.168	OCDD	0.00349
PCB-1254	0.168	OCDF	0.00349
PCB-1260	0.168	PeCDD, 2,3,7,8-	0.00000699
Benz(a)anthracene	0.232	PeCDF, 1,2,3,7,8-	0.00000699
Benzene	1.4	PeCDF, 2,3,4,7,8-	0.0000699
Benzo(a)pyrene	0.0232	Phenanthrene	
Benzo(b)fluoranthene	0.232	Total PCBs (high risk)	0.168
Benzo(k)fluoranthene	2.32	Total PCBs (lowest risk)	4.81
Carbon Tetrachloride	0.51	Total PAHs	0.0232
Chloroform	0.166	Pyrene	181
Chrysene	23.2	TCDD, 2,3,7,8-	0.00000349
Dibenz(a,h)anthracene	0.0232	TCDF, 2,3,7,8-	0.0000349
1,1-DCE	0.119	Tetrachloroethylene	4.04
1,2-DCE	68.2	TCE	3.25
cis-1,2-DCE	17.1	Vinyl Chloride	0.141
trans-1,2-DCE	28.4	Xylene, Mixture	963
Ethylbenzene	28.7	Xylene, m-	5560
Fluoranthene	242	Xylene, o-	5590

Table 4.3. Background Values for Groundwater Drawing from the RGA and McNairy Formation[a] at PGDP (DOE 2001a)

Analytical Compound	(mg/L or pCi/L) RGA	McNairy
Aluminum	2.189	0.687
Aluminum, Dissolved	0.311	0.579
Antimony	0.060[b]	0.060[b]
Antimony, Dissolved	0.060[b]	0.060[b]
Arsenic	0.005[b]	0.005[b]
Arsenic, Dissolved	0.005[b]	0.005[b]
Barium	0.235	0.296
Barium, Dissolved	0.2	0.268
Beryllium	0.004[b]	0.017[b]
Beryllium, Dissolved	0.004[b]	0.004[b]
Cadmium	0.010[b]	0.010[b]
Cadmium, Dissolved	0.010[b]	0.010[b]
Calcium	41.238	38.858
Calcium, Dissolved	38.166	38.829
Chloride	91.021	19.708
Chromium	0.144	0.060[b]
Chromium, Dissolved	0.050[b]	0.050[b]
Cobalt	0.045[b]	0.096
Cobalt, Dissolved	0.045[b]	0.045[b]
Copper	0.036	0.057
Copper, Dissolved	0.02	0.013[b]
Fluoride	0.27	0.33
Iron	5.03	18.36
Iron, Dissolved	0.267	12.372
Lead	0.129	0.050[b]
Lead, Dissolved	0.098	0.050[b]
Magnesium	16.262	13.418
Magnesium, Dissolved	16.215	14.171
Manganese	0.119	0.941
Manganese, Dissolved	0.068	0.894
Mercury	0.0002[b]	0.0002[b]
Mercury, Dissolved	0.0002[b]	0.0002[b]
Molybdenum	0.050[b]	0.050[b]
Molybdenum, Dissolved	0.050[b]	0.050[b]
Nickel	0.682	0.109[b]
Nickel, Dissolved	0.305	0.050[b]
Nitrate as Nitrogen	15.561	1.474
Potassium	5.195	55.752
Potassium, Dissolved	4.096	51.205
Selenium	0.005[b]	0.005[b]
Selenium, Dissolved	0.005[b]	0.005[b]
Silica	26.401	36
Silver	0.011[b]	0.050[b]
Silver, Dissolved	0.060[b]	0.050[b]
Sodium	59.45	29.2
Sodium, Dissolved	60.433	27.98
Sulfate	19.947	28.9
Thallium	0.056[b]	0.644
Thallium, Dissolved	0.056[b]	0.056[b]
Uranium	0.002[b]	0.001[b]
Uranium, Dissolved	0.002[b]	0.001

Table 4.3. Background Values for Groundwater Drawing from the RGA and McNairy Formation[a] at PGDP (DOE 2001a) (Continued)

	(mg/L or pCi/L)	
Analytical Compound	**RGA**	**McNairy**
Vanadium	0.134	0.126
Vanadium, Dissolved	0.134	0.126
Zinc	0.054	0.142
Zinc, Dissolved	0.049	0.116
Gross Alpha	5.8	11.9
Gross Beta	13.8	144.5
Neptunium-237	0.8	0.5
Plutonium-239	0.1	0.2
Radium-226	0.6	1.2
Radon-222	626	295
Techntium-99	22.3	20.6
Thorium-230	1.1	1.5
Total Radium	1.3	0.7
Uranium-234[c]	0.7	0.3
Uranium-235[c]	0.3	0.2
Uranium-238[c]	0.7	0.3

[a] Values are for those derived over all observations.
[b] Background value was derived qualitatively over all observations because analyte was never detected or was detected infrequently at a concentration near the analyte's detection limit.
[c] Uranium isotopic concentrations were derived from the mass concentration of uranium.

Table 4.4. Groundwater MCLs and Child Resident No Action Levels Used in BGOU Screening

Analytical Compound	**MCL (mg/L)**	**Child Resident No Action Level (mg/L)[a]**
Inorganics		
Antimony [b]	0.006	0.000564
Arsenic [b]	0.010	0.000035
Barium	2	
Beryllium	0.004	0.00264
Cadmium	0.005	0.000661
Chromium [b]	0.1	1.76
Copper	1.3	0.0557
Cyanide	0.2	
Fluoride	4.0	
Iron		0.449
Lead	0.015	0.015
Manganese		0.035
Mercury [b]	0.002	0.000444
Molybdenum		0.00753
Nickel [b]		0.0301
Nitrate	10	
Nitrite	1	
Selenium	0.05	0.00754
Silver		0.0075
Thallium [b]	0.002	0.00012

Table 4.4. Groundwater MCLs and Child Resident No Action Levels Used in BGOU Screening (Continued)

Analytical Compound	MCL (mg/L)	Child Resident No Action Level (mg/L)
Uranium	0.03	0.000906
Vanadium		0.00925
Zinc		0.45
Organics		
Acenaphthene		0.0136
Acrylonitrile		0.0000426
Anthracene		0.0766
Benz(a)anthracene		0.0000132
Benzene	0.005	0.000385
Benzo(a)pyrene		0.000000951
Benzo(b)fluoranthene		0.00000951
Benzo(k)fluoranthene		0.000168
Carbon tetrachloride	0.005	0.000181
Chloroform		0.0000287
Chrysene		0.00132
Chlorobenzene	0.1	
Dibenz(a,h)anthracene		0.000000456
Dioxins/Furans (Total)		6.09E-11
o-Dichlorobenzene	0.6	
p-Dichlorobenzene	0.075	
1,2-Dichloroethane	0.005	
1,1-DCE	0.007	0.000047
1,2-DCE		0.00247
cis-1,2-DCE	0.07	0.00273
trans-1,2-DCE	0.1	0.00548
Methylene chloride	0.005	
Bis(2-ethylhexyl)phthalate	0.006	
Ethylbenzene	0.7	0.00468
Fluoranthene		0.0226
Fluorene		0.00972
Heptachlor	0.0004	
HpCDD, 2,3,7,8-		5.45E-09
HpCDF, 2,3,7,8-		3.51E-08
HxCDD, 2,3,7,8-		3.51E-09
HxCDF, 2,3,7,8-		3.51E-09
Indeno(1,2,3-cd)pyrene		0.00000631
Naphthalene		0.000285
OCDD		1.91E-08
OCDF		2.03E-08
PeCDD, 2,3,7,8-		2.5E-10
PeCDF, 1,2,3,7,8-		1.48E-10
PeCDF, 2,3,4,7,8-		1.29E-09
Total PCBs [b]	0.0005	0.0000793
PCB-1016		0.0000468
PCB-1221		0.000112
PCB-1232		0.000128
PCB-1242		0.000123
PCB-1248		0.0000775
PCB-1254		0.0000194
PCB-1260		0.0000428
Total PAHs		0.000000951
Pyrene		0.0182
TCDD, 2,3,7,8-		6.09E-11
TCDF, 2,3,7,8-		1.6E-09
Tetrachloroethene	0.005	0.000582
Toluene	1	
1,2,4-Trichlorobenzene	0.07	

Table 4.4. Groundwater MCLs and Child Resident No Action Levels Used in BGOU Screening (Continued)

Analytical Compound	MCL (mg/L or pCi/L)	Child Resident No Action Level (mg/L or pCi/L)
1,1,1-Trichloroethane	0.2	
1,1,2-Trichloroethane	0.005	
TCE	0.005	0.0016
Vinyl chloride	0.002	0.000035
Total Xylene	10	0.0653
m,p-Xylene	10	0.439
1,3-Dimethylbenzene	10	0.439
Radionuclides		
Americium-241		0.371
Cobalt-60		2.46
Cesium-137		1.27
Neptunium-237		0.573
Plutonium-238		0.295
Plutonium-239		0.286
Plutonium-240		0.286
Radium-226		0.1
Radon-222		0.866
Strontium-90		0.522
Technetium-99		14
Thorium-228		0.129
Thorium-230		0.424
Thorium-232		0.382
Uranium-234		0.546
Uranium-235		0.538
Uranium-238		0.443

[a] NALs were taken from Table A.18 of the PGDP Risk Methods Document (2001) for PGDP Primary COPCs.
[b] These NALs were used for the following compounds with more than 1 NAL listed in Table A.18 of the PGDP Risk Methods Document (2001): Antimony (metallic); Arsenic, inorganic; Chromium (total); Mercury, inorganic salts; Nickel soluble salts; Thallium chloride; Total PCBs (low risk)

4.2 SOURCES OF CONTAMINATION

Previous modeling has determined radionuclides such as ^{99}Tc, neptunium-237 (^{237}Np), plutonium-239 (^{239}Pu), uranium-234 (^{234}U), uranium-235 (^{235}U), and uranium-238 (^{238}U); VOCs such as TCE, 1,1-DCE, vinyl chloride, 1,2-DCE, carbon tetrachloride, and chloroform; metals; and some SVOCs as contributing to groundwater contamination. The COPCs from previous modeling for each SWMU are listed in Table 4.5.

Table 4.5. Summary of Historical Modeling Results

Location	Chemicals of Potential Concern Determined by Historical Groundwater Modeling
SWMU 2	TCE and other VOCs ^{99}Tc
SWMU 3	^{99}Tc and naphthalene
SWMU 4	VOCs (TCE; 1,1-DCE; vinyl chloride; 1,2-DCE; carbon tetrachloride, and chloroform), metals (arsenic, cobalt, copper, iron, and manganese), and radionuclides (^{237}Np, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U).
SWMU 5	1,1-DCE; naphthalene; manganese; iron; and ^{99}Tc
SWMU 6	^{99}Tc and iron
SWMUs 7 and 30	^{99}Tc and vinyl chloride

Figures 4.1 through 4.16 present locations of all historical and RI sampling for soils and groundwater.

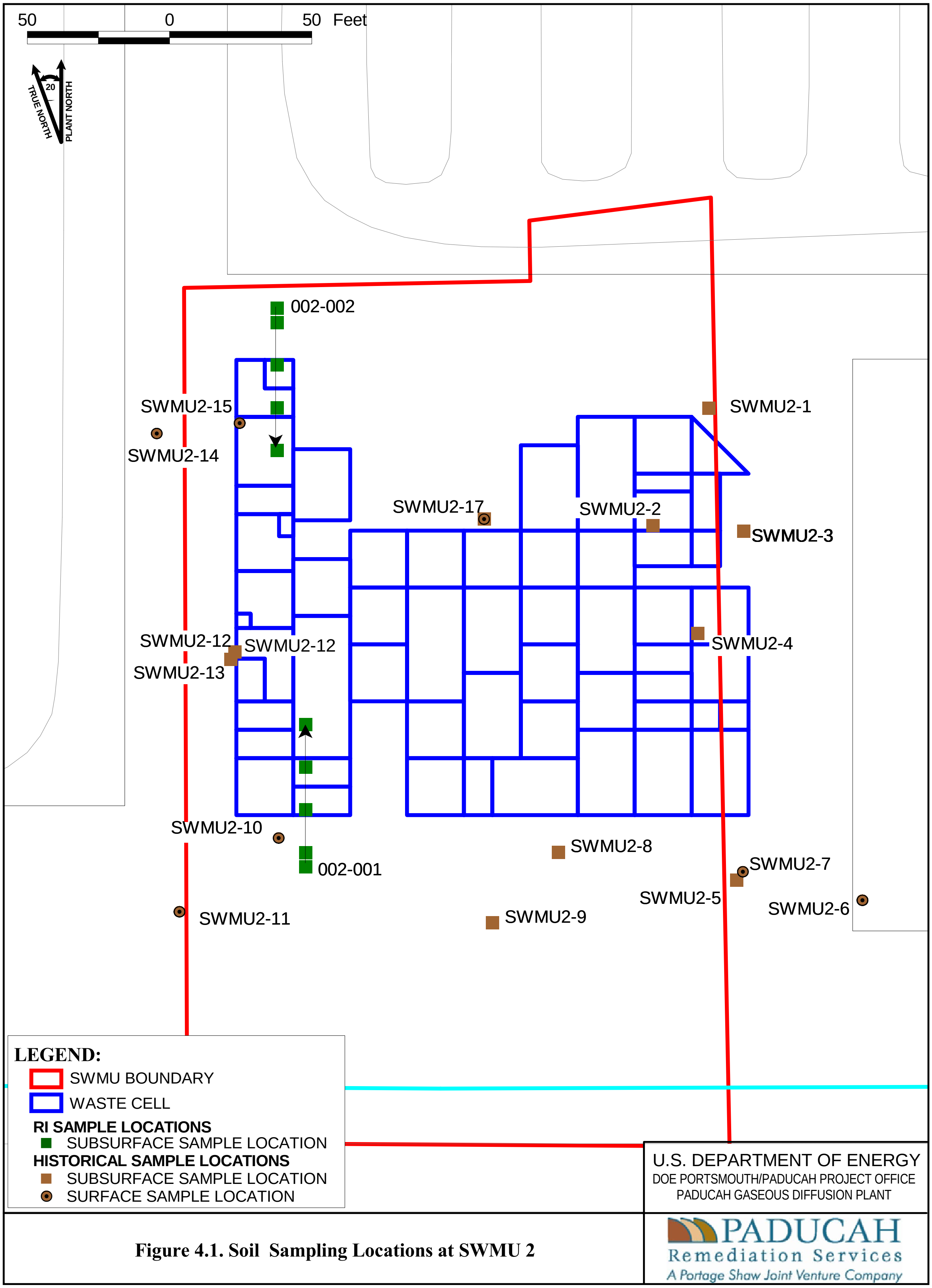

Figure 4.1. Soil Sampling Locations at SWMU 2

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

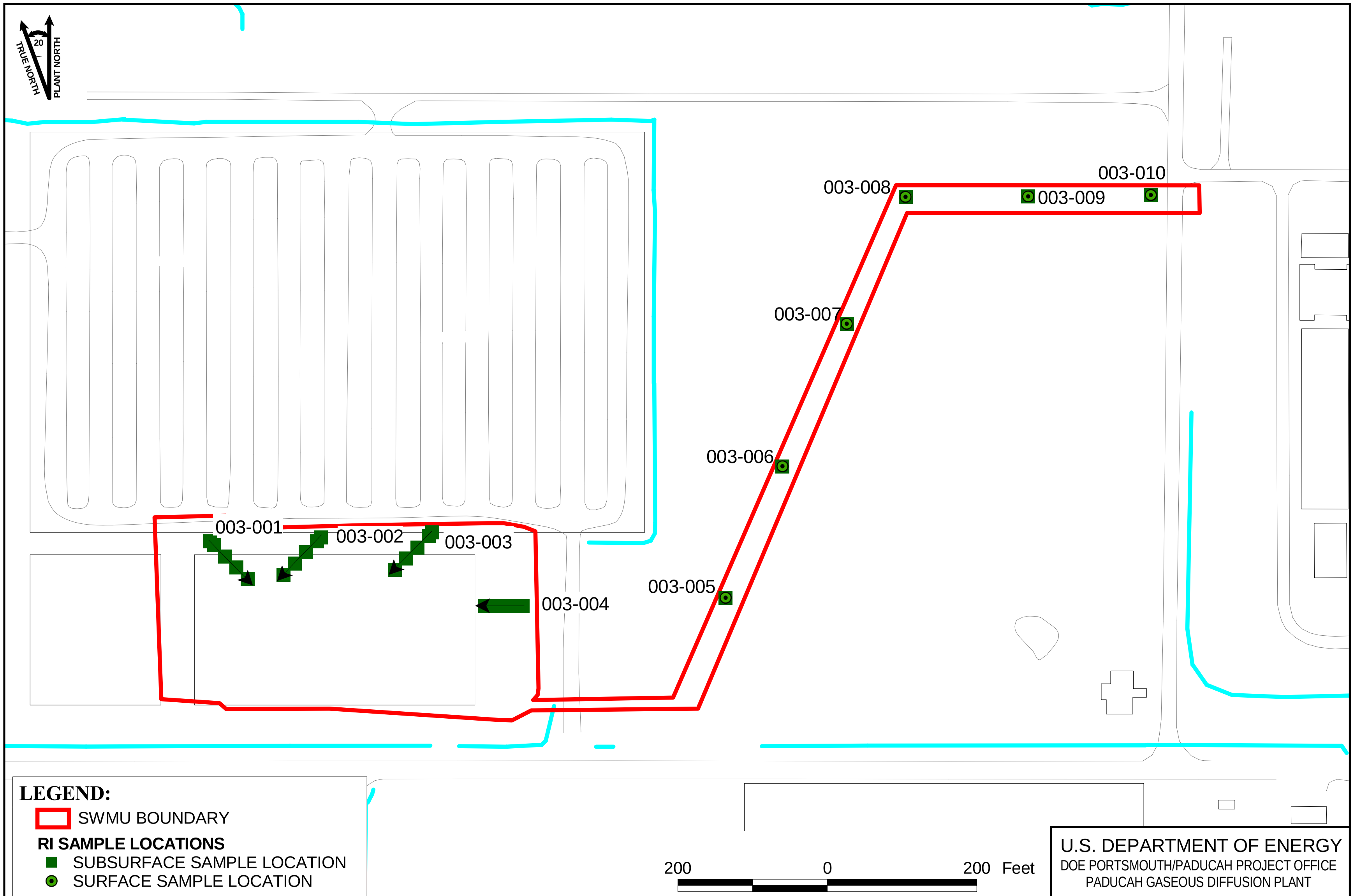

Figure 4.2. Soil Sampling Locations at SWMU 3

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

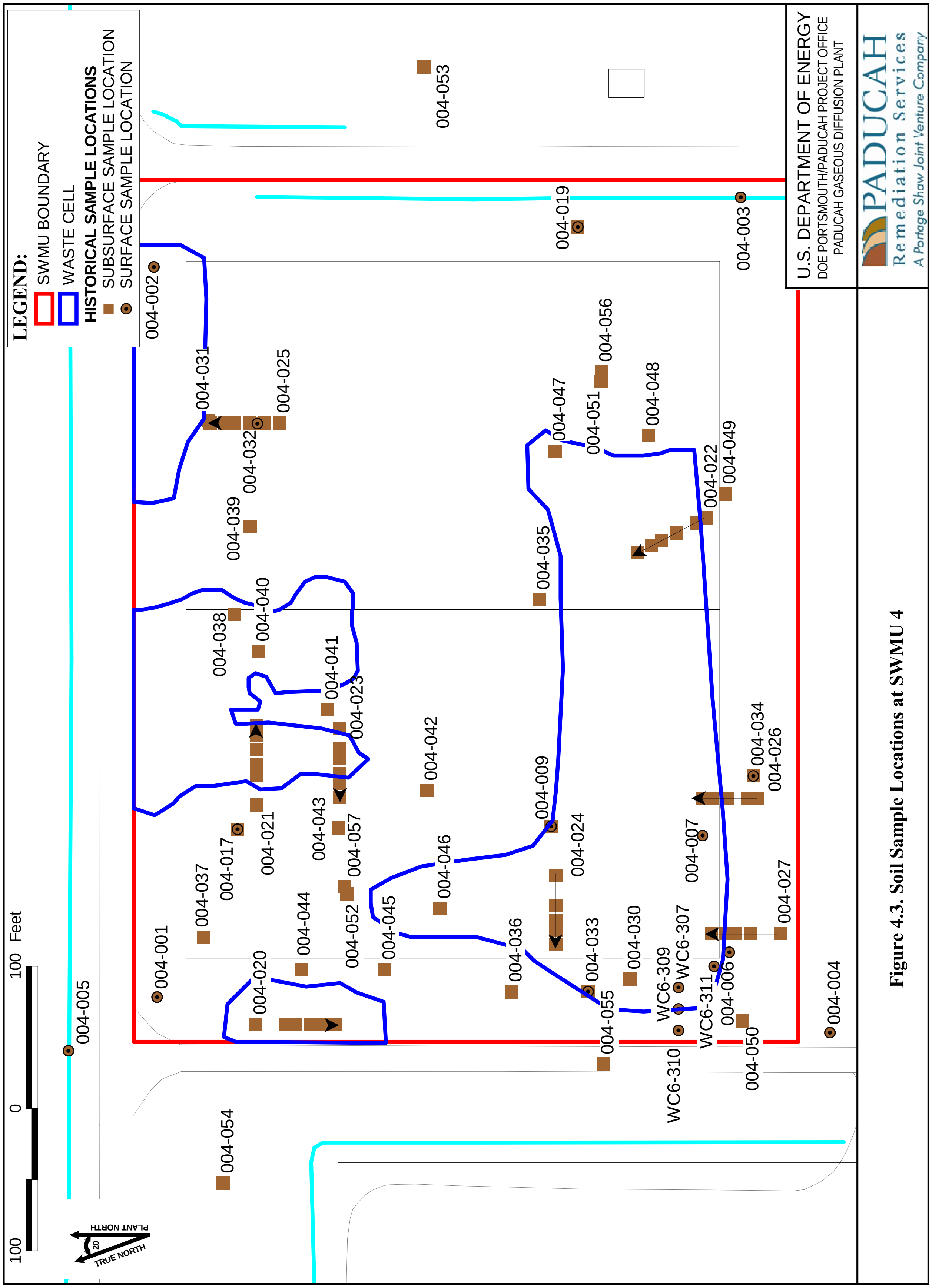

Figure 4.3. Soil Sample Locations at SWMU 4

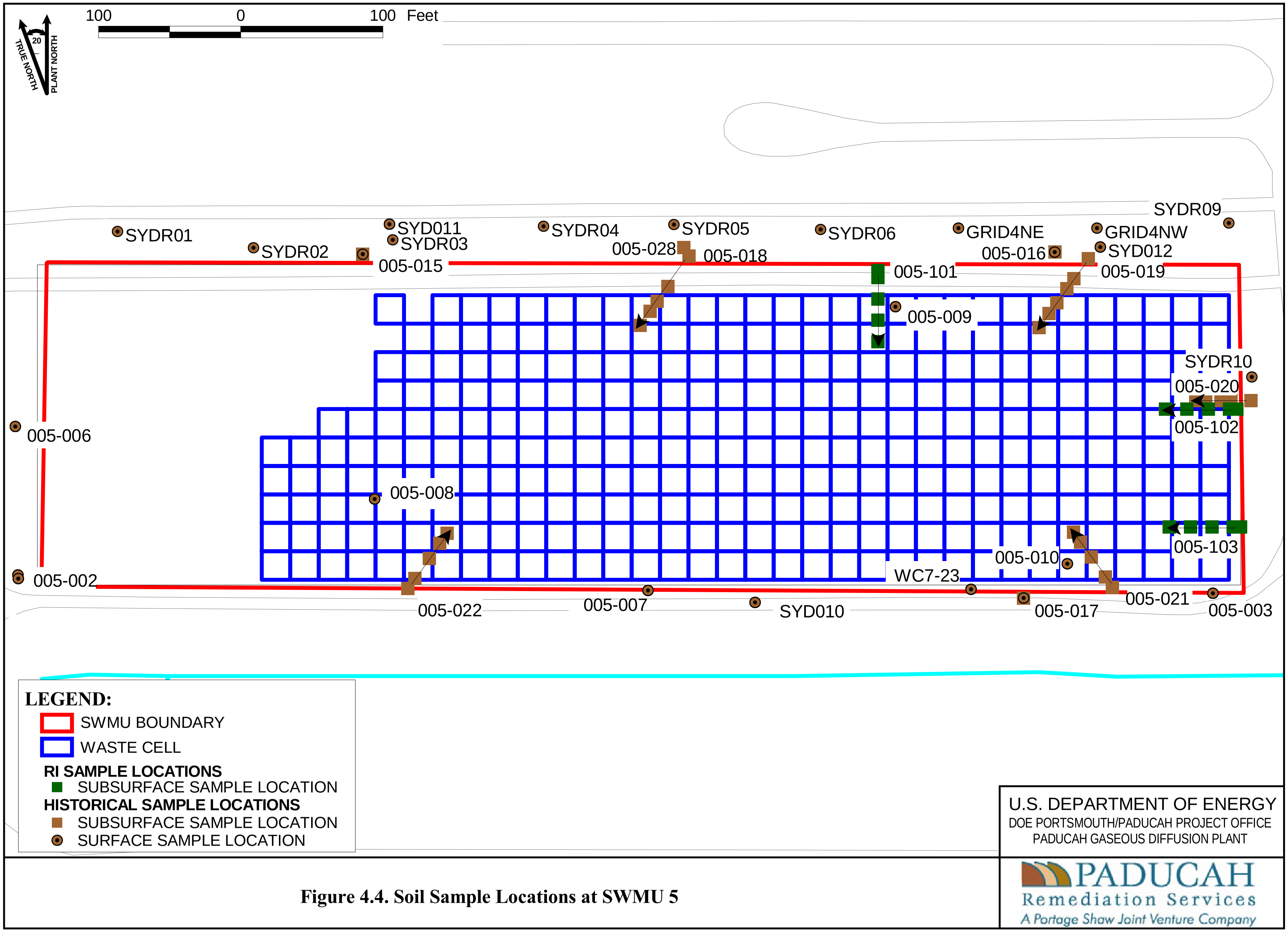

Figure 4.4. Soil Sample Locations at SWMU 5

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

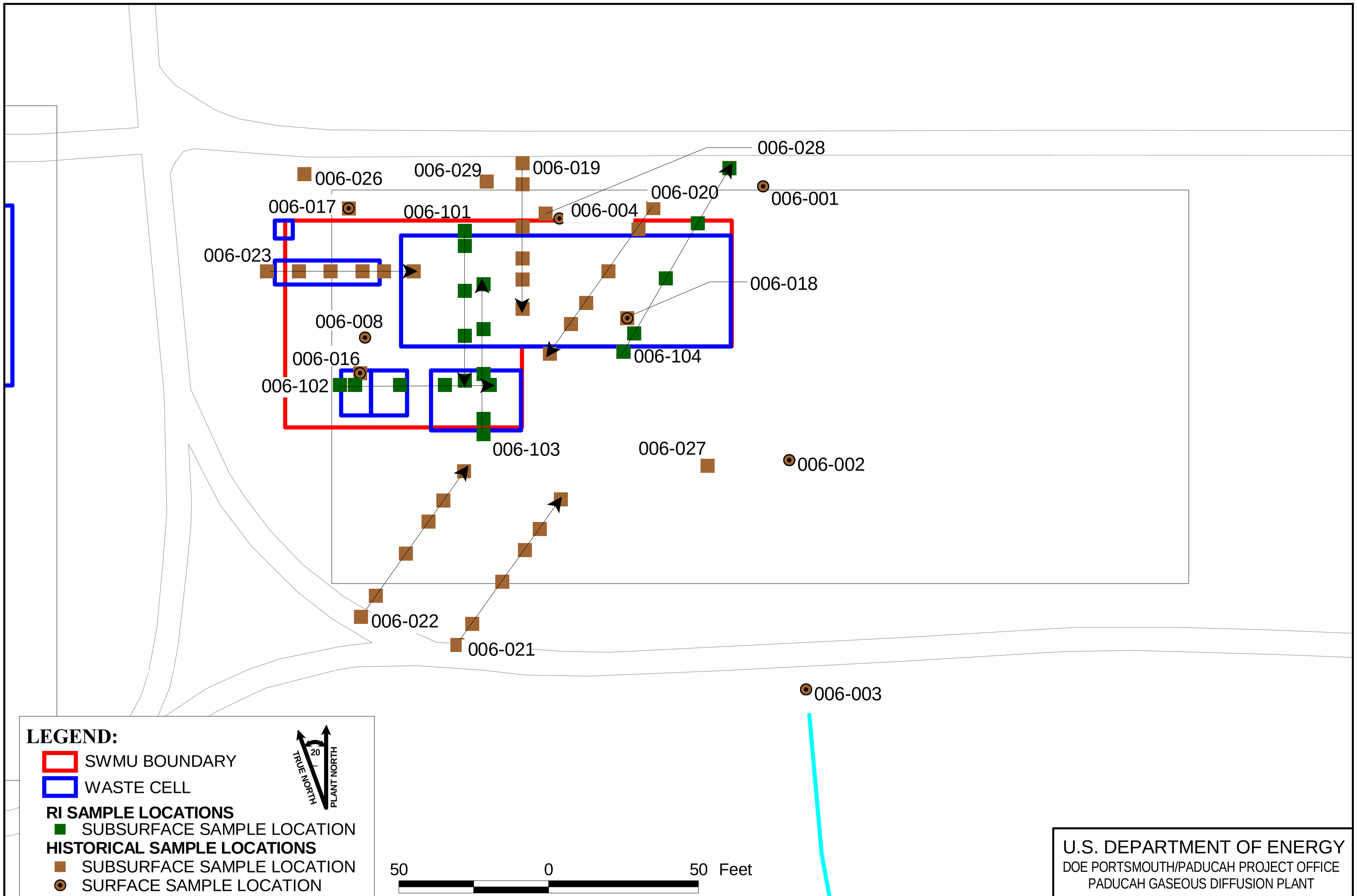

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Figure 4.5. Soil Sample Locations at SWMU 6

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

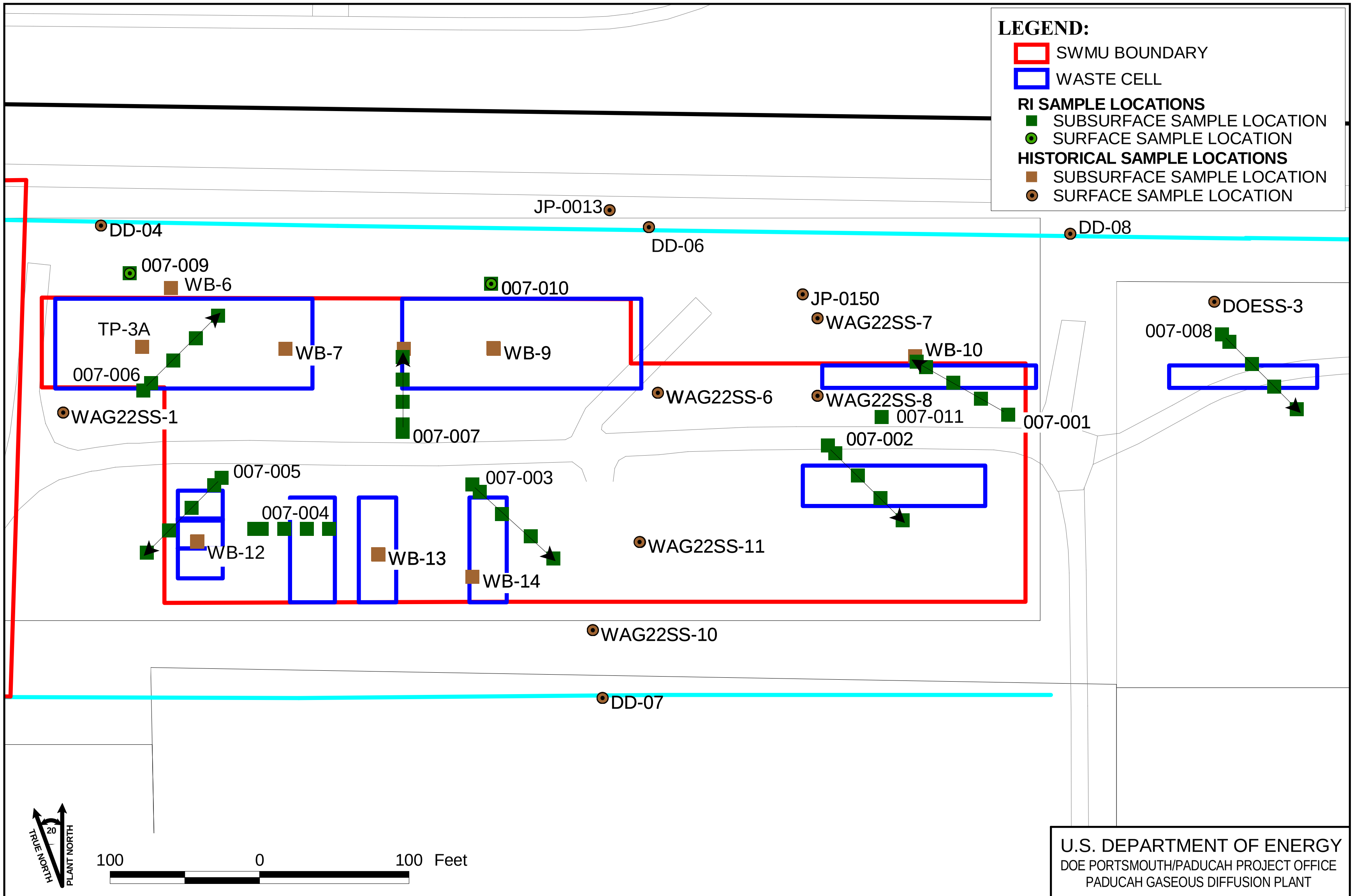

Figure 4.6. Soil Sample Locations at SWMU 7

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Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

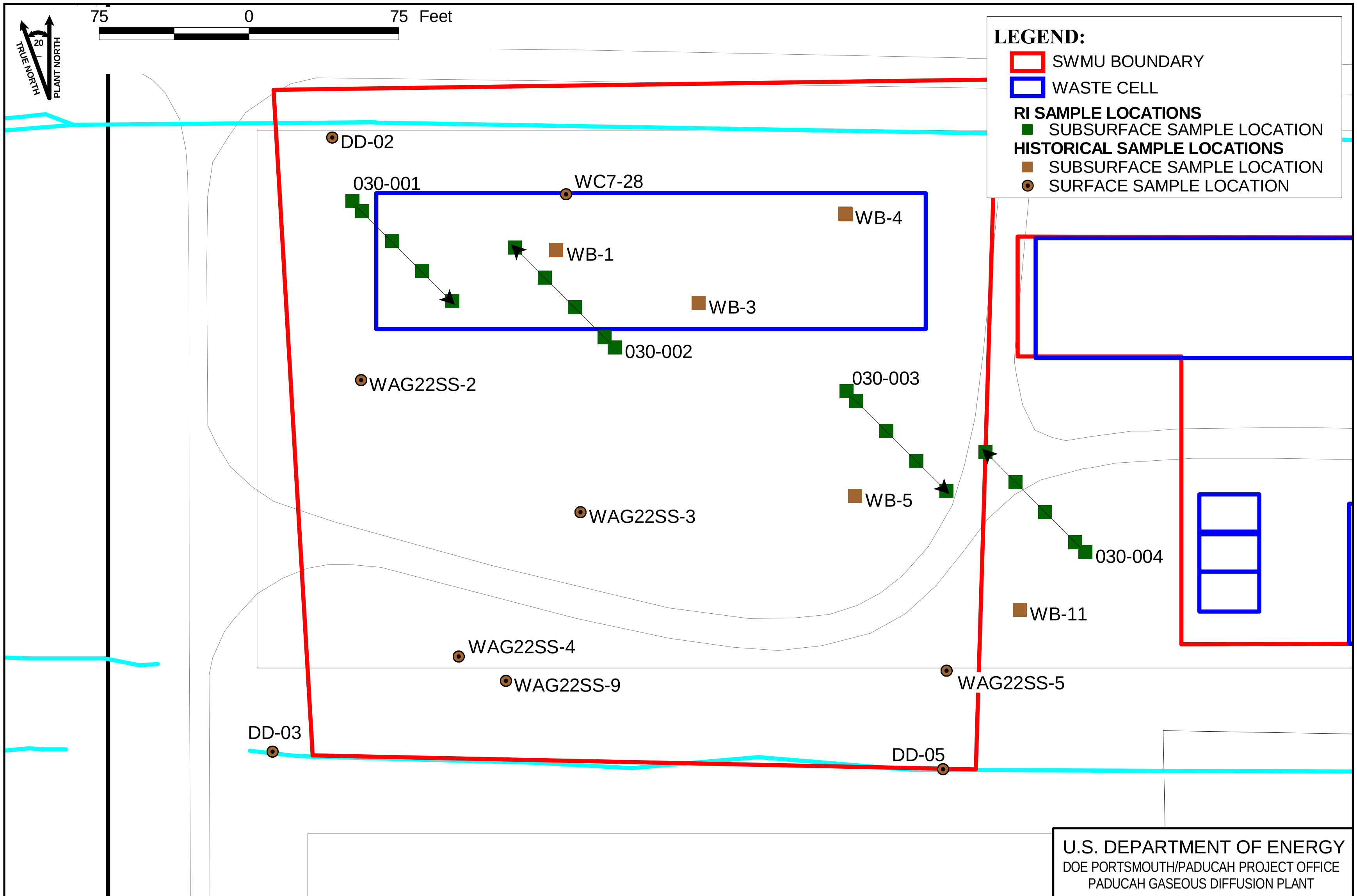

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Figure 4.7. Soil Sample Locations at SWMU 30

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

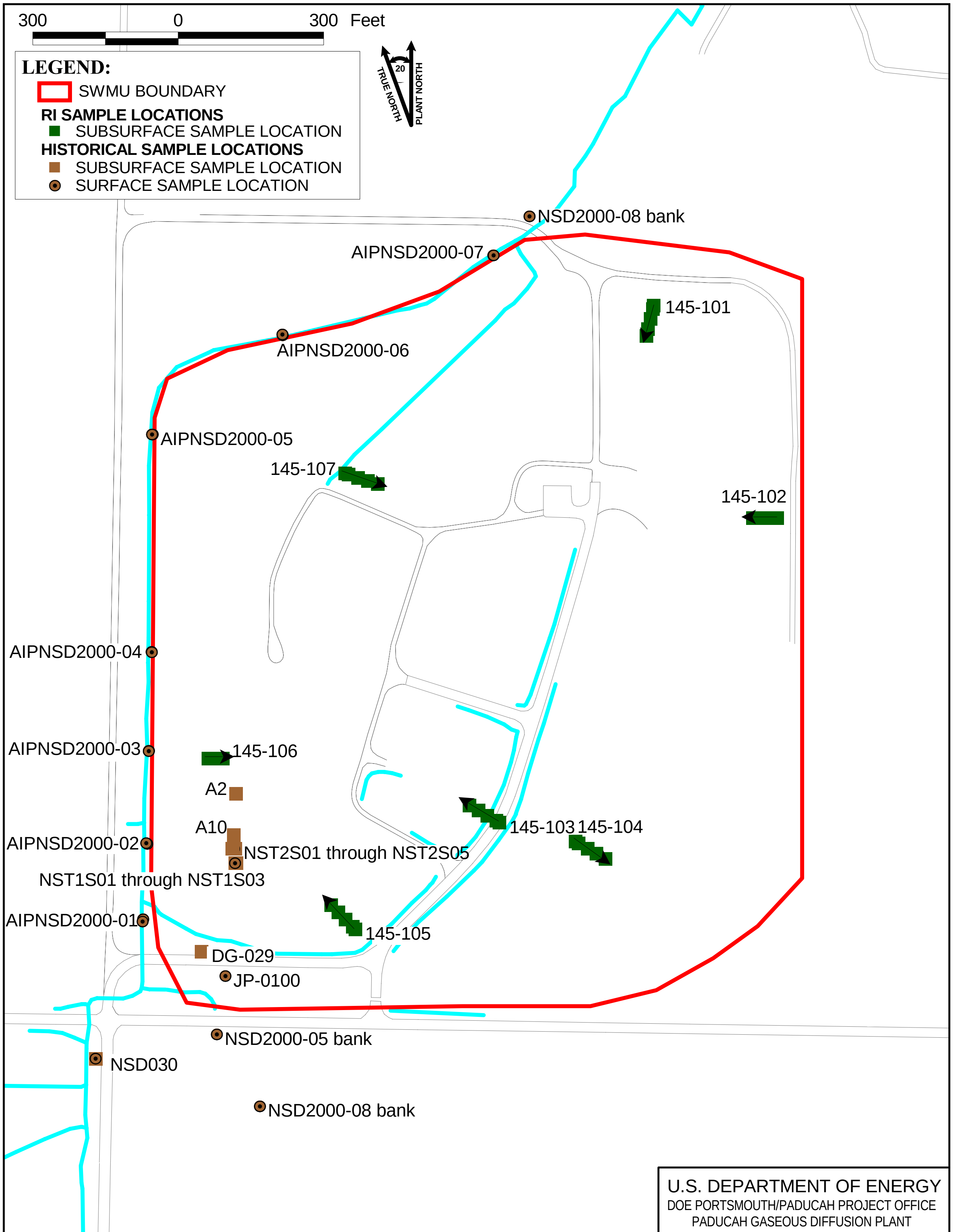

Figure 4.8. Soil Sample Locations at SWMU 145

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Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

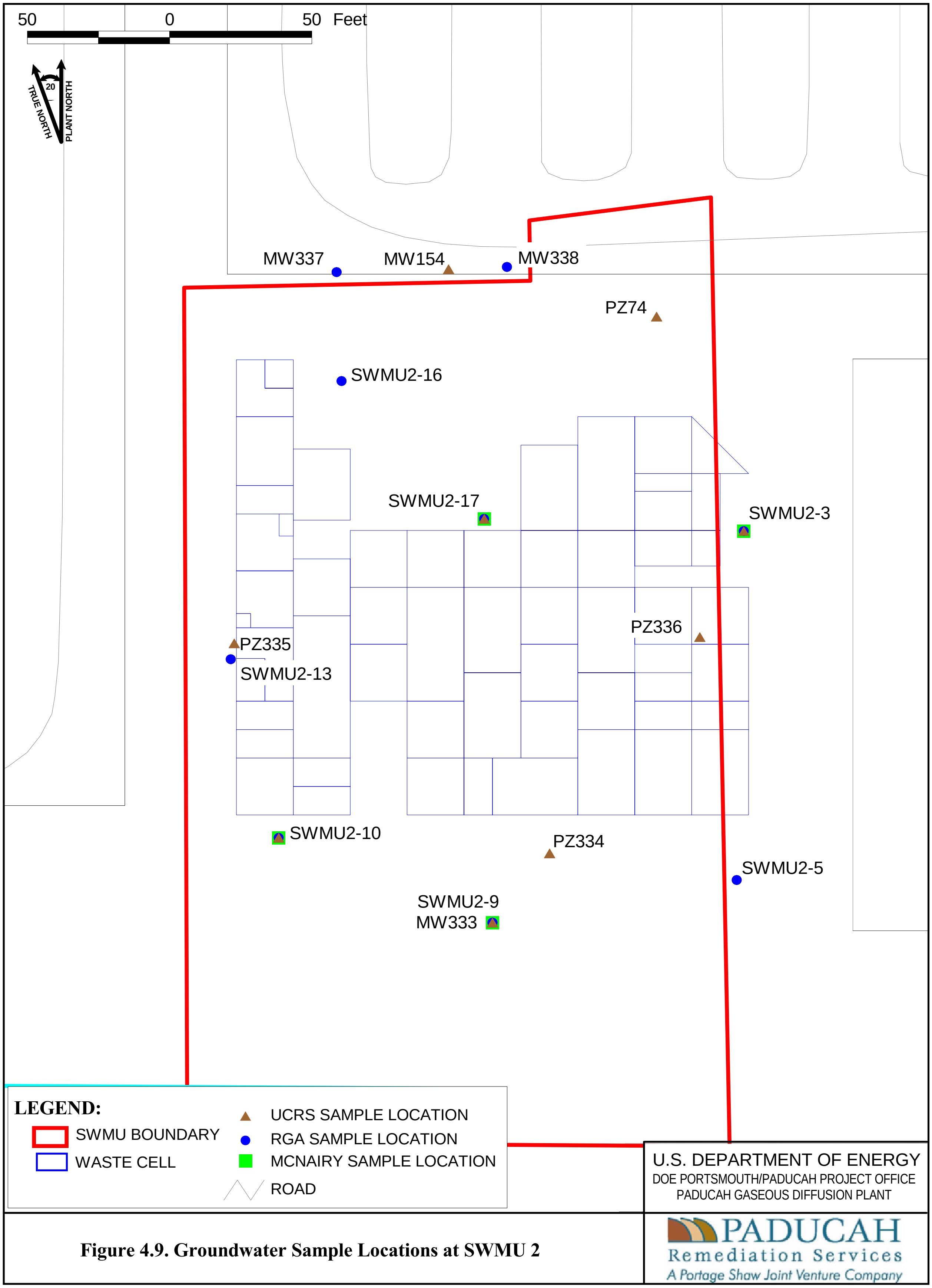

Figure 4.9. Groundwater Sample Locations at SWMU 2

Figure No. \BGOU\RI_4.apr
DATE 10-29-07

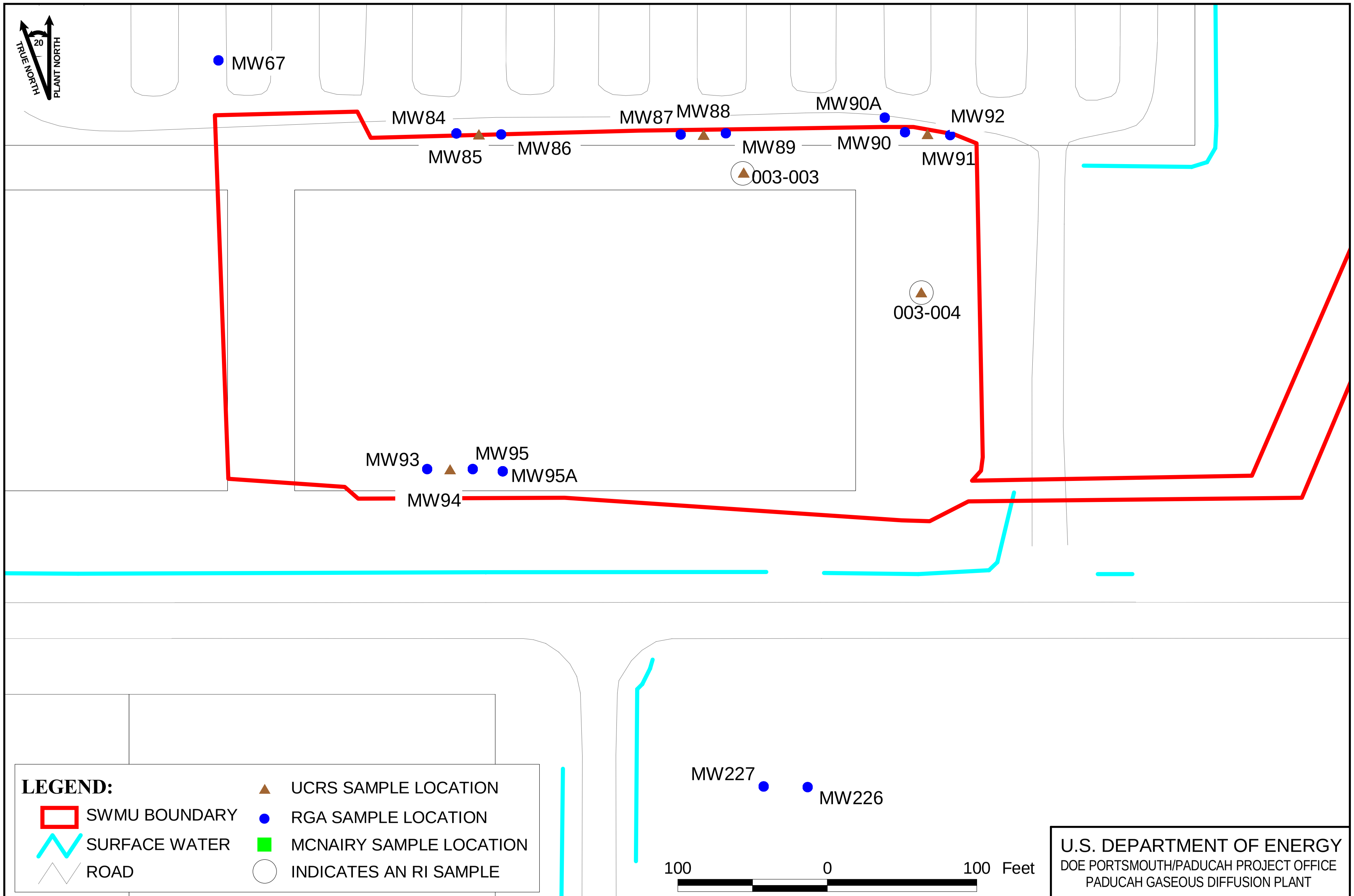

Figure 4.10. Groundwater Sample Locations at SWMU 3

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Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

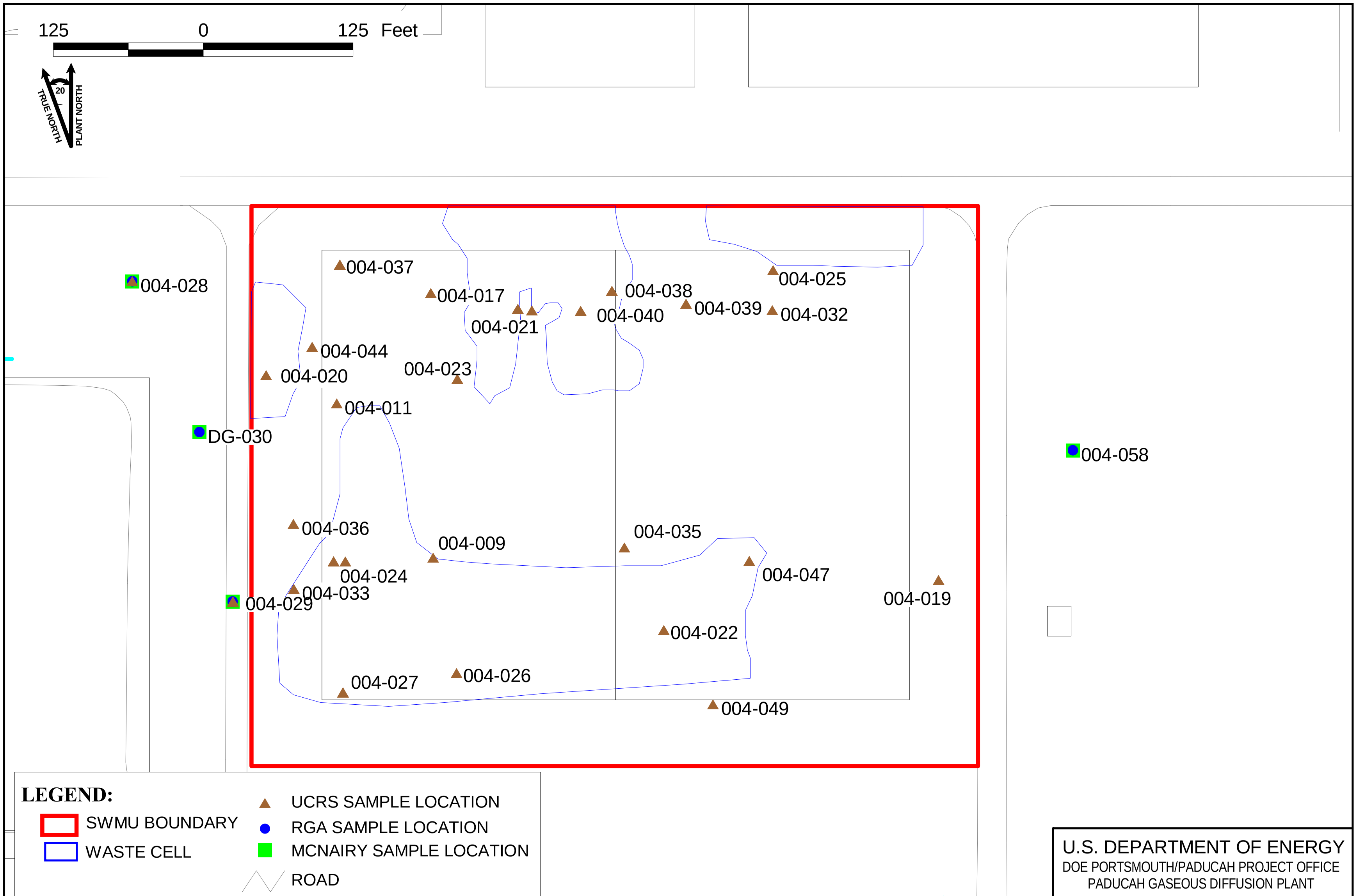

Figure 4.11. Groundwater Sample Locations at SWMU 4

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Figure No. \BGOU\RI.apr
DATE 10-15-07

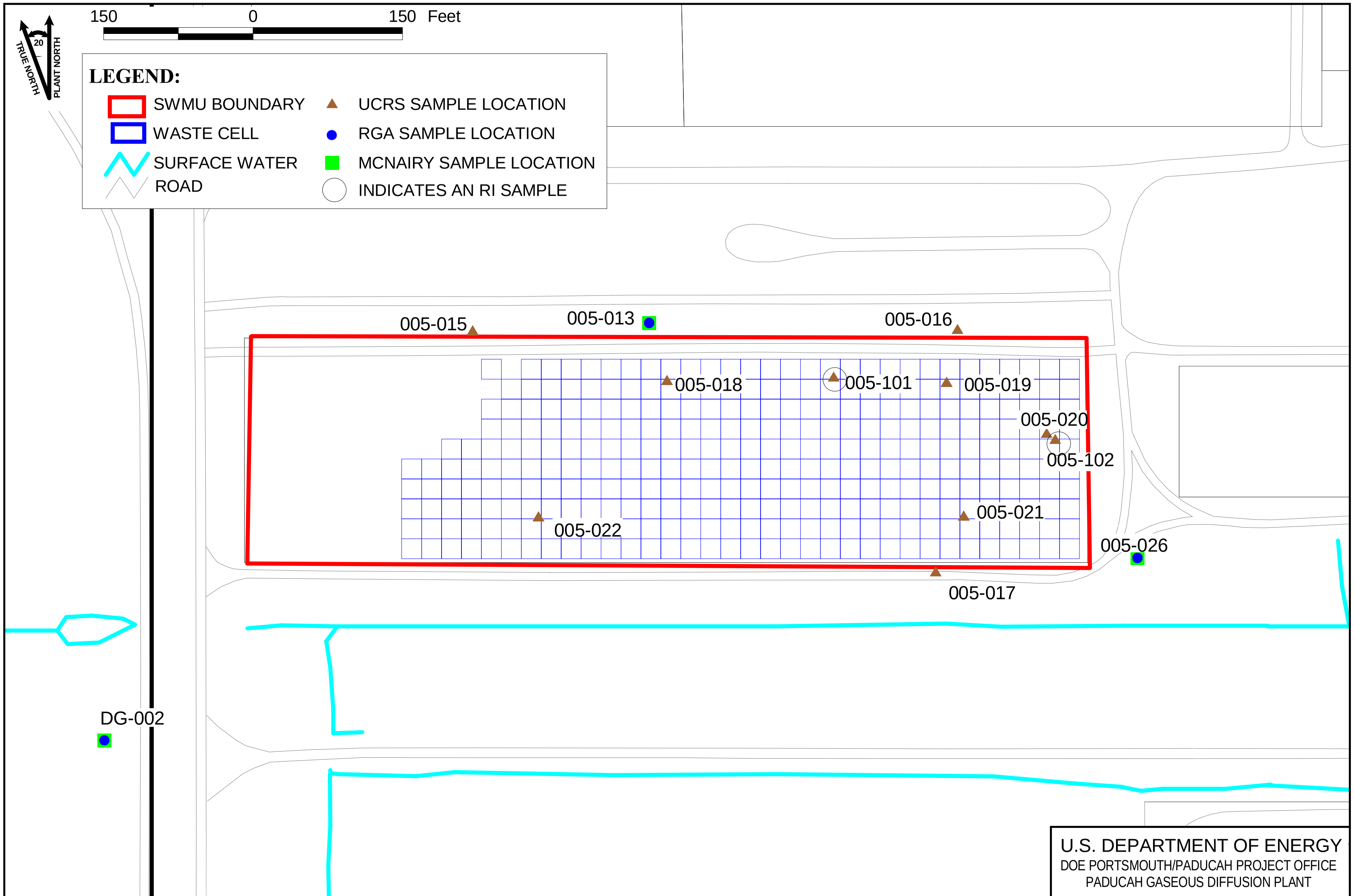

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Figure 4.12. Groundwater Sample Locations at SWMU 5

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

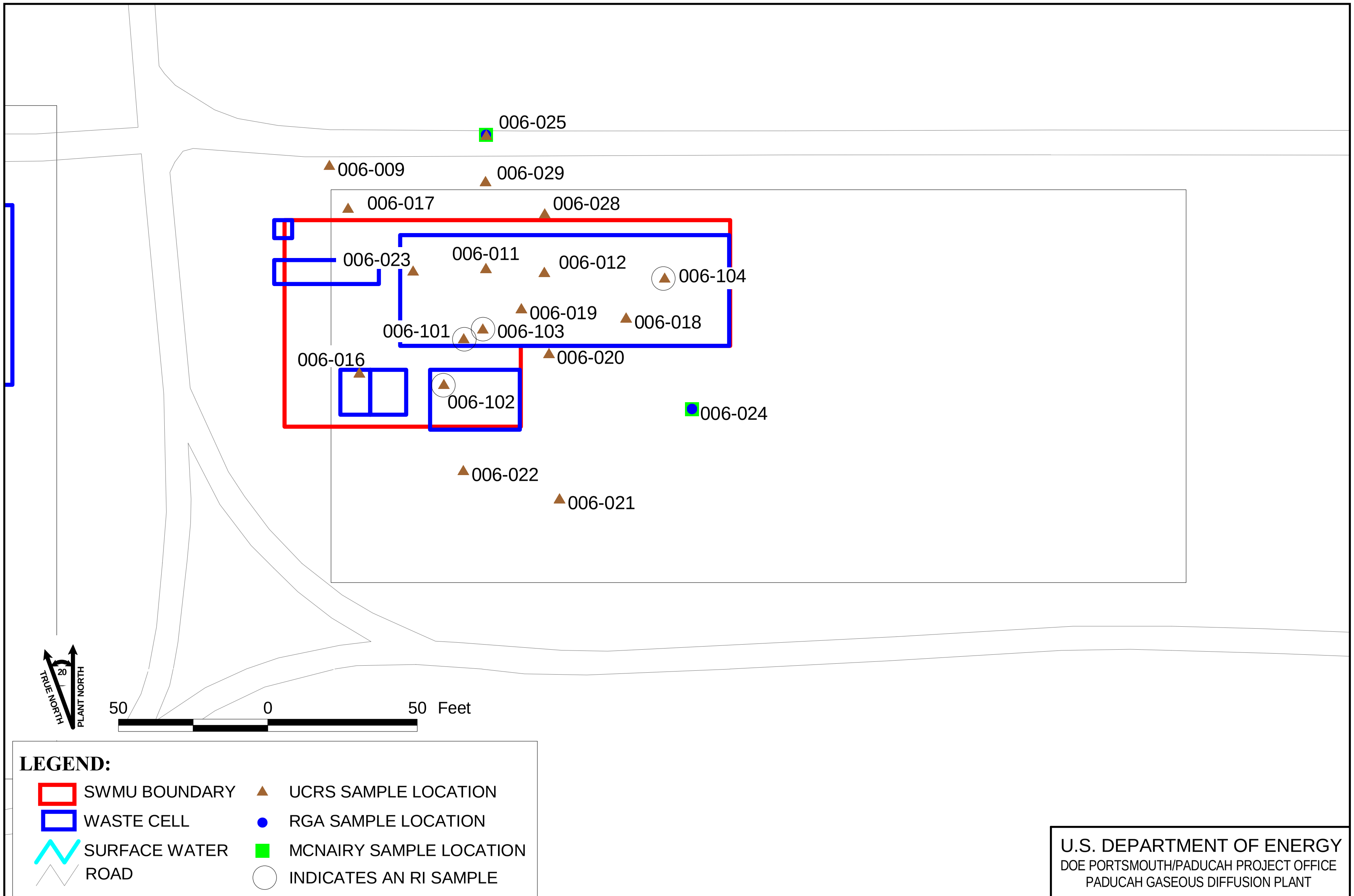

Figure 4.13. Groundwater Sample Locations at SWMU 6

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

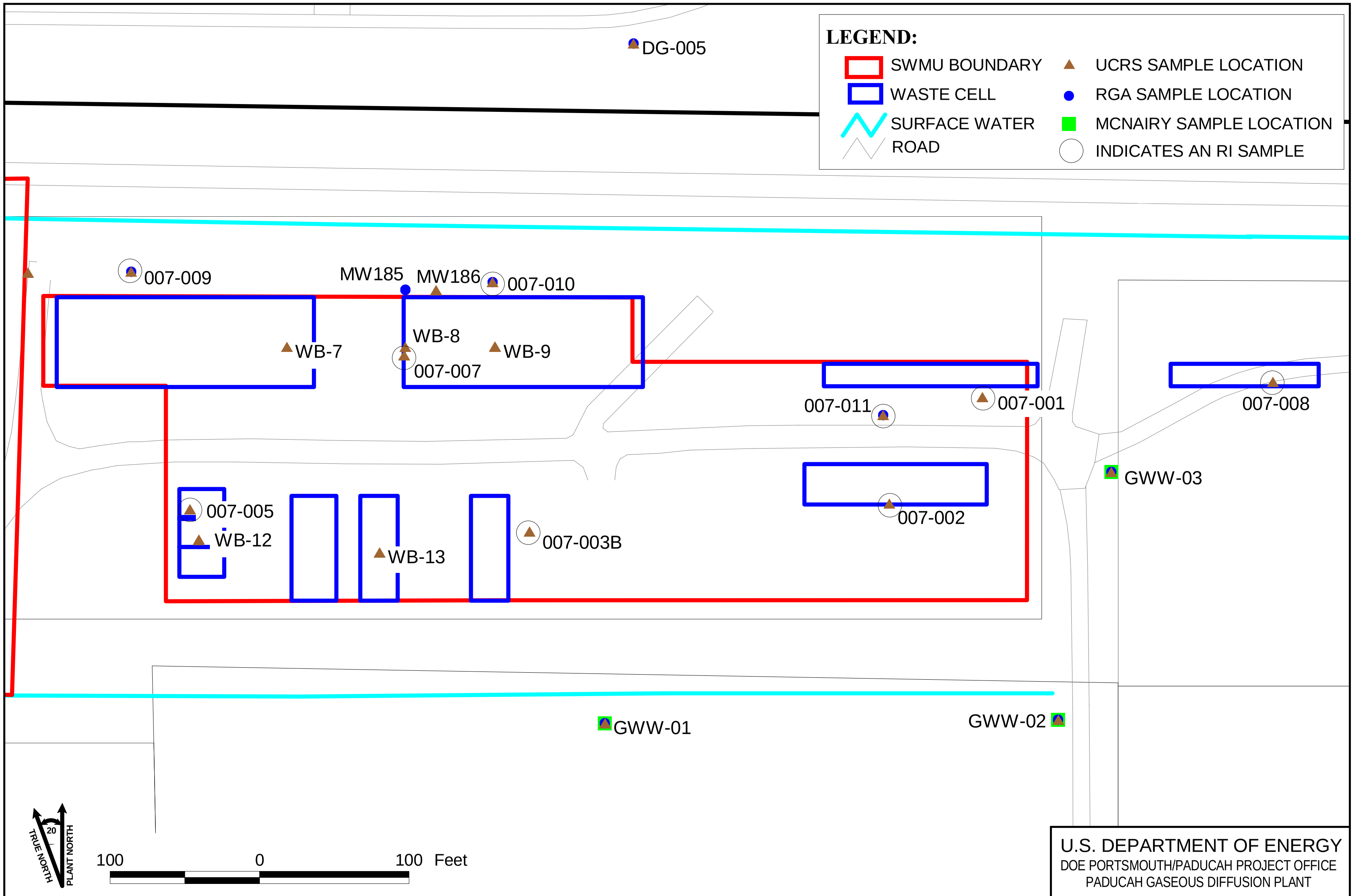

Figure 4.14. Groundwater Sample Locations at SWMU 7

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

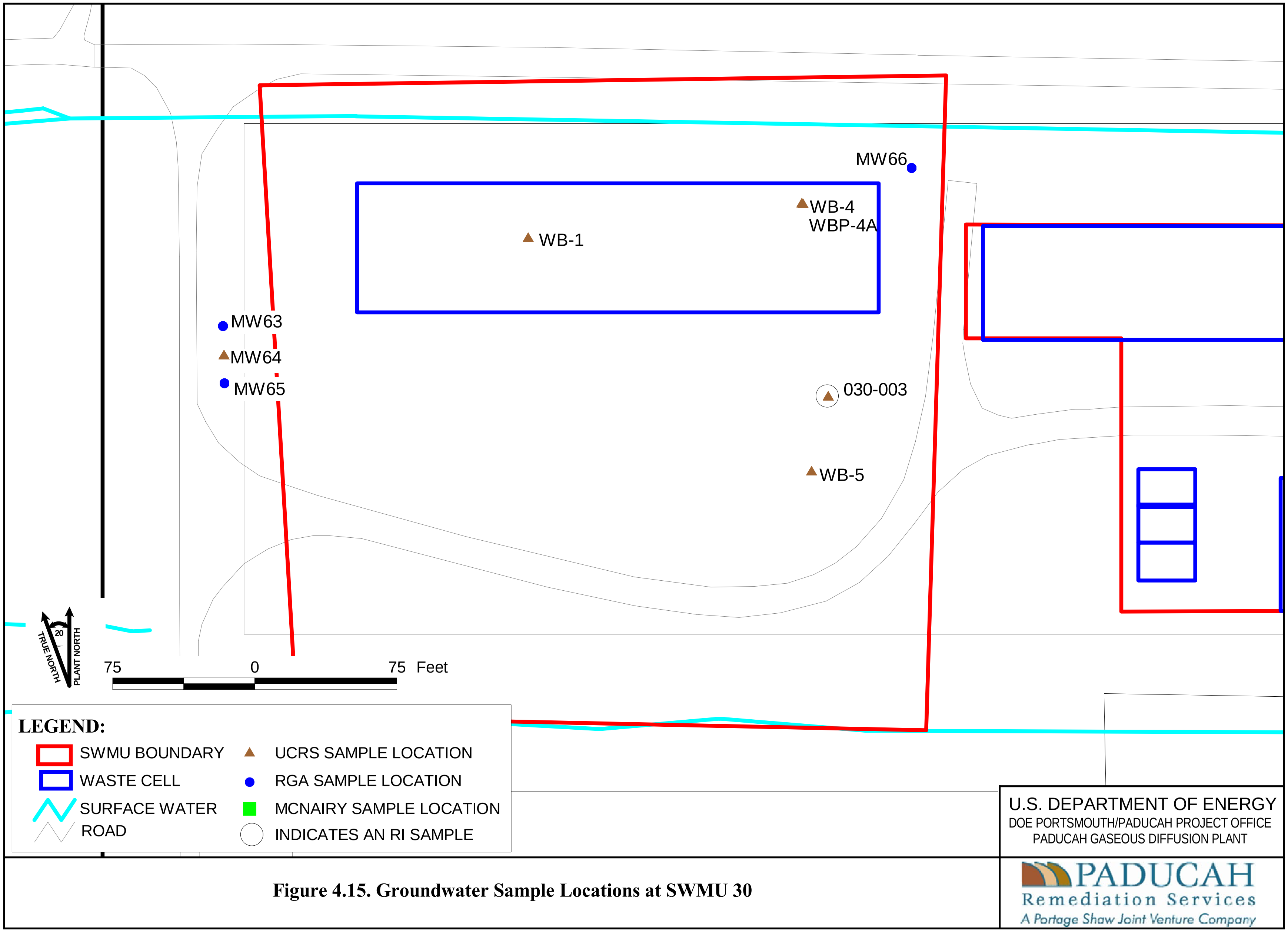

Figure 4.15. Groundwater Sample Locations at SWMU 30

Figure No. \BGOU\D1-RI_4.apr
DATE 05-21-08

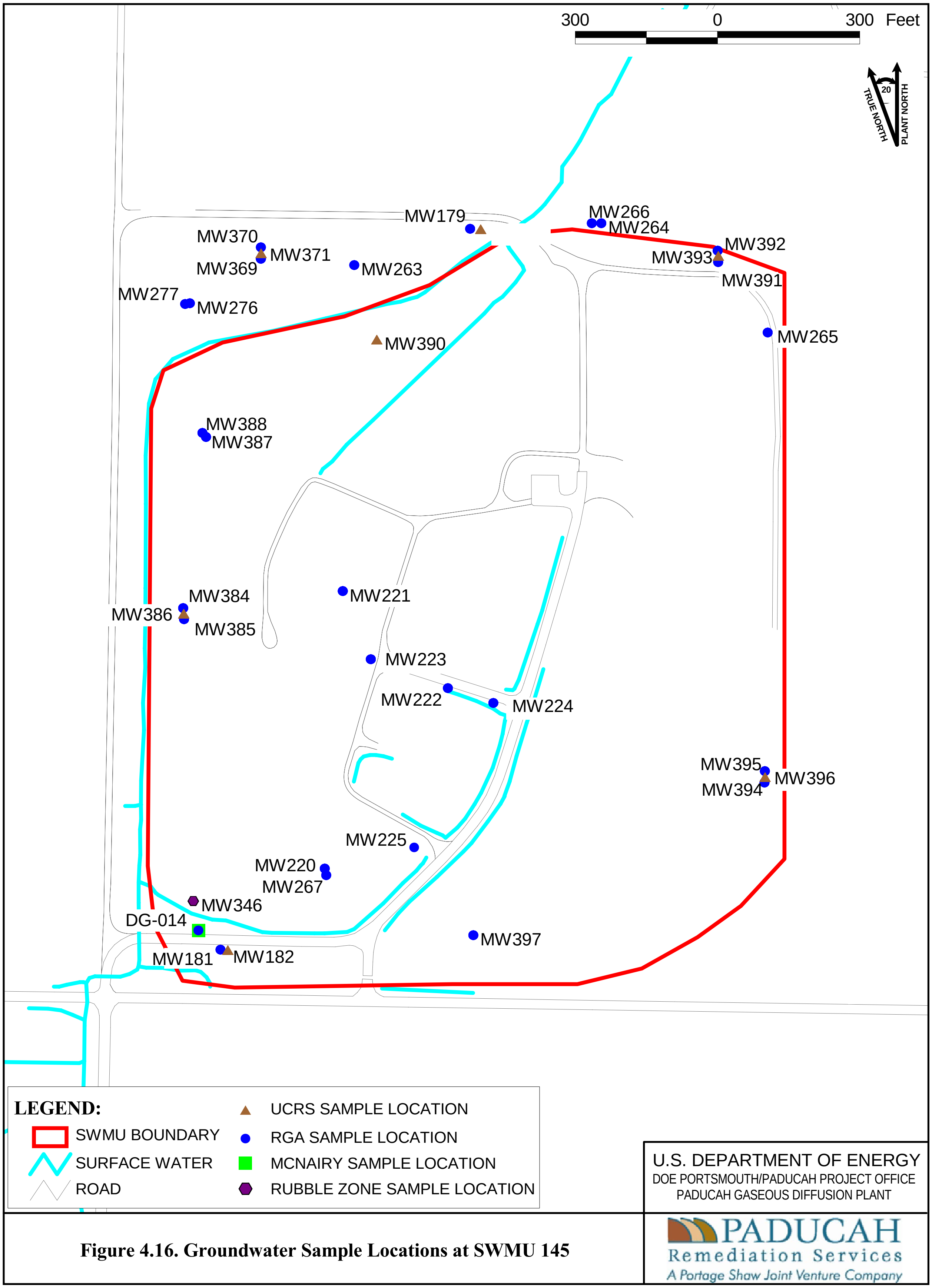

Figure 4.16. Groundwater Sample Locations at SWMU 145

Figure No. \BGOU\RI_4.apr
DATE 2-8-08

4.3 SUBSURFACE SOILS

4.3.1 SWMU 2

The RI collected subsurface soil samples from two angled borings at SWMU 2. Review of the RI data along with historical data identified the contaminants presented in Table 4.6. Table 4.7 lists the locations of the metals, organics, and radionuclides detected above screening levels.

As stated in Section 1.3.1.2, records for SWMU 2 indicate the waste consisted of uranium, oils, and TCE. The maximum result of uranium (1,500 mg/kg) was detected at a depth of 5 ft bgs in boring SWMU2-12. (This boring from the SWMU 2 Interim Remedial Design Investigation was one of several sample locations intended to characterize soils adjacent to a waste pit.[5]) The next highest uranium result from boring SWMU 2-2 of the SWMU 2 Interim Remedial Design Investigation (also intended to characterize soils adjacent to a waste pit) was 33 mg/kg, detected at 12 ft bgs. (The waste pits penetrate to a depth of approximately 17 ft.) The most prevalent metals detected above background level in subsurface soil samples at SWMU 2 are arsenic, thallium, and uranium. (Arsenic and thallium are commonly associated with uranium.) Arsenic was detected above background throughout the depth of the angled borings (60 ft) installed by the RI.

TCE and its degradation products *cis*-1,2-DCE and vinyl chloride were detected at high levels (140 mg/kg, 130 mg/kg, and 1.4 mg/kg, respectively) in the historic sample location SWMU 2-2 at a depth of 12 ft bgs. (This is the only detection of *cis*-1,2-DCE above the excavation worker NAL in all analyses related to the BGOU SWMUs.) This boring was not in a known area of TCE burial in SWMU 2. All other VOC detections in subsurface soils of SWMU 2 were less than 1 mg/kg. Although PCBs were suspected to be associated with the waste buried in SWMU 2, PCBs were detected above 1 ppm in only one subsurface soil sample below a depth of 6 ft (the approximate depth of the top of buried waste). (The maximum PCB detection in shallower subsurface soils was 0.06 mg/kg.)

The highest activities of the uranium isotopes ^{234}U (155 pCi/g) and ^{238}U (947 pCi/g) were detected at historic sample location SWMU2-12 at a depth of 5 ft bgs. (The waste sample recovered from the penetrated drum contained 7.6 pCi/g ^{234}U and 43.5 pCi/g ^{238}U.) All other detections of uranium isotopes in subsurface soil were less than 10 pCi/g.

---

[5] Boring SWMU2-12 penetrated and sampled a waste drum at a depth of 7 to 8 ft.

Table 4.6. SWMU 2 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Arsenic	22	13.7	28/29	8/29	28/29
Beryllium	1.3	1.05	19/29	4/29	1/29
Iron	N/A[b]	34,900	11/11	1/11	11/11
Manganese	1,200	481	29/29	2/29	25/29
Thallium	1.7	N/A	10/29	10/29	7/29
Uranium	1,500	15.3	12/58	10/58	7/58
Vanadium	38	23.2	28/29	1/29	27/29
Organics – Volatiles (mg/kg)					
cis-1,2-DCE	130	0.118	6/29	N/A	1/29
TCE	140	0.428	10/58	N/A	1/58
Vinyl chloride	1.4	N/A	1/29	N/A	1/29
Organics –PCBs (mg/kg)					
Total PCBs	4.2	N/A	5/28	N/A	1/28
PCB-1248	4.2	N/A	5/28	N/A	1/28
Radionuclides (pCi/g)					
Uranium-234	155	0.824	52/58	1/58	1/58
Uranium-235/236	25.8	N/A	46/47	3/47	1/47
Uranium-238	947	5.87	52/58	11/58	12/58

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.7. SWMU 2 Locations of Subsurface Soil Contaminants

		RI Data		Historical Data									
Analysis	Depth (ft)	002-001	002-002	SWMU2-1	SWMU2-12	SWMU2-13	SWMU2-17	SWMU2-2	SWMU2-3	SWMU2-4	SWMU2-5	SWMU2-8	SWMU2-9
Inorganics (mg/kg)													
Arsenic	5				12			7.7					
	8			18						21		3.8	
	10-12	2.47	1.22	6.8	4.5			22		9.9		10	
	15-16	2.06	1.21	1.9	4.6					7.6		3.6	
	20			1.1	1.7					8.5		2.3	
	30	3.98	2.52										
	45	1.26	13.7										
	60	2.38	2.02										
Beryllium	5				0.65			0.42					
	8			1.3						0.49		0.51	
	10-12	ND	ND	0.52	0.55			0.82		0.51		0.58	
	15-16	ND	ND	0.38	0.75					0.45		0.37	
	20			0.29	0.39					0.55		0.49	
	30	ND	ND										
	45	ND	1.05										
	60	ND	ND										
Iron	10-12	8250	5950										
	15-16	7900	6830										
	20	13600	10600										
	30	7110	34900										
	45	7190	12800										
	60	8250	5950										
Manganese	5				770			370					
	8			850						180		130	
	10-12	49.9	119	440	620			1200		130		210	
	15-16	481	278	240	360					130		230	
	20			170	670					130		320	
	30	165	35										
	45	35.7	454										
	60	193	146										
Thallium	5				ND			ND					
	8			0.88						1.7		0.55	
	10-12	ND	ND	1.3	ND			ND		1.3		0.99	
	15-16	ND	ND	ND	ND					1.2		0.63	
	20			ND	ND					1.2		0.61	
	30	ND	ND										
	45	ND	ND										
	60	ND	ND										
Uranium	5				1500			ND					ND
	8			ND						ND		ND	
	10-12	ND	15.3	ND	ND	ND		33		ND		ND	
	15-16	ND	ND	ND	ND		ND		ND	ND	ND	ND	
	20-25			ND	ND	ND				ND	11	24	ND
	30-35	1.05	ND				ND		22		ND		
	40-45	ND	1.49			ND	ND		ND				ND
	50-55					ND	ND		ND		ND		4.9
	60-70	ND	ND						ND		ND		
	75					24							11
	85						13						

Table 4.7. SWMU 2 Locations of Subsurface Soil Contaminants (Continued)

		RI Data		Historical Data									
Analysis	**Depth (ft)**	002-001	002-002	SWMU2-1	SWMU2-12	SWMU2-13	SWMU2-17	SWMU2-2	SWMU2-3	SWMU2-4	SWMU2-5	SWMU2-8	SWMU2-9
Vanadium	5				23			21					
	8			37						21		10	
	10-12	2.8	10.8	24	23			38		13		23	
	15-16	ND	11.9	11	33					11		13	
	20			6.5	15					17		12	
	30	21.4	15										
	45	17.8	23.2										
	60	6.85	16.9										
Organics – Volatiles (mg/kg)													
cis-1,2-DCE	5				ND			2.7					
	8			ND						0.0019		0.00093	
	10-12	ND	ND	ND	ND			130		ND		ND	
	15-16	ND	ND	ND	ND					ND		ND	
	20			ND	ND					ND		ND	
	30	ND	ND										
	45	0.118	ND										
	60	ND	0.0149										
TCE	5				0.28			ND					ND
	8			ND						ND		0.01	
	10-12	ND	ND	ND	ND	ND		140		ND		0.0025	
	15-16	ND	ND	ND	ND		ND		ND	ND	ND	0.0021	
	20-25			ND	ND	ND				ND	ND	0.0022	ND
	30-35	ND	ND				ND		ND		ND		
	40-45	0.428	ND			ND	ND		ND				0.0078
	50-55					ND	ND		ND		ND		
	60	ND	0.366										
Vinyl chloride	5				ND			ND					
	8			ND						ND		ND	
	10-12	ND	ND	ND	ND			1.4		ND		ND	
	15-16	ND	ND	ND	ND					ND		ND	
	20			ND	ND					ND		ND	
	30	ND	ND										
	45	ND	ND										
	60	ND	ND										
Organics – Pesticides and PCBs (mg/kg)													
Total PCBs	5				0.058			ND					
	8			ND						ND		ND	
	10-12	ND	ND	ND	0.031			4.2		ND		ND	
	15-16	ND	ND	ND	0.015					ND		ND	
	20				0.041					ND		ND	
	30	ND	ND										
	45	ND	ND										
	60	ND	ND										

Table 4.7. SWMU 2 Locations of Subsurface Soil Contaminants (Continued)

		RI Data		Historical Data									
Analysis	**Depth (ft)**	002-001	002-002	SWMU2-1	SWMU2-12	SWMU2-13	SWMU2-17	SWMU2-2	SWMU2-3	SWMU2-4	SWMU2-5	SWMU2-8	SWMU2-9
PCB-1248	5				0.058			ND					
	8			ND						ND		ND	
	10-12	ND	ND	ND	0.031			4.2		ND		ND	
	15-16	ND	ND	ND	0.015					ND		ND	
	20				0.041					ND		ND	
	30	ND	ND										
	45	ND	ND										
	60	ND	ND										
Radionuclides (pCi/g)													
Uranium-234	5				155			1.15					1.57
	8			1.72						1.04		0.98	
	10-12	ND	0.824	0.81	0.98	1.16		2.07		0.79		0.99	
	15-16	ND	ND	0.86	0.77		0.81		0.77	0.71	0.76	0.77	
	20-25			0.8	0.83	0.73				0.76	0.52	0.89	0.44
	30-35	0.35	0.176				0.93		0.58		0.87		
	40-45	ND	0.297			0.57	1.17		0.86				1.19
	50-55					1.2	0.6		0.93		0.69		0.6
	60	ND	0.25										
	70-75					0.26			0.63		0.48		0.52
	85						0.57						
	95					0.27			1.2				
Uranium-235/236	5				25.8			0.06					0.1
	8			0.19						0.03		0.06	
	10-12			0.07	0.06	0.1		0.38		0.06		0.14	
	15-16			0.08	0.04		0.1		0.07	0.04	0.06	0.1	
	20-25			0.04	0.09	0.09				0.09	0.03	0.08	0.05
	30-35						0.05		0.04		0.11		
	40-45					0.02	0.06		0.12				0.06
	50-55					0.07	0.05		0.07		0.06		0.04
	70-75					0.01			0.04		0.05		ND
	85						0.06						
	95					0.03			0.11				
Uranium-238	5				947			1.82					2.83
	8			6.25						1.08		0.95	
	10-12	ND	5.87	1.02	2.02	1.23		8.02		1.04		0.98	
	15-16	ND	ND	0.82	0.97		0.95		0.75	0.71	0.86	0.87	
	20-25			0.84	1.39	0.78				0.84	0.52	0.9	0.58
	30-35	0.319	0.132				0.97		0.62		0.8		
	40-45	ND	0.241			0.6	1.27		0.93				1.11
	50-55					1.26	0.71		1.14		0.8		0.75
	60	ND	0.206										
	70-75					0.21			0.69		0.52		0.23
	85						0.29						
	95					0.33			1.2				

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. Maximum value is shown for each depth interval.

4.3.2 SWMU 3

No historical subsurface soil data were available for SWMU 3; however, subsurface soil samples were collected from four angled borings at C-404 as part of this RI, in addition to the six shallow borings along the former discharge ditch. A review of RI data identified the contaminants listed in Table 4.8.

Table 4.8. SWMU 3 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Antimony	N/A[b]	11	3/40	3/40	3/40
Arsenic	N/A	8.25	36/40	1/40	36/40
Uranium	N/A	83.6	11/40	7/40	4/40
Radionuclides (pCi/g)					
Cesium-137	N/A	0.456	1/40	1/40	1/40
Uranium (total)	N/A	25.8	9/40	N/A	1/40
Uranium-234	N/A	3.02	14/40	1/40	1/40
Uranium-238	N/A	22.4	18/40	6/40	6/40

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.9 shows the locations of the samples with metals and radionuclides detected above screening levels.

Wastes disposed of in SWMU 3 include all liquid effluents from C-400 operations from 1952 through 1957. C-404 continued to receive solid uranium-contaminated and radioactively contaminated wastes from 1957 until 1986.

The most prevalent metal detected above its screening values in subsurface soil at SWMU 3 is uranium, followed by antimony. Uranium contamination has migrated to a depth of 10 to 15 ft under C-404 (both as a metal and as a radionuclide) and as much as 10 ft under the former discharge ditch (as a metal). Antimony contamination is limited to a depth of 5 to 10 ft along the former discharge ditch. (SWMUs 3 and 145 are the only BGOU SWMUs to have antimony concentrations that exceed the contaminant screening criteria.) Arsenic was detected frequently in subsurface soil samples, but exceeded the PGDP background level in only 1 of 40 samples.

Table 4.9. SWMU 3 Locations of Subsurface Soil Contaminants

		RI – Angled Borings				RI – Ditch Samples					
Analysis	**Depth (ft)**	003-001	003-002	003-003	003-004	003-005	003-006	003-007	003-008	003-009	003-010
Inorganics (mg/kg)											
Antimony	5					ND	ND	9.89	11	ND	ND
	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.1
	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	30	ND	ND	ND	ND						
	45	ND	ND	ND	ND						
	60	ND	ND	ND	ND						
Arsenic	5					3.76	3.9	7.03	1.25	2.93	2.68
	10	5.69	3.09	2.47	3.81	4.67	2.96	2.57	1.4	2.02	2.61
	15	0.956	2.12	5.19	1.46	ND	1.68	2.3	1.18	1.16	1.27
	30	ND	3.32	ND	3.02						
	45	8.25	2.39	2.61	3.01						
	60	1.65	ND	1.28	2.36						
Uranium	5					19.9	5.3	15.8	ND	1.17	ND
	10	83.6	33.7	ND	1.78	ND	ND	6.09	ND	ND	ND
	15	ND	ND	5.18	ND	ND	ND	ND	ND	ND	ND
	30	1.05	ND	ND	ND						
	45	1.41	ND	ND	ND						
	60	ND	ND	ND	ND						
Radionuclides (pCi/g)											
Cesium-137	5					0.456	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	30	ND	ND	ND	ND						
	45	ND	ND	ND	ND						
	60	ND	ND	ND	ND						
Uranium	5				7.46	3.48	6.55	ND	ND	ND	
	10	8.53	25.8	ND	ND	ND	ND	2.7	ND	ND	ND
	15	0.464	ND	ND	ND	ND	ND	ND	ND	ND	ND
	30	ND	ND	ND	ND						
	45	0.602	ND	ND	ND						
	60	ND	ND	0.371	ND						
Uranium-234	5					1.08	0.533	0.913	ND	0.142	ND
	10	0.927	3.02	ND	ND	ND	ND	0.392	ND	ND	ND
	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	30	0.18	ND	ND	ND						
	45	0.305	0.144	ND	ND						
	60	0.178	0.211	0.249	ND						
Uranium-238	5					6.29	2.91	5.55	0.127	0.201	ND
	10	7.47	22.4	ND	0.2	0.142	ND	2.28	ND	ND	ND
	15	0.354	0.325	ND	ND	ND	ND	ND	ND	ND	ND
	30	0.192	ND	ND	ND						
	45	0.271	0.129	ND	ND						
	60	0.147	ND	0.19	ND						

ND = not detected
Blank cells indicate interval was not sampled for the specified analysis. Maximum value is shown for each depth interval.

4.3.3 SWMU 4

Table 4.10 summarizes the review of SWMU 4 subsurface soil data to identify site-related contaminants. Table 4.11 shows the locations and depths of these contaminants.

SWMU 4 served as a disposal repository of radiologically contaminated and uncontaminated debris originating from the C-410 UF_6 feed plant. Beryllium is the most widely detected metal in subsurface soils above background (52 of 126 analyses), but exceeds the NAL in only 6 of 126 analyses. Iron and vanadium are the most common metals to exceed both PGDP background (in 7 of 126 analyses for both) and the NAL (in 126 of 126 analyses of iron and 125 of 126 analyses of vanadium). Manganese exceeds PGDP background in 6 of 126 analyses and exceeds the NAL in 92 of 126 analyses. The iron and vanadium exceedances are well distributed across SWMU 4. Most of the exceedances occur at depths of 20 to 55 ft.

TCE is widely present (47 of 314 analyses) in subsurface samples from borings located within burial pits. Highest levels (up to 41 mg/kg) are commonly found in the soils below the large southern burial pit, with levels as high as 25 mg/kg at the maximum depth of the soil samples (61 ft). Subsurface soil analyses also document the TCE degradation product vinyl chloride above screening levels in 3 of 318 subsurface samples from borings within the area of the large southern burial pit. Likewise, the highest levels of PCBs cluster around the east end of the southern burial pit (in soils of 6 ft depth or less).

The most common radionuclides with activities that exceed background and the excavation worker NAL are the uranium isotopes ^{234}U and ^{238}U. These detections are commonly limited to soils less than 10 ft deep and occur across the site.

Table 4.10. SWMU 4 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Arsenic	17.1	N/A[b]	12/125	5/125	12/125
Beryllium	2.02	N/A	85/126	52/126	6/126
Iron	34,500	N/A	126/126	7/126	126/126
Manganese	2,700	N/A	125/126	6/126	92/126
Vanadium	75.5	N/A	126/126	7/126	125/126
Organics – Volatiles (mg/kg)					
TCE	41	N/A	47/314	N/A	9/314
Vinyl chloride	0.29	N/A	7/318	N/A	3/318
Organics –PCBs (mg/kg)					
Total PCBs	4.3	N/A	10/153	N/A	10/153
PCB-1016	2.5	N/A	1/172	N/A	1/172
PCB-1248	0.8	N/A	2/172	N/A	2/172
PCB-1254	27	N/A	8/172	N/A	7/172
PCB-1260	0.5	N/A	2/172	N/A	2/172
Radionuclides (pCi/g)					
Cesium-137	1.48	N/A	2/160	2/160	2/160
Technetium-99	269	N/A	13/182	13/182	2/182
Thorium-230	68.7	N/A	2/2	2/2	1/2
Uranium	6,260	N/A	16/24	N/A	13/24
Uranium-234	69	N/A	15/23	14/23	13/23
Uranium-235	4.2	N/A	1/158	1/158	1/158
Uranium-238	126	N/A	15/23	14/23	14/23

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b]N/A = not applicable

Table 4.11. SWMU 4 Locations of Subsurface Soil Contaminants

Analysis	Depth (ft)	004-009	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-030	004-031	004-032	004-033	004-034	004-035	004-036	004-037	004-038	004-039	004-040	004-041	004-042	004-043	004-044	004-045	004-046	004-047	004-048	004-049	004-050	004-051	004-052	004-053	004-054	004-055	004-056	004-057
Inorganics (mg/kg)																																								
Arsenic	5-6	ND	8.29	ND											ND	ND	ND	ND	17.1	6.96	ND		ND	ND	ND	ND	8.24	9.22	9.45	ND	ND		ND							
	10-12						ND	ND	ND	7.28	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND								
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND									
	20-25																	ND	ND	ND	ND		ND		ND	ND		ND		ND		ND		ND	ND					
	25-30	ND	ND	ND	ND		ND				ND				ND										ND	ND														
	30-40	ND				5.75	ND	ND	ND	ND	ND	ND								ND		ND						5.56												
	40-45		ND	ND	ND	6.13	ND	ND	ND	7.7	ND	5.16			ND																			ND						
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND	ND		ND																			ND	ND					
	60		ND	ND		ND			ND			ND			ND																									
Beryllium	5-6	ND	0.79	ND											0.58	0.77	ND	0.9	0.85	0.76	0.78		0.62	0.53	ND	ND	0.83	0.7	0.52	0.64	0.6		0.57							
	10-12						0.8	ND	ND	0.77	0.62							0.78	0.58	0.65	0.79		0.69		1.01	0.61		ND		0.87		ND								
	15-16	0.51	ND	0.55											ND	0.55	ND	0.62	0.56	0.52	ND	ND	ND	0.56	ND	0.53	ND	0.74	ND	ND	ND									
	20-25																	0.86	ND	ND	ND		0.5		ND	0.53		ND		0.57		ND		ND	ND					
	25-30	ND	0.59	0.88	0.77		ND				0.86				ND										0.69	0.95														
	30-40	ND				0.98	0.98	0.69	ND	0.78	0.72	0.61								0.76		0.58						1.07												
	40-45		ND	0.6	0.65	1.03	0.89	1.05	0.87	1.04	0.9	1.3			ND																			ND	ND					
	50-55		0.71	0.75	0.73	2.02	0.99	0.93	0.62	1.9		0.9	1.98		1.62																			0.74	0.78					
	60		0.89	0.58		0.53			ND			ND			0.64																									
Iron	5-6	6540	21200	8360											10100	22800	9260	30200	21000	23200	19600		12300	7880	9470	8800	19800	15000	14600	11300	10500		13300							
	10-12						7880	13000	12400	11100	15100							15500	22300	15600	13400		12900		21500	16600		10500		9590		6320								
	15-16	9250	9210	16000											8200	10100	6890	11700	9330	10300	5010	8230	7550	8940	11100	9250	8520	12600	7390	10000	5150									
	20-25																	27800	9300	3980	6270		10700		7170	11200		5010		13200		11900		5100	5510					
	25-30	8980	18700	20500	15500		4880				10600				8550										10300	24300														
	30-40	10300				31800	11800	21100	9570	15800	14000	9600								22900		16100						25200												
	40-45		7410	34500	8960	25800	5990	28600	22900	20000	19100	23500			5200																			3750	8210					
	50-55		16600	28000	16500	28900	11700	28900	10200	23800		12700	33400		27600																			14900	17100					
	60		11100	8780		8670			4020			7280			9420																									
Manganese	5-6	330	207	29.3											26.1	308	521	292	1140	1520	177		131	129	740	119	1200	264	510	41.6	141		267							
	10-12						58.9	426	90.8	1060	357							126	458	261	126		246		193	119		81		81.3		45.4								
	15-16	2700	229	ND											52.8	590	28.5	83.1	347	250	36.2	42.6	53.1	55.4	132	87.3	289	63.8	280	249	40.8									
	20-25																	88.4	232	141	339		492		80.9	70.3		84.2		77.9		101		21.7	197					
	25-30	123	213	42.9	199		19.6				38.1				14.9					34.4					58.6	107		278												
	30-40	84.6				42.3	69.6	132	34.8	94.5	60.8	360										48.4																		
	40-45		188	47.7	129	44.6	164	43.4	260	72	182	124			12.9																			30.4	74.2					
	50-55		240	1200	49.8	83	162	95.2	188	218		168	93.8		97.3																			24.5	101					
	60		51.4	147		37.9			38			37.8			168																									
Vanadium	5-6	15.5	26.5	18.2											14.1	31.5	16.5	30.8	33.6	29	25.9		17.5	18.9	15.4	18	25.3	23.4	18.5	25.1	15.2		21.6							
	10-12						23.7	23.7	22	21.3	22.9							26	28.9	27.8	27		18.6		33.7	26.6		19.4		11.9		13.8								
	15-16	22.8	19.3	25.5											19.1	21.1	10.8	30.9	20.5	21	13.3	17.6	21.1	24.9	22.8	20.6	19.3	26.5	16.1	22.3	13.6									
	20-25																	52.3	13.6	6.9	16.9		19.1		14.6	17.5		13.6		29.6		16.1		13.4	14.8					
	25-30	18.6	27.5	46.4	32.8		12.7				32.3				14.2					34.1					24.8	33.5		39.8												
	30-40	17.6				38.6	25.5	29.5	20.9	75.5	20.2	21.1										26.8																		
	40-45		12.3	37.9	20.3	32.5	34	48.9	21.2	26.6	27.5	24.3			13.3																			11.5	19.8					
	50-55		23.5	17.3	11.8	23.6	21.9	24.3	12.6	28.3		16.2	24.6		25.1																			11	13.9					
	60		11.9	11.6		8.3			4.26			7.25			10.9																									
Organics - Volatiles (mg/kg)																																								
TCE	3-6	ND	ND	ND											ND	0.004	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND		ND	ND			ND	ND	ND	ND	ND
	9-12						ND	ND	0.016	ND	0.0036	ND						ND	ND	ND	ND		0.035		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	0.079	ND	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.035	ND	ND			ND	ND	ND	ND	ND
	20-25																0.053	0.82	ND	ND	0.0064		ND	ND	ND	ND		ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
	25-30	ND	ND	ND	ND	ND	ND	ND			0.0072		ND		ND	ND				ND		ND	ND		ND	0.42	ND	ND	ND					ND	ND	ND		ND		ND
	30-40	0.77				0.06	41	ND	4.4	ND	0.2	0.049										ND					ND													
	40-45		ND	ND	0.049	ND	4.9	ND	8.5	ND	0.012	0.113			ND					ND														0.46	ND					
	50-55		0.015	ND	0.038	ND	6	ND	7	ND	0.12	2.86	9.2		ND																			ND	ND					
	60		0.042	ND	0.033	ND	1.1	ND	2.1	ND		13	25		ND																									

Table 4.11. SWMU 4 Locations of Subsurface Soil Contaminants (Continued)

Analysis	Depth (ft)	004-009	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-030	004-031	004-032	004-033	004-034	004-035	004-036	004-037	004-038	004-039	004-040	004-041	004-042	004-043	004-044	004-045	004-046	004-047	004-048	004-049	004-050	004-051	004-052	004-053	004-054	004-055	004-056	004-057
Vinyl	3-6	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND		ND	ND			ND	ND	ND	ND	ND
Choride	9-12						ND	ND	ND	ND	ND	ND						ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	0.051	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND
	20-25																ND	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
	25-30	ND	ND	ND	ND	ND	ND	ND			ND		ND		ND	ND						ND	ND		ND	ND	ND	ND	ND					ND	ND	ND		ND		ND
	30-40	0.29				ND	0.22	ND	ND	ND	ND	ND								ND		ND			ND		ND	ND												
	40-45		ND	ND	ND	ND	0.018	ND	ND	ND	ND	ND			ND					ND														ND	ND					
	50-55		ND	ND	ND	ND	0.011	ND	ND	ND	ND	ND	ND		ND																			ND	ND					
	60		ND	ND	ND	ND	ND	ND	ND	ND		ND	0.24		ND																									
Organics - Pesticides/PCBs (mg/kg)																																								
PCB, Total	3-6	0.424	ND	ND											ND	ND	ND	10.3	ND	ND	0.308	0.908	4.3	ND	ND	ND	ND	ND	0.8	27			ND			ND	ND	ND	4.76	0.026
	9-12						ND	ND	ND	0.5	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND
	20-25																	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND		ND				ND		ND	ND	ND
	25-30	ND	ND	ND	ND		ND				ND				ND					ND			ND		ND	ND		ND	ND							ND		ND		ND
	30-40	ND				ND	ND	ND	ND	ND	ND	ND										ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																									
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND			ND																									
	60		ND	ND		ND		ND	ND			ND			ND																									
PCB-1016	3-6	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND			ND			ND	ND	ND	ND	ND
	9-12						ND	ND	ND	ND	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND
	20-25																	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND		ND				ND		ND	ND	ND
	25-30	ND	ND	ND	ND		ND				ND				ND					ND			ND		ND	ND		ND	ND							ND		ND		ND
	30-40	ND				ND	ND	ND	ND	ND	ND	ND										ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																									
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND			ND																									
	60		ND	ND		ND		ND	ND			ND			ND																									
PCB-1248	3-6	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8	ND			ND			ND	ND	ND	ND	ND
	9-12						ND	ND	ND	0.3	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND
	20-25																	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND		ND				ND		ND	ND	ND
	25-30	ND	ND	ND	ND		ND				ND				ND					ND			ND		ND	ND		ND	ND							ND		ND		ND
	30-40	ND				ND	ND	ND	ND	ND	ND	ND										ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																									
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND			ND																									
	60		ND	ND		ND		ND	ND			ND			ND																									
PCB-1254	3-6	ND	ND	ND											ND	ND	ND	10.3	ND	ND	0.308	0.908	1.3	ND	ND	ND	ND	ND	ND	27			ND			ND	ND	ND	4.76	0.026
	9-12						ND	ND	ND	0.2	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND
	20-25																	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND		ND				ND		ND	ND	ND
	25-30	ND	ND	ND	ND		ND				ND				ND					ND			ND		ND	ND		ND	ND							ND		ND		ND
	30-40	ND				ND	ND	ND	ND	ND	ND	ND										ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																									
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND			ND																									
	60		ND	ND		ND		ND	ND			ND			ND																									
PCB-1260	3-6	0.424	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND			ND			ND	ND	ND	ND	ND
	9-12						ND	ND	ND	ND	ND							ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND
	20-25																	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND		ND				ND		ND	ND	ND
	25-30	ND	ND	ND	ND		ND				ND				ND					ND			ND		ND	ND		ND	ND							ND		ND		ND
	30-40	ND				ND	ND	ND	ND	ND	ND	ND			ND							ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																									
	50-55		ND	ND	ND	ND	ND	ND	ND	ND		ND			ND																									
	60		ND	ND		ND		ND	ND			ND			ND																									

Table 4.11. SWMU 4 Locations of Subsurface Soil Contaminants (Continued)

Analysis	Depth (ft)	004-009	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-030	004-031	004-032	004-033	004-034	004-035	004-036	004-037	004-038	004-039	004-040	004-041	004-042	004-043	004-044	004-045	004-046	004-047	004-048	004-049	004-050	004-051	004-052	004-053	004-054	004-055	004-056	004-057
Radionuclides (pCi/g)																																								
Cesium-137	3-6	ND	ND	ND		ND							1.48		ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND		ND	ND			ND	ND	ND	0.544	ND
	9-12							ND	ND									ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND
	20-25																ND	ND	ND	ND	ND		ND	ND	ND	ND		ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
	25-30	ND	ND		ND			ND							ND	ND				ND		ND	ND		ND	ND	ND	ND	ND					ND	ND	ND		ND		ND
	30-40	ND				ND		ND	ND													ND					ND													
	40-45		ND	ND	ND	ND		ND	ND																									ND	ND					
	50-55		ND	ND	ND	ND		ND	ND				ND		ND																			ND	ND					
	60		ND	ND	ND	ND		ND	ND				ND		ND																									
Technetium-99	3-6	9.01	4.79	ND		ND							269	ND	ND	10.4	ND	5.7	6.37	ND	ND	ND	29.4	ND	ND	ND	ND	ND	14.6	26.1	235		ND			ND	ND	ND	8.38	ND
	9-12						ND	ND	ND	ND	ND	ND						ND	ND	ND	ND		ND		ND	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND
	20-25		ND										ND		ND			ND	ND	ND	ND	ND	ND		ND	ND		ND	ND	ND		ND		ND	ND	ND	ND	ND	ND	ND
	25-30				ND	ND	ND	ND			ND									ND					ND			ND						ND						
	30-40	ND			ND	ND	ND	ND	ND	ND	ND	ND										ND																		
	40-45		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND																			ND	ND					
	50-55		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND																			ND	ND					
	60			ND	ND	ND	ND	ND	ND	ND		ND	ND		ND																									
Thorium-230	6												68.7										2.06																	
Uranium	3-6	23.2			6.66								6260	51.7		57.3		114			23.8		165						183		118								84.5	
	9-12						ND			8.64																														
	25-30						ND																																	
	30-40						ND			ND		2.33																												
	40-45						ND			ND																														
	50-55									ND																														
Uranium-234	3-6	7.68			2.68									14.5		12.7		36.5			8.18		69						53.4		47.9								26.4	
	9-12						ND			3.06																														
	25-30						ND																																	
	30-40						ND			ND		1.74																												
	40-45						ND			ND																														
	50-55									ND																														
Uranium-235	3-6	ND	ND	ND		ND									ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND		ND	ND			ND	ND	ND	ND	ND
	9-12							ND	ND									ND	ND	ND	ND		ND		4.2	ND		ND		ND		ND				ND	ND	ND	ND	ND
	15-16	ND	ND	ND											ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND
	20-25																ND	ND	ND	ND	ND		ND		ND	ND		ND		ND	ND	ND		ND	ND	ND	ND	ND	ND	ND
	25-30	ND	ND		ND			ND							ND	ND				ND		ND	ND		ND	ND	ND	ND	ND					ND	ND	ND		ND		ND
	30-40	ND				ND		ND	ND													ND					ND													
	40-45		ND	ND																														ND	ND					
	50-55		ND	ND	ND	ND		ND	ND				ND		ND																			ND	ND					
	60		ND	ND	ND	ND		ND	ND				ND		ND																									
Uranium-238	3-6	15.1			3.84									36.3		43.7		75			15.1		92.7						126		67.8								56.5	
	9-12						ND			5.41																														
	15-16																																							
	20-25																																							
	25-30						ND																																	
	30-40						ND			ND		0.524																												
	40-45						ND			ND																														
	50-55									ND																														
	60																																							

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

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4.3.4 SWMU 5

This RI collected subsurface soil samples from three angled borings at SWMU 5. Review of RI and historical data for SWMU 5 identified the contaminants listed in Table 4.12.

Table 4.12. SWMU 5 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Beryllium	2.59	N/A[b]	31/59	26/59	8/59
Iron	32,900	21,800	59/59	4/59	57/59
Manganese	1,750	690	59/59	2/59	44/59
Vanadium	56.9	34.3	59/59	4/59	59/59

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b]N/A = not applicable

The SWMU 5 burial pits are approximately 20 ft deep. Metals and radionuclides are the primary potential contaminants of interest at SWMU 5, since the majority of items believed to be buried there include some radionuclide-contaminated scrap metal and slag from PGDP nickel and aluminum smelters. The most prevalent metal detected in subsurface soils above its screening levels is beryllium (8 of 59 analyses), followed by iron and vanadium (4 of 59 analyses). The metals exceedances are well distributed across SWMU 5. High levels of vanadium tended to occur at moderate depths (15 to 30 ft), while beryllium exceedances are at depths of 40 ft or greater. High levels of iron range across depths of 20 to 55 ft. Table 4.13 shows the locations of detections above screening levels. The screening process did not identify any radionuclides or organic compounds as potential contaminants for SWMU 5.

Table 4.13. SWMU 5 Locations of Subsurface Soil Contaminants

		RI Data			Historical Data									
Analysis	**Depth (ft)**	005-101	005-102	005-103	005-015	005-016	005-017	005-018	005-019	005-020	005-021	005-022	005-027	005-028
Beryllium	10-15	ND	ND	ND				0.83	0.93	ND	0.67	ND		
	15-20	ND	ND	ND	0.92	ND	0.87				ND	0.64		
	20-25						1.23						0.69	0.74
	25-30									ND			0.91	0.96
	30-35	ND	ND	ND				ND	0.71	0.72	0.64	ND		
	35-40				0.75		ND						ND	ND
	40-45	ND	ND	ND	1.02			1.47		1.64	1.47	2.59		
	50-55				0.87			1.16		1.39	1.68	0.57	2.27	1.26
	60-65	ND	ND	ND	ND			0.84						
Iron	10-15	9640	11100	10400				12700	18000	8440	9390	8320		
	15-20	10700	8620	8100	16500	9440	22500				10100	9600		
	20-25						29200						16000	18700
	25-30									9130			16500	32900
	30-35	14700	20000	21800				7040	13900	10700	14000	3820		
	35-40				17100		8360						3550	7300
	40-45	1330	1380	9190	17500			17700		24400	24800	29400		
	50-55				9940			15500		18000	22700	8720	31900	13800
	60-65	8310	7530	12500	4720			10900						
Manganese	10-15	690	343	314				231	289	173	151	121		
	15-20	385	136	184	117	113	222				260	86.6		
	20-25						87.5						131	61.4
	25-30									23.2			34.8	24.6
	30-35	76.2	29.5	39.6				57	39.7	45.6	65.7	12.9		
	35-40				115		40.8						26.3	6.89
	40-45	15.5	457	37.3	827			253		68.2	84.3	144		
	50-55				1750			304		73.3	498	149	197	236
	60-65	80.8	233	196	61.8			725						
Vanadium	10-15	20.3	20.5	15.6				27.2	33.3	18.9	22.9	19.1		
	15-20	20.6	24.6	11.3	41.4	16.5	36.1				17.3	27.8		
	20-25						56.9						33	42.4
	25-30									18.2			46.6	36.6
	30-35	27.7	31.7	34.3				13.8	22.4	22.8	23	9.65		
	35-40				29.9		14.5						9.45	21.6
	40-45	6.28	9.28	8.63	20.4			20.1		26.7	29.6	36.8		
	50-55				12.4			18.8		17.2	31.1	11.2	34	15.7
	60-65	15.1	18.4	14.6	7.23			15.5						

ND = not detected
Blank cells indicate interval was not sampled for the specified analysis. Maximum value is shown for each depth interval.

4.3.5 SWMU 6

Subsurface soil samples were collected from four angled borings at SWMU 6 as part of this RI. The screen of RI and historical data identified the contaminants listed in Table 4.14.

Table 4.14. SWMU 6 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Beryllium	3.07	0.825	32/70	22/70	12/70
Iron	58,700	19,100	70/70	7/70	69/70
Manganese	1,550	315	70/70	1/70	64/70
Vanadium	79.1	38.5	69/70	10/70	69/70

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.

Each burial area within SWMU 6 received different types of waste. The contents buried within each area are summarized as follows:

- Area H—magnesium scrap
- Area I—exhaust hood blowers contaminated with perchloric acid
- Area J—contaminated aluminum scrap
- Area K—magnesium scrap
- Area L—contaminated modine cold trap

Metals analyses of subsurface soil samples from SWMU 6 rarely exceed screening criteria (both background and NALs, where applicable) for identifying contamination. Screening identified beryllium and vanadium as the most frequent metal contaminants (in 12 and 10 of 70 analyses, respectively). Of the occurrences of aluminum detected above background levels, the majority represents samples collected beneath Area J (aluminum scrap). The SWMU 6 burial pits extended to a depth of approximately 20 ft. All five detections of aluminum above PGDP background were from a depth of 43 to 51 ft. The maximum aluminum result was 22,500 mg/kg from location 006-020 at 43 ft bgs. The screening process did not identify any radionuclides or organic compounds as potential contaminants for SWMU 6.

Table 4.15 lists the locations of the contaminants shown in Table 4.14.

Table 4.15. SWMU 6 Locations of Subsurface Soil Contaminants

		RI Data				Historical Data											
Analysis	**Depth (ft)**	006-101	006-102	006-103	006-104	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-026	006-027	006-028	006-029
Inorganics (mg/kg)																	
Beryllium	5															2.62	ND
	10-15	ND	ND	ND	ND	ND	ND	1.32	ND	ND	ND	0.5	0.56	0.59		0.64	0.59
	15-20	ND	ND	ND	ND					ND	0.52	0.67		ND	ND	ND	0.7
	20-25					0.74	1.51	1.17					0.59	1	ND		
	30-35	ND	ND	ND	ND	ND			0.81	0.88			ND	ND	1.7	0.6	
	40-45	0.825	ND	ND	ND				1.59	1.93	2.16	1.54	1.49				
	50-55									1.66	ND		1.15	2.01	3.07		
	60	ND	ND	ND	ND						ND	0.67					
Iron	5															54200	10700
	10-15	8830	14500	9660	10400	10500	9280	35300	10800	10700	9210	9140	9880	10800		10700	11800
	15-20	8630	8100	8260	7070					7520	10000	11500		6270	4160	7690	11600
	20-25					24800	58700	33700					11500	20200	9200		
	30-35	11700	14100	17200	19100	3720			18200	17300			7460	5170	22200	16800	
	40-45	16900	4850	5910	4260				20800	26700	29900	23000	20100				
	50-55									22200	5010		17300	32900	36900		
	60	ND	ND	ND	ND						5140	1180					
Manganese	5															353	349
	10-15	150	216	282	309	106	207	411	1550	230	164	222	165	93.4		79.3	143
	10-15	126	288	152	151					184	100	81		92.1	108	157	174
	20-25					167	191	333					281	117	62.4		
	30-35	103	57.1	19.7	27.1				80.1	119			59.7			63.2	
	35-40					39.7								22.7	60.1		
	40-45	59.2	35.6	150	60.5				433	602	162	96	398				
	50-55									102	144		130	442	64.3		
	60	315	132	98.6	149						183	66.4					

Table 4.15. SWMU 6 Locations of Subsurface Soil Contaminants (Continued)

		RI Data				Historical Data											
Analysis	**Depth (ft)**	006-101	006-102	006-103	006-104	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-026	006-027	006-028	006-029
Vanadium	5															65.6	17.9
	10-15	5.1	16	26.5	30.9	22.5	19.1	52.7	19.8	22.6	18.1	18.9	23.8	21.6		25	24.4
	15-20	5.54	7.97	26	25.5					17.8	20.2	29.1		11.4	11.9	15.5	25
	20-25					46.6	79.1	64.7					20.1	49.1	16.6		
	30-35	11.4	13.5	35.1	33.8				33	32.9			13.9			31.6	
	35-40					10.7								10	71.1		
	40-45	5.58	6.58	26.4	19.1				23.1	42.8	33.6	23.4	19.2				
	50-55									27.3	6.26		18.8	30.6	42.5		
	60	ND	5.03	38.5	7.29						5.42	13.4					

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. Maximum value shown for each depth interval.

4.3.6 SWMU 7

SWMU 7 consists of six discrete burial pit areas containing uranium-contaminated concrete, uranium-contaminated scrap metal and equipment, and empty uranium and magnesium powder drums. The SWMU 7 burial pits range from 6 to 10 ft deep.

Table 4.16 summarizes the contaminants detected in the subsurface at SWMU 7.

Table 4.16. SWMU 7 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Arsenic	N/A[b]	13.9	50/69	1/69	50/69
Beryllium	N/A	1.55	7/69	3/69	1/69
Iron	17,000	34,700	69/69	1/69	65/69
Manganese	1,200	628	69/69	1/69	44/69
Uranium	45	8.94	12/69	3/69	1/69
Organics –PCBs (mg/kg)					
Total PCBs	0.41	2.45	5/69	N/A	2/69
PCB-1248	0.41	N/A	1/69	N/A	1/69
PCB-1260	N/A	2.45	1/69	N/A	1/69
Organics – Volatiles (mg/kg)					
1,1-DCE	N/A	1.66	4/69	N/A	2/69
Vinyl chloride	N/A	0.585	5/69	N/A	1/69
Radionuclides (pCi/g)					
Thorium-230	3.7	1.34	39/67	3/67	2/67
Uranium	240	6.87	14/68	N/A	4/68
Uranium-234	115	1.34	41/76	10/76	3/76
Uranium-235/236	1.03	N/A	8/8	6/8	3/8
Uranium-238	150	5.87	35/76	22/76	18/76

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Metals concentrations in subsurface soil samples of SWMU 7 rarely exceed background levels. Uranium metal has been detected above screening levels only at three locations (WB-9, 007-009, and 007-010). These locations characterize burial pits B and C, which contained uranium-contaminated noncombustible trash. The highest concentration of uranium at these locations is 45 mg/kg. This level is greater than five times the next highest level of 8.94 mg/kg.

The screening process identified two VOCs as contaminants at SWMU 7; vinyl chloride and 1,1-DCE. Both were detected infrequently (1 and 2 detections in 69 analyses, respectively). Uranium-238 is the most widely detected radionuclide contaminant above PGDP background levels in subsurface soils at SWMU 7; its maximum ^{238}U analysis is 150 pCi/g from WBP-12A. (Total Uranium was detected as high as 240 pCi/g from WBP-9A.) Subsurface soil samples for Pit E (located outside of the SWMU 7 boundary) at 10 ft depth contained arsenic concentrations in excess of screening levels. None of the other Pit E analyses documented metals or radionuclides above screening levels or the presence of any organic contaminants.

Table 4.17 presents the locations of subsurface contaminants.

Table 4.17. SWMU 7 Locations of Subsurface Soil Contaminants

		RI Data												Historical Data											
Analysis	Depth (ft)	007-001	007-002	007-003A	007-003B	007-004	007-005	007-006	007-007	007-008	007-009	007-010	007-011	TP-3A	WB-10	WB-12	WB-13	WB-14	WB-6	WB-7	WB-8	WB-9	WBP-12A	WBP-13A	WBP-9A
Inorganics (mg/kg)																									
Arsenic	5-10										7.88	3.47	1.66		ND	ND	ND	ND	ND	ND	ND	ND			
	10	3.3	2.74	2.28		2.18	3.63	4.48	3.36	3.8	ND	1.32	2.68												
	15	1.45	6.22	1.85		1.75	1.1	2.44	1.4	ND	1.22	1.35	1.59												
	30	0.917	2.5	1.18		4.57	ND	1.62	1.1	2.76	1.41	1.66	1.37												
	45	0.973	ND		1.24	1.1	ND	ND	1.02	ND	1.06	2.99	ND												
	60	ND	13.9		5.19	2.88	1.59	1.9	1.25	ND	1.99	1.49	2.44												
Beryllium	5-10										ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND			
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	1.55		1	0.978	ND	0.588	0.512	ND	0.629	ND	0.542												
Iron	5-10										26000	8180	6580		11000	15000	14000	17000	13000	12000	14000	14000			
	10	10900	9160	9170		8440	11900	13700	12300	9130	6890	9210	12300												
	15	9090	11900	8960		8260	9020	10700	7420	5360	7270	7180	9320												
	30	4080	10500	7820		17600	3790	8440	7430	9950	7580	8890	8550												
	45	1900	1670		5650	10200	2320	3660	3950	1050	7110	20600	1440												
	60	4280	34700		20500	19600	11000	12600	13500	2500	12900	6730	17600												
Manganese	5-10										234	218	197		380	470	380	1200	390	280	630	320			
	10	371	181	292		205	172	192	327	277	104	225	192												
	15	254	256	93.7		80.2	38.1	71.4	56.1	66.9	49.1	52.4	89.2												
	30	25.6	25.8	104		212	38.6	34.7	12.2	11.1	20.7	129	152												
	45	20.4	4.88		27.2	60.7	31.2	34.7	29.5	5.53	14.2	44.1	45.9												
	60	40	237		88.2	75.6	103	628	196	15.2	107	54.8	235												
Uranium	5-10										8.94	7.56	3.86		ND	ND	ND	ND	ND	ND	ND	45			
	10	ND	ND	ND		ND	ND	1.08	2.22	ND	ND	ND	0.962												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		1.45	ND	ND	ND	ND	ND	1.15	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	1.3	ND												
	60	ND	ND		ND	1.23	ND	0.989	ND	ND	ND	ND	ND												
Organics –PCBs (mg/kg)																									
PCB, Total	5-10										2.45	ND	ND		ND	0.41	ND	ND	ND	0.0091	0.032	0.054			
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
PCB-1248	5-10										ND	ND	ND		ND	0.41	ND	ND	ND	ND	ND	ND			
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												

Table 4.17. SWMU 7 Locations of Subsurface Soil Contaminants (Continued)

		RI Data												Historical Data											
Analysis	Depth (ft)	007-001	007-002	007-003A	007-003B	007-004	007-005	007-006	007-007	007-008	007-009	007-010	007-011	TP-3A	WB-10	WB-12	WB-13	WB-14	WB-6	WB-7	WB-8	WB-9	WBP-12A	WBP-13A	WBP-9A
PCB-1260	5-10										2.45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND			
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
Organics – Volatiles (mg/kg)																									
1,1-DCE	5-10										ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND			
	10	ND	1.11	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	15	ND	1.66	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	0.00649		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	0.00552		ND	ND	ND	ND	ND	ND	ND	ND	ND												
Vinyl chloride	5-10										ND	0.00546	ND		ND	ND	ND	ND	ND	ND	ND	ND			
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	0.0075	ND												
	15	ND	ND	ND		ND	ND	ND	ND	ND	ND	0.00699	ND												
	30	ND	ND	ND		ND	ND	ND	0.585	ND	ND	0.0351	ND												
	45	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
	60	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
Radionuclides (pCi/g)																									
Thorium-230	5-10										1.34	0.211	0.376		1.26	1.11	1.19	1.46	1.22	1.01	3.7	3.03			
	10	0.442	0.521	ND		ND	0.294	0.471	0.351	0.446	0.462	0.487	0.359												
	12-15	0.284	0.375	ND		ND	ND	ND	ND	0.369	0.232	0.33	0.299												
	30	ND	0.278	ND		ND	ND	ND	0.24	0.252	ND	0.241	0.182												
	45	ND	ND		ND	0.299	ND	0.27	ND	ND	ND	0.267	ND												
	60		ND		ND	ND	ND	0.555	ND	ND	0.239	ND	0.142												
Uranium	5-10										3.76	6.87	3.98	15									192	2.7	
	10	ND	ND	ND		ND	ND	ND	ND	ND	ND	2.21	ND	4.9											240
	12-15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	2.6											
	30	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND												
	45	ND	ND		ND	ND	ND	0.497	ND	ND	ND	ND	ND												
	60		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND												
Uranium-234	5-10										1.34	0.903	1.2	6.7	1.21	1.85	2.59	3.34	10.8	2.7	12.3	13.2	39.4	0.9	
	10	0.148	ND	0.193		0.219	ND	0.212	0.182	0.142	0.304	0.319	ND	2.3											115
	12-15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	1.1											
	30	ND	0.14	0.18		0.258	ND	ND	0.245	0.206	ND	ND	ND												
	45	ND	ND		0.201	0.395	ND	0.239	ND	ND	ND	0.327	ND												
	60		ND		0.326	0.219	ND	0.26	ND	0.173	ND	ND	ND												
Uranium-235/236	6-7														0.07	0.12	0.34	0.35	0.86	0.17	0.88	1.03			
Uranium-238	5-10										2.36	5.87	2.66	8.4	2.02	4.07	12.3	10.8	23.2	4.01	15.4	15.2	150	1.8	
	10	0.147	ND	ND		0.335	ND	0.28	0.341	ND	0.719	1.84	0.262	2.4											119
	12-15	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	0.181	1.4											
	30	ND	ND	ND		0.499	ND	ND	0.217	ND	ND	0.251	ND												
	45	ND	ND		ND	0.225	ND	0.233	ND	ND	ND	1.34	ND												
	60		ND		ND	ND	ND	0.197	ND	ND	ND	ND	ND												

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

4.3.2 SWMU 30

SWMU 30 was used to burn combustible trash, which may have contained uranium contamination. Ash and debris then were buried in a pit contained within the SWMU (excavated to a depth of approximately 12 ft). Table 4.18 summarizes the subsurface soil contaminants for SWMU 30 determined by the data review.

Table 4.18. SWMU 30 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Beryllium	N/A[b]	1.48	7/25	5/25	2/25
Iron	29,000	22,200	25/25	1/25	25/25
Manganese	1,200	486	25/25	1/25	18/25
Vanadium	40	19.3	24/25	1/25	17/25
Organics –PCBs (mg/kg)					
Total PCBs	0.18	N/A	5/26	N/A	1/26
PCB-1260	0.18	N/A	4/26	N/A	1/26
Organics – Semivolatiles (mg/kg)					
Benzo(a)pyrene	0.052	N/A	1/26	N/A	1/26
Total PAHs	0.062795	N/A	3/26	N/A	1/26
Radionuclides (pCi/g)					
Uranium	59	2.97	8/23	N/A	2/23
Uranium-234	20.6	2.46	19/28	5/28	4/28
Uranium-235/236	0.55	N/A	5/5	3/5	1/5
Uranium-238	37.4	0.77	16/28	6/28	6/28

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

As in neighboring SWMU 7, metals concentrations in subsurface soil samples of SWMU 30 rarely exceed background levels. Iron, manganese, and vanadium are the most frequent metals to be detected above the excavation worker NALs.

Few organic compounds are present in subsurface soils at SWMU 30. The screening steps identified benzo(a)pyrene and Total PAHs as organic contaminants, at frequencies of two and one in 26 analyses, respectively. Analyses of the RI samples did not detect PCBs, but a review of historical data identified four PCB-1260 detections (locations WB-1, WB-4, WB-5, and WB-11) and one PCB-1254 detection (location WB-3), all at depths of 6 to 7 ft and distributed across the SWMU. The highest level, 0.18 mg/kg of PCB-1260, was detected in a sample from 6 ft bgs at location WB-1 from within the area of Burial Pit A.

The uranium isotopes ^{234}U (maximum 20.6 pCi/g), $^{235/236}$U (maximum 0.55 pCi/g), and ^{238}U (maximum 37.4 pCi/g) are the only radionuclide contaminants at depths of 10 ft or less.

Locations containing subsurface soil contaminants are presented in Table 4.19.

Table 4.19. SWMU 30 Locations of Subsurface Soil Contaminants

		RI Data				Historical Data						
Analysis	**Depth (ft)**	030-001	030-002	030-003	030-004	WB-1	WB-11	WB-3	WB-4	WB-5	WBP-1A	WBP-4A
Inorganics (mg/kg)												
Beryllium	5-10					ND	ND		ND	ND		
	10	ND	ND	ND	ND							
	15	ND	ND	ND	ND							
	30	ND	ND	ND	ND							
	45	0.484	0.909	ND	ND							
	60	0.806	1.48	1.41	0.61							
Iron	5-10					21000	17000		29000	14000		
	10	5940	8960	13100	9400							
	15	16200	7690	11300	5890							
	30	10800	7900	18600	6620							
	45	17700	22200	11100	5020							
	60	16200	21600	20000	15400							
Manganese	5-10					340	1200		740	230		
	10	66	69.4	188	161							
	15	92.1	62.2	92.9	36.6							
	30	24.8	15.6	26.1	15.7							
	45	70.6	73.1	30.8	22.8							
	60	163	72.3	486	171							
Vanadium	5-10					40	25		31	18		
	10	3.69	5.41	5.66	ND							
	15	4.35	3.82	10.4	4.08							
	30	13.8	6.38	19.3	3.33							
	45	5.78	9.32	7.3	3.21							
	60	6.82	17.6	8.87	3.79							
Organics –PCBs (mg/kg)												
PCB, Total	5-10					0.18	0.02	0.028	0.049	0.065		
	10	ND	ND	ND	ND							
	15	ND	ND	ND	ND							
	30	ND	ND	ND	ND							
	45	ND	ND	ND	ND							
	60	ND	ND	ND	ND							
PCB-1260	7					0.18	0.02	ND	0.049	0.065		
	10	ND	ND	ND	ND							
	15	ND	ND	ND	ND							
	30	ND	ND	ND	ND							
	45	ND	ND	ND	ND							
	60	ND	ND	ND	ND							

Table 4.19. SWMU 30 Locations of Subsurface Soil Contaminants (Continued)

		RI Data				Historical Data						
Analysis	Depth (ft)	030-001	030-002	030-003	030-004	WB-1	WB-11	WB-3	WB-4	WB-5	WBP-1A	WBP-4A
Organics – Semivolatiles (mg/kg)												
Benzo(a)pyrene	5-10					ND	0.052	ND	ND	ND		
	10	ND	ND	ND	ND							
	15	ND	ND	ND	ND							
	30	ND	ND	ND	ND							
	45	ND	ND	ND	ND							
	60	ND	ND	ND	ND							
Total PAH	5-10					ND	0.062795	ND	0.006725	0.001712		
	10	ND	ND	ND	ND							
	15	ND	ND	ND	ND							
	30	ND	ND	ND	ND							
	45	ND	ND	ND	ND							
	60	ND	ND	ND	ND							
Radionuclides (pCi/g)												
Uranium	5-10										34	59
	10	ND	1.02	ND	0.35							
	15	1.3	ND	2.97	ND							
	30	ND	ND	ND	ND							
	45	0.815	ND	ND	ND							
	60	0.651	ND	ND	ND							
Uranium-234	5-10					0.2	2.26	2.24	6.56	5.87	8.1	20.6
	10	ND	0.592	ND	0.15							
	15	0.5	ND	2.46	ND							
	30	ND	ND	ND	ND							
	45	0.429	0.203	0.206	0.163							
	60	0.517	ND	0.173	0.16							
Uranium-235/236	5-10					0.02	0.14	0.16	0.55	0.4		
Uranium-238	5-10					0.38	2.74	2.92	10.3	8.2	25.3	37.4
	10	ND	0.397	ND	0.181							
	15	0.77	ND	0.424	ND							
	30	ND	ND	ND	ND							
	45	0.357	0.149	0.163	0.333							
	60	ND	ND	ND	ND							

ND = not detected
Blank cells indicate interval was not sampled for the specified analysis. Maximum value shown for each depth interval.

4.3.3 SWMU 145

The RI collected subsurface soil samples from seven angled borings at SWMU 145. Table 4.20 lists the contaminants identified by a review of the RI data along with historical data.

Table 4.20. SWMU 145 Subsurface Soil Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above Background Value	above Excavation Worker NAL
Inorganics (mg/kg)					
Antimony	N/A[b]	20.2	15/45	15/45	15/45
Arsenic	21.9	7.88	39/59	4/59	39/59
Beryllium	2.08	1.24	23/59	15/59	5/59
Uranium	311	1.55	24/53	7/53	7/53
Organics –PCBs (mg/kg)					
Total PCBs	12.5	0.33	5/55	N/A	5/55
PCB-1254	1.9	0.33	3/55	N/A	3/55
PCB-1260	12.5	N/A	2/55	N/A	2/55
Radionuclides (pCi/g)					
Americium-241	1.956	N/A	2/64	N/A	1/64
Cesium-137	1.057	N/A	11/64	4/64	7/64
Technetium-99	281	1.83	12/63	11/63	5/63
Thorium-228	1.92	0.775	58/68	1/68	58/68
Thorium-230	193	0.534	52/55	6/55	12/55
Thorium-232	2.282	0.727	59/66	2/66	2/66
Uranium	593	0.795	11/50	N/A	7/50
Uranium-233/234	4.7	N/A	5/5	1/5	N/A
Uranium-234	254	0.405	36/63	13/63	12/63
Uranium-235	2.2	N/A	16/62	7/62	3/62
Uranium-238	326	0.378	43/68	18/68	18/68

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Locations of SWMU 145 subsurface soil contaminants are listed in Table 4.21.

The metal detected predominantly above screening levels in subsurface soils at SWMU 145 is antimony. One third of the samples had an antimony level that exceeded background and the excavation worker NAL criteria. The only other metal that was frequently present at concentrations above the NAL (but rarely exceeds background) was arsenic.

Of the organics in subsurface soils, PCBs were detected at levels above NAL criteria at three historical sampling locations within the former NSDD disposal trench (NST1S01, NST2S02, and A10, all at depths of 2 to 3 ft). The maximum detected PCB result was 12.5 mg/kg from A10.

Table 4.21. SWMU 145 Locations of Subsurface Soil Contaminants

		RI Data							Historical Data											
Analysis	**Depth (ft)**	145-101	145-102	145-103	145-104	145-105	145-106	145-107	A10	A2	DG-029	NSD030	NST1S01	NST1S02	NST1S03	NST2S01	NST2S02	NST2S03	NST2S04	NST2S05
Inorganics (mg/kg)																				
Antimony	2-4											ND								
	10	18.1	11.5	13.6	ND	10.9	ND	9.81												
	15	ND	ND	9.59		11	ND	ND												
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	20.2	ND			ND									
	35-37						16.6				ND									
	40-45	14.7	ND	ND	ND	12.5	11.1	ND			ND									
	55-60	13.2	ND	ND	10.7	17.7		ND												
Arsenic	2-4								10.5			5.52	ND	ND		7.48	5.25			
	8-10	3.71	7.18	7.16	3.33	6.45	3.32	7.88	5.03	ND									11.5	
	15	1.19	2.87	6.67		3.57	2.04	3.25		21.9					5.76			13.7		ND
	19-25										ND									
	30-34	ND	2.01	2.36	3.39	2.16	3.68	ND			ND									
	35-37						2.46				ND									
	40-45	6.98	1.57	1.72	1.92	2.81	3.1	ND			ND									
	55-60	ND	1.49	3.16	2.63	3.92		ND												
Beryllium	2-4								ND			0.5	ND	0.66		0.75	0.62			
	8-10	ND	ND	ND	ND	ND	ND	ND	0.6	0.78									1.86	
	12-15	ND	ND	ND		ND	ND	ND		2.08					0.68			0.68		0.59
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	0.812	ND			1.5									
	35-37						ND				1.88									
	40-45	ND	ND	ND	ND	0.827	0.745	ND			1.48									
	55-60	ND	ND	1.24	0.706	0.798		ND												
Uranium	2-4								20			234	150	41.4		23.1	311			
	8-10	ND	1.15	0.993	ND	ND	0.976	ND	3.8	1.9									1.9	
	12-15	ND	ND	ND		ND	ND	ND		3					2			59.3		1.65
	30	ND	ND	ND	ND	ND	1.55	ND												

Table 4.21. SWMU 145 Locations of Subsurface Soil Contaminants (Continued)

		RI Data							Historical Data											
Analysis	**Depth (ft)**	145-101	145-102	145-103	145-104	145-105	145-106	145-107	A10	A2	DG-029	NSD030	NST1S01	NST1S02	NST1S03	NST2S01	NST2S02	NST2S03	NST2S04	NST2S05
	35						1.48													
	40-45	ND	ND	ND	ND	ND	ND	1.16												
	55-60	1.16	ND	1.41	0.999	ND		ND												
Organics –PCBs (mg/kg)																				
PCB, Total	2-4								12.5			1.4	1.9	ND		ND	1.1			
	8-10	ND	ND	0.33	ND	ND	ND	ND	ND	ND									ND	
	12-15	ND	ND	ND	ND	ND	ND	ND		ND					ND			ND		ND
	19										ND									
	30	ND	ND	ND	ND	ND	ND	ND												
	35						ND													
	40-45	ND	ND	ND	ND	ND	ND	ND												
	55-60	ND	ND	ND	ND	ND		ND												
PCB-1254	2-4								ND			0.9	1.9	ND		ND	ND			
	8-10	ND	ND	0.33	ND	ND	ND	ND	ND	ND									ND	
	12-15	ND	ND	ND	ND	ND	ND	ND		ND					ND			ND		ND
	19										ND									
	30	ND	ND	ND	ND	ND	ND	ND												
	35						ND													
	40-45	ND	ND	ND	ND	ND	ND	ND												
	55-60	ND	ND	ND	ND	ND		ND												
PCB-1260	2-4								12.5			0.5	ND	ND		ND	ND			
	8-10	ND	ND	ND	ND	ND	ND	ND	ND	ND									ND	
	12-15	ND	ND	ND	ND	ND	ND	ND		ND					ND			ND		ND
	19										ND									
	30	ND	ND	ND	ND	ND	ND	ND												
	35						ND													
	40-45	ND	ND	ND	ND	ND	ND	ND												
	55-60	ND	ND	ND	ND	ND		ND												

Table 4.21. SWMU 145 Locations of Subsurface Soil Contaminants (Continued)

		RI Data							Historical Data												
Analysis	Depth (ft)	145-101	145-102	145-103	145-104	145-105	145-106	145-107	A10	A2	DG-029	NSD030	NST1S01	NST1S02	NST1S03	NST2S01	NST2S02	NST2S03	NST2S04	NST2S05
Radionuclides (pCi/g)																					
Americium-241	2-4								ND			0.22	ND	ND		ND	ND			
	8-10	ND	ND	ND	ND	ND	ND	ND	ND	ND									ND	
	11-15	ND	ND	ND	ND	ND	ND	ND		ND	ND				ND			1.956		ND
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	ND	ND			ND									
	35-37						ND				ND									
	40-45	ND	ND	ND	ND	ND	ND	ND			ND									
	55-60	ND	ND	ND	ND	ND		ND												
Cesium-137	2-4								0.71			0.374	0.2593	0.1664		0.1243	0.5336			
	8-10	ND	ND	ND	ND	ND	ND	ND	0.086	ND									ND	
	11-15	ND	ND	ND	ND	ND	ND	ND		ND	ND				ND			1.057		ND
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	ND	ND			ND									
	35-37						ND				ND									
	40-45	ND	ND	ND	ND	ND	ND	ND			ND									
	55-60	ND	ND	ND	ND	ND		ND												
Techntium-99	2-4								ND			153	65.9	82		67.6	23.6			
	8-10	ND	ND	ND	ND	ND	ND	ND	10.2	ND									ND	
	11-15	ND	ND	ND	ND	ND	ND	ND		ND	ND				12.9			281		15.6
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	ND	ND			ND									
	35-37						ND				ND									
	40-45	ND	ND	ND	ND	ND	ND	ND			ND									
	55-60	ND	ND	ND	ND	1.83		ND												
Thorium-228	2-4								0.17			1.92	0.209	0.238		0.314	0.27			
	8-10	0.248	0.388	0.376	0.382	0.459	0.4	0.339	0.359	0.461									0.269	
	11-15	0.28	0.398	0.368	0.208	0.518	0.202	0.351		0.412					0.321			0.79		0.364

Table 4.21. SWMU 145 Locations of Subsurface Soil Contaminants (Continued)

		RI Data							Historical Data											
Analysis	Depth (ft)	145-101	145-102	145-103	145-104	145-105	145-106	145-107	A10	A2	DG-029	NSD030	NST1S01	NST1S02	NST1S03	NST2S01	NST2S02	NST2S03	NST2S04	NST2S05
	30	0.239	0.236	0.506	0.386	0.355	0.56	0.199												
	35						0.574													
	40-45	0.394	0.305	0.407	0.394	0.775	0.376	0.478												
	55-60	0.324	0.196	0.558	0.457			0.247												
Thorium-230	2-4								0.38			193	0.884	1.19		0.749	0.733			
	8-10	0.237	0.347	0.412	0.373	0.472	0.295	0.394	4.5	0.508									0.313	
	11-15	0.192	0.297	0.387	0.146	0.453	0.233	0.29		0.941					0.339			55.9		1.4
	30	ND	0.21	0.273	0.322	0.17	0.291	0.213												
	35						0.407													
	40-45	0.284	0.207	0.195	0.168	0.534	0.233	0.35												
	55-60	0.211	ND	0.353	0.225	ND		0.145												
Thorium-232	2-4								0.0935			2.16	0.1819	0.221		0.277	0.256			
	8-10	0.278	0.359	0.415	0.381	0.479	0.387	0.415	0.358	0.46									0.5376	
	11-15	0.296	0.389	0.374	ND	0.5	0.295	0.401		0.309					0.361			0.77		2.282
	30	0.254	0.299	0.357	0.359	0.36	0.482	0.318												
	35						0.537													
	40-45	0.501	0.41	0.383	0.385	0.727	0.532	0.449												
	55-60	0.356	0.182	0.522	0.421	0.1		0.276												
Uranium	2-4								10.6			5.84	77.1	33.7		12	81.2			
	8-10	ND	ND	ND	ND	ND	ND	ND	593										5.4	
	12-15	ND	ND	ND	ND	ND	ND	ND										33.9		17.9
	30	ND	ND	ND	ND	ND	ND	ND												
	35						ND													
	40-45	ND	ND	ND	ND	0.795	ND	ND												
	55-60	ND	ND	ND	ND	ND		ND												
Uranium-233/234	2-4								4.7											
	8-10								0.81	0.66										
	11-15									1.1										

Table 4.21. SWMU 145 Locations of Subsurface Soil Contaminants (Continued)

		RI Data							Historical Data											
Analysis	**Depth (ft)**	145-101	145-102	145-103	145-104	145-105	145-106	145-107	A10	A2	DG-029	NSD030	NST1S01	NST1S02	NST1S03	NST2S01	NST2S02	NST2S03	NST2S04	NST2S05
Uranium-234	2-4								4.5			2.54	10.1	6.45		3.64	33			
	8-10	ND	0.177	0.184	0.128	ND	ND	ND	254	ND									1.21	
	11-15	ND	ND	0.15	ND	0.14	ND	ND		ND					0.55			14.2		6.48
	30	ND	0.152	ND	ND	0.156	0.189	0.172												
	35						0.227													
	40-45	0.17	0.209	ND	ND	0.405	0.143	0.178												
	55-60	ND	ND	0.309	0.148	ND		ND												
Uranium-235	2-4								0.32			0.157	0.67	0.25		0.18	2.2			
	8-10	ND	ND	ND	ND	ND	ND	ND	0.047	0.049									0.045	
	11-15	ND	ND	ND	ND	ND	ND	ND		0.081	ND				0.025			0.69		0.052
	19-25										ND									
	30-34	ND	ND	ND	ND	ND	ND	ND			ND									
	35-37						ND				ND									
	40-45	ND	ND	ND	ND	ND	ND	ND			ND									
	55-60	ND	ND	ND	ND	ND		ND												
Uranium-238	2-4								6.6			3.14	65.9	29.7		8.11	104			
	8-10	ND	0.123	0.192	0.142	0.129	ND	ND	326	0.63									4.11	
	11-15	ND	ND	0.142	ND	0.176	ND	0.118		1					0.66			19.8		11.1
	30	ND	0.127	ND	ND	ND	0.153	0.16												
	35						0.23													
	40-45	ND	0.17	ND	ND	0.378	ND	0.194												
	55-60	0.125	ND	0.238	0.144	ND		ND												

ND = not detected
Blank cells indicate interval was not sampled for the specified analysis. Maximum value is shown for each depth interval.

Radionuclides of potential concern in subsurface soils at SWMU 145 include americium-241 (^{241}Am), cesium-137 (^{137}Cs), ^{99}Tc, thorium isotopes, and uranium isotopes. Most of these samples derive from investigation of the buried reach of the NSDD.

4.4 GROUNDWATER

4.4.1 SWMU 2

Groundwater samples were attempted at the two angled borings installed at SWMU 2 as part of this RI; however, none were collected. A review of historical data, identified the contaminants listed in Tables 4.22, 4.23, and 4.24 for UCRS, RGA, and McNairy groundwater, respectively. Table 4.25 details the locations of the SWMU 2 groundwater analyses.

Table 4.22. SWMU 2 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Beryllium	0.078	N/A[b]	5/6	3/6	3/6
Iron	14	N/A	1/1	N/A	1/1
Manganese	37	N/A	6/6	N/A	5/6
Uranium	0.075	N/A	7/15	3/15	7/15
Vanadium	4.1	N/A	5/6	N/A	5/6
Organics – Volatiles (mg/L)					
1,1-DCE	8.33	N/A	4/4	4/4	4/4
cis-1,2-DCE	0.28	N/A	4/12	2/12	2/12
TCE	0.04	N/A	7/12	6/12	6/12
Vinyl chloride	0.005	N/A	2/7	1/7	2/7
Radionuclides (pCi/L)					
Uranium-234	10.3	N/A	10/10	N/A	9/10
Uranium-238	55.8	N/A	10/10	N/A	9/10

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.23. SWMU 2 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.081	N/A[b]	3/4	2/4	2/4	3/4
Beryllium	0.092	N/A	24/28	21/28	21/28	21/28
Cadmium	0.012	N/A	1/4	1/4	1/4	1/4
Iron	23000	N/A	12/13	10/13	N/A	11/13
Manganese	96	N/A	28/28	25/28	N/A	25/28
Uranium	0.41	N/A	5/145	4/145	4/145	5/145
Vanadium	1.9	N/A	25/28	19/28	N/A	23/28
Organics – Volatiles (mg/L)						
1,1-DCE	47.9	N/A	20/39	N/A	20/39	20/39
Chloroform	0.0029	N/A	2/19	N/A	N/A	2/19
cis-1,2-DCE	0.75	N/A	31/137	N/A	10/137	24/137
TCE	5.35	N/A	113/137	N/A	97/137	109/137
Radionuclides (pCi/L)						
Uranium-234	50.6	N/A	24/33	19/33	N/A	22/33
Uranium-238	91.7	N/A	23/34	18/34	N/A	21/34

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.24. SWMU 2 McNairy Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Organics – Volatiles (mg/L)						
1,1-DCE	7.5	N/A[b]	4/4	N/A	4/4	4/4
TCE	0.055	N/A	7/9	N/A	4/9	5/9

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.25. SWMU 2 Locations of Groundwater Contaminants

Unit	Depth (ft)	Analysis	Historical Data														
			MW154	MW333	MW337	MW338	PZ334	PZ335	PZ336	PZ74	SWMU2-10	SWMU2-13	SWMU2-16	SWMU2-17	SWMU2-3	SWMU2-5	SWMU2-9
UCRS	18-20	***Inorganics (mg/L)***															
		Beryllium	ND														
		Manganese	ND														
		Uranium	0				0.061	ND	0.023								
		Vanadium	ND														
		Organics-Volatiles (mg/L)															
		cis -1,2-DCE	ND														
		TCE	0.04														
		Vinyl chloride	ND														
		Radionuclides (pCi/L)															
		Uranium-234	0.73				5.62		2.55								
		Uranium-238	1.55				26.8		6.7								
	22-26	***Inorganics (mg/L)***															
		Beryllium									0.0069			ND			0.078
		Manganese									6.3			3			37
		Uranium									ND			ND			0.075
		Vanadium									0.42			0.012			4.1
		Organics-Volatiles (mg/L)															
		1,1-DCE												0.153	0.0143		8.33
		cis -1,2-DCE									ND			ND	0.28		ND
		TCE									ND			ND	0.039		ND
		Vinyl chloride									ND			ND	0.005		
		Radionuclides (pCi/L)															
		Uranium-234									1.76			10.3			4.11
		Uranium-238									2.57			55.8			3.96
	42-43	***Inorganics (mg/L)***															
		Beryllium								ND							0.023
		Iron								14							
		Manganese								0.07							7.1
		Uranium								ND							ND
		Vanadium								0.03							0.93

Table 4.25. SWMU 2 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	Historical Data														
			MW154	MW333	MW337	MW338	PZ334	PZ335	PZ336	PZ74	SWMU2-10	SWMU2-13	SWMU2-16	SWMU2-17	SWMU2-3	SWMU2-5	SWMU2-9
UCRS	43	***Organics-Volatiles (mg/L)***															
		1,1-DCE															0.667
		cis -1,2-DCE								ND							ND
		TCE								0.013							0.01
		Vinyl chloride								ND							ND
		Radionuclides (pCi/L)															
		Uranium-234								ND							4.14
		Uranium-238								ND							3.72
RGA	58	***Inorganics (mg/L)***															
		Beryllium										0.069				0.0031	
		Iron										1800				93	
		Manganese										26				2.1	
		Uranium										ND				ND	
		Vanadium										1.9				0.065	
		Organics-Volatiles (mg/L)															
		1,1-DCE										1.79				2.16	
		cis -1,2-DCE										0.75				ND	
		TCE										5.35				ND	
		Radionuclides (pCi/L)															
		Uranium-234										14.2				0.75	
		Uranium-238										17.6				0.55	
	61-63	***Inorganics (mg/L)***															
		Beryllium									0.047				0.012		
		Manganese									20				3.5		
		Uranium									ND				ND		
		Vanadium									0.97				0.24		
		Organics-Volatiles (mg/L)															
		1,1-DCE									0.295				3.24		
		cis -1,2-DCE									ND				ND		
		TCE									0.12				ND		

Table 4.25. SWMU 2 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	Historical Data MW154	MW333	MW337	MW338	PZ334	PZ335	PZ336	PZ74	SWMU2-10	SWMU2-13	SWMU2-16	SWMU2-17	SWMU2-3	SWMU2-5	SWMU2-9
RGA	61-63	***Radionuclides (pCi/L)***															
		Uranium-234									1.01				3.84		
		Uranium-238									0.62				9.07		
	66-68	***Inorganics (mg/L)***															
		Beryllium										0.087	0.04	0.04		0.0061	
		Iron										2000		690		110	
		Manganese										39	32	26		1.5	
		Uranium										ND	0.15	ND		ND	
		Vanadium										1.7	0.6	0.83		0.11	
		Organics-Volatiles (mg/L)															
		1,1-DCE										0.356	4.21	0.0165		4.12	
		cis -1,2-DCE										0.221	ND	ND		ND	
		TCE										1.6	0.0043	ND		ND	
		Radionuclides (pCi/L)															
		Uranium-234										0.91	0.61	50.6		1.22	
		Uranium-238										0.76	2.12	55.1		0.94	
	71-72	***Inorganics (mg/L)***															
		Beryllium									0.092				0.038	0.0059	0.068
		Manganese									51				96	14	71
		Uranium									ND				ND	0.049	0.41
		Vanadium									1.5				0.6	0.12	1.2
		Organics-Volatiles (mg/L)															
		1,1-DCE									0.375					47.9	2.14
		cis -1,2-DCE									ND				ND	ND	ND
		TCE									0.1				ND	ND	0.015
		Radionuclides (pCi/L)															
		Uranium-234									ND				2.56	3	6.68
		Uranium-238									ND				7.55	2.92	6.53

Table 4.25. SWMU 2 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	Historical Data														
			MW154	MW333	MW337	MW338	PZ334	PZ335	PZ336	PZ74	SWMU2-10	SWMU2-13	SWMU2-16	SWMU2-17	SWMU2-3	SWMU2-5	SWMU2-9
RGA	74-77	***Inorganics (mg/L)***															
		Arsenic			0.0175	ND							0.081				
		Beryllium			ND	ND						0.068	0.017	0.03			
		Cadmium			ND	ND							0.012				
		Iron			56	5.7						23000					
		Manganese			2.1	1.1						65	19	41			
		Uranium			ND	0.35						ND	ND	ND			
		Vanadium			0.052	ND						1.3	0.28	0.61			
		Organics-Volatiles (mg/L)															
		1,1-DCE			ND	ND						3.55	1.09	0.159			
		Chloroform			0.0029	0.0015											
		cis -1,2-DCE			0.062	0.0073						0.0605	ND	ND			
		TCE			0.78	0.14						0.422	0.0072	ND			
		Radionuclides (pCi/L)															
		Uranium-234			ND	0.56						3.35	13.9	12.3			
		Uranium-238			ND	0.67						3.94	91.7	14.9			
	79-82	***Inorganics (mg/L)***															
		Arsenic		0.0029													
		Beryllium		ND							0.015				0.021		0.016
		Cadmium		ND													
		Iron		6.2													
		Manganese		2.6							15				38		38
		Uranium		ND							ND				ND		ND
		Vanadium		0.0097							0.37				0.3		0.3
		Organics-Volatiles (mg/L)															
		1,1-DCE		ND							1.45				4.1		22.8
		Chloroform		ND													
		cis -1,2-DCE		0.2							ND				ND		ND
		TCE		1.6							0.052				0.0022		0.0089
		Radionuclides (pCi/L)															
		Uranium-234		9.66							1.14				3.55		0.56
		Uranium-238		ND							1.08				9.91		0.78

Table 4.25. SWMU 2 Locations of Groundwater Contaminants (Continued)

			Historical Data														
Unit	**Depth (ft)**	**Analysis**	MW154	MW333	MW337	MW338	PZ334	PZ335	PZ336	PZ74	SWMU2-10	SWMU2-13	SWMU2-16	SWMU2-17	SWMU2-3	SWMU2-5	SWMU2-9
RGA	87	***Inorganics (mg/L)***															
		Beryllium										0.035	0.029				
		Iron										1500					
		Manganese										43	23				
		Uranium										ND	ND				
		Vanadium										0.65	0.48				
		Organics-Volatiles (mg/L)															
		1,1-DCE										0.0651	0.008				
		cis -1,2-DCE										0.034	ND				
		TCE										0.37	0.011				
		Radionuclides (pCi/L)															
		Uranium-234										2.28	9.97				
		Uranium-238										2.56	57.8				
McNairy		***Organics-Volatiles (mg/L)***															
	87	1,1-DCE												3.3			
		TCE												0.0017			
	92-93	1,1-DCE									0.0715				7.5		
		TCE									0.0464				ND		0.055

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

UCRS characterization data derive from three sources:

1) Samples from PZ74 (1996 through 1998) and MW154 (1990 through 1996),
2) Samples from temporary borings (SWMU2-3, SWMU2-9, SWMU2-10, and SWMU 2-17) of the SWMU 2 Interim Remedial Design Investigation of 1996 (DOE 1997a), and
3) Samples from piezometers PZ334, PZ335, and PZ336 in 1998 to assess the potential mobility of dissolved uranium.

Locations MW154, PZ334, PZ335, and PZ336 directly monitor the horizon of the buried waste around the perimeter. Samples from all of the temporary borings at depths of 22 to 26 ft (within the HU2 interval of the UCRS) characterize groundwater immediately below the depth of the waste pits (excavated at depths of 7 to 17 ft). Locations PZ74 and SWMU2-9 (42-43 ft sample) sample the deeper HU3 interval within the UCRS.

The screen of the SWMU 2 analyses identified the metals beryllium, iron, manganese, uranium, and vanadium and the organics TCE; *cis*-1,2-DCE; and vinyl chloride (TCE and its reductive dechlorination products) and 1,1-DCE as UCRS contaminants. In addition, ^{234}U and ^{238}U levels frequently exceeded background and child resident NALs.

The only metal and radionuclides that exceeded screening criteria in the horizon of the burial cells was uranium and the uranium isotopes. Beryllium, manganese, and vanadium, the uranium isotopes, and TCE and its degradation products occurred at levels that exceed screening criteria throughout the UCRS interval below the waste pits.

Characterization data for the RGA come from seven temporary borings of the SWMU 2 Interim Remedial Design Investigation of 1996 (DOE 1997a) and MW333, MW337, and MW338 (for the period 1996 to present). The metals that exceeded screening criteria include beryllium, iron, manganese, uranium, and vanadium (also identified as UCRS contaminants) and arsenic and cadmium.

TCE, with a maximum value of 5.35 mg/L (5,350 μg/L), was the most widely detected organic contaminant in RGA groundwater at SWMU 2. The hydrogeological assessment of the SWMUs 2 and 3 area (PRS 2007a) determined that an upgradient source is responsible for the high TCE levels in the area. The uranium isotopes ^{234}U and ^{238}U occurred above screening levels. RGA groundwater samples from the location SWMU2-17 contained both ^{234}U and ^{238}U above screening criteria at 50.6 and 55.1 pCi/L, respectively. The analysis of a sample from location SWMU2-16 detected ^{238}U at 91.7 pCi/L.

Four of the temporary borings of the SWMU 2 Interim Remedial Design Investigation of 1996 (DOE 1997a), SWMU2-3, SWMU2-9, SWMU2-10, and SWMU2-17, characterized groundwater in the McNairy Formation immediately below the RGA. TCE and 1,1-DCE were the only groundwater contaminants identified by comparison against the RI screening criteria. All levels of metals and radionuclides in McNairy groundwater samples of SWMU 2 were less than PGDP background.

4.4.2 SWMU 3

A large amount of historical UCRS and RGA groundwater data were available for SWMU 3. Additionally, UCRS groundwater samples were collected from two of the four angled borings at SWMU 3 as part of this RI. The UCRS data sources included well samples collected from MW85, MW88, MW91, and MW94 for the period 1995 through present (these wells are screened between 29 and 40 ft bgs) and samples from the BGOU RI temporary borings 003-003 (at 28 ft) and 003-004 (at 30 ft). All of these samples represent the HU2 interval within the UCRS.

A review of RI and historical data determined the UCRS contaminants listed in Table 4.26. All sample locations documented levels of TCE, the radionuclides ^{99}Tc and ^{238}U, and at least one metal (arsenic, iron, lead, manganese, molybdenum, and uranium) that exceed screening criteria.

Wells characterize the upper and lower RGA to monitor for potential contamination derived from C-404. Upper RGA wells include MW67, MW84, MW87, MW90/90A, MW93, and MW227. The lower RGA wells are MW86, MW89, MW92, MW95/95A, and MW226. The data base for screening RGA contaminants is the monitoring data for the period 1995 to present. RGA Groundwater contaminants for SWMU 3 are listed in Table 4.27.

Table 4.26. SWMU 3 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL[a]	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.012	N/A[b]	34/46	9/46	34/46
Arsenic, Dissolved	0.012	0.00159	36/39	8/39	4/39
Iron	N/A	43.5	2/2	N/A	2/2
Lead	0.00539	0.0172	4/46	2/46	2/46
Manganese	N/A	1.45	2/2	N/A	2/2
Molybdenum	N/A	0.0184	2/2	N/A	1/2
Uranium	0.0518	0.00193	14/150	2/150	14/150
Organics – Volatiles (mg/L)					
TCE	1.8	0.046	105/126	82/126	104/126
Radionuclides (pCi/L)					
Technetium-99	998	8.72	161/166	1/166	159/166
Uranium-234	14.39	2.33	11/27	N/A	10/27
Uranium-238	34.81	0.912	13/27	N/A	13/27

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.27. SWMU 3 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.12	N/A[b]	28/79	2/79	2/79	28/79
Iron	6.02	N/A	14/19	1/19	N/A	6/19
Manganese	1.4	N/A	19/19	10/19	N/A	14/19
Uranium	0.09	N/A	15/395	6/395	2/395	15/395
Organics – Volatiles (mg/L)						
1,1-DCE	0.012	N/A	7/19	N/A	1/19	7/19
Chloroform	0.0005	N/A	8/20	N/A	N/A	8/20
TCE	0.61	N/A	215/337	N/A	150/337	192/337
Radionuclides (pCi/L)						
Uranium-234	199.68	N/A	10/67	8/67	N/A	8/67
Uranium-238	210.83	N/A	11/67	8/67	N/A	10/67

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.28 lists the locations of groundwater detections above screening levels.

Arsenic, iron, manganese, and uranium concentrations in RGA groundwater samples (also contaminants in the UCRS) exceeded screening levels for metals at SWMU 3. All of these metals were found in both the upper and lower RGA with no significant differentiation with depth. 1,1-DCE and TCE exceeded screening levels for organics in RGA groundwater at SWMU 3. The hydrogeological assessment of the SWMUs 2 and 3 area that was completed as part of this RI (PRS 2007a) documents that an upgradient source accounts for the high TCE levels. Because the 1,1-DCE detects only occurred in upgradient wells, it also appears to be related to an upgradient source. The only radionuclides in the SWMU 3 RGA groundwater samples to exceed background and MCLs were ^{234}U and ^{238}U, occurring in both the upper and lower RGA. The uranium isotope activities were markedly higher in well cluster MW93/MW95A.

Groundwater monitoring under the RCRA permit for the unit, however, has shown statistically significant increases of TCE above background in one of three downgradient compliance wells in the upper RGA. [*C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS 2007b) related the increase in TCE levels to trends in the Southwest Plume.] Additionally, trends of arsenic, chromium, selenium, ^{99}Tc, ^{234}U, and ^{238}U have required statistical analysis for contaminant determination. Figures 4.17 through 4.37 present trend graphs of these contaminants in UCRS and upper and lower RGA monitoring wells.

Table 4.28. SWMU 3 Locations of Groundwater Contaminants

			RI Data		Historical Data														
Unit	Depth (ft)	Analysis	003-003	003-004	MW226	MW227	MW67	MW84	MW85	MW86	MW87	MW88	MW89	MW90/ MW90A	MW91	MW92	MW93	MW94	MW95/ MW95A
UCRS	28-30	***Inorganics (mg/L)***																	
		Arsenic	ND	ND															
		Arsenic, Dissolved	0.00129	0.0016															
		Iron	43.5	24															
		Lead	0.0153	0.0172															
		Manganese	1.45	0.284															
		Molybdenum	0.0184	ND															
		Uranium	0.00178	0.00193															
		Organics-Volatiles (mg/L)																	
		TCE	0.042	0.046															
		Radionuclides (pCi/L)																	
		Technetium-99	ND	ND															
		Uranium-234	2.33	0.604															
		Uranium-238	0.912	0.793															
	33-35	***Inorganics (mg/L)***																	
		Arsenic										0.011			0.00389				
		Arsenic, Dissolved										0.0081			0.00225				
		Lead										ND			ND				
		Uranium										ND			ND				
		Organics-Volatiles (mg/L)																	
		TCE										1.8			0.079				
		Radionuclides (pCi/L)																	
		Technetium-99										524			998				
		Uranium-234										ND			ND				
		Uranium-238										ND			ND				
	39-41	***Inorganics (mg/L)***																	
		Arsenic							0.012									0.01	
		Arsenic, Dissolved							0.012									0.0025	
		Lead							ND									ND	
		Uranium							0.0518									0.00433	

Table 4.28. SWMU 3 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	RI Data: 003-003	RI Data: 003-004	Historical Data: MW226	MW227	MW67	MW84	MW85	MW86	MW87	MW88	MW89	MW90/ MW90A	MW91	MW92	MW93	MW94	MW95/ MW95A
UCRS	39-41	***Organics-Volatiles (mg/L)***																	
		TCE							0.045									0.11	
		Radionuclides (pCi/L)																	
		Technetium-99							406									660	
		Uranium-234							3.9									14.39	
		Uranium-238							23.3									34.81	
RGA	70-72	***Inorganics (mg/L)***																	
		Arsenic												0.00103					
		Iron					0.98							2.46					
		Manganese					ND							1.06					
		Uranium					ND							ND					
		Organics-Volatiles (mg/L)																	
		1,1-DCE												ND					
		Chloroform												0.00017					
		TCE					0.0022							0.0024					
		Radionuclides (pCi/L)																	
		Uranium-234					ND							ND					
		Uranium-238					ND							ND					
	74-76	***Inorganics (mg/L)***																	
		Arsenic				0.12		0.00319			0.00116			ND					
		Iron				3.14		ND			ND			ND					
		Manganese				0.144		ND			0.0396			0.491					
		Uranium				0.02		ND			ND			ND					
		Organics-Volatiles (mg/L)																	
		1,1-DCE				ND		ND			ND			ND					
		Chloroform				ND		ND			ND			0.00019					
		TCE				0.18		0.48			0.072			0.005					
		Radionuclides (pCi/L)																	
		Uranium-234				2.9		ND			ND								
		Uranium-238				6.69		ND			ND								
	80	***Inorganics (mg/L)***																	
		Arsenic															0.00159		
		Iron															ND		
		Manganese															ND		
		Uranium															ND		

Table 4.28. SWMU 3 Locations of Groundwater Contaminants (Continued)

			RI Data		Historical Data															
Unit	**Depth (ft)**	**Analysis**	003-003	003-004	MW226	MW227	MW67	MW84	MW85	MW86	MW87	MW88	MW89	MW90/ MW90A	MW91	MW92	MW93	MW94	MW95/ MW95A
RGA	80	***Organics-Volatiles (mg/L)***																	
		1,1-DCE															0.0018		
		Chloroform															ND		
		TCE															0.54		
		Radionuclides (pCi/L)																	
		Uranium-234															199.68		
		Uranium-238															210.83		
	85-90	***Inorganics (mg/L)***																	
		Arsenic			0.00195					0.004			ND			0.00105			0.00151
		Iron			6.02					ND			ND						ND
		Manganese			1.4					0.408			0.591						0.342
		Uranium			ND					0.05			ND			ND			0.09
		Organics-Volatiles (mg/L)																	
		1,1-DCE			0.012					ND			ND						0.0022
		Chloroform			ND					ND			ND						0.0005
		TCE			0.61					0.38			0.0026			ND			0.35
		Radionuclides (pCi/L)																	
		Uranium-234			ND					1.37			3.35			ND			55.4
		Uranium-238			ND					5.02			0.522			ND			7.85

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

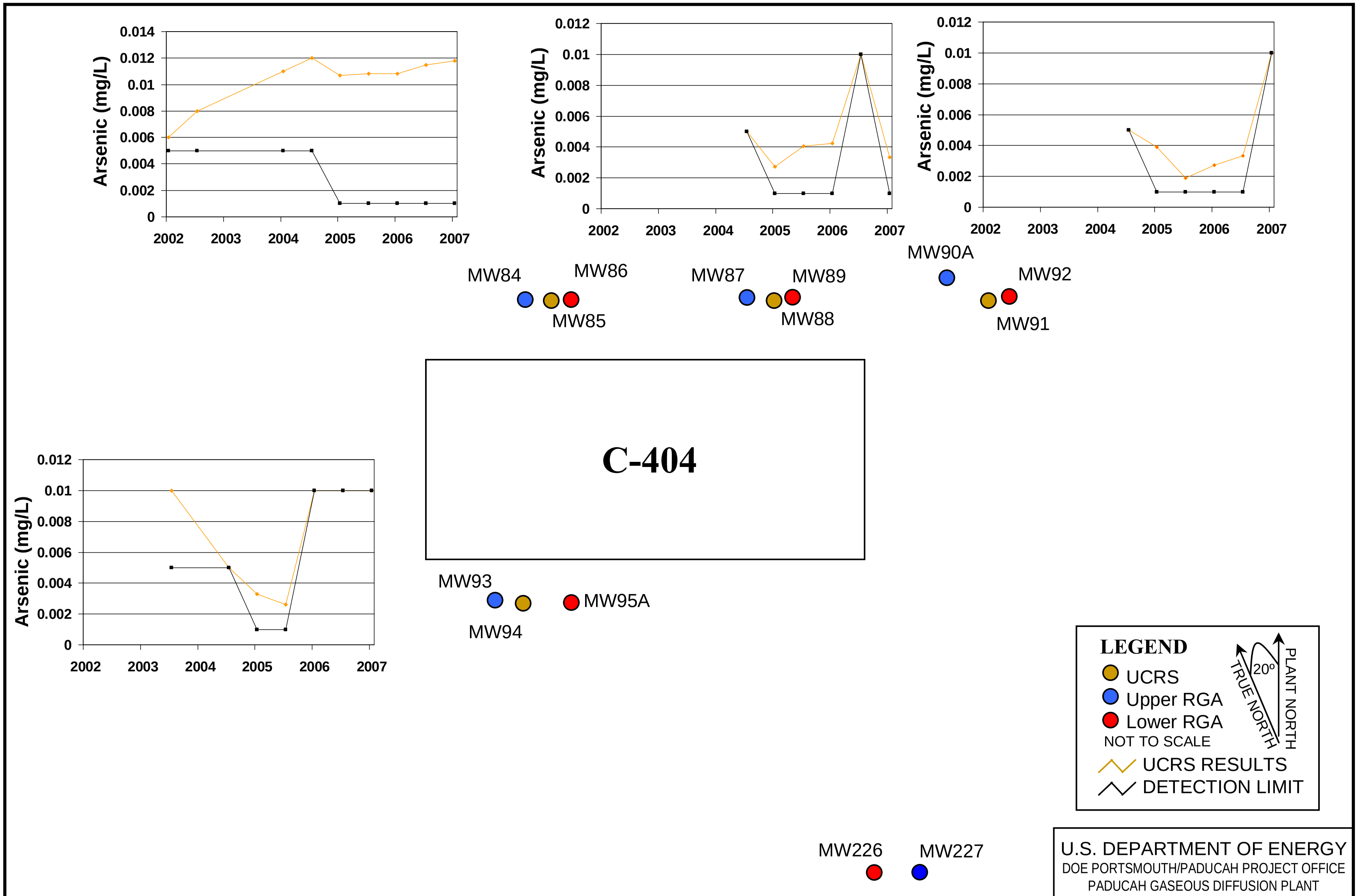

Figure 4.17. Arsenic Trends in SWMU 3 UCRS Wells

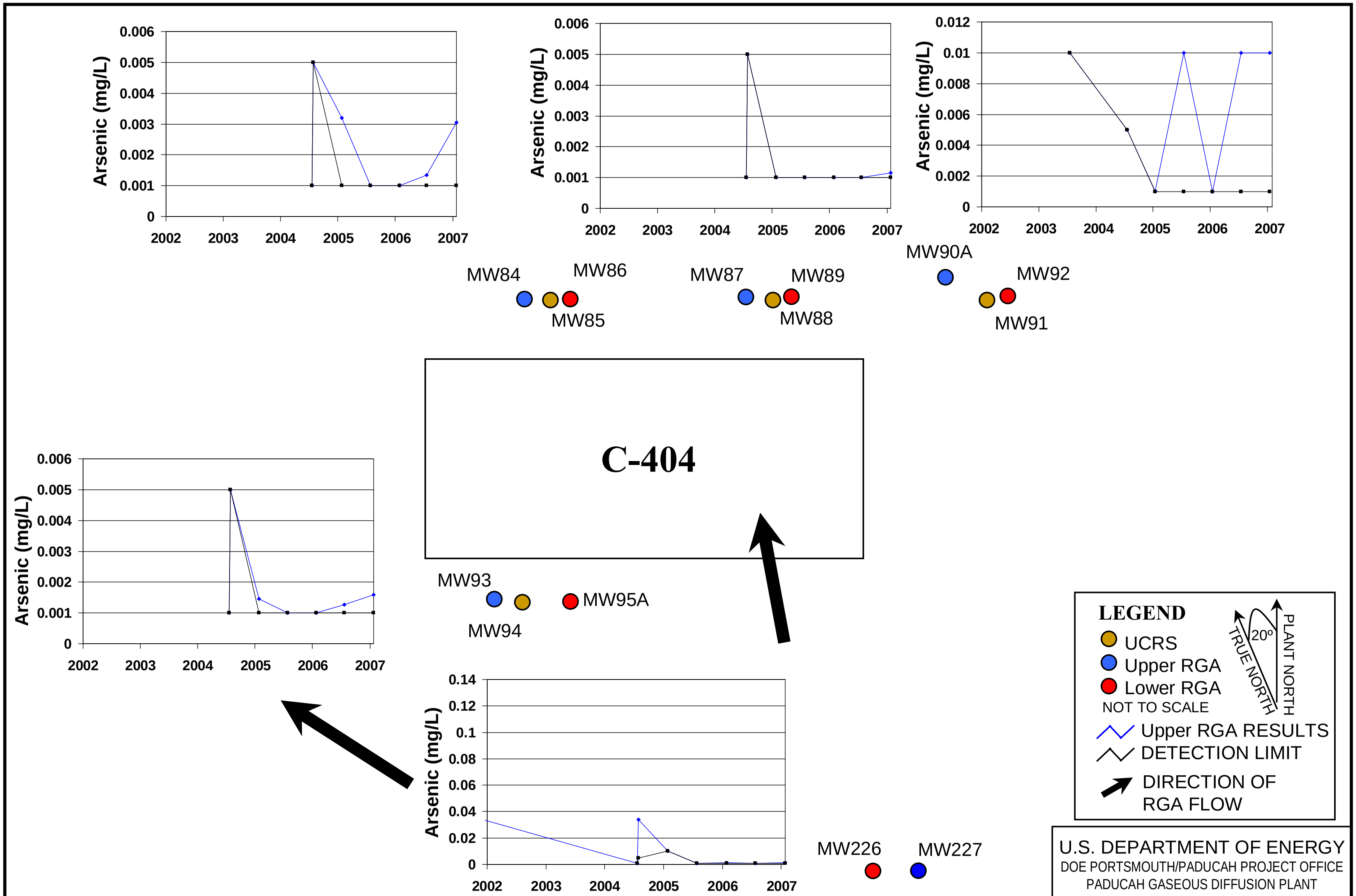

Figure 4.18. Arsenic Trends in SWMU 3 Upper RGA Wells

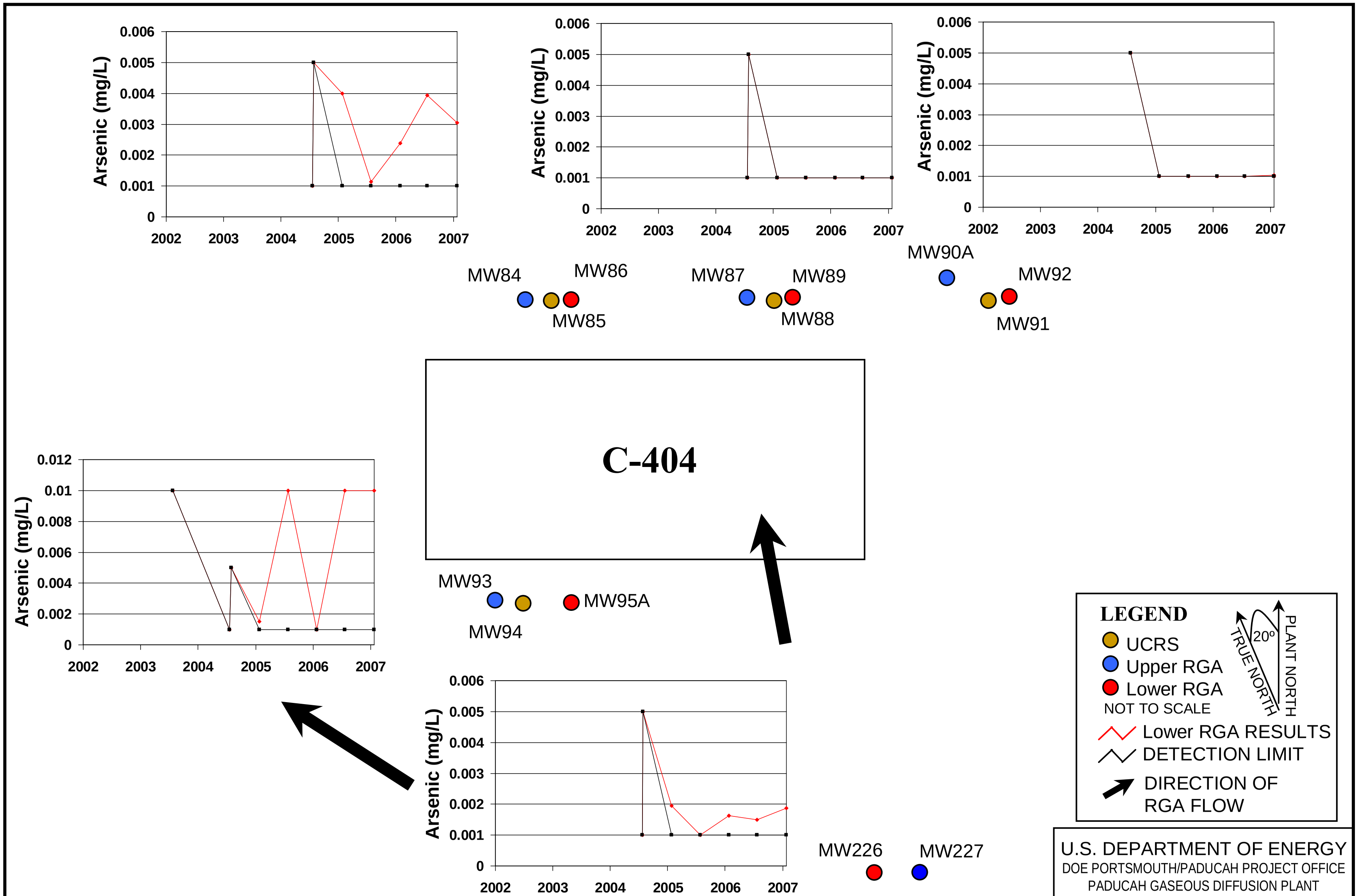

Figure 4.19. Arsenic Trends in SWMU 3 Lower RGA Wells

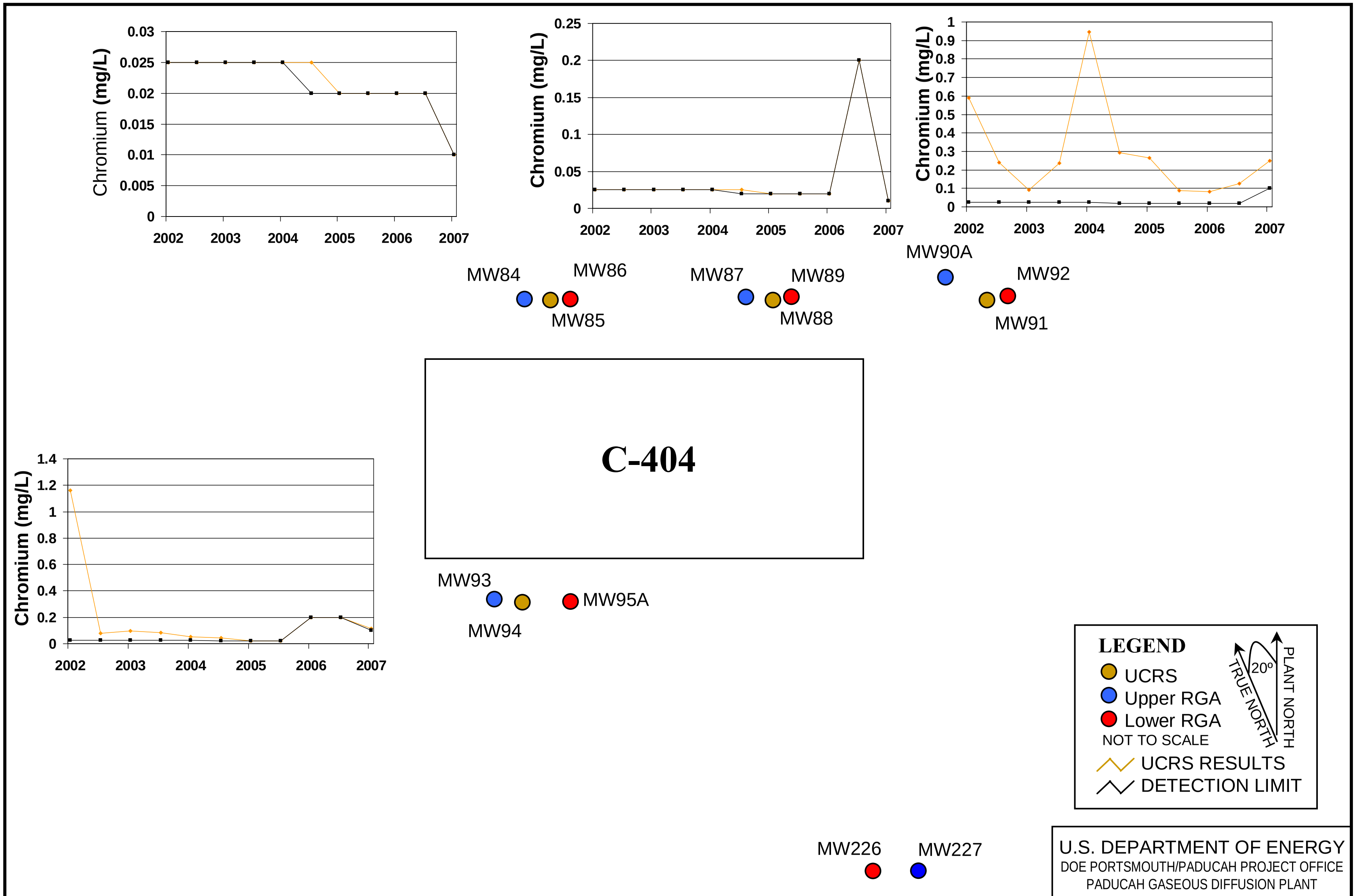

Figure 4.20. Chromium Trends in SWMU 3 UCRS Wells

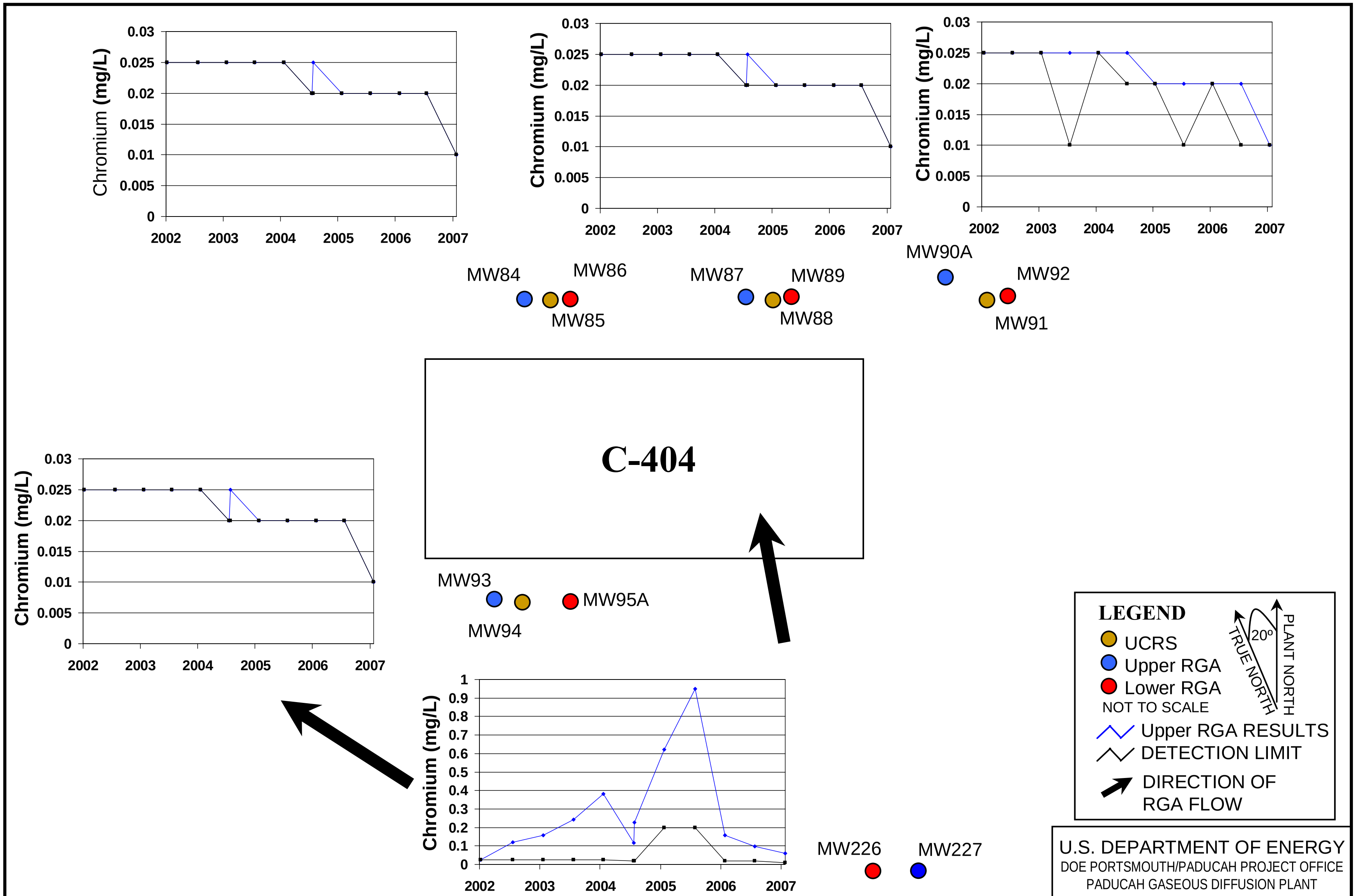

Figure 4.21. Chromium Trends in SWMU 3 Upper RGA Wells

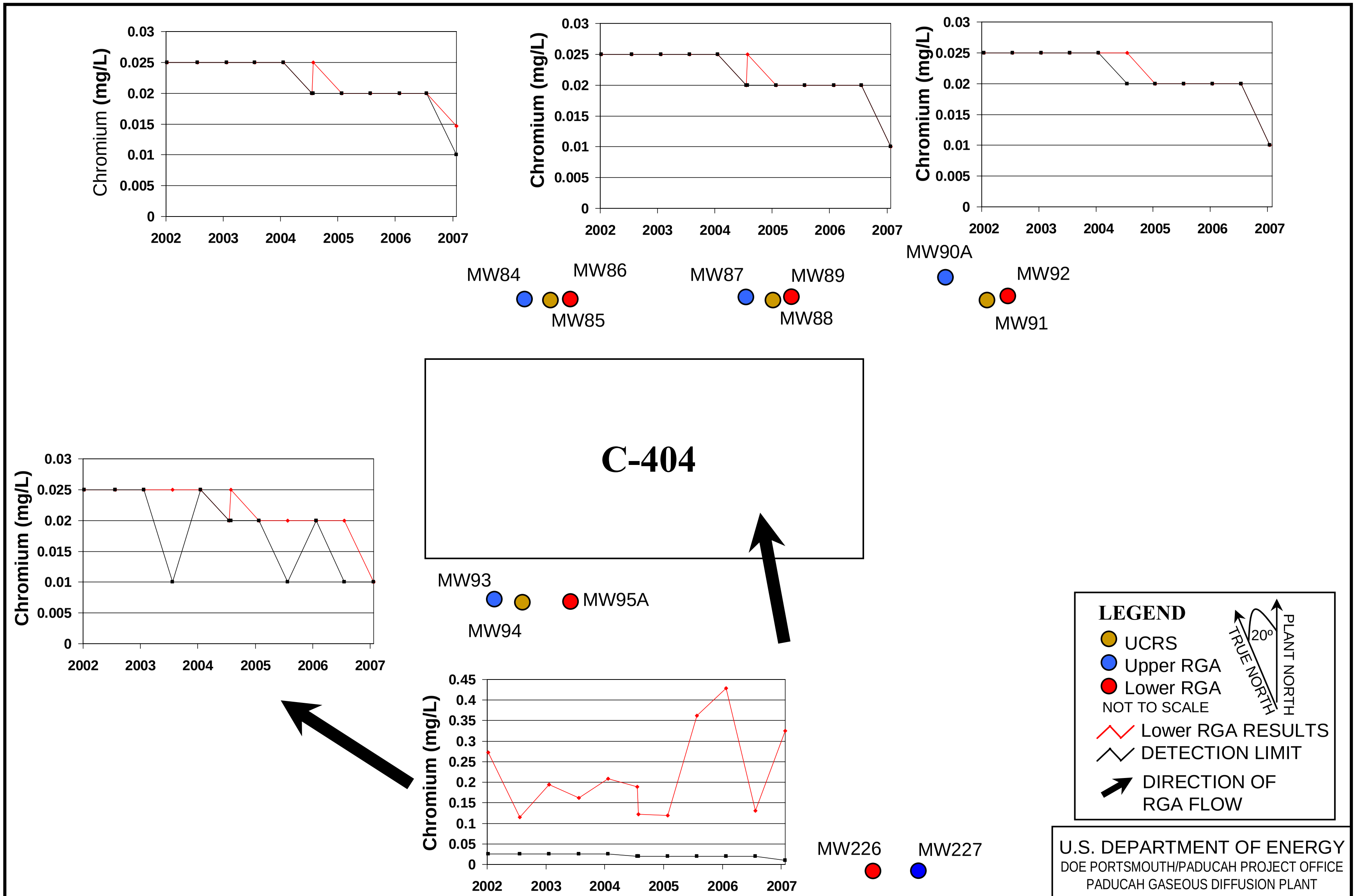

Figure 4.22. Chromium Trends in SWMU 3 Lower RGA Wells

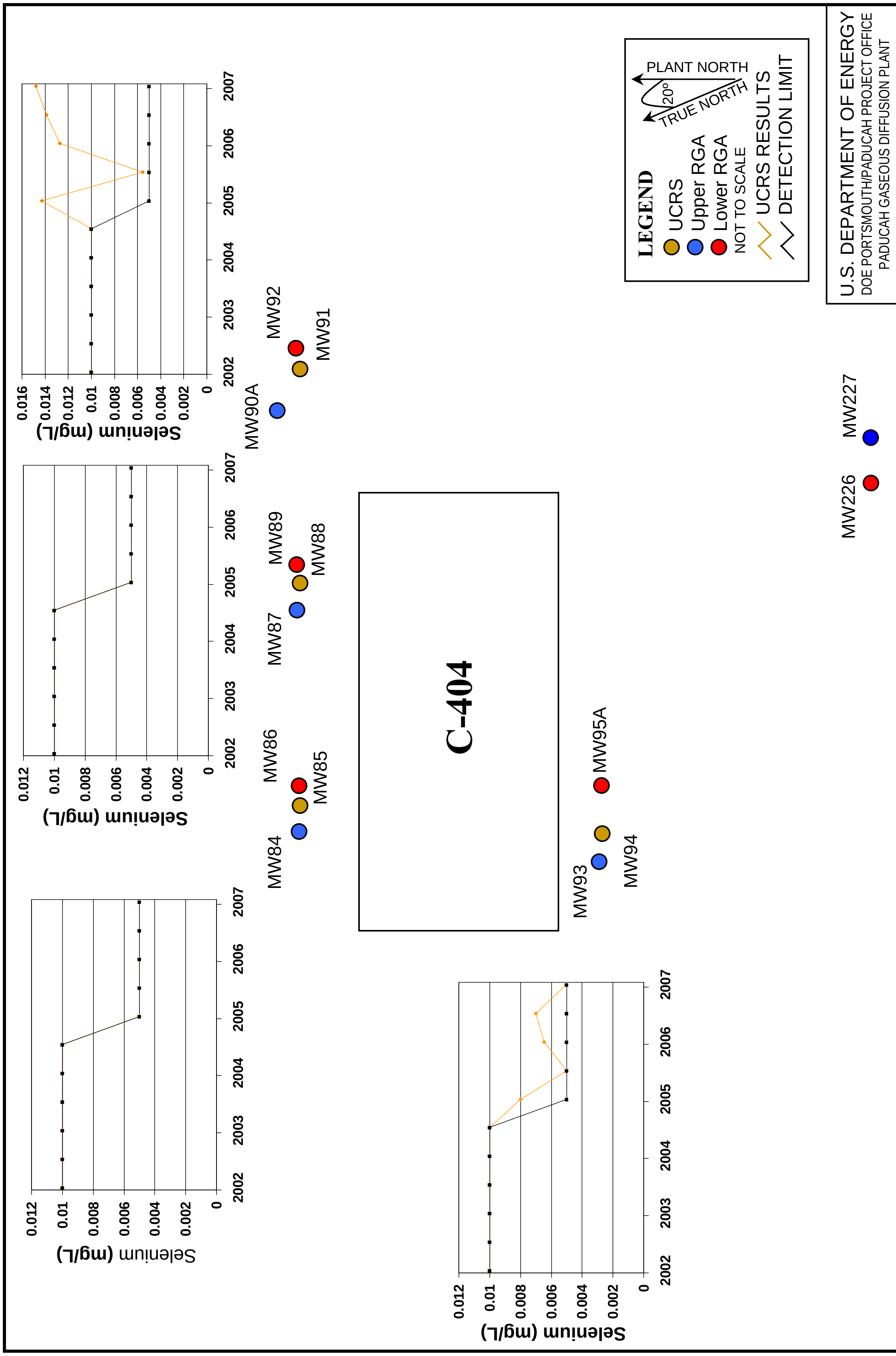

Figure 4.23. Selenium Trends in SWMU 3 UCRS Wells

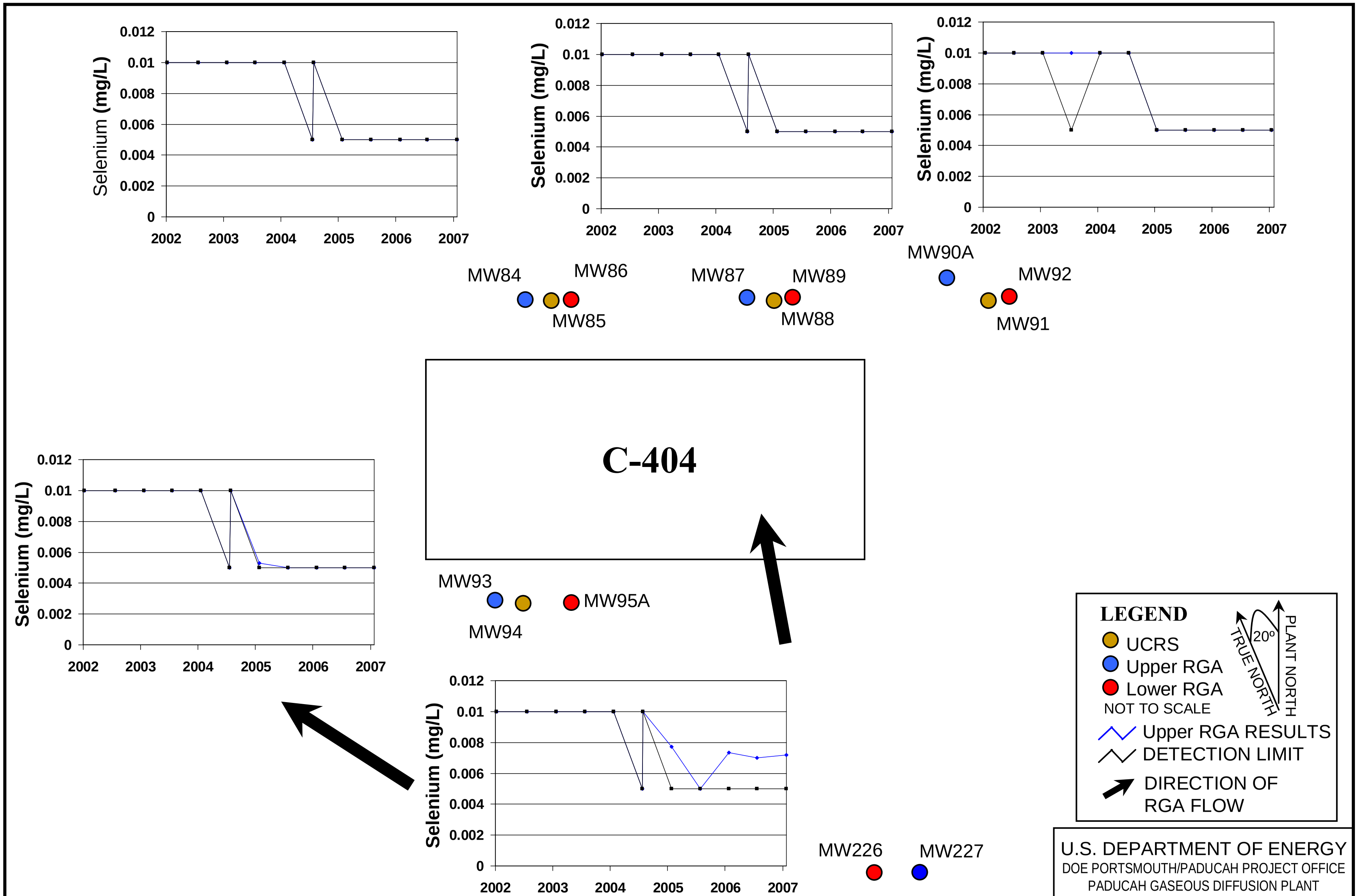

Figure 4.24. Selenium Trends in SWMU 3 Upper RGA Wells

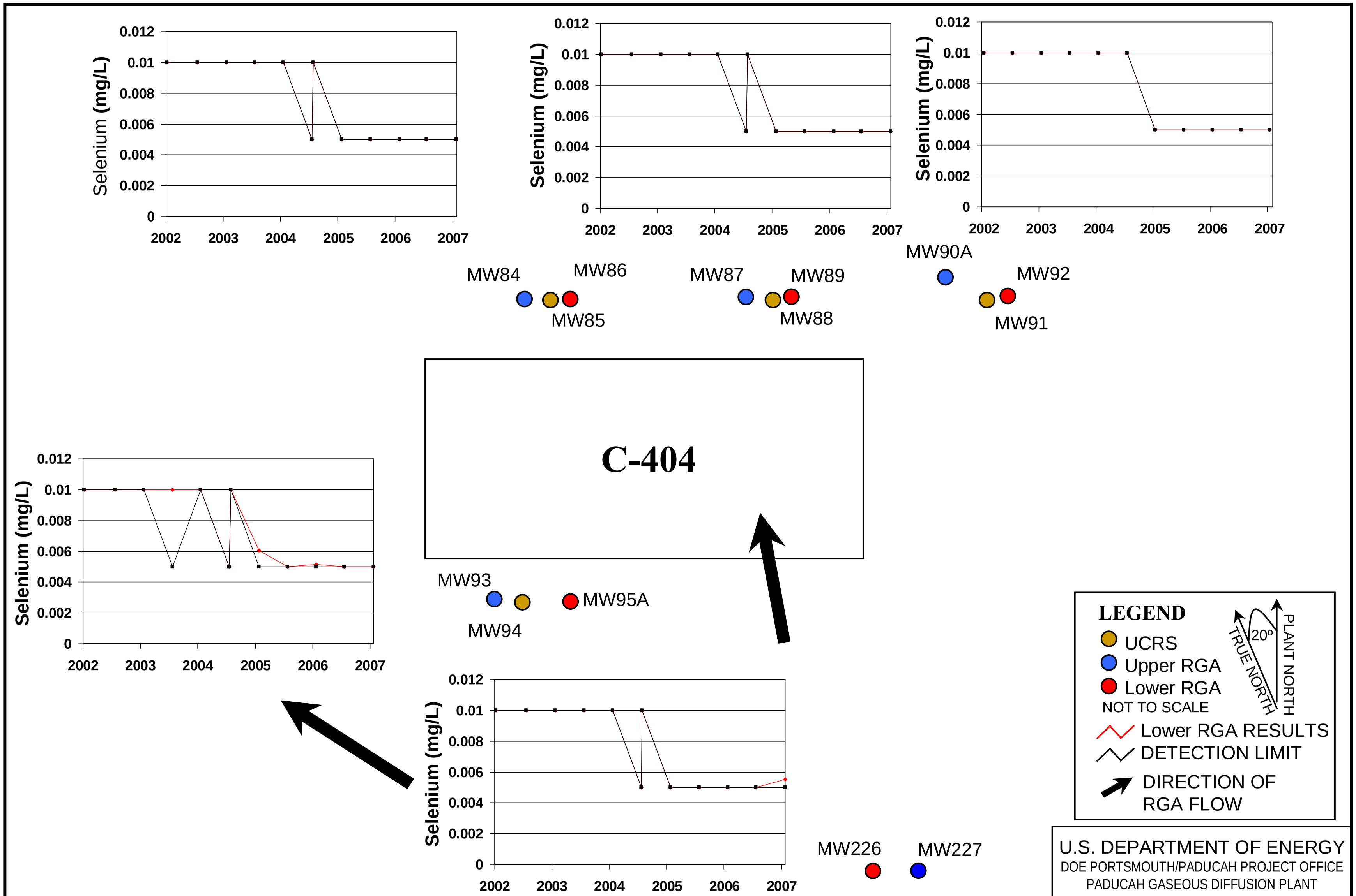

Figure 4.25. Selenium Trends in SWMU 3 Lower RGA Wells

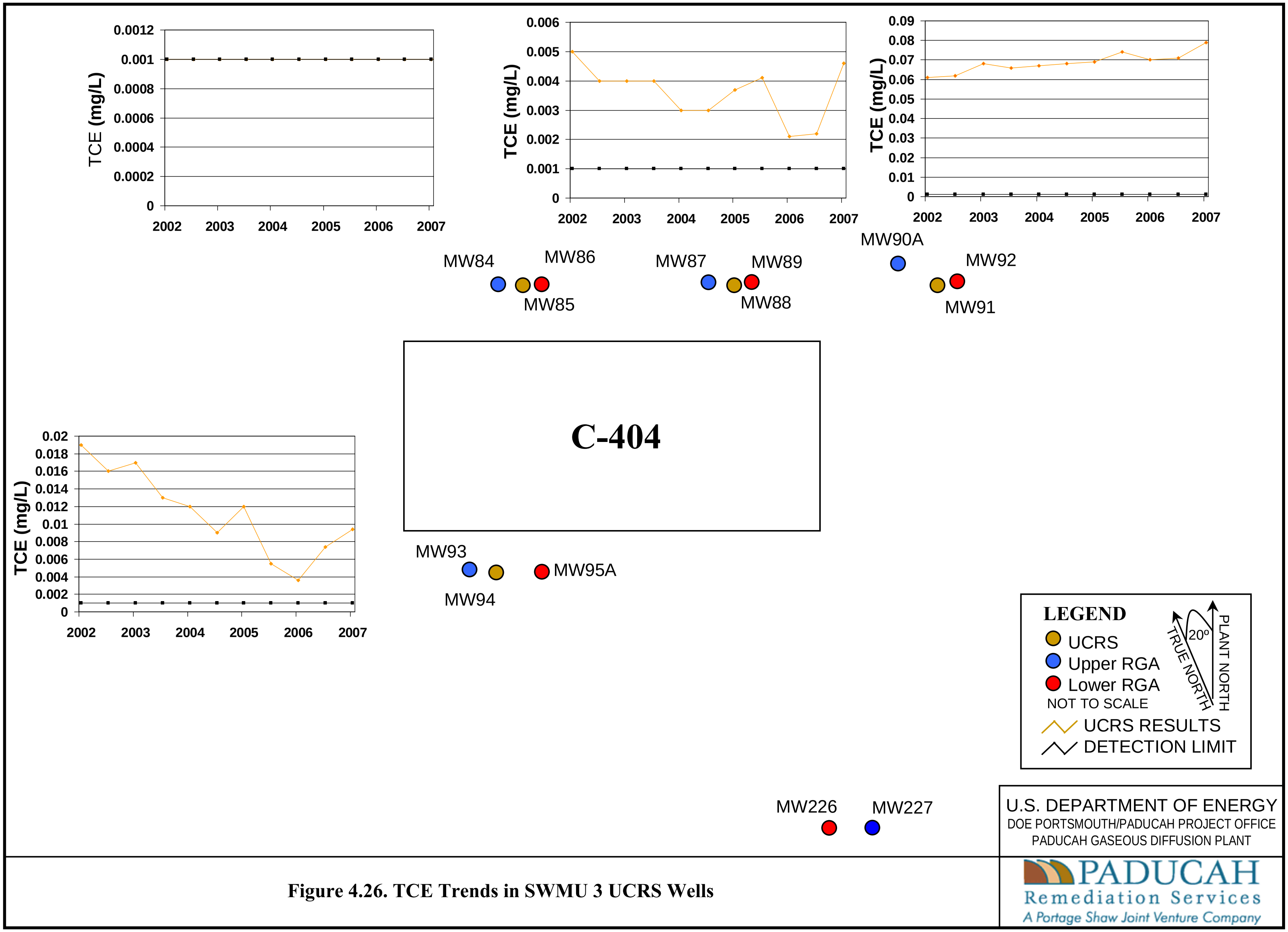

Figure 4.26. TCE Trends in SWMU 3 UCRS Wells

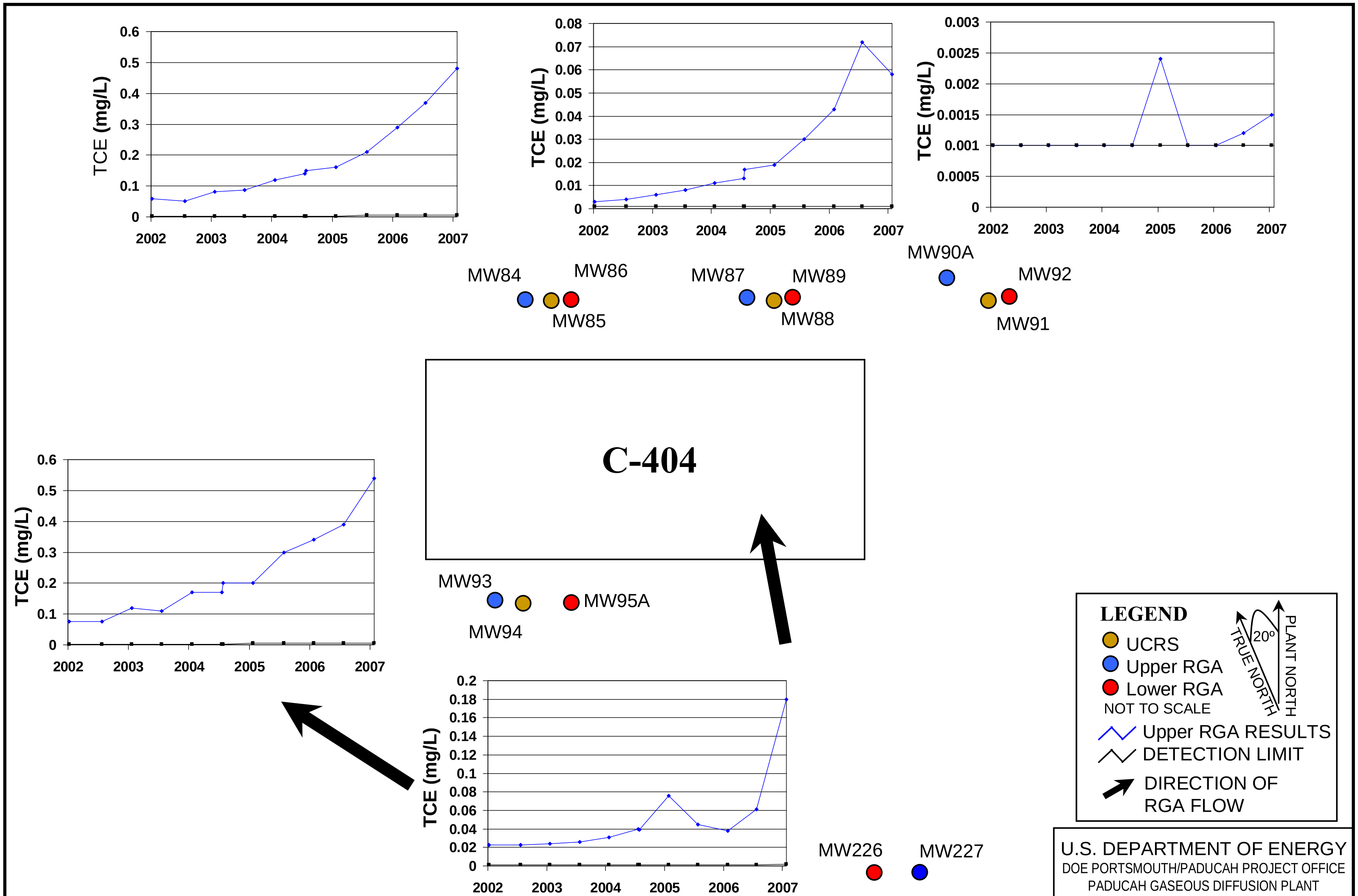

Figure 4.27. TCE Trends in SWMU 3 Upper RGA Wells

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DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

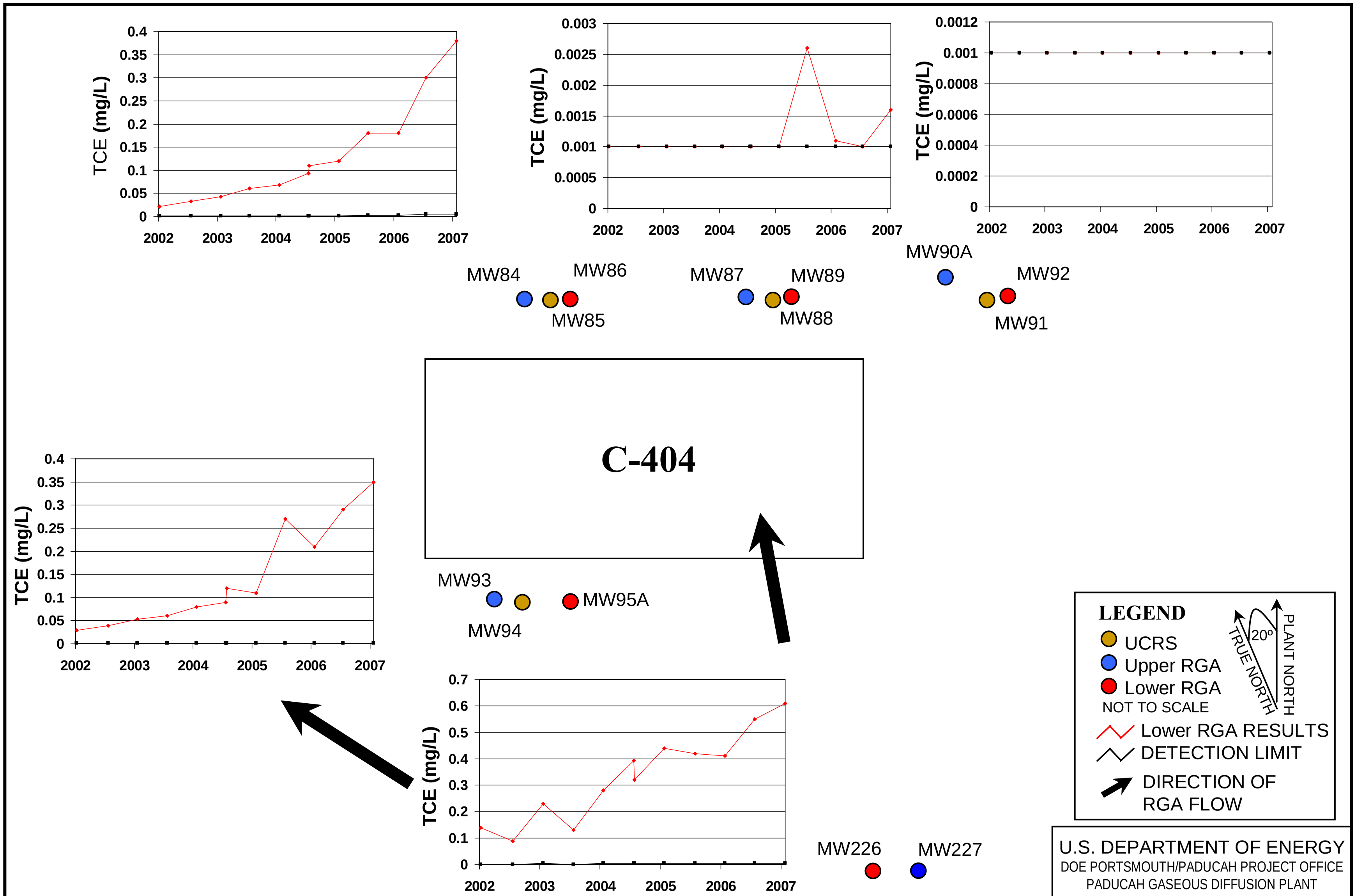

Figure 4.28. TCE Trends in SWMU 3 Lower RGA Wells

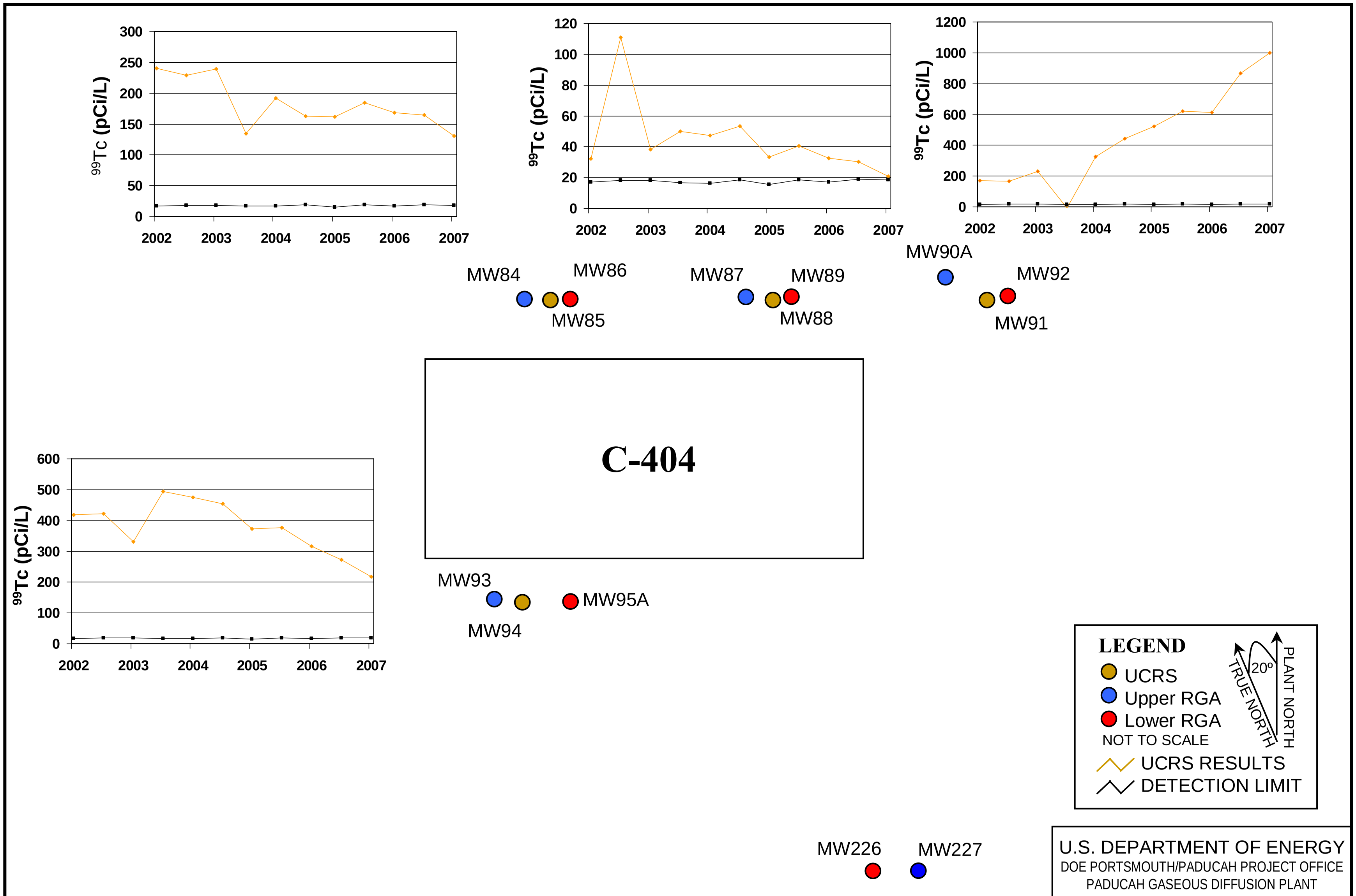

Figure 4.29. ^{99}Tc Trends in SWMU 3 UCRS Wells

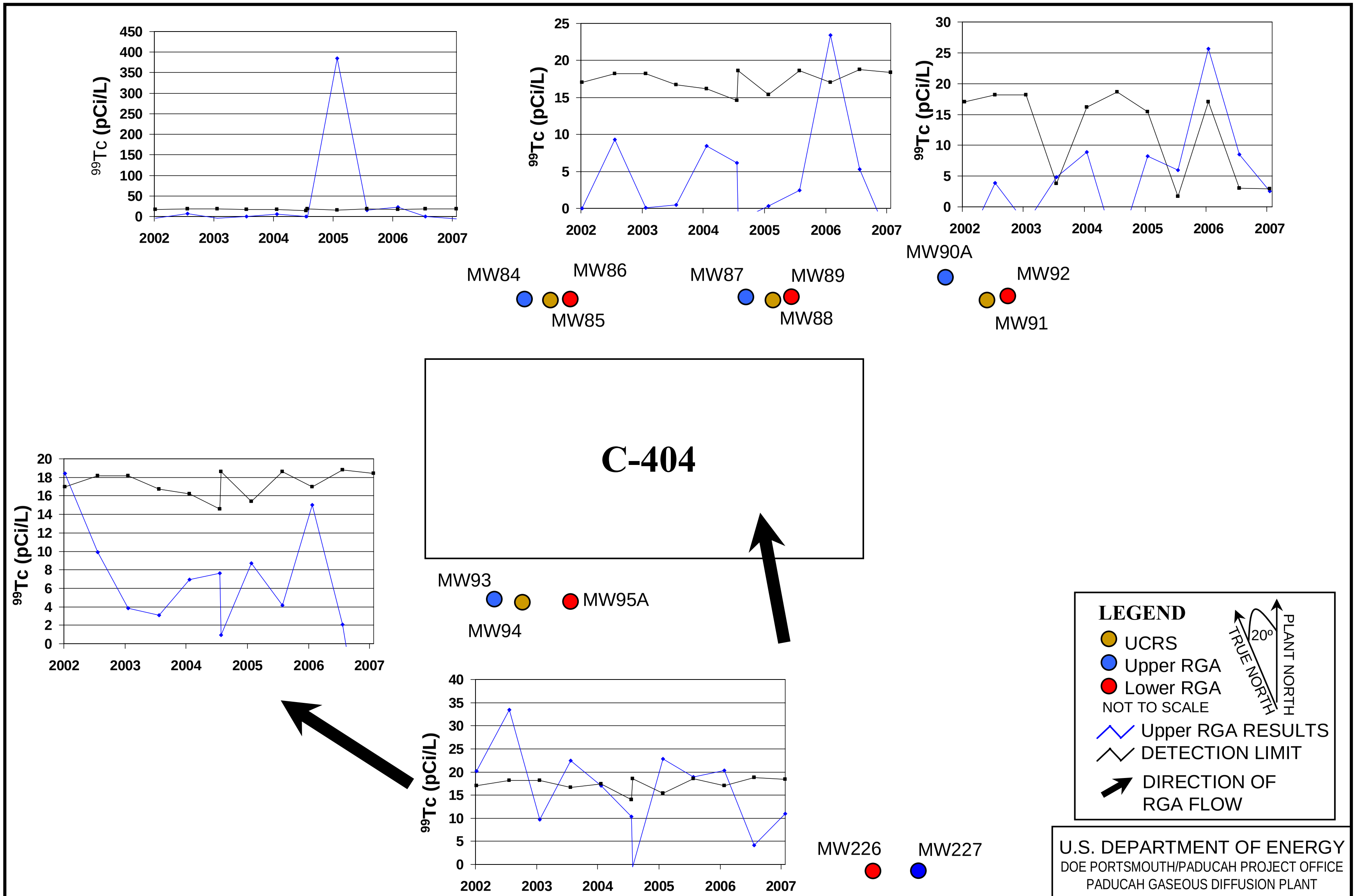

Figure 4.30. ^{99}Tc Trends in SWMU 3 Upper RGA Wells

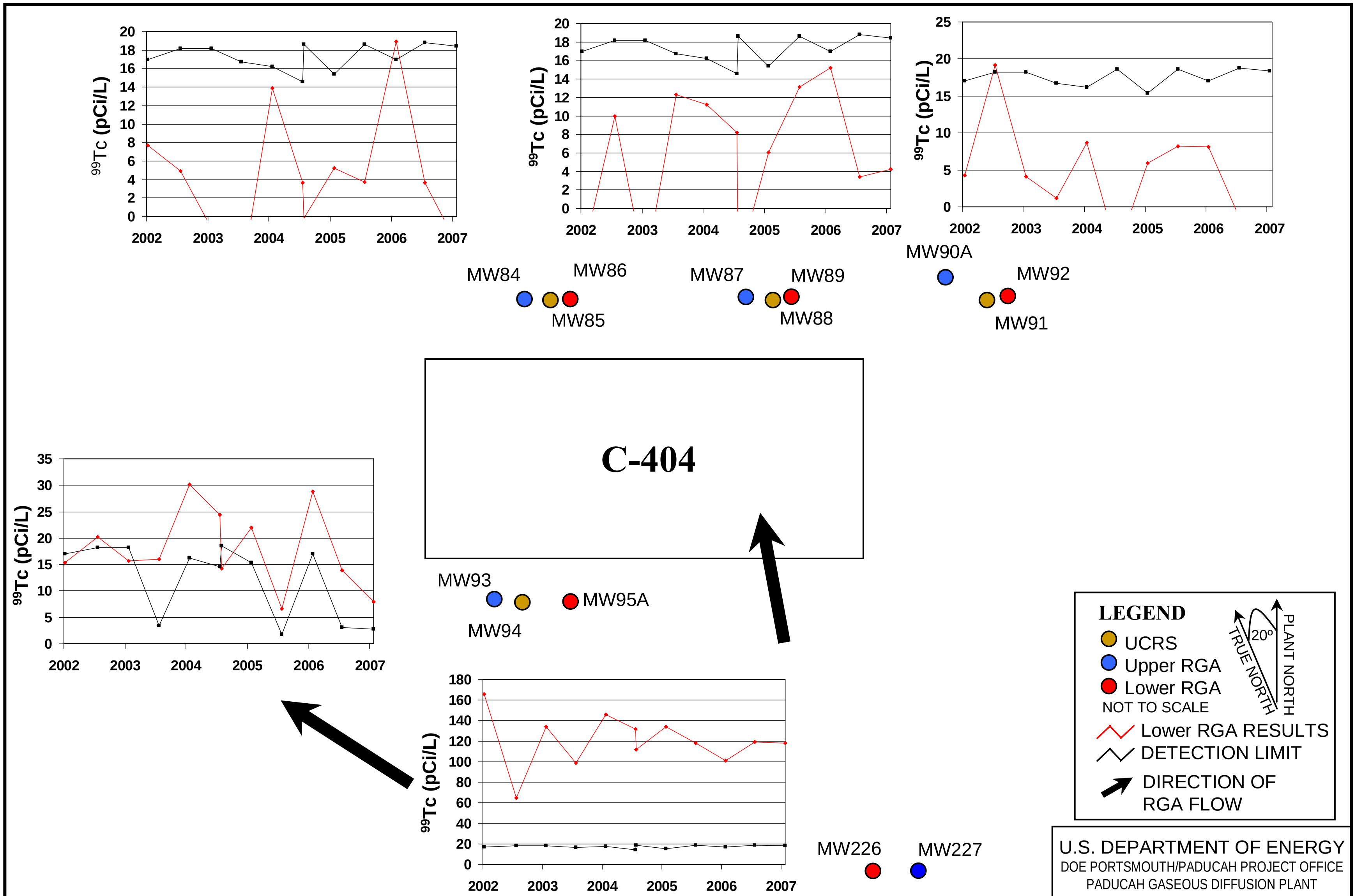

Figure 4.31. ^{99}Tc Trends in SWMU 3 Lower RGA Wells

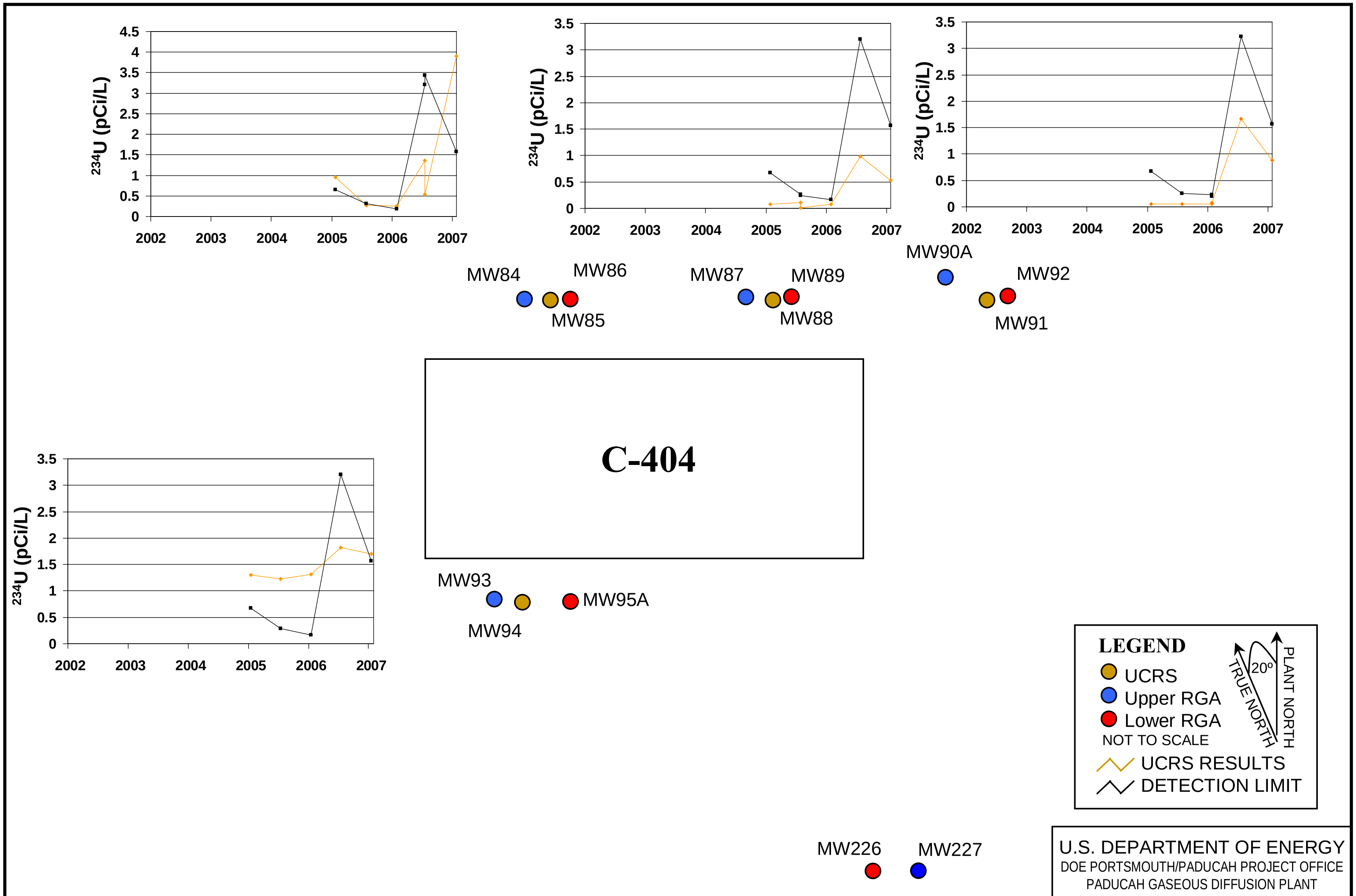

Figure 4.32. ^{234}U Trends in SWMU 3 UCRS Wells

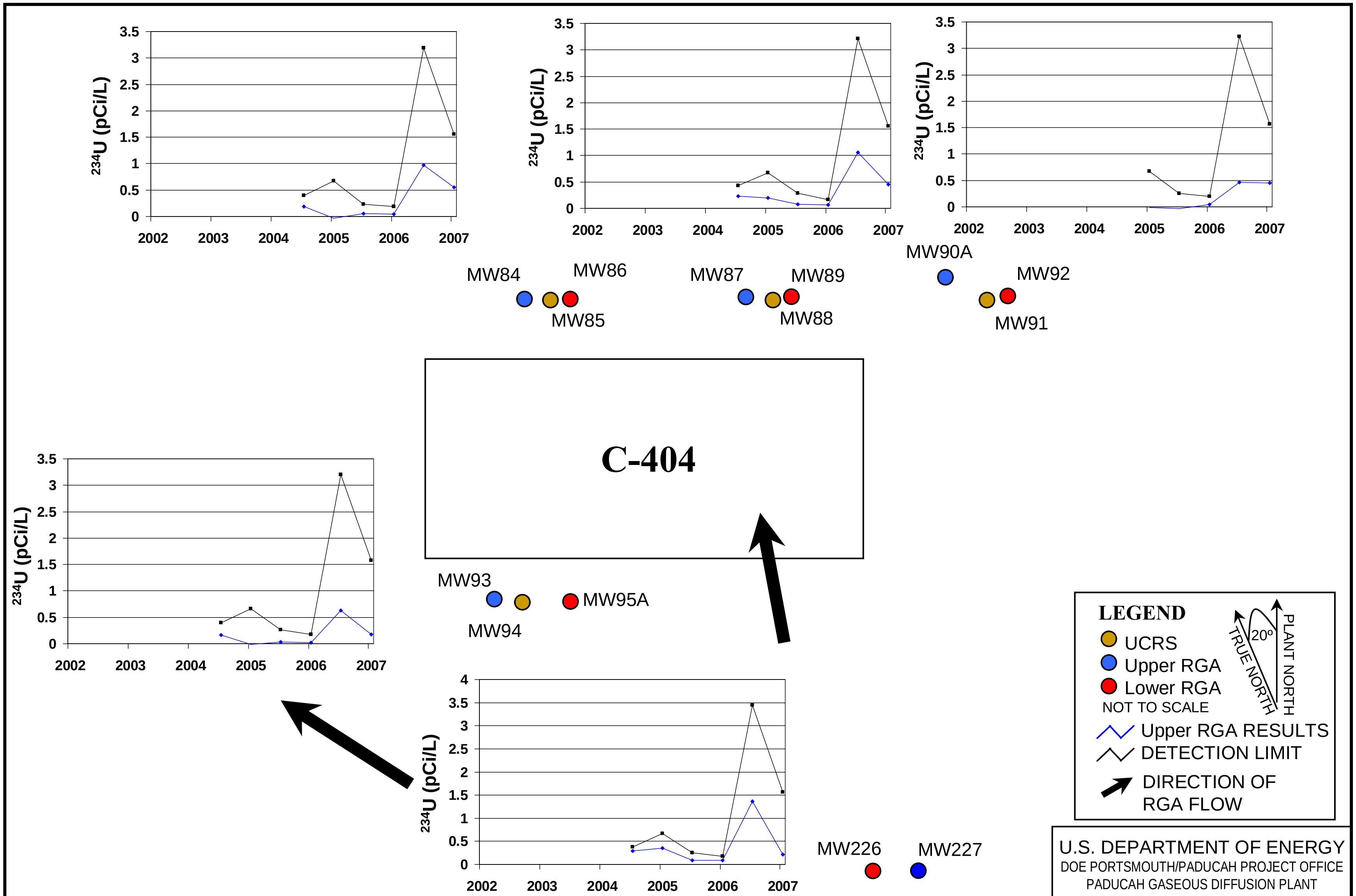

Figure 4.33. ^{234}U Trends in SWMU 3 Upper RGA Wells

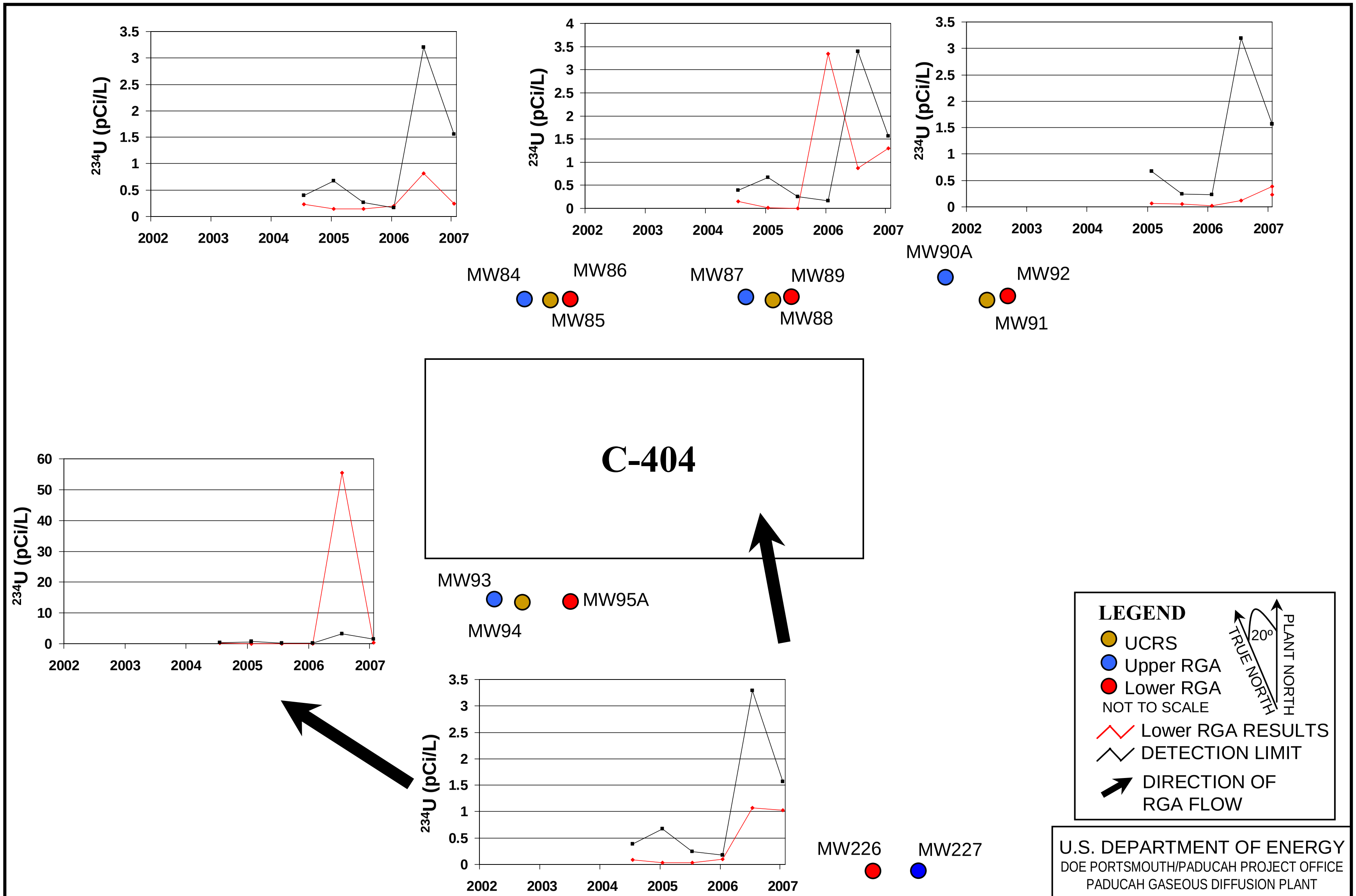

Figure 4.34. ^{234}U Trends in SWMU 3 Lower RGA Wells

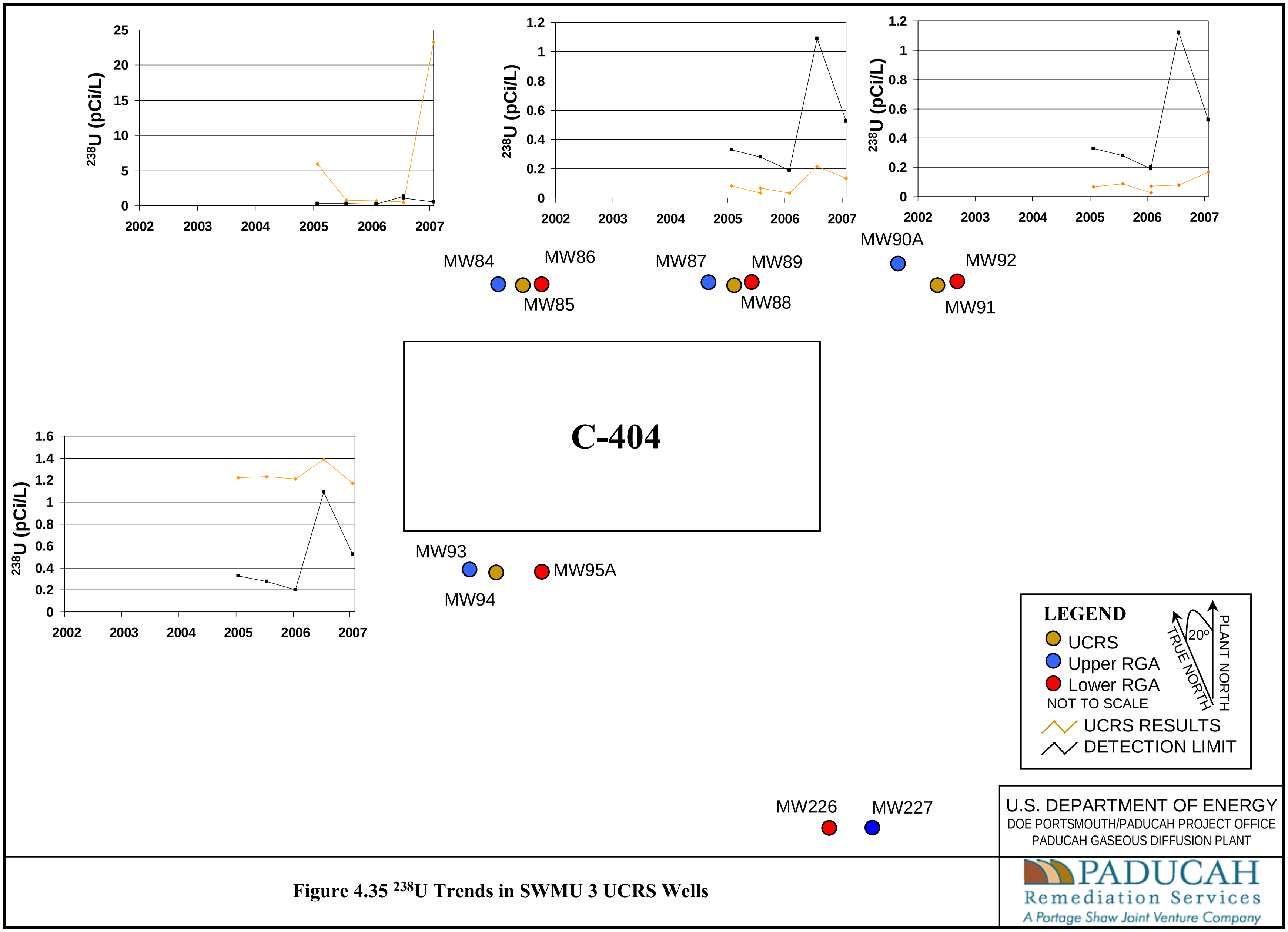

Figure 4.35 ^{238}U Trends in SWMU 3 UCRS Wells

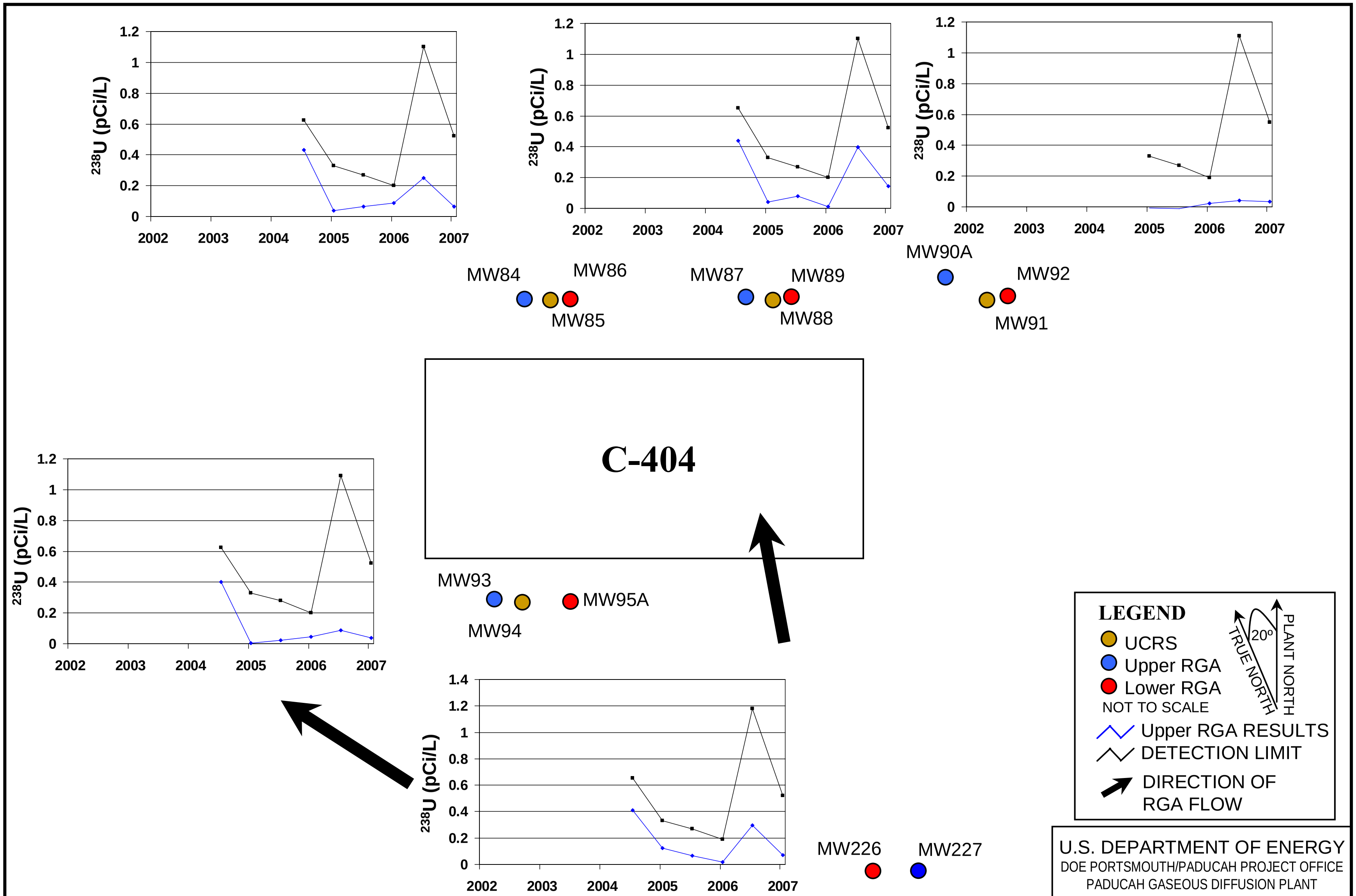

Figure 4.36. ^{238}U Trends in SWMU 3 Upper RGA Wells

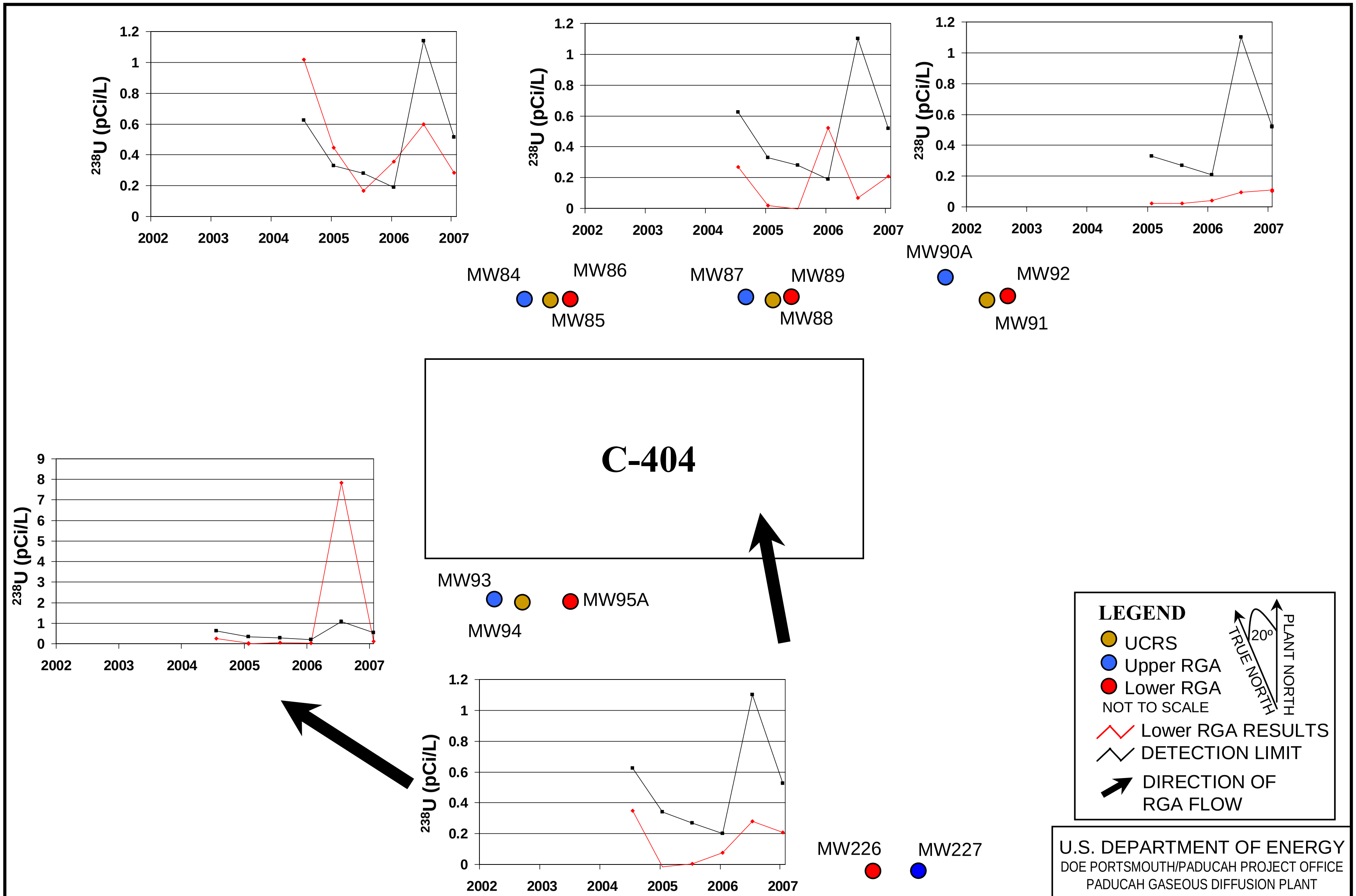

Figure 4.37. ^{238}U Trends in SWMU 3 Lower RGA Wells

4.4.3 SWMU 4

No additional sampling was conducted at SWMU 4 as part of this RI. The WAG 3 RI (DOE 2000a) provided the majority of data to characterize SWMU 4. Single temporary borings of the WAG 27 RI (DOE 1999d) and a site-wide remedial evaluation for source areas (DOE 2000b) supplied additional RGA data for the SWMU 4 area. The WAG 3 RI (DOE 2000a) provided analyses of UCRS groundwater from 26 temporary borings.

Three temporary soil borings of the WAG 3 RI (004-028, 004-029, and 004-058) and single temporary soil borings from the WAG 27 RI, DG-030 (DOE 1999d) and from a site-wide remedial evaluation for source areas (DOE 2000b) provided groundwater analyses to characterize the RGA. Tables 4.29 and 4.30 summarize the review of SWMU 4 UCRS and RGA groundwater data (primarily derived from the WAG 3 RI) to identify site-related contaminants. All RGA soil borings at SWMU 4, with the exception of 720-026, also sampled the McNairy. Groundwater samples at SWMU 4 characterized groundwater down to 50 ft below the base of the RGA. The screening steps determined that the only contaminant among the McNairy groundwater samples from SWMU 4 was TCE. Table 4.31 lists the locations of contaminants in SWMU 4 groundwater.

Table 4.29. SWMU 4 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL[a]	above Child Resident NAL[b]
Inorganics (mg/L)					
Arsenic	0.311	N/A[b]	23/27	21/27	23/27
Beryllium	0.13	N/A	12/34	12/34	12/34
Cadmium	0.031	N/A	7/23	7/23	7/23
Chromium	5.11	N/A	15/38	15/38	6/38
Copper	1.55	N/A	14/36	1/36	14/36
Iron	2560	N/A	33/38	N/A	31/38
Lead	1	N/A	9/9	9/9	9/9
Manganese	118	N/A	38/38	N/A	38/38
Mercury	0.004	N/A	7/31	1/31	7/31
Nickel	1.26	N/A	14/34	N/A	14/34
Vanadium	4.01	N/A	13/36	N/A	13/36
Zinc	8.2	N/A	24/38	N/A	15/38
Organics – Semivolatiles (mg/L)					
Naphthalene	0.007	N/A	1/17	N/A	1/17
Organics – Volatiles (mg/L)					
1,1-DCE	0.34	N/A	11/23	4/23	11/23
cis-1,2-DCE	12	N/A	22/33	14/33	20/33
trans-1,2-DCE	0.11	N/A	13/31	1/31	5/31
TCE	56	N/A	29/34	24/34	25/34
Vinyl chloride	0.44	N/A	12/26	9/26	12/26
Organics-Pesticides and PCBs (mg/L)					
PCB, Total	0.00091	N/A	2/5	1/5	2/5
PCB-1254	0.00091	N/A	2/5	1/5	2/5
Radionuclides (pCi/L)					
Technetium-99	1640	N/A	17/26	2/26	17/26

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.30. SWMU 4 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.045	N/A[b]	51/57	50/57	26/57	51/57
Beryllium	0.15	N/A	15/62	11/62	11/62	11/62
Iron	1830	N/A	86/108	41/108	N/A	72/108
Iron, Dissolved	1.22	N/A	4/4	4/4	N/A	4/4
Lead	0.328	N/A	7/8	3/8	4/8	4/8
Manganese	56.2	N/A	108/108	107/108	N/A	108/108
Manganese, Dissolved	1.59	N/A	4/4	4/4	N/A	4/4
Mercury	0.0064	N/A	4/46	3/46	2/46	2/46
Nickel	0.9	N/A	15/61	1/61	N/A	14/61
Vanadium	4.01	N/A	12/56	8/56	N/A	8/56
Zinc	3.54	N/A	22/72	21/72	N/A	7/72
Organics – Volatiles (mg/L)						
1,1-DCE	0.042	N/A	32/41	N/A	19/41	32/41
Carbon tetrachloride	0.061	N/A	3/5	N/A	2/5	3/5
Chloroform	0.055	N/A	3/4	N/A	N/A	3/4
cis-1,2-DCE	0.2	N/A	31/42	N/A	12/42	25/42
TCE	10	N/A	45/45	N/A	43/45	43/45
Vinyl chloride	0.017	N/A	20/38	N/A	3/38	20/38

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

The metals arsenic, iron, lead, and manganese frequently exceeded screening levels in both the UCRS and RGA. Volatile organic compounds also were common contaminants of the UCRS and RGA associated with SWMU 4. TCE levels exceeded the MCL in 43 of 45 analyses. Dissolved TCE trends indicate that a TCE DNAPL source is present in the UCRS at SWMU 4. A discrete DNAPL zone may be present at the base of the RGA. TCE degradation products, notably 1,1-DCE and *cis*-1,2-DCE, also frequently exceeded MCLs. Other volatile organic compounds present at SWMU 4 include carbon tetrachloride and chloroform.

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Table 4.31. SWMU 4 Locations of Groundwater Contaminants

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
UCRS	19-21	***Organics-Volatiles (mg/L)***																													
		1,1-DCE	ND		ND																							0.006			
		cis -1,2-DCE	ND		ND																							0.12			
		TCE	0.014		ND																							0.32			
		trans -1,2-DCE	ND		ND																							ND			
		Vinyl chloride	ND		ND																							0.29			
		Radionuclides (pCi/L)																													
		Technetium-99	1640		25																										
	23-24	***Organics-Volatiles (mg/L)***																													
		1,1-DCE																		0.0072							0.0007				
		cis -1,2-DCE																		1.5							0.1				
		TCE																		3.3							0.018				
		trans -1,2-DCE																		0.048							ND				
		Vinyl chloride																		0.34							0.12				
		Radionuclides (pCi/L)																													
		Technetium-99																		44							ND				
	25-26	***Inorganics (mg/L)***																													
		Beryllium																					ND								
		Cadmium																					ND								
		Chromium																					ND								
		Copper																					ND								
		Iron																					ND								
		Manganese																					4.47								
		Nickel																					ND								
		Vanadium																					ND								
		Zinc																					ND								
		Organics-Semivolatiles (mg/L)																													
		Naphthalene																					ND								
		Organics-Volatiles (mg/L)																													
		1,1-DCE																	0.05		0.0003		0.0015		0.002						
		cis -1,2-DCE																	0.96		0.069		0.0046		0.19						
		TCE																	23		0.35		0.09		0.73						
		trans -1,2-DCE																	ND		ND		ND		ND						
		Vinyl chloride																	0.071		0.0033		0.0016		0.001						
		Radionuclides (pCi/L)																													
		Technetium-99																	1240		390		23.6		23						
	36-40	***Organics-Semivolatiles (mg/L)***																													
		Naphthalene		ND																				ND							
		Organics-Volatiles (mg/L)																													
		1,1-DCE		ND																				0.0009		ND					
		cis -1,2-DCE		11																				ND		ND					
		TCE		19																				ND		0.002					
		trans -1,2-DCE		0.1																				ND		ND					
		Vinyl chloride		ND																				0.0002		ND					
		Radionuclides (pCi/L)																													
		Technetium-99																						44		120					

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
UCRS	45-48	***Inorganics (mg/L)***																													
		Arsenic															0.019														
		Beryllium														0.13	0.099					ND									
		Cadmium															0.021					ND									
		Chromium														1.34	0.3					0.19									
		Copper														0.79	0.426					ND									
		Iron														2560	1560					63.4									
		Lead															0.642														
		Manganese														42.7	118					1.2									
		Mercury														ND	0.0018					ND									
		Nickel														0.7	ND					0.083									
		Vanadium														4.01	1.22					0.125									
		Zinc														3.54	2.73					ND									
		Organics-Semivolatiles (mg/L)																													
		Naphthalene														ND	ND					ND									
		Organics-Volatiles (mg/L)																													
		1,1-DCE														ND	0.081					ND									
		cis -1,2-DCE														ND	0.13					ND									
		TCE														ND	2.2					ND									
		trans -1,2-DCE														ND	0.012					ND									
		Vinyl chloride														ND	0.012					ND									
		Radionuclides (pCi/L)																													
		Technetium-99														ND	382					194									
	50-51	***Organics-Volatiles (mg/L)***																													
		1,1-DCE										0.34																			
		cis -1,2-DCE										9																			
		TCE										48																			
		trans -1,2-DCE										0.11																			
		Vinyl chloride										0.4																			
		Radionuclides (pCi/L)																													
		Technetium-99										ND																			
	60-61	***Inorganics (mg/L)***																													
		Arsenic				ND		0.009	0.311	0.052	0.203	ND	0.014	0.02	0.086																
		Beryllium				0.037	0.005	0.103	ND	0.074	0.115	0.093	0.118	0.097	0.026																
		Cadmium				0.01	ND	0.022	0.012	ND	0.031	0.022	ND		ND																
		Chromium				0.439	0.165	1.55	0.575	1.99	2.78	1.52	2.67	5.11	2.55																
		Copper				0.243	0.103	0.942	0.131	0.691	1.05	0.62	1.03	1.55	0.722																
		Iron				705	102	1810	128	885	2540	1700	966	2090	670																
		Lead						0.757		0.312	1	0.675	0.761	0.426	0.204																
		Manganese				12.1	1.23	12.2	0.923	12.2	34.9	17.3	57.3	32.8	5.99																
		Mercury				0.0013	ND	0.0015	ND	0.0007	ND	ND	0.004	0.0015	ND																
		Nickel				0.07	0.065	0.5	0.125	0.505	ND	0.5	0.813	1.26	0.504																
		Vanadium				0.862	0.143	1.49	ND	1.13	1.95	1.52	0.99	1.98	0.376																
		Zinc				1.28	ND	3.45	2.19	3.2	8.2	4.74	5.98	6.8	2.76																
		Organics-PCBs and Pesticides(mg/L)																													
		PCB, Total								ND			0.00039	0.00091	ND																
		PCB-1254								ND			0.0002	0.00091	ND																

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
UCRS	60-61	***Organics-Semivolatiles (mg/L)***																													
		Naphthalene				ND	ND	ND	ND	ND	ND	0.007	ND	ND																	
		Organics-Volatiles (mg/L)																													
		1,1-DCE				0.0007	ND	ND	ND		ND							ND													
		cis -1,2-DCE				0.015	ND	0.029	ND	11	0.003	12	ND	0.56	ND			ND													
		TCE				0.26	0.016	1.7	ND	35	0.046	56	ND	0.65				ND													
		trans -1,2-DCE				ND	ND	ND	ND		ND	0.041	ND	ND	ND			ND													
		Vinyl chloride				ND	ND	ND	ND		ND			0.44	ND			ND													
		Radionuclides (pCi/L)																													
		Technetium-99				720		375	ND	ND	16.3	157	ND	ND	ND																
RGA	48	***Inorganics (mg/L)***																													
		Arsenic																													0.007
		Beryllium																													0.09
		Iron																													1110
		Lead																													0.328
		Manganese																													56.2
		Mercury																													0.0064
		Nickel																													ND
		Vanadium																													0.931
		Zinc																													1.89
		Organics-Volatiles (mg/L)																													
		1,1-DCE																													ND
		cis -1,2-DCE																													ND
		TCE																													0.006
		Vinyl chloride																													ND
	63	***Inorganics (mg/L)***																													
		Arsenic															0.022														
		Beryllium														0.15	0.022														
		Iron														1830	338														
		Lead															0.22														
		Manganese														25.8	10.3														
		Mercury														0.0022	ND														
		Nickel														0.9	ND														
		Vanadium														4.01	0.342														
		Zinc														3.54	0.812														
		Organics-Volatiles (mg/L)																													
		1,1-DCE														ND	0.0053														
		cis -1,2-DCE														ND	0.081														
		TCE														0.063	1.4														
		Vinyl chloride														ND	0.0009														
	68	***Inorganics (mg/L)***																													
		Arsenic															0.045														0.009
		Beryllium														ND	0.007												0.006		ND
		Iron														74.6	132												110		64.6
		Manganese														2.09	1.5												5.82		20.5
		Mercury														ND	ND												ND		ND
		Nickel														0.056	ND												0.067		0.113

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
RGA	68	***Inorganics (mg/L)***																													
		Vanadium														ND	ND												ND		ND
		Zinc														ND	0.258												0.391		0.402
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.0006	0.011												ND		0.015
		cis -1,2-DCE														0.026	0.15												ND		0.055
		TCE														1	3.8												ND		1.6
		Vinyl chloride														0.0002	0.0022												ND		0.0009
	71-73	***Inorganics (mg/L)***																													
		Arsenic															0.028														0.015
		Beryllium														ND	0.012												ND		ND
		Iron														19.8	234												50.4		29.3
		Manganese														0.487	5.54												2.59		1.75
		Mercury														ND	ND												ND		ND
		Nickel														ND	ND												ND		ND
		Vanadium														ND	0.148												ND		ND
		Zinc														ND	0.479												ND		ND
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.0003	0.0097												ND		0.0081
		cis -1,2-DCE														0.028	0.14												ND	ND	0.08
		TCE														1.5	2.1												0.006	0.1	1.5
		Vinyl chloride														0.0002	0.002												ND		0.0009
	78	***Inorganics (mg/L)***																													
		Arsenic														0.007	0.008														0.019
		Beryllium														0.006	ND												ND		ND
		Iron														165	17.6												26.7		13.2
		Manganese														5.04	0.69												1.1		1.12
		Mercury														ND	ND												ND		ND
		Nickel														0.129	ND												ND		ND
		Vanadium														ND	ND												ND		ND
		Zinc														0.549	ND												ND		ND
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.0016	0.0043												ND		0.0088
		Carbon tetrachloride														ND															0.061
		Chloroform														ND															0.055
		cis -1,2-DCE														0.065	0.02												ND		0.13
		TCE														2.1	0.4												0.018		2.5
		Vinyl chloride														ND	0.0004												ND		0.0011
	82-83	***Inorganics (mg/L)***																													
		Arsenic														0.012													0.005	ND	0.011
		Beryllium														ND	ND												ND	ND	ND
		Iron														11.5	43.1												75.5	64.3	9.15
		Iron, Dissolved																												0.803	
		Lead																												ND	
		Manganese														0.854	0.475												11.9	0.884	1.61
		Manganese, Dissolved																												0.82	

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
RGA	82-83	***Inorganics (mg/L)***																													
		Mercury														ND	ND												ND	ND	ND
		Nickel														ND	ND												0.362	0.0411	ND
		Vanadium														ND	ND												ND	ND	ND
		Zinc														ND	ND												0.236	0.1	ND
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.012	0.0007												ND	0.012	0.018
		Carbon tetrachloride																												0.0042	
		Chloroform																												0.0021	
		cis -1,2-DCE														0.11	ND												ND	0.0079	0.065
		TCE														3.7	0.069												0.042	0.5	1.4
		Vinyl chloride														ND	ND												ND	ND	0.0008
	87-88	***Inorganics (mg/L)***																													
		Arsenic														0.009														ND	0.007
		Beryllium														ND	ND												ND	ND	ND
		Iron														102	129												47.3	68.4	41.5
		Iron, Dissolved																												1.19	
		Lead																												ND	
		Manganese														7.89	2.52												1.99	1.88	1.98
		Manganese, Dissolved																												1.56	
		Mercury														ND	ND												ND	ND	ND
		Nickel														0.059	ND												ND	0.0532	0.064
		Vanadium														ND	ND												ND	ND	ND
		Zinc														0.237	0.258												ND	0.132	ND
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.021	0.0007												ND	0.031	0.012
		Carbon tetrachloride																												0.012	
		Chloroform																												0.0029	
		cis -1,2-DCE														0.1	ND												ND	0.011	0.038
		TCE														2	0.054												0.08	0.86	1
		Vinyl chloride														0.0008	ND												ND	0.017	0.0011
	92-93	***Inorganics (mg/L)***																													
		Arsenic														0.013														ND	0.01
		Beryllium														ND	ND												0.009	ND	ND
		Iron														33.3	108												502	13.4	67.3
		Iron, Dissolved																												1.22	
		Lead																												ND	
		Manganese														1.1	1.44												5.75	1.42	1.74
		Manganese, Dissolved																												1.59	
		Mercury														ND	ND												ND	ND	ND
		Nickel														ND	ND												ND	ND	0.059
		Vanadium														ND	ND												0.2	ND	ND
		Zinc														ND	0.25												0.609	ND	ND

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
RGA	92-93	***Organics-Volatiles (mg/L)***																													
		1,1-DCE														0.021	0.0009												ND	0.015	0.041
		Carbon tetrachloride																											ND		
		cis-1,2-DCE														0.17	ND												ND		0.1
		TCE														2.1	0.11												0.027	0.903	4.5
		Vinyl chloride														0.0004	ND												ND		0.0019
	98	***Inorganics (mg/L)***																													
		Arsenic																													0.023
		Beryllium														ND	ND												0.006		ND
		Iron														37.9	17.6												499		7.38
		Lead																											0.21		
		Manganese														0.943	1.07												3.1		0.187
		Mercury														ND	0.0003												ND		ND
		Nickel														ND	ND												ND		ND
		Vanadium														ND	ND												0.417		ND
		Zinc														ND	ND												0.329		ND
		Organics-Volatiles (mg/L)																													
		1,1-DCE														0.0019	0.003												ND		0.042
		cis-1,2-DCE														0.0089	0.0048												ND		0.2
		TCE														0.18	0.18												ND		10
		Vinyl chloride														ND	0.0002												ND		0.0033
	103	***Inorganics (mg/L)***																													
		Arsenic																													0.016
		Beryllium																													ND
		Iron																													133
		Manganese																													1.77
		Mercury																													ND
		Nickel																													ND
		Vanadium																													ND
		Zinc																													0.23
		Organics-Volatiles (mg/L)																													
		1,1-DCE																													0.035
		cis-1,2-DCE																													0.15
		TCE																													3.7
		Vinyl chloride																													0.0015
	108	***Inorganics (mg/L)***																													
		Beryllium																													0.021
		Iron																													1110
		Manganese																													10.1
		Mercury																													ND
		Nickel																													0.6
		Vanadium																													0.281
		Zinc																													1.32

Table 4.31. SWMU 4 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	004-008	004-009	004-011	004-017	004-019	004-020	004-021	004-022	004-023	004-024	004-025	004-026	004-027	004-028	004-029	004-032	004-033	004-035	004-036	004-037	004-038	004-039	004-040	004-044	004-047	004-049	004-058	720-026	DG-030
RGA	108	***Organics-Volatiles (mg/L)***																												
		1,1-DCE																												0.006
		cis -1,2-DCE																												0.075
		TCE																												1.3
		Vinyl chloride																												ND
	113	***Inorganics (mg/L)***																												
		Beryllium																												ND
		Iron																												54.4
		Lead																												0.052
		Manganese																												2.12
		Mercury																												ND
		Nickel																												ND
		Vanadium																												0.199
		Zinc																												ND
		Organics-Volatiles (mg/L)																												
		1,1-DCE																												0.0006
		cis -1,2-DCE																												ND
		TCE																												0.037
		Vinyl chloride																												0.0005

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

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4.4.4 SWMU 5

UCRS groundwater samples were collected from two of three angled borings installed at SWMU 5 as part of this RI. Samples of 10 temporary borings of the WAG 3 RI (DOE 2000a) provided historical data for the UCRS at SWMU 5. RI data were reviewed with historical data to determine the UCRS contaminants listed in Table 4.32.

The SWMU 5 disposal pits extend to a depth of 6 to 15 ft. These are underlain by the HU2 horizon of the UCRS at depths of 20 to 40 ft. The shallowest groundwater samples were from two WAG 3 RI soil borings at depths of 20-30 ft.

The remainder of the UCRS groundwater samples were from depths of 40 to 61 ft. Screening identified many metals in these UCRS groundwater samples from SWMU 5 with concentrations that exceed screening criteria. Of these, iron, lead, manganese, and molybdenum analyses had the highest frequency of exceedances. (Lead exceeded its MCL at three locations.) Locations with metals that exceed screening criteria were well distributed across the SWMU. Organics were not analyzed during this RI; however, analyses of historical samples of UCRS groundwater documented single detections of pyrene and TCE at concentrations that exceed screening levels. No radionuclide analyses exceeded screening criteria in the UCRS groundwater samples.

This RI did not collect RGA and McNairy groundwater at SWMU 5; however, historical data were reviewed to determine the RGA groundwater contaminants listed in Table 4.33. (The screening determined that there were no McNairy groundwater contaminants.) Only locations 005-013 and 005-026 of the WAG 3 RI were sampled for metals, organics, and radionuclides in RGA and McNairy groundwater. Additionally, the location DG-002 was sampled for VOCs and radionuclides (DOE 2000b). Manganese exceeded screening criteria in all 51 RGA groundwater samples from SWMU 5. Iron was the only other metal that commonly was present at levels exceeding screening criteria. TCE concentrations exceeded screening criteria throughout the depth of the RGA. These occurrences likely are related to the Northwest Plume, which passes to the east of the SWMU 5 area.

Table 4.32. SWMU 5 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.014	0.00182	3/4	1/4	3/4
Beryllium	0.144	N/A[b]	5/18	5/18	5/18
Chromium	6.47	N/A	6/20	6/20	3/20
Copper	1.81	N/A	6/20	1/20	6/20
Iron	2090	37.9	16/20	N/A	16/20
Lead	0.816	0.00208	6/6	4/6	4/6
Manganese	54.8	0.712	20/20	N/A	20/20
Mercury	0.0025	N/A	4/16	1/16	3/16
Molybdenum	N/A	0.0386	2/2	N/A	2/2
Nickel	1.37	0.0311	7/20	N/A	7/20
Vanadium	2.62	N/A	5/18	N/A	5/18
Zinc	6.77	0.064	10/18	N/A	5/18
Organics – Semivolatiles (mg/L)					
Pyrene	0.023	N/A	1/6	N/A	1/6
Organics – Volatiles (mg/L)					
TCE	0.029	N/A	1/10	1/10	1/10

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.33. SWMU 5 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Beryllium	0.032	N/A[b]	6/29	6/29	6/29	6/29
Cadmium	0.044	N/A	1/19	1/19	1/19	1/19
Iron	2160	N/A	41/51	19/51	N/A	35/51
Lead	0.655	N/A	1/1	1/1	1/1	1/1
Manganese	51.3	N/A	51/51	51/51	N/A	51/51
Vanadium	1.21	N/A	6/29	2/29	N/A	6/29
Zinc	0.466	N/A	6/29	6/29	N/A	1/29
Organics – Volatiles (mg/L)						
TCE	0.033	N/A	14/24	N/A	7/24	9/24

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.34 shows the locations of SWMU 5 groundwater contaminants.

Table 4.34. SWMU 5 Locations of Groundwater Contaminants

			Historical Data										RI Data		
Unit	Depth (ft)	Analysis	005-013	005-015	005-016	005-017	005-018	005-019	005-020	005-021	005-022	005-026	005-101	005-102	DG-002
UCRS	20-30	***Organics-Volatiles (mg/L)***													
		TCE			ND	ND									
	40-45	***Inorganics (mg/L)***													
		Arsenic											ND	0.00182	
		Beryllium											ND	ND	
		Chromium											ND	ND	
		Copper											ND	ND	
		Iron											34.7	37.9	
		Lead											ND	ND	
		Manganese											0.712	0.295	
		Mercury											ND	ND	
		Molybdenum											0.0376	0.0386	
		Nickel											ND	0.0311	
		Vanadium											ND	ND	
		Zinc											ND	ND	
	60-61	***Inorganics (mg/L)***													
		Arsenic						0.014							
		Beryllium		0.008			0.045	0.144		0.047	ND				
		Chromium		0.157			2.04	6.47		1.31	0.404				
		Copper		0.186			0.596	1.81		0.627	0.085				
		Iron		111			787	2090		631	62.6				
		Lead					0.248	0.816		0.258					
		Manganese		1.64			11.4	54.8		21	1.44				
		Mercury		ND			ND	0.0025		0.0017	ND				
		Nickel		0.1			0.482	1.37		0.54	0.129				
		Vanadium		0.159			0.765	2.62		0.756	ND				
		Zinc		0.556			2.44	6.77		2.24	ND				
		Organics-Semivolatiles (mg/L)													
		Pyrene		0.023			ND	ND		ND	ND				
		Organics-Volatiles (mg/L)													
		TCE		ND			ND	ND	ND	ND	0.029				
RGA	63	***Inorganics (mg/L)***													
		Beryllium	0.005									0.006			
		Cadmium	ND									ND			
		Iron	91.5									109			
		Manganese	1.73									7.16			

Table 4.34. SWMU 5 Locations of Groundwater Contaminants (Continued)

			Historical Data										RI Data		
Unit	Depth (ft)	Analysis	005-013	005-015	005-016	005-017	005-018	005-019	005-020	005-021	005-022	005-026	005-101	005-102	DG-002
RGA	63	***Inorganics (mg/L)***													
		Vanadium	0.105									0.108			
		Zinc	0.297									0.466			
		Organics-Volatiles (mg/L)													
		TCE	ND									ND			
	68	***Inorganics (mg/L)***													
		Beryllium	ND									0.009			
		Cadmium	ND									ND			
		Iron	14.6									172			
		Manganese	2.43									14.5			
		Vanadium	ND									0.13			
		Zinc	ND									0.407			
		Organics-Volatiles (mg/L)													
		TCE	0.006									ND			
	70-73	***Inorganics (mg/L)***													
		Beryllium	ND									ND			
		Cadmium	ND									ND			
		Iron	90.4									20.3			
		Manganese	6.52									3.53			
		Vanadium	ND									ND			
		Zinc	ND									ND			
		Organics-Volatiles (mg/L)													
		TCE	0.01									ND			ND
	76-78	***Inorganics (mg/L)***													
		Beryllium	0.005									ND			
		Cadmium	ND									ND			
		Iron	590									41.4			
		Manganese	5.97									3.98			
		Vanadium	ND									ND			
		Zinc	ND									ND			
		Organics-Volatiles (mg/L)													
		TCE	0.033									0.008			ND
	81-83	***Inorganics (mg/L)***													
		Beryllium										ND			
		Cadmium										ND			
		Iron										130			
		Manganese										9.93			

Table 4.34. SWMU 5 Locations of Groundwater Contaminants (Continued)

			Historical Data										RI Data		
Unit	Depth (ft)	Analysis	005-013	005-015	005-016	005-017	005-018	005-019	005-020	005-021	005-022	005-026	005-101	005-102	DG-002
RGA	81-83	***Inorganics (mg/L)***													
		Vanadium										ND			
		Zinc										ND			
		Organics-Volatiles (mg/L)													
		TCE										0.003			ND
	86-88	***Inorganics (mg/L)***													
		Beryllium	ND									ND			
		Cadmium	ND									ND			
		Iron	120									215			
		Manganese	9.85									8.8			
		Vanadium	ND									ND			
		Zinc	ND									0.257			
		Organics-Volatiles (mg/L)													
		TCE	0.02									0.005			ND
	90-93	***Inorganics (mg/L)***													
		Beryllium	ND									0.032			
		Cadmium	ND									0.044			
		Iron	348									2160			
		Lead										0.655			
		Manganese	7.85									51.3			
		Vanadium	ND									1.21			
		Zinc	0.23									ND			
		Organics-Volatiles (mg/L)													
		TCE	0.015									ND			ND
	98	***Inorganics (mg/L)***													
		Beryllium	ND									0.009			
		Cadmium	ND									ND			
		Iron	54.7									312			
		Manganese	1.73									1.81			
		Vanadium	0.101									0.473			
		Zinc	ND									0.403			
		Organics-Volatiles (mg/L)													
		TCE	ND									ND			

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

4.4.5 SWMU 6

UCRS groundwater samples were collected from all of the four angled borings installed at SWMU 6 as part of this RI. The WAG 3 RI sampled UCRS groundwater from 15 borings at SWMU 6 (DOE 2000a). RI data were reviewed with historical data (primarily from the WAG 3 RI) to determine the contaminants listed in Table 4.35.

Table 4.35. SWMU 6 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.014	0.15	9/12	3/12	9/12
Beryllium	0.09	0.0929	6/25	6/25	6/25
Cadmium	0.039	0.0288	5/21	3/21	5/21
Chromium	3	3.32	12/39	11/39	2/39
Iron	2640	2110	35/41	N/A[b]	33/41
Iron, Dissolved	N/A	61.1	2/2	N/A	2/2
Lead	2.03	2.02	7/7	5/7	5/7
Manganese	93	170	38/41	N/A	38/41
Mercury	0.003	0.00279	7/25	2/25	4/25
Molybdenum	N/A	0.359	4/4	N/A	4/4
Nickel	0.69	0.953	12/33	N/A	12/33
Uranium	N/A	0.315	3/4	2/4	3/4
Vanadium	3.34	N/A	11/39	N/A	11/39
Zinc	4.16	10.8	17/37	N/A	11/37
Organics-Pesticides and PCBs (mg/L)					
PCB-1016	0.255	N/A	2/12	2/12	2/12
Radionuclides (pCi/L)					
Neptunium-237	219	N/A	1/14	1/14	1/14
Technetium-99	2920	310	16/18	6/18	16/18
Uranium-234	754	24	3/5	N/A	3/5
Uranium-238	1520	21.8	4/5	N/A	4/5

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

The SWMU 6 disposal pits are approximately 6 to 8 ft deep. Two temporary borings of the WAG 3 RI (006-011 and 006-012) provided groundwater samples from directly below the pits, from depths of 9–12 ft within the area of Pit J (used for contaminated aluminum scrap disposal). Metals, notably iron, and the radionuclides ^{237}Np, ^{99}Tc, ^{234}U, and ^{238}U exceeded screening criteria. Samples from both borings contained PCB-1016, at levels of 0.05 to 0.26 mg/L. These were the only occurrences of organic contaminants at levels that exceed screening criteria in the UCRS groundwater samples from SWMU 6. UCRS groundwater samples from the locations 006-101, which angled beneath "Pit J," and 006-029, which sampled directly north of "Pit J," contained the highest levels of beryllium, cadmium, iron, lead, manganese, and mercury.

The HU2 interval of the UCRS occurs at approximate depths of 20 to 30 ft beneath SWMU 6. Groundwater samples from borings 006-017, 006-018, 006-025, 006-029, and 006-104 characterized contaminant levels in the HU2 interval. As discussed above, metals exceeded screening criteria with notably elevated levels of iron. The radionuclides ^{99}Tc, ^{234}U, and ^{238}U also exceeded screening criteria. These same contaminant trends persist through the HU3 interval. Ten temporary borings sampled groundwater in the HU3 interval: 006-019, 006-020, 006-021, 006-022, 006-023, and 006-028. (See Figure 4.13 for the location of these borings.)

RGA and McNairy groundwater samples were not collected at SWMU 6 as part of this RI; however, historical data were reviewed to identify the contaminants listed in Table 4.36. (The screen of analyses of McNairy groundwater samples from SWMU 6 determined that no groundwater contaminants are present.) RGA and McNairy groundwater samples were collected from the locations 006-025, north of the SWMU, and 006-024, located to the southeast. For those metals detected above screening levels in the RGA (all but manganese) and for TCE (the lone organic contaminant), the higher contaminant levels represent samples from 006-025. Iron and manganese continued to be the most common metals to exceed screening levels. TCE levels were greater than its MCL in nearly all RGA samples. The presence of TCE is due to the Northwest Plume; the west side of the plume passes beneath SWMU 6.

Table 4.36. SWMU 6 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.013	N/A[b]	3/3	1/3	1/3	3/3
Beryllium	0.029	N/A	3/21	3/21	3/21	3/21
Cadmium	0.015	N/A	2/19	2/19	2/19	2/19
Iron	2210	N/A	35/42	15/42	N/A	30/42
Lead	0.788	N/A	1/1	1/1	1/1	1/1
Manganese	27.1	N/A	42/42	42/42	N/A	42/42
Vanadium	1.24	N/A	1/18	1/18	N/A	1/18
Organics – Volatiles (mg/L)						
TCE	0.74	N/A	18/18	N/A	15/18	16/18

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.37 lists the locations of these SWMU 6 groundwater contaminants.

Table 4.37. SWMU 6 Locations of Groundwater Contaminants

			Historical Data															RI Data			
Unit	Depth (ft)	Analysis	006-009	006-011	006-012	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-024	006-025	006-028	006-029	006-101	006-102	006-103	006-104
UCRS	9-12	***Inorganics (mg/L)***																			
		Arsenic			0.005																
		Beryllium		ND	ND																
		Cadmium		ND	ND																
		Chromium		ND	ND																
		Iron		17.6	65.3																
		Manganese		0.43	1.98																
		Mercury		ND	ND																
		Nickel		ND	0.061																
		Vanadium		ND	0.137																
		Zinc		ND	ND																
		Organics-Pesticides and PCBs (mg/L)																			
		PCB-1016		0.255	0.053																
		Radionuclides (pCi/L)																			
		Neptunium-237		219	ND																
		Technetium-99		1810	2920																
		Uranium-234		754																	
		Uranium-238		1520																	
	21-22	***Inorganics (mg/L)***																			
		Arsenic															0.005				
		Beryllium					ND										0.09				
		Cadmium					ND										0.039				
		Chromium					ND										3				
		Iron					0.869										2640				
		Lead															2.03				
		Manganese					1.54										93				
		Mercury					ND										0.003				
		Nickel					ND										ND				
		Vanadium					ND										3.34				
		Zinc					ND										4.16				
		Radionuclides (pCi/L)																			
		Technetium-99	ND														16				
	27-30	***Inorganics (mg/L)***																			
		Arsenic																			
		Beryllium						0.024							0.013						0.0225
		Cadmium						0.015							ND						0.00406
		Chromium						0.678							0.277						3.32
		Iron						652							300						732
		Iron, Dissolved																			25.7
		Lead						0.417							0.204						0.427
		Manganese						14.4							8.68						20.9
		Mercury						0.002							ND						0.000755

Table 4.37. SWMU 6 Locations of Groundwater Contaminants(Continued)

			Historical Data															RI Data			
Unit	Depth (ft)	Analysis	006-009	006-011	006-012	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-024	006-025	006-028	006-029	006-101	006-102	006-103	006-104
UCRS	27-30	***Inorganics (mg/L)***																			
		Molybdenum																			0.359
		Nickel						0.05							ND						0.953
		Uranium																			0.0438
		Vanadium						1.02							0.563						ND
		Zinc						1.02							0.536						9.19
		Organics-Pesticides and PCBs (mg/L)																			
		PCB-1016																			ND
		Radionuclides (pCi/L)																			
		Neptunium-237						ND													ND
		Technetium-99						55							ND						17.3
		Uranium-234																			5.53
		Uranium-238																			5.76
	35-37	***Inorganics (mg/L)***																			
		Beryllium				ND															
		Cadmium				ND															
		Chromium				0.125															
		Iron				78.4															
		Manganese				2.02															
		Mercury				ND															
		Nickel				0.052															
		Vanadium				0.162															
		Zinc				ND															
		Radionuclides (pCi/L)																			
		Neptunium-237				ND															
		Technetium-99				690										930					
	45-46	***Inorganics (mg/L)***																			
		Arsenic																ND	ND	ND	
		Beryllium																0.0929	ND	ND	
		Cadmium																0.0288	ND	0.000837	
		Chromium																ND	ND	ND	
		Iron																2110	124	62.2	
		Iron, Dissolved																	61.1		
		Lead																2.02	ND	ND	
		Manganese																170	4.35	1.89	
		Mercury																0.00279	ND	ND	
		Molybdenum																0.0231	0.182	0.0703	
		Nickel																ND	0.14	0.0523	
		Uranium																0.315	ND	0.00275	
		Vanadium																ND	ND	ND	
		Zinc																10.8	0.812	0.497	

Table 4.37. SWMU 6 Locations of Groundwater Contaminants(Continued)

			Historical Data															RI Data			
Unit	Depth (ft)	Analysis	006-009	006-011	006-012	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-024	006-025	006-028	006-029	006-101	006-102	006-103	006-104
UCRS	45-46	***Organics-Pesticides and PCBs (mg/L)***																			
		PCB-1016																ND	ND	ND	
		Radionuclides (pCi/L)																			
		Neptunium-237																ND	ND	ND	
		Technetium-99																310	113	104	
		Uranium-234																24	ND	ND	
		Uranium-238																21.8	ND	0.558	
	60-61	***Inorganics (mg/L)***																			
		Arsenic							0.006		0.006	0.013									
		Beryllium							ND	ND	ND	0.015	ND								
		Cadmium							ND	ND	ND	ND	ND								
		Chromium							0.649	0.586	1.07	1.67	0.514								
		Iron							74.4	92.5	158	389	126								
		Manganese							2.04	1.84	1.33	9.56	1.88								
		Mercury							ND	ND	ND	ND	ND								
		Nickel							0.32	0.368	0.38	0.69	0.243								
		Vanadium							0.068	0.103	0.076	0.348	0.17								
		Zinc							ND	ND	0.611	1.14	0.463								
		Organics-Pesticides and PCBs (mg/L)																			
		PCB-1016							ND	ND	ND	ND	ND								
		Radionuclides (pCi/L)																			
		Neptunium-237							ND	ND	ND	ND	ND								
		Technetium-99							983	255	956	46.8	823								
RGA	68-68	***Inorganics (mg/L)***																			
		Beryllium												ND	0.006						
		Cadmium												ND	ND						
		Iron												63.8	88.8						
		Manganese												5.58	4.25						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.006	ND						
	73-73	***Inorganics (mg/L)***																			
		Beryllium												ND	ND						
		Cadmium												ND	ND						
		Iron												78.1	14.4						
		Manganese												9.36	1.24						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.005	0.01						

Table 4.37. SWMU 6 Locations of Groundwater Contaminants(Continued)

			Historical Data															RI Data			
Unit	Depth (ft)	Analysis	006-009	006-011	006-012	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-024	006-025	006-028	006-029	006-101	006-102	006-103	006-104
RGA	77-78	***Inorganics (mg/L)***																			
		Beryllium												ND	ND						
		Cadmium												ND	ND						
		Iron												9.28	144						
		Manganese												4.49	11.6						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.006	0.015						
	82-83	***Inorganics (mg/L)***																			
		Arsenic													0.005						
		Beryllium												ND	ND						
		Cadmium												ND	ND						
		Iron												52.7	46.6						
		Manganese												5.58	2.72						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.019	0.031						
	88-88	***Inorganics (mg/L)***																			
		Arsenic													0.005						
		Beryllium												ND	ND						
		Cadmium												ND	ND						
		Iron												139	77.8						
		Manganese												15.6	4.4						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.029	0.06						
	93-93	***Inorganics (mg/L)***																			
		Beryllium												0.006	ND						
		Cadmium												0.011	ND						
		Iron												245	112						
		Manganese												27.1	11.1						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.1	0.17						
	98-98	***Inorganics (mg/L)***																			
		Beryllium												ND	ND						
		Cadmium												ND	ND						
		Iron												52.4	71.9						
		Manganese												0.433	1.93						
		Vanadium												ND	ND						
		Organics-Volatiles (mg/L)																			
		TCE												0.27	0.74						

Table 4.37. SWMU 6 Locations of Groundwater Contaminants(Continued)

			Historical Data															RI Data			
Unit	**Depth (ft)**	**Analysis**	006-009	006-011	006-012	006-016	006-017	006-018	006-019	006-020	006-021	006-022	006-023	006-024	006-025	006-028	006-029	006-101	006-102	006-103	006-104
RGA	103	***Inorganics (mg/L)***																			
		Arsenic													0.013						
		Beryllium													0.029						
		Cadmium													0.015						
		Iron													2210						
		Lead													0.788						
		Manganese													14.5						
		Vanadium													1.24						
		Organics-Volatiles (mg/L)																			
		TCE													0.01						

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

4.4.6 SWMU 7

The SWMU 7 waste pits containing various uranium-contaminated wastes are 8 to 15 ft deep. Seven temporary soil borings sampled groundwater from within and immediately below the waste pits: WB-7, WB-8, WB-9, WBP-9A, WB-12, WBP-12A, and WB-13. Several metals, the uranium isotopes and vinyl chloride were the primary contaminants that exceeded screening levels in these samples. These same contaminants were common throughout the thickness of the UCRS.

UCRS groundwater samples were collected from six of eight angled borings and three deep vertical borings installed at SWMU 7 as part of this RI. Several sources of historical UCRS groundwater data were available for SWMU 7, as follows:

- Wells MW186 and MW187 (with a period of record for 1995 through 2007);
- Temporary borings GW-01, GW-02, GW-03, WB-7, WB-8, WB-9, WB-12, and WB-13 of the SWMUs 7 and 30 RI (DOE 1998c);
- Temporary borings WBP-9A and WBP-12A from a 1998 follow-up investigation of some SWMU 7 waste pits; and
- Temporary boring DG-005 of the site-wide remedial evaluation for source areas (DOE 2000b).

RI data were reviewed with historical data to determine the UCRS contaminants listed in Table 4.38. Screening identified nine metals in UCRS groundwater samples from SWMU 7 with levels that exceed MCLs. Arsenic, iron, and manganese were the most frequently detected metals.

Organic contaminants in UCRS groundwater at SWMU 7 consisted of five VOCs. TCE and its reductive dechlorination products *cis*-12-DCE and vinyl chloride were the most frequently detected organic contaminants. The radionuclide contaminants present in the SWMU 7 UCRS groundwater samples were ^{222}Rn and the uranium isotopes ^{234}U and ^{238}U.

The HU2 interval is relatively thin beneath SWMU 7, at approximate depths of 20 to 25-to-30 ft bgs. Seven temporary soil borings: 007-007, 007-010, 007-011, DG-005, GW-01, GW-02, and GW-03, and wells MW186 and MW187 provided groundwater samples from these depths. In addition to the radionuclides in the vicinity of the waste pits, significant levels of ^{222}Rn were present. Organic contaminants from the HU2 interval included TCE, *cis*-1,2-DCE, and vinyl chloride. (The relatively high level of the TCE degradation products, compared to TCE levels in this interval, is unusual at PGDP.)

Five temporary soil borings of the RI: 007-001, 007-002, 007-003E, 007-008, and 007-009, sampled the HU3 interval. Metals, the uranium isotopes, and TCE and its degradation products were the primary contaminants exceeding screening levels.

RGA groundwater samples were collected from 10 ft intervals within the three deep vertical borings installed as part of this RI. Historical data for the RGA were available from MW185, MW339, MW340, and temporary soil borings DG-005, GW-01, GW-02, and GW-03. This data, together with historical data were reviewed to identify the contaminants listed in Table 4.39.

Table 4.38. SWMU 7 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.31	0.276	20/24	16/24	20/24
Arsenic, Dissolved	0.173	0.316	14/15	7/15	6/15
Beryllium	0.039	0.0379	11/24	8/24	8/24
Cadmium	0.03	0.00695	9/24	4/24	9/24
Chromium	1.5	2.43	14/24	8/24	1/24
Copper	1.8	N/A	4/24	1/24	4/24
Iron	1200	1010	24/24	N/A[b]	22/24
Iron, Dissolved	0.41	53.4	11/15	N/A	6/15
Lead	1.1	0.694	14/17	10/17	10/17
Manganese	28	8.73	24/24	N/A	24/24
Manganese, Dissolved	0.55	2.9	15/15	N/A	6/15
Mercury	0.0028	0.00117	10/22	1/22	5/22
Molybdenum	1.4	0.429	11/17	N/A	10/17
Nickel	7.6	0.703	16/24	N/A	15/24
Nickel, Dissolved	1.2	0.0753	11/14	N/A	3/14
Uranium	83	0.239	28/117	21/117	25/117
Vanadium	1.8	1.72	8/17	N/A	7/17
Zinc	4	4.23	17/24	N/A	9/24
Organics – Semivolatiles (mg/L)					
Naphthalene	0.0042	N/A	3/16	N/A	3/16
Organics – Volatiles (mg/L)					
1,1-DCE	0.0029	0.0094	3/31	1/31	3/31
Benzene	0.0078	0.012	10/43	6/43	10/43
cis-1,2-DCE	2.9	6.5	63/101	50/101	61/101
TCE	2	12	89/100	86/100	87/100
Vinyl chloride	3.8	2.6	44/63	44/63	44/63
Radionuclides (pCi/L)					
Radon-222	801	N/A	6/7	N/A	6/7
Uranium-234	764	18.8	24/32	N/A	22/32
Uranium-238	4910	125	27/32	N/A	22/32

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.39. SWMU 7 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.42	0.481	48/55	44/55	32/55	40/55
Arsenic, Dissolved	0.12	0.0436	26/30	17/30	12/30	4/30
Beryllium	0.073	0.0732	33/49	22/49	22/49	19/49
Cadmium	0.016	0.02	24/47	10/47	11/47	16/47
Chromium	2	1.46	34/47	28/47	29/47	2/47
Iron	2200	2460	57/57	46/57	N/A[b]	46/57
Lead	1.6	0.489	35/39	13/39	27/39	20/39
Manganese	22	72.4	57/57	43/57	N/A	43/57
Manganese, Dissolved	0.1	12.8	29/30	25/30	N/A	2/30
Molybdenum	0.33	0.0916	31/39	15/39	N/A	18/39
Nickel	1.6	1.18	37/51	9/51	N/A	28/51
Uranium	0.09	0.093	26/156	24/156	8/156	15/156
Vanadium	2.7	N/A	14/43	9/43	N/A	13/43
Zinc	9.8	4.28	33/47	32/47	N/A	18/47
Organics – Volatiles (mg/L)						
Carbon tetrachloride	0.041	N/A	7/56	N/A	5/56	7/56
Chloroform	0.012	N/A	9/54	N/A	N/A	9/54
cis-1,2-DCE	2.1	0.58	31/107	N/A	13/107	28/107
TCE	25	18	139/141	N/A	136/141	125/141
Vinyl chloride	N/A	0.3	5/66	N/A	5/66	3/66
Radionuclides (pCi/L)						
Technetium-99	5116.9	812	136/141	130/141	43/141	123/141
Uranium-234	18.6	8.71	38/69	34/69	N/A	23/69
Uranium-238	20.3	13.9	48/71	34/71	N/A	23/71

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

The data review revealed the occurrence of 12 metal contaminants in the RGA groundwater samples from SWMU 7. As in the UCRS samples, arsenic, iron, and manganese were the most frequently detected groundwater contaminants. All of the SWMU 7 RGA organic groundwater contaminants were VOCs. TCE was the dominant organic contaminant. The RGA groundwater radionuclide contaminants of SWMU 7 consist of ^{99}Tc, ^{234}U, and ^{238}U. The occurrence of VOCs and ^{99}Tc in the RGA is largely due to the Northwest Plume, which passes beneath SWMU 7.

Three locations, GWW-01, GWW-02, and GWW-03 were sampled for McNairy groundwater, close to the McNairy contact with the RGA, at SWMU 7. Table 4.40 summarizes the review of the McNairy groundwater analyses; TCE and chloroform were the only contaminants identified.

Table 4.40. SWMU 7 McNairy Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Organics – Volatiles (mg/L)						
Chloroform	0.0038	N/A[b]	3/4	N/A	N/A	3/4
TCE	0.32	N/A	4/4	N/A	4/4	4/4

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Table 4.41 identifies all the locations of SWMU 7 groundwater contaminants.

Table 4.41. SWMU 7 Locations of Groundwater Contaminants

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
UCRS	7-9	***Inorganics (mg/L)***																									
		Arsenic																			0.0082	0.11			0.31		
		Beryllium																			ND	0.015			0.039		
		Cadmium																			ND	0.008			0.03		
		Chromium																			ND	0.6			1.5		
		Copper																			ND	0.41			1.8		
		Iron																			10	420			1200		
		Lead																			ND	0.32			0.73		
		Manganese																			0.46	12			28		
		Mercury																			ND	0.0006			0.0028		
		Molybdenum																			1.4	ND			ND		
		Nickel																			0.019	6.3			7.6		
		Uranium																			0.88	83			14	0.15	
		Vanadium																			0.022	0.7			1.8		
		Zinc																			0.075	1.6			4		
		Organics - Semivolatiles (mg/L)																									
		Naphthalene																			0.0027				ND		
		Organics - Volatiles (mg/L)																									
		1,1-DCE																			ND	ND			ND		
		Benzene																			0.0039	ND			0.00074		
		cis -1,2-DCE																			0.0022	ND			ND		
		TCE																			0.0013	ND			ND		
		Vinyl chloride																			0.011	ND			ND		
		Radionuclides(pCi/L)																									
		Uranium-234																			38.8	764			555	4.68	
		Uranium-238																			192	4910			1760	43.6	
	11-12	***Inorganics (mg/L)***																									
		Arsenic																					0.011	0.033			
		Beryllium																					ND	ND			
		Cadmium																					ND	ND			
		Chromium																					0.039	ND			
		Copper																					0.093	ND			
		Iron																					32	3.9			
		Lead																					0.027	ND			
		Manganese																					0.68	0.41			
		Mercury																					ND	ND			
		Molybdenum																					ND	0.17			
		Nickel																					0.062	0.036			
		Uranium																					ND	ND			0.11
		Vanadium																					0.057	ND			
		Zinc																					0.14	0.13			
		Organics - Semivolatiles (mg/L)																									
		Naphthalene																					0.0042	0.0037			
		Organics - Volatiles (mg/L)																									
		1,1-DCE																					ND	ND			
		Benzene																					0.0021	0.003			
		cis -1,2-DCE																					0.0036	0.0018			
		TCE																					0.00071	ND			
		Vinyl chloride																					0.018	0.0024			
		Radionuclides(pCi/L)																									
		Uranium-234																					21.6	44.9			20.2
		Uranium-238																					30.6	54.6			30.1
	22-23	***Inorganics (mg/L)***																									
		Arsenic										0.28				0.175										
		Arsenic, Dissolved														0.173										
		Beryllium										0.033				0.0002										
		Cadmium										ND				ND										

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
	22-23	Chromium											0.91				0.063										
		Copper											0.46				ND										
		Iron											1000				1										
		Iron, Dissolved															0.41										
		Lead											1.1				ND										
		Manganese											25				0.526										
		Manganese, Dissolved															0.55										
		Mercury											0.0011				ND										
		Molybdenum											ND				ND										
		Nickel											0.53				0.046										
		Nickel, Dissolved															ND										
		Uranium											ND				0.01										
		Vanadium											1.6				ND										
		Zinc											1.4				0.034										
		Organics - Semivolatiles (mg/L)																									
		Naphthalene											ND				ND										
		Organics - Volatiles (mg/L)																									
		1,1-DCE											ND	ND	ND		0.0029										
		Benzene											ND	ND	ND		0.0078										
		cis -1,2-DCE											ND	ND	ND		2.9										
		TCE											ND	ND	ND		0.69										
		Vinyl chloride											ND	ND	ND		3.8										
		Radionuclides(pCi/L)																									
		Radon-222															247										
		Uranium-234											20.2		14.6		0.36										
		Uranium-238											26.7		22.2		0.12										
UCRS	26-32	***Inorganics (mg/L)***																									
		Arsenic				0.222	0.173			0.276	ND							0.011									
		Arsenic, Dissolved				0.0031	0.133			0.316	ND							0.01									
		Beryllium				0.034	ND			0.00595	0.0379							0.0003									
		Beryllium																									
		Cadmium				0.00525	ND			0.00204	0.00695							ND									
		Chromium				2.43	ND			0.274	ND							0.12									
		Copper				ND	ND			ND	ND							ND									
		Iron				922	75.7			142	1010							2.9									
		Iron, Dissolved				34	53.4			26.4	1.06							ND									
		Lead				0.382	0.0053			0.0597	0.694							0.0018									
		Manganese				8.73	2.13			2.61	6.6							0.14									
		Manganese, Dissolved				1.71	1.7			2.9	0.862							0.22									
		Mercury				0.00117	0.000017			0.000085	0.000769							ND									
		Molybdenum				0.429	0.0382			0.0348	0.00862							ND									
		Nickel				0.703	0.0908			0.112	ND							0.7									
		Nickel, Dissolved				0.0527	0.0753			0.053	ND							1.2									
		Uranium				0.0475	0.00109			0.239	0.0726							0.00153									
		Vanadium				1.72	ND			0.345	ND							0.0018									
		Zinc				2.93	0.769			1.17	ND							0.049									
		Organics - Semivolatiles (mg/L)																									
		Naphthalene				ND	ND			ND	ND							ND									
		Organics - Volatiles (mg/L)																									
		1,1-DCE				ND	ND			ND	ND							0.0022									
		Benzene				ND	0.011			ND	ND							ND									
		cis -1,2-DCE				ND	3.4			6.5	ND							0.24									

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
UCRS	26-32	TCE				ND	5.6			12	ND							2									
		Vinyl chloride				ND	0.75			2.6	ND							ND									
		Radionuclides(pCi/L)																									
		Radon-222																801									
		Uranium-234				2.19	ND			18.8	8.39							0.39									
		Uranium-238				2.1	0.265			125	12							0.138									
	35	***Organics - Volatiles (mg/L)***																									
		1,1-DCE										ND															
		cis -1,2-DCE										ND															
		TCE										ND															
		Vinyl chloride										ND															
	43-45	***Inorganics (mg/L)***																									
		Arsenic	0.0106		0.119			ND																			
		Arsenic, Dissolved	0.00345		0.0986			0.00169																			
		Beryllium	0.00166		ND			ND																			
		Cadmium	ND		0.000818			0.000954																			
		Chromium	0.102		ND			ND																			
		Copper	ND		ND			ND																			
		Iron	59.7		40.2			25.2																			
		Iron, Dissolved	27.7		16.8			9.39																			
		Lead	0.0164		0.00638			0.0114																			
		Manganese	0.6		0.804			0.185																			
		Manganese, Dissolved	0.429		0.686			0.126																			
		Mercury	0.000136		0.000013			ND																			
		Molybdenum	0.054		0.0676			0.0199																			
		Nickel	0.0757		0.0603			ND																			
		Nickel, Dissolved	0.0402		0.0498			0.0158																			
		Uranium	0.00267		0.00137			0.00136																			
		Vanadium	ND		ND			ND																			
		Zinc	1.54		0.529			0.29																			
		Organics - Semivolatiles (mg/L)																									
		Naphthalene	ND		ND			ND																			
		Organics - Volatiles (mg/L)																									
		1,1-DCE	ND		ND			ND																			
		Benzene	ND		ND			ND																			
		cis -1,2-DCE	ND		ND			ND																			
		TCE	0.011		ND			0.0031																			
		Vinyl chloride	ND		ND			ND																			
	43-45	***Radionuclides(pCi/L)***																									
		Uranium-234	0.947		ND			ND																			
		Uranium-238	1.42		0.119			0.385																			
	50-53	***Inorganics (mg/L)***																									
		Arsenic		ND					ND																		
		Arsenic, Dissolved		0.00727					0.0276																		
		Beryllium		0.0214					0.00524																		
		Cadmium		0.00275					0.00136																		
		Inorganics (mg/L)																									
		Chromium		1.7					ND																		
		Copper		ND					ND																		
		Iron		490					115																		
		Iron, Dissolved		23.4					10.1																		
		Lead		0.218					0.074																		
		Manganese		3.29					1.08																		

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
UCRS	50-53	Manganese, Dissolved		0.757					0.593																		
		Mercury		ND					0.000158																		
		Molybdenum		0.227					0.00542																		
		Nickel		ND					ND																		
		Nickel, Dissolved		0.0329					0.0211																		
		Uranium		0.039					0.0112																		
		Vanadium		ND					ND																		
		Zinc		4.23					ND																		
		Organics - Semivolatiles (mg/L)																									
		Naphthalene		ND					ND																		
		Organics - Volatiles (mg/L)																									
		1,1-DCE		0.0094					ND																		
		Benzene		ND					0.012																		
		cis -1,2-DCE		ND					0.25																		
		TCE		ND					0.059																		
		Vinyl chloride		ND					0.14																		
		Radionuclides(pCi/L)																									
		Uranium-234		4.98					4.39																		
		Uranium-238		8.51					4.28																		
RGA	60	***Inorganics (mg/L)***																									
		Arsenic								0.0327	ND																
		Arsenic, Dissolved								0.00626	ND																
		Beryllium								0.00656	0.015																
		Cadmium								0.00148	0.00237																
		Chromium								0.162	ND																
		Iron								144	255																
		Lead								0.0279	0.11																
		Manganese								3.04	2.14																
		Manganese, Dissolved								1.51	0.628																
		Molybdenum								0.0283	0.0107																
		Nickel								0.0743	ND																
		Uranium								0.0295	0.0119																
		Vanadium								ND	ND																
		Zinc								0.348	ND																
		Radionuclides(pCi/L)																									
		Technetium-99								1.28	31.1	ND															
		Uranium-234								2.25	1.82																
		Uranium-238								13.9	1.91																
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride								ND	ND																
		Chloroform								ND	ND																
		cis -1,2-DCE								0.073	ND	ND															
		TCE								0.1	0.0068	0.0014															
		Vinyl chloride								0.016	ND	ND															
	65-66	***Inorganics (mg/L)***																									
		Arsenic											0.041	0.085													
		Beryllium											0.0051	0.017													
		Cadmium											ND	0.0044													
		Chromium											0.41	0.37													
		Iron											360	400													
		Lead											0.11	0.21													

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
RGA	65-66	Manganese											4.9	22													
		Molybdenum											0.33	ND													
		Nickel											0.35	0.44													
		Uranium											ND	ND													
		Vanadium											0.14	0.4													
		Zinc											4.2	2.1													
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride											ND	ND													
		Chloroform											ND	0.00095													
		cis-1,2-DCE										ND	ND	0.0029													
		TCE										0.021	ND	0.27													
		Vinyl chloride										ND	ND	ND													
		Radionuclides(pCi/L)																									
		Technetium-99										ND	ND	147													
		Uranium-234											1.66	2.75													
		Uranium-238											1.51	2.9													
	68-70	***Inorganics (mg/L)***																									
		Arsenic							ND	0.0348	ND	0.006			0.03												
		Arsenic, Dissolved							0.00455	0.00173	0.00476																
		Beryllium							0.00994	0.0077	0.041	ND			0.0052												
		Cadmium							0.00329	0.0018	0.0102	ND			ND												
		Chromium							ND	0.308	ND	ND			0.1												
		Iron							216	189	938	4.15			140												
		Lead							0.0935	0.0355	0.309				0.085												
		Manganese							9.31	6.75	20.5	0.1			1.9												
		Manganese, Dissolved							4.42	4.01	8.32																
		Molybdenum							0.0916	0.079	0.0459				ND												
		Nickel							ND	0.104	0.584	ND			0.12												
		Uranium							0.0118	0.03	0.031				ND												
		Vanadium							ND	ND	ND	ND			0.15												
		Zinc							ND	0.473	2.46	ND			0.99												
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride							ND	ND	ND				ND												
		Chloroform							ND	ND	ND				ND												
		cis-1,2-DCE							ND	0.0084	ND	ND			ND												
		TCE							14	0.18	0.091	0.12			ND												
		Vinyl chloride							ND	ND	ND	ND			ND												
		Radionuclides(pCi/L)																									
		Technetium-99							812	7.89	16.7	127			ND												
		Uranium-234							4.51	1.26	4.39				18.6												
		Uranium-238							6.71	7.68	4.97				2.84												
	73-78	***Inorganics (mg/L)***																									
		Arsenic											0.33	0.037	0.28	0.017											
		Arsenic, Dissolved														0.12											
		Beryllium											0.073	0.003	0.07	ND											
		Cadmium											0.011	ND	0.016	ND											
		Chromium											1.3	0.28	2	0.51											
		Iron											1700	270	2200	9.1											
		Lead											1.6	0.036	0.74	ND											
		Manganese											18	5.2	16	0.11											
		Manganese, Dissolved														0.1											

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
RGA	73-78	Molybdenum											ND	ND	0.18	ND											
		Nickel											1.1	0.33	1.6	0.34											
		Uranium											ND	ND	ND	ND											
		Vanadium											1.6	0.097	2.7	0.0031											
		Zinc											4	4.9	9.8	0.031											
		Radionuclides(pCi/L)																									
		Technetium-99										143	1310	106	15	1260											
		Uranium-234											3.36	ND	7.95	0.52											
		Uranium-238											5.3	ND	5.46	ND											
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride											0.006	ND	ND	0.041											
		Chloroform											0.0034	0.0015	ND	0.0031											
		cis -1,2-DCE										ND	0.011	0.0039	ND	0.49											
		TCE										0.18	4.8	0.28	0.00058	4.6											
		Vinyl chloride										ND	ND	ND	ND	ND											
	80-80	***Inorganics (mg/L)***																									
		Arsenic							0.0187	0.0226	0.481	0.01															
		Arsenic, Dissolved							0.00384	0.0174	0.00561																
		Beryllium							0.0024	ND	0.063	ND															
		Cadmium							0.00108	ND	0.02	ND															
		Chromium							0.239	ND	1.08	ND															
		Iron							108	47.7	2460	29.5															
		Lead							0.0232	0.00364	0.393																
		Manganese							2.85	0.506	72.4	0.42															
		Manganese, Dissolved							1.81	0.367	12.8																
		Molybdenum							0.0842	0.0347	0.0415																
		Nickel							0.109	ND	1.15	0.06															
		Uranium							0.00392	0.00866	0.0858																
		Vanadium							ND	ND	ND	ND															
		Zinc							1.33	0.273	4.12	ND															
		Radionuclides(pCi/L)																									
		Technetium-99							530	129	45.7	138															
		Uranium-234							2.34	ND	6.79																
		Uranium-238							3.83	1.81	8.14																
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride							ND	ND	ND																
		Chloroform							ND	ND	ND																
		cis -1,2-DCE							ND	ND	ND	0.003															
		TCE							18	1.7	0.12	0.24															
		Vinyl chloride							ND	ND	ND	ND															
	85-87	***Inorganics (mg/L)***																									
		Arsenic											0.25	0.091	0.18												
		Beryllium											0.068	0.006	0.031												
		Cadmium											0.012	ND	ND												
		Chromium											1.3	0.13	0.86												
		Iron											1600	340	890												
		Lead											1.6	0.019	0.35												
		Manganese											17	4.2	14												
		Molybdenum											ND	ND	0.16												
		Nickel											1.2	0.23	0.58												
		Uranium											ND	0.063	ND												
		Vanadium											1.3	0.082	1.1												
		Zinc											6.5	2.1	3.6												

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
RGA	85-87	***Radionuclides(pCi/L)***																									
		Technetium-99										177	633	56.9	ND												
		Uranium-234											14.5	1.25	6.98												
		Uranium-238											20.3	1.25	8												
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride											0.0016	ND	ND												
		Chloroform											0.0041	0.0032	ND												
		cis -1,2-DCE										0.003	0.01	0.0062	ND												
		TCE										0.32	2.9	0.35	0.0012												
		Vinyl chloride										ND	ND	ND	ND												
	90-91	***Inorganics (mg/L)***																									
		Arsenic							0.07	0.0292	0.22	0.01		0.2													
		Arsenic, Dissolved							0.0436	0.0157	0.00608																
		Beryllium							0.00276	0.00144	0.0732	ND		0.053													
		Cadmium							0.00131	ND	0.0197	ND		0.01													
		Chromium							0.206	0.0275	1.46	ND		2													
		Iron							162	86.7	2410	8.88		1800													
		Lead							0.0177	0.00355	0.489			0.27													
		Manganese							9.4	0.445	58.9	0.07		18													
		Manganese, Dissolved							8.95	0.338	7.24																
		Molybdenum							0.0889	0.0282	0.0239			0.17													
		Nickel							0.15	0.0441	1.18	ND		0.87													
		Uranium							0.00413	0.00197	0.093			ND													
		Vanadium							ND	ND	ND	ND		0.83													
		Zinc							1.05	0.333	4.28	ND		5.4													
		Radionuclides(pCi/L)																									
		Technetium-99							221	193	64	187		122													
		Uranium-234							1.08	1.44	8.71			10.2													
		Uranium-238							1.7	5.47	8.74			5.72													
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride							ND	ND	ND			ND													
		Chloroform							ND	ND	ND			0.0045													
		cis -1,2-DCE							0.58	ND	ND	0.003		0.0064													
		TCE							1.7	3.6	0.2	0.26		0.41													
		Vinyl chloride							0.3	ND	ND	ND		ND													
	95-96	***Inorganics (mg/L)***																									
		Arsenic											0.42						0.00337								
		Arsenic, Dissolved																	0.00149								
		Beryllium											0.062						0.0006	0.0003							
		Cadmium											0.016						ND								
		Chromium											1.3						0.0723								
		Iron											2100						24	11							
		Lead											0.65						ND								
		Manganese											20						1.9	0.22							
		Manganese, Dissolved																	0.00917								
		Molybdenum											0.17						0.00634								
		Nickel											0.98						0.0224								
		Uranium											ND						0.09	ND							
		Vanadium											1.1						0.018	0.014							
		Zinc											5.4						ND								

Table 4.41. SWMU 7 Locations of Groundwater Contaminants (Continued)

			RI Data									Historical Data															
Unit	Depth (ft)	Analysis	007-001	007-002	007-003B	007-005	007-007	007-008	007-009	007-010	007-011	DG-005	GWW-01	GWW-02	GWW-03	MW185	MW186	MW187	MW339	MW340	WB-12	WB-13	WB-7	WB-8	WB-9	WBP-12A	WBP-9A
RGA	95-96	***Radionuclides(pCi/L)***																									
		Technetium-99										118	1550						5116.9	747							
		Uranium-234											6.34						0.48	0.45							
		Uranium-238											6.27						ND	0.18							
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride											0.0047						ND	ND							
		Chloroform											0.012						ND	ND							
		cis -1,2-DCE										0.0039	0.023						2.1	0.013							
		TCE										0.42	14						25	6.5							
		Vinyl chloride										ND	ND						ND	ND							
	100	***Inorganics (mg/L)***																									
		Arsenic								ND																	
		Arsenic, Dissolved								ND																	
		Beryllium								ND																	
		Cadmium								ND																	
		Chromium								ND																	
		Iron								42.7																	
		Lead								0.00515																	
		Manganese								0.516																	
		Manganese, Dissolved								0.437																	
		Molybdenum								0.0237																	
		Nickel								ND																	
		Uranium								0.00374																	
		Vanadium								ND																	
		Zinc								0.37																	
		Organics - Volatiles (mg/L)																									
		Carbon tetrachloride								ND																	
		Chloroform								ND																	
		cis -1,2-DCE								ND																	
		TCE								0.042																	
		Vinyl chloride								ND																	
		Radionuclides(pCi/L)																									
		Technetium-99								36.6																	
		Uranium-234								1.11																	
		Uranium-238								5.94																	
McN		***Organics - Volatiles (mg/L)***																									
	97	Chloroform													0.00047												
		TCE													0.04												
	111	Chloroform											0.00084	0.0038	ND												
		TCE											0.11	0.32	0.021												

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

4.4.7 SWMU 30

UCRS groundwater samples were collected from one of the four angled borings installed at SWMU 30 as part of this RI (030-003). The UCRS groundwater samples in the historic data set represent MW64 (for the period of record 1995 to 2007); the SWMUs 7 and 30 RI, temporary borings WB-1, WB-4, and WB-5 (DOE 1998c); and a 1998 follow-up investigation of the main SWMU 30 waste pit, temporary boring WBP-4A. RI data were reviewed with historical data to identify the UCRS contaminants listed in Table 4.42.

Table 4.42. SWMU 30 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.067	N/A[b]	2/4	2/4	2/4
Cadmium	0.011	N/A	1/4	1/4	1/4
Iron	51	38.3	4/4	N/A	4/4
Iron, Dissolved	N/A	18.2	1/1	N/A	1/1
Lead	N/A	0.00357	3/4	2/4	2/4
Manganese	0.97	2.87	4/4	N/A	3/4
Molybdenum	0.14	0.111	2/4	N/A	2/4
Nickel	0.14	N/A	3/4	N/A	3/4
Uranium	0.17	N/A	3/6	3/6	3/6
Vanadium	0.095	N/A	2/4	N/A	2/4
Organics – Semivolatiles (mg/L)					
Naphthalene	0.00072	N/A	1/4	N/A	1/4
Organics – Volatiles (mg/L)					
Benzene	0.0054	N/A	2/5	1/5	2/5
TCE	0.45	N/A	4/6	2/6	4/6
Vinyl chloride	0.0086	N/A	2/5	2/5	2/5
Organics-Pesticides and PCBs (mg/L)					
PCB-1260	0.0029	N/A	1/3	1/3	1/3
Radionuclides (pCi/L)					
^{234}Uranium	2220	9.84	5/5	N/A	5/5
^{238}Uranium	2710	17.8	5/5	N/A	4/5
^{238}Uranium (& daughter products)	N/A	33.9	1/1	N/A	1/1

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Only a limited number of samples were available to characterize the UCRS groundwater at SWMU 30. Temporary borings WB-1, WB-4, WB-5, and WBP-4A sampled the depth interval of the buried waste at SWMU 30. (Pit A of SWMU 30 is approximately 12 ft deep.) MW64 and 030-003 characterize the HU2 interval of the UCRS, found at approximately 20 to 30 ft bgs at SWMU 30. The suite of contaminants was similar at the depth of the waste pits and within the HU2 interval. Screening of the sample analyses revealed nine metal contaminants: arsenic, cadmium, iron, lead, manganese, molybdenum, nickel, uranium, and vanadium. All but cadmium were detected at levels exceeding screening criteria in 50% or more of the samples. TCE was detected at three locations (MW64, WB-1, and WB-4); one location exceeded the screening level (MW64 up to 0.45 mg/L). Benzene (at location WB-4) and vinyl chloride (at locations WB-1 and WB-4) also were detected above screening levels. The uranium isotopes ^{234}U and ^{238}U frequently exceeded screening levels in the SWMU 30 UCRS groundwater samples.

RGA and McNairy groundwater samples were not collected at SWMU 30 as part of this RI. Historical data were reviewed for RGA groundwater to determine the contaminants listed in Table 4.43. All of the SWMU 30 RGA groundwater samples were from monitoring wells. MW63, MW66, and MW245 sample the upper RGA. MW 65 is a lower RGA well.

Table 4.43. SWMU 30 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.0123	N/A[b]	1/4	1/4	1/4	1/4
Iron	226	N/A	66/79	28/79	N/A	61/79
Iron, Dissolved	54.6	N/A	25/76	24/76	N/A	7/76
Lead	0.432	N/A	3/7	1/7	1/7	1/7
Manganese	39.9	N/A	64/79	56/79	N/A	58/79
Manganese, Dissolved	38.2	N/A	57/76	56/76	N/A	36/76
Uranium	0.19	N/A	4/128	2/128	2/128	4/128
Organics – Volatiles (mg/L)						
Chloroform	0.001	N/A	1/41	N/A	N/A	1/41
Tetrachloroethene	0.32	N/A	1/193	N/A	1/193	1/193
TCE	15	N/A	253/278	N/A	233/278	250/278
Radionuclides (pCi/L)						
^{222}Radon	632	N/A	43/44	1/44	N/A	43/44
^{99}Technetium	2911	N/A	210/279	175/279	39/279	193/279
^{234}Uranium	448	N/A	4/11	1/11	N/A	2/11
^{238}Uranium	441	N/A	1/14	1/14	N/A	1/14

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

The RGA groundwater samples from SWMU 30 contained five metal contaminants: arsenic, iron, lead, manganese, and uranium. Of the organic analytes, only TCE was detected frequently above screening levels, in all four RGA groundwater monitoring wells. Tetrachloroethene was detected at only one location, MW66, at 0.32 mg/L, which is above the screening level. Radon-222 and ^{99}Tc were the most frequently detected radionuclide contaminants. All ^{99}Tc analyses above the MCL represented samples from MW66.

No McNairy groundwater data were available.

Table 4.44 lists all SWMU 30 locations with groundwater contamination.

Table 4.44. SWMU 30 Locations of Groundwater Contaminants

			RI Data	Historical Data								
Unit	**Depth (ft)**	**Analysis**	030-003	MW245	MW63	MW64	MW65	MW66	WB-1	WB-4	WB-5	WBP-4A
UCRS	8-10	***Inorganics (mg/L)***										
		Arsenic							0.067	0.03		
		Cadmium							0.011	ND		
		Iron							10	51		
		Lead							0.23	0.084		
		Manganese							0.25	0.97		
		Molybdenum							ND	0.14		
		Nickel							0.076	0.14		
		Uranium							ND	ND		0.17
		Vanadium							0.02	0.095		
		Organics - Semivolatiles (mg/L)										
		Naphthalene							0.00072	ND		
		Organics - Volatiles (mg/L)										
		Benzene							0.0025	0.0054	ND	
		TCE							0.0022	0.0037	ND	
		Vinyl chloride							0.0086	0.0048	ND	
		Organics - Pesticides and PCBs (mg/L)										
		PCB-1260								0.0029		
		Radionuclides (pCi/L)										
		Uranium-234							2220	106		20.3
		Uranium-238							2710	247		53.6
	23	***Inorganics (mg/L)***										
		Arsenic	ND									
		Cadmium	ND									
		Iron	38.3									
		Iron, Dissolved	18.2									
		Lead	0.00357									
		Manganese	2.87									
		Molybdenum	0.111									
		Nickel	ND									
		Uranium	0.15									
		Vanadium	ND									
		Organics - Pesticides and PCBs (mg/L)										
		PCB-1260	ND									
		Organics - Semivolatiles (mg/L)										
		Naphthalene	ND									
		Organics - Volatiles (mg/L)										
		Benzene	ND									
		TCE	ND									
		Vinyl chloride	ND									
		Radionuclides (pCi/L)										
		Uranium-234	9.84									
		Uranium-238	17.8									

Table 4.44. SWMU 30 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	RI Data	Historical Data								
			030-003	MW245	MW63	MW64	MW65	MW66	WB-1	WB-4	WB-5	WBP-4A
UCRS	33	***Inorganics (mg/L)***										
		Arsenic				ND						
		Cadmium				ND						
		Iron				0.74						
		Lead				ND						
		Manganese				0.017						
		Molybdenum				ND						
		Nickel				0.083						
		Uranium				ND						
		Vanadium				ND						
		Organics - Pesticides and PCBs (mg/L)										
		PCB-1260				ND						
		Organics - Semivolatiles (mg/L)										
		Naphthalene				ND						
		Organics - Volatiles (mg/L)										
		Benzene				ND						
		TCE				0.45						
		Vinyl chloride				ND						
		Radionuclides (pCi/L)										
		Uranium-238				0.44						
RGA	60-64	***Inorganics (mg/L)***										
		Arsenic			ND			ND				
		Iron			3			3.13				
		Iron, Dissolved			ND			ND				
		Lead			0.0065			ND				
		Manganese			0.041			0.037				
		Manganese, Dissolved			ND			0.04				
		Uranium			0.19			0.19				
		Organics - Volatiles (mg/L)										
		Chloroform			ND			0.001				
		TCE			0.028			15				
		Tetrachloroethene			ND			0.32				
		Radionuclides (pCi/L)										
		Radon-222			356			632				
		Technetium-99			22.5			2911				
		Uranium-234			448			0.57				
		Uranium-238			441			ND				
	75	***Inorganics (mg/L)***										
		Arsenic		0.0123								
		Arsenic, Dissolved		0.00815								
		Iron		226								
		Iron, Dissolved		54.6								
		Lead		0.432								
		Manganese		39.9								

Table 4.44. SWMU 30 Locations of Groundwater Contaminants (Continued)

			RI Data	Historical Data								
Unit	Depth (ft)	Analysis	030-003	MW245	MW63	MW64	MW65	MW66	WB-1	WB-4	WB-5	WBP-4A
RGA	75	***Inorganics (mg/L)***										
		Manganese, Dissolved		38.2								
		Uranium		ND								
		Organics - Volatiles (mg/L)										
		Chloroform		ND								
		TCE		0.21								
		Tetrachloroethene		ND								
		Radionuclides (pCi/L)										
		Radon-222		394								
		Technetium-99		63.6								
	91	***Inorganics (mg/L)***										
		Arsenic					ND					
		Iron					0.22					
		Iron, Dissolved					ND					
		Lead					ND					
		Manganese					0.0042					
		Manganese, Dissolved					ND					
		Uranium					0.00171					
		Organics - Volatiles (mg/L)										
		Chloroform					ND					
		TCE					0.096					
		Tetrachloroethene					ND					
		Radionuclides (pCi/L)										
		Radon-222					475					
		Technetium-99					37.11					
		Uranium-234					0.17					
		Uranium-238					ND					

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

4.4.8 SWMU 145

UCRS groundwater samples were attempted at each of the seven angled borings installed at SWMU 145; however, sufficient groundwater was not available for sampling. Historical data from seven monitoring wells in the area were reviewed to identify the UCRS contaminants listed in Table 4.45. The UCRS wells with groundwater data for SWMU 145 (for the period 1995 through 2006) were MW180, MW182, MW371, MW386, MW390, MW393, and MW396.

Table 4.45. SWMU 145 UCRS Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection	
	Historical Data	RI Data		above MCL	above Child Resident NAL
Inorganics (mg/L)					
Arsenic	0.0189	N/A[b]	42/68	2/68	42/68
Iron	33.6	N/A	115/118	N/A	98/118
Iron, Dissolved	28.1	N/A	3/4	N/A	1/4
Manganese	4.53	N/A	96/112	N/A	79/112
Manganese, Dissolved	3.75	N/A	2/2	N/A	2/2
Nickel	0.595	N/A	23/118	N/A	10/118
Nickel, Dissolved	0.442	N/A	2/4	N/A	1/4
Uranium	0.6	N/A	58/185	27/185	58/185
Uranium, Dissolved	0.51	N/A	12/72	4/72	5/72
Vanadium	0.038	N/A	3/111	N/A	3/111
Organics – Volatiles (mg/L)					
Chloroform	0.003	N/A	2/81	N/A	2/81
Radionuclides (pCi/L)					
^{222}Radon	519	N/A	2/2	N/A	2/2
^{234}Uranium	840	N/A	3/7	N/A	3/7
^{238}Uranium	1270	N/A	7/10	N/A	5/10

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Screening of the SWMU 145 analyses determined six metals that exceed contaminant criteria in UCRS groundwater. Iron and manganese were common groundwater contaminants. Arsenic and uranium accounted for most of the other metal exceedances.

The VOC chloroform (in a sample from MW386) was the only UCRS groundwater organic contaminant to exceed screening criteria. Analyses detected TCE in samples from six locations; however, the maximum detected result (0.002 mg/L or 2 μg/L) was less than the screening level. PCB-1260 was detected at MW371 at 0.00007 mg/L (0.07 μg/L).

Uranium contamination in the UCRS groundwater was found primarily at location MW182. Samples from MW182 accounted for most of the detections of ^{234}U above screening levels, as well as one of the detections of ^{238}U as a groundwater contaminant. The isotope ^{238}U also was detected above screening levels at location MW180.

RGA and McNairy groundwater samples were not collected at SWMU 145 as part of this RI. Historical data for the period 1995 through 2006 were reviewed for RGA and McNairy groundwater from 25 RGA monitoring wells in the area and one temporary boring that sampled the McNairy Formation to identify the contaminants listed in Table 4.46. (The review of data determined that no McNairy groundwater contamination is present at SWMU 145.)

Table 4.46. SWMU 145 RGA Groundwater Contaminants

Analysis	Maximum Result		Frequency of Detection[a]	Frequency of Detection		
	Historical Data	RI Data		Above Back-ground	above MCL	above Child Resident NAL
Inorganics (mg/L)						
Arsenic	0.0246	N/A[b]	173/232	34/232	16/232	173/232
Chromium	5.4	N/A	299/827	161/827	186/827	20/827
Iron	117	N/A	606/809	141/809	N/A	453/809
Manganese	36.5	N/A	374/475	180/475	N/A	265/475
Manganese, Dissolved	0.246	N/A	34/36	7/36	N/A	17/36
Molybdenum	0.117	N/A	115/450	8/450	N/A	57/450
Nickel	1.89	N/A	357/810	31/810	N/A	288/810
Nickel, Dissolved	0.5	N/A	23/52	2/52	N/A	23/52
Vanadium	0.219	N/A	81/812	3/812	N/A	74/812
Vanadium, Dissolved	0.142	N/A	43/63	2/63	N/A	43/63
Organics – Volatiles (mg/L)						
Chloroform	0.004	N/A	11/222	N/A	N/A	11/222
TCE	0.033	N/A	470/820	N/A	219/820	386/820
Organics-Pesticides and PCBs (mg/L)						
PCB, Total	0.00787	N/A	25/149	N/A	8/149	25/149
PCB-1016	0.001184	N/A	16/164	N/A	3/164	16/164
PCB-1242	0.00787	N/A	10/164	N/A	5/164	9/164
Radionuclides (pCi/L)						
^{90}Strontium	11.2	N/A	2/408	N/A	2/408	2/408

[a] Frequency of detection is the number of detections of an analyte per number of analyses of regular and duplicate samples.
[b] N/A = not applicable

Iron and manganese were detected above screening levels in RGA groundwater at a frequency of over 10%. The presence of TCE in the RGA was the subject of a summer 2004 SI of the SWMU 145 area (DOE 2006c). This SI determined the presence of a TCE source in the area of SWMU 145 (Figure 4.38). Seven RGA monitoring wells of the C-746-S and -T Landfills have produced samples with PCB contamination. The highest detected levels have been 0.001 mg/L PCB-1016 and 0.008 mg/L PCB-1242.

Table 4.47 shows the locations of all SWMU 145 groundwater contaminants.

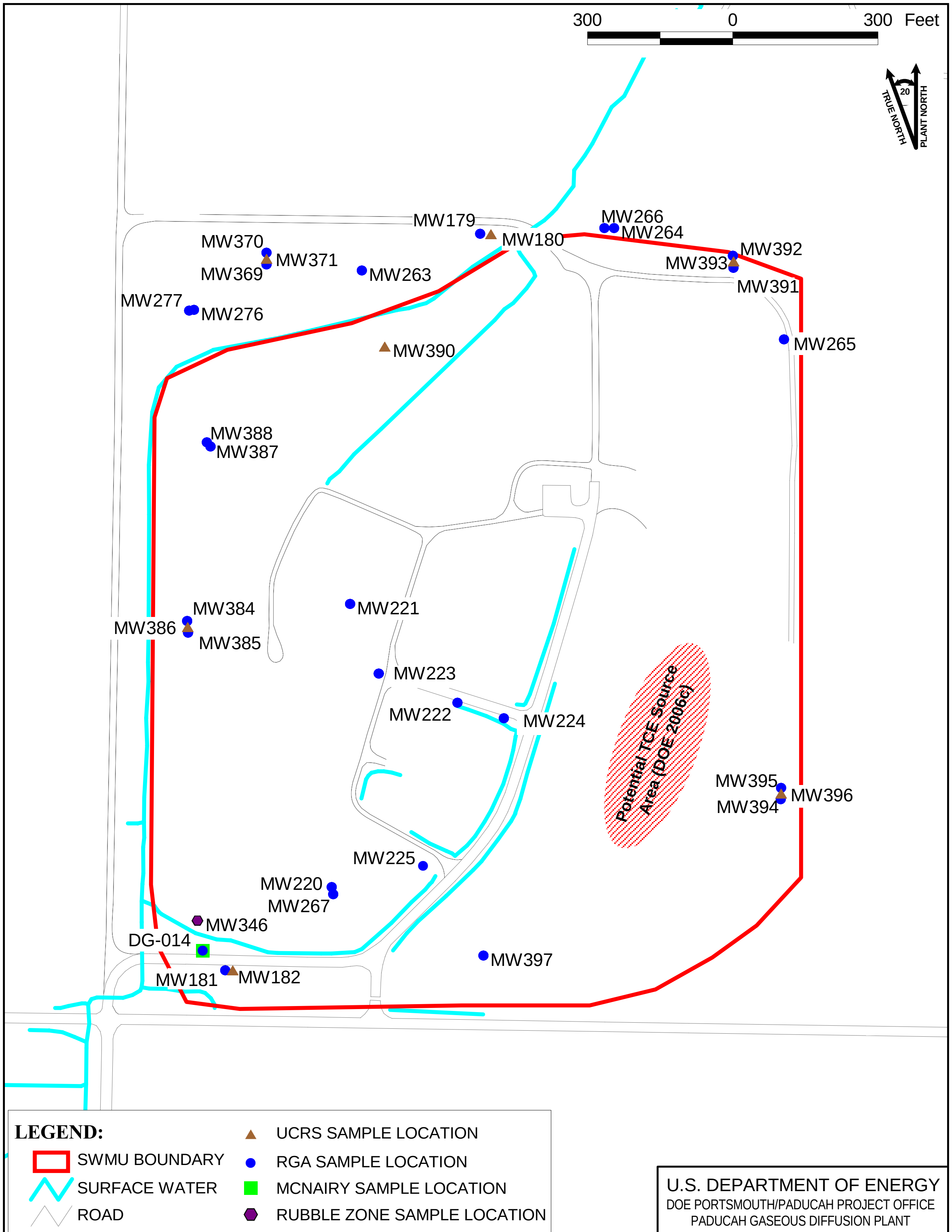

Figure 4.38. TCE Source Area at SWMU 145

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Table 4.47. SWMU 145 Locations of Groundwater Contaminants

Unit	Depth (ft)	Analysis	MW180	MW182	MW371	MW386	MW390	MW393	MW396
UCRS	20	***Inorganics (mg/L)***							
		Arsenic		0.01					
		Iron		26.9					
		Iron, Dissolved		28.1					
		Magnesium		36.1					
		Magnesium, Dissolved		33.8					
		Manganese		4.53					
		Manganese, Dissolved		3.75					
		Nickel		0.102					
		Nickel, Dissolved		ND					
		Uranium		0.6					
		Uranium, Dissolved		0.51					
		Vanadium		0.01					
		Organics - Volatiles (mg/L)							
		Chloroform		ND					
		Radionuclides (pCi/L)							
		Radon-222		351					
		Uranium-234		840					
		Uranium-238		1270					
	27-32	***Inorganics (mg/L)***							
		Arsenic			0.00112	0.00271			
		Iron	11.3		5.81	11.6			
		Iron, Dissolved	1.29						
		Magnesium	13.5		12.9	12.4			
		Magnesium, Dissolved	12.3						
		Manganese	0.352			1.02			
		Manganese			0.074				
		Manganese, Dissolved	0.193						
		Nickel	0.595		0.0124	0.0108			
		Nickel, Dissolved	0.442						
		Uranium	0.00522		0.027	0.00127			
		Uranium, Dissolved	0.002		0.00134	ND			
		Vanadium			ND	ND			
		Organics - Volatiles (mg/L)							
		Chloroform	ND		ND	0.003			
		Radionuclides (pCi/L)							
		Radon-222	519						
		Uranium-234	1.21						
		Uranium-238	1.01						

Unit	Depth (ft)	Analysis	MW180	MW182	MW371	MW386	MW390	MW393	MW396
UCRS	37-38	***Inorganics (mg/L)***							
		Arsenic					0.0189	0.007	
		Iron					33.6	15.8	
		Manganese					1.44	0.217	
		Nickel					0.146	ND	
		Uranium					0.001	0.002	
		Uranium, Dissolved					ND	0.002	
		Vanadium					0.038	ND	
		Organics - Volatiles (mg/L)							
		Chloroform					ND	ND	
	44	***Inorganics (mg/L)***							
		Arsenic							0.00378
		Iron							11.9
		Magnesium							20.4
		Manganese							1.132
		Nickel							0.00573
		Uranium							0.002
		Uranium, Dissolved							0.003
		Vanadium							ND
		Organics - Volatiles (mg/L)							
		Chloroform							ND

Table 4.47. SWMU 145 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	DG-014	MW179	MW181	MW220	MW221	MW222	MW223	MW224	MW263	MW264	MW265	MW266	MW267	MW276	MW277	MW369	MW370	MW384	MW385	MW387	MW388	MW391	MW392	MW394	MW395	MW397
RGA	45	***Organics - Volatiles (mg/L)***																										
		TCE	0.0006																									
	50-52	***Inorganics (mg/L)***																										
		Arsenic																0.0138										
		Chromium																ND										
		Iron																21.5										
		Manganese																0.867										
		Molybdenum																ND										
		Nickel																0.0168										
		Vanadium																0.027										
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total																0.00115										
		PCB-1016																0.000605										
		PCB-1242																0.00115										
		Organics - Volatiles (mg/L)																										
		Chloroform																0.001										
		TCE	0.0005															0.016										
		Radionuclides (pCi/L)																										
		Strontium-90																ND										
	55-57	***Inorganics (mg/L)***																										
		Arsenic			0.0026																	0.00416						
		Chromium		0.06	3.18							0.03										ND						
		Iron		2.25	46.2							5.8										5.46						
		Manganese		0.009	2.97							0.268										0.72						
		Manganese, Dissolved		0.009	0.041							0.246																
		Molybdenum		0.03	0.03							0.03										0.00282						
		Nickel		0.04	1.89							0.04										ND						
		Nickel, Dissolved		0.04	0.14							0.04																
		Vanadium		0.204	0.105							0.113										ND						
		Vanadium, Dissolved		0.135	0.081							0.08																
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total		ND								ND										ND						
		PCB-1016		ND								ND										ND						
		PCB-1242		ND								ND										ND						
		Organics - Volatiles (mg/L)																										
		Chloroform		ND	0.000076							0.000061										ND						
		TCE	0.00029	0.009	0.001							0.008										0.007						
		Radionuclides (pCi/L)																										
		Strontium-90		ND								ND										ND						
	58-60	***Inorganics (mg/L)***																										
		Arsenic														0.01				0.0246								
		Chromium									3.44					2.24				ND								
		Iron									9.12					20.2				17.3								
		Manganese									0.166					0.079				3.67								
		Manganese, Dissolved									0.16																	
		Molybdenum									0.03					0.096				ND								
		Nickel									0.14					0.359				ND								
		Nickel, Dissolved									0.04																	
		Vanadium									0.155					0.03				ND								
		Vanadium, Dissolved									0.107					ND												
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total									ND					ND				ND								
		PCB-1016									ND					ND				ND								
		PCB-1242									ND					ND				ND								

Table 4.47. SWMU 145 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	DG-014	MW179	MW181	MW220	MW221	MW222	MW223	MW224	MW263	MW264	MW265	MW266	MW267	MW276	MW277	MW369	MW370	MW384	MW385	MW387	MW388	MW391	MW392	MW394	MW395	MW397
RGA	58-60	***Organics - Volatiles (mg/L)***																										
		Chloroform									0.000063									ND								
		TCE	0.00023								0.023					0.029				0.002								
		Radionuclides (pCi/L)																										
		Strontium-90									ND					ND				11.2								
	65-68	***Inorganics (mg/L)***																										
		Arsenic																						0.00267				
		Chromium																						ND				
		Iron																						28.6				
		Manganese																						0.927				
		Molybdenum																						ND				
		Nickel																						0.00833				
		Vanadium																						ND				
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total																						ND				
		PCB-1016																						ND				
		PCB-1242																						ND				
		Organics - Volatiles (mg/L)																										
		Chloroform																						ND				
		TCE	ND																					0.019				
		Radionuclides (pCi/L)																										
		Strontium-90																						ND				
	69-72	***Inorganics (mg/L)***																										
		Arsenic				0.00198													0.0146				0.00228					
		Chromium				0.719							1.98				2.12		ND				0.0103					
		Iron				11.1							11.9				7.89		15.8				7.29					
		Manganese				2.54							0.204				0.184		2.51				0.096					
		Manganese, Dissolved				0.052							0.19				0.05											
		Molybdenum				0.03							0.07				0.04		ND				ND					
		Nickel				1.05							0.53				1.27		0.0264				0.00568					
		Nickel, Dissolved				0.204							0.5				0.46											
		Vanadium				0.081							0.077				ND		0.035				ND					
		Vanadium, Dissolved				0.059							0.058				ND											
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total				0.00078													0.000188				ND					
		PCB-1016				ND											ND		0.000188				ND					
		PCB-1242				0.00078											ND		ND				ND					
		Organics - Volatiles (mg/L)																										
		Chloroform				ND							0.000049				ND		ND				ND					
		TCE	ND			0.000069							0.028				0.033		0.019				0.002					
		Radionuclides (pCi/L)																										
		Strontium-90				ND													ND				ND					
	75-78	***Inorganics (mg/L)***																										
		Arsenic						0.00248													0.00249					0.00285		
		Chromium						0.144						3.04							ND					ND		
		Iron						107						17.6							5.41					1.81		
		Manganese						23.2						0.08							0.859					0.542		
		Manganese, Dissolved						0.049						0.043														
		Molybdenum						0.03						0.03							0.00272					ND		
		Nickel						0.883						0.433							0.00611					ND		
		Nickel, Dissolved						0.04						0.04														
		Inorganics (mg/L)																										
		Vanadium						0.082						0.219							ND					ND		
		Vanadium, Dissolved						0.045						0.142														

Table 4.47. SWMU 145 Locations of Groundwater Contaminants (Continued)

Unit	Depth (ft)	Analysis	DG-014	MW179	MW181	MW220	MW221	MW222	MW223	MW224	MW263	MW264	MW265	MW266	MW267	MW276	MW277	MW369	MW370	MW384	MW385	MW387	MW388	MW391	MW392	MW394	MW395	MW397
RGA	75-78	***Organics - Pesticides and PCBs (mg/L)***																										
		PCB, Total						0.0031						ND							ND					ND		
		PCB-1016						0.001167						ND							ND					ND		
		PCB-1242						0.0031						ND							ND					ND		
		Organics - Volatiles (mg/L)																										
		Chloroform						0.000073						0.000049							ND					ND		
		TCE	ND					0.00039						0.016							ND					0.021		
		Radionuclides (pCi/L)																										
		Strontium-90						ND						ND							ND					ND		
	82-85	***Inorganics (mg/L)***																										
		Arsenic					0.00218		0.00216	0.00186																	0.00257	
		Chromium					0.277		1.41	0.03					5.4												0.075	
		Iron					2.16		117	3.61					21												1.33	
		Manganese					0.818		36.5	6.32					0.056												0.629	
		Manganese, Dissolved					0.012		0.039	0.038					0.058													
		Molybdenum					0.03		0.089	0.03					0.117												0.00609	
		Nickel					0.68		1.48	0.144					0.222												0.029	
		Nickel, Dissolved					0.05		0.111	0.04					0.04													
		Vanadium					0.096		0.098	0.119					0.081												ND	
		Vanadium, Dissolved					0.072		0.059	0.072					0.058													
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total					0.00787		0.00161	0.000359					ND												ND	
		PCB-1016					ND		0.001184	0.000359					ND												ND	
		PCB-1242					0.00787		0.00161	0.00024					ND												ND	
		Organics - Volatiles (mg/L)																										
		Chloroform					0.000073		ND	0.000058					ND												ND	
		TCE					0.007		0.001	0.006					0.000065												0.014	
		Radionuclides (pCi/L)																										
		Strontium-90					ND		ND	ND					ND												ND	
	91-95	***Inorganics (mg/L)***																										
		Arsenic																							0.00368			0.00227
		Chromium																							ND			ND
		Iron																							9.8			1.58
		Manganese																							4.59			0.466
		Molybdenum																							0.00187			ND
		Nickel																							0.0107			0.00502
		Vanadium																							ND			ND
		Organics - Pesticides and PCBs (mg/L)																										
		PCB, Total																							ND			ND
		PCB-1016																							ND			ND
		PCB-1242																							ND			ND
		Organics - Volatiles (mg/L)																										
		Chloroform																							0.004			ND
		TCE																							0.014			ND
		Radionuclides (pCi/L)																										
		Strontium-90																							ND			ND

ND = not detected

Blank cells indicate interval was not sampled for the specified analysis. The maximum value is shown for each depth interval at each location.

5. FATE AND TRANSPORT

This chapter provides an overview of the fate and transport of the primary COPCs for the BGOU. (Appendix E, Section E.3 documents the methods and results of fate and transport modeling performed for the BGOU RI.) The sources modeled are SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145. Two pathways were considered in the transport modeling analyses: (1) dissolved-phase transport through the aquifer and (2) vapor transport to a residential basement.

5.1 CONCEPTUAL MODEL

The sources of contamination to the RGA considered in this report are the waste disposal areas in the BGOU SWMUs. Releases from these SWMUs have impacted soils below or adjacent to the source zones and, through vertical infiltration in soil, these sources have the potential to contaminate the groundwater underlying these sources. Subsequently, contaminated groundwater could migrate to the points of exposure (POEs). The potential POEs for the BGOU SWMUs were identified as the SWMU boundary, plant boundary, property boundary, surface seeps at Little Bayou Creek (hereafter referred to as the Little Bayou seeps), and near the Ohio River. [Modeling assessed the Little Bayou seeps and the Ohio River as the locations to assess risk to the groundwater user through a hypothetical well, consistent with the Risk Methods Document (DOE 2001a). Modeling also assessed the SWMU boundary.] Not all SWMUs have transport pathways to all of the POEs. For example, SWMU 145 is located outside of the plant boundary and does not contribute to the Little Bayou seeps. SWMUs 3, 6, 7, and 30 were determined to be the only SWMUs contributing to the Little Bayou seeps POE. SWMUs 2, 4, and 5 have POEs at the plant boundary, property boundary, and the Ohio River. Figure 5.1 shows the location of the BGOU SWMUs, plant boundary, property boundary, Little Bayou seeps, Ohio River, and contaminant flow particle tracks from the SWMUs.

Contaminant migration could have impacted three HUs underlying the source zones at the BGOU SWMUs. These units, which control the flow of shallow groundwater and contaminant migration, are as follows, in descending depth order:

- UCRS – approximately 60 ft of silt and clay with horizons of sand and gravel;
- RGA – approximately 40 ft of gravel and sand deposits that overlie the McNairy Formation; and
- McNairy Formation – approximately 225 ft of a silty and clayey sand that forms a lower confining unit to the RGA.

Previous work has shown that groundwater flow in the UCRS is primarily vertical to the RGA and then lateral toward the Ohio River and that groundwater flow in the McNairy Formation (both vertical and lateral) is significantly slower than that in the RGA. The primary contaminant pathway for the site-related contaminants is vertical migration through the UCRS followed by lateral migration in the RGA. The RGA discharges to the Ohio River and, for a limited number of SWMUs, to the Little Bayou seeps. Section 3 provides a detailed description of the geology and hydrogeology at PGDP.

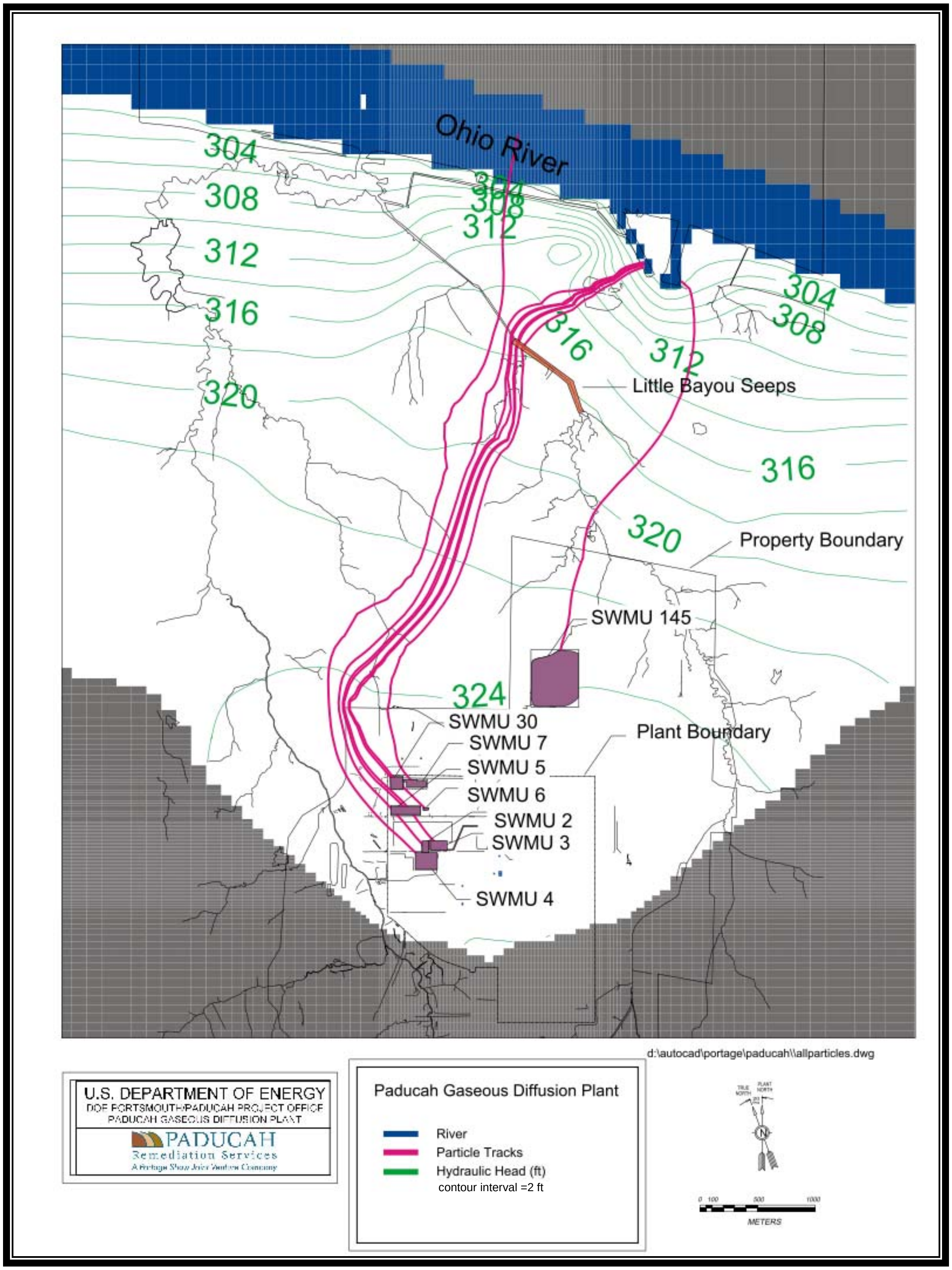

Figure 5.1. Location of the BGOU SWMUs and POEs

5.2 COPC SELECTION AND CHEMICAL PROPERTIES

5.2.1 COPC SELECTION

Several COPCs were identified for consideration in the contaminant fate and transport modeling of the BGOU SWMUs (see Appendix E). Screening of radionuclides and chemicals from the complete RI and historical data set for groundwater modeling used several steps to determine the COPC data set. They include the following:

(1) Analytes that were not detected at a SWMU were not modeled.

(2) Analytes were retained for modeling based on comparison to soil screening levels in the PGDP Risk Methods Document (DOE 2001a) [reference Tables A.7a, "Risk-based Soil Screening Levels (SSLs) for Protection of RGA Groundwater for Significant COPCs at the PGDP," and 7b, "Risk-based Soil Screening Levels for Protection of RGA Groundwater for Significant Radionuclide COPCs at the PGDP"].

(3) Analytes were retained for modeling if the analyte was included in either table. Analytes were retained for modeling if the analyte exceeded the "Child Resident SSL 1" values for the PGDP NALs. Radionuclides were screened from modeling if the radionuclide contained a footnote stating "the radionuclide does not reach groundwater within 10,000 years, precluding receptor uptake" in the PGDP Risk Methods Document (Table A.7b).

(4) Analytes were retained for modeling based on comparison to Soil/Sediment NALs (resident child) for the PGDP in the PGDP Risk Methods Document (DOE 2001a), Table A.17.

(5) Short-lived radionuclides[1] were not retained for modeling.

(6) Analytes were screened from modeling if the only detections in all of the analyses were near the detection limit and were flagged "B" to indicate the presence of blank contamination. (Metals were not screened from modeling based on analyses performed by the USEC lab that are marked with the "B" qualifier to indicate blank contamination.)

(7) Analytes were screened from modeling if the number of detections was less than 5%.[2] Analytes that are included in tables A.7a and A.7b were not subjected to this criterion.

5.2.2 CHEMICAL PROPERTIES

Table 5.1 lists the COPCs identified for fate and transport assessment along with the parameter values chosen to represent these contaminants in the SESOIL and AT123D models.

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[1] Short-lived radionuclides are radioactive decay product with a half-life less than six months.
[2] This criterion is intended to screen out artifacts in the data due to sampling, analytical, or other problems and, therefore, may not be related to site operations or disposal practices.

Table 5.1. Burial Ground COPCs for the Groundwater Pathway and Properties

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Acenaphthene	154	4.20E+00	4.00E-02	2.77E-06	1.60E-04	4.90E+03	3.9	Infinite
Anthracene	178.24	4.30E-02	3.20E-02	2.79E-06	5.55E-05	2.04E+04	16.3	Infinite
Antimony	121.75	1.00E+07	NA	3.60E-07	NA	NA	45	Infinite
PCB-1254	327	7.00E-02	1.56E-02	1.80E-06	3.40E-04	4.25E+04	34	Infinite
PCB-1260	375.7	2.70E-02	1.38E-02	1.56E-06	7.40E-05	2.07E+05	165.6	Infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	Infinite
Benzo(a)pyrene	252.32	1.62E-03	4.30E-02	3.24E-06	1.13E-06	9.69E+05	772	Infinite
Beryllium	9.01	1.00E+07	NA	3.60E-07	NA	NA	250	Infinite
Cadmium	112.41	1.00E+07	NA	3.60E-07	NA	NA	75	Infinite
cis-1,2-DCE	96.94	3.50E+03	7.00E-02	4.07E-06	4.08E-03	3.55E+01	0.028	Infinite
1,1-DCE	97	2.25E+03	9.00E-02	3.74E-06	2.61E-02	6.50E+01	0.013	Infinite
Dibenzo(a,h)-anthracene	278.33	2.50E-03	2.00E-02	1.86E-06	1.47E-08	1.78E+06	1,424	Infinite
Fluorathene	202.26	2.06E-01	3.00E-02	2.29E-06	1.61E-05	4.91E+04	39.3	Infinite
Fluorene	166	1.90E+00	6.10E-02	2.84E-06	7.70E-05	7.90E+03	6.3	Infinite
Manganese	54.94	1.00E+07	NA	3.60E-07	NA	NA	65	Infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	Infinite
Molybdenum	95.9	1.00E+07	NA	3.60E-07	NA	NA	10	Infinite
Naphthalene	128.16	3.10E+01	5.90E-02	2.70E-06	4.83E-04	1.19E+03	0.95	Infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	Infinite
^{239}Pu	239	1.00E+07	NA	3.60E-07	NA	NA	550	2.41E+04
Pyrene	202.3	1.35E-01	2.72E-02	2.61E-06	1.10E-05	6.80E+04	54.4	Infinite
Selenium	80.98	1.00E+07	NA	3.60E-07	NA	NA	5	Infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
Tetrachloroethene	165.8	2.00E+02	7.20E-02	2.95E-06	1.84E-02	2.65E+02	0.053	Infinite
TCE	131	1.10E+03	8.00E-02	3.28E-06	1.03E-02	9.40E+01	0.0752	2.66E+01[b]
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{235}U	235	1.00E+07	NA	3.60E-07	NA	NA	66.8	7.04E+08
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1,000	Infinite
Vinyl Chloride	63	2.76E+03	1.10E-01	4.43E-07	2.70E-02	1.88E+01	0.0152	Infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	Infinite

[a] The Kd of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

[b] The 26.6 year half-life for TCE is applied to the UCRS only (not used in the RGA), consistent with previous modeling at the site.

In general, all contaminants were assumed not to degrade in the environment (i.e., infinite half-life), except for radionuclides and TCE. Table 5.1 lists the half-lives assumed in the transport analyses for the COPCs.

Although radionuclides behave chemically as metals, the radioactive nuclides undergo spontaneous transformations that involve the emission of particles (alpha and beta particles) and radiant energy (gamma energy). The resulting daughters (i.e., product nuclides) may be radioactive themselves (in which case they too will undergo spontaneous decay) or may be stable nuclides. Natural uranium consists of three primary isotopes: ^{234}U, ^{235}U, and ^{238}U. The decay products of uranium isotopes also are radioactive and form decay chains.

Two of the more important decay modes are alpha decay and beta decay, the latter being differentiated into electron and positron decay. As with inorganic and organic chemical species that do not undergo nuclear transformations, the persistence of radionuclide contaminants is related largely to their geochemical mobility in the environment.

Uranium hexafluoride is the sole raw material used in the enrichment process at PGDP. Some of the uranium feed material that was handled at PGDP has been reclaimed or recycled from reprocessed, spent reactor fuel. The chemical processes by which recycled uranium is purified leave trace amounts of transuranic elements (neptunium and plutonium) and fission products (mainly ^{99}Tc). Technetium-99 (in the +7 oxidation state) is highly soluble in groundwater and is very mobile (its K_d is similar to that of TCE). The groundwater plumes of TCE and ^{99}Tc at PGDP are similar in size and geometry.

On an activity basis, the principal radionuclides expected to pass through chemical processing and contaminate the recycled uranium are the transuranic radionuclides produced in highest abundance and with moderate half-lives: ^{237}Np, plutonium-238 (^{238}Pu), ^{239}Pu, plutonium-240 (^{240}Pu), and ^{241}Am. Characterization studies (DOE 1999c) have shown that these radioisotopes are usually present in activities that are less than 1% of the uranium activity unless treatment processes have collected and concentrated them in sludges or trap material. Because ^{137}Cs has a half-life of 30 years, it is the most likely fission product (except for ^{99}Tc) still to be present at the site.

An assumption of the modeling for the BGOU RI was TCE degraded in the UCRS with a half-life of 26.6 years, but did not degrade in the RGA.[3] Although the mechanism is not well understood at PGDP, TCE and its degradation products may be degraded in the environment by various processes including hydrolysis, oxidation/reduction, photolysis, or biodegradation. TCE degradation may result in more toxic degradation products, such as vinyl chloride.

In the degradation of TCE, both aerobic and anaerobic degradation may occur. The anaerobic degradation pathway is as follows:

TCE → cis- and *trans-1,2-DCE → Vinyl Chloride → Ethene*

The anaerobic biodegradation of TCE, which initially forms *cis*-1,2-DCE, occurs under reducing conditions where sulfide- and/or methane-producing conditions exist. Such conditions occur primarily in the presence of other natural or anthropogenic carbon sources. The compounds c*is*- and *trans*-1,2-DCE are indicators of this degradation pathway because neither was used as a pure product at PGDP. Both *cis*- and *trans*-1,2-DCE may further degrade anaerobically to vinyl chloride, but the rate is slower than the degradation rate of TCE, and the process may require stronger reducing conditions than those required for reduction of TCE. Low-levels of TCE intermediate dechlorination products (produced by anaerobic degradation) are found in RGA groundwater in some on-site locations. These occurrences may be related to degradation of TCE in the UCRS, where anaerobic conditions are known to occur locally.

The RGA is dominantly an aerobic environment. Aerobic biodegradation of TCE may occur under certain conditions. For example, specialized microorganisms have been identified that aerobically degrade some of these solvents in the presence of ammonia, methane, and toluene. In aerobic settings, TCE degrades to epoxides, aldehydes, chlorinated oxides, and ethanols.

Contaminant transport modeling simulates retardation during groundwater transport using indices of water solubility and adsorption to soil. In general, organic chemicals with high solubilities are more mobile in water than those that adsorb more strongly to soils. The following properties dictate an organic chemical's mobility within a specific medium.

[3] The assumption of zero degradation for TCE in the RGA is conservative. An alternative RGA degradation rate for TCE will be selected for use in the FS. The Kentucky Research Consortium for Energy and Environment, with the participation of DOE and its regulatory oversight, is researching TCE attenuation in the RGA at PGDP. PGDP modeling will incorporate these results as they become available. Recent findings (DOE 2007d) indicate the TCE half-life in the Northwest Plume of the RGA ranges from 3.2 to 11.3 years.

- K_{oc}, the soil organic carbon partition coefficient, is a measure of the tendency for organic compounds to be adsorbed to the organic matter of soil and sediments. K_{oc} is expressed as the ratio of the amount of chemical adsorbed, per unit weight of organic carbon, to the chemical concentration in solution at equilibrium.

- K_{ow}, the octanol-water partition coefficient, is an indicator of hydrophobicity (the tendency of a chemical to avoid the aqueous phase) and is correlated with potential adsorption to soils. It also is used to estimate the potential for bioconcentration of chemicals into tissues.

- K_d, the soil/water distribution coefficient, is a measure of the tendency of a chemical to adsorb to soil or sediment particles. For organic compounds, this coefficient is calculated as the product of the K_{oc} value and the fraction of organic carbon in the soils. In general, chemicals with higher K_d values adsorb more strongly to soil/sediment particles and are less mobile than those with lower K_d values.

Release and transport mechanisms for TCE and its degradation products include vertical advective migration through unsaturated soils toward the water table, as well as gravity-driven migration as a DNAPL. The range of K_{oc} values indicates that these chlorinated VOCs are mobile through soils as dissolved constituents and tend not to partition significantly from water to soil.

Inorganic chemicals (i.e., metals) released to the unsaturated soil will be dissolved in soil moisture or absorbed onto soil particles. These dissolved metals are subject to movement with soil water. Aqueous transport mechanisms may result in metal migration through the vadose zone to groundwater. Metals, unlike organic compounds, cannot be degraded; however, metals migration can be attenuated by retardation reactions such as adsorption, surface complexation, and ion-exchange reactions with the soils which they contact. Such reactions are affected by pH, oxidation-reduction conditions, and the type and amount of organic matter, clay, and hydrous oxides present. Some metals, such as arsenic, can be transformed to other oxidation states in soil. Such transformations can affect their mobilities by affecting the way in which they react with soil particles or other solid surfaces by ion exchange, adsorption, precipitation, or complexation.

5.3 GROUNDWATER FATE AND TRANSPORT MODELING

Modeling for the BGOU RI used the SADA, SESOIL, and AT123D models, consistent with Tier 3 of the modeling matrix in the PGDP Risk Methods Document (DOE 2001a). SADA was used for the definition of the source terms, SESOIL for fate and transport modeling through the UCRS, and AT123D for fate and transport modeling through the RGA to the POEs. In addition to the models used, the MODFLOW/MODPATH models were used along with the previously developed PGDP sitewide groundwater model to establish input parameters for AT123D (i.e., distances to the POEs along flow paths (Figure 5.1), hydraulic gradient, and hydraulic conductivity). These models, along with the fixed parameter values chosen for the analyses (i.e., deterministic analysis), and model implementation are discussed in detail in Appendix E. The fate and transport modeling for the BGOU RI incorporates the sampling results of this RI and more sophisticated geospatial analysis of the source terms than those of previous models for these SWMUs; therefore, these model results differ from those of the previous models.

Modeling predicted the maximum concentration of COPCs in groundwater at the boundary of each BGOU SWMU (Table 5.2). Table 5.3 presents the results of the deterministic modeling effort for the BGOU RI for the plant boundary and off-site POEs. Among the COPCs, arsenic, ^{99}Tc, and TCE and related VOCs commonly exceeded MCLs. Table 5.4 presents the hazard quotient (HQ) and estimated lifetime cancer risk (ELCR) for each COC based on the predicted groundwater concentrations at the plant boundary and off-site POEs. The HQs and ELCRs were calculated in accordance with the Risk Methods Document (DOE 2001a). Appendix F provides a full description of the risk assessment methodology and calculations. The following discussion summarizes the results for each BGOU SWMU.

Table 5.2. Concentrations of the COPCs in Groundwater at the BGOU SWMU Boundaries Predicted in SESOIL and AT123D Modeling

COPC	Predicted Maximum Groundwater Concentration (mg/L or pi/L)[a]	MCL (mg/L or pCi/L)
SWMU 2		
Arsenic	***3.54E-02***	0.01
cis-1,2-DCE	***1.15E+01***	0.07
Manganese	7.16E-01	[b]
Naphthalene	9.38E-04	[b]
^{99}Tc	1.02E+02	900[c]
TCE	***1.48E+00***	0.005
^{234}U	1.58E+00	[b]
^{238}U	1.81E+00	[b]
Uranium	9.86E-03	0.03
SWMU 3		
Arsenic	***3.29E-02***	0.01
Manganese	8.95E-01	[b]
^{99}Tc	***5.560E+03***	900[c]
Uranium	***4.89E-02***	0.03
SWMU 4		
Arsenic	***1.77E-02***	0.01
cis-1,2-DCE	***6.68E-01***	0.07
Manganese	5.76E-01	[b]
^{99}Tc	***9.008E+03***	900[c]
TCE	***1.18E+00***	0.005
Vinyl Chloride	***2.61E-02***	0.002
SWMU 5		
Acenaphthene	6.10E-03	[b]
Arsenic	9.25E-03	0.01
Manganese	1.01E+00	[b]
Naphthalene	5.55E-03	[b]
^{99}Tc	1.27E+02	900[c]
SWMU 6		
No groundwater COPCs		

Table 5.2. Concentrations of the COPCs in Groundwater at the BGOU SWMU Boundaries Predicted in SESOIL and AT123D Modeling (Continued)

COPC	Predicted Maximum Groundwater Concentration (mg/L or pCi/L)[a]	MCL (mg/L or pCi/L)
SWMU 7		
1,1-DCE	***8.98E-02***	0.07
Arsenic	***1.78E-02***	0.01
cis-1,2-DCE	2.35E-02	0.07
Manganese	3.32E-01	[b]
PCB-1254	5.23E-05	[b]
^{99}Tc	***9.09E+02***	900[c]
TCE	***1.09E-02***	0.005
^{234}U	7.94E+00	[b]
^{238}U	7.59E+00	[b]
Uranium	3.46E-03	0.03
Vinyl Chloride	***1.35E-02***	0.002
SWMU 30		
1,1-DCE	6.05E-02	0.07
Arsenic	***1.77E-02***	0.01
Manganese	3.78E-01	[b]
Selenium	1.51E-02	0.05
^{99}Tc	2.87E+02	900[c]
TCE	***7.12E-01***	0.005
^{234}U	3.99E+00	[b]
^{238}U	5.91E+00	[b]
Uranium	8.40E-03	0.03
SWMU 145		
Antimony	***7.99E-02***	0.006
Arsenic	***6.21E-02***	0.01
^{99}Tc	***1.01E+04***	900[c]

[a] Values in bold, italic font exceed the COPC's MCL
[b] MCLs not available for these contaminants
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption

Table 5.3. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of the BGOU SWMUs

COPC	Predicted Maximum Groundwater Concentration[a,b]				
	Plant Boundary (mg/L)	Property Boundary (mg/L)	Little Bayou seeps (mg/L)	Ohio River (mg/L)	MCL (mg/L or pCi/L)
SWMU 2					
Arsenic	2.91E-03	8.35E-09	N/A	0.00E+00	0.01
cis-1,2-DCE	***1.74E+00***	***8.58E-01***	N/A	***3.38E-01***	0.07
Manganese	1.86E-05	0.00E+00	N/A	0.00E+00	[c]
Naphthalene	1.57E-04	8.27E-05	N/A	3.42E-05	[c]
^{99}Tc	1.59E+01	8.06E+00	N/A	3.11E+00	900[d]
TCE	***2.17E-01***	***1.10E-01***	N/A	***4.12E-02***	0.005
^{234}U	1.75E-05	0.00E+00	N/A	0.00E+00	[c]
^{238}U	2.03E-05	0.00E+00	N/A	0.00E+00	[c]
Uranium	8.33E-08	0.00E+00	N/A	0.00E+00	0.03
SWMU 3					
Arsenic	1.22E-03	0.00E+00	0.00E+00	N/A	0.01
Manganese	4.08E-10	0.00E+00	0.00E+00	N/A	[c]
^{99}Tc	***1.81E+03***	***1.36E+03***	8.04E+02	N/A	900[d]
Uranium	2.27E-13	0.00E+00	0.00E+00	N/A	0.03
SWMU 4					
Arsenic	2.70E-03	4.90E-06	N/A	0.00E+00	0.01
cis-1,2-DCE	***1.96E-01***	***8.94E-02***	N/A	3.16E-02	0.07
Manganese	5.01E-03	0.00E+00	N/A	0.00E+00	[c]
^{99}Tc	***2.50E+03***	***1.20E+03***	N/A	3.79E+02	900[d]
TCE	***4.22E-01***	***2.14E-01***	N/A	***7.67E-02***	0.005
Vinyl Chloride	***5.95E-03***	***2.53E-03***	N/A	7.82E-04	0.002
SWMU 5					
Acenaphthene	2.42E-03	1.34E-03	N/A	5.01E-04	NA
Arsenic	1.78E-03	1.27E-04	N/A	0.00E+00	0.01
Manganese	8.69E-02	2.30E-11	N/A	0.00E+00	[c]
Naphthalene	9.82E-04	3.72E-04	N/A	1.08E-04	NA
^{99}Tc	4.99E+01	2.64E+01	N/A	8.72E+00	900[d]
SWMU 6					
No groundwater COPCs					
SWMU 7					
1,1-DCE	***8.24E-02***	1.10E-02	4.02E-03	N/A	0.07
Arsenic	***1.26E-02***	2.35E-03	0.00E+00	N/A	0.01
cis-1,2-DCE	2.15E-02	3.13E-03	1.17E-03	N/A	0.07
Manganese	2.41E-01	1.05E-06	0.00E+00	N/A	[c]
PCB-1254	3.09E-05	3.05E-06	1.32E-12	N/A	[c]
^{99}Tc	8.25E+02	2.70E+02	1.32E+02	N/A	900[d]
TCE	***9.87E-03***	1.42E-03	5.06E-04	N/A	0.005
^{234}U	5.79E+00	5.84E-06	0.00E+00	N/A	[c]
^{238}U	5.58E+00	5.85E-06	0.00E+00	N/A	[c]
Uranium	2.53E-03	2.68E-09	0.00E+00	N/A	0.03
Vinyl Chloride	***1.24E-02***	1.21E-03	4.13E-04	N/A	0.002

Table 5.3. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of the BGOU SWMUs (Continued)

COPC	Predicted Maximum Groundwater Concentration[a,b]				
	Plant Boundary (mg/L)	Property Boundary (mg/L)	Little Bayou seeps (mg/L)	Ohio River (mg/L)	MCL (mg/L or pCi/L)
SWMU 30					
1,1-DCE	5.92E-02	4.41E-03	1.32E-03	N/A	0.07
Arsenic	***1.17E-02***	2.34E-03	0.00E+00	N/A	0.01
Manganese	2.51E-01	2.85E-04	0.00E+00	N/A	[c]
Selenium	8.30E-03	9.21E-04	3.15E-04	N/A	0.05
^{99}Tc	2.64E+02	7.08E+01	2.92E+01	N/A	900[d]
TCE	***6.80E-01***	***5.87E-02***	***1.96E-02***	N/A	0.005
^{234}U	2.75E+00	1.44E-03	0.00E+00	N/A	[c]
^{238}U	4.07E+00	1.98E-03	0.00E+00	N/A	[c]
Uranium	4.81E-03	2.41E-06	0.00E+00	N/A	0.03
SWMU 145					
Antimony	N/A	1.51E-06	N/A	0.00E+00	0.006
Arsenic	N/A	1.61E-03	N/A	0.00E+00	0.01
^{99}Tc	N/A	***1.84E+03***	N/A	***9.65E+02***	900[d]

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] MCLs not available for these contaminants
[e] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
N/A = not applicable

Table 5.4. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of BGOU SWMUs using SESOIL and AT123D[a]

COPC	Plant Boundary		Property Boundary		Little Bayou Seeps		Near Ohio River	
	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk
SWMU 2								
Arsenic	9.0E-01	7.7E-05	<1.0E-01	<1.0E-06	N/A	N/A	[b]	[b]
cis-1,2-DCE	9.2E+01	[b]	4.5E+01	[b]	N/A	N/A	1.8E+01	[b]
Manganese	<1.0E-01	[b]	[b]	[b]	N/A	N/A	[b]	[b]
Naphthalene	1.0E-01	[b]	<1.0E-01	[b]	N/A	N/A	<1.0E-01	[b]
^{99}Tc	[b]	<1.0E-06	[b]	<1.0E-06	N/A	N/A	[b]	<1.0E-06
TCE	9.9E+01	6.7E-03	5.0E+01	3.4E-03	N/A	N/A	4.6E+00	1.3E-03
^{234}U	[b]	<1.0E-06	[b]	[b]	N/A	N/A	[b]	[b]
^{238}U	[b]	<1.0E-06	[b]	[b]	N/A	N/A	[b]	[b]
Uranium	1.0E-01	[b]	[b]	[b]	N/A	N/A	[b]	[b]
SWMU 3								
Arsenic	4.0E-01	3.2E-05	[b]	[b]	[b]	[b]	N/A	N/A
Manganese	<1.0E-01	[b]	[b]	[b]	[b]	[b]	N/A	N/A
^{99}Tc	[b]	9.9E-05	[b]	7.5E-05	[b]	4.4E-05	N/A	N/A
^{238}U	[b]	<1.0E-06	[b]	[b]	[b]	[b]	N/A	N/A
Uranium	<1.0E-01	[b]	[b]	[b]	[b]	[b]	N/A	N/A
SWMU 4								
Arsenic	9.0E-01	7.2E-05	<1.0E-01	<1.0E-06	N/A	N/A	[b]	[b]
cis-1,2-DCE	1.0E+01	[b]	4.7E+00	[b]	N/A	N/A	6.0E-01	[b]
Manganese	<1.0E-01	[b]	[b]	[b]	N/A	N/A	[b]	[b]
^{99}Tc	[b]	1.4E-04	[b]	6.6E-05	N/A	N/A	[b]	2.1E-05
TCE	1.9E+02	2.0E-02	9.8E+01	6.6E-03	N/A	N/A	3.3E+01	2.4E-03
Vinyl Chloride	3.0E-01	1.9E-04	1.0E-01	7.4E-05	N/A	N/A	<1.0E-01	2.3E-05
SWMU 5								
Arsenic	6.0E-01	4.7E-05	<1.0E-01	3.4E-06	N/A	N/A	[b]	[b]
Manganese	2.0E-01	[b]	<1.0E-01	[b]	N/A	N/A	[b]	[b]
Naphthalene	5.0E-01	[b]	2.0E-01	[b]	N/A	N/A	<1.0E-01	[b]
^{99}Tc	[b]	2.7E-06	[b]	1.4E-06	N/A	N/A	[b]	<1.0E-06
SWMU 6								
No groundwater COPCs								

Table 5.4. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of BGOU SWMUs using SESOIL and AT123D[a] (Continued)

COPC	Plant Boundary		Property Boundary		Little Bayou Seeps		Near Ohio River	
	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk
SWMU 7								
1,1-DCE	8.0E-01	1.9E-03	1.0E-01	2.5E-04	<1.0E-01	9.3E-05	N/A	N/A
Arsenic	4.0E+00	3.3E-04	8.0E-01	6.2E-05	[b]	[b]	N/A	N/A
cis-1,2-DCE	1.1E+00	[b]	2.0E-01	[b]	<1.0E-01	[b]	N/A	N/A
Manganese	5.0E-01	[b]	<1.0E-01	[b]	[b]	[b]	N/A	N/A
PCB-1254	2.5E+00	4.8E-06	2.0E-01	<1.0E-06	<1.0E-01	<1.0E-06	N/A	N/A
^{99}Tc	[b]	4.5E-05	[b]	1.5E-05	[b]	7.3E-06	N/A	N/A
TCE	4.5E+00	3.1E-04	6.0E-01	4.4E-05	2.0E-01	1.6E-05	N/A	N/A
^{234}U	[b]	8.2E-06	[b]	<1.0E-06	[b]	[b]	N/A	N/A
^{238}U	[b]	9.7E-06	[b]	<1.0E-06	[b]	[b]	N/A	N/A
Uranium	4.0E-01	[b]	<1.0E-01	[b]	[b]	[b]	N/A	N/A
Vinyl Chloride	6.0E-01	3.6E-04	<1.0E-01	3.6E-05	<1.0E-01	1.2E-05	N/A	N/A
SWMU 30								
1,1-DCE	6.0E-01	1.4E-03	<1.0E-01	1.0E-04	<1.0E-01	3.0E-05	N/A	N/A
Arsenic	3.8E+00	3.1E-04	8.0E-01	6.2E-05	[b]	[b]	N/A	N/A
Manganese	5.0E-01	[b]	<1.0E-01	[b]	[b]	[b]	N/A	N/A
Selenium	2.0E-01	[b]	<1.0E-01	[b]	<1.0E-01	[b]	N/A	N/A
^{99}Tc	[b]	1.4E-05	[b]	3.9E-06	[b]	1.6E-06	N/A	N/A
TCE	3.1E+02	2.1E-02	2.7E+01	1.8E-03	9.0E+00	6.1E-04	N/A	N/A
^{234}U	[b]	3.9E-06	[b]	<1.0E-06	[b]	[b]	N/A	N/A
^{238}U	[b]	7.1E-06	[b]	<1.0E-06	[b]	[b]	N/A	N/A
Uranium	8.0E-01	[b]	<1.0E-01	[b]	[b]	[b]	N/A	N/A
SWMU 145								
Antimony	N/A	N/A	<1.0E-01	[b]	N/A	N/A	[b]	[b]
Arsenic	N/A	N/A	5.0E-01	4.3E-05	N/A	N/A	[b]	[b]
^{99}Tc	N/A	N/A	[b]	1.0E-04	N/A	N/A	[b]	5.3E-05

[a] Contaminants with an HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs – all values are rounded to one decimal place.

[b] Value not calculated since the groundwater concentrations were predicted as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

5.3.1 SWMU 2

The groundwater results presented in Table 5.3 for SWMU 2 show that the predicted groundwater concentrations of *cis*-1,2-DCE and TCE exceed their respective MCLs at the plant boundary, property boundary, and Ohio River POEs. All the remaining SWMU 2 COPCs are not predicted to exceed their respective MCLs at the POEs. The following summarizes those COCs that exceeded ELCR and HQ risk criteria.

		Plant Boundary	Property Boundary	Ohio River
Arsenic	**ELCR**	7.7E-05	--	--
	HQ	0.9	--	--
***cis*-1,2-DCE**	**ELCR**	--	--	--
	HQ	91.9	45.3	17.9
TCE	**ELCR**	6.7E-03	3.4E-03	1.3E-03
	HQ	99.1	50.3	4.6

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Figures 5.2 through 5.4 present the predicted concentrations over time of SWMU 2 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). As shown in these figures, arsenic is predicted to continue rising in concentration at 1,000 years at the plant boundary, will not reach the property boundary or Ohio River in the 1,000 year period. Both *cis*-1,2-DCE and TCE are predicted to exceed their MCLs at all POEs within approximately 100 years and then decline in concentration below the MCLs.

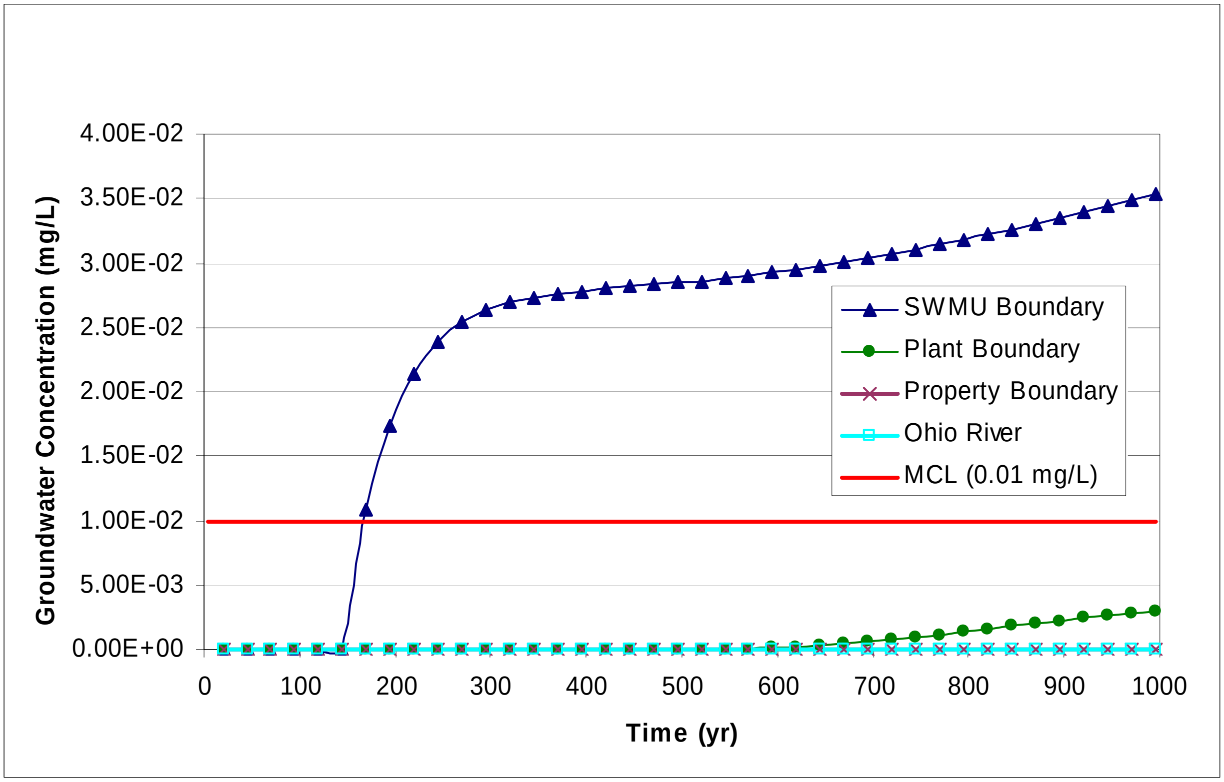

Figure 5.2. Predicted Arsenic Concentration in Groundwater at the POEs Based on Contaminant Leaching from SWMU 2

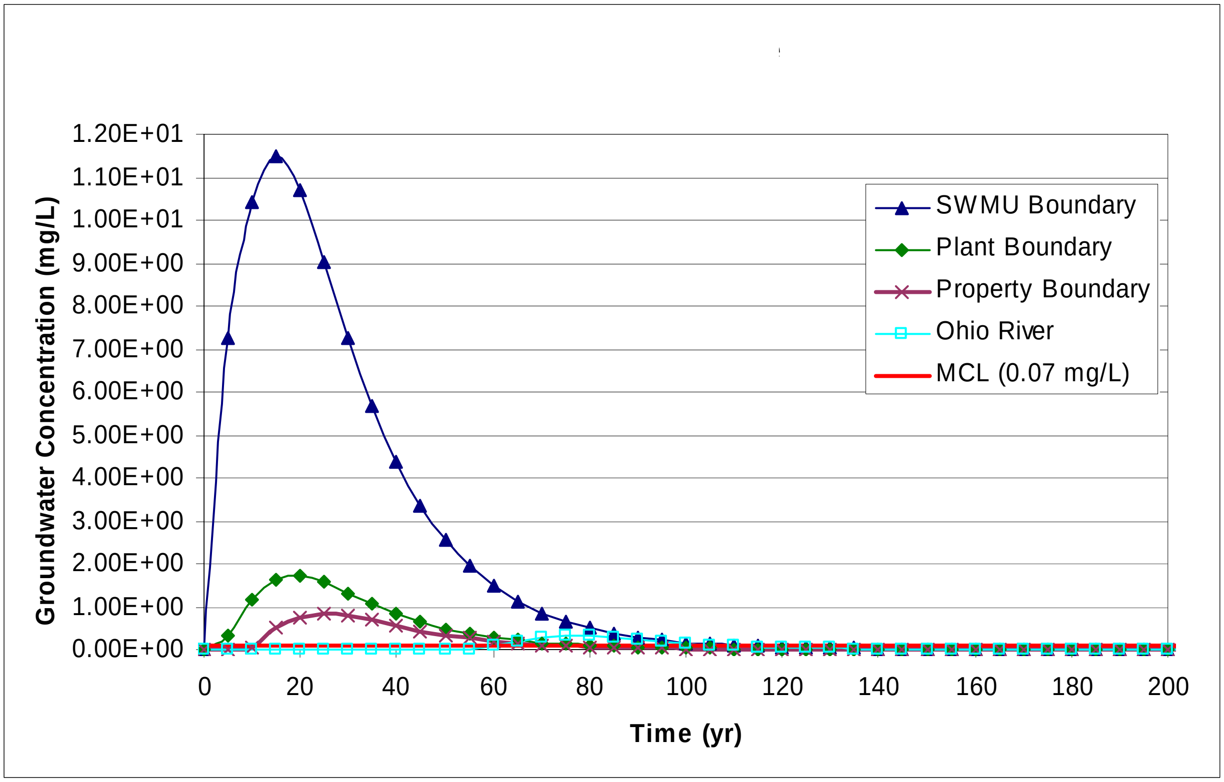

Figure 5.3. Predicted *cis*-1,2-DCE Concentration in Groundwater at the POEs Based on Contaminant Leaching from SWMU 2

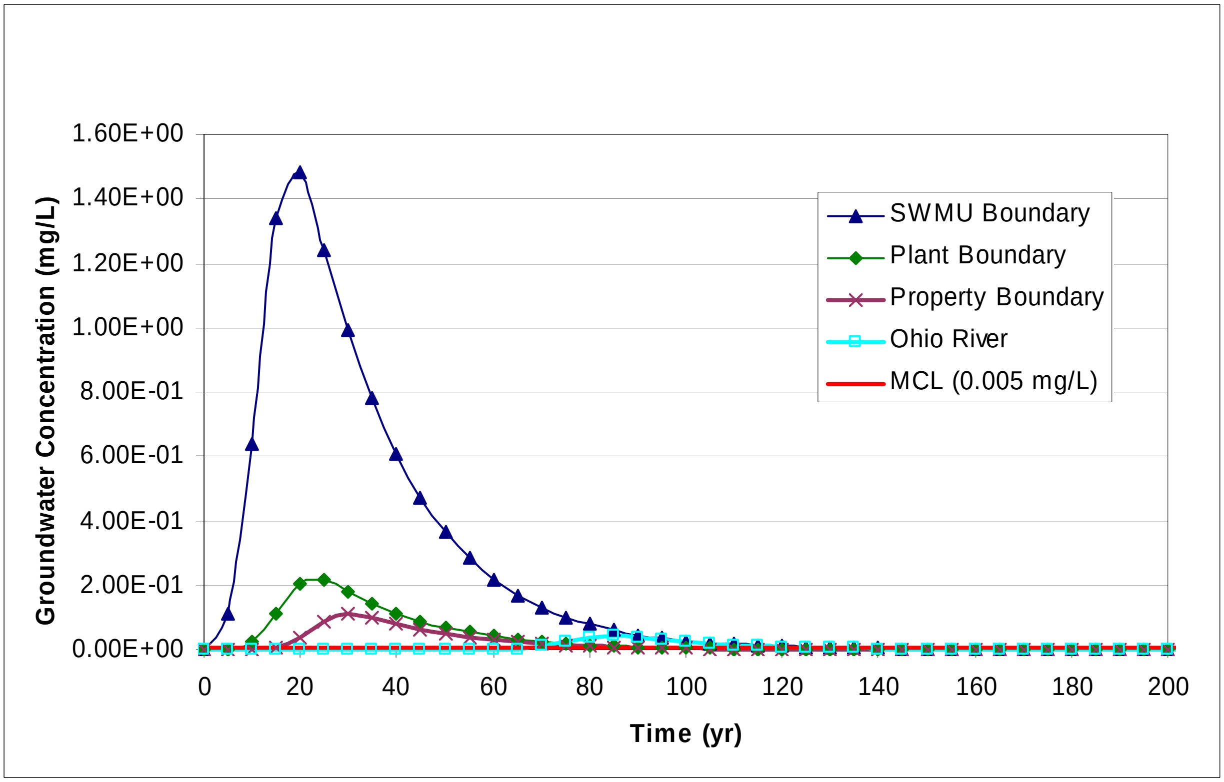

Figure 5.4. Predicted TCE Concentration in Groundwater at the POEs Based on Contaminant Leaching from SWMU 2

5.3.2 SWMU 3

Screening identified arsenic, manganese, ^{99}Tc, and uranium as COPCs for SWMU 3. Fate and transport modeling predicts that ^{99}Tc will exceed the MCL at the plant and property boundary POEs. The following summarizes those COCs that exceeded ELCR or HQ risk criteria:

		Plant Boundary	Property Boundary	Little Bayou Seeps	Ohio River
Arsenic	**ELCR**	3.2E-05	--	--	--
	HQ	0.4	--	--	--
^{99}Tc	**ELCR**	9.9E-05	7.5E-05	4.4E-05	3.9E-05
	HQ	--	--	--	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at the POEs. Figures 5.5 and 5.6 illustrate the predicted concentrations through time of SWMU 3 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). As shown in these figures, arsenic is predicted to continue rising in concentration at 1,000 years at the plant boundary at groundwater concentrations less than the MCL, but will not reach the property boundary or Little Bayou Seeps in the 1,000 year period. ^{99}Tc is predicted to peak at all POEs within 200 years and at dissolved levels greater than the MCL at the plant and property POEs.

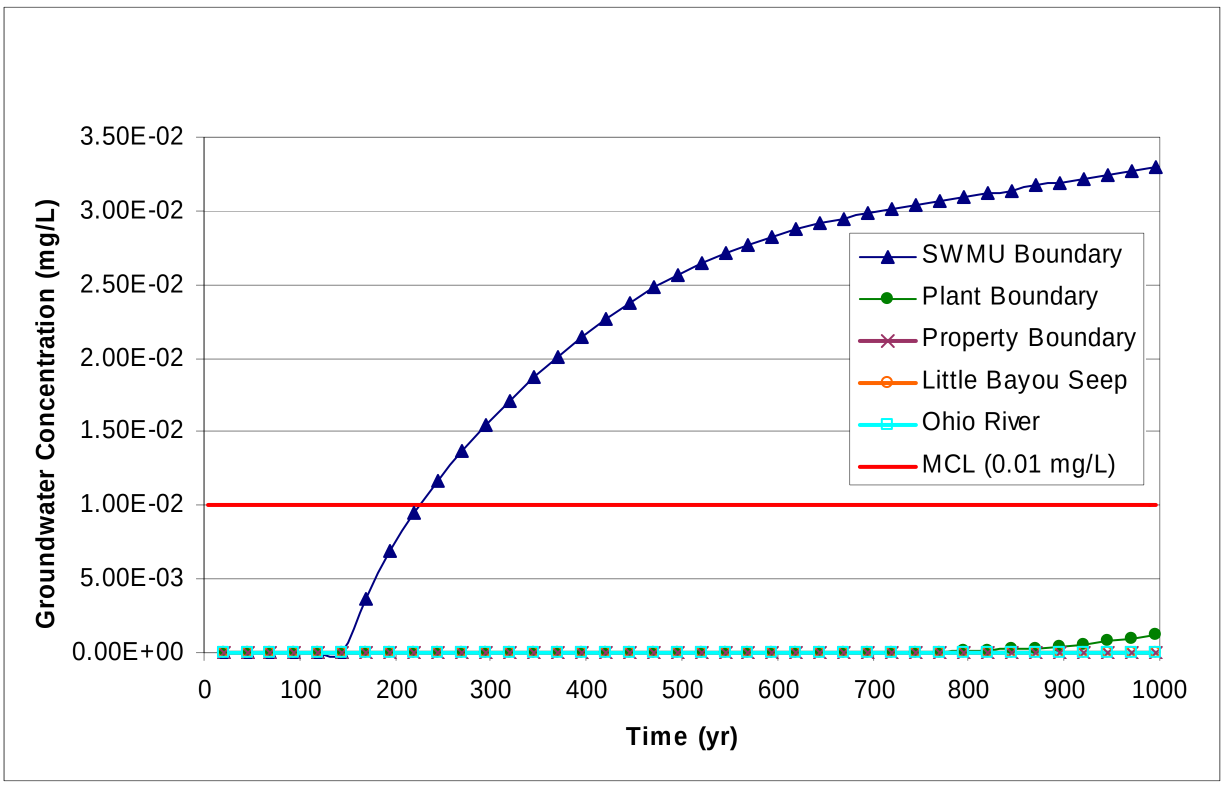

Figure 5.5. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 3

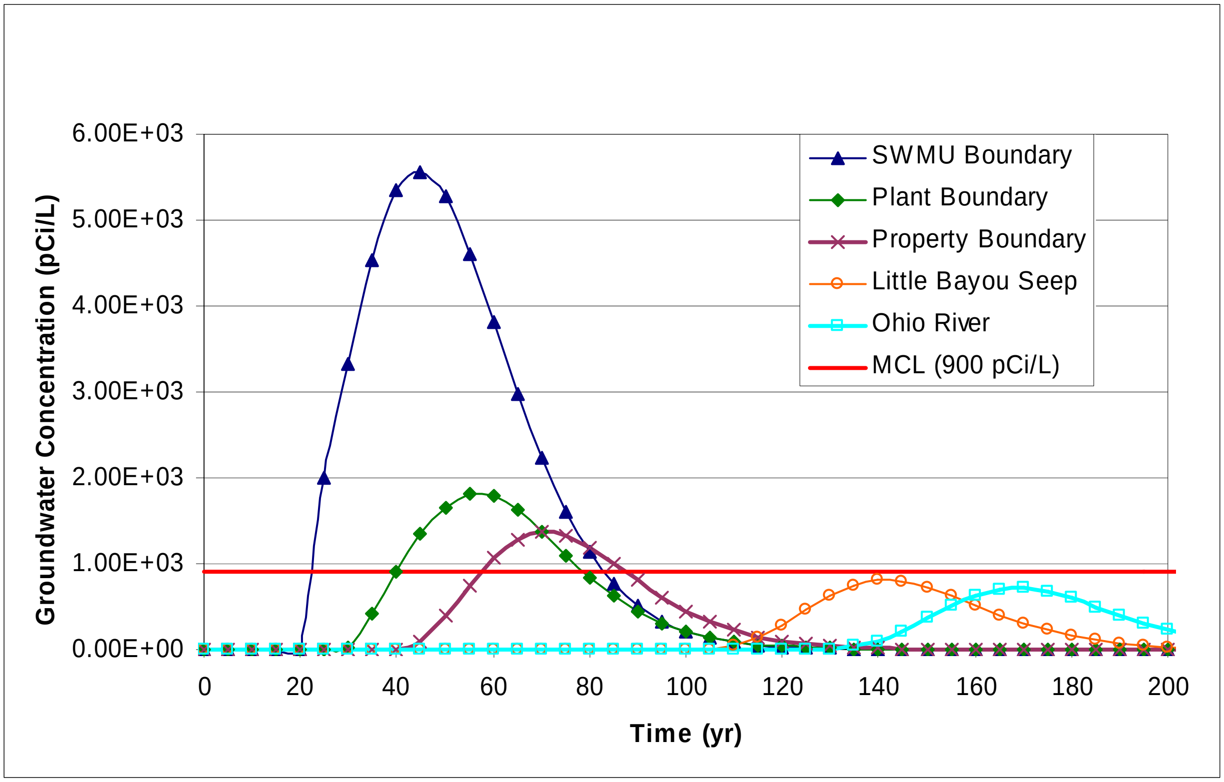

Figure 5.6. Predicted ^{99}Tc Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 3

5.3.3 SWMU 4

The groundwater results presented in Table 5.3 for SWMU 4 show that the predicted groundwater concentrations of *cis*-1,2-DCE; ^{99}Tc; TCE, and vinyl chloride will exceed their respective MCLs at the plant boundary and property boundary. TCE also is predicted to exceed the MCL at the Ohio River. The following summarizes those COCs that exceeded ELCR or HQ risk criteria:

		Plant Boundary	Property Boundary	Ohio River
Arsenic	**ELCR**	7.2E-05	--	--
	HQ	0.9	--	--
***cis*-1,2-DCE**	**ELCR**	--		--
	HQ	10.4	4.7	0.6
^{99}Tc	**ELCR**	1.4E-04	6.6E-05	2.1E-05
	HQ	--	--	--
TCE	**ELCR**	2.0E-02	6.6E-03	2.4E-03
	HQ	193	97.7	32.7
Vinyl chloride	**ELCR**	1.9E-04	7.4E-05	2.3E-05
	HQ	0.3	0.1	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Figures 5.7 through 5.11 portray the modeled concentrations over time of SWMU 4 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). As shown in these figures, the dissolved arsenic concentration is predicted to continue rising at 1,000 years at the plant boundary, but will not reach the property boundary or Ohio River in the 1,000 year period. The chemicals *cis*-1,2-DCE; TCE; vinyl chloride, and ^{99}Tc are predicted to exceed the MCL at the plant and property boundaries within 100 years. Modeling predicts TCE also will exceed the MCL at the Ohio River within 100 years.

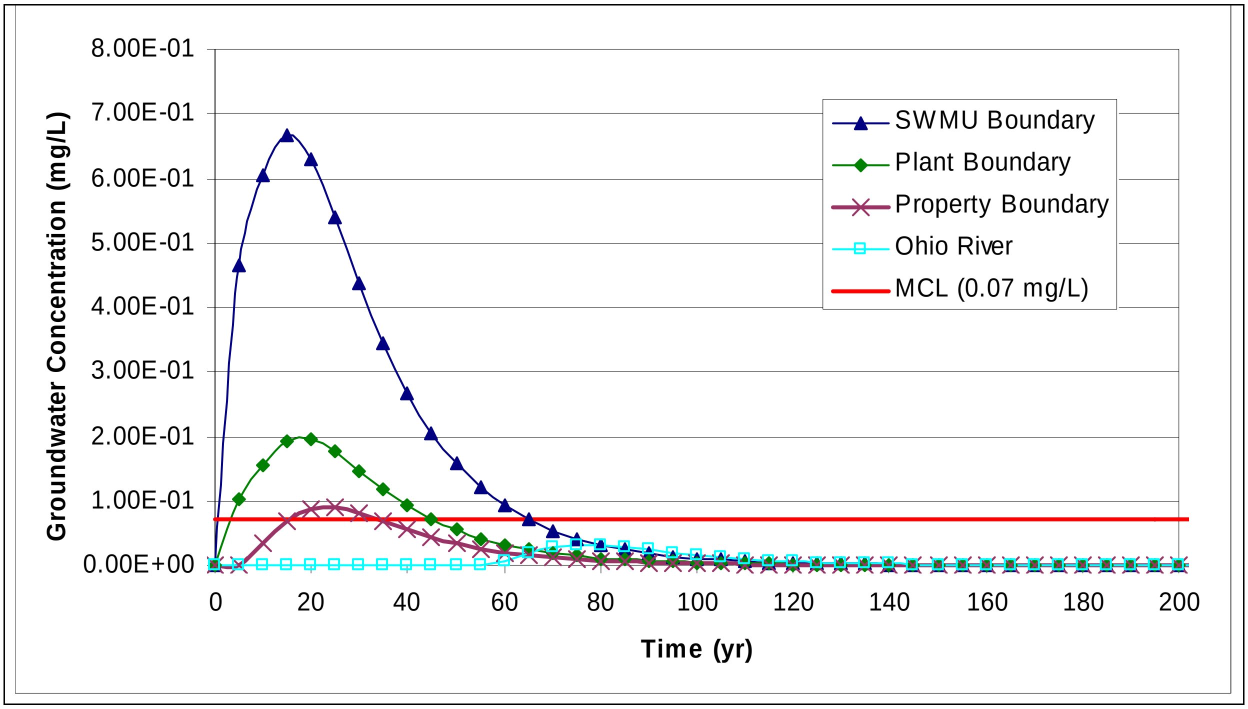

Figure 5.7. Predicted *cis*-1,2-DCE Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 4

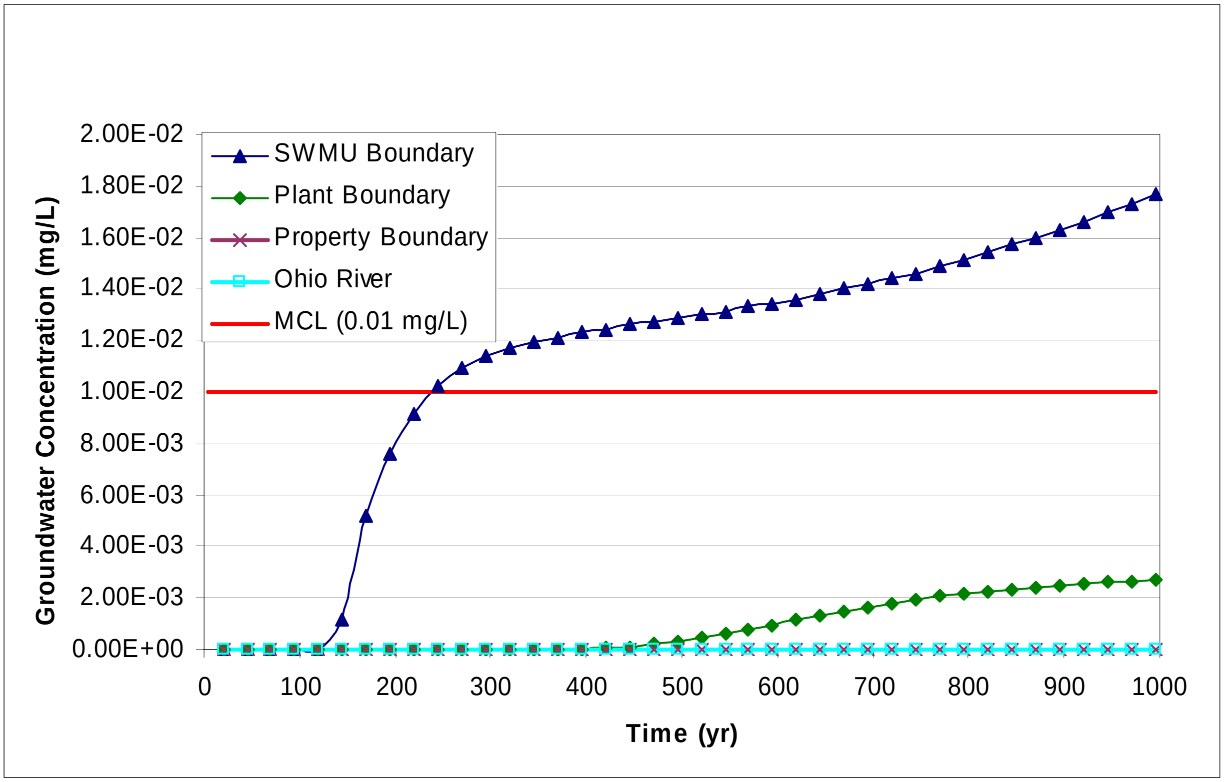

Figure 5.8. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 4

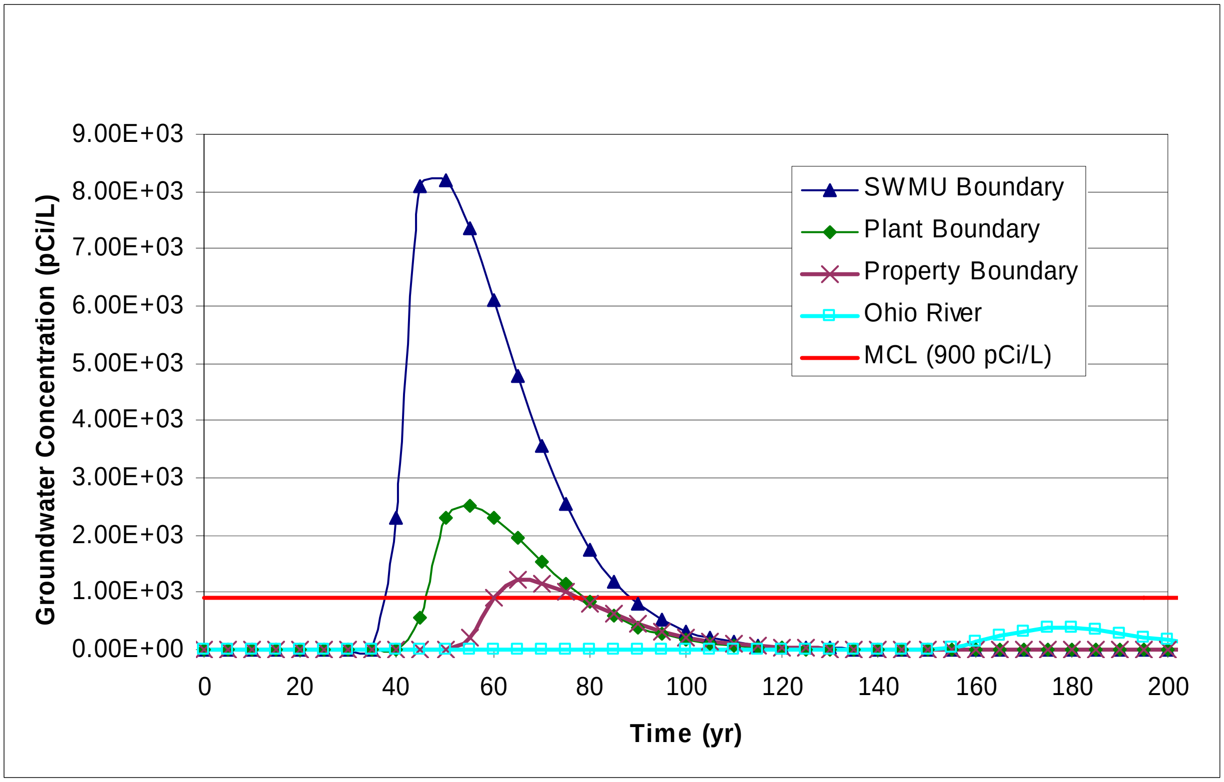

Figure 5.9. Predicted ^{99}Tc Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 4

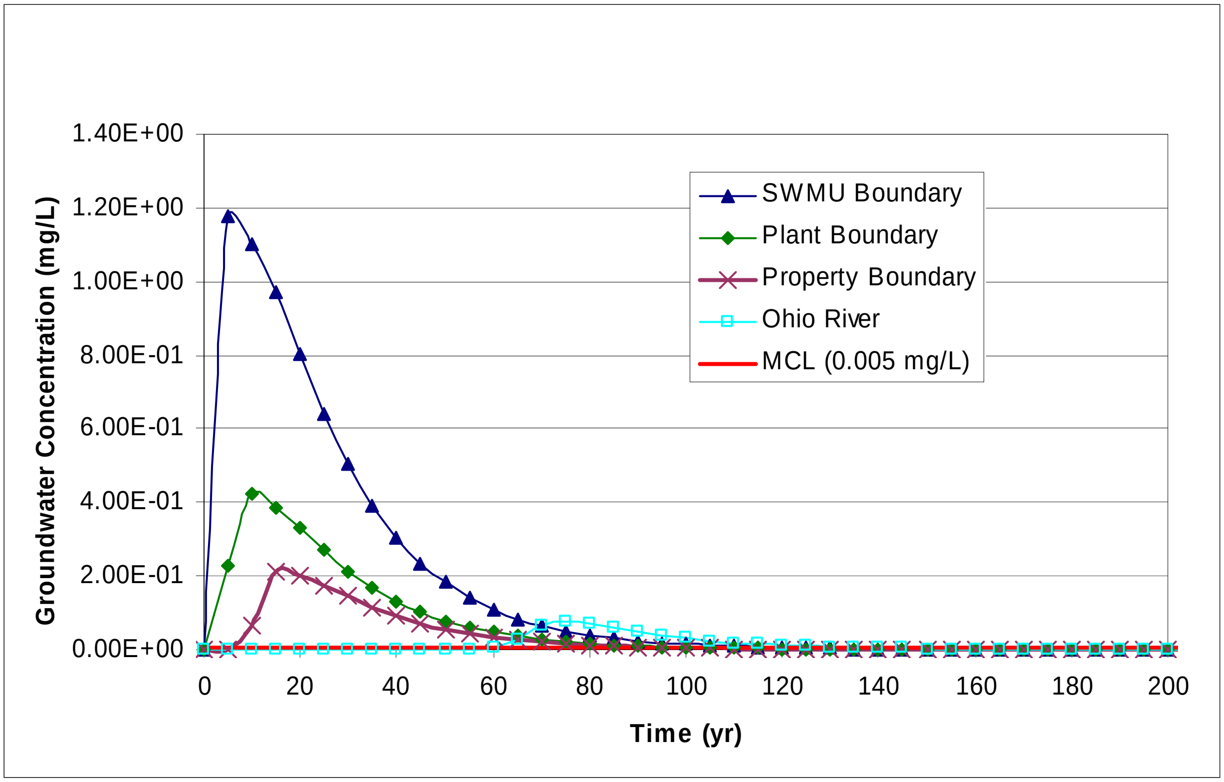

Figure 5.10. Predicted TCE Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 4

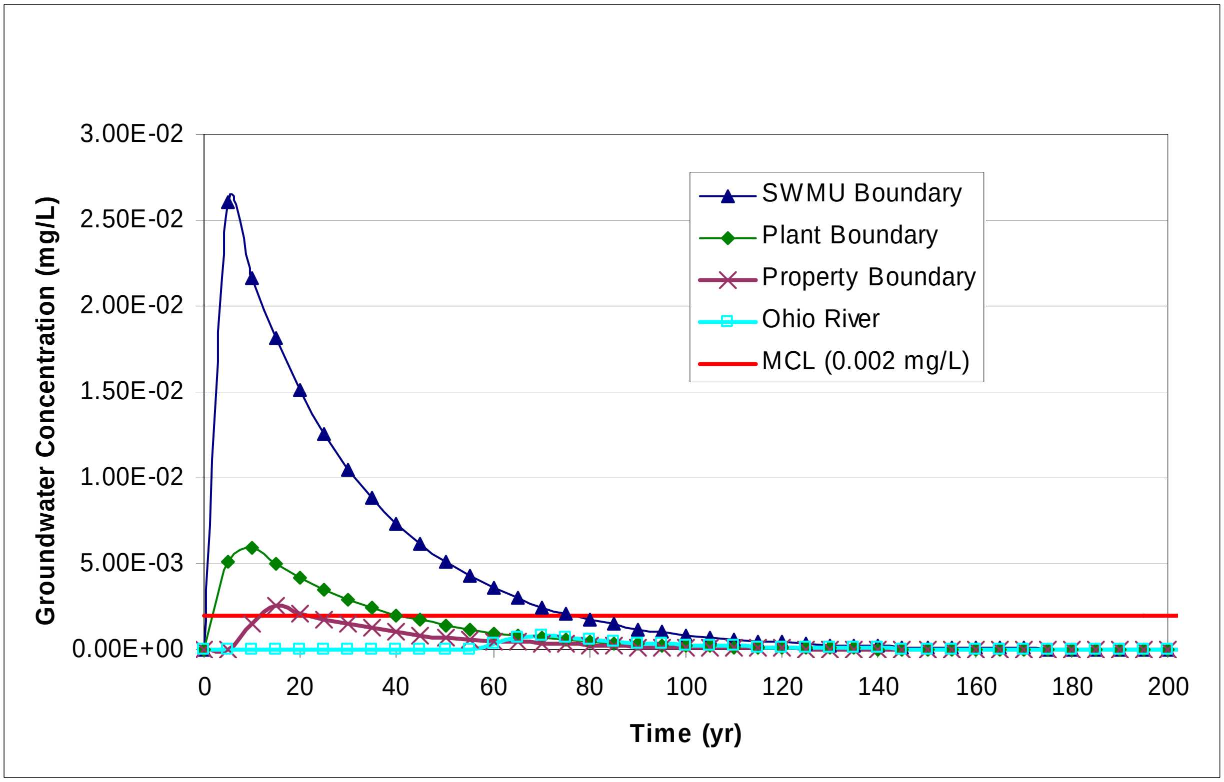

Figure 5.11. Predicted Vinyl Chloride Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 4

5.3.4 SWMU 5

All SWMU 5 COPCs are predicted to be less than their respective MCLs at all POEs. The following summarizes those COPCs that exceeded ELCR or HQ risk criteria:

		Plant Boundary	Property Boundary	Ohio River
Arsenic	**ELCR**	4.7E-05	3.4E-06	--
	HQ	0.6	--	--
Manganese	**ELCR**	--	--	--
	HQ	0.2	--	--
^{99}Tc	**ELCR**	2.7E-06	1.4E-06	--
	HQ	--	--	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Figures 5.12 through 5.15 illustrate the future predicted concentrations of SWMU 5 COPCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). As shown in these figures, the dissolved arsenic and manganese concentrations are predicted to continue rising at 1,000 years at the plant boundary. Manganese will not reach the property boundary or Ohio River in the 1,000 year period. Arsenic begins to increase in concentration at the plant boundary at 1,000 years; however, the concentrations are less than the MCL. ^{99}Tc is not predicted to exceed the MCL at the POEs.

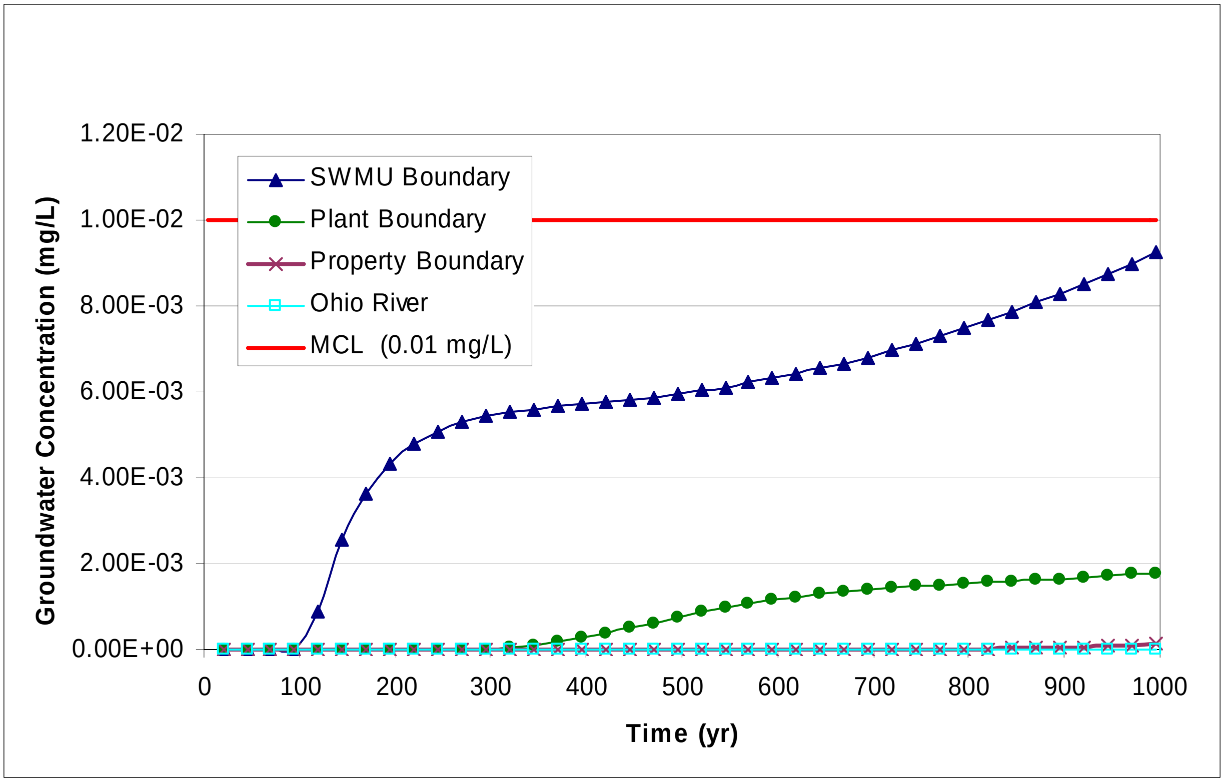

Figure 5.12. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 5

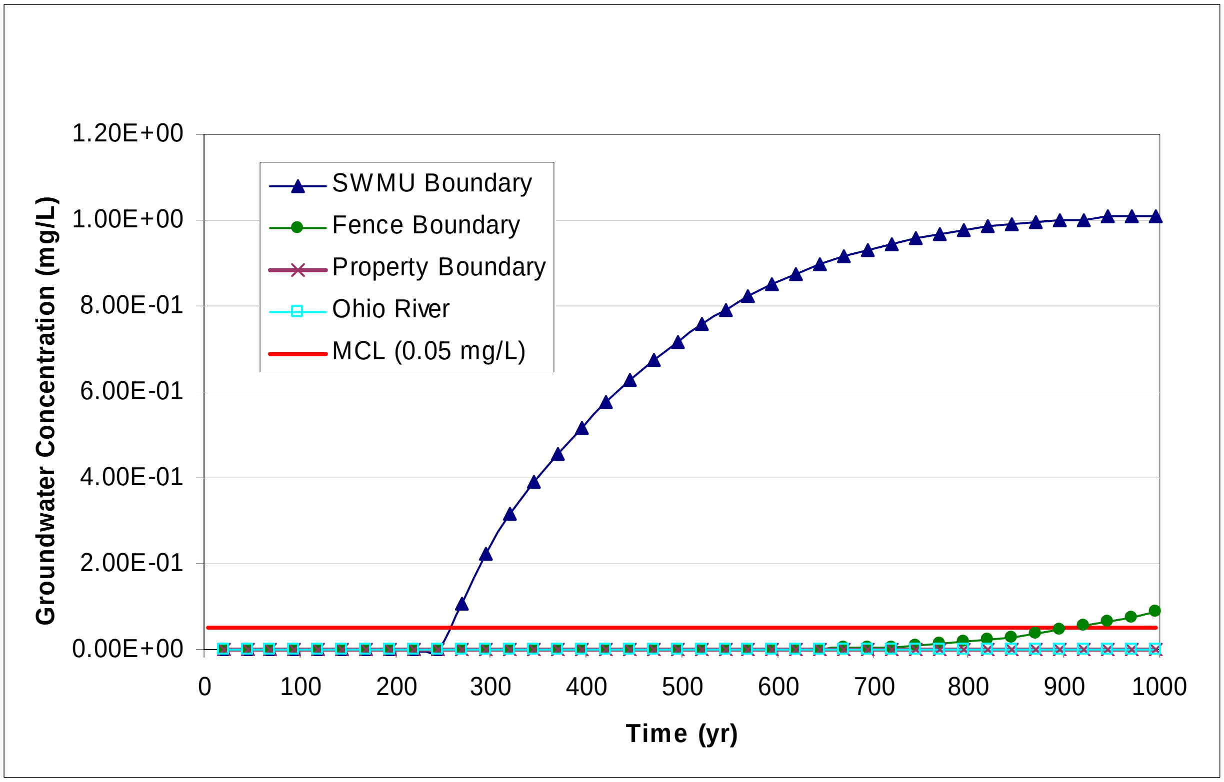

Figure 5.13. Predicted Manganese Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 5

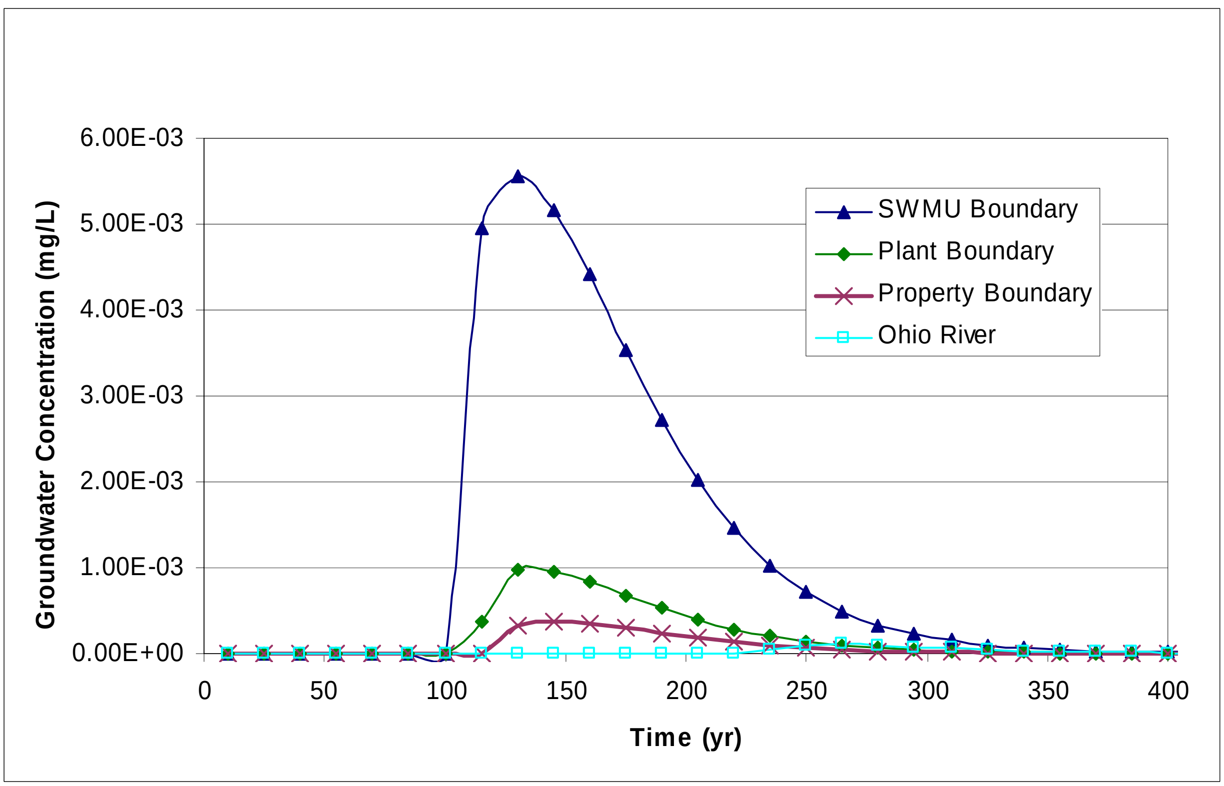

Figure 5.14. Predicted Naphthalene Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 5

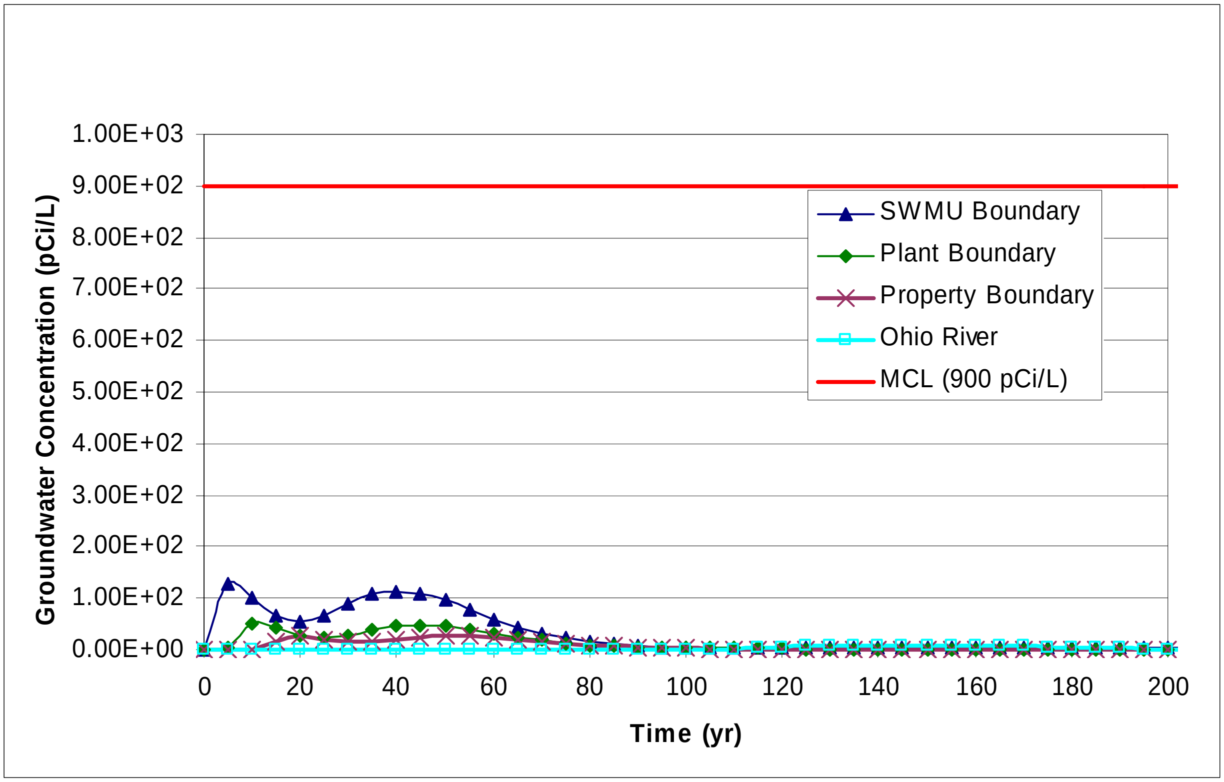

Figure 5.15. Predicted ^{99}Tc Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 5

5.3.5 SWMU 6

All of the COPCs modeled for SWMU 6 that were identified by the initial SSL screening for groundwater did not reach the water table in 1,000 years or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child NALs (see Appendix F); therefore, there were no groundwater COPCs for SWMU 6.

5.3.6 SWMU 7

The groundwater results presented in Table 5.3 for SWMU 7 show the predicted groundwater concentrations of 1,1-DCE; arsenic; TCE; and vinyl chloride will exceed their respective MCLs at the plant boundary. All SWMU 7 COPCs are modeled to be less than their respective MCLs at the property boundary, and Little Bayou seeps. The following summarizes those COCs that exceeded ELCR or HQ risk criteria:

		Plant Boundary	Property Boundary	Little Bayou Seeps
1,1-DCE	**ELCR**	1.9E-03	2.5E-04	9.3E-05
	HQ	0.8	0.1	--
Arsenic	**ELCR**	3.3E-04	6.2E-05	--
	HQ	4.0	0.8	--
***cis*-1,2-DCE**	**ELCR**	--	--	--
	HQ	1.1	0.2	--
Manganese	**ELCR**	--	--	--
	HQ	0.5	--	--
PCB-1254	**ELCR**	4.8E-06	--	--
	HQ	2.5	0.2	--
^{99}Tc	**ELCR**	4.5E-05	1.5E-05	7.3E-06
	HQ	--	--	--
TCE	**ELCR**	3.1E-04	4.4E-05	1.6E-05
	HQ	4.5	0.6	0.2
Uranium	**ELCR**	--	--	--
	HQ	0.4	--	--
^{234}U	**ELCR**	8.2E-06	--	--
	HQ	5.8	--	--
^{238}U	**ELCR**	9.6E-06	--	--
	HQ	5.6	--	--
Vinyl chloride	**ELCR**	3.6E-04	3.6E-05	1.2E-05
	HQ	0.6	--	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Figures 5.16 through 5.25 portray the predicted concentrations of SWMU 7 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). Arsenic was not modeled to reach the Little Bayou seeps in the 1,000 year modeling period.

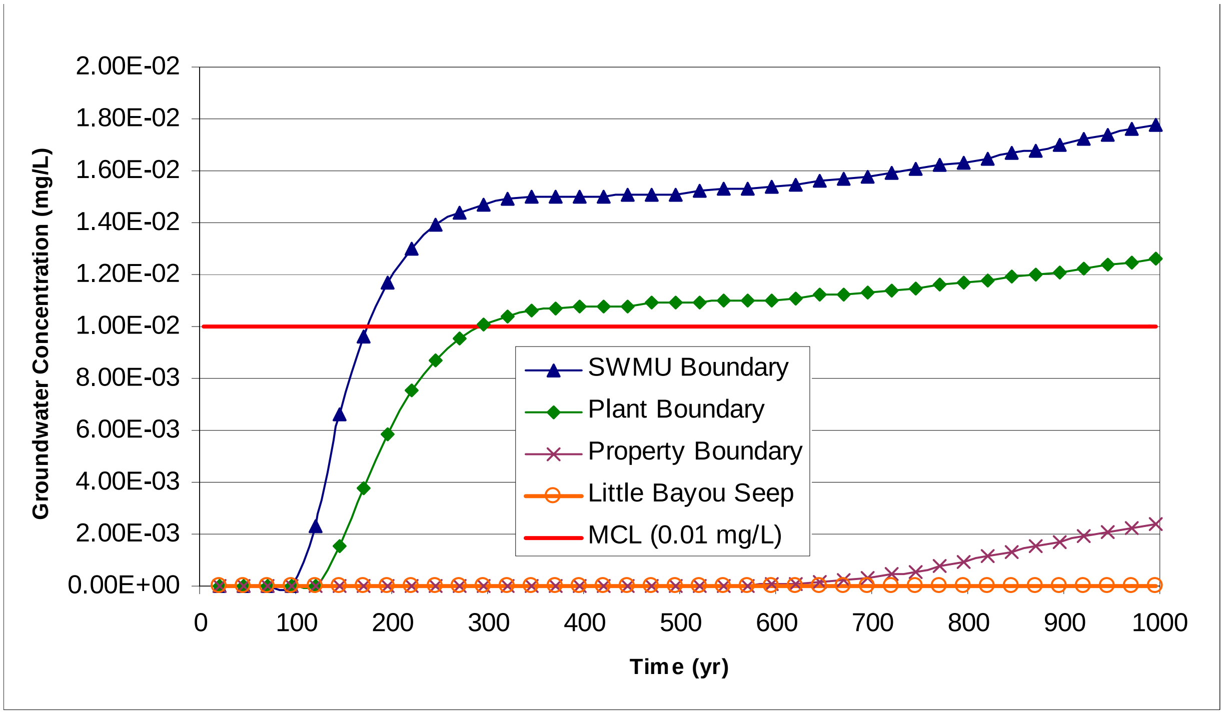

Figure 5.16. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

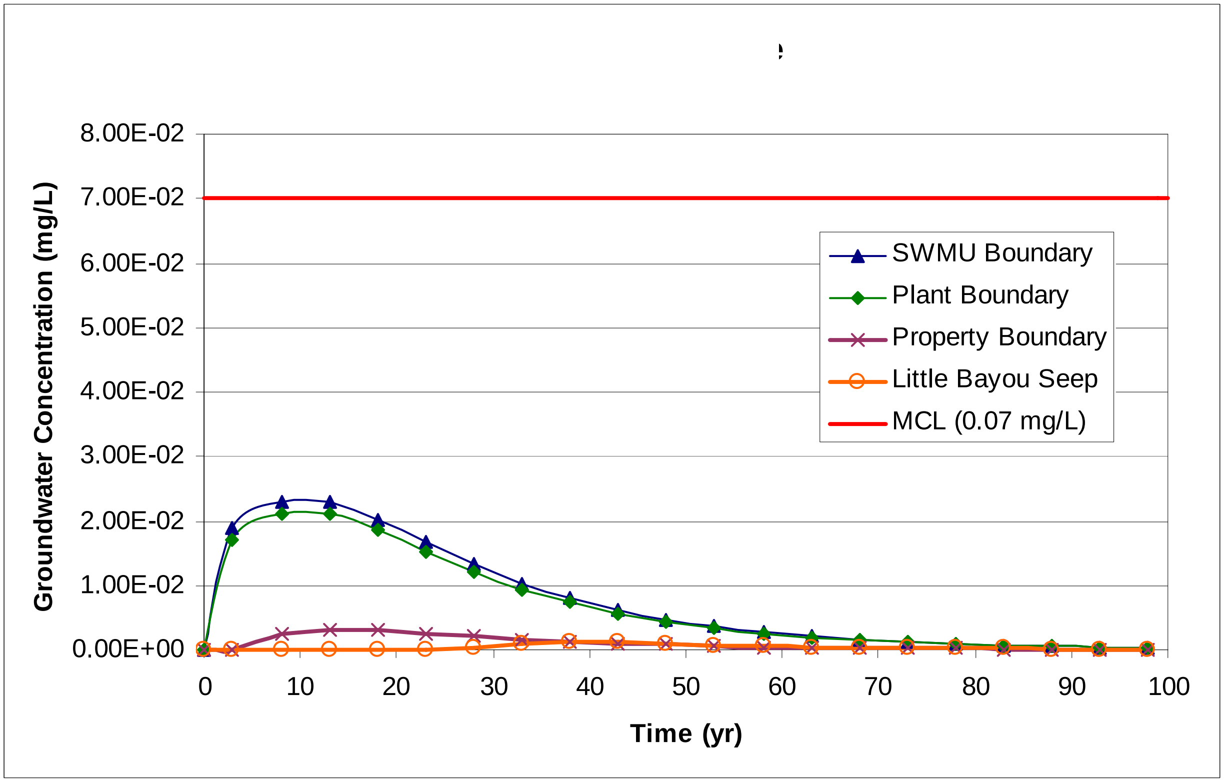

Figure 5.17. Predicted *cis*-1,2-DCE Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

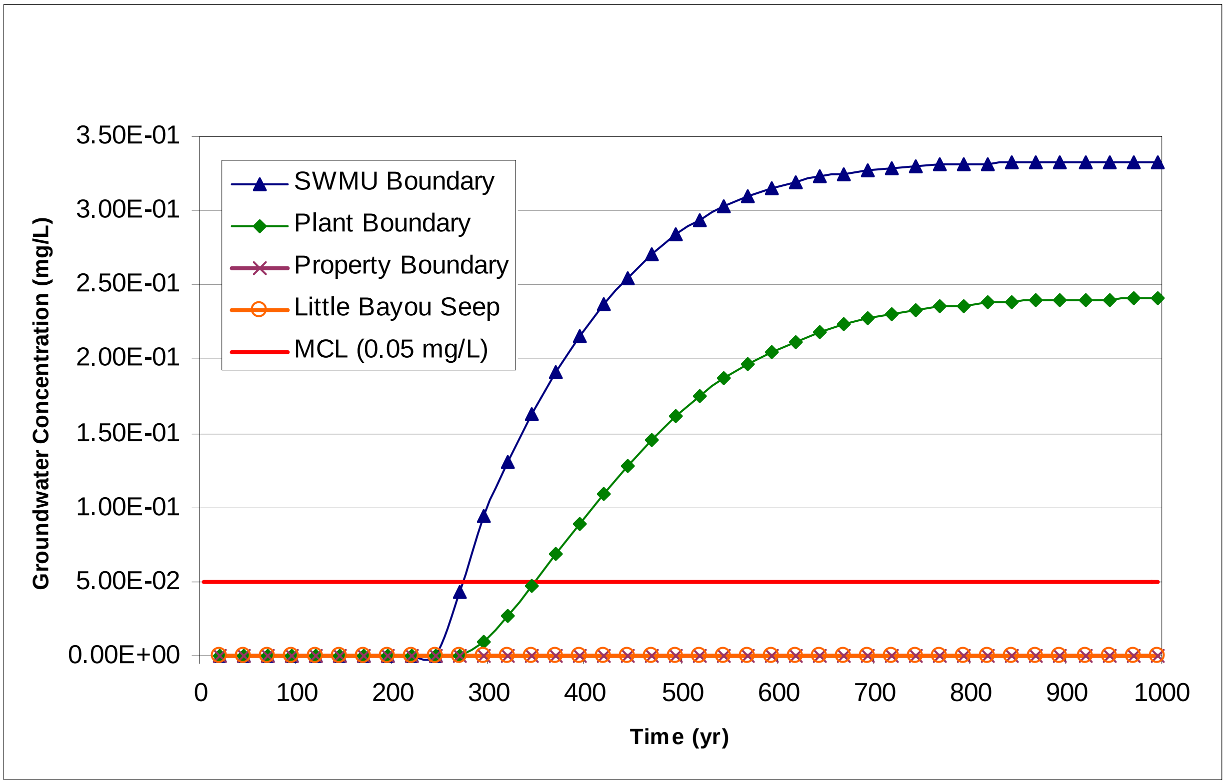

Figure 5.18. Predicted Manganese Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

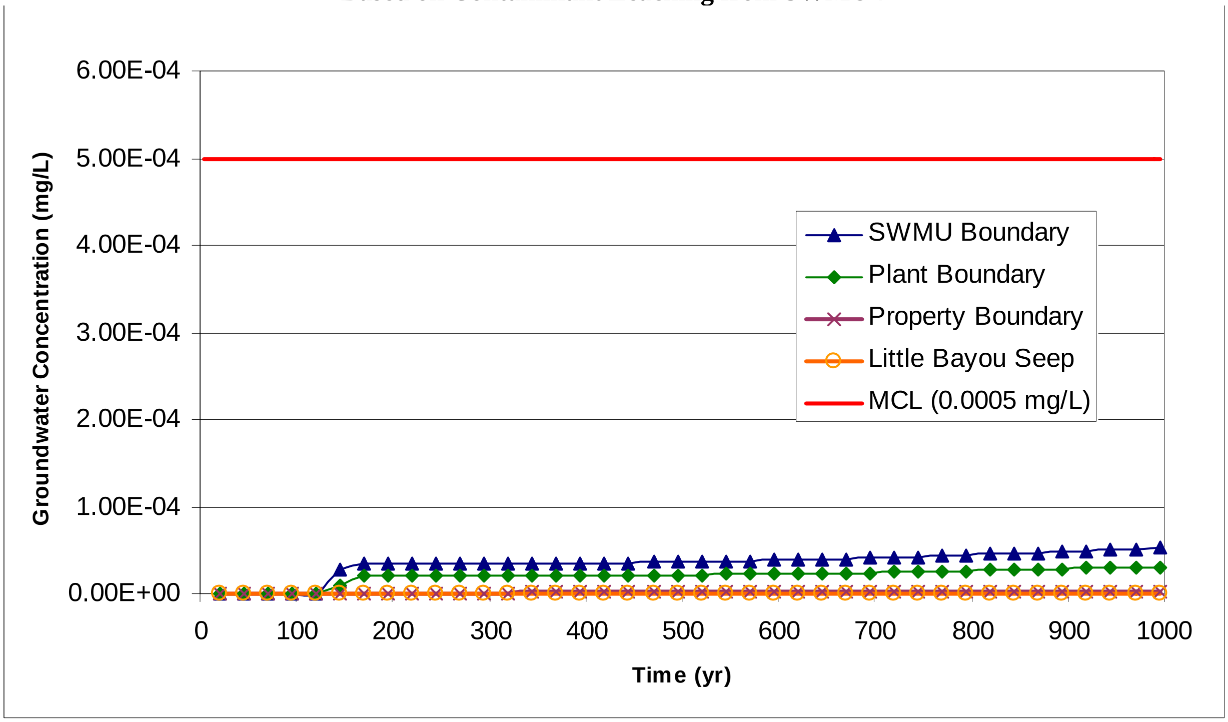

Figure 5.19. Predicted PCB-1254 Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

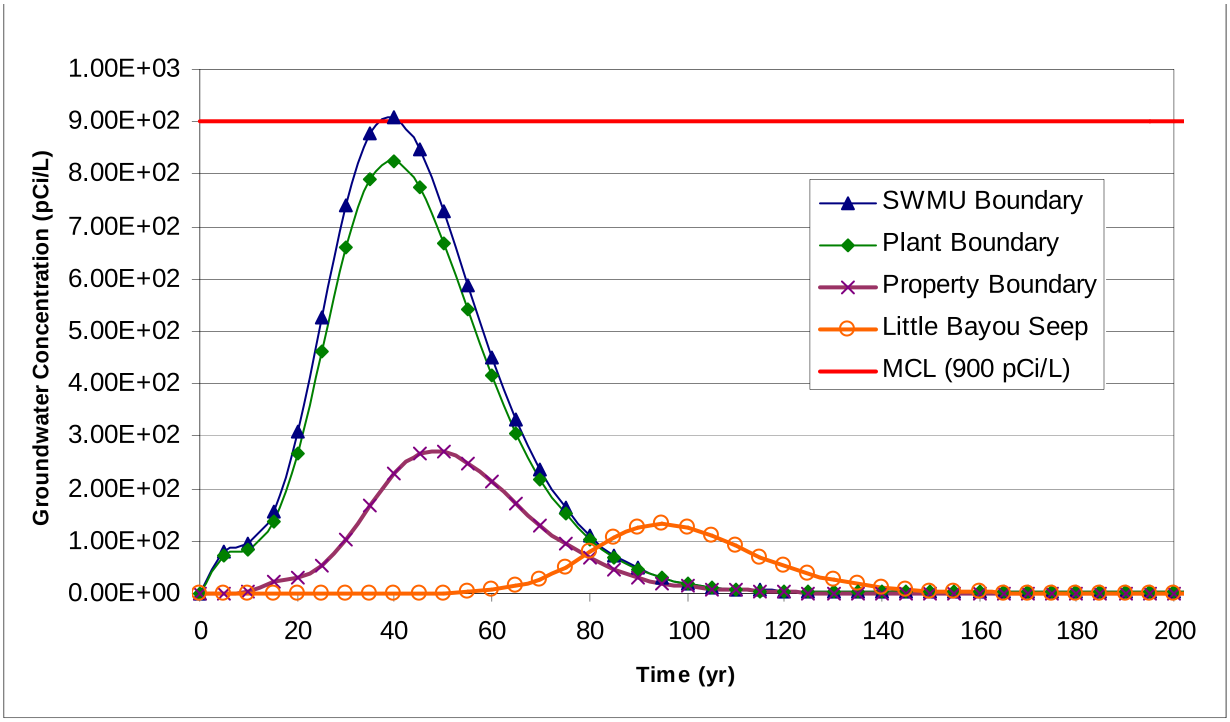

Figure 5.20. Predicted ^{99}Tc Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

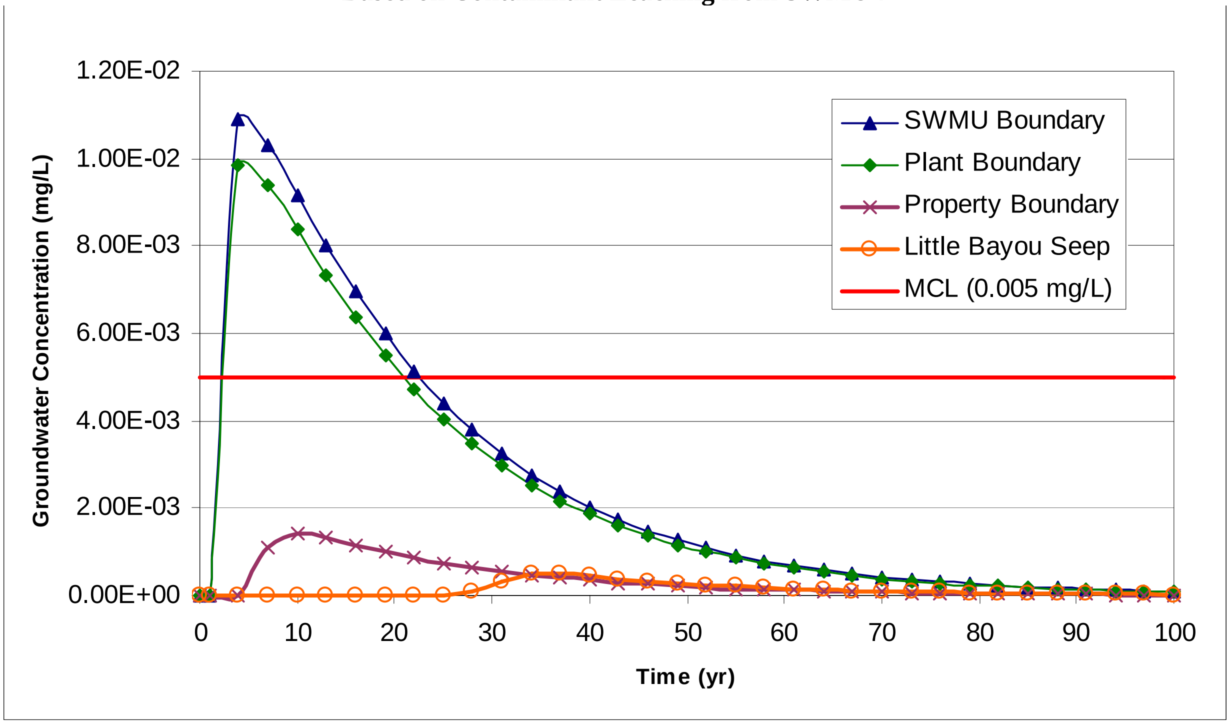

Figure 5.21. Predicted TCE Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

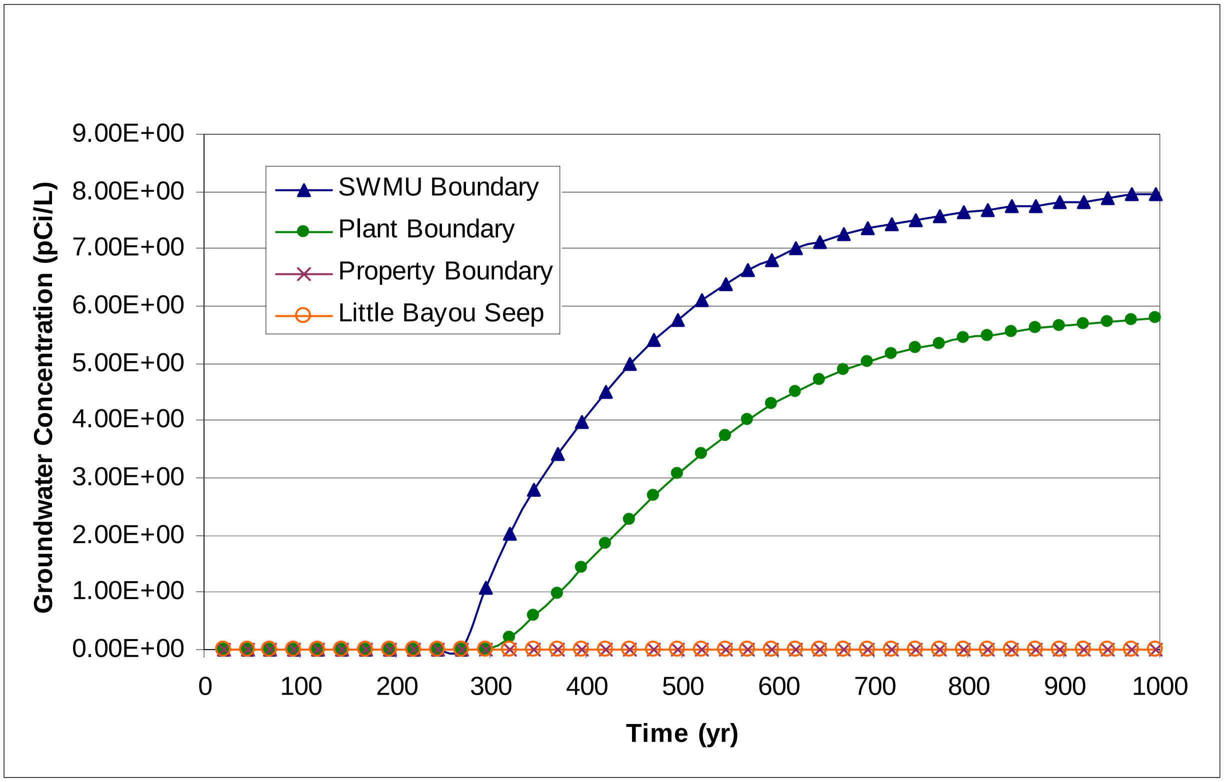

Figure 5.22. Predicted ^{234}U Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

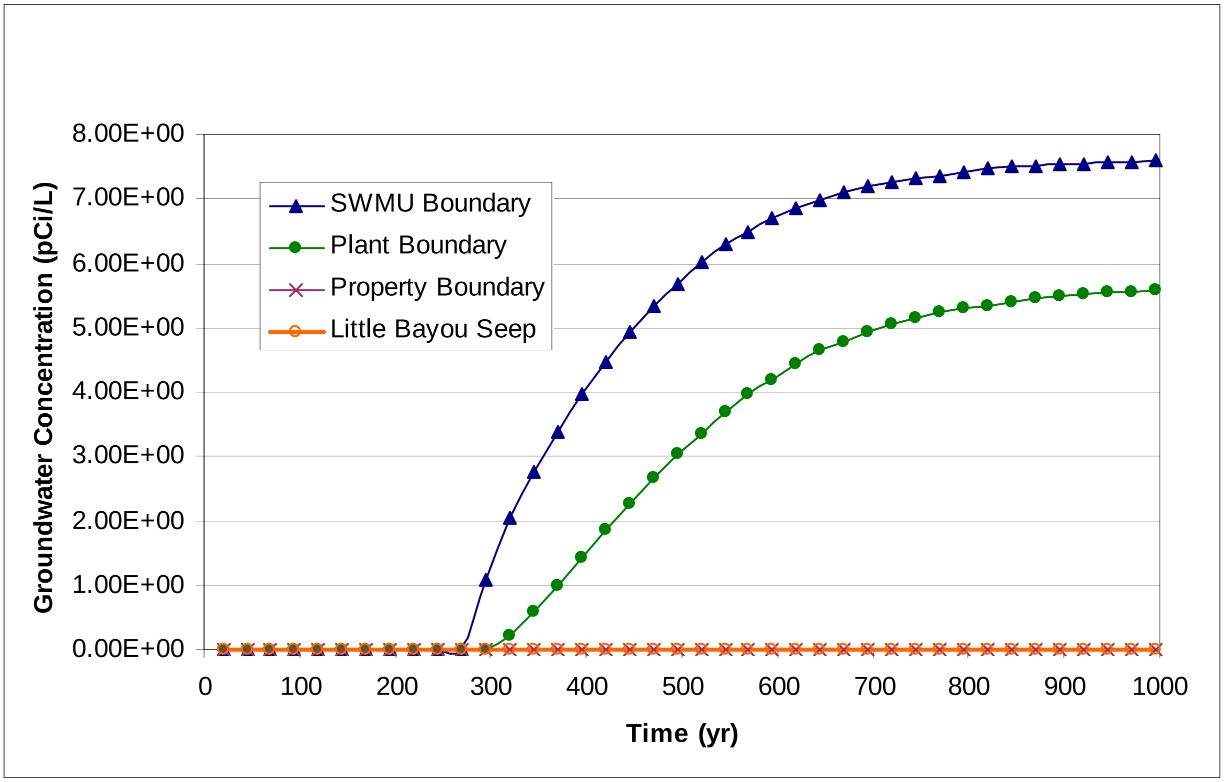

Figure 5.23. Predicted ^{238}U Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

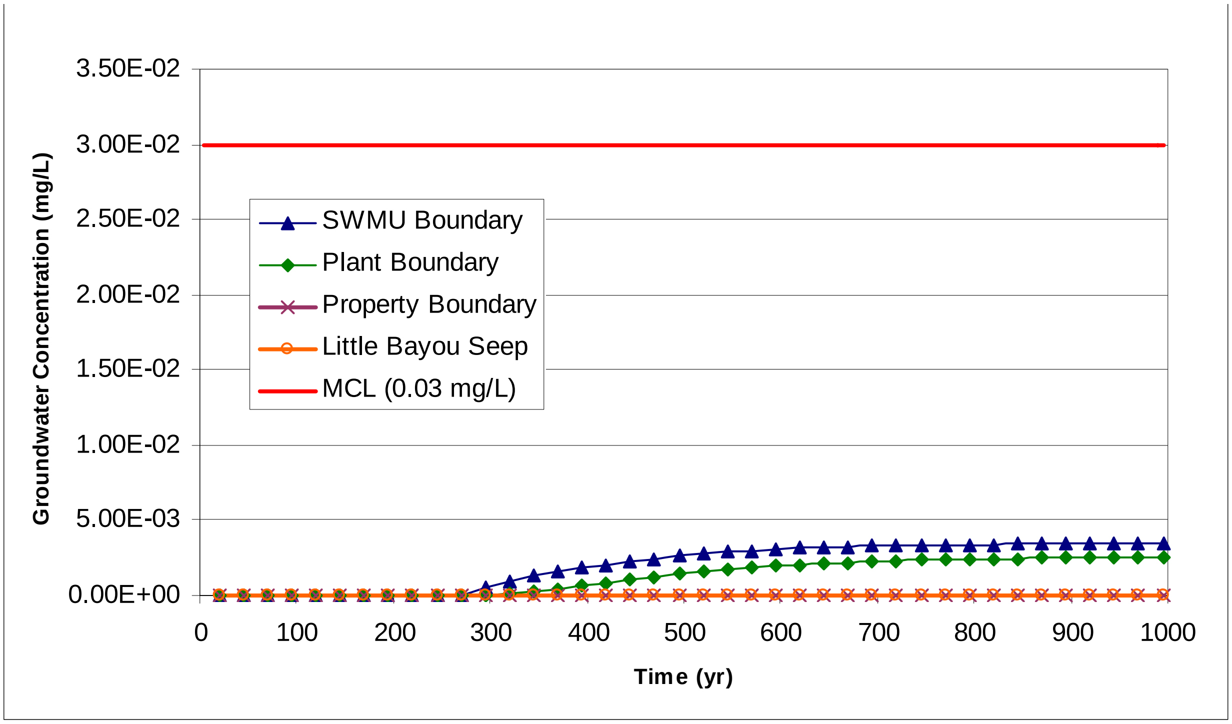

Figure 5.24. Predicted Uranium Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

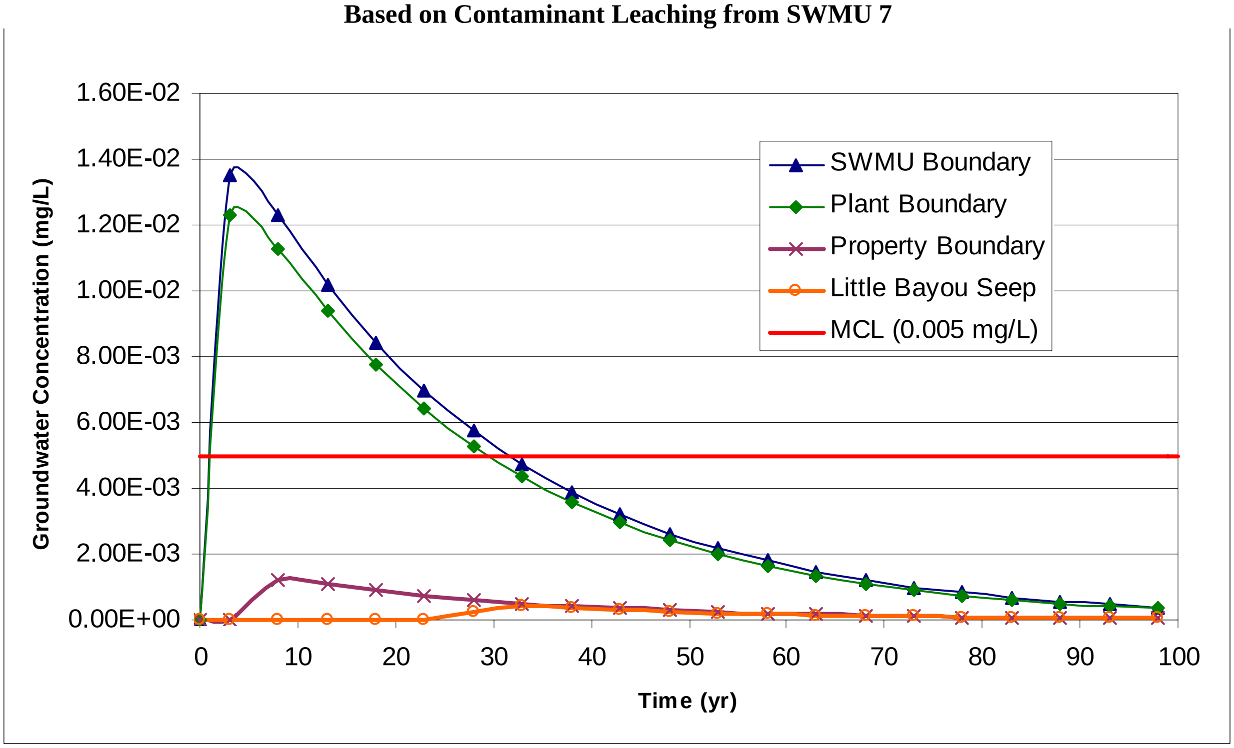

Figure 5.25. Predicted Vinyl Chloride Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 7

5.3.7 SWMU 30

The modeled groundwater concentrations of arsenic and TCE exceed their respective MCLs at the plant boundary (Table 5.3). Predicted TCE concentrations also exceed the MCL at the property boundary, and Little Bayou seeps. The following summarizes those COCs that exceeded ELCR or HQ risk criteria:

		Plant Boundary	Property Boundary	Little Bayou Seeps
1,1-DCE	**ELCR**	1.4E-03	1.0E-04	3.0E-05
	HQ	0.6	--	--
Arsenic	**ELCR**	3.1E-04	6.2E-05	--
	HQ	3.8	0.8	--
Manganese	**ELCR**	--	--	--
	HQ	0.5	--	--
Selenium	**ELCR**	--	--	--
	HQ	0.2	--	--
^{99}Tc	**ELCR**	1.4E-05	3.9E-06	1.6E-06
	HQ	--	--	--
TCE	**ELCR**	2.1E-02	1.8E-03	6.1E-04
	HQ	311	26.8	9.0
Uranium	**ELCR**	--	--	--
	HQ	0.8	--	--
^{234}U	**ELCR**	3.9E-06	--	--
	HQ	--	--	--
^{238}U	**ELCR**	7.1E-06	--	--
	HQ	--	--	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Figures 5.26 through 5.33 display the modeled concentrations of SWMU 30 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4). As shown in these figures, the dissolved arsenic and manganese concentrations are predicted to continue rising at 1,000 years at the plant boundary, with arsenic exceeding its MCL. Dissolved arsenic concentrations were less than the MCL at the property boundary, but dissolved manganese levels have not reached the property boundary or Little Bayou Seeps in the 1,000-year period.

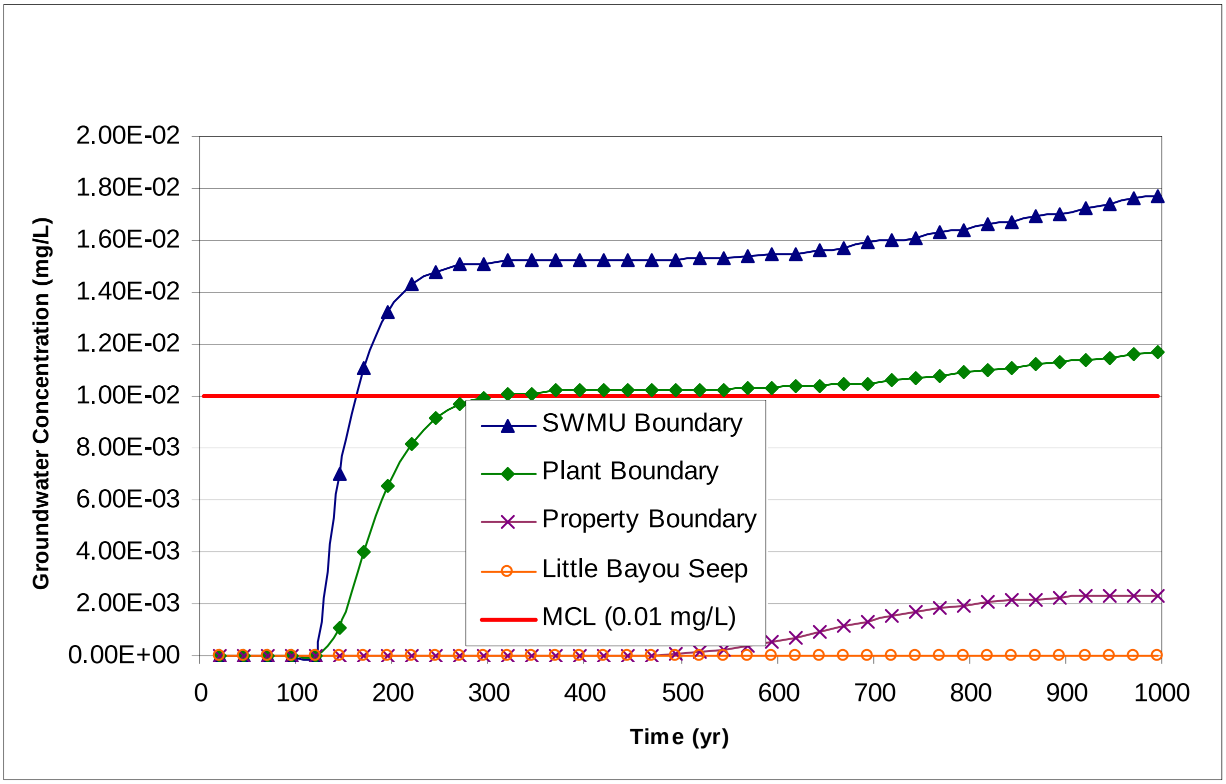

Figure 5.26. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

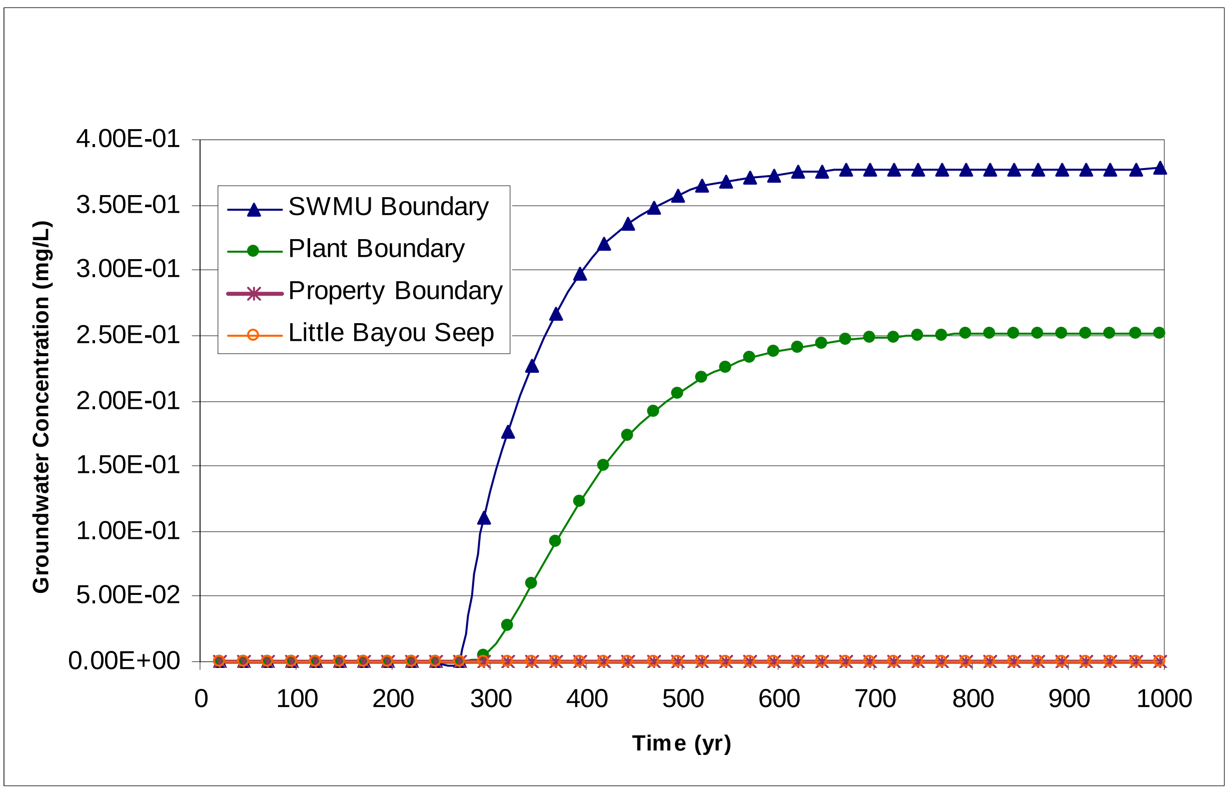

Figure 5.27. Predicted Manganese Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

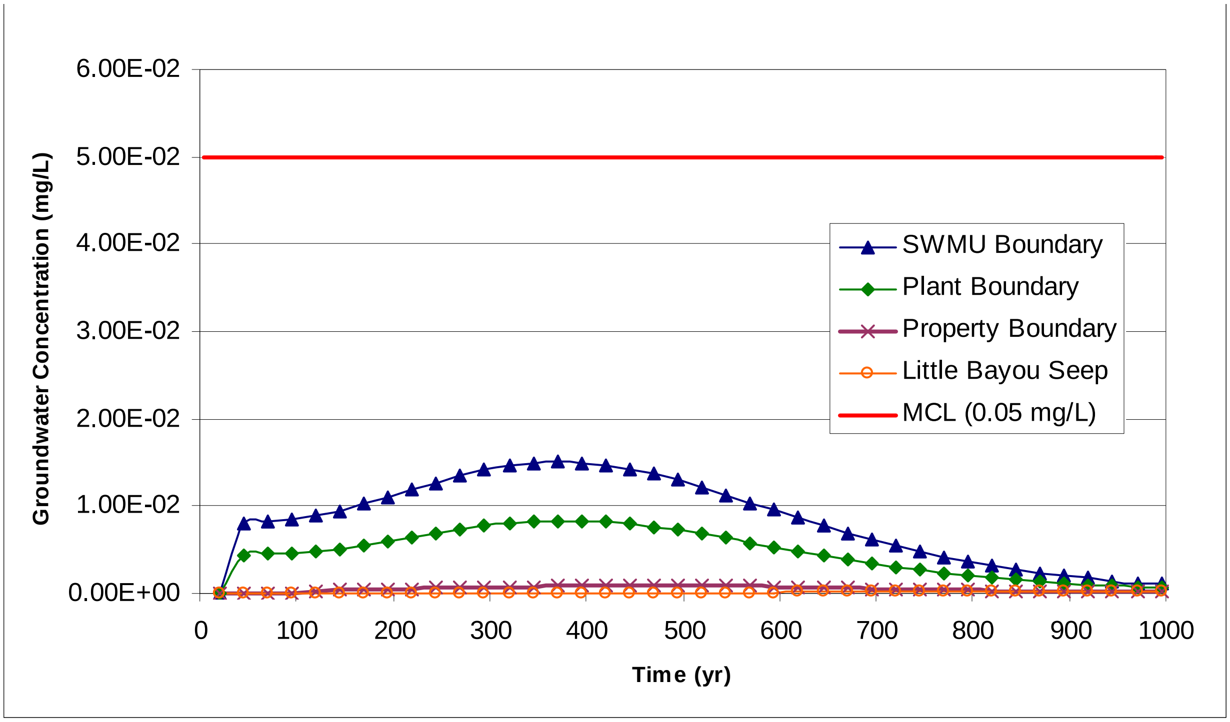

Figure 5.28. Predicted Selenium Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

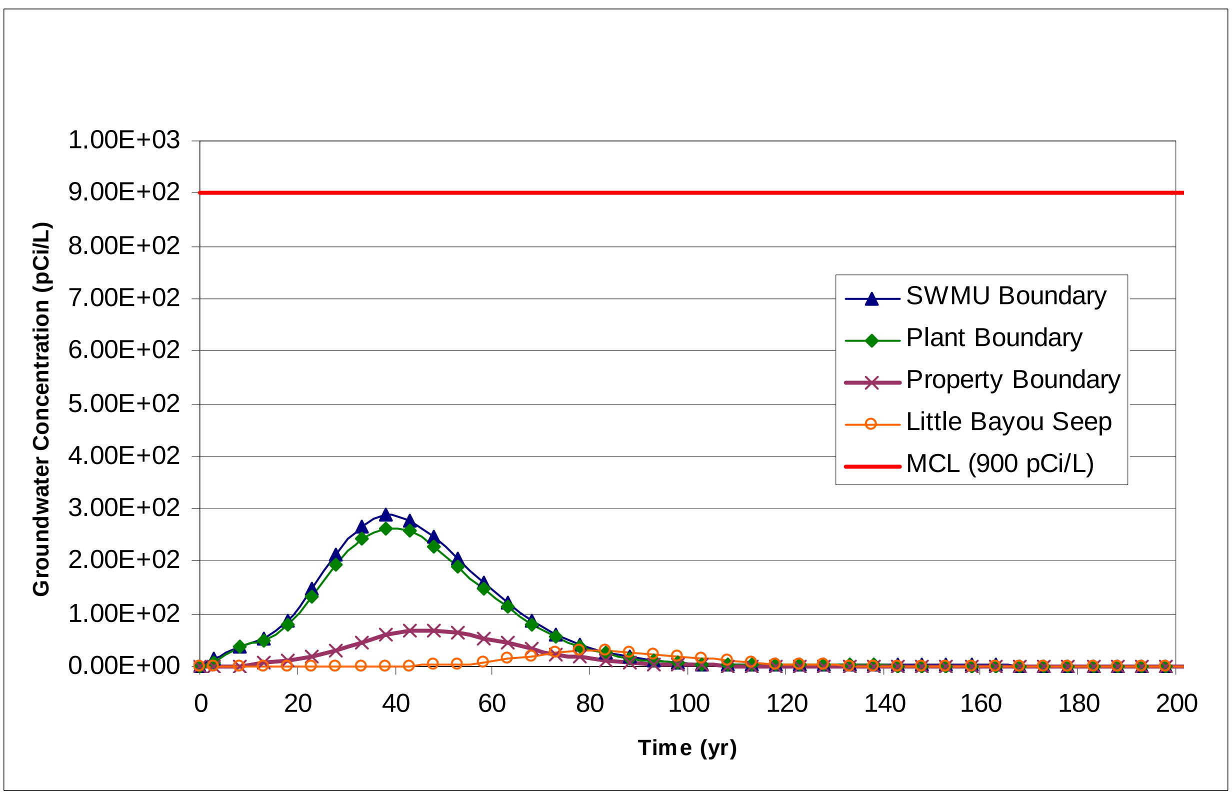

Figure 5.29. Predicted ^{99}Tc Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

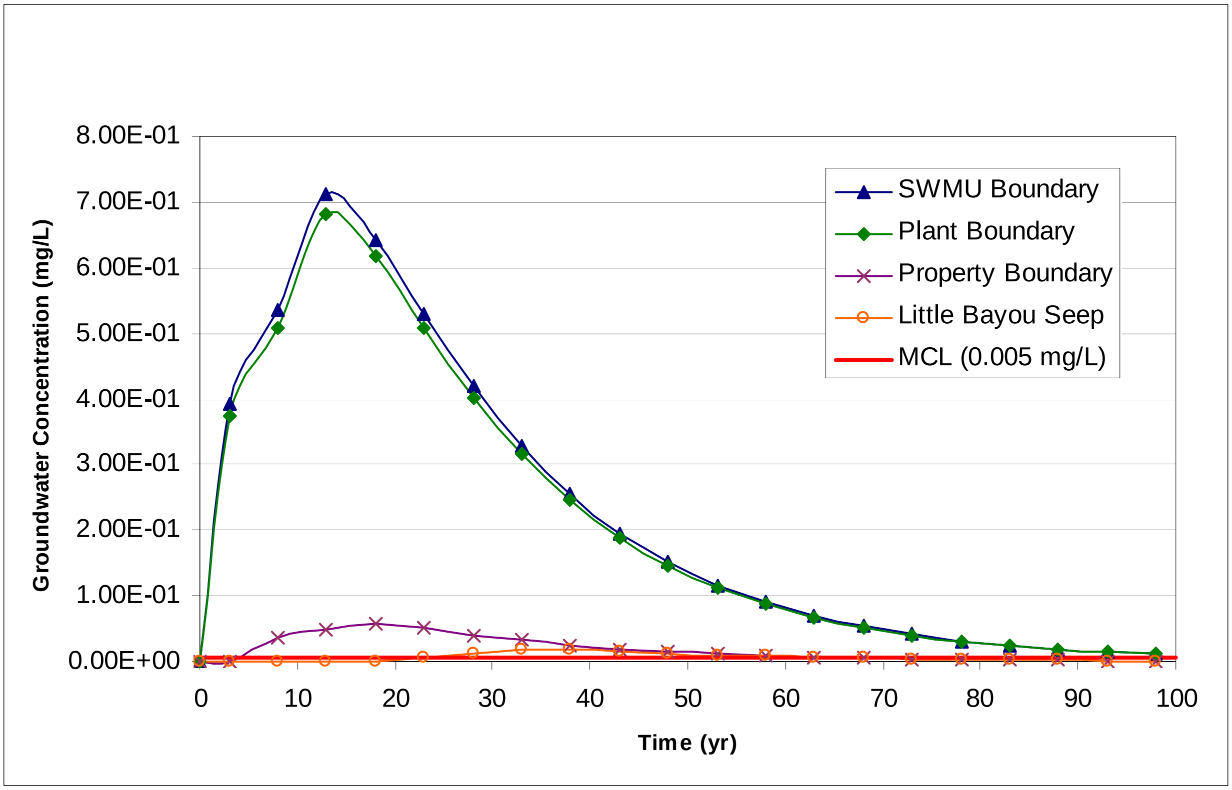

Figure 5.30. Predicted TCE Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

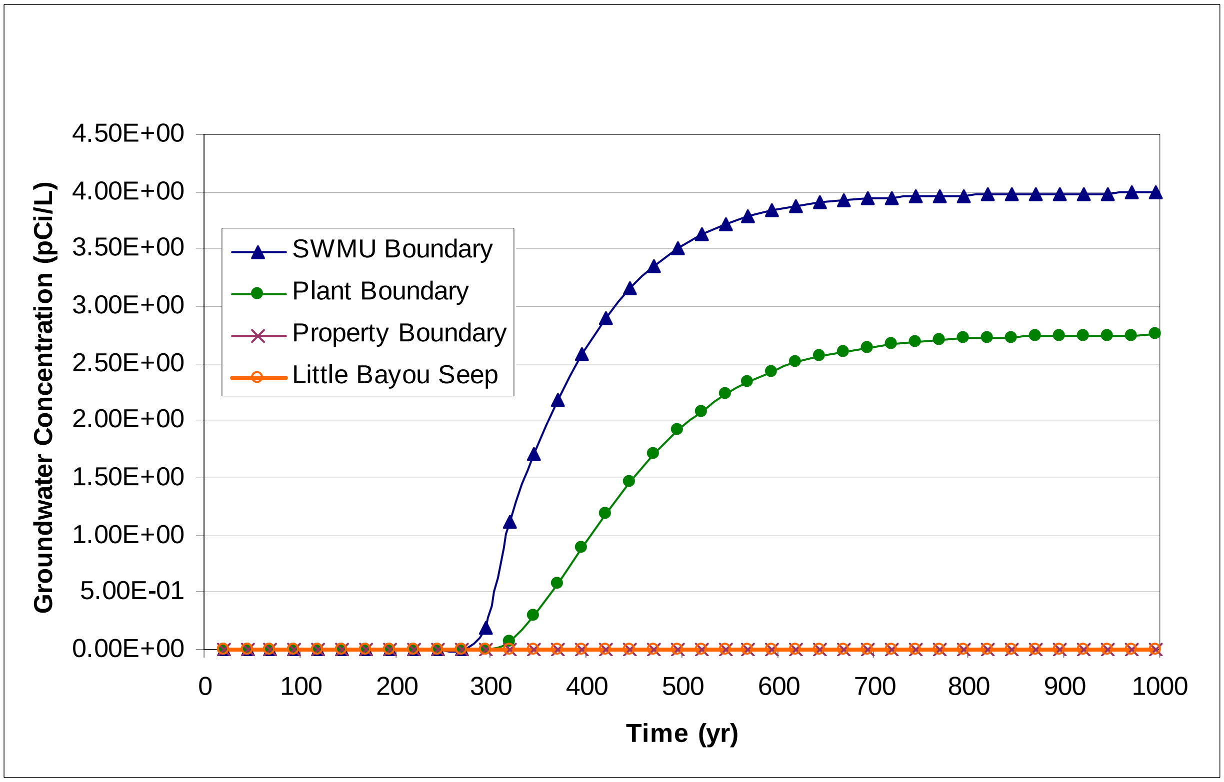

Figure 5.31. Predicted ^{234}U Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

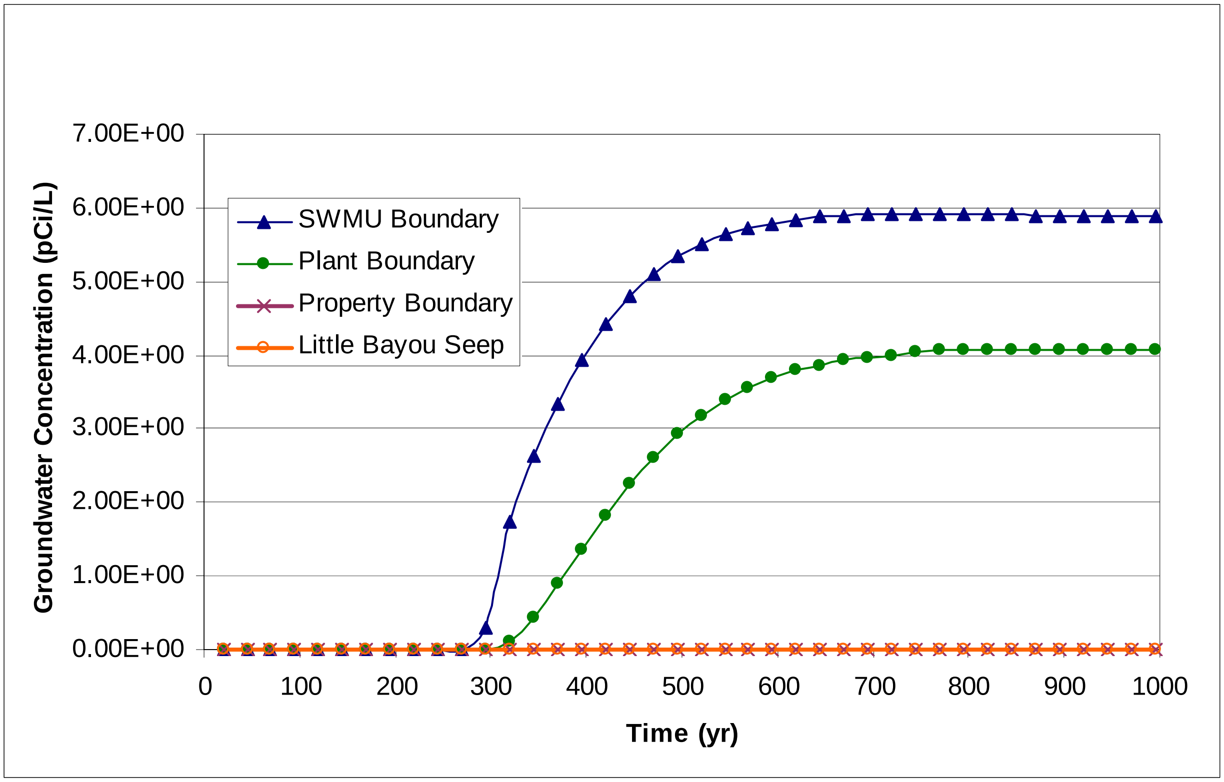

Figure 5.32. Predicted ^{238}U Activities in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

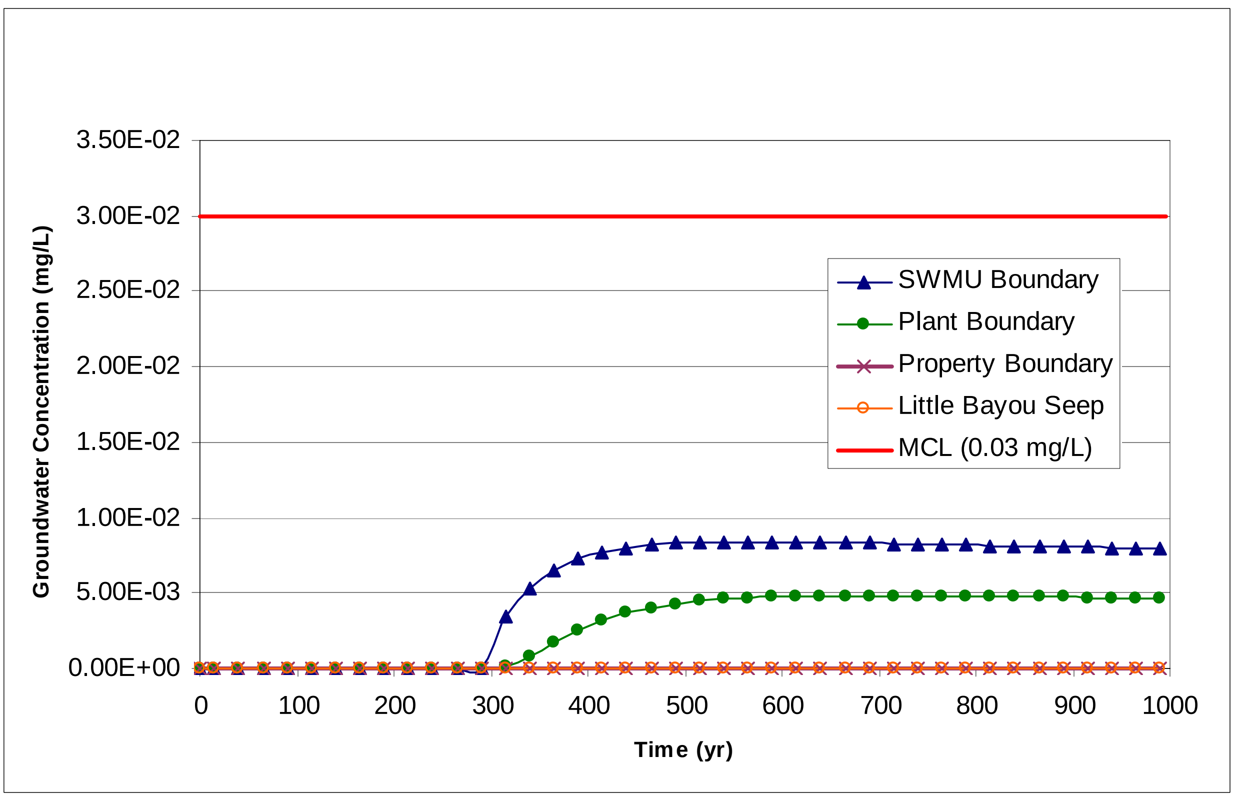

Figure 5.33. Predicted Uranium Concentration in Groundwater at the POEs Based on Contaminant Leaching from SWMU 30

5.3.8 SWMU 145

The groundwater results presented in Table 5.3 for SWMU 145 show the predicted groundwater concentration of ^{99}Tc will exceed the MCL at the property boundary and Ohio River. Modeled levels of all remaining SWMU 145 COPCs are less than their respective MCLs at the POEs. The following summarizes those COCs that exceeded ELCR or HQ risk criteria:

		Property Boundary	Ohio River
Arsenic	**ELCR**	4.3E-05	--
	HQ	0.5	--
^{99}Tc	**ELCR**	1.0E-04	5.3E-05
	HQ	--	--

-- = does not exceed

All remaining COPCs exhibited HQ values less than 0.1 and ELCR values less than 1.0E-06 at all POEs. Predicted concentrations of SWMU 145 COCs that exceed a HQ of 0.1 and/or an ELCR of 1.0E-06 (Table 5.4) are illustrated in Figures 5.34 and 5.35. As shown in these figures, arsenic is increasing in concentration at the plant boundary at 1,000 years; however, the concentrations are less than the MCL. Technetium-99 was predicted to exceed the MCL at the POEs.

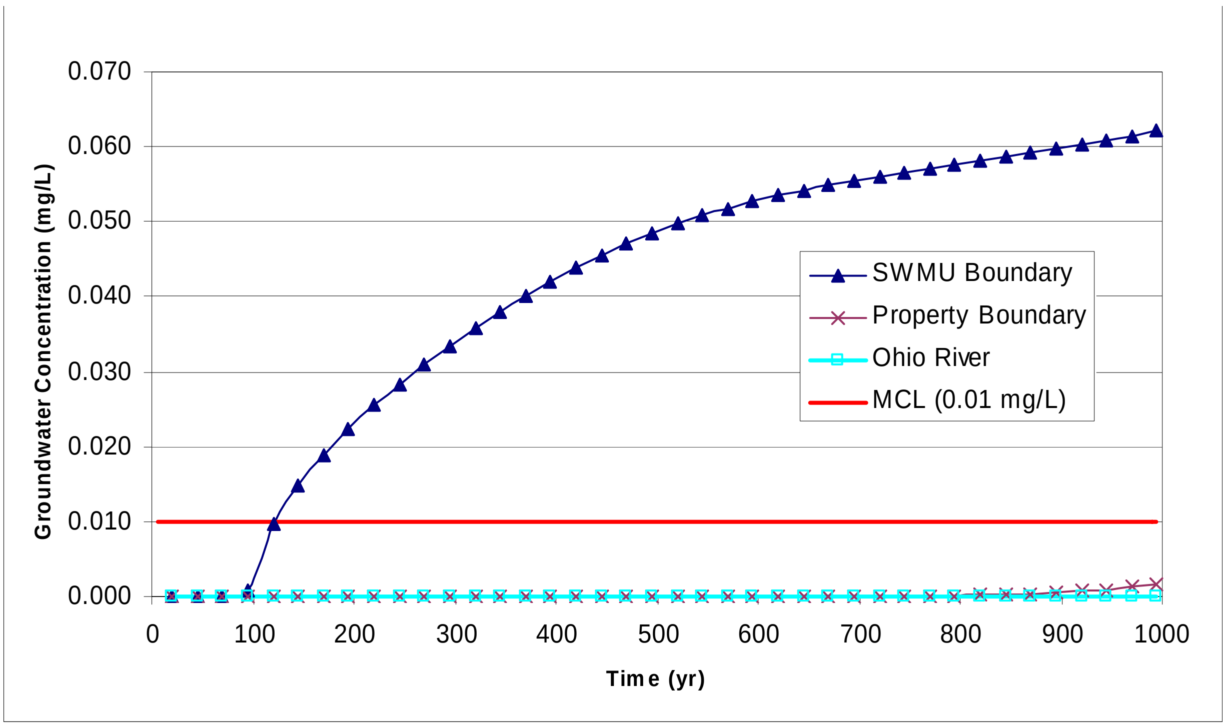

Figure 5.34. Predicted Arsenic Concentrations in Groundwater at the POEs Based on Contaminant Leaching from SWMU 145

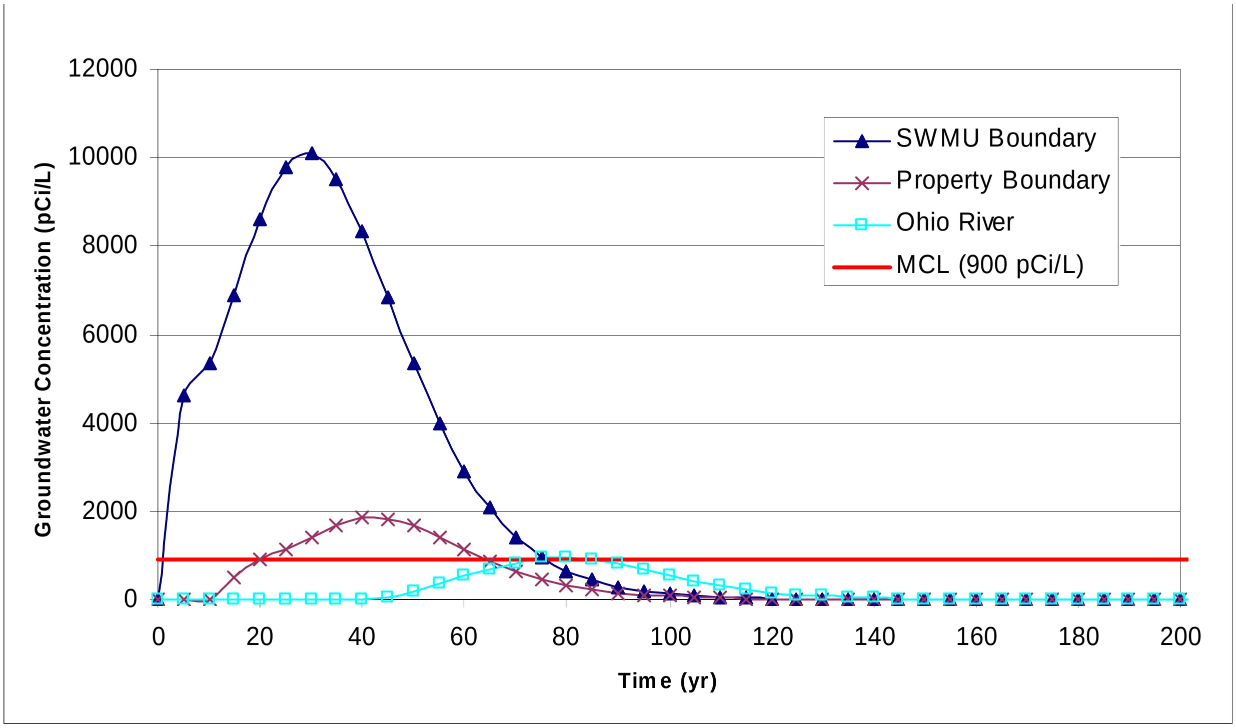

Figure 5.35. Predicted ^{99}Tc Activity in Groundwater at the POEs Based on Contaminant Leaching from SWMU 145

5.4 GROUNDWATER COPCS RETAINED AFTER MODELING

Based on the results of the modeling described above, predicted peak concentrations in groundwater beneath each SWMU were screened against the NALs for the residential child. Only analytes for which the predicted peak concentration exceeded the NAL were retained as COPCs and carried forward to the baseline human health risk assessment (BHHRA) presented in Appendix F. The results of this screening for each SWMU are shown in Tables 5.5 to 5.12. For SWMU 6 there are no COPCs, but all other SWMUs had at least one analyte carried forward as a COPC.

Table 5.5. Screening of Modeled Peak Concentrations in Groundwater for SWMU 2

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Arsenic	9.95E+02	3.54E-02	5.00E-03	3.50E-05	Y
cis-1,2-DCE	1.50E+01	1.15E+01	NA	2.73E-03	Y
Manganese	9.90E+02	7.16E-01	1.19E-01	3.50E-02	Y
Naphthalene	1.40E+02	9.38E-04	NA	2.85E-04	Y
TCE	2.00E+01	1.48E+00	NA	1.60E-03	Y
Uranium	1.00E+03	9.86E-03	2.00E-03	9.06E-04	Y
Zinc	9.90E+02	9.83E-03	4.90E-02	4.50E-01	N
^{99}Tc	4.00E+01	1.02E+02	2.23E+01	1.40E+01	Y
^{234}U	9.85E+02	1.58E+00	7.00E-01	5.46E-01	Y
^{238}U	9.90E+02	1.81E+00	7.00E-01	4.43E-01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.6. Screening of Modeled Peak Concentrations in Groundwater for SWMU 3

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Arsenic	9.80E+02	3.29E-02	5.00E-03	3.50E-05	Y
Manganese	9.70E+02	8.95E-01	1.19E-01	3.50E-02	Y
Mercury	9.80E+02	9.29E-05	2.00E-04	4.44E-04	N
TCE	3.50E+01	3.45E-04	NA	1.60E-03	N
Uranium	8.75E+02	4.89E-02	2.00E-03	9.06E-04	Y
Zinc	9.55E+02	9.30E-02	4.90E-02	4.50E-01	N
^{99}Tc	4.50E+01	5.560E+03	2.23E+01	1.40E+01	Y
^{238}U	9.90E+02	1.59E+01	7.00E-01	4.43E-01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.7. Screening of Modeled Peak Concentrations in Groundwater for SWMU 4

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Arsenic	9.90E+02	1.77E-02	5.00E-03	3.50E-05	Y
cis-1,2-DCE	1.50E+01	6.68E-01	NA	2.73E-03	Y
Manganese	1.00E+03	5.76E-01	1.19E-01	3.50E-02	Y
TCE	5.00E+00	1.18E+00	NA	1.60E-03	Y
Zinc	1.00E+03	1.57E-09	4.90E-02	4.50E-01	N
Vinyl Chloride	5.00E+00	2.61E-02	NA	3.50E-05	Y
^{99}Tc	5.00E+01	9.008E+03	2.23E+01	1.40E+01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.8. Screening of Modeled Peak Concentrations in Groundwater for SWMU 5

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Acenaphthene	4.60E+02	6.10E-03	NA	1.36E-02	N
Anthracene	1.25E+02	8.06E-03	NA	7.66E-02	N
Arsenic	1.00E+03	9.25E-03	5.00E-03	3.50E-05	Y
Fluorene	7.20E+02	3.63E-03	NA	9.72E-03	N
Manganese	9.45E+02	1.01E+00	1.19E-01	3.50E-02	Y
Naphthalene	1.30E+02	5.55E-03	NA	2.85E-04	Y
Nickel	1.00E+03	2.01E-03	3.05E-01	3.01E-02	N
Selenium	5.70E+02	1.27E-03	5.00E-03	7.54E-03	N
TCE	1.00E+01	9.91E-04	NA	1.60E-03	N
Zinc	9.40E+02	1.58E-01	4.90E-02	4.50E-01	N
^{99}Tc	5.00E+00	1.27E+02	2.23E+01	1.40E+01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.9. Screening of Modeled Peak Concentrations in Groundwater for SWMU 6

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Arsenic	9.90E+02	1.92E-03	5.00E-03	3.50E-05	N
TCE	1.10E+01	3.19E-05	NA	1.60E-03	N
Uranium	4.10E+02	1.91E-04	2.00E-03	9.06E-04	N
Zinc	4.45E+02	3.63E-02	4.90E-02	4.50E-01	N

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No

Table 5.10. Screening of Modeled Peak Concentrations in Groundwater for SWMU 7

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
1,1-DCE	9.00E+00	8.98E-02	NA	4.70E-05	Y
Arsenic	1.00E+02	1.78E-02	5.00E-03	3.50E-05	Y
Cadmium	8.55E+02	1.96E-05	1.00E-02	6.61E-04	N
cis-1,2,-DCE	1.00E+01	2.35E-02	NA	2.73E-03	Y
Manganese	8.25E+02	3.32E-01	1.19E-01	3.50E-02	Y
Mercury	9.45E+02	1.01E-05	2.00E-04	4.44E-04	N
PCB-1254	1.00E+03	5.23E-05	NA	1.94E-05	Y
Pyrene	1.00E+03	3.48E-06	NA	1.82E-02	N
Selenium	4.00E+02	1.12E-02	5.00E-03	3.01E-02	N
Tetrachloroethene	1.80E+01	1.40E-04	NA	5.82E-04	N
TCE	4.00E+00	1.09E-02	NA	1.60E-03	Y
Uranium	9.80E+02	3.46E-03	2.00E-03	9.06E-04	Y
Vinyl Chloride	3.00E+00	1.35E-02	NA	3.50E-05	Y
Zinc	7.25E+02	6.73E-02	4.90E-02	4.50E-01	N
^{99}Tc	4.00E+01	9.09E+02	2.23E+01	1.40E+01	Y
^{234}U	9.80E+02	7.94E+00	7.00E-01	5.46E-01	Y
^{235}U	6.95E+02	8.10E-02	3.00E-01	5.38E-01	N
^{238}U	9.75E+02	7.59E+00	7.00E-01	4.43E-01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.11. Screening of Modeled Peak Concentrations in Groundwater for SWMU 30

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
1,1-DCE	2.00E+00	6.05E-02	NA	4.70E-05	Y
Acenaphthene	3.90E+02	2.02E-04	NA	1.36E-02	N
Arsenic	9.90E+02	1.77E-02	5.00E-03	3.50E-05	Y
Fluorene	7.20E+02	1.26E-04	NA	9.72E-03	N
Manganese	7.90E+02	3.78E-01	1.19E-01	3.50E-02	Y
Mercury	1.00E+03	4.41E-06	2.00E-04	4.44E-04	N
Naphthalene	1.35E+02	1.81E-04	NA	2.85E-04	N
PCB-1254	1.00E+03	1.30E-05	NA	1.94E-05	N
PCB-1260	1.00E+03	5.42E-06	NA	1.94E-05	N
Pyrene	3.30E+02	1.82E-05	NA	1.82E-02	N
Selenium	3.60E+02	1.51E-02	5.00E-03	7.45E-03	Y
TCE	1.30E+01	7.12E-01	NA	5.82E-04	Y
Uranium	5.40E+02	8.40E-03	2.00E-03	9.06E-04	Y
Zinc	9.90E+02	7.77E-02	4.90E-02	4.50E-01	N
^{99}Tc	3.70E+01	2.87E+02	2.23E+01	1.40E+01	Y
^{234}U	7.05E+02	3.99E+00	7.00E-01	5.46E-01	Y
^{235}U	6.15E+02	1.38E-01	3.00E-01	5.38E-01	N
^{238}U	6.90E+02	5.91E+00	7.00E-01	4.43E-01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

Table 5.12. Screening of Modeled Peak Concentrations in Groundwater for SWMU 145

COPC	Time (years)	Peak Conc (mg/L)[a]	Background Groundwater Concentration (mg/L)[a]	Groundwater Child Resident No Action Level (mg/L)[a]	Retain as COPC?
Antimony	1000	7.99E-02	6.00E-02	5.64E-04	Y
PCB-1260	805	1.92E-03	NA	4.28E-05	Y
Arsenic	1000	6.21E-02	5.00E-03	3.50E-05	Y
Cadmium	1000	4.10E-03	1.00E-02	6.61E-04	N
Manganese	1000	8.44E-01	1.19E-01	3.50E-02	Y
Mercury	850	2.59E-04	2.00E-04	4.44E-04	N
Nickel	1000	4.14E-03	3.05E-01	3.01E-02	N
^{99}Tc	30	1.0106E+04	2.23E+01	1.40E+01	Y
^{238}U	1000	2.58E+01	7.00E-01	4.43E-01	Y

[a] Units for radionuclides are pCi/L.
NA = not applicable N = No Y = Yes

5.5 VAPOR TRANSPORT MODELING

The BGOU RI includes vapor transport modeling to evaluate the potential air concentrations in a residential basement for soil and groundwater contamination at the BGOU SWMUs and POEs. Modelers used the Johnson and Ettinger model (1991), coded into spreadsheets by EPA (2004), to assess the potential migration of VOCs into a residential basement (see Appendix E for details of the analysis).

Table 5.13 presents the resulting basement air concentrations, predicted by the model. Table 5.14 summarizes the health and cancer risks calculated in accordance with Appendix A of the Risk Methods Document.

The results of the vapor transport modeling (Table 5.14) show that TCE is predicted to have HQ values above 0.1 and/or ELCRs exceeding 1.0E-06 for a residential basement exposure above SWMUs 2, 3, 4, 7, and 30. Additional COPCs that were found to exceed the HQ value of 0.1 and/or an ELCR value of 1.0E-06 within the SWMUs included *cis*-1,2-DCE (SWMUs 2 and 4); vinyl chloride (SWMUs 4 and 7); 1,1-DCE (SWMUs 7 and 30); and mercury (SWMUs 3, 7, and 145).

Derived ELCR values exceeded 1.0E-06 for modeled TCE concentrations from groundwater transport at the plant boundary (SWMUs 2, 4, and 30) and property boundary (SWMUs 2, 4, and 30). Modeled vinyl chloride (SWMU 4) and 1,1-DCE (SWMUs 7 and 30) concentrations also equate to ELCR values greater than 1.0E-06 from groundwater transport at the plant boundary.

Table 5.13. Basement Air Concentrations Based on Vapor Transport Modeling Results for Each BGOU SWMU

		Air concentration (mg/m^3)		
Source Area	**Contaminant**	**SWMU Boundary**	**Plant Boundary**	**Property Boundary**
SWMU 2	TCE	2.81E-02	1.09E-04	5.55E-05
	cis-1,2-DCE	1.95E-01	7.82E-04	3.89E-04
	Naphthalene	2.70E-07	1.56E-08	8.43E-09
SWMU 3	TCE	1.62E-05	2.08E-08	1.10E-08
	Mercury	7.22E-06	1.12E-14	0.00E+00
SWMU 4	TCE	4.90E-03	2.12E-04	1.08E-04
	cis-1,2-DCE	5.76E-03	8.80E-05	4.05E-05
	Vinyl chloride	6.7E-03	1.98E-04	2.55E-06
SWMU 5	TCE	5.41E-06	1.98E-07	9.13E-08
	Acenaphthene	2.04E-07	7.47E-08	4.30E-08
	Fluorene	5.16E-08	2.37E-08	1.27E-08
	Naphthalene	3.80E-06	9.75E-08	3.79E-08
	Pyrene	2.28E-09	NA	NA
SWMU 6	TCE	9.34E-06	3.88E-09	1.92E-09
SWMU 7	TCE	8.63E-05	4.96E-06	7.16E-07
	cis-1,2-DCE	2.13E-04	9.66E-06	1.42E-06
	Vinyl chloride	1.23E-02	1.25E-05	1.22E-06
	1,1-DCE	1.03E-02	6.70E-05	9.03E-06
	Mercury	9.99E-06	2.22E-09	2.41E-12
	Pyrene	7.68E-09	4.93E-12	1.31E-12
	Tetrachloroethene	2.00E-05	1.71E-01	4.70E-09
SWMU 30	TCE	6.75E-02	3.42E-04	2.96E-05
	1,1-DCE	3.36E-02	4.85E-05	3.62E-06
	Acenaphthene	2.77E-08	4.96E-09	9.22E-10
	Fluorene	3.92E-09	NA	NA
	Mercury	1.66E-05	8.91E-1	2.23E-11
	Pyrene	6.56E-10	2.47E-11	6.54E-12
	Naphthalene	3.10E-07	1.90E-08	1.85E-09
SWMU 145	Mercury	1.42E-05	7.95E-08	2.60E-14

Table 5.14. Vapor Hazard Quotients and Risk Based on Vapor Transport Modeling Results for Each BGOU SWMU

Source Area	Contaminant	On-Site		Plant Boundary		Property Boundary	
		HQ	ELCR	HQ	ELCR	HQ	ELCR
SWMU 2	TCE	**3.15E+00**	**1.84E-03**	1.22E-02	**7.14E-06**	6.22E-03	**3.64E-06**
	cis-1,2-DCE	**2.50E+01**	0.00E+00	**1.00E-01**	0.00E+00	4.99E-02	0.00E+00
	Naphthalene	4.03E-04	0.00E+00	4.99E-06	0.00E+00	1.26E-05	0.00E+00
SWMU 3	TCE	1.82E-03	**1.06E-06**	2.33E-06	1.36E-09	1.23E-06	7.21E-10
	Mercury	**1.08E-01**	0.00E+00	7.70E-10	0.00E+00	0.00E+00	0.00E+00
SWMU 4	TCE	**5.54E-01**	**3.23E-04**	2.38E-02	**1.39E-05**	1.21E-02	**7.07E-06**
	cis-1,2-DCE	**7.38E-01**	0.00E+00	1.13E-02	0.00E+00	5.19E-03	0.00E+00
	Vinyl Chloride	**2.99E-01**	**4.19E-05**	8.85E-03	**1.24E-06**	1.14E-04	1.60E-08
SWMU 5	TCE	6.06E-04	3.54E-07	2.22E-05	1.30E-08	1.02E-05	5.98E-09
	Acenaphthene	4.37E-06	0.00E+00	1.60E-06	0.00E+00	9.21E-07	0.00E+00
	Fluorene	1.65E-06	0.00E+00	7.57E-07	0.00E+00	4.06E-07	0.00E+00
	Naphthalene	5.67E-03	0.00E+00	1.45E-03	0.00E+00	5.65E-04	0.00E+00
	Pyrene	9.71E-08	0.00E+00	NA	NA	NA	NA
SWMU 6	TCE	1.05E-03	6.12E-07	4.35E-07	2.54E-10	2.15E-07	1.26E-10
SWMU 7	TCE	9.68E-03	**5.65E-06**	5.56E-04	3.25E-07	8.03E-05	4.69E-08
	cis-1,2-DCE	2.73E-02	0.00E+00	1.24E-03	0.00E+00	1.82E-04	0.00E+00
	Vinyl Chloride	**5.48E-01**	**7.68E-05**	5.59E-04	7.83E-08	5.45E-05	7.64E-09
	1,1-DCE	**2.30E-01**	**3.66E-04**	1.50E-03	**2.39E-06**	2.02E-04	3.21E-07
	Mercury	**1.49E-01**	0.00E+00	3.31E-05	0.00E+00	3.59E-08	0.00E+00
	Pyrene	3.27E-07	0.00E+00	2.10E-10	0.00E+00	5.58E-11	0.00E+00
	Tetrachloroethene	1.49E-04	8.13E-09	4.78E-07	2.60E-11	3.51E-08	1.91E-12
SWMU 30	TCE	**7.57E+00**	**4.42E-03**	3.83E-02	**2.24E-05**	3.32E-03	**1.94E-06**
	1,1-DCE	**7.52E-01**	**1.20E-03**	1.09E-03	**1.73E-06**	8.10E-05	1.29E-07
	Acenaphthene	5.93E-07	0.00E+00	1.06E-07	0.00E+00	1.97E-08	0.00E+00
	Fluorene	1.25E-07	0.00E+00	NA	NA	NA	NA
	Mercury	**2.47E-01**	0.00E+00	3.83E-02	0.00E+00	3.33E-07	0.00E+00
	Naphthalene	4.62E-04	0.00E+00	1.09E-03	0.00E+00	2.76E-06	0.00E+00
	Pyrene	2.80E-08	0.00E+00	1.06E-07	0.00E+00	2.79E-10	0.00E+00
SWMU 145	Mercury	**2.12E-01**	0.00E+00	1.19E-03	0.00E+00	3.88E-10	0.00E+00

5.6 FATE AND TRANSPORT UNCERTAINTY

The source inventory, unsaturated zone transport, and saturated zone transport were modeled using the SADA, SESOIL, and AT123D computer codes. The use of these computer codes in the analyses resulted in the use of simplifying assumptions. These assumptions resulted in modeling uncertainties. This section summarizes the key uncertainties and discusses their impacts upon the modeling results. A detailed discussion of the uncertainty in the analyses is provided in Appendix E.

5.6.1 Source Term Development

The source term was developed using sampling results, geospatial analyses in SADA, and considering SESOIL limitations. The source term is based on a three-dimensional, geospatial analysis of the data using nearest neighbor interpolation in SADA; therefore, sample data was assessed both horizontally within each layer and vertically between layers. This resulted in a conservative analysis of the subsurface data, such that sample detections in a layer with no corresponding sample locations in the adjacent vertical layers, resulted in predictions of contamination in these adjacent layers. This occurred at the BGOU SWMUs due to the use of diagonal well drilling beneath the SWMUs for sample collection. The lack of vertical control throughout the layers tended to result in contamination being estimated throughout the depth of the vertical layers to the RGA. Due to the lack of sample data points, the nearest neighbor interpolation tends to estimate large areas of contamination for which there are no data; therefore, SADA provides a conservative estimate of the total contamination using the nearest neighbor interpolation method.

In several cases, the SADA estimated uranium mass in relation to other metals (i.e., vanadium and manganese) appears to be underestimated. The mass of metals, such as vanadium and manganese, also appears to be overestimated using SADA. The SADA interpolation estimates the mass between sample points. This results in an estimated mass of vanadium and manganese in the waste volume based on sample points located outside the waste zone. Likewise, the sample points for uranium outside the waste zone are used to interpolate the mass in the waste zone. The issue of the uranium mass potentially present in the waste zone in relation to the estimated SADA mass will be evaluated further in the FS.

5.6.2 SESOIL and AT123D Transport Uncertainties

SESOIL requires that the same constant area for each layer represented in the model, thus requiring that the COPC concentrations of all layers predicted using SADA be normalized against the area of the layer with the maximum estimated COPC mass. The impact of this normalization was investigated and found that the normalization process has a minor impact on the results (see Appendix E for a detailed discussion).

An additional source of uncertainty in the AT123D modeling runs involves the use of a single hydraulic conductivity and hydraulic gradient. The hydraulic conductivity and gradient are variable from the SWMU locations to the various POEs. The MODPATH model was run to establish the steady-state head distribution in the RGA. MODPATH was used to track flowpaths of particles released from the SWMU location by using the steady-state, head distribution generated by MODFLOW. The distances from the SWMU to the POEs were taken along the flowpaths to determine the distance from the SWMU to the POEs. The hydraulic gradient from the SWMU to the property boundary was estimated using the head difference divided by the distance from the release point to the property boundary POE. The conductivity along the flowpath also was estimated for use in the AT123D model.

Additional uncertainties in the fate and transport analyses include (1) selection of the sorption coefficients (K_d) for uranium in the UCRS, (2) SWMUs on the western side of the plant that may exhibit waste that is below the water table in the UCRS, and (3) the fact that SESOIL and AT123D do not consider contaminant transformation such as that for radioactive decay. These uncertainties are discussed in detail in Appendix E, Section E.3.3.

5.6.3 Potential Interaction of Sources

The simulations presented in this report for the BGOU SWMUs are based on individual simulations of each SWMU. There is a potential that source plumes from the SWMUs could interact at the POEs. According to the flow paths from the MODFLOW model, the contaminant plumes from a few of the BGOU SWMUs would interact. The interaction of the plumes cannot be assessed using the SESOIL/AT123D model, since only a mass flux to the aquifer is modeled without consideration of the water flux to the RGA. The plume concentrations for interaction of plumes would be less than the combination of the plume concentrations modeled in this report. The interaction of these contaminant plums will be assessed during the FS to ensure that the total risk from a combination of plumes is considered in the selection of remedial options.

5.6.4 Location of POEs

The POEs used in the modeling were placed at locations on the plant boundary, property boundary, Little Bayou seeps, and Ohio River where the greatest contaminant concentrations are expected in the future. By picking locations on the centerline of predicted contaminant plumes as the POEs, the modeling assumed that the hypothetical future resident would pick, by chance, the worst possible location to install a water supply well.

5.6.5 Future Environmental Changes

Several future environmental changes at the PGDP could impact the accuracy of the modeling predictions. These changes include plant shutdown and dam operation on the Ohio River. In a previous modeling effort for a landfill at PGDP, several sensitivity analyses were performed (DOE 2003) to examine the impacts those changes may have on groundwater flow and contaminant transport. The sensitivity analysis of the groundwater travel time due to plant shutdown was studied by varying the recharge over a range of values. The results of the analysis indicated that a decrease in the recharge rate resulted in a monotonic increase in the travel time to the receptor. Thus, chemicals that have short degradation half-lives would show a decrease in concentration due to plant shutdown.

The Olmstead Dam operation is expected to increase the stage (water level) of the Ohio River; therefore, a sensitivity analysis was conducted (DOE 2003) to assess changes in groundwater travel time in relation to dam operation by increasing the river stage between 304.44 ft amsl and 310.04 ft amsl (the baseline river stage is 300.04 ft amsl). The results of the analysis indicated that the travel times in the aquifer changed very little in relation to the Ohio River stage; therefore, the dam operation would have little impact on the results shown in this report.

5.6.6 Burial Cell Waste

Sample data around and beneath the BGOU SWMUs were used to develop a source inventory of contaminants. The premise of this source inventory development is based on the inherent assumption that the contaminants around and beneath the BGOU SWMUs represent the release mass from the Burial Ground disposal cells. The groundwater transport analyses do not model potential future releases directly from the SWMU burial cells.

Waste at several SWMUs was containerized in drums before disposal. Previous inspections of buried drums at PGDP have indicated that the drums were highly corroded. It is considered unlikely that a significant portion of the drummed waste fully is contained at the BGOU SWMUs due to the length of time the drums have been buried and, thus, succeptable to a corrosive environment. The drums were not modeled in this RI report due to the overall objectives of the RI analyses and uncertainty in the degradation process. The purpose of the modeling in this RI report was to identify SWMUs requiring additional analyses in the FS. Due to the large uncertainty in the degradation of the drummed waste, real measured sample data surrounding the SWMUs were used to evaluate the potential risk from the SWMU waste. This methodology resulted in the inclusion of SWMUs with drummed waste requiring further analysis in the FS; therefore, the overall objectives of the RI analysis were met without requiring a detailed analysis of the degradation of drums. The issue of containerized waste will need to be evaluated during the FS to determine the potential impact on the analysis.

5.6.7 SWMU 4 RGA TCE Source

The TCE source at SWMU 4 was assessed in this RI based on soil sample results. An additional source of TCE is known to exist is the RGA in SWMU 4. *The Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, (DOE/OR/07-2180&D2/R0) attempted to assess this TCE RGA source. No attempt was made in this report to determine a dense nonaqueous-phase liquid (DNAPL) source term for TCE in the RGA at SWMU 4. The effect of this additional source term in the RGA will need to be assessed during the FS to ensure that the total risk from a combination of TCE sources at SWMU 4 is considered in the selection of remedial options.

5.6.8 SWMU 3 UCRS Groundwater Contamination

The groundwater analyses conducted for this RI are based on soil samples obtained from soils surrounding the SWMUs and their subsequent release to the RGA and transport through the RGA. In some instances, water samples from wells in the UCRS indicated additional contaminant concentrations that were not accounted for in the analyses. For example, UCRS wells MW85, MW88, MW91, and MW94 at SWMU 3 indicated elevated levels of TCE. The water data were added to the SWMU 3 TCE soil concentrations and a SADA nearest neighbor interpolation was assessed. The resulting transport analyses indicated that the TCE concentrations were below the MCL.

6. BASELINE RISK ASSESSMENT

This section presents the results of the BRA conducted for the BGOU RI. This BRA has been prepared in two parts, as discussed in Appendices F (BHHRA) and G (Ecological Risk Assessment). These assessments are based on soil and groundwater contaminant data collected during the recently completed BGOU RI, historical soil and groundwater contaminant data, and several previous risk assessments. This BRA uses results of fate and transport modeling to estimate the baseline risks posed to human health and the environment through contact with groundwater impacted by contaminants that are migrating from the potential source areas. Chapter 5 and Appendix E present the methods used to complete the fate and transport modeling and the results of that modeling.

The PGDP Risk Methods Document is currently undergoing revision. This BRA applies updated parameter values to those specified in the PGDP Risk Methods Document (DOE 2001a), based upon both historical and recently collected data. Earlier risk assessments referenced below were based on parameters and toxicity values that are not currently in use; therefore, a direct comparison between the results presented in following text and the historical risk assessments has not been performed.

- *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895/V1-V4&D1.

- *Feasibility Study for Solid Waste Management Units 7 and 30 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1644&D2.

- *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds Solid Waste Management Units 2 and 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1141&D2.

Appendix F, Attachment 2, as well as the BGOU Work Plan, provides a short summary of the previous reports.

The BHHRA reports the hazards and risks for current and several hypothetical future uses, consistent with regulatory guidance and agreement contained in the approved PGDP Risk Methods Document (DOE 2001a). PGDP is an industrial facility. Land use is expected to remain industrial. The future on-site rural resident is not a likely land-use scenario. Additionally, DOE's excavation-penetration permit process and on-site groundwater use prohibition provide administrative controls that prevent or control some exposure scenarios that are assessed for the current on-site industrial use scenario and future on-site excavation scenario. These factors should be considered in examination of risk information provided in this report.

- **Future on-site industrial use—**direct contact with surface soil (0 to 1 ft bgs).

- **Future on-site excavation worker**—direct contact with surface and subsurface soil (0 to 10 ft bgs).

- **Future on-site recreational user**—direct contact with surface soils and consumption of game exposed to contaminated surface soil.

- **Future on-site rural resident—**direct contact with surface soil and use of modeled groundwater concentrations from the RGA at source areas, as well as vapor intrusion into a residential basement located above the source.

- **Future off-site rural resident**—use in the home of groundwater drawn from the RGA as well as vapor intrusion into basements at the DOE plant boundary, the DOE property boundary, at Little Bayou Seeps (when appropriate) and at the Ohio River.

The Screening-Level Ecological Risk Assessment (SERA) reports the potential risks under both current and potential future conditions to several receptors that may come into contact with contaminated media at the potential source areas associated with the BGOU surface soils and those areas associated with the Little Bayou Seeps. This SERA also is consistent with regulatory guidance and agreements contained in the approved PGDP Risk Methods Document (DOE 2001a).

6.1 BHHRA

The land uses and media assessed for ELCR and hazard to human health for each potential source area are presented in Table 6.1. Table 6.1 also indicates the scenarios and media that have their risk results taken from earlier assessments.

Table 6.1. Land Use Scenarios and Media Assessed for each Source Area Included in the RI for the BGOU

	Location							
	SWMU 2	**SWMU 3**	**SWMU 4**	**SWMU 5**	**SWMU 6**	**SWMU 7**	**SWMU 30**	**SWMU 145**
Future On-site Industrial Worker								
Surface Soil	X	X	X	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Subsurface Soil	X	X	X	X	X	X	X	X
Future Recreational User								
Game (Soil)	X	X	X	X	X	X	X	NA
Surface Soil	X	X	X	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Soil	X	X	X	X	X	X	X	NA
Groundwater [a]	X	X	X	X	X	X	X	X
Vapor Intrusion [b]	X	X	X	X	X	X	X	X
Future Off-site Rural Resident								
Groundwater [c]	X	X	X	X	X	X	X	X
Vapor Intrusion [b]	X	X	X	X	X	X	X	X
Future On-site Terrestrial Biota								
Soil	P	NA	NA	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	X	X	NA

Notes: Scenarios that were assessed in the RI BRA are marked with an X. Scenarios assessed in previous BRAs are marked with a P. Scenarios not assessed because the scenario is not applicable, or for which the medium is not present, are marked with an NA.
[a] The earlier BHHRAs assessed risks from use of water drawn from the RGA separately from use of water drawn from the McNairy Formation. The risks assessed in the RI BRA are for use of water drawn from the RGA.
[b] Vapor intrusion was modeled for residential basements.
[c] Modeling results were used to assess risk to the off-site rural resident. Points of exposure are at the PGDP plant boundary, at the PGDP property boundary, Little Bayou Seeps, and at the Ohio River.

The scenarios for which risk exceeds *de minimis* levels [i.e., a cumulative ELCR of 1×10^{-6} or a cumulative hazard index (HI) of 1 as defined in DOE 2001a] are summarized in Table 6.2. This information is taken from a series of risk summary tables presented at the end of this chapter (i.e., Tables 6.3 through 6.10), which present cumulative risk values for each scenario, the COCs, and the pathways of concern (POCs). See Section F.5.6.2 for an explanation of how COCs were determined. Summaries present rounded values for percent contribution, with those contributing less than 1% not shown in these summaries. More detailed results are provided in Appendix F.

Table 6.2. Scenarios for which Human Health Risk Exceeds *de minimis* Levels [a]

Scenario	Location							
	SWMU 2	**SWMU 3**	**SWMU 4**	**SWMU 5**	**SWMU 6**	**SWMU 7**	**SWMU 30**	**SWMU 145**
Results for Excess Lifetime Cancer Risk								
Future On-site Industrial Worker								
Exposure to Surface Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/Subsurface Soil	X	X	X	X	X	X	X	X
Future Recreational User								
Exposure to Game (Soil)	X	X	X	X	X	X	X	NA
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	X	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	---	X	---	---	---	X	---
Result for Systemic Toxicity [b]								
Future On-site Industrial Worker								
Exposure to Soil	X	---	---	---	---	---	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/Subsurface Soil	X	---	---	X	---	X	X	---
Future Recreational User								
Exposure to Game (Soil)	X	---	---	X	X	X	X	NA
Exposure to Soil	X	---	---	---	---	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	X	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	---	X	X	NA	X	X	---
Vapor Intrusion [c]	---	---	---	---	---	---	---	---

Notes: Scenarios where risk exceeds *de minimis* levels are marked with an X. Scenarios where risk did not exceed *de minimis* levels are marked with a ---. NA indicates that the scenario/land use combination was not assessed because the scenario is not applicable, or the medium is not present.

[a] Consistent with the PGDP Risk Methods Document (DOE 2001a), the *de minimis* levels used are a cumulative ELCR of 1×10^{-6} and a cumulative Hazard Index (HI) of 1.

[b] Systemic toxicity results summarized here for the resident and recreational user are for the child. The on-site POE considered is the SWMU boundary. The off-site POE considered is the property boundary.

[c] Based on results of preliminary deterministic contaminant transport modeling. The on-site POE considered is the SWMU boundary. The off-site POE considered is the DOE property boundary.

For all of the eight potential sources discussed in the BHHRA (i.e., SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145), the cumulative human health ELCR and systemic toxicity (i.e., hazard) exceed the accepted standards of Kentucky Department for Environmental Protection and EPA for one or more scenarios. (Please see Appendix F for a discussion of exposure assumptions used in these scenarios.) Additionally, risks from household use of groundwater by hypothetical on-site residents also exceeded these standards at all of the SWMU boundaries except for SWMU 6.

6.2 SERA

A SERA was conducted for each of the sites considered in this document (SWMUs 2, 3, 4, 5, 6, 7, and 30). No SERA was conducted for SWMU 145, as it was determined that the surface soil samples for SWMU 145 represented the soils in the ditches surrounding the SWMU and did not characterize the surface soils within the SWMU. Soils within the ditches were addressed as part of the SWOU SI/BRA (DOE 2006d). The SERA completed steps 1 and 2 in the PGDP ecological risk assessment methods guidance document (DOE 2001a), consistent with EPA risk assessment guidance. These two screening-level steps include descriptions of the sites, problem formulation and effects evaluation, development of exposure estimates, and screening-level risk calculation [comparison of maximum concentrations to No Further Action (NFA) screening levels] and have allowed the scientific management decision point to be reached that all SWMUs warrant additional evaluation for potential ecological risk. This section contains a summary description of the sites, SERA process, and the COPCs retained for further evaluation in the ERA. Appendix G presents a more detailed description of the sites and the complete results of the COPC screening for each of the individual sites.

Except for SWMU 145, the group of SWMUs included in this SERA lies within the developed area of PGDP. All the SWMUs previously were used as burial areas or landfills for process wastes and then covered with soil. All the SWMUs now are covered with maintained vegetation, except for SWMU 3, which is covered with a RCRA cap. These grassy areas provide a suitable habitat for terrestrial receptors; therefore, the results of site sampling were screened using soil NFA levels. The development of the NFA values for each media is fully described in the PGDP ecological risk methods document (DOE 2001a). These NFA screening levels are based on assessment endpoints designed to be protective of all ecological receptors that are potentially present at the site. These NFA levels are sufficiently conservative for the initial screening of sites for ecological risk.

Table 6.3. Summary of Risk Characterization for SWMU 2

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	8.78E-04	Arsenic Total PAH Total PCB ^{137}Cs ^{235}U ^{238}U	7 1 1 68 2 20	Ingestion Dermal External exposure	4 8 88	1.40E+00	Arsenic Iron Uranium	28 8 61	Ingestion Dermal	65 35
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.58E+01	Arsenic Iron Thallium Uranium	10 7 3 79	Ingestion Dermal	93 7
Future adult rural resident at current concentrations (Surface Soil)	4.25E-03	Arsenic Total PAH Total PCB ^{137}Cs ^{235}U ^{238}U	5 1 1 71 2 21	Ingestion Dermal External exposure	4 4 92	3.39E+00	Arsenic Iron Uranium	21 8 68	Ingestion Dermal	76 24
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	1.30E+03	Arsenic *cis*-1,2-DCE TCE	1 47 52	Ingestion Dermal Shower inhalation Household inhalation	46 11 5 38

Table 6.3. Summary of Risk Characterization for SWMU 2 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	4.69E-02	Arsenic TCE	2 98	Ingestion Dermal Shower inhalation Household inhalation	20 11 8 61	3.79E+02	Arsenic *cis*-1,2-DCE TCE	1 37 62	Ingestion Dermal Shower inhalation Household inhalation	45 24 4 28
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.92E+02	*cis*-1,2-DCE TCE	48 52	Ingestion Dermal Shower inhalation Household inhalation	45 12 5 38
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	6.82E-03	Arsenic TCE	1 99	Ingestion Dermal Shower inhalation Household inhalation	19 11 8 62	5.08E+01	Arsenic *cis*-1,2-DCE TCE	1 32 68	Ingestion Dermal Shower inhalation Household inhalation	62 27 1 10
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	9.56E+01	*cis*-1,2-DCE TCE	47 53	Ingestion Dermal Shower inhalation Household inhalation	45 12 5 38
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	3.42E-03	TCE	100	Ingestion Dermal Shower inhalation Household inhalation	18 11 8 63	2.79E+01	*cis*-1,2-DCE TCE	37 63	Ingestion Dermal Shower inhalation Household inhalation	44 24 4 28
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	2.25E+01	*cis*-1,2-DCE TCE	79 21	Ingestion Dermal Shower inhalation Household inhalation	16 19 7 58
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	1.28E-03	TCE	100	Ingestion Dermal Shower inhalation Household inhalation	18 11 8 63	6.70E+00	*cis*-1,2-DCE TCE	61 39	Ingestion Dermal Shower inhalation Household inhalation	16 38 5 42

Table 6.3. Summary of Risk Characterization for SWMU 2 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.24E+01	Arsenic Iron Uranium	5 6 88	Ingestion of soil Dermal Game Ingestion (Quail)	16 6 77
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	9.34E+00	Arsenic Iron Uranium	6 6 88	Ingestion of soil Dermal Game Ingestion (Quail)	4 8 88
Future adult recreational user at current concentrations	6.96E-04	Arsenic Total PAH Total PCB ^{137}Cs ^{234}U ^{235}U ^{238}U	11 18 2 32 2 2 33	Ingestion of soil Ingestion of quail Dermal External exposure	2 43 14 42	1.04E+01	Arsenic Iron Uranium	2 6 92	Dermal Ingestion of soil Game Ingestion (Quail)	2 2 96
Future excavation worker at current concentrations (Subsurface Soil)	5.88E-04	Arsenic Total PAH Total PCB ^{137}Cs $^{239/240}Pu$ ^{234}U ^{235}U ^{238}U	16 1 5 22 1 2 4 49	Ingestion Dermal Inhalation External exposure	42 11 1 47	2.97E+00	Arsenic Iron Thallium Uranium	20 17 7 55	Ingestion Dermal	89 10

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.4. Summary of Risk Characterization for SWMU 3

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	3.52E-06	^{238}U	100	External exposure	89	1.48E-01	Antimony	73	*No POC with HI greater than or equal to 0.1	
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	1.78E+00	Antimony Uranium	48 52	Ingestion Dermal	79 21
Future adult rural resident at current concentrations (Surface Soil)	1.73E-05	^{238}U	100	Ingestion External exposure	9 91	3.12E-01	Antimony Uranium	66 34	Ingestion Dermal	49 51
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	2.20E+01	Arsenic Manganese Uranium	48 17 36	Ingestion Dermal	99 1
Future adult rural resident at current concentrations (RGA groundwater only)	1.20E-03	Arsenic ^{99}Tc ^{238}U	72 25 2	Ingestion	100	6.32E+00	Arsenic Manganese Uranium	48 17 35	Ingestion	99
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	3.98E-01	Arsenic	100	Ingestion	98
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	1.32E-04	Arsenic ^{99}Tc	25 75	Ingestion	100	1.12E-01	Arsenic	100	Ingestion	100
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA		*No applicable COCs			
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	7.46E-05	^{99}Tc	100	Ingestion	100		*No applicable COCs			

Table 6.4. Summary of Risk Characterization for SWMU 3 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA		*No applicable COCs			
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	4.41E-05	^{99}Tc	100				*No applicable COCs			
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	6.87E-01	Antimony Uranium	27 73	Ingestion Dermal Ingestion of quail	17 21 61
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	5.21E-01	Antimony Uranium	27 73	Ingestion of quail Dermal	70 26
Future adult recreational user at current concentrations	5.07E-06	^{238}U	100	Ingestion of quail External exposure	74 23	4.94E-01	Uranium	90	Ingestion of quail	88
Future excavation worker at current concentrations (Subsurface Soil)	1.20E-05	^{137}Cs ^{238}U	33 65	Ingestion External exposure	38 62	3.14E-01	Antimony Uranium	65 35	Ingestion Dermal	78 22

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.5. Summary of Risk Characterization for SWMU 4

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	9.54E-05	Arsenic Total PAH Total PCB $^{239/240}$Pu ^{234}U ^{238}U	30 25 6 3 2 33	Ingestion Dermal Inhalation External exposure	13 55 2 31	2.62E-01	Arsenic	68	Dermal	76
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.41E+00	Arsenic Iron Vanadium	50 42 5	Ingestion Dermal	68 32
Future adult rural resident at current concentrations (Surface Soil)	3.59E-04	Arsenic Total PAH Total PCB ^{237}Np $^{239/240}$Pu ^{234}U ^{238}U	27 18 4 1 3 2 45	Ingestion Dermal Inhalation External exposure	20 38 1 42	5.14E-01	Arsenic Iron	63 27	Ingestion Dermal	34 66
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	5.82E+02	Arsenic *cis*-1,2-DCE TCE	1 6 93	Ingestion Dermal Shower inhalation Household inhalation	67 20 1 11
Future adult rural resident at current concentrations (RGA groundwater only)	5.41E-02	Arsenic TCE Vinyl chloride ^{99}Tc	1 68 31 1	Ingestion Dermal Shower inhalation Household inhalation	15 37 5 42	1.98E+02	Arsenic *cis*-1,2-DCE TCE	1 4 95	Ingestion Dermal Shower inhalation Household inhalation	57 36 1 7
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	2.04E+02	*cis*-1,2-DCE TCE	5 94	Ingestion Dermal Shower inhalation Household inhalation	68 21 1 11

Table 6.5. Summary of Risk Characterization for SWMU 4 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.03E-02	TCE Vinyl chloride ^{99}Tc	98 1 1	Ingestion Dermal Shower inhalation Household inhalation	14 7 5 74	6.97E+01	*cis*-1,2-DCE TCE	3 97	Ingestion Dermal Shower inhalation Household inhalation	57 36 1 7
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	1.03E+02	*cis*-1,2-DCE TCE	5 95	Ingestion Dermal Shower inhalation Household inhalation	68 21 1 10
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	6.79E-03	TCE Vinyl chloride ^{99}Tc	98 1 1	Ingestion Dermal Shower inhalation Household inhalation	20 11 8 61	3.51E+01	*cis*-1,2-DCE TCE	3 97	Ingestion Dermal Shower inhalation Household inhalation	56 36 1 6
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	3.33E+01	*cis*-1,2-DCE TCE	2 98	Ingestion Dermal Shower inhalation Household inhalation	75 23 1 1
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	2.43E-03	TCE Vinyl chloride ^{99}Tc	98 1 1	Ingestion Dermal Shower inhalation Household inhalation	20 11 8 62	1.26E+01	*cis*-1,2-DCE TCE	3 97	Ingestion Dermal Shower inhalation Household inhalation	56 36 1 6
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	7.41E-01	Arsenic Iron	39 55	Ingestion of soil Game ingestion (quail) Dermal	18 38 42
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	5.65E-01	Arsenic Iron	42 52	Game Ingestion (quail) Dermal	43 52
Future adult recreational user at current concentrations	3.73E-04	Arsenic Total PAH Total PCB ^{239}Pu ^{234}U ^{238}U	10 72 3 1 4 11	Ingestion of soil Ingestion of game (quail) Dermal External exposure	2 77 19 3	4.12E-01	Iron	77	Game ingestion (quail) Dermal	70 24

Table 6.5. Summary of Risk Characterization for SWMU 4 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future excavation worker at	2.00E-03	Arsenic	1	Ingestion	9	4.89E-01	Arsenic	36	Ingestion	76
current concentrations		Total PAH	1	Dermal	7		Iron	44	Dermal	22
(Subsurface Soil)		Total PCB	11	Inhalation	1					
		^{137}Cs	79	External exposure	83					
		^{226}Ra	4							
			2							
		^{230}Th	1							
		^{234}U	2							
		^{238}U								

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.6. Summary of Risk Characterization for SWMU 5

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	5.75E-03	Total PAH	100	Ingestion Dermal	3 97	8.96E-01	Arsenic Uranium Fluoranthene Naphthalene	18 28 30 21	Ingestion Dermal Inhalation	29 51 20
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	9.38E+00	Aluminum Arsenic Uranium Fluoranthene Naphthalene	2 11 64 13 9	Ingestion Dermal Inhalation	73 19 9
Future adult rural resident at current concentrations (Surface Soil)	1.57E-02	Arsenic Total PAH	1 99	Ingestion Dermal	8 92	1.67E+00	Arsenic Uranium Fluoranthene Naphthalene	17 41 27 11	Ingestion Dermal Inhalation	44 46 10
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	7.91E+00	Arsenic Manganese Naphthalene	38 27 35	Ingestion Shower inhalation Household inhalation	64 1 31
Future adult rural resident at current concentrations (RGA groundwater only)	2.52E-04	Arsenic ^{99}Tc	97 3	Ingestion	100	2.08E+00	Arsenic Manganese Naphthalene	41 30 29	Ingestion Household inhalation	70 25
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.25E+00	Arsenic Manganese Naphthalene	46 15 40	Ingestion Household inhalation	60 35
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	4.99E-05	Arsenic ^{99}Tc	95 6	Ingestion	100	3.24E-01	Arsenic Naphthalene	50 33	Ingestion	67

Table 6.6. Summary of Risk Characterization for SWMU 5 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	2.28E-01	Naphthalene	82	Household inhalation	72
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	4.81E-06	Arsenic ^{99}Tc	70 30	Ingestion	100	<0.1	NE	NE	NE	NE
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA		*No COC with HI greater than or equal to 0.1		*No POC with HI greater than or equal to 0.1	
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		*No COC with ELCR greater than or equal to 10E-6		*No POC with ELCR greater than or equal to10E-6			*No COC with HI greater than or equal to 0.1		*No POC with HI greater than or equal to 0.1	
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	4.24E+00	Arsenic Uranium Fluoranthene Naphthalene	6 76 12 5	Ingestion of soil Ingestion of game (quail) Dermal Inhalation	13 65 17 5
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	3.21E+00	Arsenic Uranium Fluoranthene	7 76 14	Ingestion of game (quail) Dermal	74 21
Future adult recreational user at current concentrations	5.74E-02	Total PAH	100	Ingestion of quail Dermal	87 13	3.17E+00	Uranium Fluoranthene	89 7	Ingestion of game (quail) Dermal	90 7
Future excavation worker at current concentrations (Subsurface Soil)	5.23E-03	Arsenic Total PAH	1 99	Ingestion Dermal	20 80	1.91E+00	Arsenic Uranium	13 86	Ingestion Dermal	93 6

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.7. Summary of Risk Characterization for SWMU 6

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	4.41E-05	Total PAH ^{235}U	58 39	Ingestion Dermal External exposure	3 58 40	1.06E-01	Uranium	98	No POC with HI greater than or equal to 0.1.	
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.49E+00	Uranium	99	Ingestion	98
Future adult rural resident at current concentrations (Surface Soil)	1.61E-04	Total PAH Total PCB ^{235}U ^{238}U	43 1 54 2	Ingestion Dermal External exposure	5 40 55	2.82E-01	Uranium	98	Ingestion	93
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at current concentrations (RGA groundwater only)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.33E+00	Uranium	100	Ingestion of soil Ingestion of game (quail)	15 83

Table 6.7. Summary of Risk Characterization for SWMU 6 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	1.00E+00	Uranium	100	Ingestion of game (quail)	95
Future adult recreational user at current concentrations	3.01E-04	Total PAH ^{235}U ^{238}U	96 3 1	Ingestion-quail Dermal External exposure	87 11 2	1.16E+00	Uranium	100	Ingestion of game (quail)	98
Future excavation worker at current concentrations (Subsurface Soil)	3.92E-05	Total PAH ^{235}U ^{238}U	59 38 3	Ingestion Dermal External exposure	19 47 33	6.71E-01	Uranium	100	Ingestion	99

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.8. Summary of Risk Characterization for SWMU 7

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	8.70E-04	Arsenic Total PAH Total PCB ^{228}Th ^{234}U ^{235}U ^{238}U	2 38 13 14 1 1 32	Ingestion Dermal Inhalation External exposure	6 49 2 44	5.25E-01	Uranium	62	Ingestion Dermal	68 32
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	9.99E+00	Aluminum Arsenic Iron Thallium Uranium Vanadium	1 6 9 3 78 1	Ingestion Dermal	94 7
Future adult rural resident at current concentrations (Surface Soil)	3.32E-03	Arsenic Total PAH Total PCB ^{228}Th ^{234}U ^{235}U ^{238}U	2 27 10 18 1 1 42	Ingestion Dermal Inhalation External exposure	9 33 1 58	1.28E+00	Arsenic Iron Uranium	13 9 68	Ingestion Dermal	78 22
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	1.89E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	30 4 3 5 7 22 26 3	Ingestion Dermal contact Inhalation while showering Inhalation household use	61 21 2 16
Future adult rural resident at current concentrations (RGA groundwater only)	3.13E-03	Arsenic 1,1-DCE TCE Vinyl chloride ^{99}Tc	15 66 4 12 2	Ingestion Dermal contact Inhalation while showering Inhalation household use	61 4 5 30	6.39E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	26 3 3 3 5 31 27 3	Ingestion Dermal contact Inhalation household use	51 37 10

Table 6.8. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.45E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	28 4 3 5 8 17 31 4	Ingestion Dermal contact Inhalation while showering Inhalation household use	62 19 2 17
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.98E-03	Arsenic 1,1-DCE TCE Vinyl chloride ^{99}Tc	11 64 10 12 2	Ingestion Dermal contact Inhalation while showering Inhalation household use	55 3 5 37	4.78E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	24 3 2 4 6 25 33 3	Ingestion of groundwater Dermal contact Inhalation household use	54 34 11
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	1.97E+00	Arsenic 1,1-DCE *cis*-1,2-DCE Total PCBs TCE	38 5 8 12 33	Ingestion Dermal contact Inhalation household use	66 16 16
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	4.11E-04	Arsenic 1,1-DCE TCE Vinyl chloride ^{99}Tc	15 62 11 9 4	Ingestion Dermal contact Inhalation while showering Inhalation household use	57 3 5 36	6.36E-01	Arsenic Total PCBs TCE	34 18 36	Ingestion Dermal contact	59 29
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA	3.73E-01	TCE	61	Ingestion Inhalation household use	53 30
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	1.28E-04	1,1-DCE TCE Vinyl chloride ^{99}Tc	73 12 10 6	Ingestion Dermal contact Inhalation while showering Inhalation household use	50 4 5 41	1.15E-01	No COPC with HI greater than or equal to 0.1.	---	No POC with HI greater than or equal to 0.1.	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								

Table 6.8. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	4.76E+00	Arsenic Iron Uranium	3 8 87	Ingestion of soil Ingestion of game (quail) Dermal	16 78 5
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	3.57E+00	Arsenic Iron Uranium	3 7 88	Ingestion of soil Ingestion of game (quail) Dermal	4 89 7
Future adult recreational user at current concentrations	3.97E-03	Arsenic Total PAH Total PCB ^{228}Th ^{234}U ^{238}U	1 84 5 1 1 9	Ingestion of soil Ingestion of quail Dermal External exposure	1 81 14 4	3.99E+00	Iron Uranium	7 91	Ingestion of game (quail)	96
Future excavation worker at current concentrations (Subsurface Soil)	7.71E-04	Arsenic Total PAH Total PCB ^{228}Th ^{234}U ^{235}U ^{238}U	2 38 16 5 3 1 35	Ingestion Dermal Inhalation External exposure	37 40 1 21	1.31E+00	Iron Uranium	14 65	Ingestion	93

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.9. Summary of Risk Characterization for SWMU 30

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	1.13E-03	Total PAH Total PCB ^{237}Np ^{234}U $^{235/236}$U ^{238}U	57 8 1 1 4 29	Ingestion Dermal Inhalation External exposure	6 63 1 30	1.36E+00	Uranium	93	Ingestion Dermal	87 13
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	3.16E+01	Aluminum Antimony Nickel Thallium Uranium	1 1 1 1 96	Ingestion Dermal	98 2
Future adult rural resident at current concentrations (Surface Soil)	3.93E-03	Total PAH Total PCB ^{237}Np ^{234}U ^{235}U ^{238}U	45 7 1 1 5 42	Ingestion Dermal Inhalation External exposure	10 46 1 44	3.61E+00	Uranium	94	Ingestion Dermal	92 8
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	3.34E+02	Arsenic TCE	2 98	Ingestion Dermal contact Inhalation while showering Inhalation household use	71 21 1 7
Future adult rural resident at current concentrations (RGA groundwater only)	2.40E-02	Arsenic 1,1-DCE TCE	2 6 92	Ingestion Dermal contact Inhalation while Inhalation household use	22 11 8 60	1.17E+02	Arsenic 1,1-DCE TCE	1 1 97	Ingestion Dermal contact Inhalation while showering Inhalation household use	58 37 1 5
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	3.16E+02	Arsenic TCE	1 98	Ingestion of groundwater Dermal contact Inhalation while showering Inhalation household use	70 21 1 7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.28E-02	Arsenic 1,1-DCE TCE	1 6 93	Ingestion Dermal contact Inhalation while showering Inhalation household use	21 11 8 61	1.10E+02	Arsenic TCE	1 99	Ingestion Dermal contact Inhalation while showering Inhalation household use	58 37 1 5

Table 6.9. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	2.76E+01	Arsenic TCE	3 97	Ingestion Dermal contact Inhalation while showering Inhalation household use	71 21 1 7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	1.99E-03	Arsenic 1,1-DCE TCE	3 5 92	Ingestion Dermal contact Inhalation while Inhalation household use	22 10 8 60	9.56E+00	Arsenic TCE	2 98	Ingestion Dermal contact Inhalation household use	58 37 4
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA	8.97E+00	TCE	100	Ingestion Dermal contact Inhalation household use	70 22 7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	6.41E-04	1,1-DCE TCE	5 95	Ingestion Dermal contact Inhalation while showering Inhalation household use	20 11 8 62	3.12E+00	TCE	100	Ingestion Dermal contact Inhalation household use	57 38 5
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.64E+01	Uranium	98	Ingestion of soil Ingestion of game (quail) Dermal	16 83 2
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	1.24E+01	Uranium	99	Ingestion of soil Ingestion of game (quail) Dermal	4 94 2

Table 6.9. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult recreational user at current concentrations	7.15E-03	Total PAH Total PCB ^{234}U ^{238}U	91 2 1 6	Game ingestion-quail Dermal External exposure	85 13 2	1.43E+01	Uranium	99	Ingestion of soil Ingestion of game (quail)	1 98
Future excavation worker at current concentrations (Subsurface Soil)	9.40E-04	Arsenic Total PAH Total PCB ^{99}Tc ^{228}Th ^{234}U ^{235}U ^{238}U	2 62 11 1 1 3 3 18	Ingestion Dermal Inhalation External exposure	31 56 1 12	8.85E+00	Arsenic Iron Uranium	1 3 93	Ingestion Dermal	98 2

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table 6.10. Summary of Risk Characterization for SWMU 145

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HIa	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child rural resident at current concentrations (Surface Soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future adult rural resident at current concentrations (Surface Soils)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	3.99E+01	Antimony Arsenic	50 50	Ingestion Dermal contact	98 2
Future adult rural resident at current concentrations (RGA groundwater only)	2.20E-03	Arsenic ^{99}Tc	75 25	Ingestion	100	1.17E+01	Antimony Arsenic	51 49	Ingestion Dermal contact	96 5
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	5.16E-01	Arsenic	100	Ingestion	100
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	1.44E-04	Arsenic ^{99}Tc	30 70	Ingestion	100	1.48E-01	Arsenic	100	Ingestion	100
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	5.29E-05	^{99}Tc	100	Ingestion	100	NE	NE	NE	NE	NE
Future child recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 6.10. Summary of Risk Characterization for SWMU 145 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future teen recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future adult recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future excavation worker at current concentrations	2.18E-04	Arsenic Total PAH Total PCB ^{137}Cs ^{90}Sr ^{99}Tc ^{235}U ^{238}U	10 10 45 1 1 1 1 32	Ingestion Dermal Inhalation External exposure	43 37 3 16	8.28E-01	Antimony Arsenic Uranium	28 17 48	Ingestion Dermal	82 18

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1 or pathway not considered.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

In accordance with the PGDP ecological risk methods document, conservative estimates of the maximum concentration of analytes detected at the site were used in the ecological screening. For any analyte detected at a site, the maximum concentration was represented by the maximum detected concentration or the maximum detection limit if that detection limit was higher than the concentration in the maximum detected sample. Screening levels also are available for some classes of compounds (PCBs and PAHs). The calculation of maximum concentrations for these class screening levels and their application at the sites are described in Appendix G. The data set from OREIS developed for the human health risk assessment in this document was used as the data set from which the maximum concentrations were developed. The data set used to determine maximum concentrations for the SERA included analytes detected only below their background concentrations and analytes that may have been removed as essential nutrient in the human health risk assessment.

The results of the comparison of the site data to the NFA levels is provided in Table 6.11. This table lists the number of COPCs in each suite retained for each site and the medium for further consideration. This table shows that most inorganic analytes and detected organic analytes were retained for further consideration in the ERA.

Table 6.11. Data Summary for Surface Soil

Area	Media	Metal	Rad	Pesticide/PCB	SVOC	VOC
SWMU 2	soil	22	----	7	12	----
SWMU 3	soil	16	----	----	----	2
SWMU 4	soil	19	----	1	----	----
SWMU 5	soil	19	----	1	22	1
SWMU 6	soil	18	----	----	12	----
SWMU 7	soil	23	1	4	21	2
SWMU 30	soil	22	----	2	21	----

----: no COPCs

6.3 OBSERVATIONS

Consistent with regulatory guidance and agreements contained in the PGDP Risk Methods Document, this BHHRA presents risks for land use scenarios representing current use, as well as several reasonable future uses. The scenarios described in the BHHRA are as follows.

- Future on-site industrial use – direct contact with surface soil (soil found 0 to 1 ft bgs).

- Future on-site excavation worker – direct contact with surface and subsurface soil (soil 0 to 10 ft bgs).

- Future recreational user – direct contact with surface soils and consumption of game exposed to surface soils.

- Future on-site rural resident – direct contact with surface soil at and use of groundwater drawn from the RGA at source areas and vapor intrusion into basements.

- Future off-site rural resident – use in the home of groundwater drawn from the RGA at the DOE plant boundary, property boundary, and the Ohio River or seeps.

SWMU 145 was evaluated only for subsurface soils and groundwater. Specific observations for this BHHRA are presented here. Summaries present rounded values for percent contribution, with those contributing less than 1% removed. More detailed results are provided in Appendix F.

6.3.1 Observations - Future Industrial Worker

Cumulative HIs for the industrial worker were greater than 1 at SWMUs 2 and 30 based on soil exposure. At SWMU 2, uranium and arsenic were the primary drivers contributing 61% and 28%, respectively. At SWMU 30, uranium was the primary driver contributing 93% to the HI.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at SWMU 2, 5, 7, and 30 for exposure to soil (SWMU 145 was not evaluated for this scenario). The following summarizes the cumulative risk estimates and major contributors (> 5%) to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 8.78E-04; drivers are arsenic at 7%, ^{137}Cs at 68%, and ^{238}U at 20%.
- SWMU 5 cumulative ELCR 5.75E-03; driver is Total PAHs at 99%.
- SWMU 7 cumulative ELCR 8.70E-04; drivers are Total PAHs at 38%, Total PCBs at 13%, Thorium-228 (^{228}Th) at 14%, and ^{238}U at 32%.
- SWMU 30 cumulative ELCR 1.13E-03; drivers are Total PAHs at 57%, Total PCBs at 8%, and ^{238}U at 30%.

The current industrial/maintenance worker (based on 16 days of exposure per year) had ELCRs less than 1E-04 for all SWMUs except SWMU 5 (ELCR was 3.68E-04 at SWMU 5). Over 99% of the risk at SWMU 5 under this scenario was due to the risk from Total PAHs.

For both the current worker (16 days of exposure per year) and the default future worker Total PAHs are the risk driver for the ELCR for all SWMUs with an ELCR exceeding 1E-04, with the exception of SWMU 2. Uranium and arsenic were the major contributors to HIs at SWMU 2 and 30; the maximum detected concentrations of these metals in surface soils at these sites are elevated above background. The industrial scenario is the most probable future use for the site, indicating that ^{137}Cs, PAHs, uranium, and arsenic may need to be addressed during the FS.

6.3.2 Observations - Future Excavation Worker

Cumulative HIs for the future excavation worker were greater than 1 for SWMUs 2, 5, 7, and 30 based on soil exposure. The following summarizes the cumulative HIs and major contributors (> 5%) to elevated hazards at these SWMUS.

- SWMU 2 cumulative HI 2.97; drivers are arsenic at 20%, iron at 17%, thallium at 7%, and Total Uranium at 55%.
- SWMU 5 cumulative HI 1.91; drivers are arsenic at 13% and Total Uranium at 86%.
- SWMU 7 cumulative HI 1.31; drivers are iron at 14% and Total Uranium at 65%.
- SWMU 30 cumulative HI 8.85; driver is Total Uranium at 93%.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at: SWMU 2, SWMU 4, SWMU 5, SWMU 7, SWMU 30, and SWMU 145 for exposure to soil. The following summarizes the cumulative risk estimates and major contributors (> 5%) to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 5.88E-04; drivers are arsenic at 16%, Total PCBs at 5%, ^{137}Cs at 22%, and ^{238}U at 49%.

- SWMU 4 cumulative ELCR 2.00E-03; drivers are Total PCBs at 11%, and ^{137}Cs at 79%.

- SWMU 5 cumulative ELCR 5.23E-03; drivers are Total PAHs at 99%.

- SWMU 7 cumulative ELCR 7.71E-04; drivers are Total PAHs at 38%, Total PCBs at 16%, ^{228}Th at 5%, and ^{238}U at 35%.

- SWMU 30 cumulative ELCR 9.40E-04; drivers are Total PAHs at 62%, Total PCBs at 11%, and ^{238}U at 18%.

- SWMU 145 cumulative ELCR 2.18E-04; drivers are arsenic at 10%, Total PAHs at 10%, Total PCBs at 45%, and ^{238}U at 32%.

Risk and hazard for some COPCs that are listed as risk drivers for the future excavation worker are based on exposure point concentrations that may overestimate exposure. For SWMU 5, only one arsenic detection in the subsurface dataset exceeded background; therefore, the risks from exposure across the site are similar to those that would be expected from background. The uranium hazard, though elevated over background, is based on the maximum of 3 detected concentrations out of 31 samples. At SWMU 7, most of the detected concentrations of arsenic and iron in the subsurface also are at or near background. This also is true of arsenic at SWMU 145. This indicates that these metals are not the risk drivers of concern for the FS.

6.3.3 Observations - Future Recreational Users

Cumulative HIs for the child, teen, and adult recreational users were greater than 1 for SWMUs 2, 5, 6, 7, and 30 based on soil exposure. The following summarizes the cumulative HIs exceeding 1 for SWMUs and receptors and the major contributors (> 5%) to their hazards.

- SWMU 2 cumulative HI (child) 12.4; drivers are arsenic at 5%, iron at 6%, and Total Uranium at 88%.

- SWMU 2 cumulative HI (teen) 9.34; drivers are arsenic at 6%, iron at 6%, and Total Uranium at 88%.

- SWMU 2 cumulative HI (adult) 10.4; drivers are iron at 6% and Total Uranium at 92%.

- SWMU 5 cumulative HI (child) 4.24; drivers are arsenic at 6%, Total Uranium at 76%, fluoranthene at 12%, and naphthalene at 5%.

- SWMU 5 cumulative HI (teen) 3.21; drivers are arsenic at 7%, Total Uranium at 76%, and fluoranthene at 14%.

- SWMU 5 cumulative HI (adult) 3.17; drivers are Total Uranium at 89% and fluoranthene at 7%.

- SWMU 6 cumulative HI (child) 1.33; driver is Total Uranium at 100%.

- SWMU 6 cumulative HI (teen) 1.00; driver is Total Uranium at 100%.

- SWMU 6 cumulative HI (adult) 1.16; driver is Total Uranium at 100%.
- SWMU 7 cumulative HI (child) 4.76; drivers are iron at 8% and Total Uranium at 87%.
- SWMU 7 cumulative HI (teen) 3.57; drivers are iron at 7% and Total Uranium at 88%.
- SWMU 7 cumulative HI (adult) 3.99; drivers are iron at 7% and Total Uranium at 91%.
- SWMU 30 cumulative HI (child) 16.4; driver is Total Uranium at 98%.
- SWMU 30 cumulative HI (teen) 12.4; driver is Total Uranium at 99%.
- SWMU 30 cumulative HI (adult) 14.3; driver is Total Uranium at 99%.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at SWMUs 2, 4, 5, 6, 7, and 30 for soil exposure and consumption of game. The following summarizes the cumulative risk estimates and major contributors (> 5%) to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 6.96E-04; drivers are arsenic at 11%, Total PAHs at 18%, ^{137}Cs at 32%, and ^{238}U at 33%.
- SWMU 4 cumulative ELCR 3.73E-04; drivers are arsenic at 10%, Total PAHs at 72%, and ^{238}U at 11%.
- SWMU 5 cumulative ELCR 5.74E-02; driver is Total PAHs at 100%.
- SWMU 6 cumulative ELCR 3.01E-04; driver is Total PAHs at 96%.
- SWMU 7 cumulative ELCR 3.97E-03; drivers are Total PAHs at 84%, Total PCBs at 5%, and ^{238}U at 9%.
- SWMU 30 cumulative ELCR 7.15E-03; drivers are Total PAHs at 91%, and ^{238}U at 6%.

At SWMU 7 most arsenic and iron values in the surface soils are at or near the background value, indicating that these metals are not risk drivers of concern for the FS for the recreational user exposure. A major pathway for risk to the recreational user is the modeled consumption of quail. As discussed in the uncertainty section, the default factors used to model contaminant transfer in game are extremely conservative. Iron and uranium both show very large contributions to HI from quail ingestion compared to ingestion of other game (deer and rabbits) and other pathways. The results of the quail ingestion risk and hazard calculations, therefore, are not the most appropriate pathway for consideration for decision-making in the FS.

6.3.4 Observations - Future On-Site Rural Residents

Because of the nature of residential use, risk and hazard contributions were noted for both soil and groundwater exposure. The following summarizes the cumulative HIs and ELCRs observed for each resident.

Hazards - Future Child Residential Exposure to Soil. Cumulative HIs based on direct contact with soil for the child rural resident were greater than 1 for all of the SWMUs.[1] The largest contributors to elevated hazards are as follows:

- SWMU 2: arsenic at 10%, iron 8%, and Total Uranium at 79%
- SWMU 3: antimony at 48% and Total Uranium at 52%
- SWMU 4: arsenic at 50%, iron at 42%, and vanadium at 5%
- SWMU 5: arsenic at 11%, Total Uranium at 64%, fluoranthene at 13%, and naphthalene at 9%
- SWMU 6: Total Uranium at 99%
- SWMU 7: arsenic at 6%, iron at 9%, and Total Uranium at 78%
- SWMU 30: Total Uranium at 96%

At SWMUs 4 and 7, surface soils showed only slightly elevated concentrations of both arsenic and iron. Arsenic at SWMU 5 also was near background in surface soils. Total uranium accounted for essentially all of the hazard at SWMU 6, but the exposure point concentration was based on a single detection out of 15 samples at the site and is unlikely to reflect realistic future exposure. These metals, therefore, are not of particular concern for decision making in the FS.

Hazards - Future Adult Resident Exposure to Soil. Cumulative HIs for the future on-site adult resident were greater than 1 for SWMUs 2, 5, 7, and 30. The largest contributors to elevated hazards are as follows:

- SWMU 2: arsenic at 21%, Total Uranium at 68%, and iron 8%
- SWMU 5: arsenic at 17%, Total Uranium at 41%, fluoranthene at 27%, and naphthalene at 11%
- SWMU 7: arsenic at 13%, iron at 9%, and Total Uranium at 68%
- SWMU 30: Total Uranium at 94%

Hazards - Future Resident Exposure to Groundwater. Cumulative HIs based on exposure to groundwater for the future on-site rural resident were greater than 1 for all of the SWMUs evaluated (SWMU 6 was not evaluated). The following lists those constituents that contributed to elevated HIs. The major contaminants driving the hazard were ingestion of uranium metal and iron, and ingestion and inhalation of TCE and *cis*-1,2 DCE.

The following lists those constituents that contributed to elevated HIs by SWMU for the Child Resident:

- SWMU 2: TCE at 52% and *cis*-1,2-DCE at 47%
- SWMU 3: arsenic at 48%, uranium at 36%, and manganese at 17%
- SWMU 4: TCE at 93% and *cis*-1,2-DCE at 6.1%
- SWMU 5: arsenic at 38%, naphthalene at 35%, and manganese at 27%
- SWMU 7: arsenic at 30%, TCE at 26%, Total PCBs at 22%, and *cis*-1,2-DCE at 6.6%
- SWMU 30: TCE at 97%
- SWMU 145: antimony at 50% and arsenic at 50%

Risks – Future Residential Exposure to Soil. Cumulative ELCRs exceeding 1E-06 from direct contact with soil was observed for all of the SWMUs. Cumulative ELCR greater than 1E-04 were identified for all of the SWMUs, except SWMU 3. The largest contributors to elevated risks are as follows:

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[1] SWMU 145 was evaluated for excavation worker scenario only.

- SWMU 2: ^{137}Cs at 71%, and ^{238}U at 21%
- SWMU 4: Arsenic at 27%, Total PAHs at 18%, and ^{238}U at 45%

- SWMU 5: Total PAHs at 99%
- SWMU 6: Total PAHs at 43%, ^{235}U at 54%
- SWMU 7: Total PAHs at 27%, Total PCBs at 10%, ^{228}Th at 18%, and ^{238}U at 42%
- SWMU 30: Total PAHs at 45%, Total PCBs at 7%, ^{235}U at 5%, and ^{238}U at 42%

The arsenic contributing to risk at SWMU 4 from surface soil exposure is due to arsenic concentrations near background.

Risks – Future Residential Exposure to Groundwater. Cumulative ELCRs exceeding 1E-06 from direct exposure to groundwater was observed for all of the SWMUs evaluated (SWMU 6 was not evaluated). Cumulative ELCR greater than 1E-04 were identified for all of the SWMUs evaluated. The major contaminants (> 5%) driving risk were ingestion of arsenic and TCE.

- SWMU 2: TCE at 98%
- SMMU 3: Arsenic at 72%, ^{99}Tc at 25%
- SWMU 4: TCE at 68%, vinyl chloride at 31%
- SWMU 5: Arsenic at 97%
- SWMU 7: Arsenic at 15%, 1,1-DCE at 66%, and vinyl chloride at 12%
- SWMU 30: 1,1-DCE at 6% and TCE at 92%
- SWMU 145: Arsenic at 75% and ^{99}Tc at 25%

6.3.5 Observations - Future Off-Site Rural Residents

Risk and hazard estimates for future off-site residential use are based on modeled groundwater concentrations. The following summarizes the results of the quantitative assessment at the plant boundary, property boundary, and at the Ohio River (or seeps).

Future Residential Exposure to Groundwater - Plant Boundary. SWMU 6 was not evaluated for groundwater exposure, and SWMU 145 lies outside the plant boundary. Cumulative HIs based on exposure to groundwater at the DOE plant boundary were greater than one for SWMU 2, SWMU 4, SWMU 5, SWMU 7, and SWMU 30. The major contaminants contributing to hazard were TCE, *cis*-1,2-DCE, arsenic, manganese, and Total PCBs.

The cumulative ELCR was greater than 1E-06 for SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 7, and SWMU 30. The cumulative ELCR was greater than 1E-04 for SWMU 2, SWMU 3, SWMU 4, SWMU 7, and SWMU 30. The major contaminants contributing to risk were TCE, 1,1-DCE, vinyl chloride, ^{99}Tc, and arsenic.

Future Residential Exposure to Groundwater - Property Boundary. Cumulative HIs based on exposure to groundwater at the DOE property boundary were greater than 1 for SWMU 2, SWMU 4, and SWMU 7, and SWMU 30. The major contaminants driving hazard were ingestion of arsenic, TCE, *cis*-1,2-DCE, and Total PCBs. Other contaminats made only minor contributions to the cumulative HI.

Cumulative ELCR exceeded 1E-06 for groundwater exposure for all of the SWMUs, except SWMU 6. Cumulative ELCRs greater than 1E-04 from groundwater use were identified for SWMUs 2, 4, 7, 30, and

145. The major contaminants driving risk were ingestion of arsenic, TCE, 1,1-DCE, vinyl chloride, and ^{99}Tc.

Future Residential Exposure to Groundwater – Ohio River or Seeps. Cumulative HIs based on exposure to groundwater for the future off-site rural resident at the Ohio River were greater than 1 for SWMUs 2, 4, and 30. The major contaminants driving hazard were ingestion of TCE and *cis*-1,2-DCE.

Cumulative ELCRs of 1E-06 from groundwater exposure were observed for SWMUs 2, 3, 4, 7, 30, and 145. Cumulative ELCRs greater than 1E-04 from groundwater use were identified for SWMU 2, 4, 7, and 30. The contaminants driving risk were ingestion of TCE, 1,1-DCE, vinyl chloride, and ^{99}Tc.

6.3.6 Overall Observations from the BHHRA

The following summarize the observations noted for the BHHRA for BGOU. The discussion focuses on the individual exposure scenarios examined for the assessment.

6.3.6.1 Future Industrial Worker

SWMUs 2 and 30 exceed a hazard level of 1 for industrial worker exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. SWMUs 2, 5, 7, and 30 exceed risk levels of 1E-04 for industrial worker exposure to soil, with ^{137}Cs, Total PAHs, and ^{238}U serving as the primary risk drivers. Other COCs contributing to elevated risks include Total PCBs and ^{228}Th.

6.3.6.2 Future Excavation Worker

SWMUs 2, 5, 7, and 30 exceed a hazard level of 1 for excavation worker exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. Other COCs contributing to hazards include arsenic, and iron. SWMUs 2, 4, 5, 7, 30, and 145 exceed the risk level of 1E-04 for excavation worker exposure to soil, with Total PCBs, Total PAHs, ^{238}U, and ^{137}Cs serving as the primary risk drivers. Other COCs contributing to elevated risks include arsenic, ^{226}Ra, and ^{228}Th.

6.3.6.3 Future Recreational Users

SWMUs 2, 5, 6, 7 and 30 exceed a hazard level of 1 for recreational user exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. Other COCs contributing to hazard include arsenic, iron, and PAH compounds fluoranthene and naphthalene. SWMUs 2, 4, 5, 6, 7, and 30 exceed a risk level of 1E-04 for recreational user exposure to soil, with Total PAHs, ^{238}U, and ^{137}Cs serving as the primary risk drivers. Other COCs contributing to elevated risks include arsenic and Total PCBs.

6.3.6.4 Future On-Site Residents

SWMUs 2, 3, 4, 5, 6, 7, and 30 exceed a hazard level of 1 for on-site residential exposure to soil. Total Uranium, arsenic, and iron serve as the primary drivers for hazard for the child and adult resident. Other COCs contributing to elevated hazard include antimony, fluoranthene, iron, naphthalene, and vanadium. SWMUs 2, 3, 4, 5, 6, 7, and 30 exceed a risk level of 1E-04 for on-site residential exposure to soil, with ^{137}Cs, ^{238}U, and Total PAHs serving as the primary risk drivers. Other COCs contributing to elevated risks include Total PCBs, arsenic, ^{228}Th, and ^{235}U.

For residential groundwater use at the SWMU boundary, ELCR was greater than 1E-04 and HI was greater than 1 for all SWMUs except SWMU 6. The primary risk drivers are TCE, arsenic, vinyl chloride, 1,1-DCE, and ^{99}Tc.

6.3.6.5 Future Off-Site Residents

SWMUs 2, 4, 5, 7, and 30 exceed a hazard level of 1 for off-site residential exposure to groundwater at the PGDP plant boundary. SWMUs 2, 4, 7, and 30 exceed a hazard level of 1 at the property boundary. SWMUs 2, 4, and 30 exceed a hazard level of 1 at the Ohio River (or seeps). The primary drivers for hazard are arsenic, TCE, *cis*-1,2-DCE, and 1,1-DCE. SWMUs 2, 3, 4, 7, and 30 at the plant boundary; SWMUs 2, 4, 7, 30, and 145 at the property boundary; and SWMUs 2, 4, 7, and 30 at the Ohio River (or seeps) exceed a risk level of 1E-04 for off-site residential exposure to groundwater. The primary risk drivers are TCE, 1,1-DCE, and ^{99}Tc.

6.3.7 Observations from the SERA

The screening results are used to support a decision whether to continue with additional evaluation of potential ecological risk at these sites. The results of the screening indicate that numerous COPCs at each site warrant further evaluation; however, a number of uncertainties impact the potential usefulness of the SERA results. Many COPCs were retained because no NFA value was available for comparison; not because they exceeded their NFA screening level. Maximum detected concentrations used for screening analytes may not provide appropriate estimates of the concentrations to which ecological receptors are exposed at these sites. In addition, at least some COPCs at each site were evaluated based on screening of a detection limit that substantially exceeded the maximum detected concentration. COPCs evaluated based on detection limits are discussed further in Appendix G. In addition, the NFA screening levels are protective of entire suites of receptors, some of which may not be present at these disturbed sites. Also, in accordance with the PGDP ecological risk assessment guidance (DOE 2001a), analytes detected only below background are not excluded from the ecological screening. Retention of COPCs present at background concentrations would overestimate the risks related to site-related contaminants. These uncertainties, combined with the results of the SERA, indicate the need for further evaluation of these sites.

7. SUMMARY AND CONCLUSIONS

This chapter summarizes and presents conclusions about the nature and extent of contamination, fate and transport, and risk assessment at the eight burial grounds evaluated during this RI. The conclusions are drawn from known site conditions, historical knowledge of the burial grounds, and geological and environmental sampling data collected from the burial areas.

7.1 OVERVIEW

The PGDP SMP (DOE 2007a) focuses environmental restoration activities into five strategic initiatives, as follows:

- BGOU Strategic Initiative,
- Decontamination and Decommissioning (D&D) OU Strategic Initiative,
- Groundwater OU Strategic Initiative,
- Soils OU Strategic Initiative, and
- Surface Water OU Strategic Initiative.

These initiatives include a series of prioritized response actions, ongoing site characterization activities to support future response action decisions, and D&D of the operating gaseous diffusion plant once it ceases operation. After completion of these activities, the Comprehensive Site OU evaluation will be conducted, with implementation of additional actions, as needed, to ensure long-term protectiveness.

7.2 RECOMMENDED REMEDIAL ACTION OBJECTIVES

General site cleanup objectives have been developed that serve as guiding principles for creating more detailed remedial action objectives (RAOs) to focus OUs on site-specific problems. A primary objective for the BGOU is to contribute to the protection of off-site residents by addressing sources of groundwater contamination. Based on the current and foreseeable future land use, on-site industrial workers, recreational users, and off-site residents are the primary human receptors having the greatest potential for exposure to site contamination originating from PGDP. The primary pathways of exposure are (1) the groundwater pathway for off-site residents; (2) the surface water pathway (i.e., surface water and sediments) for recreational users (assumed to be primarily local residents); and (3) direct contact with waste, soil, and sediment for industrial workers. The following are the BGOU RAOs.

- Contribute to protection of current and future residential receptors from exposure to contaminated groundwater by addressing sources of groundwater contamination.

- Protect industrial workers from exposure to waste and contaminated soils.

- Treat or remove principal threat wastes wherever practicable, consistent with 40 *CFR* § 300.430 (a)(iii)(A).

The selected response actions for each OU must meet the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) threshold criteria: 1) be protective of human health and the environment and 2) attain Applicable or Relevant and Appropriate Requirements (ARARs) [or provide grounds for invoking a waiver under CERCLA 121(d)(4)]. The National Contingency Plan (NCP) defines protectiveness in terms of risk-based levels and states that acceptable health-based exposure levels for known or suspected carcinogens are concentration levels that represent an excess upper-bound lifetime cancer risk between 10^{-4} to 10^{-6}. The NCP requires the 10^{-6} risk level be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure. For systemic toxicants, EPA guidance defines a HI of 1 as an acceptable health-based exposure level.

7.3 REMEDIAL INVESTIGATION SCOPE

The scope of the BGOU Strategic Initiative includes an RI, BRA, FS, remedy selection, and implementation of actions, as necessary, for protection of human health and the environment. This BGOU RI addresses eight SWMUs containing burial grounds and landfills at PGDP: seven (SWMUs 2, 3, 4, 5, 6, 7, and 30) are located within the main PGDP secure area; and one (SWMU 145) is located within a controlled access area to the north.

SWMU	Facility
2	C-749 Uranium Burial Ground
3	C-404 Low-Level Radioactive Waste Burial Ground
4	C-747 Contaminated Burial Yard and C-748-B Burial Area
5	C-746-F Burial Yard
6	C-747-B Burial Ground
7	C-747-A Burial Ground
30	C-747-A Burn Area
145	Area P

Ditches bound each of the BGOU SWMUs. The nature and extent of contamination within these ditches is within the scope of the Surface Water OU Strategic Initiative and the Comprehensive Site OU evaluation.

The BGOU RI/FS Work Plan identified four primary goals for this RI and for the follow-up FS (DOE 2006a). Table 7.1 summarizes these goals and references sections of the RI report (where applicable) that address these goals.

The potential areas of buried metal within the C-746-P and C-746-P1 Scrap Yards (SWMU 13) identified during this BGOU RI field investigation will be characterized with a Sampling and Analysis Plan addendum to the BGOU RI/FS Work Plan and follow-on field investigation. The results will be documented and assessed in the BGOU FS.

Table 7.1. Goals Identified for the BGOU RI

GOAL 1:	**CHARACTERIZE NATURE OF SOURCE ZONE**
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?
GOAL 2:	**DEFINE EXTENT OF SOURCE ZONE AND CONTAMINATION IN SOIL AND OTHER SECONDARY SOURCES AT ALL UNITS**
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 relationship of the UCRS gradient to the source, to surface water bodies, and to the RGA?
GOAL 3:	**DETERMINE SURFACE AND SUBSURFACE TRANSPORT MECHANISMS AND PATHWAYS**
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?
GOAL 4:	**SUPPORT EVALUATION OF REMEDIAL ALTERNATIVES**
4-1:	What are the possible remedial technologies applicable for this unit?
4-2:	What are the physical and chemical properties of media to be remediated?
4-3:	Are cultural impediments present?
4-4:	What is the extent of contamination (geologic limitations presented by the source zone or secondary contamination source)?
4-5:	What would be the impact of action on and by other sources?
4-6:	What would the impact of an action at the source be on the integrator units?
4-7:	What are stakeholders' perceptions of contamination at or migrating from source zone or secondary contamination sources?

Table 7.1. Goals Identified for the BGOU RI (Continued)

GOAL 1: Characterize Nature of Source Zone

		SWMU	Location in Text
1-1 & 1-3	What are the suspected contaminants? What are the concentrations and activities at the source?	SWMU 2 SWMU 3 SWMU 4 SWMU 5 SWMU 6 SWMU 7 SWMU 30 SWMU 145	Section 4.3.1 Section 4.3.2 Section 4.3.3 Section 4.3.4 Section 4.3.5 Section 4.3.6 Section 4.3.7 Section 4.3.8
1-2 & 1-5	What are the plant processes that could have contributed to the contamination? When and over what duration did releases occur? What are the chemical and physical properties of associated material at the source areas?	SWMU 2 SWMU 3 SWMU 4 SWMU 5 SWMU 6 SWMU 7 SWMU 30 SWMU 145	Section 1.3.1.2 Section 1.3.2.2 Section 1.3.3.2 Section 1.3.4.2 Section 1.3.5.2 Section 1.3.6.2 Section 1.3.7.2 Section 1.3.8.2
1-4	What is the area and volume of the source zone?	SWMU 2	Section 1.3.1.1 and Appendix E, Table E.3.3
		SWMU 3	Section 1.3.2.1 and Appendix E, Table E.3.7
		SWMU 4	Section 1.3.3.1 and Appendix E, Table E.3.11
		SWMU 5	Section 1.3.4.1 and Appendix E, Table E.3.15
		SWMU 6	Section 1.3.5.1 and Appendix E, Table E.3.19
		SWMU 7	Section 1.3.6.1 and Appendix E, Table E.3.21
		SWMU 30	Section 1.3.7.1 and Appendix E, Table E.3.25
		SWMU 145	Section 1.3.8.1 and Appendix E, Table E.3.29

Table 7.1. Goals Identified for the BGOU RI (Continued)

GOAL 2: Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units

		SWMU	Location in Text
2-1	What are the past, current, and potential future migratory paths?	All SWMUs	Section 5.1 and Figure 5.1
2-2	What are the past, current, and potential future release mechanisms?	All SWMUs	Section 4
2-3	What are the contaminant concentrations or activity gradients?	SWMU 2	Section 4.3.1
		SWMU 3	Section 4.3.2
		SWMU 4	Section 4.3.3
		SWMU 5	Section 4.3.4
		SWMU 6	Section 4.3.5
		SWMU 7	Section 4.3.6
		SWMU 30	Section 4.3.7
		SWMU 145	Section 4.3.8
2-4	What is the vertical and lateral extent of contamination?	SWMU 2	Table 4.7, Appendix D, SWMU 2
		SWMU 3	Table 4.9, Appendix D, SWMU 3
		SWMU 4	Table 4.11, Appendix D, SWMU 4
		SWMU 5	Table 4.13, Appendix D, SWMU 5
		SWMU 6	Table 4.15, Appendix D, SWMU 6
		SWMU 7	Table 4.17, Appendix D, SWMU 7
		SWMU 30	Table 4.19, Appendix D, SWMU 30
		SWMU 145	Table 4.21, Appendix D, SWMU 145
2-5	What is the relationship of the UCRS gradient to the source, to surface water bodies, and to the RGA?	SWMU 2	Section 3.9.3.1
		SWMU 3	Section 3.9.3.1
		SWMU 4	Section 3.9.3.2
		SWMU 5	Section 3.9.3.3
		SWMU 6	Section 3.9.3.3
		SWMU 7	Section 3.9.3.4
		SWMU 30	Section 3.9.3.4
		SWMU 145	Section 3.9.3.5

Table 7.1. Goals Identified for the BGOU RI (Continued)

GOAL 3: Determine Surface and Subsurface Transport Mechanisms and Pathways

		SWMU	Location in Text
3-1 & 3-2	What are the contaminant migration trends? To what area is the dissolved-phase plume migrating?	SWMU 2	Section 5.3.1
		SWMU 3	Section 5.3.2
		SWMU 4	Section 5.3.3
		SWMU 5	Section 5.3.4
		SWMU 6	Section 5.3.5
		SWMU 7	Section 5.3.6
		SWMU 30	Section 5.3.7
		SWMU 145	Section 5.3.8
3-3	What are the effects of underground utilities and plant operations on migration pathways including ditches?	All SWMUs	Section 3.9.2
3-4	What is the role of the UCRS in contaminant transport?	SWMU 2	Section 4.4.1
		SWMU 3	Section 4.4.2
		SWMU 4	Section 4.4.3
		SWMU 5	Section 4.4.4
		SWMU 6	Section 4.4.5
		SWMU 7	Section 4.4.6
		SWMU 30	Section 4.4.7
		SWMU 145	Section 4.4.8
3-5	What are the physical and chemical properties of the formations and subsurface matrices?	All SWMUs	Section 3.9.3

Table 7.1. Goals Identified for the BGOU RI (Continued)

GOAL 4: Support Evaluation of Remedial Alternatives

		SWMU	Location in Text
4-1	What are the possible remedial technologies applicable for this unit?	All SWMUs	Tables 7.10 and 7.11, To be evaluated in FS
4-2	What are the physical and chemical properties of media to be remediated?	All SWMUs	Sections 1.3 and 3.9.3
4-3	Are cultural impediments present?	All SWMUs	Section 3.9.1. To be further evaluated in FS
4-4	What is the extent of contamination (geologic limitations presented by the source zone or secondary contamination source)?	SWMU 2 SWMU 3 SWMU 4 SWMU 5 SWMU 6 SWMU 7 SWMU 30 SWMU 145	Section 3.9.3.1 Section 3.9.3.1 Section 3.9.3.2 Section 3.9.3.3 Section 3.9.3.3 Section 3.9.3.4 Section 3.9.3.4 Section 3.9.3.5
4-5	What would be the impact of action on and by other sources?	All SWMUs	To be evaluated in FS
4-6	What would the impact of an action at the source on the integrator units?	All SWMUs	To be evaluated in FS
4-7	What are stakeholders' perceptions of contamination at or migrating from source zone or secondary contamination sources?	All SWMUs	To be evaluated in FS

7.4 NATURE AND EXTENT OF CONTAMINATION

Materials that were disposed of in each of the SWMUs of the BGOU contained hazardous substances. The conceptual model applicable to all of the BGOU SWMUs is that releases from these SWMUs have impacted soils below or adjacent to the source zones and, through vertical infiltration in the soil, have the potential to contaminate the groundwater underlying these sources. Analysis of soil and groundwater from the area of each SWMU documents the presence of metals, organic compounds, and radionuclides above screening levels. Section 4 summarizes the characterization of the area of these SWMUs, as part of the BGOU RI and previous efforts.

Iron and manganese are frequently detected contaminants in subsurface soils in six of the SWMUs (Table 7.2). Arsenic and vanadium were other metals that were a frequently detected contaminant in the subsurface soils of the BGOU.

Table 7.2. Subsurface Soil Analytes Frequently Detected above Background or Soil Screening Level

Source Areas	Metals	Organic Compounds	Radionuclides
SWMU 2	Arsenic, Iron, Manganese, Vanadium	--	--
SWMU 3	Arsenic	--	--
SWMU 4	Iron, Manganese, Vanadium	--	^{230}Th, U, ^{234}U, ^{238}U
SWMU 5	Iron, Manganese, Vanadium	--	--
SWMU 6	Iron, Manganese, Vanadium	--	--
SWMU 7	Arsenic, Iron, Manganese	--	$^{235/236}$U
SWMU 30	Iron, Manganese, Vanadium	--	$^{235/236}$U
SWMU 145	Arsenic	--	^{228}Th

-- = none
$^{233/236}$U = uranium-235/236
U = uranium

Metals are the most common of the frequently detected contaminants in both UCRS and RGA groundwater samples (Tables 7.3 and 7.4). Iron and manganese are the predominant contaminants in the UCRS. Iron is less prevalent in the RGA.

Table 7.3. UCRS Groundwater Analytes Frequently Detected above Screening Level

Source Area	Metals	Organic Compounds	Radionuclides
SWMU 2	Beryllium, Iron, Manganese, Uranium, Vanadium	1,1-DCE; TCE	^{234}U, ^{238}U
SWMU 3	Arsenic, Iron, Manganese	TCE	^{99}Tc, ^{234}U
SWMU 4	Arsenic, Iron, Lead, Manganese	*cis*-1,2-DCE; TCE	^{99}Tc
SWMU 5	Arsenic, Iron, Lead, Manganese, Molybdenum	--	--
SWMU 6	Arsenic, Iron, Lead, Manganese, Molybdenum, Uranium	--	^{99}Tc, ^{234}U, ^{238}U
SWMU 7	Arsenic, Iron, Lead, Manganese, Molybdenum, Nickel	TCE; Vinyl chloride	^{222}Rn, ^{234}U, ^{238}U
SWMU 30	Arsenic, Iron, Lead, Manganese, Molybdenum, Nickel, Uranium, Vanadium	--	^{234}U, ^{238}U
SWMU 145	Iron, Manganese	--	^{222}Rn, ^{238}U

-- = none

Table 7.4. RGA Groundwater Analytes Frequently Detected above Screening Level

Source Areas	Metals	Organic Compounds	Radionuclides
SWMU 2	Arsenic, Beryllium, Iron, Manganese, Vanadium	1,1-DCE; TCE	^{234}U, ^{238}U
SWMU 3	Manganese	TCE	--
SWMU 4	Arsenic, Manganese, Iron, Lead	1,1-DCE; Carbon Tetrachloride; Chloroform; *cis*-1,2-DCE; TCE; Vinyl Chloride	--
SWMU 5	Iron, Lead, Manganese	--	--
SWMU 6	Lead, Manganese	TCE	--
SWMU 7	Arsenic, Iron, Manganese	TCE	--
SWMU 30	Manganese	TCE	--
SWMU 145	--	--	--

-- = none

Principal threat wastes are defined by EPA as "source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur." No threshold level for risk has been established to indicate a principal threat waste; however, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, EPA recommends that treatment alternatives be evaluated (EPA 1991).

The BGOU SWMUs contain two waste types that constitute principal threat wastes: TCE DNAPL and uranium wastes at SWMUs 2 and 3. Dissolved contaminant trends in the RGA indicate that SWMU 4 and the adjoining areas of SWMUs 7 and 30 contain TCE sources as DNAPL. The mobility and toxicity of DNAPLs make them principal threat waste. Additionally, adsorbed TCE is present in subsurface soil at SWMU 2 at levels that present significant potential risk and will require evaluation of a treatment alternative.

The uranium wastes at SWMUs 2 and 3 present potential significant risk which will persist for thousands of years. Remedial actions for large volumes of radioactive wastes, as at SWMUs 2 and 3, are uniquely challenging. The contained uranium constitutes principal threat wastes.

7.5 FATE AND TRANSPORT

Modeling assessed fate and transport of contaminants for two pathways: (1) dissolved-phase transport through the aquifer and (2) vapor transport to a residential basement. Section 5 and Appendix E document the fate and transport modeling applied to the BGOU RI.

Previous work has shown that the primary pathway for groundwater flow and the site-related contaminants is vertical migration through the UCRS, followed by lateral migration in the RGA. Contaminated groundwater could migrate to the POEs. The PGDP Risk Methods Document (DOE 2001a) identified the POEs for the BGOU SWMUs as the plant boundary, property boundary, surface seeps at Little Bayou Creek, and near the Ohio River. Not all SWMUs have transport pathways to all of the POEs. For example, SWMU 145 is located outside of the plant boundary and does not contribute to the Little Bayou seeps. SWMUs 3, 6, 7, and 30 were determined to be the only SWMUs contributing to the Little Bayou seeps POE. Table 7.5 identifies analytes that were modeled to exceed MCLs at the POEs.

Table 7.5. Analytes Predicted to Exceed Maximum Contaminant Limits at the Points of Exposure

Source Area	Contaminant	SWMU Boundary	Plant Boundary	Property Boundary	Little Bayou seeps	Ohio River
SWMU 2	Arsenic	**Yes**[a]	No[b]	No	N/A[c]	No
	cis-1,2-DCE	**Yes**	**Yes**	**Yes**	N/A	**Yes**
	TCE	**Yes**	**Yes**	**Yes**	N/A	**Yes**
SWMU 3	Arsenic	**Yes**	No	No	No	N/A
	^{99}Tc	**Yes**	**Yes**	**Yes**	No	N/A
	Uranium	**Yes**	No	No	No	N/A
SWMU 4	Arsenic	**Yes**	No	No	N/A	No
	cis-1,2-DCE	**Yes**	**Yes**	**Yes**	N/A	No
	^{99}Tc	**Yes**	**Yes**	**Yes**	N/A	No
	TCE	**Yes**	**Yes**	**Yes**	N/A	No
	Vinyl Chloride	**Yes**	**Yes**	**Yes**	N/A	No
SWMU 5	None					
SWMU 6	None					
SWMU 7	1,1-DCE	**Yes**	**Yes**	No	No	N/A
	Arsenic	**Yes**	**Yes**	No	No	N/A
	^{99}Tc	**Yes**	No	No	No	N/A
	TCE	**Yes**	**Yes**	No	No	N/A
	Vinyl Chloride	**Yes**	**Yes**	No	No	N/A
SWMU 30	Arsenic	**Yes**	**Yes**	No	No	N/A
	TCE	**Yes**	**Yes**	**Yes**	**Yes**	N/A
SWMU 145	Antimony	**Yes**	N/A	No	N/A	No
	Arsenic	**Yes**	N/A	No	N/A	No
	^{99}Tc	**Yes**	N/A	**Yes**	N/A	**Yes**

[a] Yes = The modeled analyte concentration exceeds its MCL
[b] No = The modeled analyte concentration does not exceed its MCL
[c] N/A = The POE does not apply to the SWMU

Vapor transport modeling assessed contaminant concentrations in a hypothetical residential basement at the SWMU and in hypothetical residential basements at the POEs. (Appendix E, Section E.3.2 documents the vapor transport modeling performed for the BGOU RI.) Table 7.6 summarizes the results of vapor transport modeling.

Table 7.6. Analytes with Basement Air Concentrations of Concern Based on Vapor Transport Modeling Results at the Points of Exposure

Source Area	Contaminant	On-Site	Plant Boundary	Property Boundary
SWMU 2	TCE	**Yes**[a]	**Yes**	**Yes**
	cis-1,2-DCE	**Yes**	No[b]	No
SWMU 3	TCE	**Yes**	No	No
	Mercury	**Yes**	No	No
SWMU 4	TCE	**Yes**	**Yes**	**Yes**
	Vinyl Chloride	**Yes**	**Yes**	No
	cis-1,2-DCE	**Yes**	No	No
SWMU 5		None		
SWMU 6		None		
SWMU 7	TCE	**Yes**	No	No
	Vinyl Chloride	**Yes**	No	No
	1,1-DCE	**Yes**	**Yes**	No
	Mercury	**Yes**	No	No
SWMU 30	TCE	**Yes**	**Yes**	**Yes**
	1,1-DCE	**Yes**	**Yes**	No
	Mercury	**Yes**	No	No
SWMU 145	Mercury	**Yes**	No	No

[a] Yes = modeled air concentration equals or exceeds 1.0E-06 ELCR or 0.1 HQ
[b] No = modeled air concentration is less than 1.0E-06 ELCR or 0.1 HQ

7.6 RISK ASSESSMENT

PGDP is an industrial facility. Land use is expected to remain industrial. The future on-site rural resident is not a likely land-use scenario. Additionally, DOE's excavation-penetration permit process and on-site groundwater use prohibition provide administrative controls that prevent or control some exposure scenarios that are assessed for the current on-site industrial use scenario and future on-site excavation scenario. These factors should be considered in examination of risk information provided in this report.

The risk for the on-site resident for soil exceeds 1E-04 and the hazard index (HI) is greater than 1 at all SWMUs except for SWMU 3 (for which the risk was between 1E-06 and 1E-04) and SWMU 145 (which was not evaluated for soil exposure). The contaminants that are risk drivers for soil are Total Uranium, antimony, arsenic, iron, Total PAHs, ^{235}U, ^{137}Cs, and ^{238}U.

Residential use of groundwater was evaluated at the SWMU boundary, plant boundary, property boundary, and Ohio River (or seeps) for all SWMUs except SWMU 6. At the SWMU boundary, risks and hazards from groundwater use for all evaluated SWMUs exceeded 1E-04 risk and exceeded an HI of 1. The major contaminants driving the groundwater risks and hazards at these on-site points of exposure are arsenic, antimony (at SWMU 145), naphthalene (at SWMU 5), manganese, uranium, TCE, Total PCBs (at SWMU 7), *cis*-1,2-DCE, vinyl chloride, 1,1-DCE, and ^{99}Tc. At the plant boundary, risks and hazards from groundwater for SWMUs 2, 3, 4, 5, 7, and 30 exceeded 1E-04 risk or exceeded an HI of 1. At the property boundary, risks and hazards from groundwater for SWMUs 2, 4, 7, 30, and 145 exceeded 1E-04 risk or exceeded an HI of 1. At the Ohio River (or seeps), risks and hazards from groundwater for SWMUs 2, 4, 7, and 30 exceeded 1E-04 risk or exceeded an HI of 1. The major contaminants driving the groundwater risks and hazards at these off-site points of exposure are arsenic, Total PCBs (at SWMU 7), TCE, *cis*-1,2-DCE, 1,1-DCE, and ^{99}Tc.

As mentioned, the on-site residential scenario discussed here is not a realistic future use for these sites. For exposure to soil of at least one of the other on-site receptor scenarios (industrial worker, excavation worker, or recreational user), all SWMUs have an excess lifetime cancer risk (ELCR) ≥ 1.0E-06. For at least one of these scenarios, SWMUs 2, 5, 6, 7, and 30 have HIs > 1. Recreational users had risks exceeding 1E-04 and/or HIs greater than 1 at all SWMUs (except SWMU 3 and SWMU 145), with the majority of the risk coming from uranium and PAHs. Risk and hazard for the recreational receptor are driven primarily by the game ingestion pathway, which is not a realistic scenario for cleanup decisions because it is based on very high exposures of game animals and transfer factors from the site soil to game. Soil exposures of workers are more relevant to the potential future uses of the site.

For the excavation worker who is exposed to both surface soil and subsurface soil, HIs were greater than one at SWMUs 2, 5, 7, and 30. Risks for the excavation worker exceeded 1E-04 at SWMUs 2, 4, 5, 7, 30, and 145. The risk/hazard drivers for the excavation worker scenario were antimony (at SWMU 145), arsenic, iron, PAHs, Total PCBs, ^{137}Cs, ^{235}U, ^{238}U, and uranium.

The most likely future scenario is the industrial worker. The ELCR for the scenario exceeded 1E-04 at SWMUs 2, 5, 7, and 30 primarily due to risk from ^{137}Cs (SWMU 2 only), PAHs, Total PCBs (at SWMU 7), ^{228}Th (at SWMU 7), and ^{238}U. The HI exceeds 1 for the industrial worker at SWMUs 2 and 30; arsenic and uranium are the hazard drivers. Risks for the current worker (at 16 days per year of exposure) were much less than those for the future industrial worker; risks for the current worker exceeded 1E-04 only at SWMU 5.

The risk drivers for groundwater use and on-site workers reflect the most likely future uses at and near the site and are the ones that need to be addressed in the FS. Table 7.7 presents a summary of the dominant exposure pathways and COCs for each SWMU for exposure to subsurface soil and groundwater.

Table 7.7. Exposure Pathways and COCs Associated with Dominant Risk for Each SWMU

Source Area	HI	ELCR
SWMU 2	• Ingestion of groundwater and household inhalation of vapors (TCE; *cis*-1,2-DCE) • Ingestion of subsurface soil (uranium)	• Household inhalation of vapors (TCE) • Ingestion of groundwater (TCE) • Ingestion and external exposure to subsurface soil (^{137}Cs, ^{238}U)
SWMU 3	• Ingestion of groundwater (arsenic, uranium)	• Ingestion of groundwater (arsenic, ^{99}Tc) • External exposure to subsurface soil[a] (^{238}U)
SWMU 4	• Ingestion of groundwater (TCE)	• Household inhalation of vapors and dermal exposure (TCE, vinyl chloride) • External exposure to subsurface soil (^{137}Cs)
SWMU 5	• Ingestion of RGA groundwater (arsenic, naphthalene) • Ingestion of subsurface soil (uranium)	• Ingestion of RGA groundwater (arsenic)
SWMU 6	• Ingestion of subsurface soil (uranium)	• Dermal exposure to subsurface soil (PAHs)
SWMU 7	• Ingestion of RGA groundwater (TCE, arsenic, PCB-1254) • Ingestion of subsurface soil (uranium)	• Household inhalation of vapors and ingestion of RGA groundwater (1,1-DCE) • Dermal exposure and ingestion of subsurface soil (PAHs, PCBs, ^{238}U)
SWMU 30	• Ingestion of RGA groundwater (TCE) • Ingestion of subsurface soil (uranium)	• Household inhalation of vapors (TCE) • Dermal exposure and ingestion of subsurface soil (PAHs, PCBs, ^{238}U)
SWMU 145	• Ingestion of RGA groundwater (antimony, arsenic)	• Ingestion of RGA groundwater (arsenic) • Dermal exposure and ingestion of

	subsurface soil (arsenic, PAHs, PCBs, ^{238}U)

The BGOU RI includes a SERA for SWMUs 2, 3, 4, 5, 6, 7, and 30. (SWMU 145 is located beneath the C-746-S and -T Landfills and has negligible surface soil.) Comparison of site characterization data against NFA screening levels determined that all of the SWMUs have metals and organic compounds (in surface soil) that are COPCs for risk to the environment, while only SWMU 7 has a radionuclide COPC (in surface soil).

7.7 CONCLUSIONS

Table 7.8 summarizes the decision rules of the BGOU Strategic Initiative (DOE 2006a). For each SWMU of the BGOU, risk levels associated with contamination at the SWMUs and associated with groundwater contamination derived from all of the SWMUs meet the criteria of the decision rules to progress to evaluate actions that will mitigate risk and to achieve ARARs; to seek an ARAR waiver in accordance with EPA guidance; or to propose alternative standards.

The following are the major contaminant distribution findings for sources investigated in the BGOU RI.

- Environmental media, specifically subsurface soil and groundwater, have been impacted by releases of contaminants at all of the BGOU SWMUs.

- TCE trends in the RGA indicate that TCE DNAPL is present at SWMU 4 and in the vicinity of the shared border between SWMUs 7 and 30. (See Section 3.9.4.) Concentrations of TCE at SWMU 4 suggest that TCE DNAPL may be present both in the waste cells and underlying soils of the UCRS and in the matrix of the RGA. TCE trends at SWMUs 7 and 30 indicate that the TCE DNAPL source is likely constrained to the UCRS soils.

- The BHHRA completed as part of the BGOU RI indicates that excess upper-bound lifetime risk from exposure to contaminated media exists and that response actions may be appropriate for impacted media at each of the sites. For on-site receptor scenarios with soil exposure, all SWMUs have excess upper-bound lifetime risks for hazard (HI ≥ 1) and cancer (ELCR ≥ 1.0E-06) from some contaminants. All but SWMU 3 have an ELCR ≥ 1.0E-04. The metals arsenic and uranium, the organic compounds TCE, PAHs, and PCBs, and the radionuclides ^{238}U and ^{137}Cs are common contaminants that present the dominant risks.

- For on-site groundwater use, all evaluated SWMUs exceeded 1E-04 risk and/or exceeded an HI of 1. The major contaminants driving the groundwater risks at these on-site points of exposure are arsenic, uranium, ^{99}Tc, TCE, *cis*-1,2-DCE, and 1,1-DCE.

- For off-site groundwater use scenarios, SWMUs 2, 4, 7, and 30 have a cumulative HI ≥ 1 and/or ELCR ≥ 1.0E-04. (SWMU 145 also has ELCR ≥ 1.0E-04.) SWMUs 3 and 5 have ELCR ≥ 1.0E-06. The organic compound TCE is a major risk driver.

- The SERA retained a number of COPCs at each of the sites. Each SWMU requires further ecological evaluation.

Table 7.8. Decision Rules for the BGOU Strategic Initiative

GOAL	DECISION RULE	*If* statement	*Then* statement
Nature of Contamination	1a	If the concentration of analytes found in the source zone could result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through contact with contaminated media, **or** if the concentration of analytes in the source zone could result in detrimental impacts to nonhuman receptors through contact with contaminated media as indicated by exceeding ecological screening criteria, **and** if the concentrations of analytes in the source zone are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise pursue a "no further action" decision (see D1b and D1c)
	1b	If concentrations of analytes found in the source zone exceed ARARs,	then evaluate actions that will bring contamination within the source zone into compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards
	1c	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 ARARs, **and** if the concentrations of these contaminants could result in risks greater than those defined in D1a or concentrations greater than ARARs,	then evaluate actions that will mitigate potential future risk or obtain compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards
Extent of Contamination	2a	If secondary contamination sources are found, **and** if the concentration of analytes within the secondary contamination source is found to potentially result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through contact with contaminated media at the unit, **and** if the concentrations of analytes are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise, do not consider secondary contamination sources when making remedial decisions for the unit

Table 7.8. Decision Rules for the BGOU Strategic Initiative (Continued)

GOAL	DECISION RULE	*If* statement	*Then* statement
Fate and Transport	3a	If contaminants are found in the source zone, **or** if secondary contamination sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from secondary contamination sources at concentrations that may potentially result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through use of contaminated media at downgradient points of exposure, **and** the concentrations of analytes are greater than those expected to occur naturally in the environment,	then evaluate actions that will mitigate risk; otherwise, do not consider risk posed by migratory pathways when evaluating remedial alternatives for the unit (see D3b)
	3b	If contaminants are found in the source zone, **or** if secondary contamination sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from the secondary contamination source at concentrations that exceed ARARs,	then evaluate actions that will bring migratory concentrations into compliance with ARARs; seek an ARAR waiver (such as technical impracticability, inconsistent application of state standards, interim measure, greater risk to human health and the environment, equivalent standard of performance) in accordance with EPA guidance; or propose/obtain alternative standards; otherwise, do not consider ARARs when examining migratory pathways during the evaluation of remedial actions (see D3a)
Risk Assessment	4a	If Decision D1a, D1b, D1c, D2a, D3a, or D3b indicate that response actions are needed,	then evaluate response actions to mitigate risk in the source zone

7.7.1 Recommendations for Future Work

DOE's planning assumptions from the life cycle baseline for the burial grounds assumes the removal and/or treatment of principal threat wastes from SWMU 2, SWMU 3, and SWMU 4, as practicable; and *in situ* stabilization/capping of remaining burial grounds.

The forthcoming BGOU FS will evaluate remedial action objectives. Tables 7.9 and 7.10 present the preliminary recommended remedial alternatives.

Table 7.9. Potential Remedial Actions for Primary Sources (Waste and Vadose Soils)

	Soil
Institutional Controls	• Access controls
	• Land-use restrictions
	• Environmental media monitoring
Containment	• Low-permeability capping
	• Constructed barriers
	• Dust and vapor suppression
	• Erosion control
	• Retro-fitted liners
	• Surface water control
Recovery or Removal	• Excavation/storage
	• Excavation/disposal
Treatment	• *In situ* grouting
	• Freezing

Table 7.10. Potential Remedial Actions for Secondary Sources (DNAPL)

	Groundwater
Institutional Controls	• Access controls
	• Land-use restrictions
	• Environmental media monitoring
Containment	• Constructed barriers
	• Hydraulic containment
	• Retro-fitted liners
	• Subsurface drainage
Recovery or Removal	• Extraction/storage
	• Extraction /disposal
Ex Situ Treatment	• Coagulation/flocculation
	• Freeze crystallization
	• Gravity separation
	• Media filtration
	• Membrane separation
	• Neutralization
In Situ Treatment	• *In situ* neutralization
	• Reactive walls
	• Phytoremediation

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APPENDIX A

TECHNICAL MEMORANDUM FOR FIELD ACTIVITIES

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ACRONYMS

AOC	area of contamination
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
ES&H	Environment, Safety, and Health
HSA	hollow-stem auger
NSDD	North-South Diversion Ditch
PaducahOREIS	Paducah Oak Ridge Environmental Information System
PCB	polychlorinated biphenyl
PEMS	Project Environmental Measurements System
PGDP	Paducah Gaseous Diffusion Plant
pH	negative logarithm of the hydrogen-ion concentration
PPE	personal protective equipment
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RI	remedial investigation
SWMU	solid waste management unit
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
WAG	Waste Area Group

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A.1. INTRODUCTION

The purpose of this memorandum is to provide certain technical details regarding field activities pertaining to the Burial Grounds Operable Unit (BGOU) Remedial Investigation (RI). A brief summary of project objectives is provided below; a more thorough discussion is contained in the body of the report.

The BGOU is one of six operable units located within the Paducah Gaseous Diffusion Plant (PGDP). This operable unit consists of contamination associated with PGDP's landfills and burial grounds. Burial grounds addressed by this RI include the following solid waste management units (SWMUs):

SWMU 2	C-749 Uranium Burial Ground
SWMU 3	C-404 Low-Level Radioactive Waste Burial Ground
SWMU 4	C-747 Contaminated Burial Yard and C-748-B Burial Area
SWMU 5	C-746-F Burial Yard
SWMU 6	C-747-B Burial Ground
SWMUs 7 and 30	C-747-A Burial Ground and Burn Area (which includes the area beneath SWMU 12, the C-747-A UF_4 Drum Yard);
SWMU 145	C-746-P Construction/Demolition Debris Disposal and Spoils Area (including the residential/inert borrow area and old North-South Diversion Ditch (NSDD) disposal trench)

The primary focus of this RI was to collect field and analytical data necessary to determine the nature and extent of any soil and groundwater contamination originating from, and immediately under, the burial cells; support the completion of a baseline human health risk assessment and a screening-level ecological risk assessment; and evaluate appropriate remedial alternatives (if necessary) at each of the SWMUs. The RI had the following four specific objectives:

- Characterize Nature of Source Zone—Characterize the nature of contaminant source materials by using existing data and, if required, by collecting additional data;

- Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units—Define the nature, extent (vertical and lateral), and magnitude of contamination in soils, sediments, surface water, and groundwater by using existing data and, if required, by collecting additional data; determine the presence, general location (if practicable), and magnitude of any dense nonaqueous-phase liquid zones;

- Determine Surface and Subsurface Transport Mechanisms and Pathways—Gather existing quality data and, if necessary, collect additional adequate-quality data to analyze contaminant transport mechanisms, evaluate risk, and support a Feasibility Study; and

- Support Evaluation of Remedial Technologies—Determine if the existing data are sufficient to evaluate alternatives that will reduce risk to human health and the environment and/or control the migration of contaminants off-site.

The following table presents various procedures and work instructions that were used to complete the fieldwork conducted as part of the BGOU RI.

Table A.1. Procedures Used in the RI of the BGOU

Work Instructions or Procedures Required for Fieldwork and Sampling Activities
Archival of Environmental Data Within the Environmental Restoration Program
Chain-of-Custody
Cleaning and Decontaminating Sample Containers and Sampling Equipment
Data Entry
Data Management Coordination
Data Validation
Environmental Radiological Screening
Equipment Decontamination
Field Measurement Procedures: pH, Temperature, and Conductivity, and Dissolved Oxygen
Field Quality Control
Filter Pack and Screen Selection for Wells and Piezometers
Groundwater Sampling Procedures: Water Level Measurements
Identification and Management of Waste Not From a Radioactive Material Management Area
Labeling, Packaging, and Shipping of Environmental Field Samples
Lithologic Logging
Monitoring Well Development
Monitoring Well Installation
Monitoring Well Purging and Groundwater Sampling
Off-Site Decontamination Pad Operating Procedures
On-Site Handling and Disposal of Waste Materials
Opening Containerized Waste
Paducah Contractor Records Management Program
Pumping Liquid Wastes Into Tankers
Quality Assured Data
Sampling of Containerized Wastes
Use of Field Logbooks
Well and Temporary Boring Abandonment

The existing data for SWMU 4 was determined to be sufficient to evaluate the nature and extent of contamination and provide data from under the burial cells; therefore, no additional samples were collected for this SWMU. Borings were collected from under some of the burial cells for SWMUs 5 and 6 in a previous investigation; however, not all cells were evaluated. For SWMU 5, additional borings were collected from cells not previously targeted. For SWMU 6, physical constraints limited access to the area during previous investigations. Equipment had been removed subsequent to the Waste Area Group (WAG) 3 RI from the area, and it was possible to collect samples and evaluate those cells during this RI.

Activities addressed in this technical memorandum (Appendix A) are discussed in the following chapters:

- Chapter 2—Sampling Strategy
- Chapter 3—Surveying
- Chapter 4—Sampling Procedures
- Chapter 5—Field Decontamination
- Chapter 6—Waste Management
- Chapter 7—Environment, Safety, and Health
- Chapter 8—Fieldwork Documentation
- Chapter 9—Deviation from Planned Sample Locations

A.2. SAMPLING STRATEGY

The field sampling strategy used for the RI consisted of intrusive media sampling (surface and subsurface soil, and groundwater). The investigation activities used standard industry practices that were consistent with U.S. Environmental Protection Agency (EPA) procedures and protocols. Sampling activities at the burial grounds focused on the soils and groundwater beneath the burial pits down to a depth of 60 ft bgs (below ground surface). Surface and subsurface soils adjacent to but not beneath the burial pits were not part of this investigation. These will be evaluated through the Soils Operable Unit. Likewise, the Regional Gravel Aquifer (RGA) was not part of this investigation. It will be evaluated through the Groundwater Operable Unit. Borings adjacent to the NSDD were advanced to a depth of 15 ft bgs to evaluate impacts from the pipeline that once discharged leachate from SWMU 3 into the NSDD.

A.2.1 SOIL/SEDIMENT SAMPLING

The drilling technology for the angled borings and the six shallow vertical borings was a track-mounted rig capable of both direct push technology (DPT) and hollow-stem auger (HSA) drilling. This track-mounted drill rig utilized push rods to advance a soil sample tube with an acetate liner to collect undisturbed soil samples. If refusal was met using the push rods, auger flights then were drilled over the push rods to advance the borings to the sample depth. The deep vertical borings were completed with a larger HSA drill rig capable of reaching a depth of 100 ft bgs. For the deeper samples, drillers advanced the hollow stem augers to near the sample depth and then pushed the DPT sample tube through the hollow-stem augers to the sample depth to collect the soil samples.

The BGOU RI Work Plan directed the use of angled borings to sample from beneath the burial cells. Per the RI Work Plan, the field crew did not collect soil samples at or near the surface in the angled borings because these borings were begun at a specified distance away from the burial cells, outside the influence of the buried waste. Table A.2 summarizes the common soil sample depths.

Table A.2. BGOU RI Soil Sample Depths

Target Vertical Depth (ft)*			Actual Drilled Length (ft) at 45° Angle			Actual Vertical Depth (ft)	
Top	Bottom		Top	Bottom		Top	Bottom
8	10		10	15		7	11
13	15		15	20		11	14
28	30		40	45		28	32
43	45		60	65		42	46
58	60		80	85		57	60

*Specified in the BGOU RI Work Plan

Drilling and sampling difficulties necessitated slight adjustments to sampling depths in some instances. Collection of duplicate samples, likewise, required a longer sample interval to accommodate the increased sample volume. In addition, the sampling depths of the two lower intervals in boreholes 145-106 and 145-107 were adjusted to accommodate a locally thinner Upper Continental Recharge System (UCRS). Cross sections and tables in Section 4 and the boring logs in Appendix B document the depth of each soil sample.

The BGOU RI included sampling from both shallow and deep vertical borings. Ten shallow borings were installed along a former drainage ditch that connected the C-404 Landfill and the NSDD. The field crew collected samples from these borings at the surface and from 1 to 5 ft, 5 to 10 ft, and 10 to 15 ft. Three deep borings were installed within SWMU 7. With the exception of the surface soil sample in boring 007-011, the field crew collected soil samples in these borings from depths of 0 to 1 ft, 3 to 5 ft, 8 to 10 ft, 13 to 15 ft, 28 to 30 ft, 43 to 45 ft, and 58 to 60 ft. (The 0-1 ft depth interval in boring 007-011 consisted of gravel road base which was not amenable to laboratory analysis.)

Soil samples collected from the three vertical borings of SWMU 7 generally were from the following depths: 0 to 1 ft, 3 to 5 ft, 8 to 10 ft, 13 to 15 ft, 28 to 30 ft, 43 to 45 ft, and 58 to 60 ft bgs (a total of seven soils samples per boring).

The field crew sampled the soil borings in accordance with U.S. Department of Energy (DOE) Prime Contractor-approved procedures, consistent with *Environmental Investigation Standard Operating Procedures and Quality Assurance Manual*, EPA Region 4, November 2001. As soon as the drill crew recovered the acetate liner containing the soil sample, the soil core was placed in the sample preparation area. A health and safety officer and radiation control officer scanned the acetate sleeve and the ends of the soil core for volatile organic compounds and radiation before releasing the core to the sample crew. Once the soil core in acetate sleeve was cleared, the sample crew opened the acetate sleeve with a utility knife and, once again, a health and safety officer and radiation control officer scanned the sample for contamination. The field scans of the acetate liner and soil core rarely identified contamination. When contamination was found, the health and safety officer and radiation control officer directed the field crew in any additional personal protective equipment (PPE) requirements and appropriate handling precautions.

Immediately upon approval from the health and safety officer and radiation control officer for the field crew to sample the soil core, the field crew collected the samples for volatile organic compound (VOC) analysis by filling two 2 ounce, wide-mouth, sample bottles with soil, ensuring that no air space was present, and securely sealing the filled bottles. At the same time, the project geologist examined soil core samples for lithologic description. After the collection of the VOC samples and the description of the lithology were complete, the remaining soil was placed in a clean bowl and mixed thoroughly. Samplers placed the resulting soil mixture in the appropriate sample jars for analysis.

A.2.2 GROUNDWATER SAMPLING

Groundwater samples were collected from multiple discrete depths within the UCRS and RGA using temporary borings at various locations. The RI field crew collected water samples in the UCRS where the temporary soil borings intersected water-producing zones. Water sampling in the RGA began at the top of the RGA (approximately 60 ft bgs) and continued at 10 ft intervals to the base of the RGA (approximately 100 ft bgs). This strategy resulted in a total of up to six water samples collected from the borings, depending on the presence of water-bearing zones in the UCRS and the thickness of the RGA at a boring's location. The drilling and sampling process allowed collection of discrete-depth water samples with minimum vertical cross-contamination.

A.3. SURVEYING

As the field crew performed the BGOU RI sampling, they marked the boring locations using flagging and wooden stakes. Entries in project logbooks and on field maps further documented the sample locations. Brass markers were incorporated as part of pad installation for any monitoring wells. The BGOU RI included surveying of sampling locations upon completion of the RI field activities. This survey work was performed by or under responsible charge of a Professional Land Surveyor registered in the Commonwealth of Kentucky, locating each sample point with its horizontal and vertical position using the PGDP coordinate system for horizontal control. Additionally, the survey identified the State Plane Coordinates for each sample location using the U.S. Coast and Geodetic Survey North American Datum of 1983. The datum for vertical control was the U.S. Coast and Geodetic Survey North American Vertical Datum of 1988. Accuracy for this work was that of a Class 1 First Order survey.

Project personnel entered the coordinates into the Paducah Project Environmental Measurements System (PEMS), and the coordinate locations were transferred with the station's ready-to-load file to the Paducah Oak Ridge Environmental Information System (PaducahOREIS).

The BGOU RI performed nonintrusive data collection (surface geophysics) for several of the SWMUs. Because these SWMUs consist of one or more burial pits of various depths that are filled with a heterogeneous collection of wastes and backfill soils, the BGOU represented a difficult target for geophysical characterization. Magnetic properties of the metal drums and buried metal scrap offered the best contrast with the native soils for imaging.

Geophysical surveys of SWMUs 7 and 30 and 145, using an EM-61 magnetometer, delineated the burial pits exact location and extent prior to sampling activities. The geophysical crew implemented the EM-61 survey along continuous lines spaced 4 to 5 ft apart, covering an area that extended approximately 10 ft beyond the currently identified burial pit edges.

A.4. SAMPLING PROCEDURES

During the sampling event, three types of samples—soil/sediment, groundwater, and field quality control (QC)—were collected and submitted for analysis. The sampling team varied between two and three members. Prior to initiation of field sampling, all sample team members completed general and project-specific training.

The sampling team collected, stored, and shipped the samples according to preestablished QC protocols and approved project procedures, which were consistent with EPA Region 4 sampling methodologies. Sample container, preservation, and holding time requirements were in accordance with the EPA Engineering Support Branch Standard Operating Procedures.

Samples collected for this project were assigned unique sample identifiers that were recorded on the sample labels and chain-of-custody forms. Sample team crew members directly affixed labels to the sample containers that included the following information:

- Station name,
- Sample identification number,
- Sample matrix,

- Sample type,
- Type or types of analysis required,
- Date and time of collection,
- Sampler name,
- Sample preservation (if required), and
- Destination laboratory.

The sampling team wore proper PPE during sampling. PPE consisted of, in part, company-issued clothing, safety glasses, and latex gloves. Sampling in radiological contamination areas sometimes necessitated modifications of the PPE requirements (as prescribed in work permits and directed by the project's Health Physics technician).

A.4.1 SOIL/SEDIMENT SAMPLES

The field crew sampled the soil borings in accordance with DOE Prime Contractor-approved procedures, consistent with *Environmental Investigation Standard Operating Procedures and Quality Assurance Manual*, EPA Region 4, November 2001, collecting soil for VOC analysis, followed by samples for lithologic description as soon as the acetate sleeve was cut open. After the description of the lithology was complete, the remaining soil was placed in a clean stainless steel bowl and mixed thoroughly using a stainless steel spoon to homogenize the soil taken from the sample interval before sampling for other analyses. Since round bowls were used for sample preparation, adequate mixing was achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

Sample team members filled the sample containers and ensured that each lid was securely tightened. The sample container then was placed in a cooler with an ice pack to maintain a preservation temperature of 4 degrees Celsius. Crew members recorded all pertinent information in the sampling logbook.

A.4.2 GROUNDWATER SAMPLES

Where the temporary soil borings intersected water-bearing units, the BGOU RI collected a groundwater sample from the UCRS and multiple discrete depths in the RGA. This RI (fieldwork performed in 2007) resulted in a total of 30 groundwater samples. The first step in collecting both UCRS and RGA groundwater sample was to purge the drill pipe and the disturbed soil in the vicinity of the open pipe. The field crew used bladder pumps to purge the boring and to collect the water samples.

Since sampling took place immediately after drilling ceased, there was no stagnant water to remove from the boring and, therefore, no predetermined minimum purge volume. The sample crew collected the water sample in both the UCRS and RGA only after the measure of select geochemical parameters [i.e., acidity as reported as the negative logarithm of the hydrogen-ion concentration (pH), specific conductivity, and temperature] stabilized within the purge water (signifying that the discharging water was representative of groundwater quality). The geochemical parameters were considered stabilized when the following criteria were met:

- At least three measurements taken three minutes apart have consistent readings for temperature, conductivity, and pH;

- Temperature measurements agree within 1°C;

- Conductivity measurements agree within 10%; and
- pH measurements agree within 0.5 units.

When the geochemical parameters stabilized, the sampling crew adjusted the flow rate of the pump for sampling. Groundwater samples were collected in accordance with SWMU-specific sampling plans (Work Plan for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant, Paducah, KY, DOE/OR/07-2179&D2/R1, August). (The sampling plans were specific as to the analytes for each SWMU and the horizons, UCRS and RGA, to be sampled.) All samples required multiple analyses. With the exception of a duplicate groundwater sample in boring 007-007, each groundwater interval that was sampled yielded sufficient volume to fill sample bottles for all analyses. The sampling crew collected the field parameters of groundwater temperature, pH, and specific conductance during each sampling event.

After sampling was completed, the sample crew removed the tubing and pump from the boring. The pump and tubing was decontaminated in accordance with DOE Prime Contractor-approved procedures prior to its next use.

A.4.3 FIELD QC SAMPLES

To ensure reliability of the analytical data and to meet the data quality objectives for the project, the following QC sample types were obtained during sample collection:

- Trip Blanks—Analysis of trip blanks documented the occurrence of cross contamination by VOCs during sample handling and shipping. The sample crew prepared trip blanks by filling VOC vials with deionized water before collection of the field samples. These trip blanks accompanied the filled sample bottles in ice chests in the field and during shipment and through interim storage in secured refrigerators until laboratory analysis. The trip blanks were analyzed for VOCs only.
- Field Blanks—Field blanks served as a check for potential airborne environmental contamination at the sample site. For the field blanks, the sample crew typically filled sample bottles with deionized water in the project's sample staging area and transported the bottles to the field sample station, where they were opened during the sampling process. Field blanks also were used as a reagent blank, as needed. The BGOU RI required field blanks at a frequency of one in 20 samples (5%) for each sample matrix.
- Field Duplicate Samples—Field duplicate samples determined the sampling variance. The sampling crew collected one duplicate for every ten samples (10%), per matrix. The field duplicate was analyzed for the same set of analytical parameters as the sample it duplicated.
- Equipment Blanks or Rinsate Samples—Equipment blanks provided a measure of the decontamination process effectiveness and were used as reagent blanks, as needed. These equipment blanks were required only when nondisposable equipment was being used. The equipment blanks consisted of deionized water passed through or over decontaminated sampling equipment and analyzed for the same parameters as the samples collected with the equipment. Equipment blanks were collected at a frequency of one for every 20 samples (5%).

In addition to the QC samples that were collected for laboratory analysis, temperature blanks accompanied the soil and groundwater samples in the transport coolers to document proper preservation of the samples. All transport coolers contained temperature blanks.

A.5. FIELD DECONTAMINATION

The field decontamination procedure, *Decontamination of Sampling Equipment and Devices* (PRS-ENM-2702), determined the decontamination activities for the stainless steel spoons and bowls used in soil sampling and the pumps and tubing used for groundwater sampling. This procedure, as applied during the RI, is summarized as follows:

- Equipment first was cleaned with tap water and nonphosphate detergent, using a brush if necessary, to remove particulate matter and surface films.
- The equipment then was rinsed thoroughly with tap water, followed by an analyte-free water rinse, and then wiped with an isopropyl alcohol towelett.
- The inside of the pump and tubing was cleaned by purging soap water, followed by tap water and analyte-free water, through the pump and tubing.
- Cleaned sample equipment was allowed to air dry.
- Cleaned equipment was handled only by personnel wearing clean latex gloves to prevent recontamination.
- If cleaned sampling equipment was not reused immediately, it was wrapped in aluminum foil.

Large Equipment Decontamination (BJC-ES-2701) governed the cleaning of other sampling equipment such as the drill rigs and associated tooling. This procedure provides for the use of high-pressure steam as the primary cleaning agent. Because of its remote location, the BGOU RI drill crew constructed a temporary decontamination pad at SWMU 145 that was used in cleaning the drill rig and tooling. The on-site decontamination facility, C-416, supported cleaning activities for the drill rig and associated tooling during sampling at all other (on-site) BGOU RI locations.

A.6. WASTE MANAGEMENT

The RI work plan included a project-specific waste management plan to provide instruction regarding waste storage and disposition. A variety of wastes were generated during the field investigation, including sample residuals and associated waste derived from sample collection. The waste generated was stored in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste storage areas within the CERCLA area of contamination (CERCLA AOC) during the characterization period and prior to disposal. Consistent with EPA Policy, the storage of waste within the CERCLA AOC does not trigger Resource Conservation and Recovery Act (RCRA) storage requirements (similarly, movement of waste within a CERCLA AOC does not trigger RCRA disposal requirements). As a best management practice, waste storage areas within the CERCLA AOC were managed in accordance with the substantive RCRA 90-Day storage standards; the 90-Day storage restriction and the requirement to label hazardous waste was not applied to the storage areas.

PPE was considered to fall into the same waste classification as the environmental media with which it came into contact. PPE, plastic, and paper were segregated by classification, collected in plastic bags, and labeled appropriately. These items then were handled as solid waste.

Decontamination water that included small quantities of soil sediments/mud was generated from cleaning the equipment. The water was collected and stored in a polyethylene tank and discharged to the Kentucky Pollutant Discharge Elimination System Outfall 001 after final characterization documented that the stored water met release criteria in the Kentucky Pollutant Discharge Elimination System permit for Outfall 001.

Solid waste was containerized in 55-gallon drums, or approved equivalent, that were lined with a thick plastic liner and placed in CERCLA waste storage areas. The amount of free liquid was minimized. Any substantial amount of free liquid is being decanted and placed in an approved container. Drummed soils and other solid wastes have been disposed of in the C-746-U Landfill.

All clean trash (i.e., trash that was not chemically or radiologically contaminated) was segregated according to established guidelines and then collected and disposed of. Examples of clean trash are office paper, aluminum cans, packaging materials, glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items.

Based on sample analyses, existing data, or process knowledge, the waste was classified into one of the following categories:

- RCRA-listed hazardous waste,
- RCRA-characteristic hazardous waste,
- Polychlorinated biphenyl (PCB) waste,
- Transuranic waste,
- Low-level waste,
- Mixed waste, or
- Nonhazardous waste.

Waste minimization requirements were implemented, as appropriate, and included those established by the 1984 Hazardous and Solid Waste Amendments of RCRA; DOE Orders 5400.1, 5400.3, 435.1; and DOE Prime Contractor's requirements. Requirements specified in the waste management plan regarding waste generation, waste tracking, waste reduction techniques, and the waste reduction program, in general, also were implemented.

To support DOE's commitment to waste reduction, an effort was made during field activities to minimize waste generation as much as possible, largely through ensuring that potentially contaminated wastes were localized and did not come into contact with any clean media (which could create more contaminated waste). Waste minimization also was accomplished through waste segregation, selection of PPE, waste handling (spill control), and the use of alternative treatment standards.

A.7. ENVIRONMENT, SAFETY, AND HEALTH

A project-specific environment, safety, and health (ES&H) plan was included in the approved work plan and was used to provide instruction regarding safety and health of workers, the public, and the environment. The ES&H Plan established the specific applicable standards and practices to be used during execution of the RI to protect the safety and health of workers, the public, and the environment. The document contained information about the sites, potential contaminants and hazards that may be encountered on-site, and hazards inherent in routine procedures. The list of contaminants was site-specific and based on previous investigations. The plan also outlined directly, or by reference, federal and state standards, pertinent consensus standards, and applicable contract requirements. The ES&H plan was implemented in accordance with 29 *CFR* § 1910.120, Hazardous Waste Operations and Emergency Response. Additional health and safety requirements were incorporated into the ES&H plan for the various field activities through preparation of project-specific activity hazard analyses.

The project team held daily safety and plan of the day meetings at the beginning of each shift. This approach ensured that the planned daily activities were reviewed prior to execution and the potential hazards were identified and discussed with the entire field team. These meetings are documented in the project work package and in the field logbooks.

A.8. FIELDWORK DOCUMENTATION

Field documentation was maintained throughout the BGOU RI in various types of documents and formats, including the field logbooks, sample labels, sample tags, chain-of-custody forms, and field data sheets. The following general guidelines for maintaining field documentation was implemented. Documentation requirements are listed below. Entries were written clearly and legibly using indelible ink.

- Corrections were made by striking through the error with a single line that did not obliterate the original entry. Corrections were dated and initialed.
- Dates and times were recorded using the format "mm/dd/yy" for the date and the military (i.e., 24-hour) clock for the time.
- Zeroes were recorded with a slash (/) to distinguish them from letter Os.
- Blank lines were prohibited. Information was recorded on each line or a blank line was lined out, initialed, and dated.
- No documents were altered, destroyed, or discarded, even if they were illegible or contained inaccuracies that required correction.
- Information blocks on field data forms were completed or a line was drawn through the unused section, and the area was dated and initialed.
- Unused logbook pages were marked with a diagonal line drawn from corner to corner and a signature and date was placed on the line.
- Photocopies of logbooks, field data sheets, and chain-of-custody forms were made and stored in the project file.
- The following information was recorded on the outside of the front cover of each logbook using indelible ink:

    — Project name,
    — Unique logbook name and number,
    — Client and contract number,
    — Task and document control number,

— Activity or site name; and
— Start and completion date of the logbook.

Quality assurance personnel conducted periodic reviews of the data forms and logbooks (including data forms placed in the logbooks) prepared by field personnel to verify the following:

- Accuracy of entries;
- Legibility and clarity of entries;
- Completeness, to ensure that at least the minimum required information was recorded;
- Consistency of information recorded; and
- Signature and date of entries by the designated team member.

A.9. DEVIATION FROM PLANNED SAMPLE LOCATIONS

A.9.1 INTRODUCTION

A Geographic Information System provided sample coordinates from maps of the intended sample locations in the BGOU RI Work Plan. Some of these locations were later adjusted to address additional data regarding the placement of waste. Once these locations were agreed upon, conventional survey methods located the sample coordinates at each SWMU. Table A.3 lists originally planned sample location coordinates and the final sample location coordinates.

A.9.2 DISCUSSION OF DEVIATION FROM COORDINATE LOCATIONS

During the survey and location of the sample boreholes, there were some boreholes that could not be located at the planned coordinates due to steep topography and surface structures, the presence of buried shock sensitive (explosive) waste, and High Radiation Areas. When obstructions or conditions prevented location of a sample at the planned location, the samples locations were offset close to the intended site. This section presents a summary of the samples that were relocated and provides the distance that the samples were offset from the intended coordinates.

Table A.3. BGOU RI Sample Locations

Sample Location	Planned Easting	Planned Northing	Final Easting	Final Northing	Displacement (ft)
			SWMU 2		
002-001	-6312.96	-924.80	-6275.65	-1030.25	111.9
002-002	-6228.85	-824.49	-6285.73	-813.89	57.9
			SWMU 3		
003-001	-6071.13	-826.20	-6072.45	-814.33	11.9
003-002	-5901.41	-824.49	-5904.5	-808.99	15.8
003-003	-5751.48	-823.53	-5755.25	-802.32	21.5
003-004	-5654.54	-908.49	-5634.54	-910.43	20.1
003-005	-5361.38	-899.92	-5372.98	-899.56	11.6
003-006	-5292.80	-725.05	-5296.92	-723.92	4.3
003-007	-5212.22	-533.04	-5210.8	-533.49	1.5
003-008	-5133.36	-363.32	-5132.26	-363.78	1.2
003-009	-4968.78	-363.32	-4968.32	-363.17	0.5
003-010	-4804.20	-361.60	-4804.22	-361.38	0.2
			SWMU 5		
005-101	-6676.72	200.58	-6615.28	194.07	61.8
005-102	-6545.21	199.28	-6352.97	86.61	222.8
005-103	-6345.99	19.59	-6350.41	3.87	16.3
			SWMU 6		
006-101	-6253.46	121.60	-6224.07	156.46	45.6
006-102	-6288.55	97.72	-6275.76	95.12	13.1
006-103	-6234.47	75.00	-6217.78	68.71	17.8
006-104	-6180.98	104.34	-6178.21	93.91	10.8
			SWMU 7		
007-001	-6270.86	913.50	-6271.04	913	0.5
007-002	-6342.41	807.58	-6328.25	859.9	54.2
007-003	-6557.62	784.20	-6566.19	834.02	50.6
(offset)			-6561.94	834.35	50.3
007-004	-6682.69	788.71	-6711.86	794.3	29.7
007-005	-6745.51	759.69	-6713.91	838.26	84.7
007-006	-6751.14	884.76	-6786.05	876.72	35.8
007-007	-6588.89	883.64	-6602.83	849.08	37.3
007-008	-6061.29	924.76	-6064.71	934.28	10.1
007-009	-6830.86	990.12	-6785.37	964.98	52.0
007-010	-6590.86	988.99	-6543.57	957.99	56.5
007-011	-6260.72	810.96	-6282.4	869.1	62.1
			SWMU 30		
030-001	-7114.24	994.91	-7187.03	976.62	75.1
030-002	-6954.24	922.79	-7035.76	883.46	90.5
030-003	-6926.07	883.36	-6939.76	881.58	13.8
030-004	-6814.52	793.22	-6800.23	781.03	18.8
			SWMU 145		
145-101	-1832.30	4329.28	-2156.26	4493.87	363.4
145-102	-1821.86	3790.02	-1895.42	4042.42	262.9
145-103	-2413.30	3748.28	-2465.84	3406.88	345.4
145-104	-2618.56	3716.96	-2333.16	3381.42	440.5
145-105	-2917.76	4367.55	-2765.27	3183.99	1193.3
145-106	-2343.72	4565.85	-3088.28	3545.83	1262.9
145-107	-2044.52	4510.19	-2809.44	4138.49	850.4

APPENDIX B

LITHOLOGIC LOGS AND WELL CONSTRUCTION DIAGRAMS, GROUNDWATER STABILIZATION LOGS, AND WELL DEVELOPMENT LOGS

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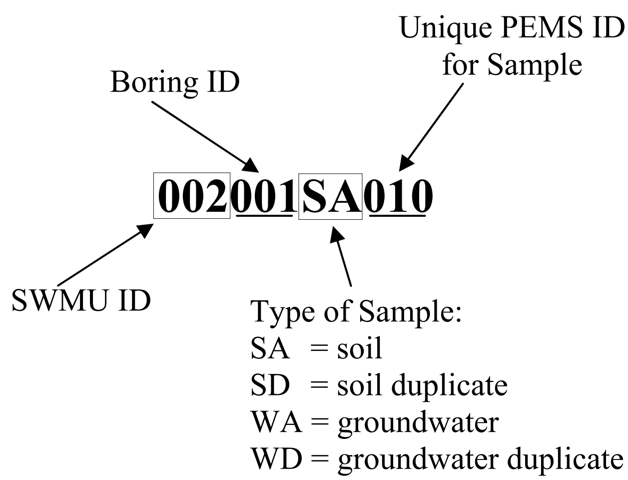
SAMPLE ID LEGEND



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SWMU 2

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LITHOLOGIC LOG	BORING/WELL ID 002-001-ASB	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 002
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 14:30/4-4-07	End Time/Date: 11:15/4-5-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6275.65 N -1030.259	Direction (plant grid): North

Depth (ft)	SAMPLE INTERVAL	SAMPLE ID	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	002001SA010	CLAY, light brown, 7.5YR 6/4, firm, moist, with orange streaks	~~~	14:44
	11-14	002001SA015	CLAY, gray, 7.5YR 6/1, firm, moist, mottled, with gray streaks	~~~	14:52
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	002001SA030	CLAY, brown, 7.5YR 4/2, soft, moist, mottled, with black streaks: 5% chert fragments ⅛" across	~~~	16:30 Additional sample was required. Collected a second sample liner.
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	002001SA045	SAND, medium to coarse grained, poorly sorted with angular to rounded chert approximately ⅛" to ½" across	- - -	10:36
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	002001SA060	SAND, fine to coarse grained, poorly sorted	- - -	11:15

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY ~~~
SAND - - -

LITHOLOGIC LOG	***BORING/WELL ID 002-002-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 002
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 14:38/4-3-07	End Time/Date: 10:40/4-4-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6285.732 N -813.893	Direction (plant grid): South

Depth (ft)	SAMPLE INTERVAL	SAMPLE ID	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	002002SA010	CLAY, light brown, 7.5YR 6/4, firm, moist, with gray and orange streaks	~~~~~~~~~~	14:44
10	11-14	002002SA015	CLAY, brown, 7.5YR 5/4, firm, moist, mottled, with gray and orange streaks	~~~~~~~~~~	14:49
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	002002SA030 002002SD030	CLAY, strong brown, 7.5YR 5/6, firm, moist, with gray streaks: 5% sand	~~~~~~~~~~	15:19
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	002002SA045	CLAY, strong brown, 7.5YR 5/8, hard, dry, mottled with black streaks	~~~~~~~~~~	9:00 / 4/4/07
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	002002SA060	SAND, medium grained, dark red: 10% clay	- - - - - - - - - -	10:40

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND:	
CLAY	~~~~~~~~~~
SAND	- - - - - - - - - -

SWMU 3

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LITHOLOGIC LOG	*BORING/WELL ID 003-001-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 9:30/4-9-07	End Time/Date: 15:30/4-9-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6072.453 N -814.337	Direction (plant grid): Southeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	003001SA010	CLAY, brown, 7.5YR 6/4, firm, moist, with gray and black streaks	~~~~~~~~~~	9:40
10	11-14	003001SA015	CLAY, brown, 7.5YR 5/2, firm, moist, mottled, with gray and orange streaks	~~~~~~~~~~	9:47
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
	28-30	003001SA030	CLAY, light gray, 7.5YR 7/1, soft, moist, with orange streaks	~~~~~~~~~~	13:02
30	30-32		CLAY, strong brown, 7.5YR 5/8, firm, dry, with gray streaks: 5% sand		
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
	42-46	003001SA045	CLAY, strong brown, 7.5YR 5/6, firm, moist, with gray and orange streaks	~~~~~~~~~~	14:15
45, 50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	003001SA060	CLAY, brown, 7.5YR 5/4, firm moist, mottled, with black streaks	~~~~~~~~~~	15:30

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 85 feet.	SAND	- - - - - - - -

LITHOLOGIC LOG	*BORING/WELL ID 003-002-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 10:30/4-10-07	End Time/Date: 16:22/4-10-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5904.505 N -808.997	Direction (plant grid): Southwest:

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	003002SA010	CLAY, gray, 7.5YR 5/1, hard, dry, mottled, roots, with orange streaks	CLAY	10:37
10	11-14	003002SA015	CLAY, brown, 7.5YR 5/4, soft, moist, with gray and orange streaks	CLAY	10:42
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	003002SA030	CLAY, gray, 7.5YR 5/1, firm, moist: sand (10%)	CLAY	14:37
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	003002SA045	CLAY, strong brown, 7.5YR 4/6, firm, moist: sand (5%) gray	CLAY	15:47
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	003002SA060	CLAY, white, 7.5YR 8/1, hard, moist, with orange streaks: sand (5%)	CLAY	16:22

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY (~~~~), SAND (-----)

LITHOLOGIC LOG	*BORING/WELL ID* ***003-003-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 13:29/4-12-07	End Time/Date: 10:22/4-16-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5755.259 N -802.323	Direction (plant grid):

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	003003SA010	CLAY, brown, 7.5YR 5/4, firm, moist, with gray and orange streaks		13:38
15	11-14	003003SA015	CLAY, light gray, 7.5YR 7/1, firm, moist, with orange streaks		13:42
20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	003003SA030 003003WA060	CLAY, white, 7.5YR 8/1, soft, dry, with brown streaks		16:52
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	003003SA045	CLAY, gray, 7.5YR 6/1, very soft, wet, with orange streaks: sand (20%)		9:05 / 4-13-07 Duplicate
			CLAY, gray, 7.5YR 6/1, very soft, wet, with orange streaks: sand (20%)		9:20
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	003003SD060	CLAY, brown, 7.5YR 5/4, hard, moist, with orange, gray and black streaks		10:12 / Duplicate
		003003SA060			10:22

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	
	SAND	

LITHOLOGIC LOG	***BORING/WELL ID 003-004-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 15:10/4-16-07	End Time/Date: 13:41/4-17-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5634.547 N -910.438	Direction (plant grid): West

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	003004SA010	CLAY, gray, 7.5YR 6/1, firm, moist, with brown and orange streaks	~~~~~~~~~	15:25
	11-14	003004SA015	CLAY, strong brown, 7.5YR 5/6, firm, moist, with gray and orange streaks	~~~~~~~~~	15:30
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	003004SA030 003004WA060	SAND, reddish brown, fine grained, well sorted, with gray streaks	~~~~~~~~~	16:07
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	003004SA045	CLAY, brown, 7.5YR 5/4, firm, moist, with gray streaks	~~~~~~~~~	12:55 / 4-17-07
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	003004SA060	CLAY, brown, 7.5YR 4/4, hard, moist, with gray streaks	~~~~~~~~~	13:41

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~
Total Linear Depth is 85 feet.	SAND	- - - - - - -

LITHOLOGIC LOG

BORING/WELL ID 003-005-VSB

Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 12:54 / 2-7-07	End Time/Date: 13:54 / 2-7-07
Borehole Diameter: 2.25"	Drilling Method: Direct Push
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 15 feet	Angle: Vertical
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5372.989 N -899.566	Direction (plant grid): N/A

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0	0-1	003005SA001	CLAY, gray, 7.5YR 6/1, soft, moist, mottled with orange streaks	~~~~~~~~~	13:22
	1-5	003005SA005	CLAY, light gray, 7.5YR 7/1, soft, moist with orange streaks	~~~~~~~~~	13:30
5	5-10	003005SA010 003005SD010	CLAY, light brown, 7.5YR 6/3, firm, moist with orange and gray streaks	~~~~~~~~~	13:36 Duplicate sample was collected.
10	10-15	003005SA015	CLAY, light gray, 7.5YR 7/1, firm, moist with orange streaks	~~~~~~~~~	13:54

Total Depth is 15 feet.	LEGEND: CLAY	~~~~~~~~~
	SAND	-------------

LITHOLOGIC LOG	*BORING/WELL ID 003-006-VSB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 10:05 / 2-7-07	End Time/Date: 11:10 / 2-7-07
Borehole Diameter: 2.25"	Drilling Method: Direct Push
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 15 feet	Angle: Vertical
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5296.92 N -723.924	Direction (plant grid): N/A

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-1	003006SA001	CLAY, brown, 7.5YR 5/3, firm, moist, mottled with gray and orange streaks: Chert (40%)		10:36
	1-5	003006SA005	CLAY, strong brown, 7.5YR 5/6 soft, moist: Sand (30%) and Chert (30%)		10:48
5	5-10	003006SA010	CLAY, brown, 7.5YR 5/4, soft, moist with few orange and gray streaks		11:04
10	10-15	003006SA015	CLAY, light brown, 7.5YR 6/4, soft, moist with orange streaks		11:10

Total Depth is 15 feet.	LEGEND: CLAY	
	SAND	

LITHOLOGIC LOG	***BORING/WELL ID** **003-007-VSB***	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 8:51 / 2-7-07	End Time/Date: 9:20 / 2-7-07	
Borehole Diameter: 2.25”	Drilling Method: Direct Push	
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 15 feet	Angle: Vertical	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -5210.803 N -533.498	Direction (plant grid): N/A	

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0	0-1	003007SA001	CLAY, brown, 7.5YR 5/3, hard, moist, mottled with gray and orange streaks		8:51
	1-5	003007SA005	CLAY, brown, 7.5YR 5/4, firm, moist, with orange streaks		9:00
5	5-10	003007SA010	CLAY, light brown, 7.5YR 6/3, firm, moist with few black streaks		9:09
10	10-15	003007SA015	CLAY, light brown, 7.5YR 6/4, firm, moist with orange streaks		9:28
Total Depth is 15 feet.			LEGEND: CLAY		
			SAND		

LITHOLOGIC LOG	***BORING/WELL ID 003-008-VSB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 13:24 / 2-6-07	End Time/Date: 13:47 / 2-6-07
Borehole Diameter: 2.25"	Drilling Method: Direct Push
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 15 feet	Angle: Vertical
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -5132.269 N -363.783	Direction (plant grid): N/A

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0	0-1	003008SA001	CLAY, light brown, 7.5YR 6/3, firm, moist, mottled, roots with gray and orange streaks	~~~~~~~~~~	13:24
	1-5	003008SA005	CLAY, reddish yellow, 7.5YR 6/6, soft, moist, with black, white, and orange streaks	~~~~~~~~~~	13:30
5	5-10	003008SA010	CLAY, reddish yellow, 7.5YR 6/8, firm, moist with gray, white, and black streaks	~~~~~~~~~~	13:39
10	10-15	003008SA015	CLAY, light brown, 7.5YR 6/4, soft, moist with gray and orange streaks	~~~~~~~~~~	13:47

Total Depth is 15 feet.	LEGEND: CLAY	~~~~~~~~~~
	SAND	-------------

LITHOLOGIC LOG	*BORING/WELL ID 003-009-VSB*	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 11:48 / 2-6-07	End Time/Date: 12:27 / 2-6-07	
Borehole Diameter: 2.25”	Drilling Method: Direct Push	
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 15 feet	Angle: Vertical	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -4938.326 N -363.171	Direction (plant grid): N/A	

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0	0-1	003009SA001	CLAY, brown, 7.5YR 5/3, firm, moist, mottled, roots with a few gray and orange streaks	~~~~	11:48
	1-5	003009SA005	CLAY, brown, 7.5YR 4/3, firm, moist, with a few gray and orange streaks	~~~~	12:07
5	5-10	003009SA010	CLAY, light brown, 7.5YR 6/3, firm, moist, mottled with gray and orange streaks	~~~~	12:17
10	10-15	003009SA015	CLAY, brown, 7.5YR 5/4, soft, moist with gray streaks	~~~~	12:27

Total Depth is 15 feet.	LEGEND: CLAY	~~~~
	SAND	----

LITHOLOGIC LOG	*BORING/WELL ID 003-010-VSB*	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 003	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 9:26 / 2-6-07	End Time/Date: 10:05 / 2-6-07	
Borehole Diameter: 2.25"	Drilling Method: Direct Push	
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 15 feet	Angle: Vertical	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -4804.221 N -361.385	Direction (plant grid): N/D	

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-1	003010SA001	CLAY, brown, 7.5YR 5/3, hard, moist with a few gray and black streaks	~~~~~~~~~	9:26
	1-5	003010SA005	CLAY, brown, 7.5YR 5/4, soft, moist, with gray and orange streaks	~~~~~~~~~	9:45
5	5-10	003010SA010	CLAY, brown, 7.5YR 5/4, soft, moist, mottled with gray, black and orange streaks	~~~~~~~~~	9:55
10	10-15	003010SA015	CLAY, brown, 7.5YR 5/3, very soft, moist with orange streaks	~~~~~~~~~	10:05

Total Depth is 15 feet.	LEGEND: CLAY	~~~~~~~~~
	SAND	-------------

SWMU 5

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LITHOLOGIC LOG	*BORING/WELL ID 005-101-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 005
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik
Start Time/Date: 11:42/5-17-07	End Time/Date: 8:45/5-18-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 40°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6615.283 N 194.077	Direction (plant grid): South

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	005101SA010	CLAY, light brown, 7.5YR 6/4, soft, moist with gray and orange streaks	~~~~~~~~~~	12:01
10	11-14	005101SA015	CLAY, light brown, 7.5YR 6/4, soft, moist, with gray and orange streaks	~~~~~~~~~~	12:10
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	005101SA030	CLAY, brown, 7.5YR 5/4, firm, moist with gray, black and orange streaks	~~~~~~~~~~	13:39
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	005101SA45 005101WA060	SAND, tan, medium grained, well sorted	------------	15:00
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	005101SA060	SAND, reddish brown, fine grained, well sorted	------------	8:45 / 5-18-07

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY ~~~~~~~~~~
SAND ------------

LITHOLOGIC LOG	*BORING/WELL ID 005-102-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 005
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:50/4-21-07	End Time/Date: 14:50/4-21-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6352.979 N 86.614	Direction (plant grid): West

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	005102SA010	CLAY, brown, 7.5YR 5/4, soft, moist, with black organic layers and gray streaks		9:05
	11-14	005102SA015	CLAY, light gray, 7.5YR 7/1, soft, moist, with orange streaks		9:12
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	005102SA030	CLAY, strong brown, 7.5YR 5/4, firm, moist with gray streaks		10:04
35	32-40	N/A	Core not retrieved	N/A	N/A
40	40-41	005102WA060	Core not retrieved	N/A	N/A
	41-42	N/A	Core not retrieved	N/A	N/A
45	42-46	005102SA045	SAND, light gray, fine grained: Clay (30%), black layers		12:06
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	005102SA060	CLAY, brown, 7.5YR 5/4, soft, moist: sand (25%)		14:50

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY
SAND

LITHOLOGIC LOG	*BORING/WELL ID 005-103-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 005
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 15:18/4-18-07	End Time/Date: 4-19-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6350.415 N 3.873	Direction (plant grid): West

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0–5	0-7	N/A	Core not retrieved	N/A	N/A
5–10	7-11	005103SA010	CLAY, brown, 7.5YR 5/4, soft, moist, with gray and orange streaks	CLAY	15:30
10	11-14	005103SA015	CLAY, brown, 7.5YR 5/4, firm, dry, with gray streaks	CLAY	15:32
15–25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	005103SA030	Sand, fine grained with gray streaks: Clay (35%)	SAND	16:33
35–40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	005103SA045	CLAY, brown, 7.5YR 5/4, firm, dry, with gray streaks	CLAY	4-19-07
50–55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	005103SA060 005103SD060	CLAY, brown, 7.5YR 5/4, firm, dry, with gray streaks	CLAY	Duplicate
			SAND, medium grained and wet	SAND	

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY ~~~~ ; SAND - - - -

LITHOLOGIC LOG	***BORING/WELL ID*** ***005-103B-ASB***	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 005	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 11:49/4-18-07	End Time/Date: 13:35 / 4-18-07	
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers	
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 60 feet	Angle: 45º	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E N	Direction (plant grid): Southwest	

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	005-103B-8-10 ft	CLAY, reddish yellow, 7.5YR 6/6, firm, moist, with gray and black streaks	CLAY	12:00 Sample not submitted to lab*
10	11-14	005-103B-13-15 ft	CLAY, brown, 7.5YR 5/4, hard, moist, with gray and black streaks	CLAY	12:04 Sample not submitted to lab*
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
	28-32	005-103B-28-30 ft	CLAY, strong brown, 7.5YR 5/6, firm, moist, with gray and orange streaks: Sand (10%)	CLAY	13:35

Total Vertical Depth is 30 feet.	LEGEND: CLAY	~~~~~~
Total Linear Depth is 45 feet.	SAND	- - - - - -

* Angled boring 005-103B was drilled in the wrong direction. Samples 005-103B-8-10 ft and 005-103B-13-15 ft were discarded because the samples were not collected from below buried waste in SWMU 5.

SWMU 6

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LITHOLOGIC LOG	*BORING/WELL ID* ***006-101-ASB***	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 006	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 15:45/2-26-07	End Time/Date: 9:46/2-28-07	
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers	
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 60 feet	Angle: 45°	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -6224.07 N 156.469	Direction (plant grid): South	

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0–5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	006101SA010	CLAY, brown, 7.5YR 5/3, firm, moist, with gray and orange streaks	CLAY	16:00
15	11-14	006101SA015	CLAY, light brown, 7.5YR 6/4, firm, moist, mottled, with orange streaks	CLAY	16:12
20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	006101SA030 006101SD030	CLAY, reddish yellow, 7.5YR 6/6, firm, moist, mottled, with gray and orange streaks	CLAY	8:30 / 2-27-07
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	006101SA045 006101WA060	CLAY, brown, 7.5YR 4/4, hard, moist, with gray streaks	CLAY	9:44
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
60	57-60	006101SA060	SAND, fine to medium grained, poorly sorted	SAND	9:46 / 2-28-07

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~
	SAND	------

LITHOLOGIC LOG	*BORING/WELL ID* ***006-102-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 006
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 9:25/2-22-07	End Time/Date: 2-26-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6275.763 N 95.128	Direction (plant grid): East

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	006102SA010	CLAY, brown, 7.5YR 4/4, firm, moist, mottled, with gray and orange streaks	~~~~~~~~~~	9:34
	11-14	006102SA015 006102SD015	CLAY, brown, 7.5YR 5/4, hard, moist, mottled, with gray and orange streaks	~~~~~~~~~~	9:39
15	14-18	N/A	Core not retrieved	N/A	N/A
	18-19	006102WA060	Core not retrieved	N/A	N/A
20, 25	19-28	N/A	Core not retrieved	N/A	N/A
30	28-32	006102SA030	CLAY, strong brown, 7.5YR 5/6, hard, moist, mottled, with gray and orange streaks	~~~~~~~~~~	11:00
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
	42-46	006102SA045	SAND, fine to coarse grained, poorly sorted	------------	14:15 1" of Recovery
45, 50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	006102SA060	SAND, fine to medium grained, poorly sorted	------------	2-26-07

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	------------

LITHOLOGIC LOG	*BORING/WELL ID 006-103-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 006
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 11:40/2-8-07	End Time/Date: 10:11/2-14-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6217.781 N 68.719	Direction (plant grid): North

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
	7-11	006103SA010	CLAY, light brown, 7.5YR 6/4, firm, moist, with gray, black, and orange streaks	~~~~~~~~~~	12:02
10	11-14	006103SA015	CLAY, light brown, 7.5YR 6/4, firm, moist, with gray, black, and orange streaks	~~~~~~~~~~	12:08
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	006103SA030	CLAY, brown, 7.5YR 5/4, firm, moist, with gray streaks: Sand (5%)	~~~~~~~~~~	13:37
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
	42-46	006103SA045	CLAY, strong brown, 7.5YR 5/6, hard, moist, with gray and orange streaks	~~~~~~~~~~	14:04 / 2-9-07
45	46-50	N/A	Core not retrieved	N/A	N/A
50	50-51	006103WA060	Core not retrieved	N/A	N/A
55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	006103SA060	CLAY, strong brown, 7.5YR 5/6, firm, moist: sand (10%), white, fine grained	------------	10:11 / 2-14-07

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 85 feet.	SAND	------------

LITHOLOGIC LOG	***BORING/WELL ID*** ***006-104-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 006
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 9:50/2-19-07	End Time/Date: 14:05/2-21-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner / Todd Mills	Protective Level: Modified Level D
Coordinates: E -6178.211 N 93.911	Direction (plant grid): Northeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	006104SA010	CLAY, brown, 7.5YR 5/4, firm, moist, with gray streaks	~~~~~~~~~~	10:11
	11-14	006104SA015	CLAY, brown, 7.5YR 5/3, hard, moist, with gray streaks	~~~~~~~~~~	
15 20 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	006104SA030	CLAY, strong brown, 7.5YR 4/6, hard, dry, with sand streaks	~~~~~~~~~~	13:41
35 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	006104SA045 006104WA060	CLAY, pinkish gray, 7.5YR 7/2, very stiff, moist, from 43 to 45 feet	~~~~~~~~~~	
50 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	N/A	Core not retrieved	N/A	13:09 Attempt failed 57-60’ sample
60	60-63	N/A	Core not retrieved	N/A	13:50 Attempt failed 64-66’ sample
	63-65	006104SA060	SAND, fine grained, reddish brown, well sorted, black streaks	-------------	14:05

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	-------------

SWMU 7

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LITHOLOGIC LOG	***BORING/WELL ID 007-001-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik
Start Time/Date: 09:54/3-28-07	End Time/Date: 09:41/3-29-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6271.047 N 913.003	Direction (plant grid): Southeast

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
	7-11	007001SD010	CLAY, strong brown, 7.5YR 5/8, hard, moist, mottled, with gray and orange streaks		10:14 Duplicate
10		007001SA010	CLAY, brown, 7.5YR 5/3, firm, moist, mottled, with black and orange streaks		10:17
	11-14	007001SA015	CLAY, brown, 7.5YR 5/3, firm, moist, mottled, with black and orange streaks		10:24
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007001SA030	CLAY, gray, 7.5YR 6/1, firm, moist, with orange streaks: Sand (5%)		12:45
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	007001SA045 007001WA060	SAND, gray, medium grained, poorly sorted: Chert (10%) angular to subangular, ranging from ¼ to ½ inch across		13:44
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	007001SA060	SAND, gray, medium grained, poorly sorted: Chert (4 inch seam), angular, ½ to ¾ inch across		9:22 / 3-29-07 Min. sample recovered.
60	60-62.5		SAND, gray, medium grained, poorly sorted: Chert (4 inch seam), angular, ½ to ¾ inch across		9:41: Additional sample required.
	62.5-65	N/A	Core not retrieved	N/A	N/A

Total Vertical Depth is 62.5 feet. **Total Linear Depth is 87.5 feet.**	LEGEND: CLAY	
	SAND	

LITHOLOGIC LOG	***BORING/WELL ID** 007-002-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik
Start Time/Date: 12:04/3-27-07	End Time/Date: 16:42/3-27-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6328.252 N 859.906	Direction (plant grid): Southeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	007002SA010	CLAY, gray, 7.5YR 6/1, firm, moist, mottled, with gray streaks	~~~~~~~~~~	12:25
	11-14	007002SA015	CLAY, light brown, 7.5YR 6/4, firm, moist, mottled, with gray and orange streaks	~~~~~~~~~~	12:39
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007002SA030	CLAY, strong brown, 7.5YR 5/6, firm, moist, mottled with gray and orange streaks: Sand (5%)	~~~~~~~~~~	14:38
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	007002SA045	SAND, gray, medium grained, well sorted, moist	-------------	15:38
	46-50	N/A	Core not retrieved	N/A	N/A
50	50-51	007002WA060			
55	51-57	N/A			
	57-60	007002SA060	CLAY, light brown, 7.5YR 6/3, soft, moist with gray and orange streaks: Sand (15%) fine grained	~~~~~~~~~~	16:42

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 85 feet.	SAND	-------------

LITHOLOGIC LOG	***BORING/WELL ID 007-003-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik
Start Time/Date: 8:35/3-19-07	End Time/Date: 11:08/3-21-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E N	Direction (plant grid): Southeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	007003SA010	CLAY, brown, 7.5YR 5/2, soft, moist, with few orange streaks	~~~	8:40
	11-14	007003SA015	CLAY, pinkish gray, 7.5YR 6/2, firm, moist, mottled with gray and orange streaks	~~~	8:47
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007003SA030	CLAY, strong brown, 7.5YR 5/6, soft, moist, mottled with gray and orange streaks	~~~	9:28
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	007003SA045 007003WA060	SAND, fine to medium grained, poorly sorted, water with angular chert up to ¼ across	---	13:48 / 3-20-07
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	007003SA060	CLAY, reddish yellow, 7.5YR 6/8, hard, moist with gray streaks	~~~	11:08 / 3-21-07

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~
	SAND	---

LITHOLOGIC LOG	***BORING/WELL ID 007-004-ASB***	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik	
Start Time/Date: 8:56/3-26-07	End Time/Date: 15:30/3-26-07	
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers	
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 60 feet	Angle: 45°	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -6711.864 N 794.304	Direction (plant grid): East	

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	007004SA010	CLAY, gray, 7.5YR 6/1, firm, moist, with few orange streaks	~~~~~~~~~~	9:12
	11-14	007004SA015	CLAY, gray, 7.5YR 5/1, soft, moist with orange streaks	~~~~~~~~~~	9:18 40% recovery
15	14-18		CLAY, gray, 7.5YR 5/1, soft, moist with orange streaks	~~~~~~~~~~	Additional sample
20 25	18-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007004SA030	SAND, medium to coarse grained, poorly sorted: Chert (25%), angular, up to ½ inch across	------------	12:12
35 40	32-42	N/A	Core not retrieved	N/A	N/A
	42-46	007004SA045	CLAY, light brown, 7.5YR6/3, soft, moist, with gray streaks	------------	13:30
45 50 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	007004SA060	CLAY, brown, 7.5YR 5/3, hard, moist, mottled with black streaks	~~~~~~~~~~	15:30

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	------------

LITHOLOGIC LOG	***BORING/WELL ID 007-005-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 15:24/3-12-07	End Time/Date: 3-13-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6713.919 N 838.269	Direction (plant grid): Southwest

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	007005SA010	CLAY, light gray, 7.5YR 7/1, firm, moist, mottled with orange streaks		15:37
	11-14	007005SA015	GRAVEL		Gravel collapsed the sample liner – no recovery
15	14-18		CLAY, light brown, 7.5YR 6/4, firm, moist, mottled with gray streaks		16:20
20, 25	18-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007005SA030	CLAY, gray, 7.5YR 6/1, soft, moist, mottled with orange streaks		9:04 / 3-13-07
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	007005SA045 007005WA060	SAND, fine to coarse grained, poorly sorted, wet, iron stained: Chert (5%), subangular		9:54
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	007005SA060	CLAY, strong brown, 7.5YR 5/6, firm, moist, mottled with gray streaks with sand seams		

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND : GRAVEL ; CLAY ; SAND

LITHOLOGIC LOG	***BORING/WELL ID** 007-006-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Ryan Kulik
Start Time/Date: 15:42/3-21-07	End Time/Date: 15:15 / 3-23-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6786.053 N 876.721	Direction (plant grid): Northeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	007006SA010	CLAY, brown, 7.5YR 5/4, hard, moist with gray and orange streaks	~~~~~~~~~~	16:21
	11-14	007006SA015	CLAY, light brown, 7.5YR 6/4, firm, moist with gray streaks	~~~~~~~~~~	16:45
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	007006SA030	CLAY, reddish yellow, 7.5YR 6/6, hard, moist with gray and orange streaks: Sand (5%)	~~~~~~~~~~	9:22 / 3-22-07
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	N/A	N/A	N/A	No recovery
50	46-51	007006SA045	Clay, brown, 7.5YR 5/3, hard, mist, mottled, with orange and gray streaks	~~~~~~~~~~	13:00 / 3-23-07
55	51-57	N/A	Core not retrieved	N/A	N/A
	57-60	007006SA060	Clay, brown, 7.5YR 5/3, hard, mist, mottled, with orange and gray streaks	~~~~~~~~~~	15:15

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	-------------

LITHOLOGIC LOG	BORING/WELL ID 007-007-ASB	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 13:56/3-14-07	End Time/Date: 10:10 / 3-16-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6602.836 N 849.08	Direction (plant grid): North

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0–5	0-7	N/A	Core not retrieved	N/A	N/A
5–10	7-11	007007SA010	CLAY, gray, 7.5YR 6/1, soft, moist		14:38
10–15	11-14	007007SA015	CLAY, light brown, 7.5YR 6/4, firm, moist with gray and orange streaks		14:42
15–25	14-28	N/A	Core not retrieved	N/A	N/A
25–30	28-32	007007SA030	CLAY, reddish yellow, 7.5YR 6/6, firm, moist with gray and orange streaks: Sand (5%)		16:32
30–40	32-42	N/A	Core not retrieved	N/A	N/A
40–45	42-46	007007SA045 007007SD045 007007WA060 007007WD060	SAND, fine grained up to ½" across, poorly sorted, water		13:26 / 3-15-07
45–55	46-57	N/A	Core not retrieved	N/A	N/A
55–60	57-60	007007SA060	SAND , fine to medium grained with 5% clay		10:10 / 3-16-07

Total Vertical Depth is 60 feet.
Total Linear Depth is 83 feet.

LEGEND: CLAY
SAND

LITHOLOGIC LOG	*BORING/WELL ID 007-008-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 9:20/4-2-07	End Time/Date: 16:41 / 4-2-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6064.711 N 934.282	Direction (plant grid): Southeast

SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0-7	N/A	Core not retrieved	N/A	N/A
7-11	007008SA010	CLAY, gray, 7.5YR 6/1, soft, moist, with orange streaks		9:30
11-14	007008SA015	CLAY, light gray, 7.5YR 7/1, firm, moist, mottled, with orange streaks		9:35
14-28	N/A	Core not retrieved	N/A	N/A
28-32	007008SA030	CLAY, strong brown, 7.5YR 5/6, firm, moist, mottled with gray streaks		10:34
32-42	N/A	Core not retrieved	N/A	N/A
42-46	007008SA045 007008WA060	SAND, medium grained, wet: Chert (5%) angular, ⅛" across		12:42
46-57	N/A	Core not retrieved	N/A	N/A
57-60	007008SA060	SAND , medium grained with 10% clay: Chert (few), angular up to ½" across		16:41

Total Vertical Depth is 60 feet.
Total Linear Depth is 83 feet.

LEGEND: CLAY, SAND

LITHOLOGIC LOG	BORING/WELL ID 007-009-VSB	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 12:05/4-30-07	End Time/Date: 5-8-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: CME High Torque 55 and Geoprobe® 6620DT
Total Depth (Vertical): 96 feet	Angle: Vertical
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6785.376 N 964.982	Direction (plant grid): N/A

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-1	007009SA001	CLAY, light brown, 7.5YR 6/3, hard, dry with black and orange streaks	CLAY	12:15: Pused two additional liners
	1-5	007009SA005	CLAY, light brown, 7.5YR 6/3, firm, moist with gray and orange streaks	CLAY	12:19
5	5-10	007009SA010	CLAY, light brown, 7.5YR 6/3, firm, moist with gray and orange streaks	CLAY	12:24
10	10-15	007009SA015	CLAY, light brown, 7.5YR 6/4, soft, moist with orange streaks	CLAY	12:27
15, 20	15-25	N/A	Core not retrieved	N/A	N/A
25	25-30	007009SA030	CLAY, light brown, 7.5YR 6/3, firm, moist, mottled with gray and orange streaks	CLAY	12:49
30, 35	30-40	N/A	Core not retrieved	N/A	N/A
40	40-45	007009SA045	CLAY, light brown, 7.5YR 4/3, very hard, moist, with gray streaks	CLAY	13:37
45, 50	45-55	007009WA030	Core not retrieved	N/A	N/A
55	55-60	007009SA60	CLAY, brown, 7.5YR 4/4, firm, moist, with gray streaks	SAND	10:29 / 5-1-07

Total Vertical Depth is 96 feet. Water samples collected at the following depths: 69, 80, 90, 90D ft.

LEGEND: CLAY ~~~~ ; SAND - - - -

LITHOLOGIC LOG	***BORING/WELL ID*** ***007-010-VSB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:45/5-10-07	End Time/Date: 5-15-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig:CME High Torque 55 and Geoprobe® 6620DT
Total Depth (Vertical): 100 feet	Angle: Vertical
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6543.575 N 957.997	Direction (plant grid): N/A

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-1	007010SA001	Gravel – fill material	GRAVEL	8:45: Pushed 4 liners. 780,00 dpm
	1-5	007010SA005	CLAY, white, 7.5YR 8/1, soft, moist	CLAY	8:50
5	5-10	007010SA010	CLAY, white, 7.5YR 8/1, firm, moist, mottled with orange streaks	CLAY	9:20
10	10-15	007010SA015	CLAY, pinkish white, 7.5YR 6/4, soft, moist with gray streaks	CLAY	12:19
15, 20	15-25	N/A	Core not retrieved	N/A	N/A
25	25-30	007010SA030	CLAY, brown, 7.5YR 5/4, hard, moist, mottled with gray and orange streaks	CLAY	12:35
30, 35	30-40	N/A	Core not retrieved	N/A	N/A
40	40-45	0070110SA045 007010WA030	CLAY, brown, 7.5YR 5/4, firm, moist, with orange streaks: Sand (10%)	CLAY	9:30 / 5-11-07
45, 50	45-55	N/A	Core not retrieved	N/A	N/A
55	55-60	007010SA060 007010WA060	SAND, fine grained reddish brown with black streaks: Silt (10%)	SAND	15:45

Total Vertical Depth is 100 ft
Water samples collected at the following depths: 66, 80, 90, 100 ft

LEGEND: GRAVEL, CLAY, SAND

LITHOLOGIC LOG	***BORING/WELL ID*** ***007-011-VSB***	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 007	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 14:21/4-24-07	End Time/Date: 4-26-07	
Borehole Diameter: 8.25"	Drilling Method: 4.25" ID Augers	
Sampling Method: Split Spoons	Drill Rig: CME High Torque 55	
Total Depth (Vertical): 100 feet	Angle: Vertical	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -6282.4 N 869.1	Direction (plant grid): N/A	

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-1	N/A	Sample not Collected – Soil all rock and Gravel		15:09
	1-5	007011SA005	CLAY, gray, 7.5YR 6/1, firm, moist, mottled with orange streaks		15:20
5	5-10	007010SA010	CLAY, white, 7.5YR 8/1, firm, moist, mottled with orange streaks		15:30
10	10-15	007010SA015	CLAY, light gray, 7.5YR 7/1, soft, moist, variegated gray and orange		15:53
15 20	15-25	N/A	Core not retrieved	N/A	N/A
25	25-30	007011SA030 007011SD030	CLAY, light gray, 7.5YR 7/1, soft, moist, variegated gray and orange		16:04
30 35	30-40	N/A	Core not retrieved	N/A	N/A
40	40-45	007011SA045 007011WA030	SAND, fine grained, gray: Chert (15%) sub angular, ⅛" to ½" across		8:20 / 4-25-07
45 50	45-55	N/A	Core not retrieved	N/A	N/A
55	55-60	007011SA060 007011WA060	SAND, medium grained, gray: Chert (5%), angular, ⅛" to 3" across		13:35

Total Vertical Depth is100 feet. Water samples collected at the following depths: 70, 80, 90 ft.	LEGEND: GRAVEL		CLAY	
			SAND	

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SWMU 30

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LITHOLOGIC LOG

BORING/WELL ID 030-001-ASB

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 030
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:34/3-5-07	End Time/Date: 14:40/3-5-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -7187.038 N 976.622	Direction (plant grid): Southeast

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	030001SA010	CLAY, light brown, 7.5YR 6/4, firm, moist, mottled, with gray and orange streaks		8:52
	11-14	030001SA015	CLAY, light brown, 7.5YR 6/4, firm, moist, mottled, with gray and orange streaks		8:56
15	14-18		CLAY, light brown, 7.5YR 6/4, firm, moist, mottled, with gray and orange streaks		9:04 Additional sample was required
20, 25	18-28	N/A	Core not retrieved	N/A	N/A
30	28-32	030001SA030	SAND, iron stained, fine grained, well sorted, slight moisture		9:31
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	030001SA045	CLAY, light brown, 7.5YR 6/3, hard, moist, with red and black streaks		10:20
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	030001SA060	CLAY, light brown, 7.5YR 6/4, soft, moist, with gray and orange streaks: Sand from 84 to 85', fine to medium grained , poorly sorted		14:40

Total Vertical Depth is 60 feet.	LEGEND: CLAY	
Total Linear Depth is 85 feet.	SAND	

LITHOLOGIC LOG	*BORING/WELL ID 030-002-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 030
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:30/3-6-07	End Time/Date: 13:31/3-6-07
Borehole Diameter: 2.25"	Drilling Method: Direct Push
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -7035.76 N 883.462	Direction (plant grid): Northwest

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	030002SA010	CLAY, reddish yellow, 7.5YR 6/6, hard, moist, mottled, with gray and orange streaks	CLAY	8:48
	11-14	030002SA015	CLAY, reddish yellow, 7.5YR 6/6, firm, moist, mottled, with gray and orange streaks	CLAY	8:54
15	14-18		CLAY, light brown, 7.5YR 6/3, firm, moist, with gray and orange streaks	CLAY	8:56 Additional sample required
20, 25	18-28	N/A	Core not retrieved	N/A	N/A
30	28-32	030002SA030	CLAY, light brown, 7.5YR 6/4, hard, moist, with gray and orange streaks: Sand from 40 to 41', medium to coarse grained, poorly sorted, iron stained	CLAY	9:19
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	030002SA045	CLAY, brown, 7.5YR 5/3, hard, moist, mottled, with gray and orange streaks	CLAY	10:41
	46-50	030002SD045	CLAY, brown, 7.5YR 5/3, hard, moist, mottled, with gray and orange streaks	CLAY	Duplicate
50, 55	50-57	N/A	Core not retrieved	N/A	N/A
	57-60	030002SA060	CLAY, light gray, 7.5YR 7/1, hard, moist, with orange streaks: Sand (5%)	CLAY	13:31 / 3-6-07

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY, SAND

LITHOLOGIC LOG	***BORING/WELL ID 030-003-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 030
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:30/3-7-07	End Time/Date: 13:11/3-8-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6939.763 N 881.58	Direction (plant grid): Southeast

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	030003SA010	CLAY, brown, 7.5YR 4/4, firm, moist, with gray streaks	~~~~~~~~~~	8:35
	11-14	030003SA015	CLAY, brown, 7.5YR 5/3, firm, moist, with orange streaks	~~~~~~~~~~	8:48
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	030003SA030	CLAY, reddish yellow, 7.5YR 6/6,very hard, moist, with gray streak	~~~~~~~~~~	14:56
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	030003SA045	CLAY, strong brown, 7.5YR 5/6, hard, moist, with gray and orange streaks	~~~~~~~~~~	10:33 / 3-8-07
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	030003SA060 030003WA060	CLAY, strong brown, 7.5YR 5/6, hard, moist, mottled, with gray streaks	~~~~~~~~~~	13:11

Total Vertical Depth is 60 feet. **Total Linear Depth is 85 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	-------------

LITHOLOGIC LOG	*BORING/WELL ID 030-004-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 030
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 3-6-07	End Time/Date: 3-6-07
Borehole Diameter: 2.75"	Drilling Method: Direct Push
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -6800.238 N 781.032	Direction (plant grid): Northwest

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	030004SA010	CLAY, white, 7.5YR 8/1, hard, moist, with orange streaks	~~~~~~~~~~	
	11-14	030004SA015	CLAY, white, 7.5YR 8/1, hard, moist, with orange streaks	~~~~~~~~~~	
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	030004SA030	CLAY, white, 7.5YR 8/1, hard, moist, with a few orange streaks	~~~~~~~~~~	
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	030004SA045	CLAY, white, 7.5YR 8/1, hard, moist, with a few orange streaks	~~~~~~~~~~	
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	030004SA060	CLAY, brown, 7.5YR 4/4, very hard, dry, with gray streaks	~~~~~~~~~~	14:32

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 85 feet.	SAND	-------------

SWMU 145

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LITHOLOGIC LOG	BORING/WELL ID 145-101-ASB	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 14:15/1-24-07	End Time/Date: 12:35 / 1-24-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Todd Mills / Mark Gartner	Protective Level: Modified Level D
Coordinates: E -2156.26 N 4493.87	Direction (plant grid): South

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0	0-7	N/A	Core not retrieved	N/A	N/A
5	7-11	145101SA010	CLAY, brown, 7.5YR 4/3, medium firm, slightly moist, with gray streaks	~~~~~~~~~~	14:22
10	11-14	145101SA015	CLAY, gray, 7.5YR 6/1, medium firm, moist with light gray streaks	~~~~~~~~~~	14:31
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145101SA030	CLAY, gray, 7.5YR 6/1, firm, slightly moist with gray streaks	~~~~~~~~~~	15:15
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145101SA045	CLAY, brown, 7.5YR 4/4, very firm, slightly moist, with black streaks	~~~~~~~~~~	10:15 / 1-25-07
	46-50	N/A	Core not retrieved	N/A	N/A
50	50-53	145101SA060	CLAY, light brown, 7.5YR 6/4, hard, moist, gray and orange streaks with a 3" sand seam, white, fine grained to ¼" across, poorly sorted	~~~~~~~~~~	12:35

Total Vertical Depth is 53 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 75 feet.	SAND	- - - - - - - -

LITHOLOGIC LOG	***BORING/WELL ID*** ***145-102-ASB***	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 8:40/1-16-07	End Time/Date: 16:42/1-18-07
Borehole Diameter: 2.75"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -1895.42 N 4042.42	Direction (plant grid): West

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0–5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	145102SA010	CLAY, brown, 7.5YR 7/1, firm, dry, black organic material, with orange streaks	~~~ (clay)	9:42
	11-14	145102SA015	CLAY, gray, 7.5YR 7/1, firm, dry, crumbly	~~~ (clay)	
15–25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145102SA030 145102SD030	CLAY, brown, 7.5YR 4/4, hard, moist, with orange and gray streaks	~~~ (clay)	10:28
35–40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145102SA045	CLAY, reddish yellow, 7.5YR 6/6, firm, moist, gray and orange streaks	~~~ (clay)	13:07
50–55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	145102SA060	CLAY (from 80 to 81.5'), strong brown, 7.5 YR 4/6, hard, moist, with black streaks SAND (from 81.5 to 83'), light gray fine grained, well sorted	~~~ (clay)	16:42

Total Vertical Depth is 60 feet.
Total Linear Depth is 83 feet.

LEGEND: CLAY ~~~~
SAND - - - -

LITHOLOGIC LOG	*BORING/WELL ID 145-103-ASB*	Page 1 of 1
Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145	
Project: BGOU RI	Client: USDOE/PRS	
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield	
Start Time/Date: 11:47 / 1-9-07	End Time/Date: 15:19/1-9-07	
Borehole Diameter: 2.75"	Drilling Method: Direct Push	
Sampling Method: DT-21 Dual Tube	Drill Rig: Geoprobe® 6620DT	
Total Depth (Vertical): 60 feet	Angle: 45°	
Logged By: Mark Gartner	Protective Level: Modified Level D	
Coordinates: E -2465.84 N 3406.88	Direction (plant grid): Northwest	

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	145103SA010	CLAY, dark gray, 7.5YR 4/1, soft, moist, rock fragments	~~~ (clay)	12:02
	11-14	145103SA015	CLAY, gray, 7.5YR 6/1, firm, dry	~~~ (clay)	12:12
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145103SA030	CLAY, brown, 7.5YR 5/3, firm, moist, with gray streaks	~~~ (clay)	12:52
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145103SA045	CLAY, brown, 7.5YR 5/4, firm, moist, gray streaks: Sand (10%)	~~~ (clay)	13:49
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	145103SA060	CLAY, strong brown, 7.5 YR 5/6, hard, moist with black and gray streaks: Sand (10%)	~~~ (clay)	15:19

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~
Total Linear Depth is 85 feet.	SAND	- - -

LITHOLOGIC LOG

BORING/WELL ID *145-104-ASB*

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 14:34 / 1-10-07	End Time/Date: 12:42/1-22-07
Borehole Diameter: 2.75”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -2333.16 N 3381.42	Direction (plant grid): East

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	145104SA010	CLAY, greenish gray, GLEY1 6/10Y, soft, dry, wood fragments	~~~~~~~~~~	14:57
	11-14	145104SA015	CLAY, greenish gray, GLEY1 6/10Y, soft, dry, wood fragments	~~~~~~~~~~	15:16 Stop drilling activities due to High LEL readings.
15, 20, 25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145104SA030	CLAY, brown, 7.5YR 4/4, firm, moist with orange streaks	~~~~~~~~~~	9:45
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145104SA045	CLAY, brown, 7.5YR 5/4, hard, moist with gray and orange streaks	~~~~~~~~~~	10:26
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	145104SA060	CLAY, strong brown, 7.5 YR 5/8, hard, dry, with 1” sand seam, white, fine grained, dry	~~~~~~~~~~	12:42

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 82.5 feet.	SAND	- - - - - - - - - -

LITHOLOGIC LOG	***BORING/WELL ID*** ***145-105-ASB***	

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 12:38 / 1-8-07	End Time/Date: 13:41/1-23-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45º
Logged By: Mark Gartner / Todd Mills	Protective Level: Modified Level D
Coordinates: E -2765.27 N 3183.99	Direction (plant grid): Northwest

Depth (ft)	SAMPLE INTERVAL	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
0–5	0-7	N/A	Core not retrieved	N/A	N/A
5–10	7-11	145105SA010	CLAY, brown, 7.5YR 5/3, soft, moist, mottles with gray and red streaks	CLAY	12:52
10	11-14	145105SA015	CLAY, brown, 7.5YR 4/3, firm, moist, dark orange streaks	CLAY	13:02
15–25	14-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145105SA030	CLAY, reddish yellow, 7.5YR 6/6, firm, dry, with gray streaks: Sand seam (1’), fine grained, with a few angular chert fragments	CLAY	14:26
35–40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145105SA045	CLAY, light brown, 7.5YR 6/4, hard, dry, gray streaks:	CLAY	15:49
50–55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	145105SA060	SILTY CLAYEY, strong brown, 7.5YR 5/6, sand and gravel	CLAY	14:10 / 1-23-07

Total Vertical Depth is 60 feet.
Total Linear Depth is 85 feet.

LEGEND: CLAY (~~~~), SAND (- - - -)

LITHOLOGIC LOG	*BORING/WELL ID 145-106-ASB*	Page 1 of 1

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 9:20/1-26-07	End Time/Date: 14:49/1-26-07
Borehole Diameter: 6.25”	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25” ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 43 feet	Angle: 45º
Logged By: Todd Mills	Protective Level: Modified Level D
Coordinates: E -3088.28 N 3545.83	Direction (plant grid): East

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0 5	0-7	N/A	Core not retrieved	N/A	N/A
	7-11	145106SA010	CLAY, very pale brown, 10YR 7/3, firm, slightly moist, with iron staining	~~~~~~~~~~	Duplicate sample
10		145106SD010	CLAY, very pale brown, 10YR 7/3, firm, slightly moist, with iron staining	~~~~~~~~~~	10:13
	11-14	145106SA015	CLAY, gray, 7.5YR 7/1, firm, dry	~~~~~~~~~~	10:25
15 20 25	14-28	N/A	Core not retrieved	N/A	N/A
	28-30	145106SA030	CLAY, brown, 7.5YR 4/3, very firm, moist, with black streaks	~~~~~~~~~~	11:39
30	30-33	N/A	Core not retrieved	N/A	N/A
35	33-35	145106SA045	CLAY, brown, 7.5YR 4/4, very firm, moist	~~~~~~~~~~	13:59
	38-40	145106SA060	CLAY, brown, 7.5YR 4/4, very firm, slightly moist, black streaks	~~~~~~~~~~	15:00
40	40-43	N/A	Core not retrieved	N/A	N/A

Total Vertical Depth is 43 feet. **Total Linear Depth is 60 feet.**	LEGEND: CLAY	~~~~~~~~~~
	SAND	- - - - - - - -

LITHOLOGIC LOG

BORING/WELL ID 145-107-ASB

Facility: Paducah Gaseous Diffusion Plant, Paducah, KY	Site: SWMU- 145
Project: BGOU RI	Client: USDOE/PRS
Drilling Contractor: Chase Environmental, LLC	Driller: Jeff Brownfield
Start Time/Date: 13:50 / 1-29-07	End Time/Date: 11:24/1-31-07
Borehole Diameter: 6.25"	Drilling Method: Direct Push Through Augers
Sampling Method: DT-21 Dual Tube / 2.25" ID Augers	Drill Rig: Geoprobe® 6620DT
Total Depth (Vertical): 60 feet	Angle: 45°
Logged By: Mark Gartner	Protective Level: Modified Level D
Coordinates: E -2809.44 N 4138.49	Direction (plant grid): South

Depth (ft)	SAMPLE		LITHOLOGIC DESCRIPTION	GRAPHIC LOG	COMMENTS
	INTERVAL	NUMBER			
0, 5	0-7	N/A	Core not retrieved	N/A	N/A
10	7-11	145107SA010	CLAY, brown, 7.5YR 4/2, firm, moist with gray and orange streaks: Quartz (5%), ⅛" to ¼" across, rounded to subangular	~~~~~~~~~~	14:02
	11-14	145107SA015	CLAY, dark gray, 7.5YR 4/1, soft, moist	~~~~~~~~~~	14:10
15	14-18	145107SA015	CLAY, dark gray, 7.5YR 4/1, soft, moist	~~~~~~~~~~	Additional sample was required.
20, 25	18-28	N/A	Core not retrieved	N/A	N/A
30	28-32	145107SA030	CLAY, brown, 7.5YR 4/4, firm, moist, gray streaks with 10% sand: Sand seam (2.5'), fine grained to medium grained, poorly sorted with 10% clay	~~~~~~~~~~	15:11
35, 40	32-42	N/A	Core not retrieved	N/A	N/A
45	42-46	145107SA045	CLAY, light gray, 7.5YR 7/1, very hard, dry with orange streaks	~~~~~~~~~~	15:44 / 1-30-07
50, 55	46-57	N/A	Core not retrieved	N/A	N/A
	57-60	145107SA060	SAND, white, fine grained, dry with iron staining	- - - - - - - - - -	11:24 / 1-31-07

Total Vertical Depth is 60 feet.	LEGEND: CLAY	~~~~~~~~~~
Total Linear Depth is 83 feet.	SAND	- - - - - - - - - -

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APPENDIX C

ANALYTICAL DATA AND QA/QC EVALUATION RESULTS

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APPENDIX C

ANALYTICAL DATA AND QA/QC EVALUATION RESULTS

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APPENDIX D

THREE DIMENSIONAL VISUALIZATION FIGURES

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APPENDIX D

THREE DIMENSIONAL VISUALIZATION FIGURES

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APPENDIX E

CONTAMINANT FATE AND TRANSPORT MODELING RESULTS FOR THE BGOU

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ACRONYMS

AT123D	Analytical Transient 1-, 2-, 3-Dimensional Model
BGOU	Burial Grounds Operable Unit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	contaminant of concern
COPC	chemical of potential concern
DAF	diluation/attenuation factor
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DQO	Data Quality Objective
ELCR	excess lifetime cancer risk
EPA	U. S. Environmental Protection Agency
f_{oc}	soil organic carbon fraction
HQ	hazard quotient
HU	hydrogeologic unit
K_d	distribution coefficient
K_{oc}	organic carbon partition coefficient
MCL	Maximum Contaminant Level
MEPAS	Multimedia Environmental Pollutant Assessment System
Paducah OREIS	Paducah Oak Ridge Environmental Information System
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
POE	point of exposure
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RESRAD	RESidual RADioactive Materials
RfD	reference dose
RGA	Regional Gravel Aquifer
RGO	remedial goal option
RI	Remedial Investigation
SADA	Statistical Analysis and Decision Assistance Model
SESOIL	Seasonal Soil Compartment Model
SQL	sample quantitation limit
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
^{99}Tc	technetium-99
TCE	trichloroethene
UCL	upper confidence limit
UCRS	Upper Continential Recharge System
VOC	volatile organic compound

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E.1. INTRODUCTION

This appendix presents the methods and results of the fate and transport modeling performed for the Burial Grounds Operable Unit (BGOU) Remedial Investigation (RI), consisting of [Solid Waste Management Unit (SWMU) 2, SWMU3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145].

The fate and transport modeling of the BGOU RI is consistent with the Tiers 1, 2 and 3 of the modeling matrix included in the Paducah Gaseous Diffusion Plant (PGDP) Risk Methods Document (DOE 2001). This modeling matrix is consistent with the 2007 revision to the Risk Methods Document, since the methodologies are the same for fate and transport modeling. As indicated by this matrix (Table E.1.1), Tier 1 consists of simple screens using soil screening levels (SSLs) to identify those contaminants that may migrate from source areas to undefined downgradient points of exposure (POEs); Tier 2 consists of source delineation and transport modeling using input parameters that are unlikely to underestimate the potential for contaminant transport to undefined downgradient POEs (i.e., are conservative estimates of contaminant transport); and Tier 3 consists of source delimitation and transport modeling using input parameters that result in more accurate estimates of future contaminant concentrations at POEs at the PGDP plant boundary, PGDP property boundary, Little Bayou seeps, and the Ohio River.

Section 5 summarizes the modeling results documented by this appendix.

Table E.1.1. Modeling Matrix for Groundwater[a]

	Values for Soil to Protect Groundwater	Model	Point of Exposure	Notes
INVESTIGATION DOCUMENTS	Tier 1 Initial analysis used to identify COPCs that might migrate from source areas and require further fate and transport analysis.	Concentrations in source term are the maximum detected concentrations of contaminants in the source. Contaminant concentrations compared to site screening levels and groundwater protection values in Appendix A of the PGDP Methods Document.	At source unit.	Use dilution/attenuation factor (DAF) of 1 for site screening levels unless site-specific values are available. Groundwater Protection value based on residential use and targets of 1E-6, 0.1, and 1 for risk, hazard, and dose, respectively. If site-specific DAF values are used, then the groundwater protection value should be justified. The depth to groundwater will be considered in the calculation.
	Tier 2 Analysis is used to refine the list of COPCs that might migrate from source areas. Depending on the DQOs for the project, additional fate and transport analysis of selected COPCs might be completed.	Concentrations in source term for all contaminants are the lesser of the maximum and UCL95 concentration of the appropriate distribution. Fate and transport modeling completed using SESOIL and/or RESRAD.	At source unit.	Includes source delimitation. The analysis will recognize SESOIL limitations when modeling inorganic COPCs-refine K_ds.
DECISION DOCUMENTS	Tier 3 Analysis is used for COCs identified from Tier 2 modeling. Includes consideration of COC concentrations at downgradient locations. The results of this analysis may be used to develop clean-up levels for some COCs.	Source term developed using SADA. Fate and transport completed using SESOIL and RESRAD with AT123D.	At source unit and at downgradient exposure points. Exposure points are at the plant boundary, the property boundary, Little Bayou seeps, and the Ohio River.	Uses source delimitation and refined K_ds from previous tiers. Contaminant migration paths will be derived using the sitewide groundwater model. On the Terrace (southern portion of PGDP), different points of exposure will apply and be determined using the sitewide groundwater model.
	Tier 4 Analysis is used for the COCs presenting the greatest risk at downgradient exposure points. The results of this analysis may be used to develop clean-up levels for some COCs.	Source modeling and MODFLOW T	Down-gradient points Exposure points are at the plant boundary, the property boundary, Little Bayou Creek, and the Ohio River.	To be used to refine clean-up goals (if needed). On the Terrace (southern portion of PGDP), different points of exposure will apply and be determined using the sitewide groundwater model.

[a] Adapted from Table 3.2 of the PGDP Risk Methods Document (DOE/OR/07-1506&D2).

AT123D = Analytical Transient 1-, 2-, 3-Dimensional
COC = contaminant of concern
COPC = chemical of potential concern
DAF = dilution/attenuation factor
DQO = Data Quality Objective
K_d = distribution coefficient
RESRAD = Residual Radioactive Materials
SADA = Statistical Analysis and Decision Assistance
SESOIL = Seasonal Soil Compartment Model
UCL = upper confidence level

E.2. RESULTS FROM PREVIOUS MODELING EFFORTS

E.2.1 SUMMARY

Transport modeling results contained in previous investigations and risk assessments were examined to determine the types of models completed previously and the results of those modeling activities. All reports considered were from work completed between 1990 and 2004.

As part of this summary, previously completed transport models were categorized into one of the four modeling tiers described in Table 3.2 in the Risk Methods Document (DOE 2001). These tiers and their descriptions are as follows:

- Tier 1: Results are derived using simple comparisons between sampling results and soil screening levels for groundwater protection. No source-term calculations are performed. Results are used for scoping investigation activities. The POE considered is at the source unit.

- Tier 2: Results are derived using analytical models such as the Multimedia Environmental Pollutant Assessment System (MEPAS), Residual Radioactive Materials (RESRAD), SESOIL, and AT123D. Source-terms are conservatively derived by assuming that the source-term volume consists of all areas with a detected result and that the source-term concentration is equal to the maximum detected concentration over all samples. Results are used to determine if a response action should be considered for the source. The POE considered is at the source unit.

- Tier 3: Results are derived using analytical models such as MEPAS, RESRAD, SESOIL, and AT123D. Source-terms are less conservatively derived than under Tier 2 by using three-dimensional plots and/or computer programs that can perform geospatial modeling (e.g., SADA). The source concentration is assumed to be the average concentration over all detected concentrations within the source volume. Results are used in decision documents to select among possible response actions and to derive cleanup levels. The POEs considered are at the source unit and at downgradient points (e.g., the PGDP boundary, property boundary, and either Little Bayou Creek or the Ohio River).

- Tier 4: Results are derived using numerical models, such as MODFLOW T. Similar to Tier 3, source-terms are derived using three-dimensional plots and/or computer programs that can perform geospatial modeling. The source concentration is assumed to be the average concentration over all detected concentrations within the source volume. Results are used in decision documents to design a selected response action, such as in refining cleanup levels and selecting monitoring points. The POEs considered are at the source unit and at downgradient points (e.g., the PGDP boundary, property boundary, and either Little Bayou Creek or the Ohio River).

Generally, all previous modeling that has been performed for the burial grounds falls within Tier 2; however, in most cases, modeling to downgradient POEs (i.e., the PGDP boundary and/or property boundary) was included. Modeling to the downgradient points is similar to the Tier 3 requirement. No modeling to Little Bayou Creek or the Ohio River has been completed previously for the burial grounds.

Table E.2.1 and the following text summarizes previous modeling performed for each burial ground. No previous modeling has been performed for SWMU 145. All risk and hazard estimates presented are for hypothetical residential use of groundwater obtained from the Regional Gravel Aquifer (RGA) at locations such as the plant boundary and property boundary.

Table E.2.1. Summary of Previous Modeling Performed for Burial Grounds at PGDP

Unit	Tier/Model Used	Report	PGDP boundary		Property boundary		River/Little Bayou Creek seeps	
			Total risk/hazard	**COCs**	**Total risk/hazard**	**COCs**	**Total risk/hazard**	**COCs**
SWMU 2	Tier 1—None	*Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/SUB/13B-97777C P-03/1991/1, December 1991.	Not calculated; qualitative determination	TCE, ^{99}Tc, Beryllium, Chromium, Lead	Not calculated	NA	Not calculated	NA
	Tier 1—None	*Solid Waste Landfill Subsurface Investigation Report*, KY/ERWM-12, February 1994.	Not calculated; qualitative determination	^{99}Tc, Uranium, metals	Not calculated	NA	Not calculated	NA
	Tier 2—MEPAS	*Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management Unit 2 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1549&D1, February 1997b.	VOCs Risk = 3E-05 Hazard = <1 Dose = NA Based on predicted maximum concentration at PGDP boundary at 35 years from present	TCE	Risk = 2E-05 Hazard = <1 Dose = NA Based on predicted maximum concentration at PGDP boundary 35 years from present	TCE	Not calculated	NA
			Metals Risk = 1E-05 Hazard = <1 Dose = NA Based on predicted maximum concentration at PGDP boundary at 1,505 years from present	Arsenic	Risk = 1E-05 Hazard = <1 Dose = NA Based on predicted maximum concentration at boundary at more than 1,000 years from present	Arsenic	Not calculated	NA
	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 6E-03 Hazard = 1,000 Dose = <1 mrem/year	Risk: TCE, vinyl chloride, ^{99}Tc Hazard: *cis*-1,2-DCE; TCE	Not calculated	NA
SWMU 3	Tier 1—None	*Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/SUB/13B-97777C P-03/1991 /1, December 1991.	Not calculated; qualitative determination	TCE, ^{99}Tc, Beryllium, Chromium, Lead	Not calculated	NA	Not calculated	NA

Table E.2.1 Summary of Previous Modeling Performed for Burial Grounds at PGDP (Continued)

Unit	Tier/Model Used	Report	PGDP boundary		Property boundary		River/Little Bayou Creek seeps	
			Total risk/hazard	COCs	Total risk/hazard	COCs	Total risk/hazard	COCs
SWMU 3	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 7E-06 Hazard = 2 Dose = <1 mrem/year	Risk: ^{99}Tc Hazard: naphthalene	Not calculated	NA
SWMU 4	Tier 2—MEPAS	*Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1, September 2000.	TCE and solvents Risk = 6E-02 Hazard = 2000 (Assumed 100 years from present)	Risk: 1,1-DCE; TCE; vinyl chloride; carbon tetrachloride Hazard: 1,1-DCE; TCE	Not calculated; however, a comparison of concentrations indicates that risks and hazards would be about one order of magnitude less than those calculated for the PGDP boundary.	Assumed the same as PGDP boundary COCs	Not calculated	NA
			Metals and radionuclides Risk = 6E-03 Hazard = 400 (Assumed at >1,000 years from present)	Risk: Arsenic, ^{237}Np, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, ^{238}U Hazard: Arsenic, Cobalt, Copper, Iron, Manganese				
			Dose = Not calculated	NA				
	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = >1 Hazard = 2,000,000 Dose = 2 mrem/year	Risk: carbon tetrachloride; chloroform; 1,1-DCE; TCE; vinyl chloride; ^{99}Tc Hazard: carbon tetrachloride; chloroform; *cis*-1,2-DCE; *trans*-1,2-DCE; 1,1-DCE; TCE; vinyl chloride Dose: ^{99}Tc	Not calculated	NA

Table E.2.1 Summary of Previous Modeling Performed for Burial Grounds at PGDP (Continued)

Unit	Tier/Model Used	Report	PGDP boundary		Property boundary		River/Little Bayou Creek seeps	
			Total risk/hazard	COCs	Total risk/hazard	COCs	Total risk/hazard	COCs
SWMU 5	Tier 2—MEPAS	*Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1, September 2000.	TCE and solvents Risk = <1E-06 Hazard = <1 Metals and radionuclides Risk = <1E-06 Hazard = 100 (Assumed at >1,000 years from present) Dose = Not calculated	Risk: none Hazard: none Risk: none Hazard: Iron, Manganese NA	Not calculated; however, a comparison of concentrations indicates that risks and hazards would be about one order of magnitude less than those calculated for the PGDP boundary.	Assumed the same as PGDP boundary COCs	Not calculated	NA
	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 5E-03 Hazard = 100 Dose = <1 mrem/year	Risk: 1,1-DCE and ^{99}Tc Hazard: naphthalene Dose: None	Not calculated	NA
SWMU 6	Tier 2—MEPAS	*Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1, September 2000.	TCE and solvents Risk = <1E-06 Hazard = <1 Metals and radionuclides Risk = <1E-06 Hazard = 20 (Assumed at >1,000 years from present) Dose = Not calculated	Risk: none Hazard: none Risk: none Hazard: Iron NA	Not calculated; however, a comparison of concentrations indicates that risks and hazards would be about one order of magnitude less than those calculated for the PGDP boundary.	Assumed the same as PGDP boundary COCs	Not calculated	NA
	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 3E-05 Hazard = <1 Dose = <1 mrem/year	Risk: ^{99}Tc Hazard: none Dose: none	Not calculated	NA
SWMU 7	Tier 1—None	*Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/SUB/13B-97777C P-03/1991/1.	Not calculated; qualitative determination	TCE; 1,2-DCE; vinyl chloride; ^{99}Tc; Arsenic; Chromium; Nickel	Not calculated	NA	Not calculated	NA

Table E.2.1 Summary of Previous Modeling Performed for Burial Grounds at PGDP (Continued)

Unit	Tier/Model Used	Report	PGDP boundary		Property boundary		River/Little Bayou Creek seeps	
			Total risk/hazard	COCs	Total risk/hazard	COCs	Total risk/hazard	COCs
SWMU 7	Tier 2—SESOIL/AT123D	*Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1604&D2, January 1998.	Not calculated	NA	Risk = 2E-04 Hazard = <1 Dose = Not calculated (Results are for sources at both SWMUs 7 and 30 and are for 100 years from present.)	Risk: vinyl chloride, ^{99}Tc Hazard: none Dose: NA	Not calculated	NA
	Tier 3—SESOIL/AT123D	*Technetium-99 Transport Modeling Results for Sources at SWMUs 7 and 30 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-266, March 1998.	Risk = Not calculated Hazard = NA Dose = Not calculated [Results are maximum contribution from the incinerator area (Area Z) in SWMU 7]	Maximum concentration of ^{99}Tc was 63 pCi/L at 20 years from present	Risk = Not calculated Hazard = NA Dose = Not calculated [Results are maximum from the incinerator area (Area Z) in SWMU 7]	Maximum concentration of ^{99}Tc was 11 pCi/L at 25 years from present	Not calculated	NA
	Tier 2—SESOIL/AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 8E-04 Hazard = 30 Dose = 11 mrem/year	Risk: benzene, chloroform, ethylbenzene, ^{99}Tc Hazard: Copper, benzene, naphthalene Dose: ^{99}Tc	Not calculated	NA
SWMU 30	Tier 1—None	*Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/SUB/13B-97777C P-03/1991/1.	Not calculated; qualitative determination	TCE; 1,2-DCE; vinyl chloride; ^{99}Tc; Arsenic; Chromium; Nickel	Not calculated	NA	Not calculated	NA
	Tier 2—SESOIL/AT123D	*Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1604&D2, January 1998.	Not calculated	NA	Risk = 2E-04 Hazard = <1 Dose = Not calculated (Results are for sources at both SWMUs 7 and 30 and are for 100 years from present.)	Risk: vinyl chloride, ^{99}Tc Hazard: none Dose: NA	Not calculated	NA

Table E.2.1. Summary of Previous Modeling Performed for Burial Grounds at PGDP (Continued)

Unit	Tier/Model Used	Report	PGDP boundary		Property boundary		River/Little Bayou Creek seeps	
			Total risk/hazard	COCs	Total risk/hazard	COCs	Total risk/hazard	COCs
SWMU 30	Tier 3—SESOIL/ AT123D	*Technetium-99 Transport Modeling Results for Sources at SWMUs 7 and 30 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, KY/EM-266, March 1998.	Risk = Not calculated Hazard = NA Dose = Not calculated (Results are maximum contribution from Pits B/C in SWMU 30.)	Maximum concentration of ^{99}Tc was 122 pCi/L at 20 years from present	Risk = Not calculated Hazard = NA Dose = Not calculated (Results are maximum contribution from Pits B/C in SWMU 30.)	Maximum concentration of ^{99}Tc was 21 pCi/L at 25 years from present	Not calculated	NA
	Tier 2—SESOIL/ AT123D	*Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2104&D0, September 2003.	Not calculated	NA	Risk = 3E-04 Hazard = 8 Dose = 5 mrem/year	Risk: ^{99}Tc Hazard: naphthalene Dose: ^{99}Tc	Not calculated	NA

COC = contaminant of concern
DCE = dichloroethene
MEPAS = Multimedia Environmental Pollutant Assessment System
mrem = millirem
NA = Not applicable
^{237}Np = neptunium-237
^{239}Pu = Plutonium-239
SESOIL = Seasonal Soil Compartment Model
^{99}Tc = technetium-99
TCE = trichloroethene
^{234}U = uranium-234
^{235}U = uranium-235
^{238}U = uranium-238
VOC = volatile organic compound

More modeling results are available for SWMU 2 than other BGOU SWMUs. However, no modeling has extended to Tier 3. Tier 2 modeling results, which have included modeling to the PGDP boundary and property boundary POEs, have concluded that this unit may be a potential contributor of trichloroethene (TCE) and other volatile organic compounds (VOCs) to groundwater. In addition, this unit may be a contributor of technetium-99 (^{99}Tc), but the risks due to ^{99}Tc levels are two orders of magnitude less (i.e., equal to 3E-05) than those from solvents (5E-03). It is unlikely that this unit is a contributor of metals to groundwater, and an extensive analysis in *Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management 2 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1549&D1, (DOE 1997) determined that the uranium metal present in the burial ground is unlikely to contribute to groundwater contamination.

SWMU 3 may contribute contaminants to groundwater; however, no modeling has extended to Tier 3. Tier 2 modeling results, at the property boundary POE, have concluded that this unit is a minor contributor of ^{99}Tc to groundwater (Risk = 7E-06). Naphthalene also has been identified as a contaminant of concern (COC) (for hazard), but this result is suspect due to conservative source-term development. This unit has not been shown to be a contributor of metals to groundwater.

SWMU 4 previous modeling identified a risk over 1 and hazard over 2,000,000 at the property boundary POE using Tier 2 modeling. The maximum risks are predicted to be from chloroform (> 1), 1,1-DCE (3.98×10^{-1}), carbon tetrachloride (1.22×10^{-1}), TCE (2.37×10^{-2}), and vinyl chloride (1.46×10^{-2}). The maximum hazards are predicted to be from chloroform (1,710,000), *cis*-1,2-DCE (789,000), *trans*-1,2-DCE (16,900), and carbon tetrachloride (11,600) (DOE 2003a). COCs include VOCs [TCE; 1,1-dichloroethene (DCE); vinyl chloride; 1,2-DCE; carbon tetrachloride, and chloroform], metals (arsenic, cobalt, copper, iron, and manganese), and radionuclides [neptunium-237 (^{237}Np), plutonium-239 (^{239}Pu), ^{99}Tc, uranium-234 (^{234}U), uranium-235 (^{235}U), and uranium-238 (^{238}U)]. Although Tier 2 modeling derived elevated risk and hazard, these results are highly uncertain because of the conservative source term used in the modeling.

SWMU 5 previous modeling identified COCs for risk as 1,1-DCE and ^{99}Tc and identified COCs for hazard as naphthalene, Mn, and Fe. Although Tier 2 modeling derived an elevated risk (5E-05) and hazard (100), these results are highly uncertain due to the conservative Tier 2 source-term used in the modeling.

SWMU 6 Tier 2 modeling derived elevated risk from ^{99}Tc (3E-05) and hazard from iron (20); however, these results are highly uncertain due to the conservative source-term used in the modeling.

SWMU 7 may contribute contaminants to groundwater; however, Tiers 2 and 3 modeling results indicate that the contamination contributed is probably not significant. While early Tier 2 modeling identified SWMU 7 as a potential source of ^{99}Tc and vinyl chloride, later Tier 3 modeling determined that the level of ^{99}Tc that might reach a receptor at the PGDP boundary or property boundary (maximum of 63 and 11 pCi/L) is well below the Maximum Contaminant Level (MCL) (900 pCi/L). Later Tier 2 modeling (i.e., that from the sitewide risk model) did identify additional COCs; however, this result is highly uncertain given the conservative source-term used.

SWMU 30 may contribute contaminants to groundwater; however, Tiers 2 and 3 modeling results indicate that the contamination contributed probably is not significant. While early Tier 2 modeling identified SWMU 30 as a potential source of ^{99}Tc and vinyl chloride; later Tier 3 modeling determined that the level of ^{99}Tc that might reach a receptor at the PGDP boundary or property boundary (maximum of 122 and 21 pCi/L) is well below the MCL (900 pCi/L). Later Tier 2 modeling (i.e., that from the sitewide risk model) did identify ^{99}Tc as an important COC; however, this result is highly uncertain given the conservative source-term used.

Attachment E.1 provides more detailed summaries and excerpts of reports of previous modeling for the BGOU RI SWMUs.

E.3. MODELING COMPLETED AS PART OF BGOU RI

E.3.1 GROUNDWATER MODELING

The BGOU RI performed fate and transport modeling using the SADA, SESOIL, MODFLOW/MODPATH, and AT123D models. In general, the selected POEs where groundwater concentrations of the chemicals of potential concern (COPCs) were estimated were the plant boundary, property boundary, Little Bayou seeps, and near the Ohio River; however, not all SWMUs have transport pathways to all of the POEs. For example, SWMU 145 is located outside of the plant boundary and does not contribute to the Little Bayou seeps.

Modelers used the following approach to evaluate the migration of the selected COPCs from the BGOU SWMUs to groundwater and subsequently to the POEs.

1. Develop a conceptual model of each SWMU including estimated depths to the RGA and the derived flow paths and distances to the POEs using MODFLOW/MODPATH and the PGDP sitewide groundwater model.

2. Refine the source zones for each COPC in a SWMU using the SADA model.

3. Perform leachate modeling using SESOIL to estimate the rate of contaminant loading over time from each source area in a SWMU.

4. Perform saturated flow and transport modeling with AT123D using contaminant loading information from SESOIL.

Contaminant migration may have impacted three hydrogeologic units underlying the source areas at the SWMUs comprising the BGOU. These units, which control the flow of groundwater and contaminant migration at these SWMU source areas, are as follows (in descending order):

1. Upper Continential Recharge System (UCRS) – approximately 60 ft of silt and clay with horizons of sand and gravel;

2. RGA – approximately 40 ft of gravel, sand, and silt deposits that overlie the McNairy Formation; and

3. McNairy Formation – approximately 225 ft of sand and silt with some clay.

Previous work has shown that groundwater flow in the UCRS is primarily vertical and that the lateral groundwater flow in the McNairy is significantly slower than that in the RGA. The primary contaminant pathway considered in the fate and transport modeling is vertical migration through the UCRS followed by lateral migration in the RGA to the POEs.

SADA. Spatial Analysis and Decision Assistance model (UT 2005) was used to estimate the source volumes of COPCs from the sample results through geospatial interpolation techniques. (See Attachment E.1 for additional information on source delineation). Surface and subsurface sampling results were taken from the Paducah Oak Ridge Environmental Information System (Paducah OREIS). The limitations of this data include the lack of sampling results for the waste, which may exhibit higher concentrations than the surrounding soil samples. In addition, a portion of the waste is contained in drums at several SWMUs which was not modeled in this report. The limitations of the data used in the analyses are presented in detail in Section E.3.3. Information for each result included the sample and station identifier, the date of sample collection, the location and depth at which the sample was taken, whether the COPC was detected or not detected at the sample quantitation limit (SQL), and the result. The results initially were screened against the risk-based SSLs for protection of RGA groundwater for significant COPCs at PGDP contained in the Risk Methods Document (DOE 2001) (see Appendix F).

Modelers divided each COPC source area into rows and columns with a uniform spacing of 20 ft for SWMUs 2, 3, 4, 5, 6, 7, and 30 and a uniform spacing of 100 ft for SWMU 145. Multiple domains with varying depths were used to characterize the COPC source areas vertically in relation to the existing aquifers; therefore, the domain was further discretized into horizontal layers. COPC results for each domain were compiled, and COPC concentrations in each cell of the domain were predicted using geospatial interpolation.

The techniques in SADA that can be used for source term development are nearest neighbor, natural neighbor, inverse distance, ordinary kriging, and indicator kriging. The nearest neighbor technique was selected for source zone refinement because it yielded results that are most compatible with the conceptual site models of contaminant releases summarized in following sections. In addition, nearest neighbor interpolation provided greater contrast in contaminant concentrations and greater ease in source delineation through visual inspection.

As shown in the source term tables of following sections, the size of sources varied between the layers. The SESOIL input parameter for contaminant sources allows only one value for the source area; therefore, for each contaminant, the area of the SADA layer with the highest contaminant mass was used as the SESOIL input for source zone area. The COPC concentrations in the other layers were normalized to the area of the layer with the maximum mass.

SESOIL. Seasonal Soil Compartment Model (Bonazountas and Wagner 1984) was used for leachate modeling. SESOIL estimates contaminant concentrations in the soil profile following introduction via direct application and/or interaction with other media. The model defines the soil compartment as a soil column extending from the ground surface through the unsaturated zone to the top of the saturated soil zone/water table. Processes simulated in SESOIL are categorized in three cycles—the hydrologic cycle, sediment cycle, and pollutant cycle. Each cycle is a separate submodule in the SESOIL code. The hydrologic cycle includes rainfall, surface runoff, infiltration, soil-water content, evapotranspiration, and groundwater recharge. The sediment cycle includes sediment washload as a result of rainstorms (i.e., soil erosion that results from surface runoff). The pollutant cycle includes convective transport, volatilization, adsorption/desorption, and degradation/decay. A contaminant in SESOIL can partition in up to four phases (liquid, adsorbed, air, and pure). Output of the SESOIL model includes contaminant concentrations at various soil depths and contaminant loss from the unsaturated soil zone in terms of surface runoff, percolation to groundwater, volatilization, and degradation. SESOIL predicts the monthly contaminant load to the water table from the area of concern that can be directly input into the AT123D model for contaminant migration in the saturated zone to selected downgradient POEs.

The hydrologic modeling parameter values used in the SESOIL modeling were based on representative conditions at the PGDP and site specific values for the individual SWMU (Table E.3.1). The modeling parameters were selected so that they could account for expected variability in the hydraulic system and would be unlikely to underestimate contaminant release and transport. However, SESOIL does have limitations in regard to modeling waste that may potentially be located in the water table in the UCRS and contaminant transformations such as that resulting from radionuclide decay. These issues and their contribution to the uncertainty in the analyses are addressed in Section E.3.3.

Table E.3.1. Soil Parameters Used in SESOIL Modeling for the BGOU RI

Input Parameter	SWMU 2	Source
Soil type	Silty clay	PGDP site-specific
Bulk density (g/cm3)	1.46	Laboratory analysis
Percolation rate (cm/year)	11	PGDP calibrated model
Intrinsic permeability (cm2)	1.6E-10	Calibrated
Disconnectedness index	10	Calibrated
Porosity	0.45	Laboratory analysis
Depth to water table (m)		Site specific (to RGA) based on field observation
SWMU 2	19.5	
SWMU 3	19.8	
SWMU 4	19.2	
SWMU 5	18.3	
SWMU 6	19.2	
SWMU 7	18.3	
SWMU 30	18.6	
SWMU 145	17.7	
Fraction of organic carbon (%)	0.08	Laboratory analysis
Frendlich equation exponent	1	SESOIL default value

The chemical-specific parameters used in the SESOIL modeling included each COPC's solubility in water, organic carbon partition coefficient (K_{oc}), Henry's Law constant, distribution coefficient (K_d), diffusion coefficients in air and water, and, for TCE and radionuclides, degradation rate constant. The chemical-specific parameters are presented for each SWMU COPC in Sections E.3.1.1 through E.3.1.8. The K_d values for organic compounds were derived using the following relationship.

$$K_d = K_{oc} \times f_{oc}$$

where: K_d is the distribution coefficient,

K_{oc} is the organic carbon partition coefficient, and

f_{oc} is the fraction of organic carbon for source area soils.

The f_{oc} used for the unsaturated zone at PGDP was 0.08 (DOE 1998a).

AT123D. AT123D Simulation of Waste Transport in the Aquifer System (Yeh 1981) was used for saturated flow and contaminant transport modeling. AT123D computes the spatial-temporal concentration distribution of chemicals in the aquifer system and predicts the transient spread of a chemical plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D are advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the groundwater resulting from a mass release (either continuous or instant or depleting source) from a source. In the present modeling, the time varying mass loading was transferred from the SESOIL output file, and the concentrations of COPCs were estimated at the selected POEs. The chemical-specific parameters match those used in SESOIL modeling, except no degradation of TCE was assumed in the RGA. The chemical-specific parameters are presented for each SWMU COPC in Sections E.3.1.1 through E.3.1.8. Excluding the distance to the POEs, Table E.3.2

presents the hydrogeologic parameters used for saturated flow and contaminant transport modeling for the BGOU RI.

Table E.3.2. Hydrogeologic Parameters Used in AT123D Modeling for the BGOU RI

Input Parameter	SWMU 2	Source
Bulk density (kg/m3)	1,670	Laboratory analysis
Effective porosity	0.3	PGDP sitewide model calibrated value
Hydraulic conductivity (m/hour)		PGDP sitewide model calibrated value
SWMUs 2, 3, 4, 5, 6, 7, and 30	19.05	
SWMU 145	6.35	
Hydraulic gradient		PGDP sitewide model calibrated value
SWMUs 2 and 3	0.0002	
SWMU 4	0.0002	
SWMU 5	0.0002	
SWMUs 6 and 145	0.0008	
SWMU 7	0.0003	
SWMU 30	0.00036	
Aquifer thickness	9.14 m 30 ft	Site average
Longitudinal dispersivity (m)	15	Approximate values used in the past
Density of water (kg/m3)	1,000	Default
Fraction of organic carbon (%)	0.02	Laboratory analysis
Source Area	Variable	These dimensions were derived from the SADA analysis for each COPC.

MODFLOW/MODPATH. The U.S. Geological Survey's Modular Three-Dimensional Finite-Difference Ground-Water Model/A Particle-Tracking Postprocessor Model for MODFLOW (USGS 2005) computer codes were used to evaluate the particle tracks from selected BGOU SWMUs and to determine the distances to the POEs, hydraulic gradients, and hydraulic conductivities of the RGA for input into the AT123D model. Figure E.3.1 shows MODPATH particle tracks for all of the BGOU SWMUs.

E.3.1.1 SWMU 2

The C-749 Uranium Burial Ground (SWMU 2) is located within the west-central portion of the plant. SWMU 2 was used from 1951 to 1977 for the disposal of uranium and uranium-contaminated wastes. Disposal records for SWMU 2 indicate that 270 tons of uranium, 59,000 gal of oils, and 450 gal of TCE were disposed of in the unit (DOE 1999a).

E.3.1.1.1 Conceptual model for source areas at SWMU 2

SWMU 2 occupies an area of approximately 32,000 ft^2 (0.73 acres); with approximate dimensions of 160 ft by 200 ft. The thickness of the UCRS is estimated to be 64 ft (depth to the top of the RGA). The primary waste at SWMU 2 consists of uranium and uranium alloys, placed in pits that were excavated to depths of 7 to 17 ft. Other wastes at the unit consist of uranyl fluoride and TCE.

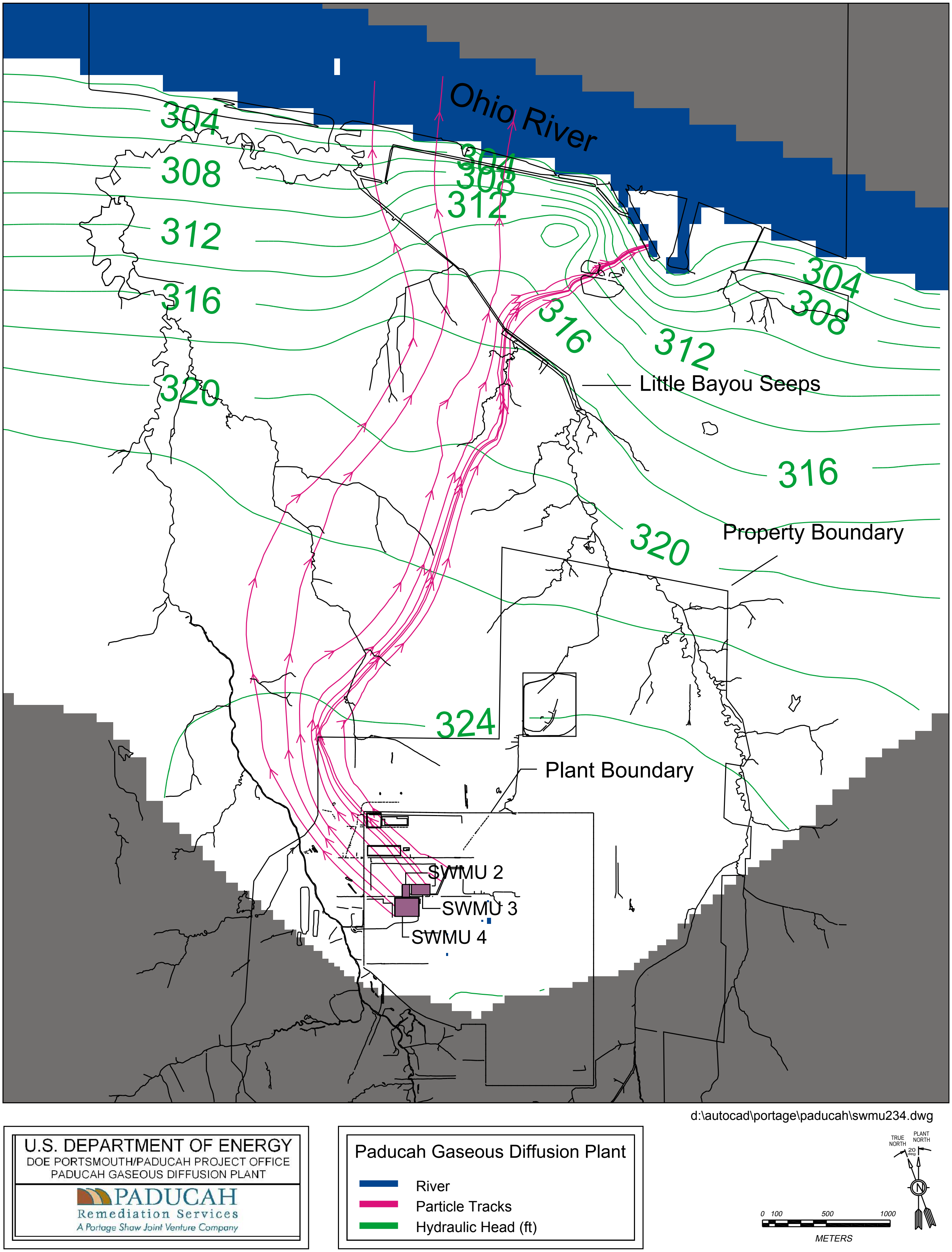

Figure E.3.1. Particle Tracking Results for SWMU 2, 3, and 4

The uranium buried at PGDP most likely is in the metallic state or is coated with uranium (IV) oxide. Neither of these forms of uranium is very susceptible to leaching. The kinetics of dissolution of the buried metal and uranium (IV) oxide is controlled by the amount of oxygen and carbon dioxide that leaches through the waste. Site records show that much of the metal was coated with oil. Petroleum-based oils are resistant to chemical and biological degradation and from leaching by percolating waters. In addition, oils consume oxygen as they slowly degrade, which lowers the oxidation-reduction potential. Under such conditions, uranium dissolution is negligible (ORNL 1998).

The conceptual model for SWMU 2 is that contaminants in the disposal site directly impacted soils below and adjacent to the areas where the material was buried and, through vertical infiltration in soil, potentially may impact the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.1.2 Contaminant transport modeling for SWMU 2 using SESOIL and AT123D

SESOIL allows for the input of 4 soil layers with up to 10 sublayers within each soil layer for contaminant source input. For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (3.5 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 64 ft in depth. Figure E.3.2 provides an illustraton of the SADA and SESOIL contaminant loading layers. Table E.3.3 presents the COPCs remaining after the screening process and the source terms for each COPC source zone at SWMU 2. Table E.3.4 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 2. The distances to the POEs used in the AT123D model for SWMU 2 are 1,528 ft to the plant boundary, 3,753 ft to the property boundary, and 21,126 ft to the Ohio River. SWMU 2 particle tracks do not travel to the Little Bayou seeps.

E.3.1.1.3 Groundwater modeling results for SWMU 2

Table E.3.5 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 2. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years [i.e., antimony, benzo(a)pyrene, mercury, nickel, ^{235}U, and vanadium] or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., zinc) (see Section 5.4 of the main text). PCB-1254 was detected at SWMU 2 in five samples; however it did not pass the initial screening for COPCs.

As shown in Table E.3.5, the predicted maximum groundwater concentrations of *cis*-1,2-DCE and TCE at the plant boundary, property boundary, and Ohio River are predicted to exceed the MCL in the future. None of the other COPCs are expected to attain concentrations that exceed their respective MCLs at any of the POEs.

SESOIL LAYER	SESOIL SUB LAYER	SADA LAYER
1 (0-1 ft)	1 (1 ft)	L1
2 (1-10 ft)	1 (9 ft)	L2
3 (10-50 ft)	1 (10 ft)	L3
	2 (10 ft)	L4
	3 (10 ft)	L5
	4 (10 ft)	L6
4 (50-64 ft)	1 (3.5 ft)	L7
	2 (3.5 ft)	
	3 (3.5 ft)	
	4 (3.5 ft)	

Figure E.3.2. Conceptualization of the SADA and SESOIL Layers for Contaminant Loading

Table E.3.3. Summary of Source Term Characteristics Developed by SADA for SWMU 2

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Antimony			
L1	0-1	11.60	1.77E+05	1.77E+05	8.48E+04	1.15	13.28
L2	01-10	10.05	1.54E+05	1.54E+06	6.41E+05	1.00	10.05
L3	10-20	0.00	0.00	0.00	0.00	0.00	0.00
L4	20-30	0.00	0.00	0.00	0.00	0.00	0.00
L5	30-40	0.00	0.00	0.00	0.00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-64	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		7.26E+05		
				Arsenic			
L1	0-1	22.10	4.80E+04	4.80E+04	4.39E+04	1.21	26.79
L2	01-10	8.36	3.96E+04	3.96E+05	1.37E+05	1.00	8.36
L3	10-20	6.85	3.96E+04	4.36E+05	1.23E+05	1.00	6.85
L4	20-30	5.77	3.96E+04	4.36E+05	1.04E+05	1.00	5.77
L5	30-40	6.47	3.96E+04	4.36E+05	1.16E+05	1.00	6.47
L6	40-50	5.87	3.96E+04	4.36E+05	1.06E+05	1.00	5.87
L7	50-64	4.92	3.96E+04	3.56E+05	7.26E+04	1.00	4.92
			Total Mass		7.03E+05		
				Benzo(a)pyrene			
L1	0-1	0.14	1.88E+04	1.88E+04	1.09E+02	1.00	0.14
L2	01-10	0.00	0.00	0.00	0.00	0.00	0.00
L3	10-20	0.00	0.00	0.00	0.00	0.00	0.00
L4	20-30	0.00	0.00	0.00	0.00	0.00	0.00
L5	30-40	0.00	0.00	0.00	0.00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-64	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		1.09E+02		
				***cis*-1,2-DCE**			
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L2	01-10	1.06	1.64E+04	1.64E+05	7.17E+03	2.41	2.55
L3	10-20	114.72	6.80E+03	7.48E+04	3.55E+05	1.00	114.72
L4	20-30	70.45	9.60E+03	1.06E+05	3.08E+05	1.41	99.46
L5	30-40	80.50	8.40E+03	9.24E+04	3.08E+05	1.24	99.44
L6	40-50	44.87	1.16E+04	1.28E+05	2.37E+05	1.71	76.54
L7	50-64	37.17	1.12E+04	1.01E+05	1.55E+05	1.65	61.22
			Total Mass		1.37E+06		
				Manganese			
L1	0-1	372.83	4.80E+04	4.80E+04	7.40E+05	1.21	451.92
L2	01-10	369.68	3.96E+04	3.96E+05	6.05E+06	1.00	369.68
L3	10-20	386.99	3.96E+04	4.36E+05	6.97E+06	1.00	386.99
L4	20-30	378.32	3.96E+04	4.36E+05	6.81E+06	1.00	378.32
L5	30-40	377.03	3.96E+04	4.36E+05	6.79E+06	1.00	377.03
L6	40-50	316.18	3.96E+04	4.36E+05	5.69E+06	1.00	316.18
L7	50-64	277.65	3.96E+04	3.56E+05	4.09E+06	1.00	277.65
			Total Mass		3.71E+07		

Table E.3.3. Summary of Source Term Characteristics Developed by SADA for SWMU 2 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Mercury			
L1	0-1	0.29	3.72E+04	3.72E+04	4.41E+02	1.00	0.29
L2	01-10	0.02	1.60E+03	1.60E+04	1.19E+01	0.04	0.0008
L3	10-20	0.02	8.00E+02	8.80E+03	6.18E+00	0.02	0.0004
L4	20-30	0.02	8.00E+02	8.80E+03	6.18E+00	0.02	0.0004
L5	30-40	0.00	0.00	0.00	0.00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-64	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		4.65E+02		
				Napthalene			
L1	0-1	0.27	3.72E+04	3.72E+04	4.17E+02	1.00	0.27
L2	01-10	0.00	0.00	0.00	0.00	0.00	0.00
L3	10-20	0.00	0.00	0.00	0.00	0.00	0.00
L4	20-30	0.00	0.00	0.00	0.00	0.00	0.00
L5	30-40	0.00	0.00	0.00	0.00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-64	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		4.17E+02		
				Nickel			
L1	0-1	29.10	4.80E+04	4.80E+04	5.77E+04	1.32	38.37
L2	01-10	11.31	3.56E+04	3.56E+05	1.66E+05	0.98	11.06
L3	10-20	11.97	3.64E+04	4.00E+05	1.98E+05	1.00	11.97
L4	20-30	10.76	3.20E+04	3.52E+05	1.57E+05	0.88	9.46
L5	30-40	10.88	3.28E+04	3.61E+05	1.62E+05	0.90	9.81
L6	40-50	10.95	2.92E+04	3.21E+05	1.45E+05	0.80	8.78
L7	50-64	10.04	2.88E+04	2.59E+05	1.08E+05	0.79	7.94
			Total Mass		9.94E+05		
				^{99}Tc			
L1	0-1	1.82	5.20E+04	5.20E+04	3.92E+09	1.67	3.04
L2	01-10	0.58	3.12E+04	3.12E+05	7.44E+09	1.00	0.58
L3	10-20	0.32	1.96E+04	2.16E+05	2.86E+09	0.63	0.20
L4	20-30	0.10	1.68E+04	1.85E+05	7.80E+08	0.54	0.06
L5	30-40	0.16	1.20E+04	1.32E+05	8.59E+08	0.38	0.06
L6	40-50	0.07	1.72E+04	1.89E+05	5.42E+08	0.55	0.04
L7	50-64	0.07	1.32E+04	1.19E+05	3.27E+08	0.42	0.03
			Total Mass		1.67E+10		
				TCE			
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00		
L2	01-10	0.13	9.60E+03	9.60E+04	5.11E+02	1.04	0.13
L3	10-20	42.65	9.20E+03	1.01E+05	1.78E+05	1.00	42.65
L4	20-30	24.28	1.16E+04	1.28E+05	1.28E+05	1.26	30.61
L5	30-40	14.58	1.16E+04	1.28E+05	7.69E+04	1.26	18.39
L6	40-50	8.94	1.28E+04	1.41E+05	5.20E+04	1.39	12.44
L7	50-64	0.20	1.08E+04	9.72E+04	8.06E+02	1.17	0.24
			Total Mass		4.37E+05		

Table E.3.3. Summary of Source Term Characteristics Developed by SADA for SWMU 2 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				^{234}U			
L1	0-1	16.01	5.20E+04	5.20E+04	3.44E+10	1.25	20.01
L2	01-10	14.33	4.16E+04	4.16E+05	2.46E+11	1.00	14.33
L3	10-20	0.81	4.28E+04	4.71E+05	1.57E+10	1.03	0.83
L4	20-30	0.76	4.04E+04	4.44E+05	1.39E+10	0.97	0.73
L5	30-40	0.83	4.12E+04	4.53E+05	1.56E+10	0.99	0.82
L6	40-50	0.72	4.08E+04	4.49E+05	1.34E+10	0.98	0.71
L7	50-64	0.64	4.20E+04	3.78E+05	9.92E+09	1.01	0.64
			Total Mass		3.49E+11		
				^{235}U			
L1	0-1	2.73	5.20E+04	5.20E+04	5.86E+09	1.30	3.55
L2	01-10	3.43	4.00E+04	4.00E+05	5.67E+10	1.00	3.43
L3	10-20	0.09	4.00E+04	4.40E+05	1.72E+09	1.00	0.09
L4	20-30	0.08	4.00E+04	4.40E+05	1.48E+09	1.00	0.08
L5	30-40	0.07	4.00E+04	4.40E+05	1.34E+09	1.00	0.07
L6	40-50	0.07	4.00E+04	4.40E+05	1.27E+09	1.00	0.07
L7	50-64	0.00	0.00	0.00	0.00E+00	0.00	0.00
			Total Mass		6.83E+10		
				^{238}U			
L1	0-1	88.34	5.20E+04	5.20E+04	1.90E+11	1.25	110.43
L2	01-10	83.85	4.16E+04	4.16E+05	1.44E+12	1.00	83.85
L3	10-20	1.49	4.28E+04	4.71E+05	2.90E+10	1.03	1.53
L4	20-30	1.10	4.04E+04	4.44E+05	2.02E+10	0.97	1.07
L5	30-40	1.02	4.12E+04	4.53E+05	1.92E+10	0.99	1.01
L6	40-50	0.88	4.08E+04	4.49E+05	1.64E+10	0.98	0.87
L7	50-64	0.71	4.20E+04	3.78E+05	1.11E+10	1.01	0.71
			Total Mass		1.73E+12		
				Uranium			
L1	0-1	167.67	4.80E+04	4.80E+04	3.33E+05	7.06	1,183.53
L2	01-10	798.80	6.80E+03	6.80E+04	2.25E+06	1.00	798.80
L3	10-20	14.51	8.80E+03	9.68E+04	5.81E+04	1.29	18.78
L4	20-30	18.13	1.44E+04	1.58E+05	1.19E+05	2.12	38.39
L5	30-40	13.60	1.12E+04	1.23E+05	6.93E+04	1.65	22.40
L6	40-50	12.45	8.00E+03	8.80E+04	4.53E+04	1.18	14.65
L7	50-64	5.79	9.20E+03	8.28E+04	1.98E+04	1.35	7.84
			Total Mass		2.89E+06		
				Vanadium			
L1	0-1	28.55	4.80E+04	4.80E+04	5.67E+04	1.26	36.06
L2	01-10	19.14	3.80E+04	3.80E+05	3.01E+05	1.00	19.14
L3	10-20	20.37	3.80E+04	4.18E+05	3.52E+05	1.00	20.37
L4	20-30	17.44	3.80E+04	4.18E+05	3.01E+05	1.00	17.44
L5	30-40	17.44	3.96E+04	4.36E+05	3.14E+05	1.04	18.17
L6	40-50	16.62	3.96E+04	4.36E+05	2.99E+05	1.04	17.32
L7	50-64	15.05	3.96E+04	3.56E+05	2.22E+05	1.04	15.68
			Total Mass		1.85E+06		

Table E.3.3. Summary of Source Term Characteristics Developed by SADA for SWMU 2 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Zinc			
L1	0-1	104.88	4.80E+04	4.80E+04	2.08E+05	1.00	104.88
L2	01-10	32.00	3.20E+03	3.20E+04	4.23E+04	0.07	2.13
L3	10-20	35.78	4.00E+03	4.40E+04	6.51E+04	0.08	2.98
L4	20-30	34.70	3.20E+03	3.52E+04	5.05E+04	0.07	2.31
L5	30-40	35.30	4.80E+03	5.28E+04	7.71E+04	0.10	3.53
L6	40-50	35.72	4.80E+03	5.28E+04	7.80E+04	0.10	3.57
L7	50-64	34.10	4.80E+03	4.32E+04	6.09E+04	0.10	3.41
			Total Mass		5.82E+05		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.4. Chemical-Specific Parameters of the COPCs Used in SEOIL Modeling of SWMU 2

COPCs	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Antimony	121.75	1.00E+07	NA	3.60E-07	NA	NA	45	infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Benzo(a)pyrene	252.32	1.62E-03	4.3E-02	3.24E-06	1.13E-06	9.69E+05	772	infinite
cis-1,2-DCE	96.94	3.50E+03	0.07	4.07E-06	4.08E-03	35.5	0.028	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	infinite
Naphthalene	128.16	31.0	0.059	2.70E-06	4.83E-04	1.19E+03	0.95	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{235}U	235	1.00E+07	NA	3.60E-07	NA	NA	66.8	7.04E+08
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

Table E.3.5. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 2

COPC	Predicted Maximum Groundwater Concentration[a,b] SWMU (mg/L)	Plant Boundary (mg/L)	Property Boundary (mg/L)	Ohio River (mg/L)	MCL (mg/L)
Arsenic	***3.54E-02***	2.91E-03	8.35E-09	0	0.01
cis-1,2-DCE	***1.15E+01***	***1.74E+00***	***8.58E-01***	***3.38E-01***	0.07
Manganese	***7.16E-01***	1.86E-05	0	0	[d]
Naphthalene	9.38E-04	1.57E-04	8.27E-05	3.42E-05	[d]
^{99}Tc	1.02E+02	15.9	8.06	3.11	900[c]
TCE	***1.48E+00***	***2.17E-01***	***1.10E-01***	***4.12E-02***	0.005
^{234}U	1.58E+00	1.75E-05	0	0	[d]
^{238}U	1.81E+00	2.03E-05	0	0	[d]
Uranium	9.86E-03	8.33E-08	0	0	0.03

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

The hazard quotients (HQs) and excess lifetime cancer risks (ELCRs) calculated in accordance with the Risk Methods Document are presented in Table E.3.6. (Appendix F provides a full description of the risk assessment methodology and calculations.) The predicted TCE concentrations result in the greatest HQs and cancer risks; therefore, TCE is the most important COC for contaminant migration at SWMU 2, while *cis*-1,2-DCE also provides (HQs) greater than 1. Arsenic also provides a cancer risk greater than 10^{-5}.

Table E.3.6. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 2 Using SESOIL and AT123D[a]

COC	SWMU Hazard Quotient	SWMU Cancer Risk	Plant Boundary Hazard Quotient	Plant Boundary Cancer Risk	Property Boundary Hazard Quotient	Property Boundary Cancer Risk	Near Ohio River Hazard Quotient	Near Ohio River Cancer Risk
Arsenic	1.13E+01	9.38E-04	0.9	7.7E-05	<0.1	<1.0E-06	[b]	[b]
cis-1,2-DCE	6.07E+02	[b]	91.9	[b]	45.3	[b]	17.9	[b]
Manganese	1.52E+00	[b]	<0.1	[b]	[b]	[b]	[b]	[b]
Naphthalene	4.74E-01	[b]	0.1	[b]	<0.1	[b]	<0.1	[b]
^{99}Tc	[b]	5.60E-06	[b]	<1.0E-06	[b]	<1.0E-06	[b]	<1.0E-06
TCE	6.76E+02	3.09E-02	99.1	6.7E-03	50.3	3.4E-03	4.6	1.3E-03
^{234}U	[b]	2.23E-06	[b]	<1.0E-06	[b]	[b]	[b]	[b]
^{238}U	[b]	2.68E-06	[b]	<1.0E-06	[b]	[b]	[b]	[b]
Uranium	1.58E+00	[b]	0.1	[b]	[b]	[b]	[b]	[b]

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.2 through 5.4 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06. As shown in these figures, arsenic is predicted to continue rising in concentration at 1,000 years at the plant boundary, but has not reached the property boundary or Ohio River in the 1,000 year period. Both *cis*-1,2-DCE and TCE are predicted to exceed the their MCLs at all POEs within approximately 100 years and then decline in concentration below the MCLs.

E.3.1.2 SWMU 3

The C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3) is located in the west-central portion of PGDP. PGDP operated SWMU 3 as a surface impoundment from approximately 1952 until early 1957. During this time, all influents to the impoundment originated from C-400. In 1957, the C-404 surface impoundment was converted to a solid waste disposal facility for solid uranium-contaminated wastes. Approximately 6,615,000 lb of uranium-contaminated wastes were disposed of at SWMU 3. The total volume is approximately 260,000 ft^3. Some uranium-contaminated waste also is contaminated with TCE, radionuclides, and metals. In 1986, the disposal of all waste at C-404 Landfill was halted, and a portion of the disposed waste was found to be Resource Conservation and Recovery Act (RCRA)-hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987 (DOE 1987; DOE 1989).

E.3.1.2.1 Conceptual model for source areas at SWMU 3

SWMU 3 occupies an area of approximately 53,200 ft^2 (1.2 acres), with approximate dimensions of 140 by 380 ft. The thickness of the UCRS is estimated to be 65 ft (depth to the top of the RGA). The primary wastes at SWMU 3 consist of uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, and radioactively contaminated trash. There are no records documenting the cleanout of sludges and sediments from the pond when it was converted to a landfill. A partial clay cap was installed on the eastern end of the landfill in 1982 (DOE 1987).

The conceptual model for SWMU 3 is that contaminants in the disposal site directly impacted soils below and adjacent to the areas where the material was landfilled and, through vertical infiltration in soil, may potentially impact the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.2.2 Contaminant transport modeling for SWMU 3 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. Although SWMU 3 waste is contained in a mounded area, the mounding was not modeled in SESOIL. Instead the waste was assumed to be located at grade. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (3.75 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 65 ft in depth. Table E.3.7 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.8 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 3. The distances to the POEs used in the AT123D model for SWMU 3 are 2,049 ft to the plant boundary, 4,455 ft to the property boundary, and 16,598 ft to the Little Bayou seeps.

Table E.3.7. Summary of Source Term Characteristics Developed by SADA for SWMU 3

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Arsenic			
L1	0-1	4.97	4.20E+05	4.20E+05	8.62E+04	0.51	2.54
L2	01-10	3.89	8.20E+05	8.20E+06	1.32E+06	1.00	3.89
L3	10-20	2.42	7.70E+05	8.47E+06	8.49E+05	0.94	2.28
L4	20-30	2.50	7.70E+05	8.47E+06	8.75E+05	0.94	2.35
L5	30-40	2.44	7.70E+05	8.47E+06	8.53E+05	0.94	2.29
L6	40-50	2.44	7.70E+05	8.47E+06	8.53E+05	0.94	2.29
L7	50-65	2.28	7.60E+05	6.84E+06	6.44E+05	0.93	2.11
			Total Mass		5.48E+06		
				Manganese			
L1	0-1	359.57	4.20E+05	4.20E+05	6.24E+06	0.50	179.79
L2	01-10	276.44	8.40E+05	8.40E+06	9.60E+07	1.00	276.44
L3	10-20	177.46	8.40E+05	9.24E+06	6.78E+07	1.00	177.46
L4	20-30	184.17	8.40E+05	9.24E+06	7.04E+07	1.00	184.17
L5	30-40	185.80	8.40E+05	9.24E+06	7.10E+07	1.00	185.80
L6	40-50	184.36	8.40E+05	9.24E+06	7.04E+07	1.00	184.36
L7	50-65	178.20	8.40E+05	7.56E+06	5.57E+07	1.00	178.20
			Total Mass		4.37E+08		
				Mercury			
L1	0-1	0.02	1.40E+05	1.40E+05	1.34E+02	1.08	0.02
L2	01-10	0.02	1.20E+05	1.20E+06	9.92E+02	0.92	0.02
L3	10-20	0.02	1.20E+05	1.32E+06	1.09E+03	0.92	0.02
L4	20-30	0.02	1.30E+05	1.43E+06	1.18E+03	1.00	0.02
L5	30-40	0.02	1.30E+05	1.43E+06	1.18E+03	1.00	0.02
L6	40-50	0.02	1.30E+05	1.43E+06	1.16E+03	1.00	0.02
L7	50-65	0.02	1.40E+05	1.26E+06	1.04E+03	1.08	0.02
			Total Mass		6.77E+03		
				Molybdenum			
L1	0-1	4.35	2.80E+05	2.80E+05	5.03E+04	1.87	8.12
L2	01-10	3.78	1.50E+05	1.50E+06	2.34E+05	1.00	3.78
L3	10-20	0.00	0.00	0.00	0.00	0.00	0.00
L4	20-30	0.00	0.00	0.00	0.00	0.00	0.00
L5	30-40	0.00	0.00	0.00	0.00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-65	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		2.85E+05		
				Nickel			
L1	0-1	7.90	4.20E+05	4.20E+05	1.37E+05	0.51	4.05
L2	01-10	9.89	7.20E+05	7.20E+06	2.94E+06	0.88	8.69
L3	10-20	8.20	8.20E+05	9.02E+06	3.06E+06	1.00	8.20
L4	20-30	8.17	8.10E+05	8.91E+06	3.01E+06	0.99	8.07
L5	30-40	8.11	8.10E+05	8.91E+06	2.99E+06	0.99	8.01
L6	40-50	8.04	8.30E+05	9.13E+06	3.03E+06	1.01	8.14
L7	50-65	8.04	8.20E+05	7.38E+06	2.45E+06	1.00	8.04
			Total Mass		1.76E+07		

Table E.3.7. Summary of Source Term Characteristics Developed by SADA for SWMU 3 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				^{99}Tc			
L1	0-1	12.58	2.60E+05	2.60E+05	1.35E+11	0.74	9.34
L2	01-10	26.86	3.50E+05	3.50E+06	3.89E+12	1.00	26.86
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L4	20-30	2.40	1.00E+04	1.10E+05	1.09E+10	0.03	0.07
L5	30-40	2.40	1.00E+04	1.10E+05	1.09E+10	0.03	0.07
L6	40-50	2.40	1.00E+04	1.10E+05	1.09E+10	0.03	0.07
L7	50-65	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		4.05E+12		
				TCE			
L1	0-1	0.0063	3.00E+04	3.00E+04	7.85E+00	3.00	0.02
L2	01-10	0.0152	1.00E+04	1.00E+05	6.28E+01	1.00	0.02
L3	10-20	0.0152	1.00E+04	1.10E+05	6.91E+01	1.00	0.02
L4	20-30	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L5	30-40	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L6	40-50	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L7	50-65	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		1.40E+02		
				^{238}U			
L1	0-1	1.29	4.20E+05	4.20E+05	2.24E+10	0.70	0.90
L2	01-10	6.67	6.00E+05	6.00E+06	1.65E+12	1.00	6.67
L3	10-20	12.63	1.90E+05	2.09E+06	1.09E+12	0.32	4.00
L4	20-30	12.63	1.90E+05	2.09E+06	1.09E+12	0.32	4.00
L5	30-40	12.26	1.90E+05	2.09E+06	1.06E+12	0.32	3.88
L6	40-50	12.26	1.90E+05	2.09E+06	1.06E+12	0.32	3.88
L7	50-65	10.53	2.00E+05	1.80E+06	7.84E+11	0.33	3.51
			Total Mass		6.76E+12		
				Uranium			
L1	0-1	15.97	2.90E+05	2.90E+05	1.92E+05	0.52	8.27
L2	01-10	20.56	5.60E+05	5.60E+06	4.76E+06	1.00	20.56
L3	10-20	40.45	1.80E+05	1.98E+06	3.31E+06	0.32	13.00
L4	20-30	38.59	1.90E+05	2.09E+06	3.33E+06	0.34	13.09
L5	30-40	36.09	1.80E+05	1.98E+06	2.95E+06	0.32	11.60
L6	40-50	36.09	1.80E+05	1.98E+06	2.95E+06	0.32	11.60
L7	50-65	40.62	1.50E+05	1.35E+06	2.27E+06	0.27	10.88
			Total Mass		1.98E+07		
				Vanadium			
L1	0-1	25.30	4.20E+05	4.20E+05	4.39E+05	0.50	12.65
L2	01-10	19.01	8.40E+05	8.40E+06	6.60E+06	1.00	19.01
L3	10-20	17.04	8.40E+05	9.24E+06	6.51E+06	1.00	17.04
L4	20-30	17.24	8.40E+05	9.24E+06	6.58E+06	1.00	17.24
L5	30-40	17.17	8.40E+05	9.24E+06	6.56E+06	1.00	17.17
L6	40-50	17.23	8.40E+05	9.24E+06	6.58E+06	1.00	17.23
L7	50-65	16.99	8.40E+05	7.56E+06	5.31E+06	1.00	16.99
			Total Mass		3.86E+07		

Table E.3.7. Summary of Source Term Characteristics Developed by SADA for SWMU 3 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Zinc			
L1	0-1	25.73	3.90E+05	3.90E+05	4.15E+05	0.60	15.44
L2	01-10	31.35	6.50E+05	6.50E+06	8.42E+06	1.00	31.35
L3	10-20	30.78	3.80E+05	4.18E+06	5.32E+06	0.58	17.99
L4	20-30	32.05	3.60E+05	3.96E+06	5.25E+06	0.55	17.75
L5	30-40	31.78	3.50E+05	3.85E+06	5.06E+06	0.54	17.11
L6	40-50	31.78	3.50E+05	3.85E+06	5.06E+06	0.54	17.11
L7	50-65	32.27	3.50E+05	3.15E+06	4.20E+06	0.54	17.38
			Total Mass		3.37E+07		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.8. Chemical-Specific Parameters of the COPCs Used in SEOIL Modeling of SWMU 3

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	infinite
Molybdenum	95.9	1.00E+07	NA	3.60E-07	NA	NA	10	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

E.3.1.2.3 Groundwater modeling results for SWMU 3

Table E.3.9 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 3. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years (i.e., molybdenum, nickel, and vanadium) or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., mercury, TCE, and zinc) (see Section 5.4 of the main text).

Table E.3.9. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 3

	Predicted Maximum Groundwater Concentration[a,b]				
COPC	**SWMU (mg/L)**	**Plant Boundary (mg/L)**	**Property Boundary (mg/L)**	**Little Bayou seeps (mg/L)**	**MCL (mg/L)**
Arsenic	***3.29E-02***	1.22E-03	0	0	0.01
Manganese	***8.95E-01***	4.08E-10	0	0	
^{99}Tc	***5.560E+03***	1.81E+03	1,360	804	900[c]
^{238}U	1.59E+01	7.32E-11	0	0	[d]
Uranium	***4.89E-02***	2.27E-13	0	0	0.03

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

As shown in Table E.3.9, the predicted maximum groundwater concentrations for all COPCs except ^{99}Tc are less than the MCLs for the contaminants at the POEs. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.10. The predicted ^{99}Tc concentrations result in the greatest cancer risks; therefore, ^{99}Tc is the most important COC for contaminant migration at SWMU 3, while arsenic also provides an elevated cancer risk.

Table E.3.10. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 3 Using SESOIL and AT123D[a]

	SWMU		Plant Boundary		Property Boundary		Little Bayou Seeps	
COC	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**
Arsenic	1.05E+01	8.72E-04	0.4	3.2E-05	[b]	[b]	[b]	[b]
Manganese	3.65E+00	[b]	<0.1	[b]	[b]	[b]	[b]	[b]
^{99}Tc	[b]	3.05E-04	[b]	9.9E-05	[b]	7.5E-05	[b]	4.4E-05
Uranium	7.82E+00	[b]	<0.1	[b]	[b]	[b]	[b]	[b]

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.5 and 5.6 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06. As shown in these figures, arsenic is predicted to continue rising in concentration at 1,000 years at the plant boundary, but has not reached the property boundary or Little Bayou Seeps in the 1,000 year period. ^{99}Tc is predicted to exceed the MCL within 200 years and then decline in concentration at the plant and property POEs.

E.3.1.3 SWMU 4

The C-747 Contaminated Burial Yard and the C-748-B Burial Area (SWMU 4) is located in the western section of the plant area. PGDP used the C-747 Burial Yard from 1951 to 1958 for the disposal of radiologically contaminated and uncontaminated debris originating from the C-410 uranium hexafluoride feed plant. The area consists of two pits covering an area of approximately 8,300 ft^2 (50 ft by 15 ft and 50 ft by 150 ft) (Union Carbide 1978). The C-748-B Burial Area is listed in the 1973 Union Carbide document on waste disposal as a Proposed Chemical Landfill Site and is located on the west side of C-747. SWMU 4 also may have received sludges designated for disposal at the C-404 Burial Grounds. These sludges potentially included uranium-contaminated solid waste and ^{99}Tc contaminated magnesium fluoride. Potential contaminants associated with this SWMU include uranium, ^{99}Tc, metals, and TCE (DOE 1998c).

E.3.1.3.1 Conceptual model for source areas at SWMU 4

SWMU 4 occupies an area of approximately 286,700 ft^2 (6.6 acres). The thickness of the UCRS is estimated to be 63 ft (depth to the top of the RGA). The conceptual model for SWMU 4 is that potentially contaminated trash and scrap was buried in waste pits at SWMU 4. Subsequently, contaminants in the disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs. Previous work on the Southwest Plume discusses a secondary TCE DNAPL source in the RGA below SWMU 4. This source was not modeled, however, further discussion is provided in Section E.3.3.7.

E.3.1.3.2 Contaminant transport modeling for SWMU 4 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (3.25 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 63 ft in depth, the four sublayer division of this layer allowed for better numerical solution of the final flux to the RGA. Table E.3.11 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.12 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 4. The distances to the POEs used in the AT123D model for SWMU 3 are 984 ft to the plant boundary, 3,000 ft to the property boundary, and 22,967 ft to the Ohio River. SWMU 4 particle tracks do not travel to the Little Bayou seeps.

Table E.3.11. Summary of Source Term Characteristics Developed by SADA for SWMU 4

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Arsenic			
L1	0-1	8.87	1.14E+05	1.14E+05	4.16E+04	2.12	18.79
L2	01-10	8.48	5.36E+04	5.36E+05	1.88E+05	1.00	8.48
L3	10-20	6.76	2.88E+04	3.17E+05	8.85E+04	0.54	3.63
L4	20-30	6.70	3.24E+04	3.56E+05	9.87E+04	0.60	4.05
L5	30-40	6.43	2.96E+04	3.26E+05	8.65E+04	0.55	3.55
L6	40-50	6.37	2.48E+04	2.73E+05	7.18E+04	0.46	2.95
L7	50-63	5.81	1.76E+04	1.06E+05	2.53E+04	0.33	1.91
			Total Mass		6.00E+05		
				***cis*-1,2-DCE**			
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00		
L2	01-10	3.84	1.32E+04	1.32E+05	2.10E+04	0.31	1.20
L3	10-20	1.64	3.48E+04	3.83E+05	2.60E+04	0.82	1.35
L4	20-30	1.54	4.24E+04	4.66E+05	2.97E+04	1.00	1.54
L5	30-40	1.11	4.92E+04	5.41E+05	2.49E+04	1.16	1.29
L6	40-50	0.88	4.76E+04	5.24E+05	1.90E+04	1.12	0.98
L7	50-63	0.98	4.96E+04	2.98E+05	1.21E+04	1.17	1.15
			Total Mass		1.33E+05		

Table E.3.11. Summary of Source Term Characteristics Developed by SADA for SWMU 4 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Manganese			
L1	0-1	475.31	3.47E+05	3.47E+05	6.82E+06	1.50	711.33
L2	01-10	327.05	2.32E+05	2.32E+06	3.14E+07	1.00	327.05
L3	10-20	320.36	2.32E+05	2.55E+06	3.38E+07	1.00	320.36
L4	20-30	193.55	2.32E+05	2.55E+06	2.04E+07	1.00	193.55
L5	30-40	178.70	2.32E+05	2.55E+06	1.89E+07	1.00	178.70
L6	40-50	234.60	2.32E+05	2.55E+06	2.48E+07	1.00	234.60
L7	50-63	133.92	2.32E+05	1.39E+06	7.71E+06	1.00	133.92
			Total Mass		1.44E+08		
				Nickel			
L1	0-1	21.47	2.72E+05	2.72E+05	2.41E+05	1.36	29.10
L2	01-10	16.79	2.00E+05	2.00E+06	1.39E+06	1.00	16.79
L3	10-20	12.83	1.93E+05	2.12E+06	1.12E+06	0.96	12.34
L4	20-30	14.05	1.22E+05	1.35E+06	7.82E+05	0.61	8.58
L5	30-40	15.75	1.06E+05	1.17E+06	7.59E+05	0.53	8.33
L6	40-50	13.23	1.21E+05	1.33E+06	7.29E+05	0.60	8.00
L7	50-63	10.99	1.14E+05	6.84E+05	3.11E+05	0.57	6.25
			Total Mass		5.34E+06		
				^{99}Tc			
L1	0-1	39.00	1.36E+04	1.36E+04	2.19E+10	0.17	6.53
L2	01-10	49.65	8.12E+04	8.12E+05	1.67E+12	1.00	49.65
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L7	50-63	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		1.69E+12		
				TCE			
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00		
L2	01-10	2.39	8.24E+04	8.24E+05	8.16E+04	0.86	2.06
L3	10-20	2.85	6.60E+04	7.26E+05	8.55E+04	0.69	1.96
L4	20-30	3.02	7.24E+04	7.96E+05	9.93E+04	0.75	2.28
L5	30-40	2.56	9.60E+04	1.06E+06	1.12E+05	1.00	2.56
L6	40-50	2.45	9.84E+04	1.08E+06	1.10E+05	1.03	2.51
L7	50-63	3.15	9.96E+04	5.98E+05	7.77E+04	1.04	3.26
			Total Mass		5.65E+05		
				^{234}U			
L1	0-1	15.57	3.47E+05	3.47E+05	2.24E+11	2.03	31.66
L2	01-10	27.69	1.75E+05	1.75E+06	2.01E+12	1.03	28.40
L3	10-20	27.59	1.71E+05	1.88E+06	2.14E+12	1.00	27.59
L4	20-30	28.03	1.67E+05	1.83E+06	2.13E+12	0.98	27.38
L5	30-40	28.26	1.62E+05	1.78E+06	2.08E+12	0.95	26.74
L6	40-50	28.76	1.58E+05	1.73E+06	2.06E+12	0.92	26.53
L7	50-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		1.06E+13		

Table E.3.11. Summary of Source Term Characteristics Developed by SADA for SWMU 4 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				^{238}U			
L1	0-1	30.55	3.47E+05	3.47E+05	4.39E+11	2.03	62.10
L2	01-10	52.13	1.75E+05	1.75E+06	3.78E+12	1.03	53.48
L3	10-20	51.72	1.71E+05	1.88E+06	4.02E+12	1.00	51.72
L4	20-30	52.47	1.67E+05	1.83E+06	3.98E+12	0.98	51.25
L5	30-40	52.77	1.62E+05	1.78E+06	3.88E+12	0.95	49.93
L6	40-50	53.71	1.58E+05	1.73E+06	3.85E+12	0.92	49.56
L7	50-63	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		1.99E+13		
				Uranium			
L1	0-1	118.94	3.47E+05	3.47E+05	1.71E+06	2.03	241.79
L2	01-10	884.57	1.75E+05	1.75E+06	6.41E+07	1.03	907.36
L3	10-20	827.57	1.71E+05	1.88E+06	6.43E+07	1.00	827.57
L4	20-30	807.78	1.67E+05	1.83E+06	6.13E+07	0.98	788.86
L5	30-40	789.77	1.62E+05	1.78E+06	5.80E+07	0.95	747.23
L6	40-50	768.17	1.58E+05	1.73E+06	5.51E+07	0.92	708.80
L7	50-63	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
			Total Mass		3.04E+08		
				Vanadium			
L1	0-1	25.21	3.47E+05	3.47E+05	3.62E+05	1.50	37.73
L2	01-10	21.69	2.32E+05	2.32E+06	2.08E+06	1.00	21.69
L3	10-20	22.83	2.32E+05	2.55E+06	2.41E+06	1.00	22.83
L4	20-30	26.28	2.32E+05	2.55E+06	2.77E+06	1.00	26.28
L5	30-40	25.06	2.32E+05	2.55E+06	2.64E+06	1.00	25.06
L6	40-50	22.81	2.32E+05	2.55E+06	2.41E+06	1.00	22.81
L7	50-63	20.40	2.32E+05	1.39E+06	1.17E+06	1.00	20.40
			Total Mass		1.38E+07		
				Vinyl Chloride			
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L2	01-10	0.16	6.40E+03	6.40E+04	4.15E+02	0.37	0.06
L3	10-20	0.08	1.64E+04	1.80E+05	6.05E+02	0.95	0.08
L4	20-30	0.09	9.20E+03	1.01E+05	3.95E+02	0.53	0.05
L5	30-40	0.19	1.72E+04	1.89E+05	1.49E+03	1.00	0.19
L6	40-50	0.18	1.76E+04	1.94E+05	1.43E+03	1.02	0.18
L7	50-63	0.20	2.08E+04	1.25E+05	1.04E+03	1.21	0.24
			Total Mass		5.37E+03		
				Zinc			
L1	0-1	40.73	3.26E+05	3.26E+05	5.50E+05	1.00	40.73
L2	01-10	8.48	5.36E+04	5.36E+05	1.88E+05	0.16	1.39
L3	10-20	6.76	2.88E+04	3.17E+05	8.85E+04	0.09	0.60
L4	20-30	6.70	3.24E+04	3.56E+05	9.87E+04	0.10	0.67
L5	30-40	6.43	2.96E+04	3.26E+05	8.65E+04	0.09	0.58
L6	40-50	6.37	2.48E+04	2.73E+05	7.18E+04	0.08	0.48
L7	50-63	5.81	1.76E+04	1.06E+05	2.53E+04	0.05	0.31
			Total Mass		1.11E+06		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.12. Chemical-Specific Parameters of the COPCs Used in SEOIL Modeling of SWMU 4

COPCs	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
cis-1,2-DCE	96.94	3.50E+03	0.07	4.07E-06	4.08E-03	35.5	0.028	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite
Vinyl Chloride	63	2,760	0.11	4.43E-07	0.0270	18.8	0.0152	26.6

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

E.3.1.3.3 Groundwater modeling results for SWMU 4

Table E.3.13 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 4. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years (i.e., arsenic, antimony, nickel, ^{234}U, ^{238}U, and vanadium) or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., zinc) (see Section 5.4 of the main text).

Table E.3.13. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 4

COPC	Predicted Maximum Groundwater Concentration[a,b]				
	SWMU (mg/L)	Plant Boundary (mg/L)	Property Boundary (mg/L)	Ohio River (mg/L)	MCL (mg/L)
Arsenic	***1.77E-02***	2.70E-03	4.89E-06	0	0.01
cis-1,2-DCE	***6.68E-01***	***1.96E-01***	***8.94E-02***	3.16E-02	0.07
Manganese	***5.76E-01***	5.01E-03	0	0	[d]
^{99}Tc	***9.008E+03***	***2,501***	***1,200***	379	900[c]
TCE	***1.18E+00***	***4.22E-01***	***2.14E-01***	***7.67E-02***	0.005
Vinyl Chloride	***2.61E-02***	***5.95E-03***	***2.53E-03***	7.82E-04	0.002

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

As shown in Table E.3.13, the predicted maximum groundwater concentrations for *cis*-1,2-DCE, ^{99}Tc, TCE and vinyl chloride exceed the MCLs at the plant and property boundary. TCE also is predicted to exceed the MCL at the Ohio River. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.14. The predicted TCE, vinyl chloride, and ^{99}Tc concentrations result in the greatest cancer risks; with TCE being the most important COC for contaminant migration at SWMU 4. TCE also exhibits the highest HQ for SWMU 4.

Table E.3.14. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 4 Using SESOIL and AT123D[a]

	SWMU		Plant Boundary		Property Boundary		Near Ohio River	
COC	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**
Arsenic	5.67E+00	4.69E-04	0.9	7.2E-05	<0.1	<1.0E-06	[b]	[b]
cis-1,2-DCE	3.53E+01	[b]	10.4	[b]	4.7	[b]	0.6	[b]
Manganese	1.23E+00	[b]	<0.1	[b]	[b]	[b]	[b]	[b]
^{99}Tc	[b]	4.94E-04	[b]	1.4E-04	[b]	6.6E-05	[b]	2.1E-05
TCE	5.39E+02	3.67E-02	193	2.0E-02	97.7	6.6E-03	32.7	2.4E-03
Vinyl Chloride	1.21E+00	1.65E-02	0.3	1.9E-04	0.1	7.4E-05	<0.1	2.3E-05

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.7 through 5.11 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06 for contaminants migrating from SWMU 4. As shown in these figures, manganese is predicted to continue rising in concentration at 1,000 years at the plant boundary, but has not reached the property boundary or Ohio River in the 1,000 year period. *Cis*-1,2-DCE; ^{99}Tc; TCE; and vinyl chloride are predicted to exceed the MCL at the plant and property boundaries within 100 years. TCE also is predicted to exceed the MCL at the Ohio River within 100 years.

E.3.1.4 SWMU 5

The C-746-F Burial Yard is located in the northwestern section of the PGDP secured area, adjacent to SWMU 6 to the east. Disposal pits were located on a grid system. Documentation of the size of these grids ranges from 10 ft by 10 ft cells to 20 ft by 20 ft cells excavated to a depth of 6 to 15 ft bgs. SWMU 5 was in operation from 1965 to 1987. The burial pits were used for the burial of components from the “Work for Others” activities, some radionuclide-contaminated scrap metal, and slag from the nickel and aluminum smelters. Metals and radioisotopes are the primary potential contaminants of interest at this SWMU.

E.3.1.4.1 Conceptual model for source areas at SWMU 5

SWMU 5 occupies an area of approximately 197,400 ft^2 (4.5 acres). The thickness of the UCRS is estimated to be 60 ft (depth to the top of the RGA). Metals and radionuclides were buried in pits at SWMU 5. The conceptual model for SWMU 5 is that contaminants in disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.4.2 Contaminant transport modeling for SWMU 5 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (2.5 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 60 ft in depth. Table E.3.15 presents the COPCs remaining after the screening process and the source terms for each COPC.

Table E.3.15. Summary of Source Term Characteristics Developed by SADA for SWMU 5

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Acenaphthene			
L1	0-1	2.71	1.54E+05	1.54E+05	1.73E+04	1.00E+00	2.71
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.73E+04		
				Anthracene			
L1	0-1	3.51	1.80E+05	1.80E+05	2.61E+04	1.00E+00	3.51
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		2.61E+04		
				Arsenic			
L1	0-1	8.78	1.04E+05	1.04E+05	3.79E+04	1.76E+00	15.49
L2	01-10	2.51	4.52E+04	4.07E+05	4.22E+04	7.64E-01	1.91
L3	10-20	2.31	4.12E+04	4.12E+05	3.94E+04	6.96E-01	1.61
L4	20-30	3.47	5.92E+04	5.92E+05	8.49E+04	1.00E+00	3.47
L5	30-40	1.65	3.48E+04	3.48E+05	2.38E+04	5.88E-01	0.97
L6	40-50	1.79	3.72E+04	3.72E+05	2.75E+04	6.28E-01	1.12
L7	50-60	1.50	3.48E+04	3.48E+05	2.16E+04	5.88E-01	0.88
			Total Mass		2.77E+05		
				Benzo(a)pyrene			
L1	0-1	6.14	2.52E+05	2.52E+05	6.40E+04	1.00E+00	6.14
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		6.40E+04		
				Dibenz(a,h)anthracene			
L1	0-1	0.44	2.96E+04	2.96E+04	5.40E+02	1.00E+00	0.44
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		5.40E+02		

Table E.3.15. Summary of Source Term Characteristics Developed by SADA for SWMU 5 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Fluoranthene			
L1	0-1	14.25	1.79E+05	1.79E+05	1.06E+05	1.00E+00	14.25
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.06E+05		
				Fluorene			
L1	0-1	3.29	1.32E+05	1.32E+05	1.80E+04	1.00E+00	3.29
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.80E+04		
				Manganese			
L1	0-1	3.82E+02	4.03E+05	4.03E+05	6.36E+06	2.21E+00	845.91
L2	01-10	1.79E+02	1.82E+05	1.64E+06	1.21E+07	1.00E+00	179.07
L3	10-20	1.85E+02	1.82E+05	1.82E+06	1.39E+07	1.00E+00	185.24
L4	20-30	1.56E+02	1.82E+05	1.82E+06	1.17E+07	1.00E+00	155.86
L5	30-40	1.54E+02	1.82E+05	1.82E+06	1.16E+07	1.00E+00	154.05
L6	40-50	2.00E+02	1.82E+05	1.82E+06	1.50E+07	1.00E+00	199.52
L7	50-60	2.58E+02	1.82E+05	1.82E+06	1.94E+07	1.00E+00	258.26
			Total Mass		9.02E+07		
				Naphthalene			
L1	0-1	3.80	8.00E+03	8.00E+03	1.26E+03	1.00E+00	3.80
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.26E+03		
				Nickel			
L1	0-1	2.79E+01	3.88E+05	3.88E+05	4.47E+05	2.44E+00	68.15
L2	01-10	1.03E+01	1.43E+05	1.29E+06	5.50E+05	9.02E-01	9.32
L3	10-20	1.04E+01	1.42E+05	1.42E+06	6.14E+05	8.97E-01	9.36
L4	20-30	1.12E+01	1.59E+05	1.59E+06	7.33E+05	1.00E+00	11.16
L5	30-40	9.20E+00	1.39E+05	1.39E+06	5.28E+05	8.74E-01	8.04
L6	40-50	1.01E+01	1.50E+05	1.50E+06	6.29E+05	9.47E-01	9.58
L7	50-60	9.87E+00	1.54E+05	1.54E+06	6.29E+05	9.70E-01	9.58
			Total Mass		4.13E+06		

Table E.3.15. Summary of Source Term Characteristics Developed by SADA for SWMU 5 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				PCB-1260			
L1	0-1	0.15	1.34E+05	1.34E+05	8.23E+02	1.00E+00	0.15
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		8.23E+02		
				Pyrene			
L1	0-1	8.29	2.82E+05	2.82E+05	9.68E+04	1.00E+00	8.29
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		9.68E+04		
				Selenium			
L1	0-1	1.17	2.56E+04	2.56E+04	1.23E+03	1.00E+00	1.17
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.23E+03		
				TCE			
L1	0-1	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L2	01-10	0.0028	5.92E+04	5.33E+05	6.26E+01	1.00E+00	0.0028
L3	10-20	0.0029	6.04E+04	6.04E+05	7.34E+01	1.02E+00	0.0030
L4	20-30	0.0030	5.96E+04	5.96E+05	7.35E+01	1.01E+00	0.0030
L5	30-40	0.0030	5.92E+04	5.92E+05	7.43E+01	1.00E+00	0.0030
L6	40-50	0.0031	5.64E+04	5.64E+05	7.33E+01	9.53E-01	0.0030
L7	50-60	0.0032	5.44E+04	5.44E+05	7.28E+01	9.19E-01	0.0030
			Total Mass		4.30E+02		
				Vanadium			
L1	0-1	20.65	4.03E+05	4.03E+05	3.44E+05	2.21	45.71
L2	01-10	23.18	1.82E+05	1.64E+06	1.57E+06	1.00	23.18
L3	10-20	22.14	1.82E+05	1.82E+06	1.67E+06	1.00	22.14
L4	20-30	24.70	1.82E+05	1.82E+06	1.86E+06	1.00	24.70
L5	30-40	18.45	1.82E+05	1.82E+06	1.39E+06	1.00	18.45
L6	40-50	19.13	1.82E+05	1.82E+06	1.44E+06	1.00	19.13
L7	50-60	18.00	1.82E+05	1.82E+06	1.35E+06	1.00	18.00
			Total Mass		9.62E+06		

Table E.3.15. Summary of Source Term Characteristics Developed by SADA for SWMU 5 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Zinc			
L1	0-1	70.69	3.21E+05	3.21E+05	9.38E+05	2.37	167.74
L2	01-10	32.20	1.30E+05	1.17E+06	1.56E+06	0.96	30.96
L3	10-20	32.87	1.33E+05	1.33E+06	1.81E+06	0.99	32.38
L4	20-30	34.66	1.27E+05	1.27E+06	1.82E+06	0.94	32.51
L5	30-40	37.01	1.15E+05	1.15E+06	1.76E+06	0.85	31.53
L6	40-50	42.44	1.28E+05	1.28E+06	2.25E+06	0.95	40.30
L7	50-60	40.94	1.35E+05	1.35E+06	2.29E+06	1.00	40.94
			Total Mass		1.24E+07		
				^{99}Tc			
L1	0-1	7.16	1.42E+05	1.42E+05	4.22E+10	1.00	7.16
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
L7	50-60	3.89	9.60E+03	9.60E+04	1.54E+10	0.07	0.26
			Total Mass		5.76E+10		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.16 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 5. Figure E.3.3 shows the particle tracks that were modeled for SWMUs 5 and 6. The distances to the POEs used in the AT123D model for SWMU 5 are 778 ft to the plant boundary, 2,293 ft to the property boundary, and 19,844 ft to the Ohio River. SWMU 5 particle tracks do not travel to the Little Bayou seeps.

Table E.3.16. Chemical-Specific Parameters of the COPCs Used in SESOIL Modeling of SWMU 5

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Anthracene	178.24	0.043	0.032	2.79E-06	5.55E-05	2.04E+04	16.3	infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Benzo(a)pyrene	252.32	1.62E-03	4.3E-02	3.24E-06	1.13E-06	9.69E+05	772	infinite
Dibenzo(a,h)anthracene	278.33	0.0025	0.020	1.86E-06	1.47E-08	1.78E+06	1424	infinite
Fluorathene	202.26	0.206	0.030	2.29E-06	1.61E-05	4.91E+04	39.3	infinite
Fluorene	166.0	1.90	0.061	2.84E-06	7.7E-05	7.9E+03	6.3	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Naphthalene	128.16	31.0	0.059	2.70E-06	4.83E-04	1.19E+03	0.95	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
PCB-1260	375.70	0.027	0.014	4.32E-06	7.40E-05	2.07E+05	165.6	infinite
Pyrene	202.3	0.135	0.0272	2.61E-06	1.1E-05	6.8E+04	54.4	infinite
Selenium	80.98	1.00E+07	NA	3.60E-07	NA	NA	5	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

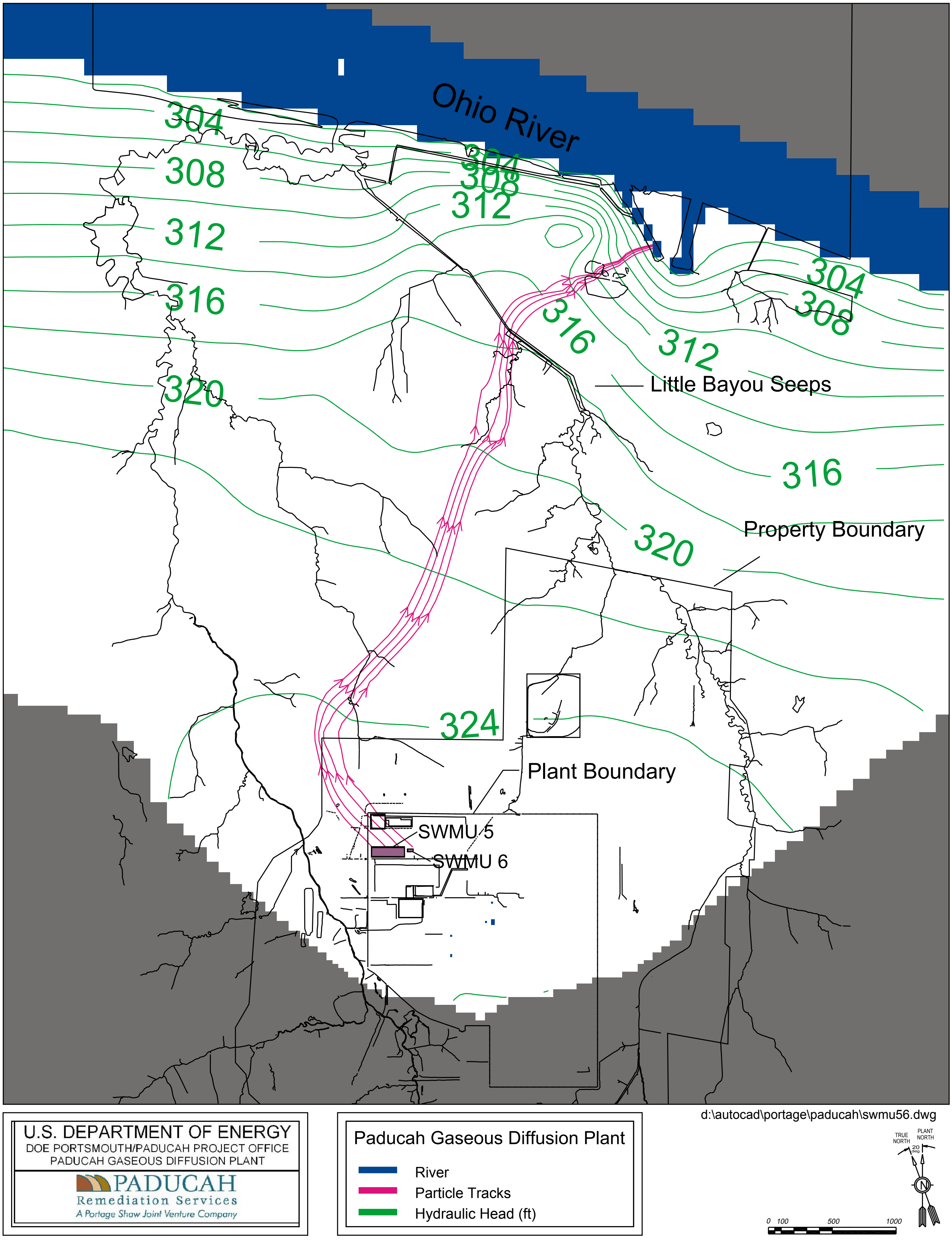

Figure E.3.3. Particle Tracks for SWMUs 5 and 6

E.3.1.4.3 Groundwater modeling results for SWMU 5

Table E.3.17 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 5. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years [i.e., benzo(a)pyrene, dibenzo(a,h)anthracene, fluoranthene, PCB-1260, pyrene, and vanadium] or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., acenaphthene, anthracene, fluorine, nickel, selenium, TCE, and zinc) (see Section 5.4 of the main text).

Table E.3.17. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 5

COPC	Predicted Maximum Groundwater Concentration[a,b] SWMU (mg/L)	Plant Boundary (mg/L)	Property Boundary (mg/L)	Ohio River (mg/L)	MCL (mg/L)
Arsenic	9.25E-03	1.78E-03	1.27E-04	0	0.01
Manganese	***1.01E+00***	***8.69E-02***	2.30E-11	0	[d]
Naphthalene	5.55E-03	9.82E-04	3.72E-04	1.08E-04	na
^{99}Tc	1.27E+02	49.9	26.4	8.72	900[c]

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

All COPCs are less than their MCL (note acenaphthene, manganese, and naphthatlene do not have MCLs). The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.18. The predicted arsenic concentration at the plant boundary results in the greatest HQ, with napthalen and mangansese also exhibiting a HQ above 0.1. Arsenic presents the highest cancer risk followed by ^{99}Tc.

Table E.3.18. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 5 Using SESOIL and AT123D[a]

COC	SWMU		Plant Boundary		Property Boundary		Near Ohio River	
	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk
Arsenic	2.96E+00	2.45E-04	0.6	4.7E-05	<0.1	3.4E-06	[b]	[b]
Manganese	2.15E+00	[b]	0.2	[b]	<0.1	[b]	[b]	[b]
Naphthalene	2.80E+00	[b]	0.5	[b]	0.2	[b]	<0.1	[b]
^{99}Tc	[b]	6.97E-06	[b]	2.7E-06	[b]	1.4E-06	[b]	<1.0E-06

[a] Contaminants with a HQ greater than 1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.12 through 5.15 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06 (see Table E.3.18) for contaminants migrating from SWMU 5. As shown in these figures, manganese is predicted to continue rising in concentration at 1,000 years at the plant boundary, but has not reached the property boundary or Ohio River in the 1,000 year period. Arsenic is also increasing in concentration at the plant boundary at 1,000 years, however the concentrations are less than the MCL. ^{99}Tc is not predicted to exceed the MCL at the POEs.

E.3.1.5 SWMU 6

The C-747-B Burial Ground is located in the northwest section of the plant area east of SWMU5. PGDP buried waste at SWMU 6 in five separate burial cells between 1960 and 1976. The contents of each cell are as follows (DOE 2000b):

- Area H—Magnesium Scrap Burial Area. The scrap buried at this location is magnesium, in various shapes generated in the machine shop.

- Area I—Exhaust Fan Burial Area. Eight exhaust hood blowers removed from C-710 were discarded in this pit. These blowers, which were about 15 inches in diameter and weighed about 100 lb each, were discarded in 1966 because of contamination with perchloric acid. Each blower was spaced about 4 ft apart in the hole.

- Area J—Contaminated Aluminum Burial Area. The contaminated scrap buried in this hole involved aluminum scrap in the form of nuts, bolts, plates, trimmings, etc., that were generated in the converter and compressor shop. This scrap was buried about 1960 or 1962.

- Area K—Magnesium Scrap Burial Area. The scrap buried at this location is magnesium in various shapes generated in the machine shop.

- Area L—Modine Trap Burial Area. A single contaminated modine trap was buried in this area. The cold trap was about 4 ft in diameter, approximately 15 ft long, and weighed about 5,000 lb.

Approximately 50% of the surface area of SWMU 6 formerly has been used to store radioactively-contaminated equipment and materials. These items include industrial forklifts and transport carts, flatbed trailers, generators, concrete pipes, and other miscellaneous items (DOE 2000b).

E.3.1.5.1 Conceptual model for source areas at SWMU 6

SWMU 6 occupies an area of approximately 13,500 ft^2 (0.31 acres). The thickness of the UCRS is estimated to be 63 ft (depth to the top of the RGA). The conceptual model for SWMU 6 is that the waste cells contain potentially contaminated materials. Subsequently, contaminants in the disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.5.2 Contaminant transport modeling for SWMU 6 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (3.25 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 63 ft in depth. Table E.3.19 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.20 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 6. Figure E.3.3 presents the head distribution and flowpaths of several particles released from the SWMU. The distances to the POEs used in the AT123D model for SWMU 6 are 1,328 ft to the plant boundary, 3,561 ft to the property boundary, 15,138 ft to the Little Bayou Seeps, and 19,424 ft to the Ohio River.

Table E.3.19. Summary of Source Term Characteristics Developed by SADA for SWMU 6

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Arsenic			
L1	0-1	5.63	2.50E+03	2.50E+03	5.82E+02	0.22	1.22
L2	01-10	3.16	9.90E+03	9.90E+04	1.29E+04	0.86	2.72
L3	10-20	2.83	9.70E+03	1.07E+05	1.25E+04	0.84	2.39
L4	20-30	3.99	1.15E+04	1.27E+05	2.08E+04	1.00	3.99
L5	30-40	2.68	3.60E+03	3.96E+04	4.38E+03	0.31	0.84
L6	40-50	3.58	5.80E+03	6.38E+04	9.44E+03	0.50	1.80
L7	50-63	3.50	6.10E+03	4.88E+04	7.06E+03	0.53	1.86
			Total Mass		6.77E+04		
				Beryllium			
L1	0-1	0.58	1.88E+04	1.88E+04	4.54E+02	0.56	0.33
L2	01-10	0.93	8.90E+03	8.90E+04	3.43E+03	0.27	0.25
L3	10-20	0.87	9.30E+03	1.02E+05	3.67E+03	0.28	0.24
L4	20-30	1.06	1.37E+04	1.51E+05	6.60E+03	0.41	0.43
L5	30-40	1.32	1.65E+04	1.82E+05	9.87E+03	0.49	0.65
L6	40-50	1.62	1.79E+04	1.97E+05	1.32E+04	0.53	0.87
L7	50-63	1.69	3.35E+04	2.68E+05	1.87E+04	1.00	1.69
			Total Mass		5.60E+04		
				Nickel			
L1	0-1	13.03	2.27E+04	2.27E+04	1.22E+04	0.64	8.28
L2	01-10	10.26	1.76E+04	1.76E+05	7.46E+04	0.49	5.06
L3	10-20	10.09	1.51E+04	1.66E+05	6.93E+04	0.42	4.27
L4	20-30	13.02	1.40E+04	1.54E+05	8.29E+04	0.39	5.11
L5	30-40	20.85	1.08E+04	1.19E+05	1.02E+05	0.30	6.31
L6	40-50	16.36	1.36E+04	1.50E+05	1.01E+05	0.38	6.23
L7	50-63	15.26	3.57E+04	2.86E+05	1.80E+05	1.00	15.26
			Total Mass		6.23E+05		
				TCE			
L1	0-1	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00	0.0000
L2	01-10	0.0033	4.30E+03	4.30E+04	5.80E+00	1.00	0.0033
L3	10-20	0.0045	4.30E+03	4.73E+04	8.75E+00	1.00	0.0045
L4	20-30	0.0052	4.30E+03	4.73E+04	1.01E+01	1.00	0.0052
L5	30-40	0.0056	3.90E+03	4.29E+04	9.97E+00	0.91	0.0051
L6	40-50	0.0062	3.10E+03	3.41E+04	8.80E+00	0.72	0.0045
L7	50-63	0.0066	2.10E+03	1.68E+04	4.61E+00	0.49	0.0032
			Total Mass		4.81E+01		
				Uranium			
L1	0-1	114.00	5.90E+03	5.90E+03	2.78E+04	1.00	114.00
L2	01-10	1.06	3.00E+03	3.00E+04	1.31E+03	0.51	0.54
L3	10-20	1.06	2.80E+03	3.08E+04	1.35E+03	0.47	0.50
L4	20-30	1.05	2.90E+03	3.19E+04	1.39E+03	0.49	0.52
L5	30-40	1.06	4.30E+03	4.73E+04	2.06E+03	0.73	0.77
L6	40-50	1.06	5.30E+03	5.83E+04	2.56E+03	0.90	0.95
L7	50-63	1.09	3.70E+03	2.96E+04	1.33E+03	0.63	0.68
			Total Mass		3.78E+04		

Table E.3.19. Summary of Source Term Characteristics Developed by SADA for SWMU 6 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Vanadium			
L1	0-1	17.71	2.88E+04	2.88E+04	2.11E+04	0.54	9.61
L2	01-10	23.24	2.72E+04	2.72E+05	2.61E+05	0.51	11.91
L3	10-20	21.39	2.72E+04	2.99E+05	2.65E+05	0.51	10.96
L4	20-30	27.18	2.72E+04	2.99E+05	3.36E+05	0.51	13.92
L5	30-40	30.16	2.72E+04	2.99E+05	3.73E+05	0.51	15.45
L6	40-50	23.99	2.72E+04	2.99E+05	2.97E+05	0.51	12.29
L7	50-63	22.81	5.31E+04	4.25E+05	4.01E+05	1.00	22.81
			Total Mass		1.95E+06		
				Zinc			
L1	0-1	56.69	2.17E+04	2.17E+04	5.09E+04	0.57	32.46
L2	01-10	31.37	1.90E+04	1.90E+05	2.46E+05	0.50	15.73
L3	10-20	34.49	1.42E+04	1.56E+05	2.23E+05	0.37	12.92
L4	20-30	34.84	1.47E+04	1.62E+05	2.33E+05	0.39	13.51
L5	30-40	44.67	1.25E+04	1.38E+05	2.54E+05	0.33	14.73
L6	40-50	55.70	1.60E+04	1.76E+05	4.05E+05	0.42	23.52
L7	50-63	54.62	3.79E+04	3.03E+05	6.85E+05	1.00	54.62
			Total Mass		2.10E+06		
				^{99}Tc			
L1	0-1	1.45E+01	6.40E+03	6.40E+03	3.84E+09	1.00	14.5
L2	01-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
L3	10-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
L4	20-30	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
L5	30-40	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
L6	40-50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
L7	50-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00	0.0
			Total Mass		3.84E+09		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.20. Chemical-Specific Parameters of the COPCs Used in SESOIL Modeling of SWMU 6

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Beryllium	9.01	1.00E+07	NA	3.60E-07	NA	NA	250	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1,000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

E.3.1.5.3 Groundwater modeling results for SWMU 6

All of the COPCs modeled at SWMU 6 that originally passed the screening steps for groundwater did not reach the water table in 1,000 years (i.e., beryllium, nickel, vanadium, and ^{99}Tc) or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., arsenic, TCE, uranium, and zinc) (see Section 5.4 of the main text),; therefore, there are no groundwater COPCs for SWMU6.

E.3.1.6 SWMU 7

The C-747-A area is located in the northwest corner of the PGDP secured area and comprises the eastern two-thirds of C-747-A. SWMU 7 includes five discrete burial pit areas (DOE 1998d) used for the disposal of wastes from 1957 to 1979. The following summarizes what is known about the size and disposed waste in the burial pits.

- Pit B—This pit measures approximately 60 ft by 172 ft in area. Buried material includes noncombustible trash and contaminated and noncombustible material and equipment. According to the Phase II PGDP Site Investigation geophysical survey (CH2M HILL 1992), the actual excavation extends beyond the designated boundaries and may connect with the adjacent burial pit (Pit C).

- Pit C—This pit is approximately the same size as Pit B. Historic records indicate that both Pit B and C received the same material.

- Pit D—This pit underlies an area of approximately 15 ft by 99 ft. Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases from C-410, used during the fluorination process of uranium tetrafluoride to uranium hexafluoride.

- Pit E (outside the eastern boundary of SWMU 7 , within an adjacent scrap yard)—This pit measures approximately 15 ft by 143 ft. Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases.

- Pits F1-F5—These five pits are all small (a combined area of approximately 20 ft by 80 ft). Documented buried material consists of uranium-contaminated scrap metal and equipment and empty uranium and magnesium powder.

- Pit G—This pit extends approximately 27 ft by 122 ft in area. Documented buried material consists of noncombustible trash and contaminated and noncombustible material and equipment.

E.3.1.6.1 Conceptual model for source areas at SWMU 7

SWMU 7 occupies an area of approximately 240,900 ft^2 (5.5 acres). The thickness of the UCRS was estimated to be 60 ft (depth to the top of the RGA). The conceptual model for SWMU 7 is that potentially contaminated materials were buried in waste pits at SWMU 7. Subsequently, contaminants in the disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.6.2 Contaminant transport modeling for SWMU 7 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (2.5 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 60 ft in depth, the four sublayer division of this layer allowed for better numerical solution of the final flux to the RGA. Table E.3.21 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.22 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 7. Figure E.3.4 presents the head distribution and flowpaths of several particles released from the SWMU. The distances to the POEs used in the AT123D model for SWMU 7 are 97 ft to the plant boundary, 2,367 ft to the property boundary, and 14,283 ft to the Little Bayou Seeps.

Table E.3.21. Summary of Source Term Characteristics Developed by SADA for SWMU 7

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			1,1-DCE				
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L2	01-10	0.87	2.80E+04	2.52E+05	9.01E+03	1.00E+00	0.87
L3	10-20	0.77	2.76E+04	2.76E+05	8.74E+03	9.86E-01	0.75
L4	20-30	0.80	2.68E+04	2.68E+05	8.83E+03	9.57E-01	0.76
L5	30-40	0.67	2.60E+04	2.60E+05	7.18E+03	9.29E-01	0.62
L6	40-50	0.68	2.48E+04	2.48E+05	7.00E+03	8.86E-01	0.60
L7	50-60	0.53	2.32E+04	2.32E+05	5.08E+03	8.29E-01	0.44
			Total Mass		4.58E+04		
			Arsenic				
L1	0-1	6.17	2.38E+05	2.38E+05	6.08E+04	1.59E+00	9.80
L2	01-10	3.60	1.50E+05	1.35E+06	2.01E+05	1.00E+00	3.60
L3	10-20	3.35	1.42E+05	1.42E+06	1.97E+05	9.49E-01	3.18
L4	20-30	3.43	1.41E+05	1.41E+06	2.00E+05	9.39E-01	3.22
L5	30-40	3.20	1.34E+05	1.34E+06	1.78E+05	8.96E-01	2.86
L6	40-50	3.43	1.26E+05	1.26E+06	1.78E+05	8.40E-01	2.88
L7	50-60	3.14	1.29E+05	1.29E+06	1.67E+05	8.59E-01	2.69
			Total Mass		1.18E+06		
			Benzo(a)pyrene				
L1	0-1	1.13	1.42E+05	1.42E+05	6.64E+03	1.00E+00	1.13
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	.0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		6.64E+03		
			Cadmium				
L1	0-1	0.56	1.22E+05	1.22E+05	2.80E+03	1.00E+00	0.558
L2	01-10	0.15	1.76E+04	1.58E+05	9.81E+02	1.45E-01	0.022
L3	10-20	0.15	1.68E+04	1.68E+05	1.03E+03	1.38E-01	0.020
L4	20-30	0.15	1.60E+04	1.60E+05	9.82E+02	1.32E-01	0.020
L5	30-40	0.15	1.48E+04	1.48E+05	9.28E+02	1.22E-01	0.018
L6	40-50	0.16	9.60E+03	9.60E+04	6.22E+02	7.89E-02	0.012
L7	50-60	0.16	7.60E+03	7.60E+04	4.96E+02	6.25E-02	0.010
			Total Mass		7.84E+03		

Table E.3.21. Summary of Source Term Characteristics Developed by SADA for SWMU 7 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			***cis*-1,2-DCE**				
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L2	01-10	0.01	3.56E+04	3.20E+05	1.37E+02	1.02E+00	0.011
L3	10-20	0.05	3.36E+04	3.36E+05	6.98E+02	9.66E-01	0.049
L4	20-30	0.06	3.64E+04	3.64E+05	8.72E+02	1.05E+00	0.061
L5	30-40	0.10	3.48E+04	3.48E+05	1.45E+03	1.00E+00	0.101
L6	40-50	0.07	3.88E+04	3.88E+05	1.09E+03	1.11E+00	0.076
L7	50-60	0.11	2.48E+04	2.48E+05	1.09E+03	7.13E-01	0.075
			Total Mass		5.33E+03		
			Fluoranthene				
L1	0-1	1.79	1.68E+05	1.68E+05	1.25E+04	1.00E+00	1.79
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.25E+04		
			Manganese				
L1	0-1	286.91	2.38E+05	2.38E+05	2.82E+06	1.35E+00	387.98
L2	01-10	210.86	1.76E+05	1.58E+06	1.38E+07	1.00E+00	210.86
L3	10-20	180.78	1.76E+05	1.76E+06	1.32E+07	1.00E+00	180.78
L4	20-30	168.55	1.76E+05	1.76E+06	1.23E+07	1.00E+00	168.55
L5	30-40	150.16	1.76E+05	1.76E+06	1.09E+07	1.00E+00	150.16
L6	40-50	123.56	1.76E+05	1.76E+06	8.99E+06	1.00E+00	123.56
L7	50-60	127.42	1.76E+05	1.76E+06	9.27E+06	1.00E+00	127.42
			Total Mass		7.12E+07		
			Mercury				
L1	0-1	0.058	1.54E+05	1.54E+05	3.72E+02	1.00E+00	0.058
L2	01-10	0.023	3.68E+04	3.31E+05	3.19E+02	2.38E-01	0.006
L3	10-20	0.022	3.64E+04	3.64E+05	3.38E+02	2.36E-01	0.005
L4	20-30	0.021	2.92E+04	2.92E+05	2.53E+02	1.89E-01	0.004
L5	30-40	0.021	3.00E+04	3.00E+05	2.58E+02	1.94E-01	0.004
L6	40-50	0.023	2.08E+04	2.08E+05	2.01E+02	1.35E-01	0.003
L7	50-60	0.024	2.00E+04	2.00E+05	1.95E+02	1.30E-01	0.003
			Total Mass		1.94E+03		
			Nickel				
L1	0-1	25.94	2.38E+05	2.38E+05	2.55E+05	1.99E+00	51.62
L2	01-10	12.64	1.27E+05	1.14E+06	5.96E+05	1.06E+00	13.40
L3	10-20	12.52	1.20E+05	1.20E+06	6.19E+05	1.00E+00	12.52
L4	20-30	13.51	9.64E+04	9.64E+05	5.38E+05	8.06E-01	10.89
L5	30-40	13.51	9.00E+04	9.00E+05	5.03E+05	7.53E-01	10.17
L6	40-50	12.56	8.84E+04	8.84E+05	4.59E+05	7.39E-01	9.29
L7	50-60	12.84	8.72E+04	8.72E+05	4.63E+05	7.29E-01	9.36
			Total Mass		3.43E+06		

Table E.3.21. Summary of Source Term Characteristics Developed by SADA for SWMU 7 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				PCB-1254			
L1	0-1	0.130	1.88E+04	1.88E+04	1.01E+02	8.87E-01	0.115
L2	01-10	0.034	2.20E+04	1.98E+05	2.79E+02	1.04E+00	0.035
L3	10-20	0.033	2.12E+04	2.12E+05	2.92E+02	1.00E+00	0.033
L4	20-30	0.033	1.92E+04	1.92E+05	2.66E+02	9.06E-01	0.030
L5	30-40	0.035	1.68E+04	1.68E+05	2.45E+02	7.92E-01	0.028
L6	40-50	0.039	9.60E+03	9.60E+04	1.55E+02	4.53E-01	0.018
L7	50-60	0.040	7.60E+03	7.60E+04	1.25E+02	3.58E-01	0.014
			Total Mass		1.46E+03		
				PCB-1260			
L1	0-1	0.63	1.80E+05	1.80E+05	4.71E+03	1.00E+00	0.63
L2	01-10	2.45	8.00E+02	7.20E+03	7.29E+02	4.43E-03	0.01
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-60	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		5.44E+03		
				Pyrene			
L1	0-1	2.07	1.68E+05	1.68E+05	1.44E+04	1.00E+00	2.07
L2	01-10	0.03	1.00E+04	9.00E+04	1.23E+02	5.95E-02	0.002
L3	10-20	0.03	9.20E+03	9.20E+04	1.26E+02	5.48E-02	0.002
L4	20-30	0.03	8.80E+03	8.80E+04	1.20E+02	5.24E-02	0.002
L5	30-40	0.03	8.80E+03	8.80E+04	1.20E+02	5.24E-02	0.002
L6	40-50	0.03	6.40E+03	6.40E+04	8.73E+01	3.81E-02	0.001
L7	50-60	0.03	5.20E+03	5.20E+04	7.09E+01	3.10E-02	0.001
			Total Mass		1.50E+04		
				Selenium			
L1	0-1	0.66	1.00E+05	1.00E+05	2.73E+03	3.85E+00	2.54
L2	01-10	0.55	2.60E+04	2.34E+05	5.29E+03	1.00E+00	0.55
L3	10-20	0.54	2.12E+04	2.12E+05	4.69E+03	8.15E-01	0.44
L4	20-30	0.53	1.84E+04	1.84E+05	4.06E+03	7.08E-01	0.38
L5	30-40	0.52	1.64E+04	1.64E+05	3.51E+03	6.31E-01	0.33
L6	40-50	0.52	1.12E+04	1.12E+05	2.41E+03	4.31E-01	0.22
L7	50-60	0.49	8.00E+03	8.00E+04	1.62E+03	3.08E-01	0.15
			Total Mass		2.43E+04		
				^{99}Tc			
L1	0-1	54.05	2.65E+05	2.65E+05	5.93E+11	1.00	54.05
L2	01-10	2.17	4.84E+04	4.36E+05	3.91E+10	0.18	0.40
L3	10-20	2.22	4.88E+04	4.88E+05	4.48E+10	0.18	0.41
L4	20-30	2.21	4.12E+04	4.12E+05	3.77E+10	0.16	0.34
L5	30-40	2.22	3.80E+04	3.80E+05	3.49E+10	0.14	0.32
L6	40-50	1.94	2.64E+04	2.64E+05	2.12E+10	0.10	0.19
L7	50-60	2.05	2.60E+04	2.60E+05	2.21E+10	0.10	0.20
			Total Mass		7.92E+11		

Table E.3.21. Summary of Source Term Characteristics Developed by SADA for SWMU 7 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			Tetrachloroethene				
L1	0-1	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000
L2	01-10	0.0062	3.60E+03	3.24E+04	8.30E+00	9.00E-01	0.0056
L3	10-20	0.0062	2.00E+03	2.00E+04	5.13E+00	5.00E-01	0.0031
L4	20-30	0.0062	4.00E+03	4.00E+04	1.03E+01	1.00E+00	0.0062
L5	30-40	0.0062	1.60E+03	1.60E+04	4.10E+00	4.00E-01	0.0025
L6	40-50	0.0062	3.20E+03	3.20E+04	8.20E+00	8.00E-01	0.0050
L7	50-60	0.0062	1.20E+03	1.20E+04	3.08E+00	3.00E-01	0.0019
			Total Mass		3.91E+01		
			TCE				
L1	0-1	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000
L2	01-10	0.0071	2.00E+04	1.80E+05	5.27E+01	5.56E-01	0.0039
L3	10-20	0.0318	2.04E+04	2.04E+05	2.68E+02	5.67E-01	0.0180
L4	20-30	0.0357	2.96E+04	2.96E+05	4.37E+02	8.22E-01	0.0294
L5	30-40	0.0550	3.20E+04	3.20E+05	7.28E+02	8.89E-01	0.0489
L6	40-50	0.0881	3.60E+04	3.60E+05	1.31E+03	1.00E+00	0.0881
L7	50-60	0.0793	2.48E+04	2.48E+05	8.13E+02	6.89E-01	0.0546
			Total Mass		3.61E+03		
			^{234}U				
L1	0-1	61.35	2.38E+05	2.38E+05	6.04E+11	1.00	61.35
L2	01-10	3.12	1.06E+05	9.58E+05	1.23E+11	0.45	1.39
L3	10-20	12.13	9.12E+04	9.12E+05	4.58E+11	0.38	4.65
L4	20-30	13.64	8.64E+04	8.64E+05	4.87E+11	0.36	4.95
L5	30-40	13.21	8.44E+04	8.44E+05	4.61E+11	0.35	4.69
L6	40-50	11.24	8.48E+04	8.48E+05	3.94E+11	0.36	4.01
L7	50-60	8.23	7.60E+04	7.60E+05	2.58E+11	0.32	2.63
			Total Mass		2.79E+12		
			^{235}U				
L1	0-1	7.75	2.38E+05	2.38E+05	7.62E+10	1.00	7.75
L2	01-10	0.40	5.72E+04	5.15E+05	8.43E+09	0.24	0.10
L3	10-20	0.50	4.00E+04	4.00E+05	8.29E+09	0.17	0.08
L4	20-30	0.50	3.36E+04	3.36E+05	6.93E+09	0.14	0.07
L5	30-40	0.52	2.72E+04	2.72E+05	5.80E+09	0.11	0.06
L6	40-50	0.51	1.64E+04	1.64E+05	3.46E+09	0.07	0.04
L7	50-60	0.58	1.12E+04	1.12E+05	2.67E+09	0.05	0.03
			Total Mass		1.12E+11		
			^{238}U				
L1	0-1	387.67	2.38E+05	2.38E+05	3.81E+12	1.00	387.67
L2	01-10	8.67	6.88E+04	6.19E+05	2.22E+11	0.29	2.51
L3	10-20	23.85	5.52E+04	5.52E+05	5.44E+11	0.23	5.53
L4	20-30	26.37	5.48E+04	5.48E+05	5.97E+11	0.23	6.07
L5	30-40	25.20	5.04E+04	5.04E+05	5.25E+11	0.21	5.34
L6	40-50	24.50	4.08E+04	4.08E+05	4.13E+11	0.17	4.20
L7	50-60	22.16	2.92E+04	2.92E+05	2.68E+11	0.12	2.72
			Total Mass		6.38E+12		

Table E.3.21. Summary of Source Term Characteristics Developed by SADA for SWMU 7 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			Uranium				
L1	0-1	374.74	2.22E+05	2.22E+05	3.45E+06	1.00E+00	374.74
L2	01-10	16.16	4.72E+04	4.25E+05	2.84E+05	2.12E-01	3.43
L3	10-20	21.38	2.84E+04	2.84E+05	2.51E+05	1.28E-01	2.73
L4	20-30	16.18	3.40E+04	3.40E+05	2.27E+05	1.53E-01	2.47
L5	30-40	17.66	2.88E+04	2.88E+05	2.10E+05	1.29E-01	2.29
L6	40-50	12.34	2.88E+04	2.88E+05	1.47E+05	1.29E-01	1.60
L7	50-60	14.84	1.84E+04	1.84E+05	1.13E+05	8.27E-02	1.23
			Total Mass		4.68E+06		
			Vanadium				
L1	0-1	26.44	2.38E+05	2.38E+05	2.60E+05	1.59	41.95
L2	01-10	12.92	1.56E+05	1.40E+06	7.48E+05	1.04	13.40
L3	10-20	12.37	1.50E+05	1.50E+06	7.67E+05	1.00	12.37
L4	20-30	11.82	1.53E+05	1.53E+06	7.47E+05	1.02	12.04
L5	30-40	11.00	1.49E+05	1.49E+06	6.77E+05	0.99	10.91
L6	40-50	10.02	1.52E+05	1.52E+06	6.28E+05	1.01	10.13
L7	50-60	10.39	1.48E+05	1.48E+06	6.34E+05	0.98	10.23
			Total Mass		4.46E+06		
			Vinyl Chloride				
L1	0-1	0.000	0.00E+00	0.00E+00	0.00E+00	0.00	0.0000
L2	01-10	0.005	7.20E+03	6.48E+04	1.46E+01	0.64	0.0035
L3	10-20	0.13	9.20E+03	9.20E+04	5.05E+02	0.82	0.11
L4	20-30	0.15	9.20E+03	9.20E+04	5.88E+02	0.82	0.13
L5	30-40	0.23	1.12E+04	1.12E+05	1.07E+03	1.00	0.23
L6	40-50	0.59	2.40E+03	2.40E+04	5.80E+02	0.21	0.13
L7	50-60	0.59	3.20E+03	3.20E+04	7.74E+02	0.29	0.17
			Total Mass		3.53E+03		
			Zinc				
L1	0-1	82.26	2.38E+05	2.38E+05	8.09E+05	2.27	186.82
L2	01-10	32.01	1.05E+05	9.43E+05	1.25E+06	1.00	32.01
L3	10-20	31.23	1.05E+05	1.05E+06	1.35E+06	1.00	31.23
L4	20-30	33.48	8.52E+04	8.52E+05	1.18E+06	0.81	27.22
L5	30-40	34.59	7.80E+04	7.80E+05	1.12E+06	0.74	25.75
L6	40-50	35.59	7.08E+04	7.08E+05	1.04E+06	0.68	24.04
L7	50-60	37.33	7.96E+04	7.96E+05	1.23E+06	0.76	28.35
			Total Mass		7.98E+06		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

E.3.1.6.3 Groundwater modeling results for SWMU 7

Table E.3.23 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 7. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years [i.e., benzo(a)pyrene, fluoranthene, nickel, PCB-1260, and vanadium] or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., cadmium, mercury, pyrene, selenium, tetrachloroethene, zinc and ^{235}U) (see Section 5.4 of the main text).

Table E.3.22. Chemical-Specific Parameters of the COPCs Used in SESOIL Modeling of SWMU 7

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/ mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
1,1-DCE	97	2.25E+03	0.09	3.74E-06	0.0261	65	0.013	infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Benzo(a)pyrene	252.32	1.62E-03	4.3E-02	3.24E-06	1.13E-06	9.69E+05	772	infinite
Cadmium	112.41	1.00E+07	NA	3.60E-07	NA	NA	75	infinite
cis-1,2-DCE	96.94	3.50E+03	0.07	4.07E-06	4.08E-03	35.5	0.028	infinite
Fluorathene	202.26	0.206	0.030	2.29E-06	1.61E-05	4.91E+04	39.3	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
PCB-1254	327	7.00E-02	1.56E-02	1.80E-06	3.40E-04	4.25E+04	34	infinite
PCB-1260	375.7	2.70E02	1.38E-02	1.56E-06	7.40E-05	2.07E+05	165.6	infinite
Pyrene	202.3	0.135	0.0272	2.61E-06	1.1E-05	6.8E+04	54.4	infinite
Selenium	80.98	1.00E+07	NA	3.60E-07	NA	NA	5	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
Tetrachloroethene	165.8	200	0.072	2.95E-06	0.0184	265	0.053	infrinite
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{235}U	235	1.00E+07	NA	3.60E-07	NA	NA	66.8	7.04E+08
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
Vinyl Chloride	63	2,760	0.11	4.43E-07	0.0270	18.8	0.0152	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

As shown in Table E.3.23, the predicted maximum groundwater concentrations for 1,1-DCE; arsenic; manganese; TCE; and vinyl chloride exceed the MCLs at the plant boundary. All COPC groundwater concentrations are less than the MCLs at the property boundary, and Little Bayou seeps. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.24. The predicted TCE and arsenic concentrations result in the greatest HQs. 1,1-DCE, arsenic, TCE and vinyl chloride provides the highest cancer risk for SWMU 7. ^{99}Tc also was predicted to present cancer risks in the 10^{-5} range.

Figures 5.16 through 5.25 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06 for contaminants migrating from SWMU 7. As shown in these figures, arsenic, TCE and vinyl chloride are predicted to exceed their respective MCLs at the plant boundary. No COCs were predicted to exceed their respective MCLs at the other POEs.

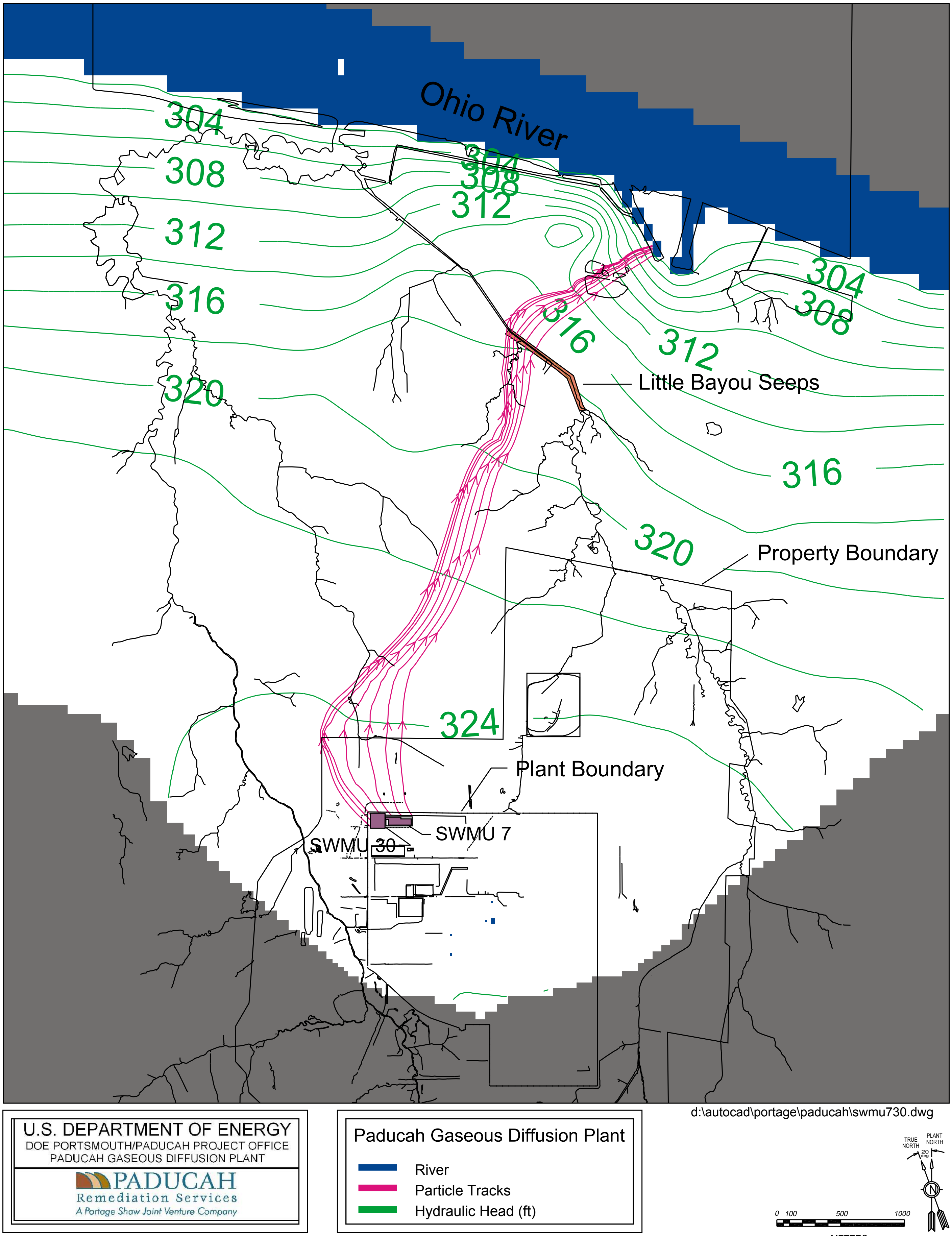

Figure E.3.4. Particle Tracks for SWMUs 7 and 30

Table E.3.23. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 7

	Predicted Maximum Groundwater Concentration[a,b]					
COPC	**SWMU (mg/L)**	**Plant Boundary (mg/L)**	**Property Boundary (mg/L)**	**Little Bayou seeps (mg/L)**	**Ohio River (mg/L)**	**MCL (mg/L)**
1,1-DCE	***8.98E-02***	***8.24E-02***	1.1E-02	4.02E-03	3.50E-03	0.07
Arsenic	***1.78E-02***	***1.26E-02***	2.35E-03	0	0	0.01
cis,-1,2-DCE	2.35E-02	2.15E-02	3.13E-03	1.17E-03	1.02E-03	0.07
Manganese	***3.32E-01***	***2.41E-01***	1.05E-06	0	0	[d]
PCB-1254	5.23E-05	3.09E-05	3.05E-06	1.32E-12	0	[d]
^{99}Tc	***9.09E+02***	825	270	132	1163	900[c]
TCE	***1.09E-02***	***9.87E-03***	1.42E-03	5.06E-04	4.34E-04	0.005
^{234}U	7.94E+00	5.79	5.84E-06	0	0	[d]
^{238}U	7.59E+00	5.58	5.85E-06	0	0	[d]
Uranium	3.46E-03	2.53E-03	2.68E-09	0	0	0.03
Vinyl Chloride	***1.35E-02***	***1.24E-02***	1.21E-03	4.13E-04	3.55E-04	0.002

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

Table E.3.24. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 7 Using SESOIL and AT123D[a]

	SWMU		Plant Boundary		Property Boundary		Little Bayou Seeps	
COC	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**
1,1-DCE	8.51E-01	2.08E-03	0.8	1.9E-03	0.1	2.5E-04	<0.1	9.3E-05
Arsenic	5.70E+00	4.72E-04	4.0	3.3E-04	0.8	6.2E-05	[b]	[b]
cis,-1,2-DCE	1.24E+00	[b]	1.1	[b]	0.2	[b]	<0.1	[b]
Manganese	7.07E-01	[b]	0.5	[b]	<0.1	[b]	[b]	[b]
PCB-1254	4.20E+00	7.09E-06	2.5	4.8E-06	0.2	<1.0E-06	<0.1	<1.0E-06
^{99}Tc	[b]	4.99E-05	[b]	4.5E-05	[b]	1.5E-05	[b]	7.3E-06
TCE	4.98E+00	1.27E-04	4.5	3.1E-04	0.6	4.4E-05	0.2	1.6E-05
^{234}U	[b]	1.11E-05	[b]	8.2E-06	[b]	<1.0E-06	[b]	[b]
^{238}U	[b]	1.32E-05	[b]	9.6E-06	[b]	<1.0E-06	[b]	[b]
Uranium	5.54E-01	[b]	0.40	[b]	<0.1	[b]	[b]	[b]
Vinyl Chloride	6.43E-01	3.72E-04	0.6	3.6E-04	<0.1	3.6E-05	<0.1	1.2E-05

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

E.3.1.7 SWMU 30

SWMU 30 consists of an historical burn-and-burial pit and the location of a former incinerator, used from 1951 to 1970 to burn combustible trash which may have contained uranium contamination. The pit is reported to have been excavated to a depth of 12 ft. SWMU 30 is bounded on the east side by C-747-A Burial Ground (SWMU 7).

E.3.1.7.1 Conceptual model for source areas at SWMU 30

SWMU 30 occupies an area of approximately 128,000 ft^2 (2.9 acres). The thickness of the UCRS was estimated to be 61 ft (depth to the top of the RGA). The conceptual model for SWMU 30 is that potentially contaminated materials were buried in waste pits at SWMU 30. Subsequently, contaminants in disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.7.2 Contaminant transport modeling for SWMU 30 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (2.75 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 61 ft in depth, the four sublayer division of this layer allowed for better numerical solution of the final flux to the RGA Table E.3.25 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.26 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 30. Figure E.3.4 presents the head distribution and flowpaths of several particles released from the SWMU. The distances to the POEs used in the AT123D model for SWMU 30 are 107 ft to the plant boundary, 2,127 ft to the property boundary, and 13,013 ft to the Little Bayou Seeps.

Table E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			1,1-DCE				
L1	0-1	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	5.00	8.00E+02	8.00E+03	1.65E+03	4.00E-01	2.00
L6	40-50	5.00	2.00E+03	2.00E+04	4.13E+03	1.00E+00	5.00
L7	50-61	5.00	2.00E+03	2.20E+04	4.55E+03	1.00E+00	5.00
			Total Mass		1.03E+04		
			Acenaphthene				
L1	0-1	0.28	5.16E+04	5.16E+04	6.06E+02	1.00E+00	0.28
L2	01-10	0.017	3.20E+03	2.88E+04	2.02E+01	6.20E-02	0.0011
L3	10-20	0.017	3.20E+03	3.20E+04	2.25E+01	6.20E-02	0.0011
L4	20-30	0.017	3.20E+03	3.20E+04	2.25E+01	6.20E-02	0.0011
L5	30-40	0.017	2.40E+03	2.40E+04	1.69E+01	4.65E-02	0.0008
L6	40-50	0.017	1.20E+03	1.20E+04	8.43E+00	2.33E-02	0.0004
L7	50-61	0.017	1.20E+03	1.32E+04	9.28E+00	2.33E-02	0.0004
			Total Mass		7.06E+02		

Table E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			Arsenic				
L1	0-1	5.86	9.24E+04	9.24E+04	2.24E+04	1.14E+00	6.67
L2	01-10	4.63	7.96E+04	7.16E+05	1.37E+05	9.80E-01	4.54
L3	10-20	4.40	8.12E+04	8.12E+05	1.48E+05	1.00E+00	4.40
L4	20-30	4.30	8.08E+04	8.08E+05	1.44E+05	9.95E-01	4.28
L5	30-40	4.07	8.16E+04	8.16E+05	1.37E+05	1.00E+00	4.09
L6	40-50	3.93	8.08E+04	8.08E+05	1.31E+05	9.95E-01	3.91
L7	50-61	3.86	8.20E+04	9.02E+05	1.44E+05	1.01E+00	3.90
			Total Mass		8.64E+05		
			Benzo(a)pyrene				
L1	0-1	1.00	9.72E+04	9.72E+04	4.01E+03	1.00E+00	1.00
L2	01-10	0.05	3.20E+03	2.88E+04	6.19E+01	3.29E-02	0.0017
L3	10-20	0.05	3.20E+03	3.20E+04	6.88E+01	3.29E-02	0.0017
L4	20-30	0.05	3.20E+03	3.20E+04	6.88E+01	3.29E-02	0.0017
L5	30-40	0.05	2.40E+03	2.40E+04	5.16E+01	2.47E-02	0.0013
L6	40-50	0.05	1.20E+03	1.20E+04	2.58E+01	1.23E-02	0.0006
L7	50-61	0.05	1.20E+03	1.32E+04	2.84E+01	1.23E-02	0.0006
			Total Mass		4.31E+03		
			Cadmium				
L1	0-1	1.92	4.68E+04	4.68E+04	3.72E+03	1.00E+00	1.925
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L7	50-61	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
			Total Mass		3.72E+03		
			Dibenzoanthracene				
L1	0-1	0.33	5.64E+04	5.64E+04	7.61E+02	1.00E+00	0.327
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
L7	50-61	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000
			Total Mass		7.61E+02		
			Fluorene				
L1	0-1	0.25	4.56E+04	4.56E+04	4.72E+02	1.00E+00	0.25
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-61	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		4.72E+02		

Table E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			Manganese				
L1	0-1	338.66	1.22E+05	1.22E+05	1.71E+06	1.46E+00	495.84
L2	01-10	250.12	8.36E+04	7.52E+05	7.78E+06	1.00E+00	250.12
L3	10-20	242.52	8.36E+04	8.36E+05	8.38E+06	1.00E+00	242.52
L4	20-30	238.27	8.36E+04	8.36E+05	8.24E+06	1.00E+00	238.27
L5	30-40	221.98	8.36E+04	8.36E+05	7.67E+06	1.00E+00	221.98
L6	40-50	206.94	8.36E+04	8.36E+05	7.15E+06	1.00E+00	206.94
L7	50-61	212.37	8.36E+04	9.20E+05	8.07E+06	1.00E+00	212.37
			Total Mass		4.90E+07		
			Mercury				
L1	0-1	0.111	8.48E+04	8.48E+04	3.88E+02	1.00E+00	0.111
L2	01-10	0.062	1.40E+04	1.26E+05	3.24E+02	1.65E-01	0.0103
L3	10-20	0.055	1.24E+04	1.24E+05	2.81E+02	1.46E-01	0.0080
L4	20-30	0.053	1.04E+04	1.04E+05	2.28E+02	1.23E-01	0.0065
L5	30-40	0.040	9.20E+03	9.20E+04	1.52E+02	1.08E-01	0.0043
L6	40-50	0.022	6.80E+03	6.80E+04	6.14E+01	8.02E-02	0.0018
L7	50-61	0.022	6.80E+03	7.48E+04	6.75E+01	8.02E-02	0.0018
			Total Mass		1.50E+03		
			Napthalene				
L1	0-1	0.31	8.00E+03	8.00E+03	1.03E+02	1.00E+00	0.31
L2	01-10	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L3	10-20	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L4	20-30	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L5	30-40	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L6	40-50	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
L7	50-61	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
			Total Mass		1.03E+02		
			Nickel				
L1	0-1	60.18	1.22E+05	1.22E+05	3.05E+05	1.65E+00	99.00
L2	01-10	17.40	7.44E+04	6.70E+05	4.82E+05	1.00E+00	17.40
L3	10-20	16.86	7.32E+04	7.32E+05	5.10E+05	9.84E-01	16.58
L4	20-30	16.42	7.32E+04	7.32E+05	4.97E+05	9.84E-01	16.16
L5	30-40	15.69	7.28E+04	7.28E+05	4.72E+05	9.78E-01	15.36
L6	40-50	15.44	7.28E+04	7.28E+05	4.65E+05	9.78E-01	15.11
L7	50-61	15.11	7.44E+04	8.18E+05	5.11E+05	1.00E+00	15.11
			Total Mass		3.24E+06		
			PCB-1254				
L1	0-1	0.200	3.00E+04	3.00E+04	2.48E+02	1.00E+00	0.200
L2	01-10	0.028	5.60E+03	5.04E+04	5.83E+01	1.87E-01	0.0052
L3	10-20	0.028	5.60E+03	5.60E+04	6.48E+01	1.87E-01	0.0052
L4	20-30	0.028	5.60E+03	5.60E+04	6.48E+01	1.87E-01	0.0052
L5	30-40	0.028	5.60E+03	5.60E+04	6.48E+01	1.87E-01	0.0052
L6	40-50	0.028	5.60E+03	5.60E+04	6.48E+01	1.87E-01	0.0052
L7	50-61	0.028	5.20E+03	5.72E+04	6.62E+01	1.73E-01	0.0049
			Total Mass		6.32E+02		

E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				PCB-1260			
L1	0-1	1.54	1.22E+05	1.22E+05	7.81E+03	1.00E+00	1.54
L2	01-10	0.08	3.00E+04	2.70E+05	8.40E+02	2.45E-01	0.018
L3	10-20	0.07	2.76E+04	2.76E+05	7.92E+02	2.25E-01	0.016
L4	20-30	0.07	2.52E+04	2.52E+05	6.93E+02	2.06E-01	0.014
L5	30-40	0.06	2.12E+04	2.12E+05	5.27E+02	1.73E-01	0.010
L6	40-50	0.05	1.84E+04	1.84E+05	4.17E+02	1.50E-01	0.008
L7	50-61	0.05	1.68E+04	1.85E+05	4.14E+02	1.37E-01	0.007
			Total Mass		1.15E+04		
				Pyrene			
L1	0-1	2.16	1.08E+05	1.08E+05	9.66E+03	1.00E+00	2.16
L2	01-10	0.043	3.04E+04	2.74E+05	4.82E+02	2.81E-01	0.012
L3	10-20	0.042	2.96E+04	2.96E+05	5.16E+02	2.74E-01	0.012
L4	20-30	0.042	2.80E+04	2.80E+05	4.81E+02	2.59E-01	0.011
L5	30-40	0.041	2.56E+04	2.56E+05	4.32E+02	2.37E-01	0.010
L6	40-50	0.040	2.40E+04	2.40E+05	4.02E+02	2.22E-01	0.009
L7	50-61	0.040	2.20E+04	2.42E+05	4.00E+02	2.04E-01	0.008
			Total Mass		1.24E+04		
				Selenium			
L1	0-1	0.66	2.12E+04	2.12E+04	5.78E+02	1.56E+00	1.03
L2	01-10	0.91	1.40E+04	1.26E+05	4.73E+03	1.03E+00	0.94
L3	10-20	0.91	1.36E+04	1.36E+05	5.09E+03	1.00E+00	0.91
L4	20-30	0.90	1.32E+04	1.32E+05	4.93E+03	9.71E-01	0.88
L5	30-40	0.92	1.20E+04	1.20E+05	4.56E+03	8.82E-01	0.81
L6	40-50	0.96	1.08E+04	1.08E+05	4.27E+03	7.94E-01	0.76
L7	50-61	0.95	1.04E+04	1.14E+05	4.51E+03	7.65E-01	0.73
			Total Mass		2.87E+04		
				^{99}Tc			
L1	0-1	20.79	1.22E+05	1.22E+05	1.05E+11	1.00	20.79
L2	01-10	1.78	3.56E+04	3.20E+05	2.36E+10	0.29	0.52
L3	10-20	1.54	3.32E+04	3.32E+05	2.12E+10	0.27	0.42
L4	20-30	1.42	3.08E+04	3.08E+05	1.80E+10	0.25	0.36
L5	30-40	1.14	2.68E+04	2.68E+05	1.26E+10	0.22	0.25
L6	40-50	0.89	2.40E+04	2.40E+05	8.80E+09	0.20	0.17
L7	50-61	0.86	2.20E+04	2.42E+05	8.56E+09	0.18	0.15
			Total Mass		1.98E+11		
				TCE			
L1	0-1	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000
L2	01-10	37.4000	3.60E+03	3.24E+04	5.01E+04	1.00E+00	37.4000
L3	10-20	37.4000	2.80E+03	2.80E+04	4.33E+04	7.78E-01	29.0889
L4	20-30	37.4000	3.60E+03	3.60E+04	5.57E+04	1.00E+00	37.4000
L5	30-40	37.4000	2.00E+03	2.00E+04	3.09E+04	5.56E-01	20.7778
L6	40-50	37.4000	2.40E+03	2.40E+04	3.71E+04	6.67E-01	24.9333
L7	50-61	37.4000	1.20E+03	1.32E+04	2.04E+04	3.33E-01	12.4667
			Total Mass		2.37E+05		

E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				^{234}U			
L1	0-1	42.53	1.22E+05	1.22E+05	2.15E+11	1.00	42.53
L2	01-10	4.39	6.56E+04	5.90E+05	1.07E+11	0.54	2.36
L3	10-20	4.64	6.76E+04	6.76E+05	1.30E+11	0.55	2.56
L4	20-30	4.54	6.64E+04	6.64E+05	1.25E+11	0.54	2.46
L5	30-40	4.04	6.80E+04	6.80E+05	1.14E+11	0.56	2.25
L6	40-50	3.99	6.60E+04	6.60E+05	1.09E+11	0.54	2.15
L7	50-61	3.50	7.00E+04	7.70E+05	1.11E+11	0.57	2.00
			Total Mass		9.11E+11		
				^{235}U			
L1	0-1	4.44	1.22E+05	1.22E+05	2.25E+10	1.00	4.44
L2	01-10	0.31	3.80E+04	3.42E+05	4.34E+09	0.31	0.10
L3	10-20	0.33	3.44E+04	3.44E+05	4.64E+09	0.28	0.09
L4	20-30	0.31	3.40E+04	3.40E+05	4.41E+09	0.28	0.09
L5	30-40	0.34	2.84E+04	2.84E+05	4.01E+09	0.23	0.08
L6	40-50	0.35	2.72E+04	2.72E+05	3.92E+09	0.22	0.08
L7	50-61	0.36	2.36E+04	2.60E+05	3.90E+09	0.19	0.07
			Total Mass		4.77E+10		
				^{238}U			
L1	0-1	103.92	1.22E+05	1.22E+05	5.26E+11	1.00	103.92
L2	01-10	7.61	5.96E+04	5.36E+05	1.69E+11	0.49	3.71
L3	10-20	9.37	5.80E+04	5.80E+05	2.25E+11	0.47	4.44
L4	20-30	9.55	5.32E+04	5.32E+05	2.10E+11	0.43	4.15
L5	30-40	8.75	5.16E+04	5.16E+05	1.87E+11	0.42	3.69
L6	40-50	8.99	4.60E+04	4.60E+05	1.71E+11	0.38	3.38
L7	50-61	8.64	4.48E+04	4.93E+05	1.76E+11	0.37	3.16
			Total Mass		1.66E+12		
				Uranium			
L1	0-1	797.22	2.88E+04	2.88E+04	9.49E+05	1.00E+00	797.22
L2	01-10	4.39	5.28E+04	4.75E+05	8.62E+04	1.83E+00	8.05
L3	10-20	4.20	5.40E+04	5.40E+05	9.38E+04	1.88E+00	7.88
L4	20-30	4.19	5.20E+04	5.20E+05	9.01E+04	1.81E+00	7.57
L5	30-40	3.97	5.40E+04	5.40E+05	8.87E+04	1.88E+00	7.45
L6	40-50	4.06	5.24E+04	5.24E+05	8.79E+04	1.82E+00	7.38
L7	50-61	3.87	5.40E+04	5.94E+05	9.50E+04	1.88E+00	7.25
			Total Mass		1.49E+06		
				Vanadium			
L1	0-1	25.32	1.22E+05	1.22E+05	1.28E+05	1.47	37.25
L2	01-10	14.34	8.32E+04	7.49E+05	4.44E+05	1.00	14.34
L3	10-20	13.51	8.32E+04	8.32E+05	4.65E+05	1.00	13.51
L4	20-30	12.98	8.36E+04	8.36E+05	4.49E+05	1.00	13.05
L5	30-40	12.05	8.36E+04	8.36E+05	4.16E+05	1.00	12.11
L6	40-50	11.28	8.36E+04	8.36E+05	3.90E+05	1.00	11.33
L7	50-61	11.04	8.36E+04	9.20E+05	4.20E+05	1.00	11.09
			Total Mass		2.71E+06		

E.3.25. Summary of Source Term Characteristics Developed by SADA for SWMU 30 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Zinc			
L1	0-1	105.49	1.22E+05	1.22E+05	5.34E+05	1.84	194.45
L2	01-10	42.25	6.72E+04	6.05E+05	1.06E+06	1.01	42.76
L3	10-20	41.98	6.60E+04	6.60E+05	1.15E+06	0.99	41.73
L4	20-30	42.44	6.52E+04	6.52E+05	1.14E+06	0.98	41.67
L5	30-40	42.67	6.44E+04	6.44E+05	1.14E+06	0.97	41.39
L6	40-50	43.94	6.36E+04	6.36E+05	1.16E+06	0.96	42.08
L7	50-61	44.35	6.64E+04	7.30E+05	1.34E+06	1.00	44.35
			Total Mass		7.51E+06		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.26. Chemical-Specific Parameters of the COPCs Used in SESOIL Modeling of SWMU 30

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
1,1-DCE	97	2.25E+03	0.09	3.74E-06	0.0261	65	0.013	infinite
Acenapthene	154.0	4.20	0.04	2.77E-6	1.60E-04	4.90E+03	3.9	infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Benzo(a)pyrene	252.32	1.62E-03	4.3E-02	3.24E-06	1.13E-06	9.69E+05	772	infinite
Cadmium	112.41	1.00E+07	NA	3.60E-07	NA	NA	75	infinite
Dibenzo(a,h) anthracene	278.33	0.0025	0.020	1.86E-06	1.47E-08	1.78E+06	1424	infinite
Fluorene	166.0	1.90	0.061	2.84E-06	7.7E-05	7.9E+03	6.3	infinite
Manganese	54.94	1.00E+07	NA	1.29E-07	NA	NA	65	infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	infinite
Naphthalene	128.16	31.0	0.059	2.70E-06	4.83E-04	1.19E+03	0.95	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
PCB-1254	327	7.00E-02	1.56E-02	1.80E-06	3.40E-04	4.25E+04	34	infinite
PCB-1260	375.7	2.70E02	1.38E-02	1.56E-06	7.40E-05	2.07E+05	165.6	infinite
Pyrene	202.3	0.135	0.0272	2.61E-06	1.1E-05	6.8E+04	54.4	infinite
Selenium	80.98	1.00E+07	NA	3.60E-07	NA	NA	5	infinite
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{235}U	235	1.00E+07	NA	3.60E-07	NA	NA	66.8	7.04E+08
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Uranium	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1,000	infinite
Zinc	67.41	1.00E+07	NA	3.60E-07	NA	NA	62	infinite

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

E.3.1.7.3 Groundwater modeling results for SWMU 30

Table E.3.27 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 30. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years [i.e., benzo(a)pyrene, cadmium, dibenzo(a,h)anthracene, nickel, and vanadium] or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., acenapthene, fluorine, mercury, naphthalene, PCB-1254, PCB-1260, pyrene, zinc and ^{235}U) (see Section 5.4 of the main text) including acenaphthene, benzo(a)pyrene, cadmium, dibenzo(a,h)anthracene, fluorine, mercury, naphthalene, nickel, PCB-1254, PCB-1260, pyrene, ^{235}U, vanadium, and zinc.

Table E.3.27. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 30

	Predicted Maximum Groundwater Concentration[a,b]					
COPC	**SWMU (mg/L)**	**Plant Boundary (mg/L)**	**Property Boundary (mg/L)**	**Little Bayou seeps (mg/L)**	**Ohio River (mg/L)**	**MCL (mg/L)**
1,1-DCE	6.05E-02	5.92E-02	4.41E-03	1.32E-03	1.10E-03	0.07
Arsenic	***1.77E-02***	***1.17E-02***	2.34E-03	0	0	0.01
Manganese	***3.78E-01***	***2.51E-01***	2.85E-04	0	0	[d]
Selenium	1.51E-02	8.30E-03	9.21E-04	3.15E-04	2.16E-04	0.05
^{99}Tc	2.87E+02	264	70.8	29.2	25.2	900[c]
TCE	***7.12E-01***	***6.80E-01***	***5.87E-02***	***1.96E-02***	***1.67E-02***	0.005
^{234}U	3.99E+00	2.75	1.44E-03	0	0	[d]
^{238}U	5.91E+00	4.07	1.98E-03	0	0	[d]
Uranium	8.40E-03	4.81E-03	2.41E-06	0	0	0.03

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

As shown in Table E.3.27, the predicted maximum groundwater concentrations for arsenic and TCE exceed their respective MCLs at the plant boundary. TCE is the only COPC that exceeds the MCLs at the property boundary, and Little Bayou seeps. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.28. The predicted TCE concentrations result in the greatest HQ and cancer risk for SWMU 30. 1,1-DCE, arsenic and ^{99}Tc also exhibit elevated cancer risks.

Table E.3.28. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 30 Using SESOIL and AT123D[a]

COC	SWMU		Plant Boundary		Property Boundary		Little Bayou Seeps	
	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk
1,1-DCE	5.73E+00	1.40E-03	0.6	1.4E-03	<0.1	1.0E-04	<0.1	3.0E-05
Arsenic	5.67E+00	4.69E-04	3.8	3.1E-04	0.8	6.2E-05	[b]	[b]
Manganese	8.05E-01	[b]	0.5	[b]	<0.1	[b]	[b]	[b]
Selenium	2.90E-01	[b]	0.2	[b]	<0.1	[b]	<0.1	[b]
^{99}Tc	[b]	1.57E-05	[b]	1.4E-05	[b]	3.9E-06	[b]	1.6E-06
TCE	3.25E+02	2.21E-02	311	2.1E-02	26.8	1.8E-03	9.0	6.1E-04
^{234}U	[b]	5.63E-06	[b]	3.9E-06	[b]	<1.0E-06	[b]	[b]
^{238}U	[b]	1.03E-05	[b]	7.1E-06	[b]	<1.0E-06	[b]	[b]
Uranium	1.34E+00	[b]	0.8	[b]	<0.1	[b]	[b]	[b]

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.26 through 5.33 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06 for contaminants migrating from SWMU 30. As shown in these figures, arsenic, manganese, and TCE are predicted to exceed their respective MCLs at the plant boundary. TCE is also predicted to exceed the MCL at the property boundary, Little Bayou seeps, and Ohio River.

E.3.1.8 SWMU 145

SWMU 145, located north of PGDP, began operation in the early 1950s. A 1973 document *The Discard of Scrap Materials by Burial at the Paducah Plant* (Union Carbide 1973), states this area was used by the contractor during the construction of PGDP to discard all types of scrap and waste materials. Use of the area for discard of scrap and waste by subcontractors continued until the early 1980s. Construction debris, such as concrete, roofing materials, wire, wood, shingles with asbestos, and welding rods are expected to have been disposed of in the area. Approximately once a year, the accumulated scrap piles were moved by plant personnel into piles or earth depressions and, whenever practicable, covered with dirt. The area was later permitted for the construction and operation of the C-746-S & T Landfills (BJC 2001). Currently, the C-746-S&T Landfills are located on top of SWMU 145 (DOE 1999b). Area P (SWMU 145) is defined by the encompassing C-746-S&T Landfills (SWMUs 9 and 10, respectively).

E.3.1.8.1 Conceptual model for source areas at SWMU 145

SWMU 145 occupies an area of approximately 1,916,640 ft^2 (44 acre). The thickness of the UCRS was estimated to be 60 ft (depth to the top of the RGA). The conceptual model for SWMU 145 is that potentially contaminated materials were buried and landfilled at SWMU 145. Subsequently, contaminants in the disposed material directly impacted soils below or adjacent to the areas where material was buried and, through vertical infiltration in soil, contaminated the groundwater underlying these sources. The infiltrating groundwater migrates vertically through the UCRS and laterally in the RGA, which could transport the contaminants to the POEs.

E.3.1.8.2 Contaminant transport modeling for SWMU 145 using SESOIL and AT123D

For this modeling effort, the soil zones were arranged in four layers. The first soil layer represented the SADA surface soil data from 0 to 1 ft deep. The second soil layer was 9 ft thick representing SADA layer 2 from 1 to 9 ft in depth, the third layer was subdivided into 4 sublayers of equal thickness (10 ft each) representing SADA layers 3 through 6. SESOIL soil layer 4 was subdivided into 4 sublayers of equal thickness (2.0 ft each) to represent the total thickness of SADA layer 7 from 50 ft to 58 ft in depth, the four sublayer division of this layer allowed for better numerical solution of the final flux to the RGA. Table E.3.29 presents the COPCs remaining after the screening process and the source terms for each COPC. Table E.3.30 lists the chemical-specific parameters applicable to the SESOIL model of SWMU 30. Figure E.3.5 presents the head distribution and flowpaths of several particles released from the SWMU. The distances to the POEs used in the AT123D model for SWMU 145 are 2,951 ft to the property boundary and 11,489 ft to the Ohio River.

Table E.3.29. Summary of Source Term Characteristics Developed by SADA for SWMU 145

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Antimony			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	11.47	1.04E+06	9.36E+06	4.44E+06	1.04	11.93
L3	10-20	11.47	9.70E+05	9.70E+06	4.60E+06	0.97	11.13
L4	20-30	11.46	1.00E+06	1.00E+07	4.74E+06	1.00	11.46
L5	30-40	11.39	9.70E+05	9.70E+06	4.57E+06	0.97	11.05
L6	40-50	11.37	9.80E+05	9.80E+06	4.61E+06	0.98	11.14
L7	50-58	11.40	9.60E+05	7.68E+06	3.62E+06	0.96	10.94
			Total Mass		2.66E+07		
				Arsenic			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	4.21	1.91E+06	1.72E+07	2.99E+06	0.97	4.10
L3	10-20	4.33	1.96E+06	1.96E+07	3.51E+06	1.00	4.33
L4	20-30	4.38	1.92E+06	1.92E+07	3.48E+06	0.98	4.29
L5	30-40	4.28	1.93E+06	1.93E+07	3.41E+06	0.98	4.21
L6	40-50	4.28	1.94E+06	1.94E+07	3.43E+06	0.99	4.24
L7	50-58	4.18	1.93E+06	1.54E+07	2.67E+06	0.98	4.12
			Total Mass		1.99E+07		
				PCB-1254			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	0.59	2.40E+05	2.16E+06	5.28E+04	1.00	0.59
L3	10-20	1.90	2.00E+04	2.00E+05	1.57E+04	0.08	0.16
L4	20-30	1.90	1.00E+04	1.00E+05	7.86E+03	0.04	0.08
L5	30-40	1.90	1.00E+04	1.00E+05	7.86E+03	0.04	0.08
L6	40-50	0.00	0.00	0.00	0.00	0.00	0.00
L7	50-58	0.00	0.00	0.00	0.00	0.00	0.00
			Total Mass		8.57E+04		
				PCB-1260			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	12.50	2.00E+04	1.80E+05	9.30E+04	1.00	12.50
L3	10-20	12.50	2.00E+04	2.00E+05	1.03E+05	1.00	12.50
L4	20-30	12.50	2.00E+04	2.00E+05	1.03E+05	1.00	12.50
L5	30-40	12.50	2.00E+04	2.00E+05	1.03E+05	1.00	12.50
L6	40-50	12.50	1.00E+04	1.00E+05	5.17E+04	0.50	6.25
L7	50-58	12.50	1.00E+04	8.00E+04	4.13E+04	0.50	6.25
			Total Mass		4.97E+05		

Table E.3.29. Summary of Source Term Characteristics Developed by SADA for SWMU 145 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				Cadmium			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	2.47	1.00E+04	9.00E+04	9.19E+03	0.20	0.49
L3	10-20	2.39	4.00E+04	4.00E+05	3.95E+04	0.80	1.91
L4	20-30	2.39	4.00E+04	4.00E+05	3.95E+04	0.80	1.91
L5	30-40	2.40	5.00E+04	5.00E+05	4.97E+04	1.00	2.40
L6	40-50	2.40	5.00E+04	5.00E+05	4.97E+04	1.00	2.40
L7	50-58	2.40	5.00E+04	4.00E+05	3.98E+04	1.00	2.40
			Total Mass		2.39E+05		
				Manganese			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	146.59	2.55E+06	2.30E+07	1.39E+08	1.00	146.59
L3	10-20	147.65	2.55E+06	2.55E+07	1.56E+08	1.00	147.65
L4	20-30	143.48	2.55E+06	2.55E+07	1.51E+08	1.00	143.48
L5	30-40	140.68	2.55E+06	2.55E+07	1.48E+08	1.00	140.68
L6	40-50	170.30	2.55E+06	2.55E+07	1.80E+08	1.00	170.30
L7	50-58	170.13	2.55E+06	2.04E+07	1.43E+08	1.00	170.13
			Total Mass		9.51E+08		
				Mercury			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	0.02	7.70E+05	6.93E+06	5.51E+03	0.95	0.02
L3	10-20	0.02	7.70E+05	7.70E+06	6.12E+03	0.95	0.02
L4	20-30	0.02	7.40E+05	7.40E+06	5.87E+03	0.91	0.02
L5	30-40	0.05	8.10E+05	8.10E+06	1.75E+04	1.00	0.05
L6	40-50	0.05	8.00E+05	8.00E+06	1.74E+04	0.99	0.05
L7	50-58	0.06	7.30E+05	5.84E+06	1.34E+04	0.90	0.05
			Total Mass		6.96E+04		
				Nickel			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	10.21	2.00E+06	1.80E+07	7.60E+06	0.95	9.68
L3	10-20	10.22	2.00E+06	2.00E+07	8.45E+06	0.95	9.69
L4	20-30	9.87	1.95E+06	1.95E+07	7.96E+06	0.92	9.12
L5	30-40	10.50	2.11E+06	2.11E+07	9.16E+06	1.00	10.50
L6	40-50	10.08	2.11E+06	2.11E+07	8.80E+06	1.00	10.08
L7	50-58	10.20	2.06E+06	1.65E+07	6.95E+06	0.98	9.96
			Total Mass		4.98E+07		
				Vanadium			
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	18.43	1.21E+06	1.09E+07	8.30E+06	1.03	18.90
L3	10-20	18.47	1.20E+06	1.20E+07	9.16E+06	1.02	18.78
L4	20-30	19.44	1.18E+06	1.18E+07	9.48E+06	1.00	19.44
L5	30-40	19.94	1.18E+06	1.18E+07	9.73E+06	1.00	19.94
L6	40-50	19.55	1.18E+06	1.18E+07	9.54E+06	1.00	19.55
L7	50-58	18.71	1.19E+06	9.52E+06	7.36E+06	1.01	18.86
			Total Mass		5.54E+07		

Table E.3.29. Summary of Source Term Characteristics Developed by SADA for SWMU 145 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
			Benzo(a)Pyrene				
L1	0-1	0.00	0.00	0.00	0.00	0.00	0.00
L2	01-10	0.00	0.00	0.00	0.00E+00	0.00	0.00
L3	10-20	0.00	0.00	0.00	0.00E+00	0.00	0.00
L4	20-30	0.00	0.00	0.00	0.00E+00	0.00	0.00
L5	30-40	0.00	0.00	0.00	0.00E+00	0.00	0.00
L6	40-50	0.00	0.00	0.00	0.00E+00	0.00	0.00
L7	50-58	0.00	0.00	0.00	0.00E+00	0.00	0.00
			Total Mass		1.82E+02		
			^{239}Pu				
L1	0-1	0.00	0.00	0.00	0.00E+00	0.00	0.00
L2	01-10	0.28	1.00E+05	9.00E+05	1.15E+10	1.00	0.28
L3	10-20	0.26	1.00E+05	1.00E+06	1.40E+10	1.00	0.26
L4	20-30	0.26	1.00E+05	1.00E+06	1.40E+10	1.00	0.26
L5	30-40	0.26	1.00E+05	1.00E+06	1.40E+10	1.00	0.26
L6	40-50	0.26	1.00E+05	1.00E+06	1.40E+10	1.00	0.26
L7	50-58	0.26	1.00E+05	8.00E+05	1.02E+10	1.00	0.26
			Total Mass		7.77E+10		
			^{99}Tc				
L1	0-1	0.00	0.00	0.00	0.00E+00	0.00	0.00
L2	01-10	26.67	1.10E+05	9.90E+05	1.09E+12	1.00	26.67
L3	10-20	15.98	1.30E+05	1.30E+06	8.59E+11	1.18	18.89
L4	20-30	15.98	1.30E+05	1.30E+06	8.59E+11	1.18	18.89
L5	30-40	15.98	1.30E+05	1.30E+06	8.59E+11	1.18	18.89
L6	40-50	11.91	1.30E+05	1.30E+06	6.40E+11	1.18	14.07
L7	50-58	11.91	1.30E+05	1.04E+06	5.12E+11	1.18	14.07
			Total Mass		4.82E+12		
			^{234}U				
L1	0-1	0.00	0.00	0.00	0.00E+00	0.00	0.00
L2	01-10	0.74	2.00E+04	1.80E+05	3.28E+11	1.00	0.74
L3	10-20	0.00	0.00	0.00	2.49E+12	0.00	0.00
L4	20-30	0.00	0.00	0.00	2.50E+12	0.00	0.00
L5	30-40	0.00	0.00	0.00	2.50E+12	0.00	0.00
L6	40-50	0.00	0.00	0.00	2.46E+12	0.00	0.00
L7	50-58	0.00	0.00	0.00	1.79E+12	0.00	0.00
			Total Mass		1.21E+13		
			^{235}U				
L1	0-1	0.00	0.00	0.00	0.00E+00	0.00	0.00
L2	01-10	0.30	5.00E+04	4.50E+05	6.16E+09	1.00	0.30
L3	10-20	0.19	5.00E+04	5.00E+05	7.16E+09	1.00	0.19
L4	20-30	0.19	5.00E+04	5.00E+05	4.22E+09	1.00	0.19
L5	30-40	0.19	5.00E+04	5.00E+05	4.22E+09	1.00	0.19
L6	40-50	0.00	0.00	0.00	0.00E+00	0.00	0.00
L7	50-58	0.00	0.00	0.00	0.00E+00	0.00	0.00
			Total Mass		2.18E+10		

Table E.3.29. Summary of Source Term Characteristics Developed by SADA for SWMU 145 (Continued)

SADA Layer	Depth (ft)	Average (mg/kg)[a]	Area (ft^2)	Volume (ft^3)	Mass (gm)[a]	Concentration Factor	Adjusted Average (mg/kg)[a]
				^{238}U			
L1	0-1	0.00	0.00	0.00	0.00E+00	0.00	0.00
L2	01-10	2.62	1.21E+06	1.09E+07	2.02E+11	0.96	2.52
L3	10-20	6.77	1.14E+06	1.14E+07	1.36E+12	0.90	6.12
L4	20-30	6.60	1.17E+06	1.17E+07	3.51E+12	0.93	6.13
L5	30-40	6.14	1.26E+06	1.26E+07	3.51E+12	1.00	6.14
L6	40-50	5.62	1.26E+06	1.26E+07	3.52E+12	1.00	5.62
L7	50-58	5.67	1.25E+06	1.00E+07	3.22E+12	0.99	5.62
			Total Mass		2.34E+12		

[a] Radionuclides are in units of pCi/g for concentrations and pCi for mass.

Table E.3.30. Chemical-Specific Parameters of the COPCs Used in SESOIL Modeling of SWMU 145

COPC	Mol. Wt. (MW) (g/mol)	Solubility in water (mg/L)	Diffusion in air (cm^2/s)	Diffusion in water (m^2/hr)	Henry's Constant (atm.m3/mol)	Koc (L/kg)	Kd[a] (L/kg)	Half Life (years)
Antimony	121.75	1.00E+07	NA	3.60E-07	NA	NA	45	infinite
PCB-1254	327	7.00E-02	1.56E-02	1.80E-06	3.40E-04	4.25E+04	34	infinite
PCB-1260	375.7	2.70E02	1.38E-02	1.56E-06	7.40E-05	2.07E+05	165.6	infinite
Arsenic	74.92	1.00E+07	NA	3.60E-07	NA	NA	29	infinite
Benzo(a)pyrene	252.32	1.62E-03	4.3E-02	3.24E-06	1.13E-06	9.69E+05	772	infinite
Cadmium	112.41	1.00E+07	NA	3.60E-07	NA	NA	75	infinite
Manganese	54.94	1.00E+07	NA	3.60E-07	NA	NA	65	infinite
Mercury	200.59	6.00E-02	3.07E-02	2.27E-06	2.44E-02	NA	52	infinite
Nickel	58.69	1.00E+07	NA	3.60E-07	NA	NA	300	infinite
Vanadium	50.94	1.00E+07	NA	3.60E-07	NA	NA	1000	infinite
^{238}U	238	1.00E+07	NA	3.60E-07	NA	NA	66.8	4.47E+09
^{235}U	235	1.00E+07	NA	3.60E-07	NA	NA	66.8	7.04E+08
^{234}U	234	1.00E+07	NA	3.60E-07	NA	NA	66.8	2.44E+05
^{99}Tc	99	1.00E+07	NA	3.60E-07	NA	NA	0.2	2.13E+05
^{239}Pu	239	1.00E+07	NA	3.60E-07	NA	NA	550	2.41e+04

[a] The soil/water distribution coefficient (Kd) of an organic compound depends on the soil's organic content (foc) and compound's organic partition coefficient (Koc). Kd values presented for organic compounds are for UCRS soils (with foc value of 0.08%) only. Kds used in AT123D are different due to the foc of 0.02% in the RGA.

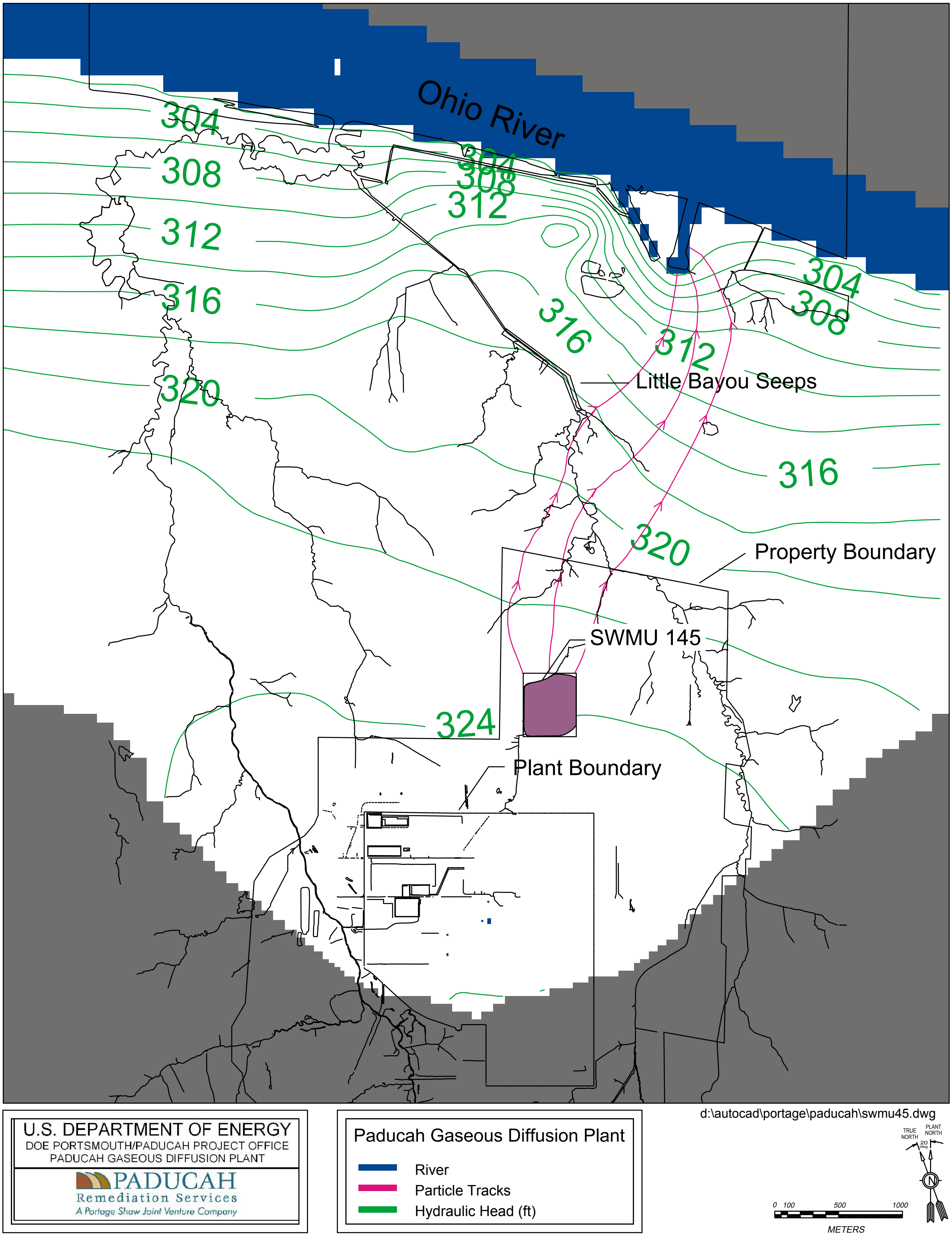

Figure E.3.5. Particle Tracks for SWMU 145

E.3.1.8.3 Groundwater modeling results for SWMU 145

Table E.3.31 summarizes the predicted maximum groundwater concentrations at the POEs for the COPCs modeled at SWMU 145. These contaminants were predicted by SESOIL to reach the water table within the 1,000 year period in concentrations that were greater then the groundwater background or greater than the groundwater child no action levels. Several contaminants that originally passed the screening for groundwater did not reach the water table in 1,000 years [i.e., PCB-1254, PCB-1260, benzo(a)pyrene, manganese, vanadium, ^{234}U, ^{235}U, and ^{239}Pu] or exhibited groundwater concentrations that were less than the groundwater background or the groundwater child no action levels (i.e., cadmium, mercury, and nickel) (see Section 5.4 of the main text).

Table E.3.31. Concentrations of the COPCs in Groundwater Predicted in SESOIL and AT123D Modeling of SWMU 145

COPC	SWMU (mg/L)	Property Boundary (mg/L)	Ohio River (mg/L)	MCL (mg/L)
Antimony	***7.99E-02***	1.51E-06	0	0.006
Arsenic	***6.21E-02***	1.61E-03	0	0.01
^{99}Tc	***1.0106E+04***	***1.84E+03***	***965***	900[c]

[a] Values in bold, italic font exceed the COPC's MCL
[b] Radionuclide concentrations are in pCi/L
[c] ^{99}Tc MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption
[d] MCLs not available for these contaminants

As shown in Table E.3.31, the predicted maximum groundwater concentration for ^{99}Tc exceeds the MCLs at the property boundary and at the Ohio River. All remaining COPCs are less than their MCLs at the POEs. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.32. The predicted arsenic concentrations at the property boundary results in the greatest HQ, with both arsenic and ^{99}Tc providing elevated cancer risks.

Table E.3.32. Hazard and Cancer Risk Predicted from Maximum Groundwater Concentrations Derived in Modeling of SWMU 145 Using SESOIL and AT123D[a]

COC	SWMU		Property Boundary		Near Ohio River	
	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient	Cancer Risk
Antimony	2.00E+01	[b]	<0.1	[b]	[b]	[b]
Arsenic	1.99E+01	1.65E-03	0.5	4.3E-05	[b]	[b]
^{99}Tc	[b]	5.54E-04	[b]	1.0E-04	[b]	5.3E-05

[a] Contaminants with a HQ greater than 0.1 or a cancer risk greater than 1.00E-06 are considered COCs.
[b] Value not calculated since the groundwater concentrations was reported as zero at this POE by AT123D, or the contaminant did not have a reported cancer slope factor or chemical toxicity RfD.

Figures 5.34 through 5.36 in Section 5 of the main text, show the predicted concentrations over time at each POE for COCs with a HQ greater than 0.1 and/or a risk greater than 1.0E-06 for contaminants migrating from SWMU 145. As shown in these figures, manganese is predicted to continue rising in concentration at 1,000 years at the plant boundary exceeding the MCL, but has not reached the property boundary or Ohio River in the 1,000 year period. Arsenic is also increasing in concentration at the plant boundary at 1,000 years, however the concentrations are less than the MCL. ^{99}Tc is not predicted to exceed the MCL at the POEs.

E.3.2 VAPOR TRANSPORT MODELING

The BGOU RI includes vapor transport modeling to evaluate the potential air concentrations in a residential basement for soil and groundwater contamination at the BGOU SWMUs and POEs. Modelers used the Johnson and Ettinger model (1991), coded into spreadsheets by EPA (2004), to assess the potential migration of VOCs into a residential basement.

Johnson and Ettinger (1991) introduced a screening-level model which incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from either subsurface soils or groundwater into indoor spaces located directly above or in close proximity to the source of contamination. The Johnson and Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination.

Since the Johnson and Ettinger model is a screening level model, the number of parameter inputs is minimized. Table E.3.33 provides the input parameter values used in the vapor transport analysis. All analyses for the BGOU RI used the default chemical property library. The contaminant source inventories for the soil layers beneath the SWMUs were obtained from the SADA analyses presented in Section E.3.1.

Table E.34 presents the resulting basement air concentrations, predicted by the model. The HQs and cancer risks calculated in accordance with the Risk Methods Document are presented in Table E.3.35.

Table E.3.33. Vapor Transport Model Input Parameter Values

Parameter	Value	Reference
Average Soil Temperature (T_s)	15 ºC	Default value
Depth below grade to bottom of enclosed space floor (L_F)	200 cm	Default value
SCS soil type	Silty Clay	Table E.3.2
Soil dry bulk density (ρ_b)	1.46 g/cm^3	Table E.3.2
Soil total porosity (n)	0.45	Table E.3.2
Soil water-filled porosity (θ_w)	0.167	Default value
Soil organic carbon fraction (f_{oc})	0.08	Table E.3.2
Enclosed space floor thickness (L_{crack})	10 cm	Default value
Soil-building pressure differential (Δ_p)	40 g/cm-s^2	Default value
Enclosed space floor length (L_B)	1,000 cm	Default value
Enclosed space floor width (W_B)	1,000 cm	Default value
Enclosed space height (H_B)	366 cm	Default value
Floor-wall seam crack width (W)	0.1 cm	Default value
Indoor air exchange rate (ER)	0.5 hr^{-1}	Default value

Table E.3.34. Basement Air Concentrations Based on Vapor Transport Modeling Results for each BGOU SWMU

		Air concentration (mg/m³)		
Source Area	Contaminant	On-Site	Plant Boundary	Property Boundary
SWMU 2	TCE	2.81E-02	1.09E-04	5.55E-05
	cis-1,2-DCE	1.95E-01	7.82E-04	3.89E-04
	Naphthalene	2.70E-07	1.56E-08	8.43E-09
SWMU 3	TCE	1.62E-05	2.08E-05	1.10E-05
	Mercury	7.22E-06	1.12E-14	0.00E+00
SWMU 4	TCE	4.90E-03	2.12E-04	1.08E-04
	cis-1,2-DCE	5.76E-03	8.80E-05	4.05E-05
	Vinyl Chloride	6.7E-03	1.98E-04	2.55E-06
SWMU 5	TCE	5.41E-06	1.98E-07	9.13E-08
	Acenapthene	2.04E-07	7.47E-08	4.30E-08
	Fluorene	5.16E-08	2.37E-08	1.27E-08
	Napththalene	3.80E-06	9.75E-08	3.79E-08
	Pyrene	2.28E-09	NA	NA
SWMU 6	TCE	9.34E-06	3.88E-09	1.92E-09
SWMU 7	TCE	8.63E-05	4.96E-06	7.16E-07
	cis-1,2-DCE	2.13E-04	9.66E-06	1.42E-06
	Vinyl Chloride	1.23E-02	1.25E-05	1.22E-06
	1,1-DCE	1.03E-02	6.70E-05	9.03E-06
	Mercury	9.99E-06	2.22E-09	2.41E-12
	Pyrene	7.68E-09	4.93E-12	1.31E-12
	Tetrachloroethene	2.00E-05	1.71E-01	4.70E-09
SWMU 30	TCE	6.75E-02	3.42E-04	2.96E-05
	1,1-DCE	3.36E-02	4.85E-05	3.62E-06
	Acenapthene	2.77E-08	4.96E-09	9.22E-10
	Fluorene	3.92E-09	NA	NA
	Mercury	1.66E-05	8.91E-1	2.23E-11
	Pyrene	6.56E-10	2.47E-11	6.54E-12
	Naphthalene	3.10E-07	1.90E-08	1.85E-09
SWMU 145	Mercury	1.42E-05	7.95E-08	2.60E-14

Table E.3.35. Vapor Hazard Quotients and Risk-Based on Vapor Transport Modeling Results for Each BGOU SWMU

		On-Site		Plant Boundary		Property Boundary	
Source Area	**Contaminant**	**HQ**	**ECLR**	**HQ**	**ECLR**	**HQ**	**ECLR**
SWMU 2	TCE	**3.15E+00**	**1.84E-03**	1.22E-02	**7.14E-06**	6.22E-03	**3.64E-06**
	cis-1,2-DCE	**2.50E+01**	NA	1.00E-01	NA	4.99E-02	NA
	Naphthalene	4.03E-04	NA	4.99E-06	NA	1.26E-05	NA
SWMU 3	TCE	1.82E-03	**1.06E-06**	2.33E-06	1.36E-09	1.23E-06	7.21E-10
	Mercury	**1.08E-01**	NA	7.70E-10	NA	NA	NA
SWMU 4	TCE	**5.54E-01**	**3.23E-04**	2.38E-02	**1.39E-05**	1.21E-02	**7.07E-06**
	cis-1,2-DCE	**7.38E-01**	NA	1.13E-02	NA	5.19E-03	NA
	Vinyl Chloride	**2.99E-01**	**4.19E-05**	8.85E-03	**1.24E-06**	1.14E-04	1.60E-08
SWMU 5	TCE	6.06E-04	3.54E-07	2.22E-05	1.30E-08	1.02E-05	5.98E-09
	Acenapthene	4.37E-06	NA	1.60E-06	NA	9.21E-07	NA
	Fluorene	1.65E-06	NA	7.57E-07	NA	4.06E-07	NA
	Napththalene	5.67E-03	NA	1.45E-03	NA	5.65E-04	NA
	Pyrene	9.71E-08	NA	NA	NA	NA	NA
SWMU 6	TCE	1.05E-03	6.12E-07	4.35E-07	2.54E-10	2.15E-07	1.26E-10
SWMU 7	TCE	9.68E-03	**5.65E-06**	5.56E-04	3.25E-07	8.03E-05	4.69E-08
	cis-1,2-DCE	2.73E-02	NA	1.24E-03	NA	1.82E-04	NA
	Vinyl Chloride	**5.48E-01**	**7.68E-05**	5.59E-04	7.83E-08	5.45E-05	7.64E-09
	1,1-DCE	**2.30E-01**	**3.66E-04**	1.50E-03	**2.39E-06**	2.02E-04	3.21E-07
	Mercury	**1.49E-01**	NA	3.31E-05	NA	3.59E-08	NA
	Pyrene	3.27E-07	NA	2.10E-10	NA	5.58E-11	NA
	Tetrachloroethene	1.49E-04	8.13E-09	4.78E-07	2.60E-11	3.51E-08	1.91E-12
SWMU 30	TCE	**7.57E+00**	**4.42E-03**	3.83E-02	**2.24E-05**	3.32E-03	**1.94E-06**
	1,1-DCE	**7.52E-01**	**1.20E-03**	1.09E-03	**1.73E-06**	8.10E-05	1.29E-07
	Acenapthene	5.93E-07	NA	1.06E-07	NA	1.97E-08	NA
	Fluorene	1.25E-07	NA	NA	NA	NA	NA
	Mercury	**2.47E-01**	NA	3.83E-02	NA	3.33E-07	NA
	Naphthalene	4.62E-04	NA	1.09E-03	NA	2.76E-06	NA
	Pyrene	2.80E-08	NA	1.06E-07	NA	2.79E-10	NA
SWMU 145	Mercury	**2.12E-01**	NA	1.19E-03	NA	3.88E-10	NA

NA = not applicable

E.3.3 UNCERTAINTY ANALYSIS FOR THE TRANSPORT MODELING

The SADA SESOIL and AT123D models were used for the investigation, resulting in the use of some simplifying assumptions. These assumptions resulted in modeling uncertainties. This section lists some of the key uncertainties and discusses their impacts upon the modeling results.

E.3.3.1 Source Term Development

The source term was developed using sampling results, geospatial analyses in SADA, and considering SESOIL limitations. While the sampling results are appropriate for source identification, a denser sampling pattern would have allowed for more refined estimates of both the COC source zone volumes and concentrations. Additionally, due to SESOIL's requirement to use the same constant area for each layer, the COC concentrations of all layers needed to be normalized against the area of the layer with the maximum estimated COC mass. These limitations in source term development increased the variability of the modeling results.

The techniques in SADA that can be used for source term development are nearest neighbor, natural neighbor, inverse distance, ordinary kriging, and indicator kriging. The nearest neighbor technique was selected for source zone refinement because it yielded results that were most compatible with the conceptual site model of contaminant release.

Each potential COC source area was discretized using rows and columns with a uniform spacing. Multiple domains with varying depths were used to characterize the COC source areas vertically in relation to the existing aquifers; therefore, the domain was further discretized into horizontal layers. COC results for each domain were compiled, and COC concentrations in each cell of the domain were predicted using geospatial interpolation (see Appendix E Attachment 2 for details).

The source term is based on a three-dimensional, geospatial analysis of the data using nearest neighbor interpolation in SADA. Therefore, sample data was assessed both horizontally within each layer and vertically between layers. This resulted in a conservative analysis of the subsurface data, such that sample detections in a layer with no corresponding sample locations in the adjacent vertical layers, resulted in predictions of contamination in these adjacent layers. For the BGOU RI, soil samples were typically collected from angled soil borings; thus, deeper samples did not underlay shallower samples. The lack of vertical control throughout the layers tended to result in contamination being estimated throughout the depth of the vertical layers to the RGA. This is illustrated in Table E.3.36 for TCE data at SWMU 4 (presenting the highest risk for all BGOU SWMUs) in which the maximum sample detection for the layers is generally much less than the maximum concentration predicted for a layer by SADA. In this case, the maximum concentration (i.e., 41 mg/kg) in layer 5 has been interpolated into layers 2, 3, 4, and 6 from layer 5. In general, SADA provides average TCE concentration in the layers that are greater in comparison to the average of the sample detections. Due to the lack of sample data points, the nearest neighbor interpolation tends to estimate large areas of contamination for which there are no data. For example, layer 2 contains two samples with detections; however, SADA predicts that 206 cells (20 ft by 20 ft grid cells) are contaminated. Therefore, SADA provides a maximum estimate of the total contamination using the nearest neighbor interpolation method.

In several cases, the SADA estimated uranium mass in relation to other metals (i.e., vanadium and manganese) appears to be underestimated. The mass of metals, such as vanadium and manganese also appear to be overestimated using SADA. The SADA interpolation estimates the mass between sample points. This results in an estimated mass of vanadium and manganese in the waste volume based on sample points located outside the waste zone. Likewise, the sample points for uranium outside the waste zone are used to interpolate the mass in the waste zone. The issue of the uranium mass potentially present in the waste zone in relation to the estimated SADA mass will be evaluated further in the Feasibility Study.

Table E.3.36. Comparison of Sample Data with SADA Predicted Concentrations for TCE at SWMU 4

SADA Layer	Depth (ft)	Number of Detects and Total Samples	Detect Average (mg/kg)	Detect Range (mg/kg)	SADA Predicted Number of Contaminated Cells[a]	SADA Predicted Average (mg/kg)	SADA Predicted Cell Contaminant Range (mg/kg)
L1	0-1	0/21	0.00	0	0	0.00	0
L2	01-10	2/67	0.006	0.004 – 0.008	206	2.39	0.0036 – 41.0
L3	10-20	6/77	0.095	0.016 – 0.4	165	2.85	0.0036 – 41.0
L4	20-30	6/73	0.29	0.0064 – 0.82	181	3.02	0.0036 – 41.0
L5	30-40	10/29	4.83	0.011 -41.0	240	2.56	0.0064 – 41.0
L6	40-50	11/29	2.14	0.012 – 9.2	246	2.45	0.0064 – 41.0
L7	50-63	13/39	4.44	0.02 – 25.0	249	3.15	0.0064 – 25.0

[a] Cells for SWMU 4 were 20 ft by 20 ft.

E.3.3.2 SESOIL and AT123D Transport Uncertainties

As noted previously, due to SESOIL's requirement to use the same constant area for each layer, the COC concentrations of all layers needed to be normalized against the area of the layer with the maximum estimated COC mass. The use of this methodology and uncertainty in the predictions were evaluated using TCE at SWMU 4 as an example and running each layer separately at its initial SADA concentration and area (i.e., no area and concentration normalization) and comparing these results to the original runs (i.e., normalized area and concentration). It should be noted that the results using this methodology will not match the total results presented previously for TCE at SWMU 4. By separating the layers, diffusion and volatilization gradients are different by individual layer compared to when all layers are modeled simultaneously in SESOIL; therefore, this is a comparison by layer and not by total mass in the system. The SADA data presented in Table E.3.37 were used in the analysis.

Table E.3.37. Summary of SADA Source Term Data for TCE at SWMU 4

SADA Layer	Depth (ft)	Total Mass (g)	Non-Normalized Average (mg/kg)	Non- Normalized Area (ft^2)	Normalized Average (mg/kg)	Normalized Area (ft^2)
L1	0-1	0.00E+00	0.00	0.00E+00	0.00	9.60E+04
L2	01-10	8.16E+04	2.39	8.24E+04	2.06	9.60E+04
L3	10-20	8.55E+04	2.85	6.60E+04	1.96	9.60E+04
L4	20-30	9.93E+04	3.02	7.24E+04	2.28	9.60E+04
L5	30-40	1.12E+05	2.56	9.60E+04	2.56	9.60E+04
L6	40-50	1.10E+05	2.45	9.84E+04	2.51	9.60E+04
L7	50-63	7.77E+04	3.15	9.96E+04	3.26	9.60E+04

The results of the analysis are presented in Figures E.3.6 through E.3.11. The results indicate that the normalization of the area and concentrations for input into SESOIL has an effect on the results but the differences are not considered significant when the total uncertainty of the sources from SADA are considered.

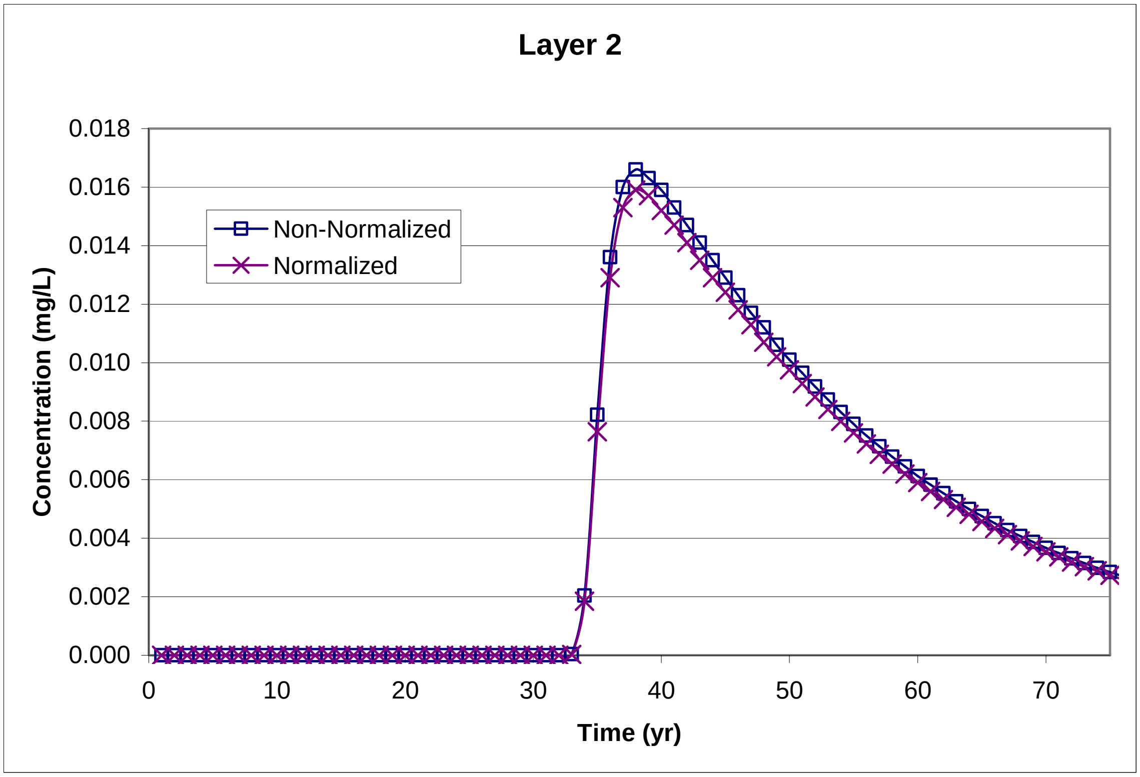

Figure E.3.6. Comparison of Predicted Groundwater Concentrations from a Layer 2 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

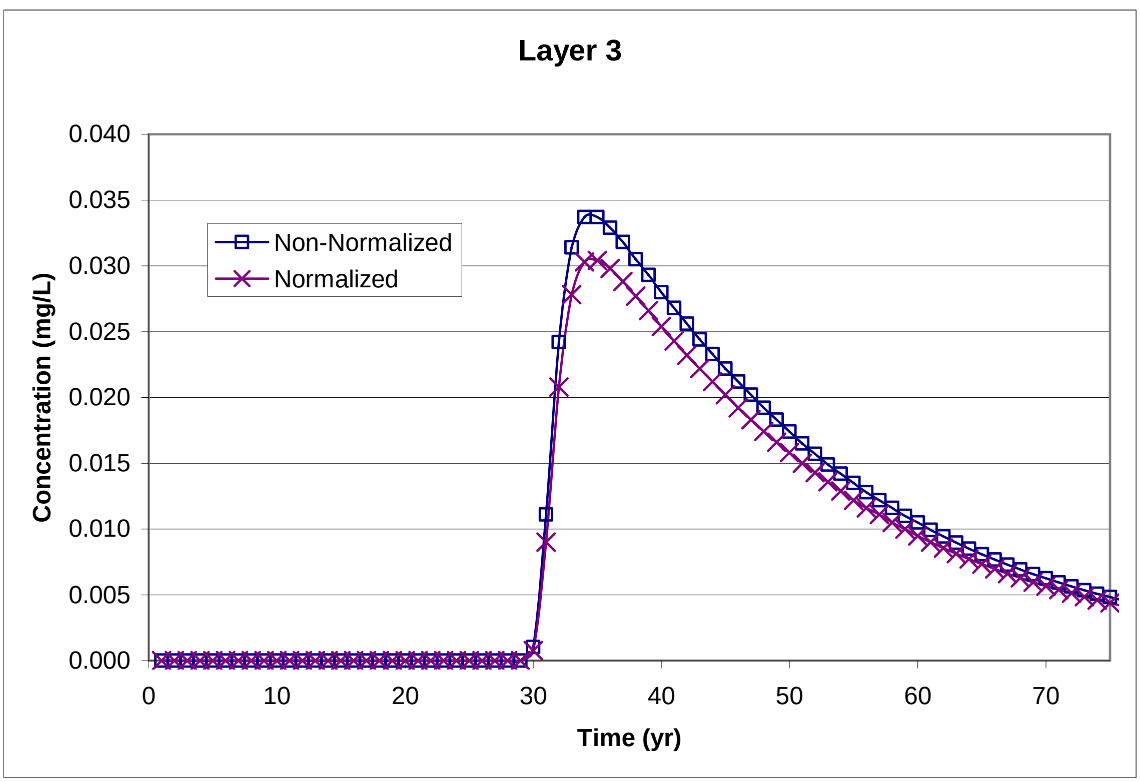

Figure E.3.7. Comparison of Predicted Groundwater Concentrations from a Layer 3 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

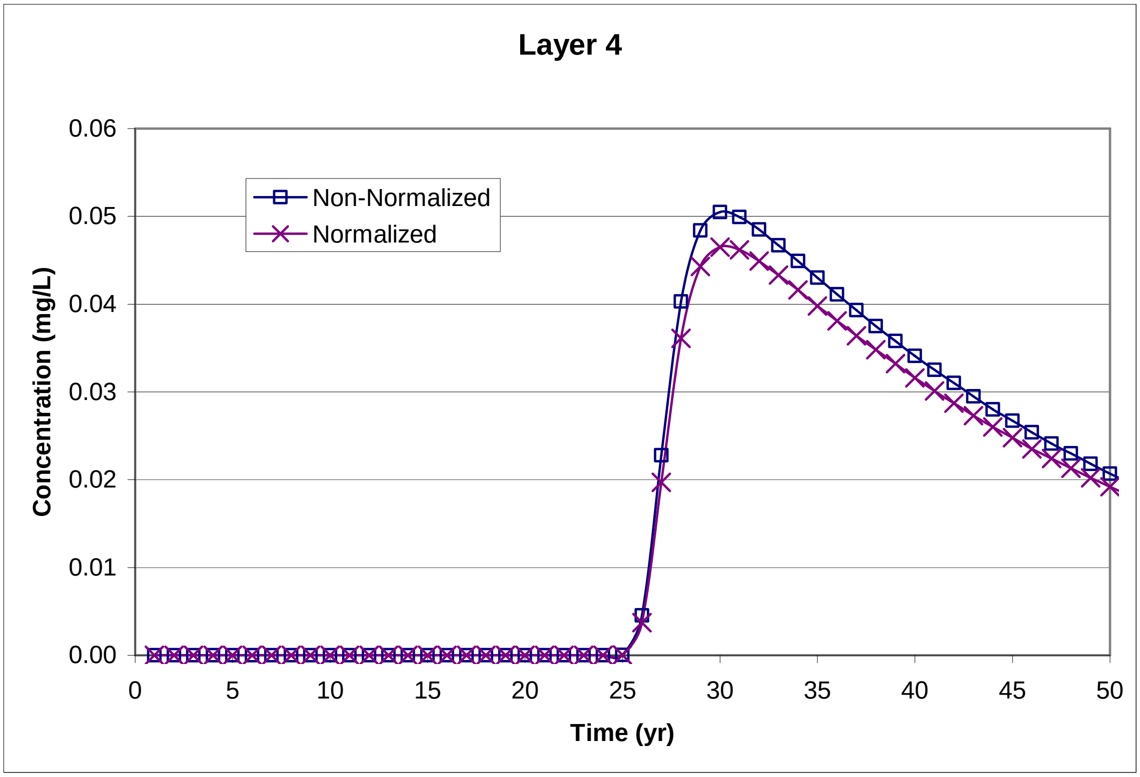

Figure E.3.8. Comparison of Predicted Groundwater Concentrations from a Layer 4 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

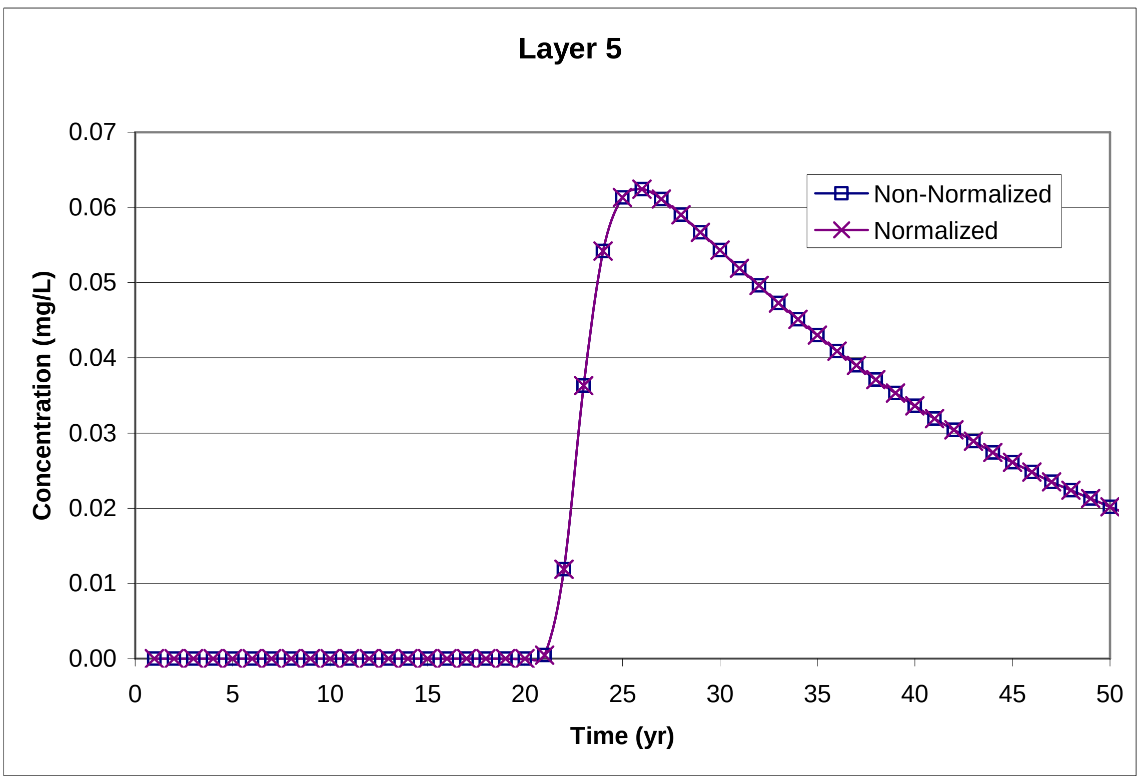

Figure E.3.9. Comparison of Predicted Groundwater Concentrations from a Layer 5 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

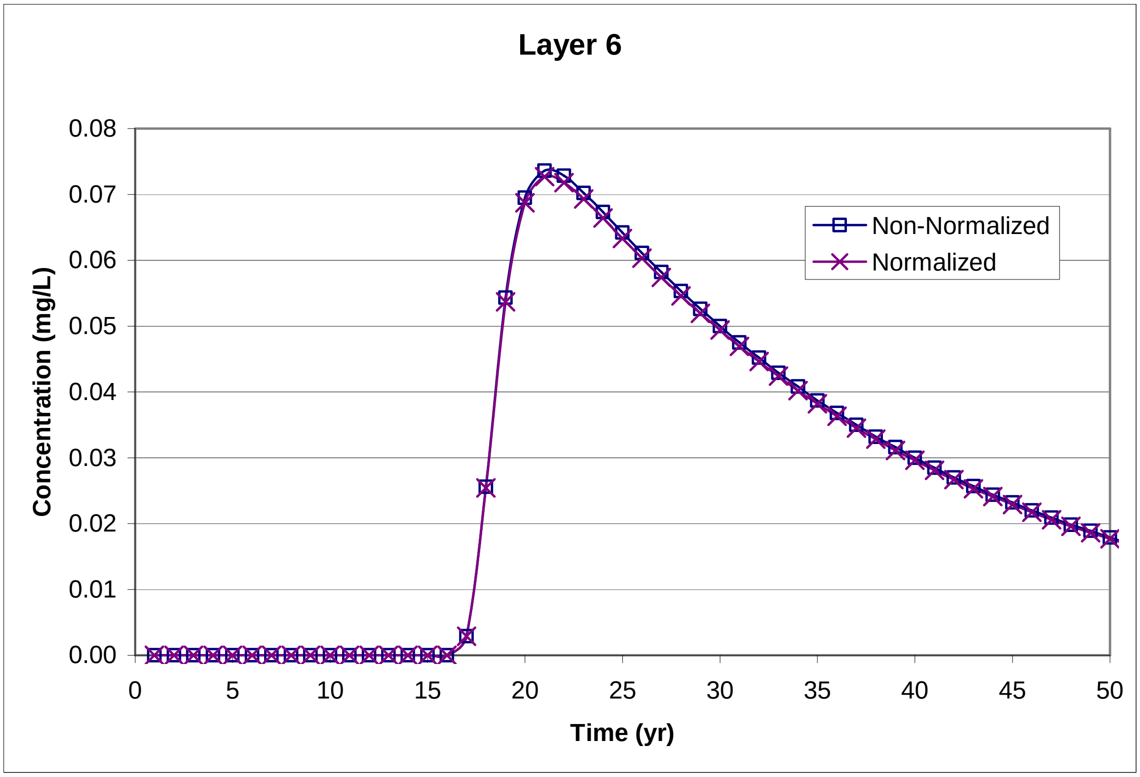

Figure E.3.10. Comparison of Predicted Groundwater Concentrations from a Layer 6 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

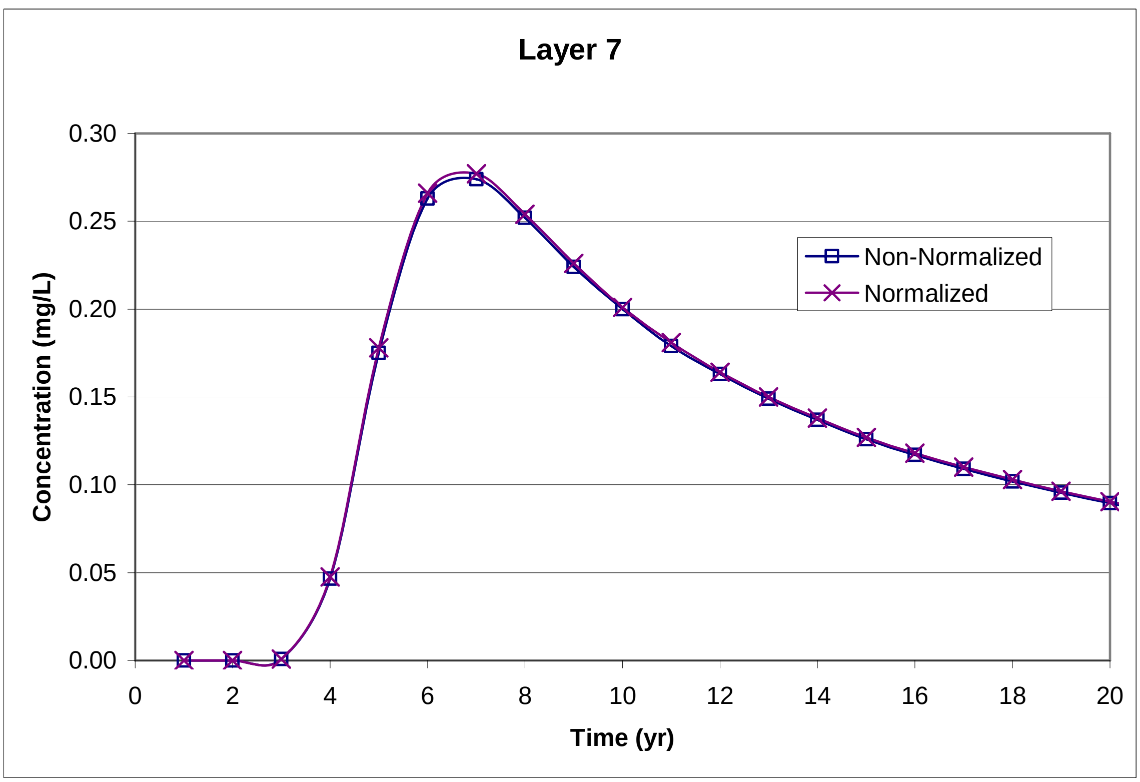

Figure E.3.11. Comparison of Predicted Groundwater Concentrations from a Layer 7 Source for TCE at SWMU 4 for the Normalized and Non-Normalized Area and Source Concentrations

An additional source of uncertainty in the AT123D modeling runs involves the use of a single hydraulic conductivity and hydraulic gradient. The hydraulic conductivity and gradient are variable from the SWMU locations to the various POEs. The MODPATH model was run to establish the steady-state head distribution in the RGA. MODPATH was used to track flowpaths of particles released from the SWMU location by using the steady-state, head distribution generated by MODFLOW. The distances from the SWMU to the POEs were taken along the flowpaths to determine the distance from the SWMU to the POEs. The hydraulic gradient from the SWMU to the property boundary was estimated using the head difference divided by the distance from the release point to the property boundary POE. The conductivity along the flowpath was also estimated for use in the AT123D model.

The selection of the sorption coefficient (K_d) for uranium in the UCRS was also evaluated for uncertainty. The sorption coefficient for sand, 66.8 L/kg was used in the analyses to provide conservatism and to account for uncertainty in the material properties directly below the SWMUs. However, site-specific measurements at PGDP have indicated that the uranium K_d in the UCRS may be much higher than used in the analyses. Therefore, the uncertainty in the uranium modeling results were evaluated using varying K_d values for uranium in the UCRS (i.e., 66.8, 133.6, 200.4, and 267.2 L/kg). The analysis was focused on SWMU 7 at the SWMU boundary and at the plant boundary. The results of the analysis for ^{238}U and ^{234}U are provided in Figures E.3.12 through E.3.15.

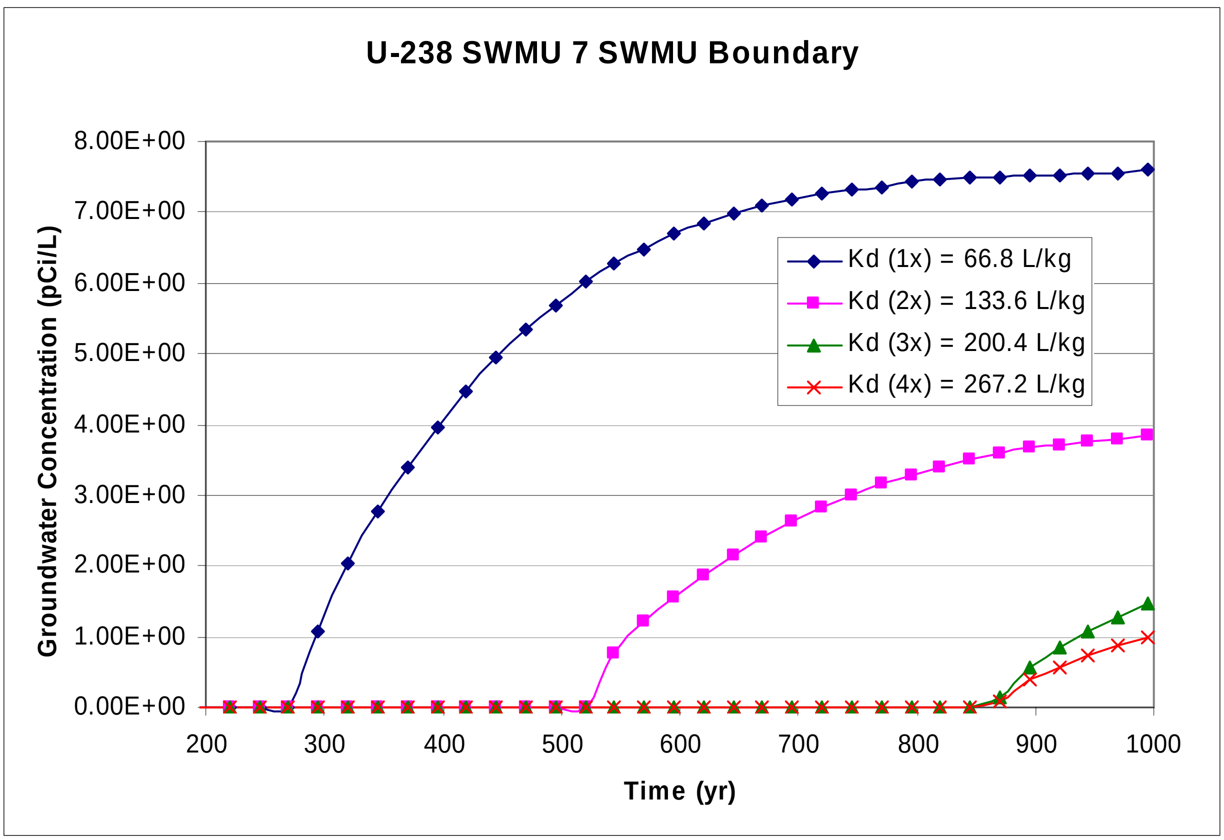

Figure E.3.12. SWMU 7 Groundwater Concentrations for ^{238}U at the SWMU Boundary for Varying UCRS K_d Values

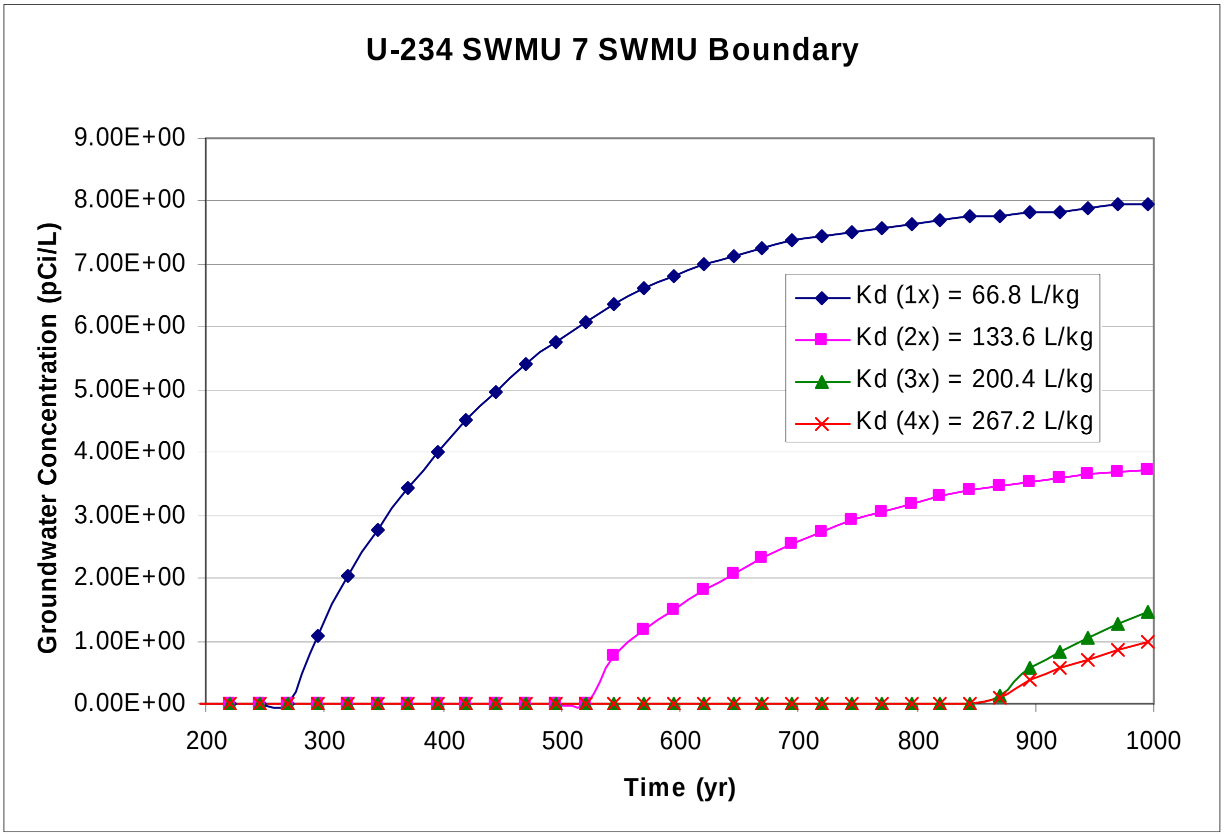

Figure E.3.13. SWMU 7 Groundwater Concentrations for ^{234}U at the SWMU Boundary for Varying UCRS K_d Values

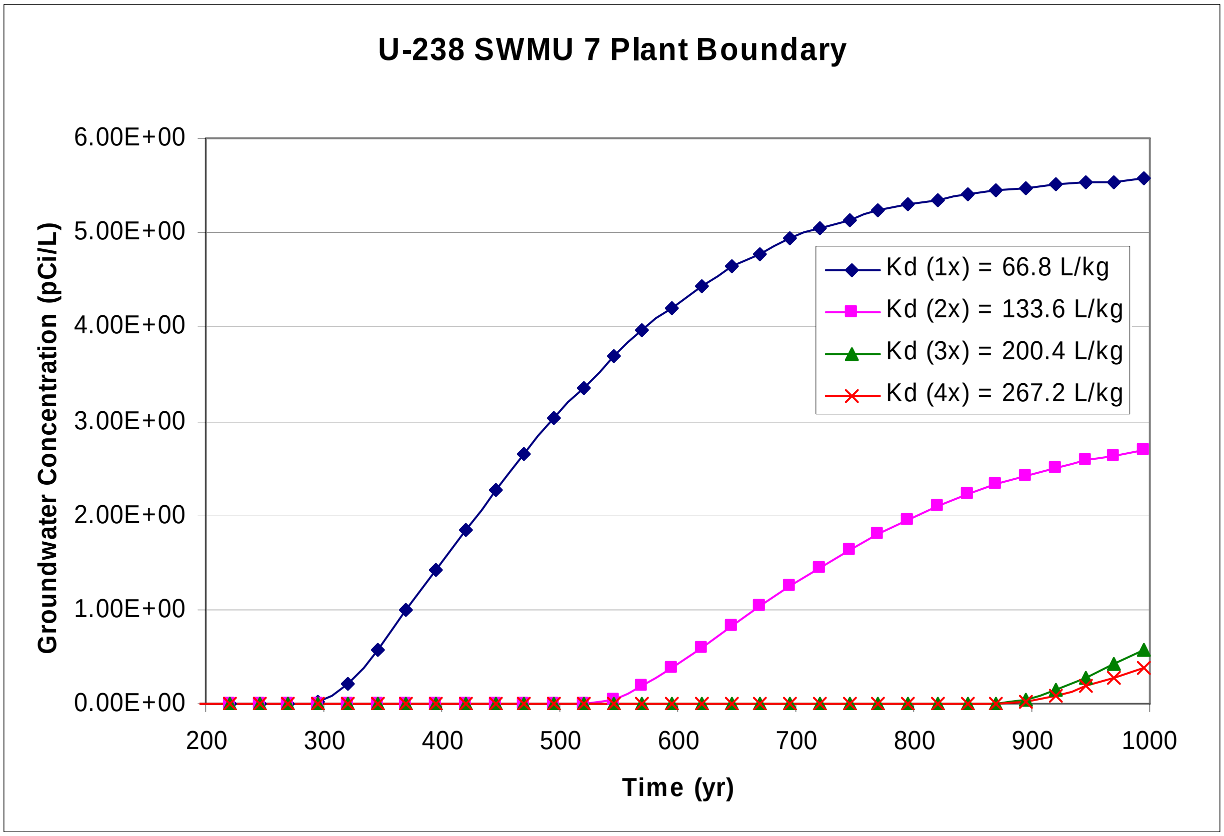

Figure E.3.14. SWMU 7 Groundwater Concentrations for ^{238}U at the Plant Boundary for Varying UCRS K_d Values

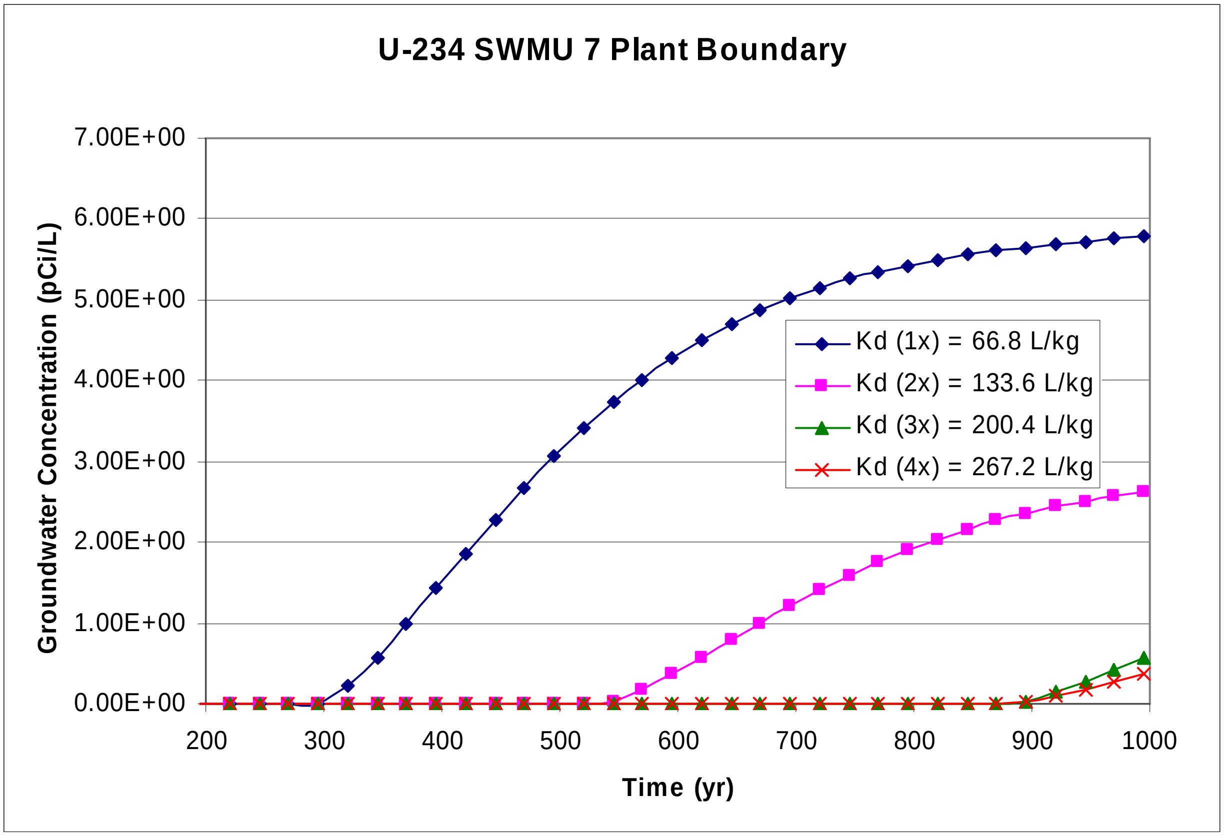

Figure E.3.15. SWMU 7 Groundwater Concentrations for ^{234}U at the Plant Boundary for Varying UCRS K_d Values

The analyses show that as the uranium K_d is increased, the arrival time of the contaminant at the POEs is shifted to later times. In addition, the maximum groundwater concentrations within the 1,000 year time period decrease. As the uranium K_d is increased beyond 4 times the original value of 66.8 L/kg, the contaminant no longer reaches the RGA water table within the 1,000 year analysis period. This analysis shows that the sand Kd of 66.8 L/kg for the UCRS is likely low and that the risks and hazards from uranium at the SWMUs will be much less than reported.

Another source of uncertainty in the fate and transport modeling involves earlier analyses of the SWMUs on the western side of the PGDP which indicated the presence of a water table in the UCRS that results in some waste being below the locally high water table. Site data indicate that at least some of the burial pits of the BGOU SWMUs are saturated, with the primary flow direction being down into the RGA. Insignificant horizontal flow is assumed to occur above the RGA. The modeling assumed that the soil zones above the RGA are unsaturated, with contaminants being transported vertically downward into the RGA. The assumption that these zones are unsaturated in the model may have resulted in overestimation of contaminant migration from the various sources to the RGA for SWMUs below the UCRS water table. Overestimation is the result of the interaction between layers with low vertical hydraulic conductivity (i.e., HU2 Confining and HU3) and the shallow water table. Generally, this interaction results in contaminant concentrations in pore water within each layer approaching equilibrium with soil prior to migration because the rate of migration is very slow. This phenomenon ultimately would result in rates of contaminant migration (i.e., flux) that are less than that which would result from the introduction (i.e., infiltration) of "clean" water from precipitation through an unsaturated layer.

An additional uncertainty involves the fact that SESOIL and AT123D do not consider contaminant transformation such as that for radioactive decay chain ingrowth of progeny. An analysis was conducted to evaluate the potential impact of progeny ingrowth from ^{238}U and ^{234}U at SWMU 7. To evaluate the movement of progeny, a simplified assumption was made that radioactive progeny travel at the same rate of the parent. This assumption has been shown to be conservative (Codell et al., 1982) and greatly simplifies the calculations. The assumption was also made that no progeny exist at the time of waste emplacement. The concentration of the i^{th} progeny in a decay chain at the receptor location is then calculated by:

$$C_i = Cparent \, \frac{DIF_i \times R_{d\ parent}}{DIFparent \times R_{d\,i}}$$

Where

DIF_i = decay ingrowth factor of the i^{th} progeny

DIF_{parent} = decay-ingrowth factor of the parent

$R_{d\,i}$ = retardation factor of the parent

$R_{d\ parent}$ = retardation factor of the parent

C_{parent} = groundwater concentration of the parent (pCi/L)

The sorption coefficients for sand were used in the analysis for uranium (66.8 L/kg), thorium (3200 L/kg) and radium (500 L/kg) (Sheppard and Thibault 1990).

The decay-ingrowth factor for an *n* member decay chain is given by Scrable et al., (1974):

$$DIF_i(t) = \frac{\lambda_i}{\lambda_l}\left[\left(\prod_{i=1}^{n-1}\lambda_i\right)\sum_{i=1}^{n}\frac{e^{-\lambda t}}{\prod_{j=1,\ j\neq i}^{n}\left(\lambda_j - \lambda_i\right)}\right]$$

Where

λ_l = decay constant for the parent (yr^{-1})

λ_i = decay constant for the ith progeny (yr^{-1})

t = time (years)

The results of the analysis for ^{238}U and ^{234}U at SWMU 7 are provided in Figure E.3.16 and E.3.17.

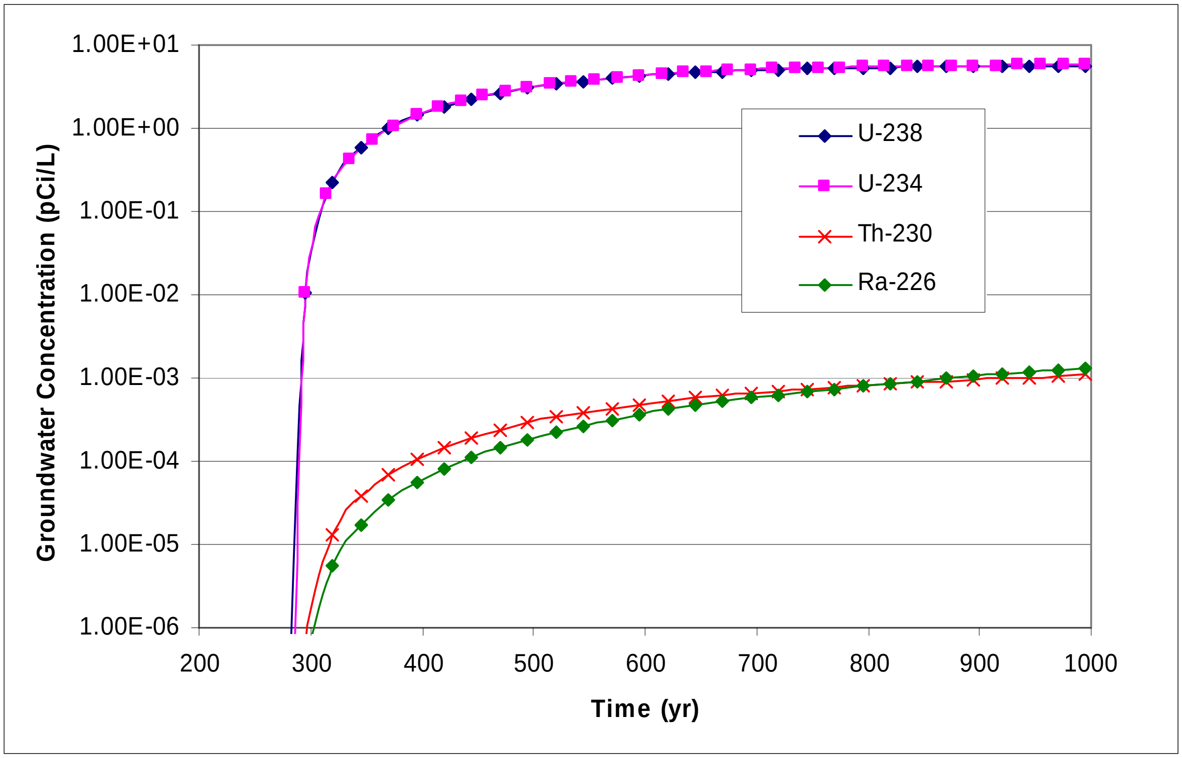

Figure E.3.16. SWMU 7 Groundwater Concentrations from Progeny Ingrowth from ^{238}U and ^{234}U at the Plant Boundary

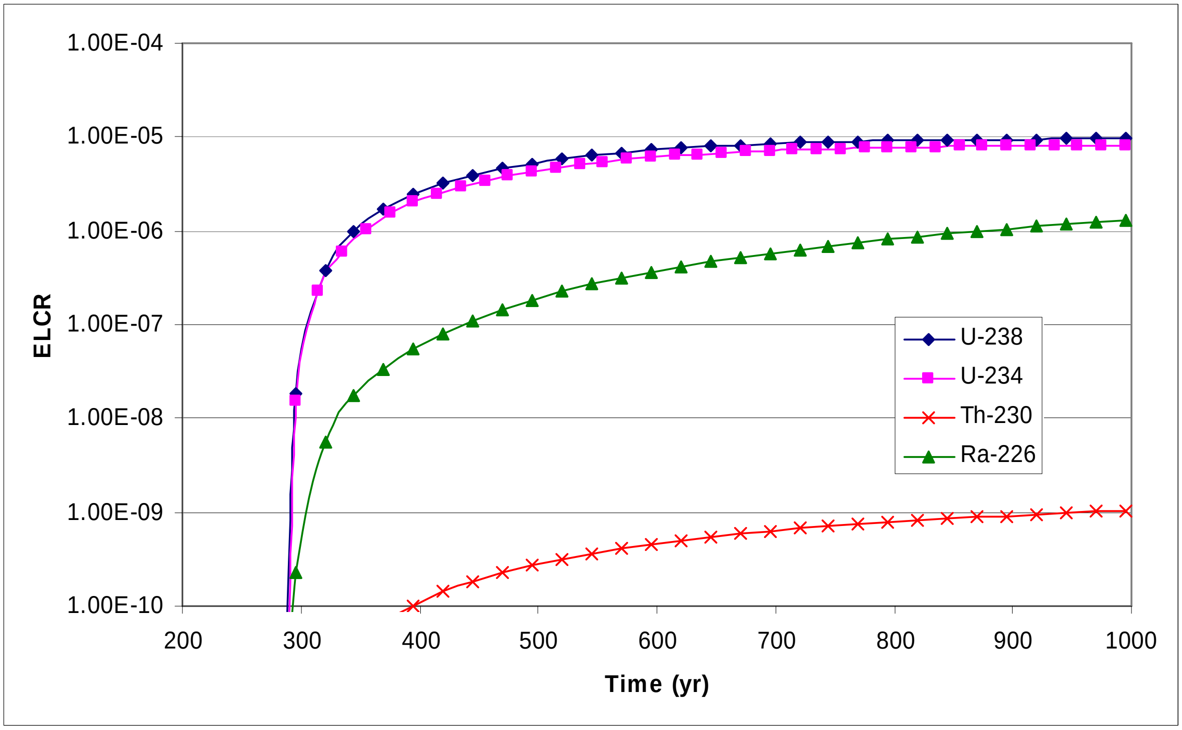

Figure E.3.17. SWMU 7 Groundwater ELCR from Progeny Ingrowth from ^{238}U and ^{234}U at the Plant Boundary

This analysis shows that the ingrowth of ^{226}Ra would provide an additional 7 % to the ELCR to that estimated for ^{238}U and ^{234}U at SWMU 7. However, this contribution is considered a conservative estimate since the progeny were assumed to transport with the uranium parents. In reality, the higher sorption coefficients for ^{230}Th and ^{226}Ra in comparison to uranium would result in differential transport such that the predicted concentrations of these progeny would be less than that provided by this simplified analysis.

E.3.3.3 Potential Interaction of Sources

The simulations presented in this report for the BGOU SWMUs are based on individual simulations of each SWMU. There is a potential that source plumes from the SWMUs could interact at the POEs. According to the flow paths presented in Figure E.3.18, the contaminant plumes from a few of the BGOU SWMUs would interact. The contaminant flow paths from SWMU 6 and SWMU 30 will interact, however, as noted previously, SWMU 6 did not have any groundwater COCs. The contaminant plumes from SWMU 3 and SWMU 5 will interact, and SWMU 2 will interact with a portion of the SWMU 5 contaminant plume. The interaction of the plumes cannot be assessed using the SESOIL/AT123D model, since only a mass flux to the aquifer is modeled without consideration of the water flux to the RGA. The plume concentrations for interaction of plumes would be less than the combination of the plume concentrations modeled in this report. Therefore, the interaction of these contaminant plumes will need to assessed during the Feasibility Study to ensure that the total risk from a combination of plumes is considered in the selection of remedial options.

E.3.3.4 Location of the POEs

The POEs used in the modeling were placed at locations on the SWMU boundary, plant boundary, property boundary, Little Bayou seeps, and Ohio River where the greatest contaminant concentrations are expected in the future. By picking locations on the centerline of predicted contaminant plumes as the POEs, the modeling assumed that the hypothetical future resident would pick, by chance, the worst possible location to install a water supply well.

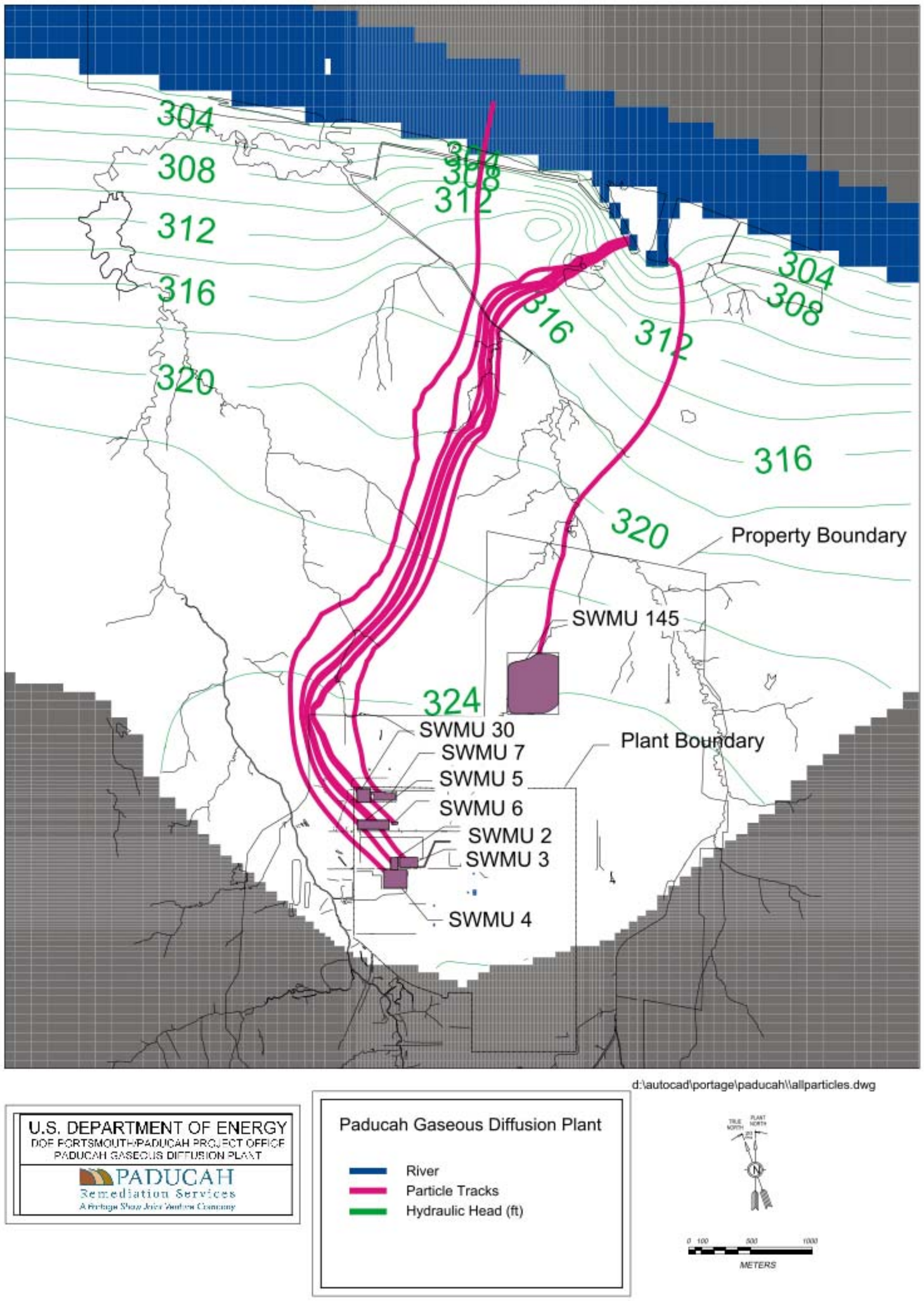

Figure E.3.18. Contaminant Plume Flow-Paths for All BGOU SWMUs

E.3.3.5 Future Environmental Changes

Several future environmental changes at the PGDP could impact the accuracy of the modeling predictions. These changes include plant shutdown and dam operation on the Ohio River. In a previous modeling effort for a landfill at PGDP, several sensitivity analyses were performed (DOE 2003b) to examine the impacts those changes may have on groundwater flow and contaminant transport. It was assumed in that sensitivity analysis that it can be expected that plant shutdown will lead to a changed recharge rate to the RGA through removal of ground cover (leading to increased recharge) and through reduced cooling water use (leading to decreased recharge); therefore, the sensitivity analysis of the groundwater travel time due to plant shutdown was studied by varying the recharge over a range of values. The results of the analysis indicated that a decrease in the recharge rate resulted in a monotonic increase in the travel time to the receptor. Thus, chemicals that have short degradation half-lives would show a decrease in concentration due to plant shutdown.

The Olmstead Dam operation is expected to increase the stage (water level) of the Ohio River; therefore, a sensitivity analysis was conducted (DOE 2003b) to assess changes in groundwater travel time in relation to dam operation, by increasing the river stage between 304.44 ft amsl and 310.04 ft amsl (the baseline river stage is 300.04 ft amsl). The results of the analysis indicated that the travel times in the aquifer changed very little in relation to the Ohio River stage; therefore, the dam operation would have little impact on the results shown in this report.

E.3.3.6 Burial Cell Waste

Sample data around and beneath the BGOU SWMUs were used to develop a source inventory of contaminants. The premise of this source inventory development is based on the inherent assumption that the contaminants around and beneath the BGOU SWMUs represent the release mass from the Burial Ground disposal cells. Therefore, the groundwater transport analyses do not model potential future releases directly from the SWMU burial cells.

Waste at several SWMUs were containerized in drums before disposal. Previous inspections of buried drums at PGDP have indicated that the drums were highly corroded. It is considered unlikely that a significant portion of the drummed waste is fully contained at the BGOU SWMUs due to the length of time the drums have been buried and thus succeptable to a corrosive environment. The drums were not modeled in this RI report due to the overall objectives of the RI analyses and uncertainty in the degradation process. The purpose of the modeling in this RI report was to identify SWMUs requiring additional analyses in the Feasibility Study. Due to the large uncertainty in the degradation of the drummed waste, real measured sample data surrounding the SWMUs were used to evaluate the potential risk from the SWMU waste. This methodology resulted in the inclusion of SWMUs with drummed waste requiring further analysis in the Feasibility Study. Therefore, the overall objectives of the RI analysis were met without requiring a detailed analysis of the degradation of drums. The issue of containerized waste will need to be evaluated during the Feasibility Study to determine the potential impact on the analysis.

E.3.3.7 SWMU 4 RGA TCE Source

The TCE source in SWMU 4 was assessed in this RI based on soil sample results. An additional source of TCE is known to exist is the RGA at SWMU 4. *The Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2180&D2, Rev 0), attempted to assess this TCE RGA source. No attempt was made in this report to determine a dense nonaqueous-phase liquid (DNAPL) source term for TCE in the RGA at SWMU 4. Therefore, the effect of this additional source term in the RGA will need to be assessed during the Feasibility Study to ensure that the total risk from a combination of TCE sources at SWMU 4 is considered in the selection of remedial options.

E.3.3.8 SWMU 3 UCRS Groundwater Contamination

The groundwater analyses conducted for this RI are based on soil samples obtained from soils surrounding the SWMUs and their subsequent release to the RGA and transport through the RGA. In some instances, water samples from wells in the UCRS indicated additional contaminant concentrations that were not accounted for in the analyses. For example, UCRS wells MW85, MW88, MW91, and MW94 at SWMU 3 indicated elevated levels of TCE. Figures E.3.19 through E.3.22 show the TCE concentrations trends for these wells in the UCRS.

The water data was added to the SWMU 3 TCE soil concentrations and a SADA nearest neighbor interpolation was assessed. The results of the SADA analysis are presented in Table E.3.38.

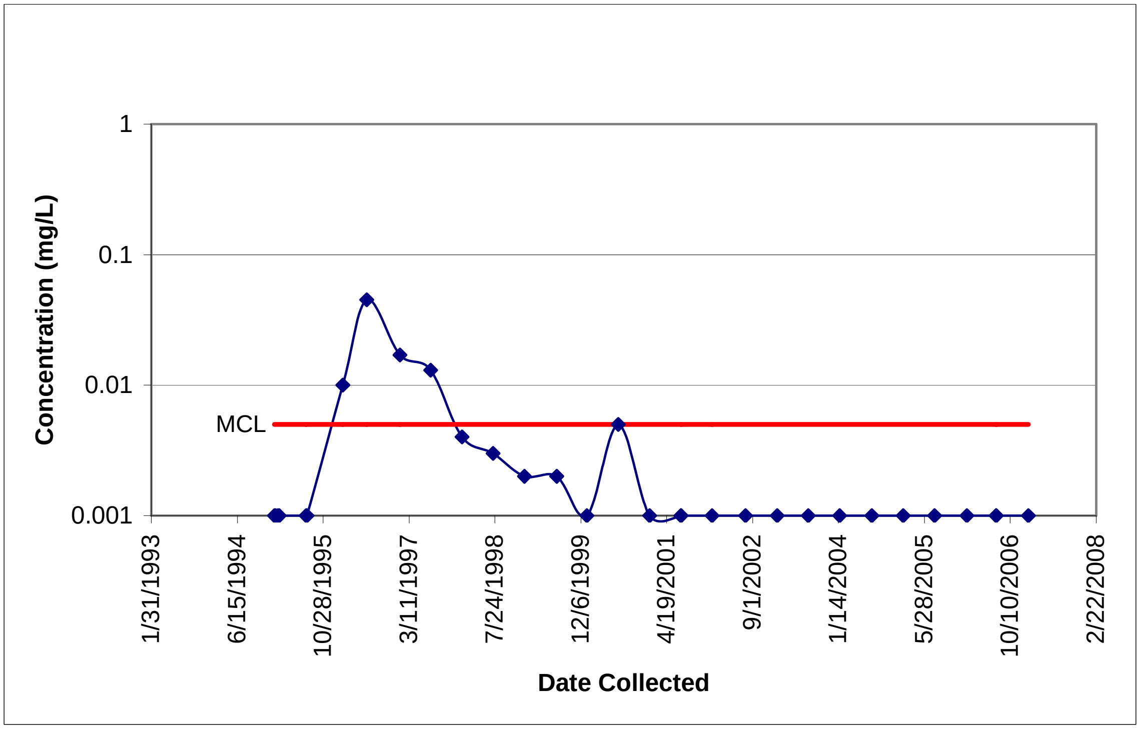

Figure E.3.19. UCRS TCE Contaminant Trend for SWMU 3 Well MW85

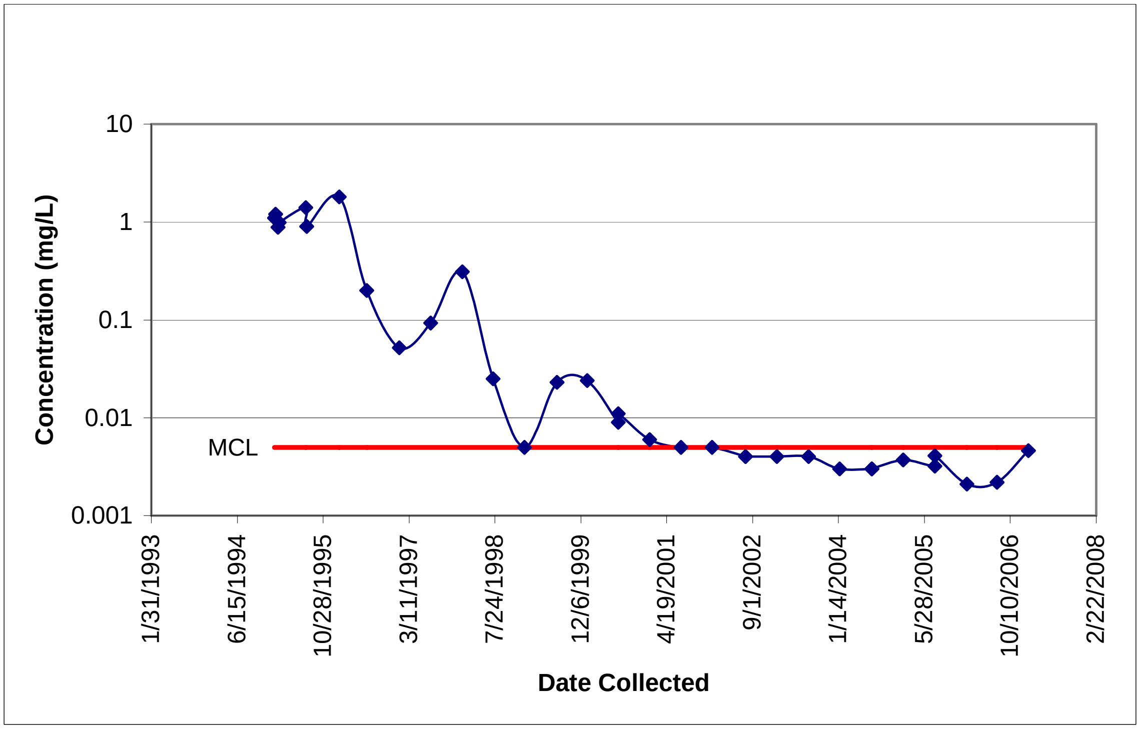

Figure E.3.20. UCRS TCE Contaminant Trend for SWMU 3 Well MW88

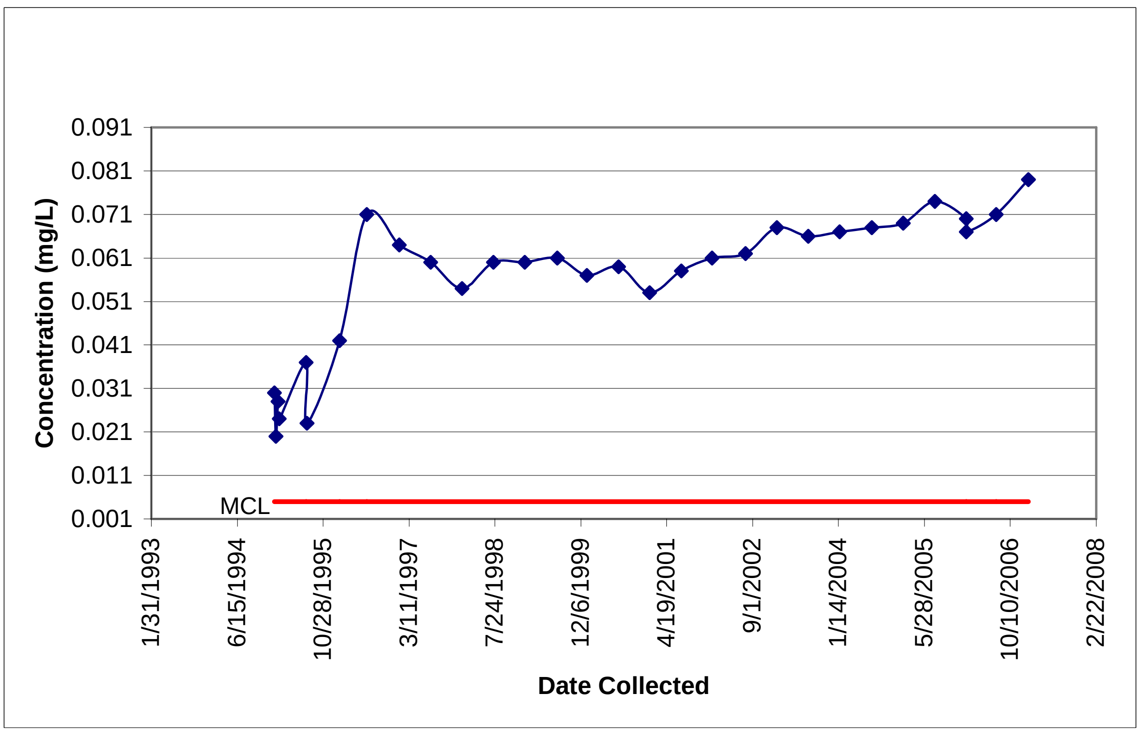

Figure E.3.21. UCRS TCE Contaminant Trend for SWMU 3 Well MW91

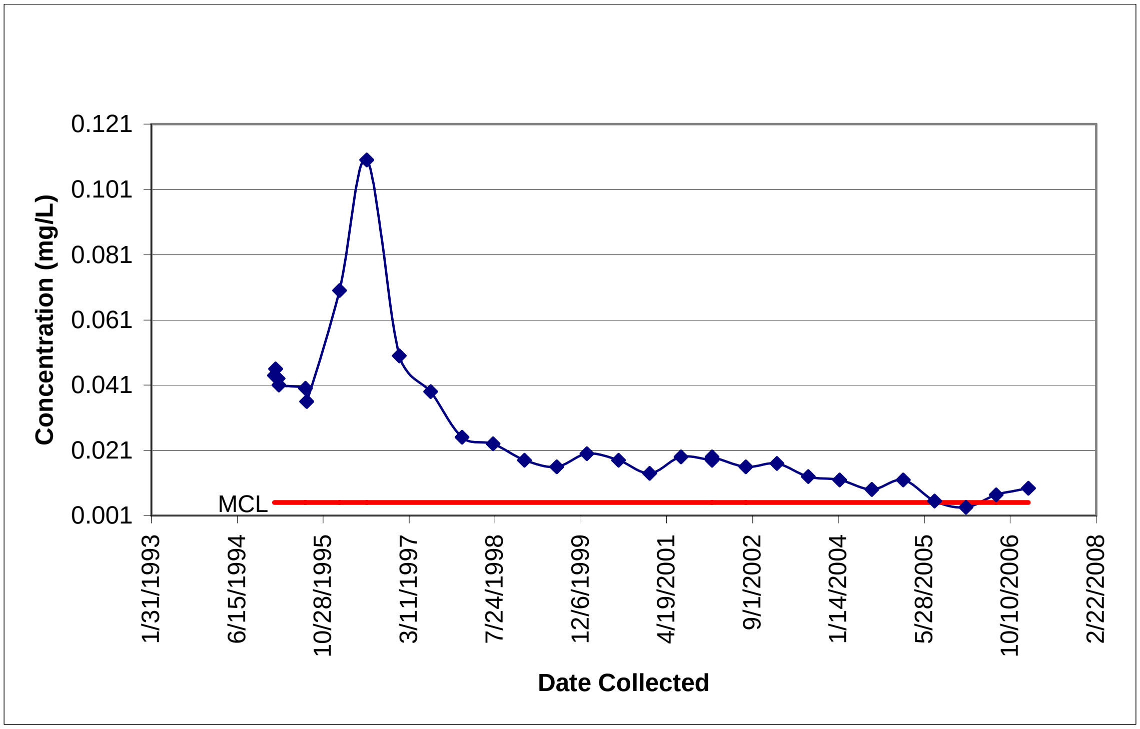

Figure E.3.22. UCRS TCE Contaminant Trend for SWMU 3 Well MW94

Table E.3.38. SWMU 3 TCE SADA Results With Well Data

Layer #	Depth Interval ft-ft bgs	Min mg/kg	Max mg/kg	Sum mg/kg	Count #	Avg mg/kg	Area ft^2	Volume ft^3	Mass gm
L0	0-1	0.01	0.01	0.02	3	0.0063	3.00E+04	3.00E+04	7.85E+00
L1	01-10	0.00	0.03	0.32	21	0.0155	2.10E+05	2.10E+06	1.34E+03
L2	10-20	0.00	0.03	0.33	22	0.0148	2.20E+05	2.42E+06	1.49E+03
L3	20-30	0.00	0.03	0.33	22	0.0148	2.20E+05	2.42E+06	1.49E+03
L4	30-40	0.00	0.03	0.33	23	0.0143	2.30E+05	2.53E+06	1.49E+03
L5	40-50	0.00	0.03	0.33	23	0.0143	2.30E+05	2.53E+06	1.49E+03
L6	50-58	0.00	0.03	0.33	23	0.0143	2.30E+05	2.30E+06	1.36E+03
								Total	**8.67E+03**

The groundwater analysis was conducted using the SADA results for both the UCRS TCE water data and the SWMU TCE soil data. The results of the analysis are provided in Figure E.3.23.

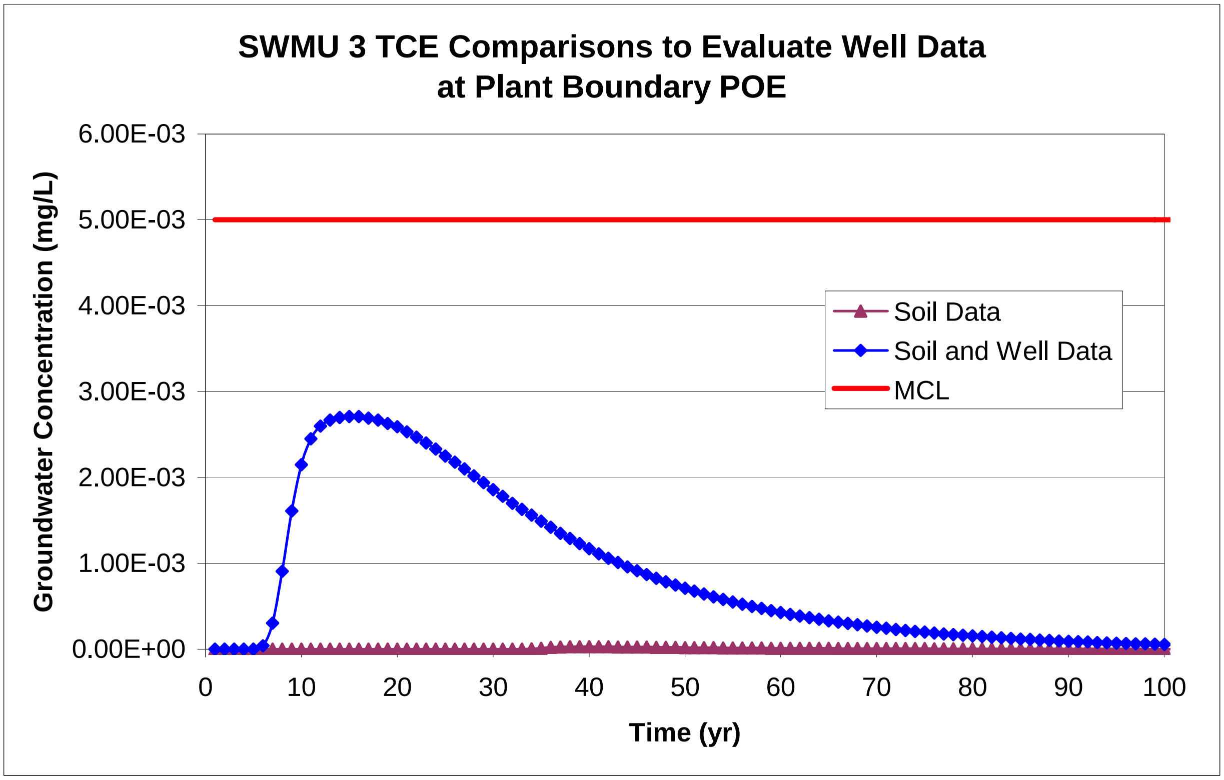

Figure E.3.23. Comparison of TCE at SWMU 3 with UCRS Well Sample Data and Soil Data

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APPENDIX E
ATTACHMENT 1

PREVIOUS FATE AND TRANSPORT MODELING FOR THE BGOU

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E1.1. INTRODUCTION

This attachment presents more detailed summaries and excerpts of previous fate and transport modeling for the Burial Ground Operable Unit SWMUs 2, 3, 4, 5, 6, 7 and 30. No previous modeling exists for SWMU 145.

E1.2. MODELING APPEARING IN THE WASTE AREA GROUP (WAG) 22, SWMUS 2 AND 3 FEASIBILITY STUDY (FS) AND ADDENDUMS, AND THE SWMU 2 DATA SUMMARY AND INTERPRETATION REPORT

This section describes previous groundwater modeling discussed in the WAG 22 SWMU 2 and 3 FS (DOE 1995a) and in the data summary and interpretation report for the SWMU 2 interim remedial design (DOE 1997).

E1.2.1 WAG 22 SWMU 2 AND 3 FS MODELING

The following is taken from the *Feasibility Study for Solid Waste Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, February 1995 (DOE 1995a).

GeoTrans (1992) conducted a modeling study of the hydrogeologic flow system beneath the PGDP to evaluate the feasibility and effectiveness of a proposed "pump-and-contain" groundwater extraction system. As part of this study, GeoTrans updated an existing model (GeoTrans 1990) by incorporating significant improvements in the hydrogeological characterization of the site. GeoTrans implemented the groundwater flow model using MODFLOW, the U. S. Geological Survey groundwater simulation code (McDonald 1988). The finite-difference grid for the GeoTrans model covered an area of approximately 60 km^2 (23 mi^2) and consisted of 91 columns, 117 rows and three layers. Layer 1 of the model represented the (UCRS); Model Layer 2 represented the RGA; and Model Layer 3 represented the McNairy Formation.

GeoTrans (1992) model used water levels from August 15, 1991, which were determined during data review to be representative of steady-state conditions, to calibrate the model. The model extended from the Ohio River in the north (simulated as a constant-head boundary) to the Porters Creek Clay terrace transition area in the south (simulated as a no-flow boundary). Constant heads simulated the observed potentiometric surface in the McNairy Formation; thus, the McNairy Formation was an infinite sink or source in the model depending on the hydraulic heads simulated in the RGA.

GeoTrans (1992) calibrated the model by matching water levels observed in the UCRS and RGA. Overall, the GeoTrans model simulates hydraulic heads more closely in the RGA. In the UCRS, the model generally mismatched hydraulic heads on the order of ±1.5 to 3 m (±5 to 10 ft). The apparent reason for the poor fit in the UCRS most likely was due to a lack of vertical discretization and the oversimplification of the hydraulic conductivity distribution in the UCRS.

McConnell (1992a; 1992b; 1993) has developed a number of groundwater flow models to study the shallow groundwater system at the PGDP site. McConnell (1993) developed a groundwater flow model to estimate the average vertical hydraulic conductivity of Hydrogeologic Unit (HU) 3, the hydraulic properties of the McNairy Formation, and the connection between the McNairy Formation and the Ohio River.

McConnell's model results suggested that the RGA is in direct communication with the Ohio River, and during high river stage conditions, groundwater is driven down into the McNairy Formation.

Additional models developed by McConnell simulated groundwater flow conditions at the C-747-A Burial Ground Area (McConnell 1992a) and the C-404 Landfill Area (McConnell 1992b). The local groundwater flow model developed for the C-747-A site evaluated the effectiveness of using an impermeable cap with and without a slurry trench partially surrounding the facility to dewater the UCRS immediately beneath the landfill. The model simulated only the UCRS and RGA HUs; a no-flow boundary represented the McNairy Formation in the model. Constant heads simulated a prescribed hydraulic gradient in the RGA and no-flow boundaries around the edges of the model in the overlying units precluded the possibility of horizontal groundwater flow in the UCRS. Model results suggested that the slurry trench in combination with the cap would be required to dewater the UCRS beneath the site.

The model of the C-404 Landfill Area (McConnell 1992b) was developed to improve the conceptual model of the groundwater flow system in the C-404 area, estimate hydraulic parameters, and assess the hydraulic effect of installing an impermeable cap over the C-404 area. This model consisted of eight model layers covering an area of 7,432 m^2 (80,000 ft^2) with minimum grid cell sizes of 15 by 15 m (50 by 50 ft). This model simulated the upper 6.1 m (20 ft) of the McNairy Formation; otherwise, boundary conditions were similar to the C-747-A model (McConnell 1992a). Due to the small size of the model and specified constant-head boundaries, the hydraulic conductivity of the RGA unit was insensitive. Model simulation results suggested that pumping in the RGA may induce leakage from the McNairy Formation, an effect inferred by Terran (1990) from the analysis of an aquifer test. Model simulations also showed that a cap installed over the landfill area reduces hydraulic heads beneath the facility, but would not be effective at dewatering it.

The objective of the McConnell study was to develop a regional model of groundwater flow at the PGDP for the purposes of testing and refining conceptual models of the groundwater flow system beneath the site and evaluating remedial alternatives for the C-749 Uranium Burial Ground, SWMU 2. Use of the model at this landfill site provided a quantitative basis for evaluating engineering alternatives and lead to informed technical and economic decisions concerning the remediation of groundwater beneath the facility. In addition, the development of this model served an important, longer range objective by providing a groundwater management tool for decision makers who needed to evaluate groundwater flow conditions at SWMUs 7 and 30, also a part of WAG 22, but which were deferred until a later date.

Previous modeling studies provided valuable information regarding hydraulic property estimates, aquifer system response, and hydrogeologic framework; however, because the previous models addressed different sets of objectives, they contained deficiencies that reduce their usefulness for this modeling study. Some of the deficiencies included the following:

Regional Model (GeoTrans 1992)

- The GeoTrans model was not satisfactorily calibrated in the UCRS layer, suggesting potential errors in the model recharge or hydraulic parameters estimates;

- The GeoTrans model did not contain sufficient vertical discretization in the UCRS and lacked sufficient horizontal discretization in the area of interest to represent heterogeneous geologic conditions beneath the PGDP;

- The GeoTrans model used a no-flow boundary condition to simulate the southern model boundary along the Porters Creek Clay terrace. Later work suggested groundwater flow may occur at this interface; and

- The hydraulic conductivity assigned to the RGA in the GeoTrans model was much higher than values that had been measured from pumping tests conducted at the site.

Site-Specific Models

- Models developed by McConnell (1992a; 1992b; 1993) did not incorporate regional groundwater flow components; and boundary conditions set close to area(s) of interest by McConnell's models overly constrained model predictions.

Geraghty & Miller's approach for their modeling study addressed the aforementioned deficiencies. The groundwater flow model resulting from this study provided a more reliable decision-making tool that incorporated regional-scale groundwater flow components in predictive simulations made at the scale appropriate for the site simulation.

To meet the objectives of the study, Geraghty & Miller developed a three-dimensional numerical model that simulates groundwater flow in the vicinity of the PGDP. Geraghty & Miller developed the model in two phases. In the first phase, Geraghty & Miller constructed and calibrated a groundwater flow model covering nearly 100 km^2 for the purpose of simulating groundwater flow on a regional scale in the principal water-bearing units beneath the site. The regional model simulated groundwater flow in a multi-aquifer system, consisting of the UCRS Hydrogeologic Unit (HU 2), RGA (HU 4/HU 5), and the McNairy Formation (HU 6), and incorporated detailed spatial information describing the distribution of heterogeneous sediments comprising the Upper Continental Deposits (HU 2). In the second phase, Geraghty & Miller used the regional modeling results to develop a site-scale groundwater flow model with the aim of evaluating the hydraulic effects of remedial alternatives on groundwater flow and contaminant migration pathways in the vicinity of SWMU 2.

For the simulation of groundwater flow at the PGDP, Geraghty & Miller selected the code MODFLOW, a publicly available groundwater flow simulation program developed by the U.S. Geological Survey (McDonald 1988). Using the 75 water-level targets selected for the calibration of the PGDP regional groundwater flow model, Geraghty & Miller evaluated the calibration of the model through the analysis of (1) simulated hydraulic head distribution in the HU 2A (Model Layer 1), HU 2B (Model Layer 2) and RGA units (Model Layer 3); (2) estimated hydraulic properties; and (3) residual statistics. The calibration objective for the PGDP regional groundwater flow model was to minimize the residual sum of squares computed for the 75 water-level calibration targets. The largest computed residual for the entire set of targets was -2.03 m (-9.95 ft); however, only six residuals out of the 75 targets exceeded +/- 1.5m (+/- 5 ft). Greater than 70% of the targets had residuals of +/- 0.6 m (+/- 2 ft) or less. Overall, the model showed a very good match to the measured water levels given the complex geologic conditions at the site. Residual statistics for the calibrated groundwater flow model also indicated good agreement between simulated and measured groundwater elevations. The mean was close to zero, and the residual standard deviation was less than 2% of the range of simulated water-level elevations for the entire model domain.

Following the calibration of the regional groundwater flow model for the PGDP, the second phase of model development was used to simulate the hydraulic effect(s) of postulated remedial alternatives on the groundwater flow system beneath SWMU 2. To perform detailed simulations of the remedial alternatives postulated for SWMU 2, Geraghty & Miller used a procedure known as telescopic mesh refinement or grid refinement to develop a site-scale model for the WAG 22 site. The finite-difference grid for the WAG 22 site model covered an area of 2.19 km^2 (0.85 mi^2) and consisted of 125 columns, 113 rows, and four layers. In the area of interest near SWMU 2, the grid cells measure 3.05 m (10 ft) on a side. Vertical discretization (layer elevations) of the WAG 22 site model was identical to the regional groundwater flow model. To preserve the characteristics of the regional groundwater flow system, the site model placed constant head boundaries along its external boundaries based on hydraulic heads simulated by the regional model. Hydraulic properties (horizontal and vertical hydraulic conductivities) and internal boundary conditions (precipitation recharge, streams and rivers, and McNair Formation constant head boundary) simulated by the site model remained unchanged form the regional model. The site model also used MODFLOW to perform the steady-state simulations of groundwater flow at the SWMU 2 site. This WAG 22 site model was used to simulate six remedial alternatives for SWMU 2.

E1.2.2 SWMU 2 DATA SUMMARY AND INTERPRETATION REPORT MODELING

The following is taken from *Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management Unit 2 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, February 1997 (DOE 1997).

E1.2.2.3 MEPAS Modeling

To quantify the potential migration of contaminants in source materials (i.e., soil, waste, and groundwater) at SWMU 2 to exposure points, MEPAS was used. For groundwater, exposure points modeled were the PGDP property boundary and the PGDP security fence. The MEPAS modeling was used to determine contaminant concentrations at exposure points over time. Tables E1.1 and E1.2 show parameters defining the environmental setting and source term used.

Transportation of contamination into the RGA and to the integrator point was modeled over a 10,000-year period. At SWMU 2, the latest sampling data showed no TCE dense non-aqueous phase liquid (DNAPL) in the RGA. However, it is known that 450 gal of TCE were disposed of at SWMU 2. To account of this material, the entire 450-gal source was modeled as being within the waste volume. It was assumed that little or no biodegradation of TCE occurs (e.g., Wilson et al. 1983, Kleopfer et al. 1985, Fetter 1993). This assumption is conservative because over long periods of time (such as the 10,000-year duration modeled in this study) TCE will probably undergo degradation into something other than vinyl chloride (Fetter 1993).

The exposure points for the groundwater flow are located at the fence and DOE boundary. From SWMU 2, the distances are 1,875 ft to the fence and 2,475 ft to the DOE boundary. The site width is perpendicular to the groundwater flow direction (north), giving a site width and length of 160 and 200 ft, respectively. For modeling, the lesser of the maximum detected concentration and the upper 95% confidence limit on the mean concentration was used for detected analytes that were on the final SAP analyte list. For analytes that were on the final SAP analyte list but were not detected, the maximum nondetected value was used. (Note, the maximum nondetected values were used because previous information indicated that each of the analytes in the final SAP analyte list should be present at SWMU 2.)

Table E1.1. MEPAS Modeling Parameters: Soil Characteristics, Hydrology, and Hydrogeology

Parameter	Waste Soil	Top Soil	HU1	HU2A	HU2 Conf	HU2B	HU3	RGA
Soil Texture[a]	9	9	9	1	11	1	11	1
% Sand[b]	5	5	5	97	10	97	8	90
% Silt[b]	75	75	75	3	40	3	38	10
% Clay[b]	20	20	20	0	50	0	54	0
% Organic Matter[c]	0.1	0.1	0.1	0.1	0.07	0.1	0.08	0.03
% Iron & Aluminum[d]	2.0	2.4	2.0	2.0	2.1	2.6	4.2	2.0
pH[e]	6.0	5.5	6.0	6.0	6.0	5.8	6.1	6.6
% Vegetative Cover[f]	---	25	---	---	---	---	---	---
Top Soil Water Capacity[f]	---	0.33	---	---	---	---	---	---
SCS Curve#[f]	---	74	---	---	---	---	---	---
Thickness[g], ft	4.6	2.0	16.5	7.5	8	6	9	40
Bulk Density[h], g/cm^3	1.96	---	1.96	2.24	1.96	2.24	1.96	2.16
Total Porosity[i], %	33	---	33	25	40	25	38	30
Field Capacity[f], %	25	---	25	13	35	13	30	---
Effective Porosity[f], %	---	---	---	---	---	---	---	25
Longitudinal Dispersivity[j] (Thickness x 0.1), ft	1.65	---	1.65	0.75	0.8	0.6	0.9	---
Saturated Hydraulic Conductivity[k], cm/s	1E-7	---	1E-7	5E-6	8E-7	1E-6	5E-7	---
Darcy Velocity[f], ft/day	---	---	---	---	---	---	---	1.17
Travel Distance[l]	---	---	---	---	---	---	---	1875/ 2475
Longitudinal Dispersivity[j] (=Travel Dist*0.1), ft	---	---	---	---	---	---	---	187.5/ 247.5
Transverse Dispersivity[j] (=Long Disp*0.33), ft	---	---	---	---	---	---	---	61.9/ 81.7
Vertical Dispersivity[j] (=Long Disp*2.5E-3), ft	---	---	---	---	---	---	---	0.469/ 0.619
% of Flux into Aquifer[m]	---	---	---	---	---	---	---	100
Perpendicular Distance to Plume Centerline, ft	---	---	---	---	---	---	---	0
Vertical Distance below GW, ft	---	---	---	---	---	---	---	0

Notes:
Table taken from DOE 1997.
"---" indicates that these data are not required for that hydrogeologic layer when setting up the MEPAS model.
[a] Selected from MEPAS based on descriptions of soil characteristics contained in SAIC (1994), Claussen et al. (1996), and SAP field investigation where 9 is silty clay loam, 1 is sand, and 11 is silty clay.
[b] Values for top soil and HU1 taken from SAIC (1994). Value for HU2A taken from Claussen et al. (1996). Values for HU2 Confining, HU2B, HU2, and RGA are estimated based on results form SAP field investigation. Value for waste set equal to HU1.
[c] Estimated from results of SAP field investigation.
[d] Estimated from results of the Phases I and II Site Investigations (CH2M Hill 1991 and 1992).
[e] Values for top soil, HU1, HU2B, and HU2 Confining estimated from results of SAP field investigation. Values for HU2A and HU3 from analyses for monitoring wells MW48 and MW53 as found in the PGDP Environmental Information Management System data base. Value for waste soil set equal to HU1.
[f] Value is estimated from MEPAS default (Droppo et al. 1989) and is based on professional judgment.
[g] All values, except for waste, were estimated from results of SAP field investigation. Value for waste soil was calculated as shown in Appendix B and Table 2.19 [of DOE 1997].
[h] Value from McConnell (1993),
[j] Calculated value.
[k] Calculated from values in Table 4.1 [of DOE 1997].
[l] Determined from PGDP site map. First value is for migration to plant security fence; second value is for migration to DOE property boundary.
[m] Value set to maximum.

Table E1.2. MEPAS Modeling Parameters: Adsorption Coefficients

Parameter	Top Soil	HU1 & Waste	HU2A	HU2 Conf	HU2B	HU3	RGA
Arsenic	19.4	19.4	5.86	19.4	5.86	19.4	5.86
Barium	2800	2800	530	16000	530	16000	530
Beryllium	1400	1400	70	8000	70	8000	70
Cadmium	423	423	14.9	56.7	14.9	567	14.9
Chromium	56.5	56.5	16.8	360	16.8	360	16.8
Manganese	25.3	25.3	16.5	36.9	16.5	36.9	16.5
Nickel	58.6	58.6	12.2	650	12.2	650	12.2
Silver	4	4	0.4	40	0.4	40	0.4
Thallium	0.2	0.2	0	0.8	0	0.8	0
Uranium	253	253	1170	3640	1170	3640	66.8
Vanadium	100	100	50	100	50	100	50
cis-1,2-dichloroethene	Analyte not found in MEPAS database						
trans-1,2-dichloroethene	0.0278	0.0278	0.007	0.115	0.007	0.012	0.0059
Aroclor 1016	1360	1360	134	2160	134	2300	111
Aroclor 1221	44	44	4.33	69.7	4.33	74.2	3.59
Aroclor 1232	5.84	5.84	0.575	9.26	0.575	9.86	0.477
Aroclor 1242	47.8	47.8	4.7	75.7	4.7	80.6	3.89
Aroclor 1248	2100	2100	207	3330	207	3540	171
Aroclor 1254	4020	4020	395	6360	395	6780	328
Aroclor 1260	50800	50800	5000	80500	5000	85700	4140
Trichloroethene	0.955	0.955	0.094	1.51	0.094	1.61	0.0779
Vinyl chloride	0.432	0.432	0.0425	0.685	0.0425	0.729	0.0352
^{241}Am	200	200	82	1000	820	1000	82
^{237}Np	3	3	3	3	3	3	3
^{239}Pu	100	100	10	250	10	250	10
^{234}Pa	50	50	0	500	0	500	0
^{99}Tc	20	20	3	20	3	20	3
^{230}Th	500	500	100	2700	100	2700	100
^{234}Th	500	500	100	2700	100	2700	100
^{234}U	243	243	906	1580	906	1580	62.98
^{235}U	243	243	906	1580	906	1580	62.98
^{238}U	243	243	906	1580	906	1580	62.98

Notes:
Table taken from DOE 1997.
All adsorption coefficients except those for uranium were generated by MEPAS. Values for uranium were taken from information gathered during recently completed SWMU 7 and 30 field investigation.

The results of the MEPAS modeling are shown in Tables E1.3. The results of the MEPAS model are not the total concentrations of SAP analytes that are present in the exposure medium (e.g., groundwater) at the exposure point but only the additional contamination that may be contributed by SWMU 2 sources.

The contributed concentration of all radionuclides, and most other analytes, is much less than the analyte's respective PRGs. This result indicates that for these SAP analytes, migration from soil and waste cells through groundwater to the exposure point at the security fence is not of concern over the 10,000 years modeled by MEPAS. However, the maximum contributed concentration of arsenic, Aroclor 1221, Aroclor 1232, Aroclor 1242, TCE, 1,1-dichloroethene, and vinyl chloride exceeds these analytes' respective human health risk-based PRG. In addition, the contributed concentration of TCE exceeds its regulatory value (i.e., MCL). Note, because similar results were obtained when MEPAS was used to model the maximum contributed concentration of SAP Analytes in RGA groundwater at the plant boundary, these results are not shown.

Table E1.3. MEPAS Results – Comparison of Estimated Maximum Concentrations of Contaminants in RGA Water at the PGDP Fence Line Originating from Soil and Waste Cells to Residential Preliminary Remediation Goals

			Preliminary Remediation Goals					
Analyte	Maximum Concentration[a]	Time of Maximum Concentration[b]	ELCR[c]	HI[d]	Regulatory Value[e]	Background[f]	Criteria Exceeded[g]	Units
Arsenic	4.93E-04	1505	3.50E-06	4.52E-04	5.00E-02	1.10E-02	P	mg/L
Barium	0.00E+00	35		1.04E-01	2.00E+00	2.90E-01	No	mg/L
Beryllium	6.45E-33	9975	1.05E-06	6.61E-03	4.00E-03	9.30E-03	No	mg/L
Cadmium	2.75E-07	9975		6.61E-04	5.00E-03	2.10E-02	No	mg/L
Chromium	8.20E-06	9975		7.05E-03	1.00E-01	1.30E-01	No	mg/L
Manganese	1.74E-02	2765		6.81E-02	1.59E-01*	1.60E-01	No	mg/L
Nickel	3.48E-06	9975		3.01E-02	6.19E-02	6.20E-02	No	mg/L
Silver	1.97E-04	1715		7.50E-03	1.00E-01*	1.10E-01	No	mg/L
Thallium	1.07E-03	35			2.00E-03	1.10E-01	No	mg/L
Uranium	4.86E-03	665		4.53E-03	2.00E-02*		No	mg/L
Vanadium	3.08E+04	8015		9.25E-03		1.40E-01	No	mg/L
Aroclor 1016	3.22E-31	9975		4.69E-05	5.00E-04		No	mg/L
Aroclor 1221	1.37E-06	4305	5.83E-07		5.00E-04		P[h]	mg/L
Aroclor 1232	9.95E-06	595	6.67E-07		5.00E-04		P[h]	mg/L
Aroclor 1242	1.26E-06	4725	6.40E-07		5.00E-04		P[h]	mg/L
Aroclor 1248	8.13E-40	9975	4.03E-07		5.00E-04		No	mg/L
Aroclor 1254	3.43E-43	9975	4.13E-07	4.30E-05	5.00E-04		No	mg/L
Aroclor 1260	0.00E+00	35	2.27E-07		5.00E-04		No	mg/L
1,1-dichloroethene	4.78E-06	35	1.62E-06	1.34E-02	7.00E-03		P[h]	mg/L
1,2-dichloroethene	5.35E-05	35	1.49E-02[i]		7.00E-02[i]		No	mg/L
Trichloroethene	5.64E-02	105	2.01E-04	7.86E-03	5.00E-03		PR	mg/L
Vinyl chloride	7.74E-05	35	2.04E-06		2.00E-03		P	mg/L
^{225}Ac	1.55E-06	3535	2.72E-01				No	pCi/L
^{227}Ac	1.89E-04	735	6.17E-02[j]				No	pCi/L
^{241}Am	6.28E-03	665	1.18E-01				No	pCi/L
^{210}Bi	6.94E-07	4025	5.30E+00				No	pCi/L
^{237}Np	5.27E-02	35	1.29E-01[j]				No	pCi/L
^{231}Pa	1.97E-04	735	2.59E-01				No	pCi/L
^{233}Pa	5.27E-02	35	8.23E+00				No	pCi/L
^{210}Pb	6.94E-07	4025	3.82E-02[j]				No	pCi/L

Table E1.3. MEPAS Results – Comparison of Estimated Maximum Concentrations of Contaminants in RGA Water at the PGDP Fence Line Originating from Soil and Waste Cells to Residential Preliminary Remediation Goals (Continued)

Analyte	Maximum Concentration[a]	Time of Maximum Concentration[b]	Preliminary Remediation Goals: ELCR[c]	HI[d]	Regulatory Value[e]	Background[f]	Criteria Exceeded[g]	Units
^{210}Po	6.94E-07	4025	1.18E-01				No	pCi/L
^{239}Pu	2.66E-02	175	1.22E-01				No	pCi/L
^{223}Ra	1.89E-04	735	1.65E-01				No	pCi/L
^{225}Ra	1.55E-06	3535	2.46E-01				No	pCi/L
^{226}Ra	4.00E-02	1155	1.30E-01[j]				No	pCi/L
^{222}Rn	7.09E-07	4025	1.03E+00[j]				No	pCi/L
^{99}Tc	3.46E-02	1365	2.76E+01				No	pCi/L
^{227}Th	1.89E-04	735	9.56E-01				No	pCi/L
^{229}Th	1.55E-06	3535	1.08E-01[j]				No	pCi/L
^{230}Th	1.04E-01	1085	1.03E+00			1.40E+00	No	pCi/L
^{231}Th	1.34E-02	665	2.16E+01				No	pCi/L
^{234}Th	1.61E-01	665	2.00E+00				No	pCi/L
^{233}U	3.24E-05	315	8.62E-01				No	pCi/L
^{234}U	1.51E-01	665	8.70E-01			1.20E+00	No	pCi/L
^{235}U	1.34E-02	665	8.21E-01[j]			1.50E-01	No	pCi/L
^{238}U	1.61E-01	665	6.23E-01[j]			1.10E+00	No	pCi/L

Notes:
Table taken from DOE 1997.
Blank cells indicate that value is not available or not applicable.
[a] Maximum concentration of analyte predicted to be in RGA water at the PGDP security fence by MEPAS. All modeling was performed over a 10,000-year period.
[b] Time at which MEPAS predicts maximum concentration will be reached.
[c] Direct contact residential use risk-based preliminary remediation goal calculated using $1X10^{-7}$ as the target excess lifetime cancer risk (ELCR) for chemicals and $1X\ 10^{-6}$ as the target ELCR for radionuclides.
[d] Direct contact residential use risk-based preliminary remediation goal calculated using 0.1 as the target hazard index.
[e] The value reported is the respective analyte's maximum contaminant level (MCL). All MCLs are Primary Drinking Water Standards except where marked with *. Marked values are either proposed Primary Drinking Water Standards or Secondary Drinking Water Standards (SMCLs).
[f] Concentration of analyte in uncontaminated media. For all water samples, the background values reported are those for the RGA.
[g] Summary of preliminary remediation goals exceeded. In this table, maximum detected concentrations are not directly comparable to preliminary remediation goals because MEPAS only predicts the additional contamination added by migration. However, the difference in magnitude between preliminary remediation goals and the maximum predicted concentrations indicates that contaminants from SWMU 2 are unlikely to contribute significantly to contamination in water at the PGDP security fence over the next 10,000 years.
[h] Source term concentration based on maximum undetected concentration.
[I] MEPAS does not offer both cis-1,2-dichloroethene and trans-1,2-dichloroethene; therefore, both isomers were modeled as trans-1,2-dichloroethene. However, the preliminary remediation goals reported are the lesser of those for the respective isomers.
[j] Preliminary remediation goal calculated using the toxicity value (i.e., slop factor) for parent isotope and short-lived daughters.

Of the seven chemicals found to have contributed concentrations that exceed screening criteria, the results for four, Aroclor 1221, Aroclor 1232, Aroclor 1242, and 1,1-dichloroethene, should be considered suspect because their contributed concentrations were based on the respective chemical's maximum nondetected concentration. Analytes that were not detected in any sample were retained in the source terms by using these analytes' maximum nondetected value. Although this approach was conservative, this procedure allowed these four chemicals, which have relative high detection limits in relation to their toxicity, to appear to migrate to exposure points at levels that may be of concern. In addition, the significance of arsenic's and vinyl chloride's contributed concentrations in relation to their screening criteria can be questioned because each chemical's contributed concentration is less than its MCL over the time period modeled.

The contributed concentrations of TCE, unlike the other chemicals, exceed both the human health risk-based PRG and the MCL in at least one time period. However, the concentrations of TCE exceed the MCL for only approximately the first 250 years modeled. After this time, the concentrations rapidly fall and are below the human health risk-based PRG based on ELCR prior to model year 500.

A secondary source of TCE may exist in the RGA at SWMU 2. Although the detected maximum concentration of TCE in RGA water is less than the criteria established for secondary sources in DOE (1996) (i.e., 10 mg/L); this concentration is 53.5% of this level. The results of the modeling of the potential secondary source in the RGA to the security fence and plant boundary are shown in Table E.1.4. The results in this table show that by year 105 from present, all contributed concentrations will be below TCE's PRGs at both the security fence and plant boundary. These results also show that the current concentration of TCE at the security fence and plant boundary exceed all of the respective analytes' PRGs and that the potential contributed concentration from SWMU 2 at 35 year is 0.5% and 0.3% respectively, of the current concentration at these locations.

Table E1.4. MEPAS Results – Comparison of Estimated Maximum Concentrations of Contaminants in RGA Water at the PGDP Fence Line Originating from Soil and Waste Cells to Residential Preliminary Remediation Goals

Time (years)	Concentration[a]	Preliminary Remediation Goals				Criteria Exceeded[f]	Units
		ELCR[b]	HI[c]	Regulatory Value[d]	Background[e]		
Results for 1,1-trichloroethene at the security fence							
Present[g]	1.50E+01	2.01E-04	7.86E-03	5.00E-03	None	PR	mg/L
35	6.11E-02					PR	mg/L
105	3.94E-07					No	mg/L
Results for 1,1-trichloroethene at the plant boundary							
Present[g]	1.50E+01	2.01E-04	7.86E-03	5.00E-03	None	PR	mg/L
35	4.51E-02					PR	mg/L
105	3.52E-06					No	mg/L

Note: Table taken from DOE 1997.

[a] Present concentrations are measured values; future concentrations are additional materials that will be in addition to materials that will be in addition to materials migrating from other sources (i.e., contributed concentrations).

[b] Direct contact residential use risk-based preliminary remediation goal calculated using $1X10^{-7}$ as the target excess lifetime cancer risk (ELCR) for chemicals.

[c] Direct contact residential use risk-based preliminary remediation goal calculated using 0.1 as the target hazard index.

[d] The value reported is the respective analyte's maximum contaminant level (MCL). All MCLs are Primary Drinking Water Standards.

[e] Concentration of analyte in uncontaminated media. For all water samples, the background values reported are those for the RGA.

[f] Summary of preliminary remediation goals exceeded. In this table, maximum detected concentrations are not directly comparable to preliminary remediation goals because MEPAS only predicts the additional contamination added by migration. However, the difference in magnitude between preliminary remediation goals and the maximum predicted concentrations indicates if the preliminary remediation goals may be exceeded. Definitions of codes are:

- P One or both of the residential use human health risk-based preliminary remediation goals are exceeded.
- R The regulatory value is exceeded.
- No No preliminary remediation goals are exceeded.

[g] Present concentrations were taken from analyses performed for sample from EW230 taken on 11/28/95.

E1.2.2.4 RESRAD Modeling

The RESRAD (Version 5.6.1) computer code was used to model the specific case of migration of radionuclide contaminants from source areas to the RGA directly under SWMU 2. Therefore, the only exposure point considered using this model was the residential use of RGA groundwater drawn from below SWMU 2. The RESRAD computer code was not used to model transport of contaminants to exposure points at the property boundary and security fence because this code cannot model lateral transport. Tables E1.5 and E1.6 show environmental setting and source term used.

Table E1.5. RESRAD Modeling Parameters: Soil Characteristics, Hydrology, and Hydrogeology

Parameter	Waste Soil	HU1	HU2A	HU2 Conf	HU2B	HU3	RGA
Thickness, m[a]	1.40	5	2.29	2.44	1.83	2.74	---
Soil density[b], g/cm^3	1.96	1.96	2.24	1.96	2.24	1.963	2.16
Total porosity[c]	0.33	0.33	0.25	0.40	0.25	0.38	0.30
Effective porosity[d]	0.25	0.25	0.13	0.35	0.13	0.30	0.25
Soil-specific b parameter[e]	10.4	10.4	4.05	10.4	4.05	10.4	4.05
Hydraulic conductivity[f], m/yr	0.032	0.032	1.58	0.025	0.32	0.16	6508
Hydraulic gradient[g]	---	---	---	---	---	---	0.02
Water table drop rate[h], m/yr	---	---	---	---	---	---	0.001
Distribution coefficients[i], cm^3/g							
^{241}Am	200	200	82	1,000	82	1,000	82
^{210}Pb	597	597	234	1,830	234	1,830	234
^{237}Np	3	3	3	3	3	3	3
^{239}Pu	100	100	10	250	10	250	10
^{231}Pa	50	50	0	500	0	500	0
^{226}Ra	100	100	24.3	124	24.3	124	24.3
^{99}Tc	20	20	3	20	3	20	3
^{229}Th	500	500	100	2,700	100	2,700	100
^{230}Th	500	500	100	2,700	100	2,700	100
^{233}U	253	253	1,170	3,640	1,170	3,640	66.8
^{234}U	253	253	1,170	3,640	1,170	3,640	66.8
^{235}U	253	253	1,170	3,640	1,170	3,640	66.8
^{238}U	253	253	1,170	3,640	1,170	3,640	66.8

Notes:
Table taken from DOE 1997.
"---" indicates that this parameter is not needed for the respective hydrogeologic unit.
[a] Taken from the site conceptual model for SWMU 2.
[b] Taken from McConnell (1993).
[c] Estimated value.
[d] Estimated value.
[e] RESRAD default estimated from soil characteristics.
[f] Taken from site conceptual model for SWMU 2.
[g] Taken from the site conceptual model for SWMU 2.
[h] Assumes minimal change due to pumping of residential well.
[i] All distribution coefficients, except for those for uranium isotopes, were default values taken from MEPAS. The distribution coefficients for uranium isotopes were those determined during the recently completed field investigation at SWMUs 7 and 30 of WAG 22. When selecting the default values for all other radioisotopes, the description of the soil characteristics of each hydrogeologic unit was used. Note, the soil type for the waste zone was assumed to be that found in HU1. This is a conservative estimate because the recently completed field investigation showed that non-native clay was used to backfill all waste pits.

Table E1.6. RESRAD Modeling Parameters: Initial Source Term Analyte Concentrations

	Input (pCi/g)[a]							
Analyte	Surface	HU1	HU2A	HU2 Confining	HU2B	HU3	RGA	Waste
^{241}Am	---	0.199	0.13	0.12	0.10	0.48	0.103	0.44
^{237}Np	0.32	0.032	0.02	0.03	0.12	0.00	0.028	0.15
^{239}Pu	7.9	0.032	0.01	0.09	0.02	0.05	0.033	0.07
^{99}Tc	58.0	0.664	0.023	0.29	0.00	0.04	0.017	0.012
^{230}Th	14.0	1.25	0.873	0.90	0.76	1.33	0.792	0.41
^{234}U	18.0	7.73	0.712	0.93	0.86	1.20	0.735	7.61
^{235}U	1.7	1.66	0.083	0.11	0.12	0.07	0.066	7.0E-06
^{238}U	69.0	53.70	0.756	0.97	0.93	1.27	0.787	10,200.00

Notes:
Table adapted from DOE 1997.
NA = not applicable.
[a] Maximum values selected from SAP database.

Table E1.7 presents the results of the RESRAD modeling. The result of this modeling is the additional contamination that may migrate to the RGA from the sources at SWMU 2. The table shows both the total contributed dose and the contributed dose from each source at SWMU 2.

Table E1.7. RESRAD Results – Contribution of Radionuclides in Soil and Waste Cells to Potential Total Dose to Resident (mrem/year) through Residential Ingestion of RGA Water

	Source Area									
Years	**RGA[a]**	**HU3**	**HU2B**	**HU2**	**HU2A**	**HU2 Total[b]**	**HU1**	**Waste Cells**	**Surface**	**Total Dose**
50	8.83E-01	3.58E-02	1.42E+00	5.44E-01	0.00E+00	1.96E+00	0.00E+00	0.00E+00	0.00E+00	2.88E+00
63	8.72E-01	4.20E-02	8.44E-01	3.54E-01	0.00E+00	1.20E+00	0.00E+00	0.00E+00	0.00E+00	2.11E+00
79.37	8.62E-01	4.92E-02	4.41E-01	2.06E-01	3.32E-01	9.79E-01	0.00E+00	0.00E+00	0.00E+00	1.89E+00
100	8.44E-01	5.71E-02	1.94E-01	1.04E-01	1.72E-01	4.71E-01	5.87E-01	1.44E+00	0.00E+00	3.40E+00
126	7.95E-01	6.05E-02	6.93E-02	4.42E-02	7.52E-02	1.89E-01	3.84E-01	3.50E-01	0.00E+00	1.78E+00
158.7	7.35E-01	6.35E-02	1.89E-02	1.50E-02	2.66E-02	6.04E-02	2.25E-01	5.91E-02	8.92E-02	1.23E+00
200	6.81E-01	6.73E-02	5.24E-03	4.18E-03	7.18E-03	1.66E-02	1.15E-01	6.35E-03	1.31E-04	8.57E-01
252	6.19E-01	7.17E-02	7.12E-04	9.66E-04	1.43E-03	3.10E-03	4.93E-02	4.65E-04	6.93E-07	7.44E-01
317.5	5.70E-01	7.69E-02	1.04E-04	2.83E-04	2.39E-04	6.26E-04	1.70E-02	1.09E-04	6.73E-07	6.64E-01
400	5.39E-01	8.44E-02	5.66E-05	1.44E-04	1.14E-04	3.14E-04	5.25E-03	1.10E-04	7.12E-07	6.29E-01
504	5.14E-01	9.21E-02	5.22E-05	8.69E-05	7.12E-05	2.10E-04	1.47E-03	1.01E-04	8.00E-07	6.08E-01
635	4.92E-01	9.79E-02	4.69E-05	5.02E-05	6.44E-05	1.62E-04	5.87E-04	9.17E-05	9.65E-07	5.91E-01
800	4.78E-01	1.03E-01	3.92E-05	2.74E-05	5.55E-05	1.22E-04	3.43E-04	7.92E-05	1.88E-03	5.83E-01
1008	4.63E-01	1.07E-01	3.00E-05	1.48E-05	4.39E-05	8.86E-05	2.09E-04	6.37E-05	7.33E-06	5.70E-01
1270	4.46E-01	1.09E-01	4.65E-03	1.23E-03	3.11E-05	5.91E-03	1.13E-04	4.66E-05	1.17E-06	5.61E-01
1600	4.26E-01	1.10E-01	9.46E-02	2.01E-02	1.94E-05	1.15E-01	5.40E-05	3.04E-05	1.21E-06	6.51E-01
2016	3.99E-01	1.09E-01	1.33E-01	3.46E-02	1.03E-05	1.68E-01	2.26E-05	1.75E-05	1.23E-06	6.75E-01
2540	3.67E-01	1.05E-01	1.69E-01	6.01E-02	5.81E-02	2.87E-01	9.31E-03	2.96E-03	1.28E-06	7.71E-01
3200	3.31E-01	1.00E-01	1.59E-01	5.93E-02	1.16E-01	3.34E-01	6.08E+02	1.73E-02	1.32E-06	8.44E-01
4032	2.92E-01	9.55E-02	1.61E-01	5.79E-02	1.36E-01	3.54E-01	8.92E-02	3.28E-02	1.38E-06	8.64E-01
5080	2.50E-01	9.04E-02	1.60E-01	5.81E-02	1.44E-01	3.62E-01	1.15E-01	5.49E-02	4.77E-02	9.20E-01
6400	2.07E-01	8.50E-02	1.45E+00	5.96E-02	1.43E-01	3.55E-01	1.15E-01	6.72E-02	1.01E-01	9.31E-01
8063	1.63E-01	7.89E-02	1.44E-01	6.17E-02	1.40E-01	3.46E-01	1.14E-01	8.77E-02	4.58E-02	8.35E-01
10160	1.21E-01	7.23E-02	1.35E-01	6.23E-02	1.31E-01	3.29E-01	1.55E-01	1.03E-01	4.35E+01	8.24E-01
12800	8.31E-02	6.46E-02	1.27E-01	4.66E-02	1.22E-01	2.95E-01	1.14E-01	1.21E-01	4.40E-02	7.22E-01
Maximum Dose	8.83E-01	1.10E-01	1.42E+00	5.44E-01	3.32E-01	1.96E+00	5.87E-01	1.44E+00	1.01E-01	3.44E+00
Year of Maximum	50	1600	50	50	79.37	50	100	100	6400	100

Note: Table taken from DOE 1997.

[a] The RGA source area was assumed to consist of hydrogeologic units 4 and 5.

[b] This column contains the sum of the results for HU2A, HU2 confining, and HU2B.

E1.3. MODELING APPEARING IN THE WAG 3 RI REPORT FOR SWMU 4

The conservative modeling in Appendix B of Volume 4 of the WAG 3 RI Report (DOE 2000a) was completed to determine if any contaminants could migrate from source areas at SWMU 4 to POEs at the plant boundary and property boundary at a rate that could result in maximum concentrations greater than risk-based screening levels. This modeling was completed using MEPAS and conservative source term estimates developed using comparisons of sampling results to background concentrations and SSLs for protection of groundwater taken from EPA sources.

The sampling results used in source term development were derived from the WAG 3 RI (DOE 2000a), the Data Gaps Investigation Report (DOE 2000b), and from earlier sampling completed in support of the PGDP Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) SI performed in the early 1990s (CH2M Hill 1991 and 1992). Source terms developed for SWMU 4 are presented in Table E1.8. As noted in the modeling report, "In all cases, modelers applied conservatism (worst case) in the definition of the extent of the source zones. In all cases, the maximum concentrations were used to develop each contaminant source-term inventory."

Input parameters used in the MEPAS modeling were based on site-specific data when available. When relevant on-site data were not available, data collected at nearby SWMUs having similar hydrogeologic conditions were used to define the input parameter. If no site-specific data were available, then default values provided by MEPAS were used. In the analysis, all sources were modeled as depleting over time and degrading in the environment. The modeled period was 10,000 years. Modeling inputs for SWMU 4 are presented in Table E1.9. The distribution coefficients (K_d) used were default values taken from MEPAS. These values are presented in Table E1.10.

The results of the MEPAS modeling for SWMU 4, taken from Appendix C of Volume 4 of the WAG 3 RI Report, are in Table E1.11. Interpretations of these results from the Southwest Groundwater Plume SI report (DOE 2006) are shown in Tables E1.12 and E1.13.

Based upon these results, the COCs for SWMU 4 for the plant boundary POE are cobalt; copper; iron; manganese; 1,1-DCE; carbon tetrachloride; TCE; vinyl chloride; ^{237}Np; ^{239}Pu; radium-226 (^{226}Ra); ^{99}Tc; ^{234}U; ^{235}U; and ^{238}U. The COCs for SWMU 4 for the property boundary POE are copper; iron; manganese; 1,1-DCE; TCE; vinyl chloride; ^{237}Np; ^{239}Pu; ^{99}Tc; ^{234}U; ^{235}U; and ^{238}U.

Table E1.8. Source Term for SWMU 4 Developed in the WAG 3 RI Report MEPAS Modeling[a]

Contaminant	Level[b] (mg/kg or pCi/g)	Parallel to Flow Axis (feet)	Perpendicular to Flow Axis (feet)	Thickness (feet)	Volume (ft^3)	Inventory[c] (g or Ci)	Note[d]
			Inorganic Chemicals (Metals)				
Aluminum	26,400	470	610	54	15,481,800	2.11E+10	Subsurface
Chromium	296	370	70	1	25,900	317,000	Surface
	42.3	NV	NV	1	22,049	38,600	Surface
	77.3	470	365	20	3,431,000	13,700,000	Subsurface
Cobalt	31.6	470	610	54	15,481,800	25,200,000	Subsurface
Copper	19.5	130	180	1	23,400	18,900	Surface
	30.1	80	165	1	13,200	16,400	Surface
	1,130	470	610	34	9,747,800	5.68E+08	Subsurface
Iron	30,700	NV	NV	1	22,049	28,000,000	Surface
	34,500	470	610	54	15,481,800	2.75E+10	Subsurface
Lead	62.5	470	175	20	1,645,000	5,300,000	Subsurface
Lithium	0.148	75	80	10	60,000	458	Subsurface
Manganese	2,920	470	640	24	7,219,200	1.09E+09	Subsurface
Nickel	153	NV	NV	1	22,049	139,000	Surface
Strontium	0.639	NV	NV	NV	NV	1,980	Subsurface
Organic Compounds							
1,1-DCE	0.340	470	610	45	10,786,500	226,000	Subsurface
1,2-DCE (mixed)	0.063	80	100	15	120,000	390	Subsurface
1,2-DCE, *cis*-	1.5	245	610	24	3,586,800	277,000	Subsurface
	11	245	610	19	2,839,550	1,610,000	Subsurface
2-Butanone	0.002	75	130	5	120,000	5.02	Subsurface
	0.031	65	105	5	34,125	54.5	Subsurface
2-Propanol	0.100	75	130	5	48,750	251	Subsurface
4-Methyl-3-penten-2-one	0.180	50	50	1	2,500	18.6	Surface
	0.67	80	100	5	40,000	1,380	Subsurface
6-(Acetyloxy)-2-hexanone	2	80	100	29	232,000	23,900	Subsurface
PCB-1016	2.5	470	610	19	5,447,300	702,000	Subsurface
PCB-1248	0.8	470	610	19	5,447,300	225,000	Subsurface
PCB-1254	27	470	610	19	5,447,300	7,580,000	Subsurface
PCB-1260	0.115	35	600	1	21,000	99.8	Surface
	0.041	450	35	1	15,750	26.7	Surface
	0.061	185	205	1	37,925	95.6	Surface
	500	470	610	19	5,447,300	140,000	Subsurface

Table E1.8. Source Term for SWMU 4 Developed in the WAG 3 RI Report MEPAS Modeling[a] (Continued)

Contaminant	Level[b] (mg/kg or pCi/g)	Parallel to Flow Axis (feet)	Perpendicular to Flow Axis (feet)	Thickness (feet)	Volume (ft^3)	Inventory[c] (g or Ci)	Note[d]
Bis(2-Methoxyethyl)phthalate	0.45	80	100	5	40,000	928	Subsurface
Carbon tetrachloride	0.170	165	95	12	188,100	1,650	Subsurface
Diethyl ether	0.009	70	45	54	170,100	78.9	Subsurface
Ethanol, 2,2'-oxybis, diacetate	2	80	100	5	40,000	4,120	Subsurface
Octachlorodibenzodioxin	8.2	80	100	5	40,000	16.9	Subsurface
Pentachlorophenol	0.21	80	100	5	40,000	433	Subsurface
TCE	48	470	610	45	10,786,500	31,900,000	Subsurface
Vinyl chloride	0.4	470	610	45	10,786,500	266,000	Subsurface
Radionuclides							
Cesium-137	1.48	210	610	10	1,281,000	0.0977	Subsurface
^{237}Np	0.266	80	165	1	13,200	0.000145	Surface
	5.78	470	610	10	2,867,000	1.62	Subsurface
^{239}Pu	0.0644	55	445	1	24,475	0.0000652	Surface
	4.17	470	610	19	2,867,000	1.17	Subsurface
^{226}Ra	2.51	470	610	19	2,867,000	0.705	Subsurface
^{99}Tc	269	NV	NV	NV	NV	75.5	Subsurface
^{230}Th	68.7	NV	NV	NV	NV	19.3	Subsurface
^{234}U	12.8	35	600	1	21,000	0.0111	Surface
	6.59	450	35	1	15,750	0.00429	Surface
	30.1	185	205	1	37,925	0.0472	Surface
	69	NV	NV	NV	NV	194	Subsurface
^{235}U	7.2	NV	NV	NV	NV	2.02	Subsurface
^{238}U	35.9	35	600	1	21,000	0.0312	Surface
	26.4	450	35	1	15,750	0.0172	Surface
	87.3	185	205	1	37,925	0.137	Surface
	126	NV	NV	NV	NV	1,760	Subsurface
Uranium, Total	6,260	282	110	15	465,300	150	Subsurface
	6,260	110	292	15	481,800	155	Subsurface

NV = no value reported in the WAG 3 RI Report.
^{230}Th = Thorium-230
[a] Information taken from Table B.5 in Appendix B of Volume 4 of the WAG 3 RI Report.
[b] The maximum concentration was used to estimate the contaminant inventory for all contaminants.
[c] Calculated using a bulk density of 1.46 g/cm^3 for Surface and 1.82 g/cm^3 for the Subsurface.
[d] Surface assumed to extend to 1 ft bgs. Thickness of subsurface differs with contaminant.

Table E1.9. Modeling Inputs for SWMU 4 MEPAS Modeling in the WAG 3 RI Report[a]

Description	Name	Value	Reference
		Top Soil Parameters (WT)	
Textural Classification	WT-CLASS	Silt loam	Soil Survey
Sand (%)	WT-SAND	15	Soil Survey
Silt (%)	WT-SILT	80	Maximum for soil type
Clay (%)	WT-CLAY	5	By difference
Organic Matter (%)	WT-OMC	0.05	CH2M Hill 1992
Iron and Aluminum (%)	WT-IRON	4	DOE 1995b
pH of Topsoil	WT-pH	7.32	RI
Vegetative Cover (%)	WT-VEGCOV	100	Description
Topsoil water capacity	WT-AVAILW	0.33	Soil Survey
SCS Curve Number	WT-SCSN	71	MEPAS
		Partially Saturated Zone Parameters (WP)	
Thickness	WP-THICK	54	RI
Textural classification	WP-CLASS	Sandy loam	RI
Sand (%)	WP-SAND	38	RI
Silt (%)	WP-SILT	41	RI
Clay (%)	WP-CLAY	21	RI
Organic Matter (%)	WP-OMC	0.05	WAG 6
Iron and Aluminum (%)	WP-IRON	4	DOE 1995b
pH of Pore Water	WP-pH	6.0	DOE 1995b
Bulk Density (g/cm^3)	WP-BULKD	1.82	RI
Total porosity (%)	WP-TOTPOR	31.28	RI
Field capacity (%)	WP-FIELDC	14	MEPAS
Longitudinal dispersivity (ft)	WP-LDISP	0.54	MEPAS
Saturated hydraulic conductivity	WP-CONDUC	3E-01 ft/day 1.06E-04 cm/sec	RI
Soil Moisture Content (%)	WS-MOISTC	31.28	MEPAS
		Saturated Zone Parameters (WZ)	
Textural classification	WZ-CLASS	Loamy sand	RI
Sand (%)	WZ-SAND	74	RI
Silt (%)	WZ-SILT	17	RI
Clay (%)	WZ-CLAY	9	RI
Organic Matter (%)	WZ-OMC	0.02	RI
Iron and Aluminum (%)	WZ-IRON	3	RI
pH of Pore Water	WZ-pH	6.36	RI
Total porosity (%)	WZ-TOTPOR	37	RI
Effective porosity (%)	WZ-EFFPOR	30	MEPAS
Darcy velocity (ft/day)	WZ-PVELOC	0.6	Conductivity = 1500 ft/d Gradient = 0.0004
Thickness	WZ-THICK	45	RI
Bulk Density (g/cm^3)	WZ-BULKD	1.67	RI
Travel Distance (ft)	WZ-DIST	Plant boundary: 890 Property boundary: 2,985	RI
Longitudinal dispersivity (ft)	WZ-LDISP	50	Bioscreen Model
Transverse dispersivity (ft)	WZ-TDISP	5.0	Bioscreen Model
Vertical dispersivity (ft)	WZ-VDISP	0.1	near zero
Total flux to aquifer (%)	WZ-FRACT	100	estimate
Perpendicular to receptor	WZ-YDIST	0	on plume centerline
Vertical to receptor	WZ-AQDEPTH	0	minimum

[a] Information taken from Table B.2 in Appendix C of Volume 4 of the WAG 3 RI Report.

Table E1.10. Distribution Coefficients (K_ds) Used for SWMU 4 MEPAS Modeling in the WAG 3 RI Report[a]

Contaminant	Surface Soil	Subsurface Soil	RGA
Inorganic Chemicals (metals)			
Aluminum	3,980	35,300	35,300
Chromium	10	565	565
Cobalt	0.2	8.81	8.81
Copper	4.19	92.2	92.2
Iron	10	15	15
Lead	10	597	597
Lithium	0	0.2	0.2
Manganese	1.5	25.3	25.3
Nickel	1.2	58.6	58.6
Strontium	2.34	100	100
Organic Compounds			
1,1-DCE	0.292	0.4	0.171
1,2-DCE (mixed)	0.0432	0.059	0.0253
1,2-DCE, *cis*-	NV	NV	NV
2-Butanone	NV	NV	NV
2-Propanol	NV	NV	NV
4-Methyl-3-penten-2-one	NV	NV	NV
6-(Acetyloxy)-2-hexanone	NV	NV	NV
PCB-1016	809	1,110	424
PCB-1248	1,250	1,700	729
PCB-1254	2,380	3,260	1,400
PCB-1260	30,100	41,200	17,600
Bis(2-Methoxyethyl)phthalate	NV	NV	NV
Carbon tetrachloride	2.26	3.09	1.32
Diethyl ether	NV	NV	NV
Ethanol, 2,2'-oxybis, diacetate	NV	NV	NV
Octachlorodibenzodioxin	NV	NV	NV
Pentachlorophenol	238	326	140
TCE	0.567	0.775	0.332
Vinyl chloride	0.256	0.35	0.15
Radionuclides			
Cesium-137	10	249	249
^{237}Np	3	3	3
^{239}Pu	4	100	100
^{226}Ra	2.43	100	100
^{99}Tc	1	1	0.1
^{230}Th	40	500	500
^{234}U	0	50	50
^{235}U	0	50	50
^{238}U	0	50	50
Uranium, Total	0	50	50

NV = Value not listed in the WAG 3 RI Report.
^{230}Th = Thorium-230
[a] Information taken from Table B.1 in Appendix B of Volume 4 of the WAG 3 RI Report. All values in mL/g.

Table E1.11. MEPAS Results for SWMU 4[a]

Source	Contaminant[b]	PGDP Plant Boundary Maximum Concentration[c]	PGDP Plant Boundary Time of Maximum (Years)	PGDP Property Boundary Maximum Concentration[c]	PGDP Property Boundary Time of Maximum (Years)	MCL[d]
Surface Soil	Chromium	2.81E-40	10,000	1.95E-52	10,000	1E-01
	Copper	4.40E-04	8,039	1.40E-04	9,585	1.3E+00
	Iron	1.97E+00	1,337	6.41E-01	1,525	3E-01*
	Nickel	2.53E-03	5,044	8.45E-04	6,107	1E-01
	PCB-1260	0	10,000	0	10,000	5E-04
	^{237}Np	5.33E-02	276	1.64E-02	315	NV
	^{239}Pu	4.16E-04	8,717	1.44E-04	10,260	NV
	^{234}U	1.37E+00	4,355	4.16E-01	5,166	20
	^{238}U	2.67E+00	4,356	8.08E-01	5,167	20
Subsurface Soil	Aluminum	0	10,000	0	10,000	2E-01*
	Chromium	1.15E-37	10,000	9.22E-53	10,000	1E-01
	Cobalt	3.29E+00	788	6.46E-01	961	NV
	Copper	7.32E+00	7,992	1.46E+00	9,539	1.3E+00
	Iron	1.16E+03	1,738	2.41E+02	2,055	3E-01*
	Lead	8.45E-42	10,000	7.54E-53	10,000	1.5E-02
	Lithium	1.76E-03	30	5.06E-04	36	NV
	Manganese	5.13E+01	2,248	9.46E+00	2,566	5E-02*
	Nickel	1.45E-01	5,019	4.29E-02	6,081	1E-01
	Strontium	2.54E-05	8,661	7.44E-06	10,450	NV
	1,1-DCE	2.57E-01	63	5.38E-02	69	7E-03
	1,2-DCE	2.24E-03	18	6.64E-04	21	7E-02**
	Carbon tetrachloride	5.94E-04	301	1.85E-04	307	5E-03
	PCB-1016	0	10,000	0	10,000	5E-04
	PCB-1248	0	10,000	0	10,000	5E-04
	PCB-1254	0	10,000	0	10,000	5E-04
	PCB-1260	0	10,000	0	10,000	5E-04
	Pentachlorophenol	3.35E-18	10,790	6.06E-19	12,910	1E-03
	TCE	2.26E+01	102	4.70E+00	111	5E-03
	Vinyl chloride	3.31E-01	57	6.90E-02	62	2E-03
	Cesium-137	0	12,920	0	12,920	NV
	^{237}Np	4.88E+02	316	9.83E+01	381	NV
	^{239}Pu	1.09E+01	8,665	2.05E+00	10,210	NV
	^{226}Ra	2.21E-01	8,208	2.16E-02	9,765	5
	^{99}Tc	6.34E+04	111	1.32E+04	113	900
	^{230}Th	3.56E-28	10,000	1.30E-43	10,000	NV
	^{234}U	4.51E+03	4,329	8.94E+02	5,140	20
	^{235}U	4.75E+01	4,330	9.45E+00	5,141	20
	^{238}U	8.33E+02	4,330	1.66E+02	5,141	20
	Total Uranium[e]	6.46E+03	4,330	2.13E+03	5,141	20

^{230}Th = Throrium-230

a Information taken from Table B.6 of Appendix B in Volume 4 of the WAG 3 RI Report.

b Table B.6 includes results for degradation products of radionuclides. These are not included here.

c Concentrations for chemicals and compounds in mg/L. Concentrations for radionuclides in pCi/L.

d Maximum contaminant levels (MCLs) taken from PGDP Risk Methods Document. MCLs for chemicals and compounds in mg/L. MCLs for radionuclides in pCi/L. All values except those marked with an asterisk (*) are primary MCLs. Values marked with an asterisk (*) are secondary MCLs. The MCL listed for 1,2-DCE (**) is the primary MCL for *cis*-1,2-DCE. The primary MCL for *trans*-1,2-DCE is 1E-01 mg/L.

e Modeled as ^{238}U.

Table E1.12. Estimated HQs for a Resident from Exposure to Maximum Modeled Concentrations from Sources at SWMU 4

Source	Contaminant	PGDP Plant Boundary		PGDP Property Boundary		Risk-based Concentrations[c]
		Maximum Concentration[a]	Hazard Quotient[b]	Maximum Concentration[a]	Hazard Quotient[b]	
Surface Soil	Chromium	2.81E-40	<0.1	1.95E-52	<0.1	1.76E+00
	Copper	4.40E-04	<0.1	1.40E-04	<0.1	5.57E-02
	Iron	1.97E+00	0.4	6.41E-01	0.1	4.49E-01
	Nickel	2.53E-03	<0.1	8.45E-04	<0.1	3.01E-02
	^{237}Np	5.33E-02	No value	1.64E-02	No value	No value
	^{239}Pu	4.16E-04	No value	1.44E-04	No value	No value
	^{234}U	1.37E+00	No value	4.16E-01	No value	No value
	^{238}U	2.67E+00	No value	8.08E-01	No value	No value
Subsurface Soil	Chromium	1.15E-37	<0.1	9.22E-53	<0.1	1.76E+00
	Cobalt	3.29E+00	3.6	6.46E-01	0.7	9.06E-02
	Copper	7.32E+00	13.1	1.46E+00	2.6	5.57E-02
	Iron	1.16E+03	258	2.41E+02	53.7	4.49E-01
	Lead	8.45E-42	No value	7.54E-53	No value	1.50E-02*
	Lithium	1.76E-03	<0.1	5.06E-04	<0.1	3.02E-02
	Manganese	5.13E+01	147	9.46E+00	27.0	3.50E-02
	Nickel	1.45E-01	0.5	4.29E-02	0.1	3.01E-02
	Strontium	2.54E-05	<0.1	7.44E-06	<0.1	9.01E-01
	1,1-DCE	2.57E-01	10.4	5.38E-02	2.2	2.46E-03
	1,2-DCE	2.24E-03	0.1	6.64E-04	<0.1	2.47E-03
	Carbon tetrachloride	5.94E-04	0.3	1.85E-04	0.1	1.90E-04
	Pentachlorophenol	3.35E-18	<0.1	6.06E-19	<0.1	2.34E-02
	TCE	2.26E+01	1,410	4.70E+00	294	1.60E-03
	Vinyl chloride	3.31E-01	10.8	6.90E-02	2.3	3.06E-03
	^{237}Np	4.88E+02	No value	9.83E+01	No value	No value
	^{239}Pu	1.09E+01	No value	2.05E+00	No value	No value
	^{226}Ra	2.21E-01	No value	2.16E-02	No value	No value
	^{99}Tc	6.34E+04	No value	1.32E+04	No value	No value
	^{230}Th	3.56E-28	No value	1.30E-43	No value	No value
	^{234}U	4.51E+03	No value	8.94E+02	No value	No value
	^{235}U	4.75E+01	No value	9.45E+00	No value	No value
	^{238}U	8.33E+02	No value	1.66E+02	No value	No value
	Total Uranium[d]	6.46E+03	No value	2.13E+03	No value	No value

^{230}Th = Throrium-230

[a] Concentrations for chemicals and compounds in mg/L. Concentrations for radionuclides in pCi/L.

[b] Calculated using comparison to risk-based concentration. Contaminants with an HQ greater than 0.1 are considered COCs.

[c] Risk-based no action screening value from Appendix A of the Risk Methods Document. In some cases, these updated values differ from those used in calculation in the WAG 3 RI Report. Values for chemicals and components are given in mg/L. Values for radionuclides are given in pCi/L. The value for lead (*) is the MCL.

[d] Evaluated as ^{238}U.

Table E1.13. Estimated Cancer Risks for a Resident from Exposure to Maximum Modeled Concentrations from Sources at SWMU 4

		PGDP Plant Boundary		PGDP Property Boundary		
Source	**Contaminant**	**Maximum Concentration[a]**	**Cancer Risk[b]**	**Maximum Concentration[a]**	**Cancer Risk[b]**	**Risk-based Concentrations[c]**
Surface Soil	Chromium	2.81E-40	No value	1.95E-52	No value	No value
	Copper	4.40E-04	No value	1.40E-04	No value	No value
	Iron	1.97E+00	No value	6.41E-01	No value	No value
	Nickel	2.53E-03	No value	8.45E-04	No value	No value
	^{237}Np	5.33E-02	<1.00E-06	1.64E-02	<1.00E-06	5.73E-01
	^{239}Pu	4.16E-04	<1.00E-06	1.44E-04	<1.00E-06	2.86E-01
	^{234}U	1.37E+00	2.41E-06	4.16E-01	<1.00E-06	5.46E-01
	^{238}U	2.67E+00	6.03E-06	8.08E-01	1.82E-06	4.43E-01
Subsurface Soil	Chromium	1.15E-37	No value	9.22E-53	No value	No value
	Cobalt	3.29E+00	No value	6.46E-01	No value	No value
	Copper	7.32E+00	No value	1.46E+00	No value	No value
	Iron	1.16E+03	No value	2.41E+02	No value	No value
	Lead	8.45E-42	No value	7.54E-53	No value	1.50E-02*
	Lithium	1.76E-03	No value	5.06E-04	No value	No value
	Manganese	5.13E+01	No value	9.46E+00	No value	No value
	Nickel	1.45E-01	No value	4.29E-02	No value	No value
	Strontium	2.54E-05	No value	7.44E-06	No value	No value
	1,1-DCE	2.57E-01	5.47E-03	5.38E-02	1.14E-03	4.70E-05
	1,2-DCE	2.24E-03	No value	6.64E-04	No value	No value
	Carbon tetrachloride	5.94E-04	3.28E-06	1.85E-04	1.02E-06	1.81E-04
	Pentachlorophenol	3.35E-18	<1.00E-06	6.06E-19	<1.00E-06	2.08E-04
	TCE	2.26E+01	1.31E-02	4.70E+00	2.72E-03	1.73E-03
	Vinyl chloride	3.31E-01	9.46E-03	6.90E-02	1.97E-03	3.50E-05
	^{237}Np	4.88E+02	8.52E-04	9.83E+01	1.72E-04	5.73E-01
	^{239}Pu	1.09E+01	3.81E-05	2.05E+00	7.17E-06	2.86E-01
	^{226}Ra	2.21E-01	2.21E-06	2.16E-02	<1.00E-06	1.00E-01
	^{99}Tc	6.34E+04	4.53E-03	1.32E+04	9.43E-04	1.40E+01
	^{230}Th	3.56E-28	<1.00E-06	1.30E-43	<1.00E-06	4.24E-01
	^{234}U	4.51E+03	8.26E-03	8.94E+02	1.64E-03	5.46E-01
	^{235}U	4.75E+01	8.83E-05	9.45E+00	1.76E-05	5.38E-01
	^{238}U	8.33E+02	1.88E-03	1.66E+02	3.75E-04	4.43E-01
	Total Uranium[d]	6.46E+03	1.46E-02	2.13E+03	4.81E-03	4.43E-01

^{230}Th = Throrium-230

a Concentrations for chemicals and compounds in mg/L. Concentrations for radionuclides in pCi/L.

b Calculated using comparison to risk-based concentration. Contaminants with a cancer risk greater than 1.00E-06 are considered COCs.

c Risk-based no action screening value from Appendix A of the Risk Methods Document. In some cases, these updated values differ from those used in calculation in the WAG 3 RI Report Values for chemicals and components in mg/L. Values for radionuclides are given in pCi/L. The value for lead (*) is the MCL.

d Evaluated as ^{238}U.

E1.4. MODELING APPEARING IN THE WAG 3 RI REPORT FOR SWMU 5

The conservative modeling in Appendix B of Volume 4 of the WAG 3 RI Report (DOE 2000a) was completed to determine if any contaminants could migrate from source areas at SWMU 5 to POEs at the plant boundary and property boundary at a rate that could result in maximum concentrations greater than risk-based screening levels. This modeling was completed using MEPAS and conservative source term estimates developed using comparisons of sampling results to background concentrations and SSLs for protection of groundwater taken from EPA sources. MEPAS transport parameters are given in Table E1.14.

Table E1.14. MEPAS Transport Parameters for SWMU 5

Input Parameter Description	Parameter Name	Value	Reference	
Topsoil parameters (wt)				
Textural classification	WT-CLASS	Silt loam	McCracken Co. Soil Survey (USDA 1976)	
Percent sand (%)	WT-SAND	15	McCracken Co. Soil Survey: conservative estimate (highest % sand)	
Percent silt (%)	WT-SILT	80	Maximum % silt for soil type	
Percent clay (%)	WT-CLAY	5	= 100% -% sand - % silt	
Percent organic matter (%)	WT-OMC	0.05	CERCLA Phase II Site Investigation (CH2M HILL 1992)	
Percent iron and aluminum (%)	WT-IRON	4	Background Concentrations and Human Health Risk-Based Screening Criteria for Metals in Soil at PGDP (DOE 1995b)	
pH of topsoil	WT-pH	8.25	WAG 3 RI data	
Percent vegetative cover off-site (%)	WT-VEGCOV	100	SWMU Maps	
Topsoil water capacity	WT-AVAILW	2.44	McCracken Co. Soil Survey = available water capacity (0.20 in./in.) × root zone depth from Table 2.1 MEPAS Guidance (12.2 in.) × vegetative cover (100%)	
SCS curve number	WT-SCSN	71	Antecedent Moisture Condition = II (normal moisture); Group C hydrologic soil group; vegetated surface, well vegetated, 60–100% vegetated	
Properties of the partially saturated zones (wp)				
Thickness (ft)	WP-THICK	WP1 39 WP2 20	WP1=1–40 ft (HU 1 + HU 2) WP2=HU 3	Boring logs at SWMU 5
Textural classification	WP-CLASS	WP1 sandy clay loam WP2 clay loam	Boring logs at SWMU 5	
Sand (%)	WP-SAND	WP1 = 38 WP2 = 10	Boring logs at SWMU 5	
Silt (%)	WP-SILT	WP1 = 27 WP2 = 30	Boring logs at SWMU 5	
Clay (%)	WP-CLAY	WP1 = 35 WP2 = 60	Boring logs at SWMU 5	

Table E1.14. MEPAS Transport Parameters for SWMU 5 (Continued)

Input Parameter Description	Parameter Name	Value	Reference
Organic matter content in soil (%)	WP-OMC	0.05	WAG 6 geotechnical data
Iron + aluminum in soil (%)	WP-IRON	4	DOE 1995b
pH of pore water in partially saturated zone	WP-pH	WP1 = 6 WP2 = 6.56	DOE 1995b and WAG 3 RI data for WP2
Bulk density(g/cm^3)	WP-BULKD	WP1 = 1.76 WP2 = 2.25	WAG 3 geotechnical data available for WP1; 2.65 × (1-Porosity)
Total porosity (%)	WP-TOTPOR	WP1 = 33.7 WP2 = 15	WAG 3 geotechnical data available for WP1; SWMU 6 boring logs used as estimate for WP2
Field capacity (%)	WP-FIELDC	WP1 = 24 WP2 = 10	Table 2.1 of MEPAS Guidance, based on soil type for WP1; SWMU 5 boring logs used as estimate for WP2
Longitudinal dispersivity (ft)	WP-LDISP	WP1 = 0.39 WP2 = 0.20	Estimated based on MEPAS guidance: D_L = 0.01 × thickness
Saturated hydraulic conductivity (ft/day)	WP-CONDUC	<u>ft/day</u> 0.3 ; <u>cm/sec</u> 1.06E-4	WAG 3 Work Plan
Moisture content (%)	WS-MOISTC	WP1 = 33.7 WP2 = 15	Moisture content = total porosity
Properties of the saturated zone (wz)			
Textural classification	WZ-CLASS	Loamy sand	WAG 3 Work Plan
Sand (%)	WZ-SAND	74	WAG 3 Work Plan
Silt (%)	WZ-SILT	17	WAG 3 Work Plan
Clay (%)	WZ-CLAY	9	WAG 3 Work Plan
Organic matter in soil (%)	WZ-OMC	0.02	WAG 3 Work Plan
Iron + aluminum in soil (%)	WZ-IRON	3	WAG 3 Work Plan
pH of pore water in saturated zone	WZ-pH	6.47	WAG 3 RI data
Total porosity (%)	WZ-TOTPOR	37	WAG 3 Work Plan
Effective porosity (%)	WZ-EFFPOR	30	Conservative estimate
Darcy velocity (ft/day)	WZPVELOC	0.6	Conservative estimate; uses conductivity of 1500 ft/day and gradient of 0.0004
Thickness (ft)	WZ-THICK	40	RGA (HU 4 + HU 5) interval: 60–100 ft bgs
Bulk density (ft)	WZ-BULKD	1.67	WAG 3 Work Plan
Travel distance (ft)	WZ-DIST	890 ft to PGDP boundary 2,780 ft to DOE property boundary	Distances measured along the groundwater flow direction from the northern perimeter of the SWMU to the PGDP boundary and to the DOE property boundary
Longitudinal dispersivity (ft)	WZ-LDISP	50.0	Reference: Bioplume groundwater model
Transverse dispersivity (ft)	WZ-TDISP	5.0	Reference: Bioplume groundwater model
Vertical dispersivity (ft)	WZ-VDISP	0.1	Conservative estimate
Percent of total flux to aquifer (%)	WZ-FRACT	100	Conservative estimate
Perpendicular distance from groundwater flow to receptor (ft)	WZ-YDIST	0	(Plume centerline concentrations)
Vertical distance below groundwater table (ft)	WZ-AQDEPTH	0	(Most conservative result)

The sampling results used in source term development were taken from sampling completed as part of the WAG 3 RI (DOE 2000), the Data Gaps Investigation Report (DOE 2000b), and from earlier sampling completed in support of the PGDP CERCLA SI performed in the early 1990s (CH2M HILL 1991 and 1992). Source terms developed for SWMU 5 are presented in Table E1.15. As noted in the modeling report, “In all cases, modelers applied conservatism (worst case) in the definition of the extent of the source zones. In all cases, the maximum concentrations were used to develop each contaminant source-term inventory.”

Three model layers, two partially saturated and one saturated were delineated at SWMU 5. The partially saturated layer includes the loess deposits making up HU 1, the permeable but discontinuous sand and gravel lenses of the UCRS, and a silty clay aquitard, HU 3 (1–60 ft bgs). The saturated layer consists of the RGA and extends from 60 ft to 100 ft bgs. The travel distance from the source to each downgradient exposure point is 890 ft to the PGDP boundary and 2,780 ft to the DOE property boundary.

Surface and subsurface soil data provided by the WAG 3 RI (DOE 2000a) and the PGDP CERCLA SI (CH2M Hill 1991 and 1992) were used to develop the source terms and inventories for the site contaminants. Table E1.15 presents the source terms used in the MEPAS modeling for SWMU 5. Metals, organic compounds, and radionuclides were identified as present above screening levels in surface soils at SWMU 5. Originally identified contaminants that were not referenced in the MEPAS chemical database and, therefore, were not modeled included 3-nitrobenzenamine, benzo(ghi)perylene, and dibenzofuran. The results of the MEPAS modeling for SWMU 5 are presented in Table E1.16. Estimated HQs and cancer risks from these modeling results are not available.

Iron is projected to contribute to the RGA from three distinct sources. Results of modeling the sources to the PGDP boundary are 49.8 mg/L in 1,411 years, 18.8 mg/L in 1,591 years, and 464 mg/L in 1,873 years. At the DOE boundary, concentrations from these sources are 18.4 mg/L in 1,602 years, 6.61 mg/L in 1,871 years, and 82.7 mg/L in 2,069 years. Manganese is projected to contribute to the RGA, resulting in 11.54 mg/L at the PGDP boundary in 2,536 years and 7.53 mg/L at the DOE boundary in 2,952 years. Contributions to the RGA from other constituents are minor. ^{99}Tc is projected to contribute to the RGA resulting in 229 pCi/L at the PGDP boundary in 130.1 years and 99.6 pCi/L in 138.6 years.

Table E1.15. Development of Source Terms for SWMU 5

Contaminant	Initial source concentration		Length parallel to flow direction (ft)	Width perpendicular to flow direction (ft)	Thickness (ft)	Contaminant inventory calculation for MEPAS: Volume (cm^3)	Bulk density (g/cm^3)	Inventory (g)	Notes
Surface soil									
Aluminum	13800	mg/kg	235	840	1	5.59E+09	1.46	1.13E+08	Entire SWMU boundary chosen as
2-Methylnaphthalene	150	μg/kg						1.22E+03	source term.
3-Nitrobenzenamine	9450	μg/kg						7.71E+04	
Acenaphthylene	9450	μg/kg						7.71E+04	
Benz(a)anthracene	19000	μg/kg						1.55E+05	
Benzo(a)pyrene	24800	μg/kg						2.02E+05	
Benzo(b)fluoranthene	49200	μg/kg						4.02E+05	
Benzo(ghi)perylene	14600	μg/kg						1.19E+05	
Dibenzofuran	3520	μg/kg						2.87E+04	
Pentachlorophenol	357	μg/kg						2.91E+03	
PCB-1260	306	μg/kg						2.50E+03	
Phenanthrene	34600	μg/kg						2.82E+05	
^{99}Tc	5.85	pCi/g	235	775	1	5.16E+09	1.46	4.40E-02	Entire length of SWMU chosen as source term for ^{99}Tc and approximately 3/4 width.
*Bulk density of 1.46 used in SWMU 1 MEPAS modeling									
Subsurface soil partially saturated zone WP1 (HU1 + HU2 Soils)									
Aluminum	12400	mg/kg	235	840	39	2.18E+11	1.76	4.76E+09	Entire area and thickness of SWMU used for modeling.
Chromium	296	mg/kg	175	215	14	1.49E+10	1.76	7.77E+06	Metals values detected
Iron	29200	mg/kg						7.67E+08	above screening levels at 005-017 in a 20–23 ft sample.
Cobalt	24.7	mg/kg	90	240	3	1.83E+09	1.76	7.98E+04	Metals detected above screening levels
Iron	33100	mg/kg			7	4.28E+09		2.49E+08	at H263 in shallow samples.
Manganese	975	mg/kg						7.35E+06	

Table E1.15. Development of Source Terms for SWMU 5 (Continued)

Contaminant	Initial source concentration		Length parallel to flow direction (ft)	Width perpendicular to flow direction (ft)	Thickness (ft)	Contaminant inventory calculation for MEPAS			Notes
						Volume (cm^3)	Bulk density (g/cm^3)	Inventory (g)	
Benzo(ghi)perylene	260	µg/kg	90	240	7	4.28E+09	1.76	1.96E+03	Semivolatiles detected above
Dibenzofuran	87	µg/kg						6.56E+02	screening levels at H263 in shallow
Phenanthrene	1300	µg/kg						9.80E+03	samples.
^{226}Ra	2.2	pCi/g	235	370	20	4.92E+10	1.76	1.91E-01	Just over 1/2 width of SWMU used for source term delineation and entire
^{238}U	2	pCi/g	235	370	31	7.63E+10	1.76	2.69E-01	length.
Subsurface soil partially saturated zone WP2 (HU3 Soils)									
Aluminum	16400	mg/kg	235	840	20	1.12E+11	2.25	4.13E+09	Entire SWMU boundary chosen as
Cobalt	19.4	mg/kg						4.88E+06	source term.
Iron	29400	mg/kg						7.40E+09	
Manganese	1750	mg/kg						4.40E+08	
Toluene	7	µg/kg	110	310	6	5.79E+09	2.25	9.12E+01	Detected only at H002 in 36–42 ft sample.
^{226}Ra	1.73	pCi/g	235	370	20	4.92E+10	2.25	1.92E-01	Just over 1/2 width of SWMU used for
^{99}Tc	3.89	pCi/g	235	370	20	4.92E+10	2.25	4.31E-01	source term delineation and entire
^{238}U	1.71	pCi/g	235	630	20	8.38E+10	2.25	3.23E-01	length.

Table E1.16. MEPAS results for SWMU 5

Source	Constituent (Daughter products are denoted with an asterisk)	PGDP boundary			DOE property boundary		
		Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk	Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk
Surface Soil	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	PCB-1260	0	0.00E+00	0.00E+00	0	0.00E+00	0.00E+00
	2-Methylnaphthalene	3.88E-05	1.38E-03	No value	7.00E-06	2.49E-04	No value
	Acenaphthylene	4.35E-03	No value	No value	8.05E-04	No value	No value
	Benz(a)anthracene	0	No value	0.00E+00	0	No value	0.00E+00
	Benzo(a)pyrene	0	No value	0.00E+00	0	No value	0.00E+00
	Benzo(b)fluoranthene	0	No value	0.00E+00	0	No value	0.00E+00
	Pentachlorophenol	1.08E-27	No value	6.00E-30	1.25E-28	No value	6.94E-31
	Phenanthrene	2.62E-03	No value	No value	3.69E-04	No value	No value
	^{99}Tc	5.78E+01	No value	3.18E-06	9.65E+00	No value	5.30E-07
UCRS-WP1	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	Chromium	0	0.00E+00	No value	0	0.00E+00	No value
	Cobalt	2.51E-05	1.21E-04	No value	7.61E-06	3.66E-05	No value
	Iron	4.98E+01	1.60E+01	No value	1.84E+01	5.92E+00	No value
	Iron (at H263)	1.88E+01	6.05E+00	No value	6.61E+00	2.13E+00	No value
	Manganese	2.32E-01	1.81E+02	No value	8.44E-02	6.59E+01	No value
	Phenanthrene	6.09E-05	No value	No value	1.64E-05	No value	No value
	^{226}Ra	5.59E-03	No value	5.53E-06	1.13E-03	No value	1.12E-06
	^{238}U	5.14E-19	No value	8.92E-25	2.13E-19	No value	3.70E-25
	*^{234}Th	5.14E-19	No value	No value	2.13E-19	No value	No value
	*^{234}U	2.81E-20	No value	3.95E-26	1.21E-20	No value	1.70E-26
	*^{230}Th	2.40E-21	No value	2.31E-27	1.07E-21	No value	1.03E-27
	*^{226}Ra	1.93E-21	No value	1.91E-24	8.61E-22	No value	8.52E-25
	*^{222}Rn	1.93E-21	No value	No value	8.61E-22	No value	No value
	*^{210}Pb	1.92E-21	No value	No value	8.58E-22	No value	No value
	*^{210}Bi	1.92E-21	No value	No value	8.58E-22	No value	No value
	*^{210}Po	1.92E-21	No value	No value	8.58E-22	No value	No value
UCRS-WP2	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	Cobalt	1.89E-03	9.09E-03	No value	2.81E-04	1.35E-03	No value
	Iron	4.64E+02	1.49E+02	No value	8.27E+01	2.66E+01	No value
	Manganese	1.56E+01	1.22E+04	No value	2.76E+00	2.16E+03	No value
	Toluene	2.78E-05	4.32E-05	No value	1.19E-05	1.85E-05	No value
	^{99}Tc	2.29E+02	No value	1.26E-05	9.96E+01	No value	5.47E-06
	^{226}Ra	5.33E-03	No value	5.28E-06	1.04E-03	No value	1.03E-06
	^{238}U	9.95E-19	No value	1.73E-24	1.91E-19	No value	3.32E-25
	*^{234}Th	9.95E-19	No value	No value	1.91E-19	No value	No value
	*^{234}U	5.45E-20	No value	7.65E-26	1.09E-20	No value	1.53E-26
	*^{230Th}	4.64E-21	No value	4.46E-27	9.57E-22	No value	9.20E-28
	*^{226}Ra	3.71E-21	No value	3.67E-24	7.72E-22	No value	7.64E-25
	*^{222}Rn	3.71E-21	No value	No value	7.72E-22	No value	No value
	*^{210}Pb	3.69E-21	No value	No value	7.69E-22	No value	No value
	*^{210}Bi	3.69E-21	No value	No value	7.69E-22	No value	No value
	*^{210}Po	3.69E-21	No value	No value	7.69E-22	No value	No value

^{210}Bi = Bismuth-210
^{210}Pb = Lead-210
^{210}Po = Polonium-210
^{222}Rn = Radon-222
^{230}Th = Throrium-230
^{234}Th = Throrium-234

E1.5. MODELING APPEARING IN THE WAG 3 RI REPORT FOR SWMU 6

The conservative modeling in Appendix B of Volume 4 of the WAG 3 RI Report (DOE 2000a) was completed to determine if any contaminants could migrate from source areas at SWMU 6 to POEs at the plant boundary and property boundary at a rate that could result in maximum concentrations greater than risk-based screening levels. This modeling was completed using MEPAS and conservative source term estimates developed using comparisons of sampling results to background concentrations and SSLs for protection of groundwater taken from EPA sources. MEPAS transport parameters are given in Table E1. 17.

The sampling results used in source term development were taken from sampling completed as part of the WAG 3 RI (DOE 2000a), the Data Gaps Investigation Report (DOE 2000b), and from earlier sampling completed in support of the PGDP CERCLA SI (CH2M HILL 1991 and 1992) performed in the early 1990s. Source terms developed for SWMU 6 are presented in Table E1.18. Benzo(ghi)perylene originally was identified as a contaminant to be modeled, but it was not referenced in the MEPAS chemical database and, therefore, could not be modeled. As noted in the modeling report, "In all cases, modelers applied conservatism (worst case) in the definition of the extent of the source zones. In all cases, the maximum concentrations were used to develop each contaminant source-term inventory."

Three model layers (two partially saturated and one saturated) were delineated at SWMU 6 (see Sect. 3.2.3 of Vol. 1). The first partially saturated layer extends to a depth of 40 ft bgs and includes the loess deposits making up HU1 and the HU2; the second partially saturated layer extends to a depth of 60 ft bgs and includes the silty clay aquitard, the HU3. The saturated layer includes the RGA and extends from an average depth of 60 ft to 100 ft bgs.

The travel distances from the source to each downgradient exposure point are 920 ft to the PGDP boundary and 2,820 ft to the DOE property boundary. The direction of groundwater flow in the RGA was assumed to be north, based on potentiometric maps of the area.

The results of the MEPAS modeling conducted for SWMU 6 are presented in Table E1.19. These results indicate that contributions from constituents in surface soil to groundwater in the RGA are negligible. Estimated HQs and cancer risks from these modeling results are not available.

Iron is contributing to the RGA from three distinct sources. Results from the sources to the PGDP boundary are 60.1 mg/L in 1,966 years, 32.8 mg/L in 1,787 years, and 7.77 mg/L in 1,787 years. At the DOE boundary, concentrations from these sources are 21.2 mg/L in 2,171 years, 11.9 mg/L in 2,076 years, and 2.56 mg/L in 2076 years. ^{99}Tc contamination from the SWMU 6 waste cell is predicted by the model to reach a maximum activity of 91.5 pCi/L at the PGDP boundary in 118.6 years and 31.8 pCi/L at the DOE property boundary in 120.1 years. Contributions to the RGA from other constituents are minor.

Table E1.17. MEPAS Transport Parameters for SWMU 6

Input Parameter Description	Parameter Name	Value	Reference
		Topsoil parameters (wt)	
Textural classification	WT-CLASS	Silt loam	McCracken Co. Soil Survey (USDA 1976)
Percent sand (%)	WT-SAND	15	McCracken Co. Soil Survey: conservative estimate (highest % sand)
Percent silt (%)	WT-SILT	80	Maximum % silt for soil type
Percent clay (%)	WT-CLAY	5	= 100% -% sand - % silt
Percent organic matter (%)	WT-OMC	0.05	CERCLA Phase II Site Investigation (CH2M HILL 1992)
Percent iron and aluminum (%)	WT-IRON	4	Background Concentrations and Human Health Risk-Based Screening Criteria for Metals in Soil at PGDP (DOE 1995b)
pH of topsoil	WT-pH	7.98	WAG 3 RI Data
Percent vegetative cover of site (%)	WT-VEGCOV	90	SWMU Maps
Topsoil water capacity	WT-AVAILW	2.20	McCracken Co. Soil Survey = available water capacity (0.20 in./in.) × root zone depth from Table 2.1 MEPAS Guidance (12.2 in.) × vegetative cover (100%)
SCS curve number	WT-SCSN	71	Antecedent Moisture Condition = II (normal moisture); Group C hydrologic soil group; vegetated surface, well vegetated, 60–100% vegetated
		Properties of the partially saturated zones (wp)	
Thickness (ft)	WP-THICK	WP1 39 WP2 20	WP1=1–40 ft (HU 1 + HU 2) WP2= HU 3 — Boring logs at SWMU 6
Textural classification	WP-CLASS	WP1 sandy clay loam WP2 clay loam	Boring logs at SWMU 6
Sand (%)	WP-SAND	WP1 = 38 WP2 = 10	Boring logs at SWMU 6
Silt (%)	WP-SILT	WP1 = 27 WP2 = 30	Boring logs at SWMU 6
Clay (%)	WP-CLAY	WP1 = 35 WP2 = 60	Boring logs at SWMU 6
Organic matter content in soil (%)	WP-OMC	0.05	WAG 6 geotechnical data
Iron + aluminum in soil (%)	WP-IRON	4	DOE 1995b
pH of pore water in partially saturated zone	WP-pH	WP1 = 6.76 WP2 = 6.29	WAG 3 RI data
Bulk density(g/cm^3)	WP-BULKD	WP1 = 1.66 WP2 = 2.25	WAG 3 geotechnical data available for WP1; 2.65 × (1-Porosity)
Total porosity (%)	WP-TOTPOR	WP1 = 37.19 WP2 = 15	WAG 3 geotechnical data available for WP1; SWMU 6 boring logs used as estimate for WP2
Field capacity (%)	WP-FIELDC	WP1 = 24 WP2 = 10	Table 2.1 of MEPAS Guidance, based on soil type for WP1; SWMU 6 boring logs used as estimate for WP2

Table E1.17. MEPAS Transport Parameters for SWMU 6 (Continued)

Input Parameter Description	Parameter Name	Value	Reference
Longitudinal dispersivity (ft)	WP-LDISP	WP1 = 0.39 WP2 = 0.20	Estimated based on MEPAS guidance: D_L = 0.01 × thickness
Saturated hydraulic conductivity (ft/day)	WP-CONDUC	ft/day: 0.3 cm/sec: 1.06E-4	WAG 3 Work Plan
Moisture content (%)	WS-MOISTC	WP1 = 37.19 WP2 = 15	Moisture content = total porosity
Properties of the saturated zone (wz)			
Textural classification	WZ-CLASS	Loamy sand	WAG 3 Work Plan
Sand (%)	WZ-SAND	74	WAG 3 Work Plan
Silt (%)	WZ-SILT	17	WAG 3 Work Plan
Clay (%)	WZ-CLAY	9	WAG 3 Work Plan
Organic matter in soil (%)	WZ-OMC	0.02	WAG 3 Work Plan
Iron + aluminum in soil (%)	WZ-IRON	3	WAG 3 Work Plan
pH of pore water in saturated zone	WZ-pH	6.275	WAG 3 RI data
Total porosity (%)	WZ-TOTPOR	37	WAG 3 Work Plan
Effective porosity (%)	WZ-EFFPOR	30	Conservative estimate
Darcy velocity (ft/day)	WZ-PVELOC	0.6	Conservative estimate; uses conductivity of 1500 ft/day and gradient of 0.0004
Thickness (ft)	WZ-THICK	40	RGA (HU 4 + HU 5) interval: 60−100 ft bgs
Bulk density (g/cm^3)	WZ-BULKD	1.67	WAG 3 Work Plan
Travel distance (ft)	WZ-DIST	920 ft to PGDP boundary 2820 ft to DOE property boundary	Distances measured along the groundwater flow direction from the northern perimeter of the SWMU to the PGDP boundary and to the DOE property boundary
Longitudinal dispersivity (ft)	WZ-LDISP	50.0	Reference: Bioplume groundwater model
Transverse dispersivity (ft)	WZ-TDISP	5.0	Reference: Bioplume groundwater model
Vertical dispersivity (ft)	WZ-VDISP	0.1	Conservative estimate
Percent of total flux to aquifer (%)	WZ-FRACT	100	Conservative estimate
Perpendicular distance from groundwater flow to receptor (ft)	WZ-YDIST	0	(Plume centerline concentrations)
Vertical distance below groundwater table (ft)	WZ-AQDEPTH	0	(Most conservative result)

Table E1.18. Development of Source Terms for SWMU 6

Contaminant	Initial source concentration		Length parallel to flow direction (ft)	Width perpendicular to flow direction (ft)	Thickness (ft)	Contaminant inventory calculation for MEPAS: Volume (cm^3)	Bulk density (g/cm^3)	Inventory (g)	Notes
Surface Soil									
Copper	21.3	mg/kg	65	80	1	1.47E+08	1.46	4.58E+03	Detected above screening levels in 006-001.
Benzo(ghi)perylene	124	µg/kg						2.67E+01	
Phenanthrene	461	µg/kg						9.91E+01	
^{99}Tc	18.8	pCi/g	115	85	1	2.77E+08	1.46	7.60E-03	Area for modeling encompasses 006-016 and 006-017.
SWMU 6 Waste Cells									
Aluminum	18,800	mg/kg	40	100	10	1.13E+09	1.66	3.53E+07	Source term is waste cell “J.”
PCB-1016	255	µg/kg						4.79E+02	
^{237}Np	0.219	pCi/g						4.12E-04	
^{99}Tc	43.3	pCi/g						8.14E-02	
^{238}U	1.52	pCi/g						2.86E-03	
Subsurface soil partially saturated zone WP1 (HU1 + HU2 Soils)									
Chromium	116	mg/kg	45	60	17	1.30E+09	1.66	2.50E+05	Area for modeling surrounds 006-027, the area of a relatively high detection of chromium.
	56.8	mg/kg	90	150	25	9.56E+09	1.66	9.01E+05	Area for modeling is entire area of SWMU
Aluminum	12,100	mg/kg			39	1.49E+10		2.99E+08	
Cobalt	17.9	mg/kg			12	4.59E+09		1.36E+05	
Copper	20.9	mg/kg			28	1.07E+10		3.71E+05	
Iron	58,700	mg/kg			39	1.49E+10		1.45E+09	
Lead	35.4	mg/kg			9	3.44E+09		2.02E+05	
Manganese	1550	mg/kg			12	4.59E+09		1.18E+07	
^{99}Tc	8.51	pCi/g	50	45	11	7.01E+08	1.66	9.90E-03	Detected above screening levels at 006-010.
^{237}Np	0.125	pCi/g						1.45E-04	
^{238}U	1.72	pCi/g						2.00E-03	

Table E1.18. Development of Source Terms for SWMU 6 (Continued)

Contaminant	Initial source concentration		Length parallel to flow direction (ft)	Width perpendicular to flow direction (ft)	Thickness (ft)	Contaminant inventory calculation for MEPAS			Notes
						Volume (cm^3)	Bulk density (g/cm^3)	Inventory (g)	
Subsurface soil partially saturated zone WP2 (HU3 Soils)									
Aluminum	22,500	mg/kg	80	185	20	8.38E+09	2.25	4.24E+08	Area for modeling is entire area of SWMU, less southeastern portion.
Cobalt	156	mg/kg						2.94E+06	
Iron	32,900	mg/kg						6.20E+08	
Lead	25.2	mg/kg						4.75E+05	
Iron	36,900	mg/kg	45	60	20	1.53E+09	2.25	1.27E+08	Detected above screening level at 006-027, outside SWMU boundary.

Table E1.19. MEPAS Results for SWMU 6

Source	Constituent (Daughter products are denoted with an asterisk)	PGDP boundary			DOE property boundary		
		Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk	Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk
Surface Soil	Copper	2.56E-12	6.15E-12	No value	2.11E-14	5.07E-14	No value
	Phenanthrene	9.78E-07	No value	No value	2.71E-07	No value	No value
	^{99}Tc	9.71E+00	No value	5.34E-07	3.15E+00	No value	1.73E-07
UCRS-Waste Cells	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	PCB-1016	0	0.00E+00	0.00E+00	0	0.00E+00	0.00E+00
	^{99}Tc	9.15E+01	No value	5.03E-06	3.18E+01	No value	1.75E-06
	^{237}Np	1.68E-01	No value	4.20E-07	5.53E-02	No value	1.38E-07
	*^{233}Pa	1.68E-01	No value	No value	5.53E-02	No value	No value
	*^{233}U	2.45E-04	No value	No value	9.33E-05	No value	No value
	*^{229}Th	3.99E-06	No value	No value	1.69E-06	No value	No value
	*^{225}Ra	3.99E-06	No value	No value	1.68E-06	No value	No value
	*^{225}Ac	3.99E-06	No value	No value	1.68E-06	No value	No value
	^{238}U	4.80E-19	No value	8.33E-25	1.42E-19	No value	2.47E-25
	*^{234}Th	4.80E-19	No value	No value	1.42E-19	No value	No value
	*^{234}U	2.66E-20	No value	3.74E-26	8.12E-21	No value	1.14E-26
	*^{230}Th	2.28E-21	No value	2.19E-27	7.22E-22	No value	6.94E-28
	*^{226}Ra	1.83E-21	No value	1.81E-24	5.84E-22	No value	5.78E-25
	*^{222}Rn	1.83E-21	No value	No value	5.84E-22	No value	No value
	*^{210}Pb	1.82E-21	No value	No value	5.82E-22	No value	No value
	*^{210}Bi	1.82E-21	No value	No value	5.82E-22	No value	No value
	*^{210}Po	1.82E-21	No value	No value	5.82E-22	No value	No value
UCRS-WP1	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	Chromium	0	0.00E+00	No value	0	0.00E+00	No value
	Cobalt	8.06E-05	3.88E-04	No value	2.33E-05	1.12E-04	No value
	Copper	3.13E-11	7.52E-11	No value	2.44E-13	5.87E-13	No value
	Iron	6.01E+01	1.93E+01	No value	2.12E+01	6.82E+00	No value
	Lead	0	0.00E+00	No value	0	0.00E+00	No value
	Manganese	4.08E-01	3.19E+02	No value	1.41E-01	1.10E+02	No value
	^{99}Tc	1.16E+01	No value	6.37E-07	3.86E+00	No value	2.12E-07
	^{237}Np	5.97E-02	No value	4.26E-08	1.95E-02	No value	1.39E-08
	*^{233}Pa	5.9E-02	No value	No value	1.95E-02	No value	No value
	*^{233}U	9.02E-05	No value	No value	3.29E-05	No value	No value
	*^{229}Th	1.47E-06	No value	No value	5.95E-07	No value	No value
	*^{225}Ra	1.47E-06	No value	No value	5.95E-07	No value	No value
	*^{225}Ac	1.47E-06	No value	No value	5.95E-07	No value	No value
	^{238}U	3.49E-19	No value	6.06E-25	1.00E-19	No value	1.74E-25
	*^{234}Th	3.49E-19	No value	No value	1.00E-19	No value	No value
	*^{234}U	1.93E-20	No value	2.71E-26	5.75E-21	No value	8.08E-27
	*^{230}Th	1.66E-21	No value	1.60E-27	5.11E-22	No value	4.91E-28
	*^{226}Ra	1.33E-21	No value	1.32E-24	4.13E-22	No value	4.09E-25
	*^{222}Rn	1.33E-21	No value	No value	4.13E-22	No value	No value
	*^{210}Pb	1.33E-21	No value	No value	4.12E-22	No value	No value
	*^{210}Bi	1.33E-21	No value	No value	4.12E-22	No value	No value
	*^{210}Po	1.33E-21	No value	No value	4.12E-22	No value	No value

Table E1.19. MEPAS Results for SWMU 6 (Continued)

Source	Constituent (Daughter products are denoted with an asterisk)	PGDP boundary			DOE property boundary		
		Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk	Potential maximum concentration (mg/L or pCi/L)	Hazard Quotient	Cancer Risk
UCRS-WP2	Aluminum	0	0.00E+00	No value	0	0.00E+00	No value
	Cobalt	1.66E-03	7.98E-03	No value	4.96E-04	2.38E-03	No value
	Iron	3.28E+01	1.05E+01	No value	1.19E+01	3.83E+00	No value
	Iron (from 006-027)	7.77E+00	2.50E+00	No value	2.56E+00	8.23E-01	No value
	Lead	0	0.00E+00	No value	0	0.00E+00	No value

^{225}Ac = Actinium-225
^{210}Bi = Bismuth-210
^{210}Pb = Lead-210
^{210}Po = Polonium-210
^{233}Pa = Protactinium-233
^{222}Rn = Radon-222
^{225}Ra = Radium-225
^{229}Th = Throrium-229
^{230}Th = Throrium-230
^{234}Th = Throrium-234
^{233}U = Uranium-233

E1.6. MODELING APPEARING IN THE WAG 22, SWMUS 7 AND 30 RI/FS

The conservative modeling in Section 5 and Appendix D of the WAG 22, SWMUs 7 and 30 RI/FS Report (DOE 1998a) was completed to determine if any contaminants could migrate from source areas at SWMUs 7 and 30 to groundwater in the UCRS and RGA at a rate that could result in maximum concentrations greater than risk-based screening levels. The following discussion is taken directly from "*Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,*" DOE/OR/07-1604/V1&D2 (DOE 1998a). Source terms developed for SWMUs 7 and 30 are presented in Tables E1.20 through E1.23. Modeling results are discussed for the four source areas, the UCRS, and the RGA. The use of four source areas (designated Pit A, Pit B/C, F Pits, and areas within SWMUs 7 and 30 outside of Pits A, B, C), the UCRS, and the RGA reflects the distribution of contaminants in the SWMU 7 and 30 source areas and surrounding environmental media. Contaminants disposed of in the three primary source areas of SWMUs 7 and 30, Pit A, Pit B/C Pits, and the F Pits include metals, radionuclides (primarily ^{99}Tc and uranium), organic solvents (primarily TCE), and fuel-related VOCs and SVOCs. Of the contaminants disposed of in the source areas , only ^{99}Tc and several VOCs were detected in the UCRS and RGA. Metals, other radionuclides, and SVOCs were not detected in either unit.

The complex nature of the hydrogeology and contaminants in SWMUs 7 and 30 preclude development of a single computer model to describe fate and transport of contaminants at this site. Rather, a combination of small-scale analytical groundwater transport models and simple estimates of contaminant attenuation/dilution along specific pathways are combined in the framework of the conceptual model for fate and transport analysis.

The output of the contaminant fate and transport modeling is presented as the expected maximum concentration of modeled contaminants at the receptor locations. These data will allow prediction of the approximate locations of future maximum concentrations resulting from the integration of the contributions from multiple sources and different pathways. For the purpose of this analysis, SWMUs 7 and 30 were divided into four source areas representing the disposal areas: (1) Pit A, (2) Pit B/C, (3) F Pits, and (4) the areas within SWMUs 7 and 30 outside of Pits A, B, C. The quantitative modeling accounted for the following:

- Contents of the source area,
- Presence of DNAPL in the source area,
- Presence or absence of a discrete cap,
- Identifiable geologic strata beneath the source area,
- Thickness of each layer in the vadose zone,
- Vertical permeability of the unsaturated soils,
- Presence of contaminated soils submerged in the groundwater,
- Water table fluctuations, and
- Receptor locations.

Once the leachate modeling for these four source areas was completed, the predicted maximum leachate concentrations were compared against the existing groundwater concentrations in the UCRS. If the predicted leachate concentrations exceeded the concentrations in the UCRS, then the leachate concentrations were compared against their respective groundwater risk-based concentrations (RBCs) that were derived using cancer risk of 1E-6 or hazard index of 1.0. For the remaining constituents, the groundwater concentrations in the UCRS were compared against their respective RBCs. All the constituents that exceeded the groundwater RBCs were selected for vertical transport modeling from the UCRS to the RGA. The constituents with concentrations (both in UCRS groundwater and predicted leachate) below the RBC were eliminated from the list of contaminant migration COPCs (CMCOPCs) and no further evaluations were performed. After performing vertical transport modeling of the CMCOPCs from the UCRS to the RGA, the predicted leachate concentrations were again compared with their respective RBCs, and if the maximum predicted leachate concentration of a COPC exceeded the groundwater RBC, it was selected for horizontal transport modeling using AT123D. If the predicted maximum leachate concentration was below the groundwater RBC, the contaminant was eliminated from the list of CMCOPCs, and no further evaluations were performed.

E1.6.1 SESOIL MODELING

The SESOIL model used for leachate modeling, when applicable, estimates pollutant concentrations in the soil profile following introduction via direct application and/or interaction with other media. The model defines the soil compartment as a soil column extending from the ground surface through the unsaturated zone and to the upper level of the saturated soil zone. Processes simulated in SESOIL are categorized in three cycles - the hydrologic cycle, sediment-cycle, and pollutant cycle. Each cycle is a separate submodule in the SESOIL code. The hydrologic cycle includes rainfall, surface runoff, infiltration, soil-water content, evapo-transpiration, and groundwater recharge. The sediment cycle includes sediment washload as a result of rainstorms (i.e., soil erosion that results from surface runoff). The pollutant cycle includes convective transport, volatilization, adsorption/desorption, and degradation/decay. A contaminant in SESOIL can partition in up to four phases (liquid, adsorbed, air, and pure).

Table E1.20. Initial COPCs Based on Soil Screening from the Burial Pit A, WAG 22

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure Concentration > SSL?
Metals and Inorganics[b]			
Aluminum	79508.96	22400	YES
Antimony	7.00	0.3	YES
Arsenic	10.00	1	YES
Barium	386.00	82	YES
Cadmium	10.00	0.4	YES
Chromium	55.00	2	YES
Copper	141.00	21.2	YES
Cyanide	0.64	2	NO
Lead	5760.06	400	YES
Manganese	5239.00	511	YES
Mercury	0.60	0.02	YES
Molybdenum	0.02	9.43E+00	NO
Nickel	132.00	7	YES
Selenium	1.00	0.3	YES
Tin	10.80	4020	NO
Vanadium	40.00	300	NO
Zinc	364.05	620	NO
Volatile Organic Compounds[c]			
1,1-Dichloroethane	27.04	1,000	NO
1,2-Dichlorobenzene	17.60	N/A	YES
1,2-Dichloroethane	0.91	1	NO
cis-1,2-DCE	20.73	20	YES
trans-1,2-DCE	0.58	30	NO
1,3-Dichlorobenzene	39.42	1400	NO
1,4-Dichlorobenzene	26.23	100	NO
4-Methy-2pentanone	7.71	200	NO
Acetone	1.71	800	NO
Benzene	2.20	2	YES
Chlorobenzene	88.31	70	YES
Chloroethene	33.62	235.08	NO
Chloromethane	2.19	0.32	YES
Ethylbenzene	9.83	700	NO
Methylene chloride	5.69	1	YES
Toluene	5.52	600	NO

Table E1.20. Initial COPCs Based on Soil Screening from the Burial Pit A, WAG 22 (Continued)

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure Concentration > SSL?
TCE	2.02	3	NO
Vinyl chloride	3.12	0.7	YES
Xylenes	25.82	1,000	NO
Semivolatile Organic Compounds[c]			
1,2,4- Trichlorobenzene	9.31	300	NO
2,4-Dichlorophenol	0.65	50	NO
2,4-Dimethylphenol	56.30	400	NO
2-Methylnaphthalene	6.79	*N/A*	YES
2-Methylphenol	0.57	8.00E+02	NO
4-Methylphenol	0.40	*N/A*	YES
Acenapththene	2046.00	29000	NO
Anthracene	2609.00	590000	NO
Benzo(a)anthracene	5616.00	80	YES
Benzo(a)pyrene	5427.00	400	YES
Benzo(a)f1uoranthene	15000.00	200	YES
Benzo(ghi)perylene	4400.00	4280	YES
Chrysene	5804.00	800	YES
Dibenzofuran	1172.00	81.6	YES
Bis(2-ethylhexyl)phthalate	37798.72	180000	NO
Di-n-octyl phthalate	407184020.00	1.00E+07	YES
Diethyl phthalate	0.20	2.30E+04	NO
Fluoranthene	23000.00	210000	NO
Fluorene	1796.00	*28000*	NO
Indeno (1,2,3-c,d)pyrene	2860.00	700	YES
Naphthalene	923.70	4000	NO
Phenanthrene	13190.00	*N/A*	YES
Pyrene	15000.00	210000	NO
Pesticides and PCBs[c]			
PCB-1254	165.30	1000	NO
PCB-1260	3047.26	1000	YES
Radionuclides[d]			
Gross Alpha	24.00	*N/A*	YES
Gross Beta	35.00	*N/A*	YES
^{237}Np	1.80	0.033	YES
^{239}Pu	5.05	1.46	YES
^{99}Tc	18.00	*0.0828*	YES
^{230}Th	38.61	33.99206	YES
^{234}U	562.04	2.2	YES
^{235}U	1.01	2.16	NO
$^{235/236}$U	42.79	2.16	YES
^{238}U	686.09	2.29	YES

[a] Soil exposure concentrations represent either back-calculated soil concentrations or soil concentrations obtained from soil sampling analysis.
[b] Concentrations of all metals and inorganics are expressed in mg/kg.
[c] Concentrations of all VOCs, SVOCs, and PCBs are expressed in µg/kg.
[d] Concentrations of all radionuclides are expressed in pCi/g.

Table E1.21 Initial COPCs Based on Soil Screening from Burial Pits B/C, WAG 22

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure Concentration > SSL?
Metals and Inorganics[b]			
Aluminum	1950219.70	22400	YES
Antimony	186.36	0.3	YES
Arsenic	41.00	1	YES
Barium	2322.52	82	YES
Beryllium	31.21	3.00	YES
Cadmium	165.10	0.4	YES
Chromium	371.08	2	YES
Cobalt	3861.50	1180	YES
Copper	31933.45	21.2	YES
Cyanide	0.77	2	NO
Lead	63520.67	400	YES
Manganese	40636.65	511	YES
Mercury	2.04	0.0205	YES
Molybdenum	21.28	9.42756	YES
Nickel	122168.78	7	YES
Silver	65.86	2	YES
Tin	94.54	4020	NO
Uranium	3544.37	N/A	YES
Vanadium	1800.30	300.0	YES
Zinc	114284.86	620	YES
Volatile Organic Compounds[c]			
1, 1- Dichloroethane	5.60	1000	NO
1, 2-DCE (total)	454.78	51.5	YES
cis-1,2-DCE	0.88	20.0	NO
1, 4-Dichlorobenzene	70.00	100	NO
2-Butanone	29.52	126	NO
4-Methyl-2-Pentanone	35.84	200	NO
Acetone	82.51	800	NO
Benzene	34.73	2	YES
Chloroethane	4.74	235.0855	NO
Ethylbenzene	179.50	700	NO
Methylene Chloride	20.52	1	YES
Toluene	753.40	600	YES
TCE	7.00	3	YES
Vinyl chloride	65.80	7.00E-01	YES
Xylenes, Total	1065.00	10000	NO
Semivolatile Organic Compounds[C]			
1,2,4-Trichlorobenzene	77.00	300	NO
2-Chlorophenol	39.00	200	NO
2,4,5-Trich1orophenol	35.00	14000	NO
2,4,6- Trichlorophenol	41.00	8	YES
2,4- Dimethylphenol	5034.00	400	YES
2-Methylnaphthalene	958.30	N/A	YES
2-Methylphenol	664.40	800	NO
4-Methylphenol	8129.00	N/A	YES
Acenaphthene	31.00	29000	NO
Benzo(b)fluoranthene	789.60.	200	YES
bis(2-ehthylhexyl)phthalate	947.10	180000	NO
Chlorobenzene	7.00	70	NO

Table E1.21 Initial COPCs Based on Soil Screening from Burial Pits B/C, WAG 22 (Continued)

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure Concentration > SSL?
Chrysene	590.20	800	NO
Di-n-butylphthalate	91.00	270000	NO
Dibenzofuran	0.79	81.62258881	NO
Diethyl phthalate	0.57	23000	NO
Fluoranthene	795.90	210000	NO
Hexachlorobutadiene	58.00	36.6	YES
Hexachloroethane	34.00	12.4	YES
Naphthalene	8.72	4000	NO
Phenanthrene	967.20	N/A	YES
Phenol	702.60	5000	NO
Pyrene	609.40	210000	NO
Pesticides and PCBs[c]			
PCB-1248	720.70	1000	NO
PCB-1254	7913.80	1000	YES
PCB-1260	11375.23	1000	YES
Radionuclides[d]			
Gross Alpha	37.00	NA	YES
Gross Beta	47.00	NA	YES
^{237}Np	19.00	0.033	YES
$^{239/240}Pu$	72.00	1.46	YES
^{99}Tc	656.50	0.0828	YES
^{230}Th	95.70	34	YES
^{234}U	362.80	2.2	YES
^{235}U	150.00	2.16	YES
$^{235/236}U$	14.28	2.16	YES
^{238}U	2100.00	2.29	YES

[a] Soil exposure concentrations represent either back-calculated soil concentrations or soil concentrations obtained from soil sampling analysis.
[b] Concentrations of all metals and inorganics are expressed in mg/kg.
[c] Concentrations of all VOCs, SVOCs, and PCBs are expressed in µg/kg.
[d] Concentrations of all radionuclides are expressed in pCi/g.

Table E1.22. Initial COPCs Based on Soil Screening from Burial Pit F, WAG 22

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure conc. > SSL?
Metals and Inorganics[b]			
Aluminum	615069.29	22352.98	YES
Barium	180.00	82	YES
Beryllium	·12.00	3.00E+00	YES
Cobalt	247.03	1177.9812	NO
Lead	5120.05	400	YES
Manganese	1200.00	51 I	YES
Molybdenum	175.24	9.42756	YES
Nickel	1891.06	7	YES
Nitrate	0.52	N/A	YES
Tin	3.80	4020	NO
Uranium	21013.03	N/A	YES
Vanadium	700.12	300	YES
Zinc	2080.27	620	YES
Volatile Organic Compounds[c]			
1,1,1- Trichloroethane	5.11	1.00E+02	YES
1,1,2- Trichloro-l,2,2, trifluoroethene	3.79	56085.504	YES
1,I-Dichloroethane	34.55	1.00E+03	YES
cis-1,2-DCE	0.64	2.00E+0l	YES
1,3-Dichlorobenzene	0.90	1400.137787	YES
Acetone	14.00	800	YES
Benzene	1.46	2	YES
Chloroethane	4.35	235.0855911	YES
Ethylbenzene	34.04	700	YES
Tetrachloroethene	0.76	3	YES
Toluene	4.41	600	YES
TCE	0.65	3.00E+00	YES
Vinyl chloride	3.89	7.00E-0l	YES
Xylenes	160.17	10000	YES
Semivolatile Organic Compounds[c]			
1,2,4- Trichlorobenzene	37.00	300	NO
2,4-Dimethylphenol	20.15	400	NO
2-Methylnaphthalene	21.62	N/A	YES
4-Methylphenol	0.75	N/A	YES
4-chloro-3-methylphenol	3.70	N/A	YES
Bis(2-ethylhexyl) phthalate	483.64	1.80E+05	NO
Diethyl phthalate	0.24	2.30E+04	NO
Di-n-octylphthalate	72.00	1.00E+07	NO
Napthalene	9.79	4.00E+03	NO
Pesticides and PCBs[c]			
PCB-1016	33.02	N/A	YES
PCB-1248	8522.20	1000	YES
PCB-1260	565.19	1.00E+03	NO

Table E1.22. Initial COPCs Based on Soil Screening from Burial Pit F, WAG 22 (Continued)

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure conc. > SSL?
Radionuclides[d]			
Gross Alpha	23.00	15.8	YES
Gross Beta	42.00	27.9	YES
^{237}Np	0.04	0.033012	YES
$^{239/240}Pu$	2.06	1.464244	YES
^{99}Tc	4.17	0.0828	YES
230Th	9.34	33.99206	NO
^{234}U	193.42	2.2	YES
$^{235/236}U$	29.37	2.16	YES
^{238}U	1243.06	2.29	YES

[a] Soil exposure concentrations represent either back-calculated soil concentrations or soil concentrations obtained from soil sampling analysis.
[b] Concentrations of all metals and inorganics are expressed in mg/kg.
[c] Concentrations of all VOCs, SVOCs, and PCBs are expressed in µg/kg.
[d] Concentrations of all radionuclides are expressed in pCi/g.

Table E1.23. Initial COPCs Based on Soil Screening from Subsurface Soils Outside Pits

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure conc. > SSL?
Metals and Inorganics[b]			
Aluminum	7242	22400	NO
Antimony	4.24	0.3	YES
Arsenic	3.143	1	YES
Barium	104.3	82	YES
Beryllium	0.6603	3’	NO
Cadmium	1.85	0.4	YES
Chromium	21.45	2	YES
Cobalt	8.279	1180	NO
Copper	16.18	21.2	NO
Cyanide	0.393	2	NO
Lead	12.26	400	NO
Manganese	417.7	511	NO
Nickel	15.99	7	YES
Selenium	0.2117	0.3	NO
Silver	0.9728	2	NO
Thallium	0.9309	0.04	YES
TIN	4.6		NO
Vanadium	23.95	300	NO
Zinc	38.95	620	NO
Volatile Organic Compounds[c]			
1,2,4- Trichlorobenzene	33	300	NO
1,4-Dichlorobenzene	25	100	NO
2-Butanone	4	126	NO
2-Chlorophenol	23	200	NO
4-Methyl-2-Pentanone	6	200	NO
Acetone	404.3	800	NO
Carbon Disulfide	4.243	2000	NO
Methylene Chloride	87.11	1	YES
Tetrachloroethene	2	3	NO
TCE	4.108	3	YES

Table E1.23. Initial COPCs Based on Soil Screening from Subsurface Soils Outside Pits (Continued)

Site Related Contaminant	Exposure Concentration[a]	SSL	Is Exposure conc. > SSL?
Semivolatile Organic Compounds[c]			
Acenepthene	17	29000	NO
Benzo(a)anthracene	56	80	NO
Benzo(a)pyrene	77	400	NO
Benzo(b)fluoroanthene	91	200	NO
Benzo(k)fluoroanthene	81	2000	NO
bis(2-ethylhexyl)phthalate	235.9	180000	NO
Chrysene	83	800	NO
Di-n-butylphthalate	181.7	270000	NO
Fluoroanthene	170	210000	NO
Indeno (1,2,3-c,d)pyrene	73	700	NO
N-nitrosodiphenylamine	140	26.4	YES
Octachlorodibenzo-p-dioxin	0.6	0.16	YES
Pentachlorophenol	120	5	YES
Phenanthrene	110	1	NO
Pyrene	140		NO
Indeno (1,2,3-c,d)pyrene	73	210000	NO
Pesticides and PCBs[c]			
PCB-1248	27.68	1000	NO
PCB-1260	55.93	1000	NO
Radionuclides[d]			
Gross Alpha	11.92		
Gross Beta	18.49		
^{237}Np	2.362	0.033	YES
^{239}Pu	5.986	1.46	YES
^{99}Tc	280	0.0828	YES
^{230}Th	22.38	34 2	NO
^{234}U	44	.2	YES
^{235}U	3.2	2.16	YES
$^{235/236}U$	0.4	2.16	NO
^{238}U	160	2.29	YES

[a] Soil exposure concentrations represent either back-calculated soil concentrations or soil concentrations obtained from soil sampling analysis.
[b] Concentrations of all metals and inorganics are expressed in mg/kg.
[c] Concentrations of all VOCs, SVOCs, and PCBs are expressed in µg/kg.
[d] Concentrations of all radionuclides are expressed in pCi/g.

E1.6.1.1 Source Areas

Although 27 constituents from Pit A were identified as the initial COPCs, only 7 of them were selected for SESOIL modeling. Similarly, 14 of the 38 initial COPCs from Pits B/C, 4 of 26 initial COPCs from the F Pits, and 7 of 18 initial COPCs from Subsurface Outside of the Pits were selected for SESOIL Modeling. The model was calibrated against the percolation rate by varying the hydraulic conductivity and the disconnectedness index and keeping all other site-specific geotechnical parameters fixed. The final parameter values used in this modeling are as follows: soil bulk dry density of 1.5 g/cm^3, porosity of 0.40, organic carbon content of 0.34%, and volumetric moisture content of 27.5%. Additional parameter values used in the model included a disconnectedness index of 10.0 and an intrinsic permeability of 9.0 x 10^{-10} cm^2, which was derived during calibration of the model to a percolation rate of 4.6 inches/year. The percolation rate was derived using water balance data for the site (Geotrans 1992).

The SESOIL model was set up using four layers extending from the ground surface to the average water table surface at 12 ft bgs. The first layer of the model extended from ground surface to 1 ft bgs and corresponds to the observed soil cover over the pits. The second layer extended from 1 ft bgs to 5 ft bgs and corresponds to the sampling interval; therefore, this layer represents the loading zone. The third layer extended from 5 ft bgs to 10 ft bgs. Most of the pit water was collected in this interval, which was used to back-calculate to corresponding soil concentrations; therefore, this layer also represents the loading zone. The fourth layer extended from 10 to 12 ft bgs, formed the leaching zone, and was divided into 5 sub layers for better resolution.

E1.6.1.2 UCRS

SESOIL-predicted maximum leachate concentrations from the individual source areas were compared against the currently observed maximum groundwater concentrations, as stated earlier, and the source term concentrations for transporting the contaminants vertically down to the RGA were developed. However, only 17 of 42 initial COPCs from the UCRS were selected for SESOIL modeling. As before, the model was calibrated against the percolation rate by varying the hydraulic conductivity and the disconnectedness index and keeping all other site-specific geotechnical parameters fixed. The final parameter values used in the modeling from UCRS are as follows: soil bulk dry density of 1.5 g/cm^3, porosity of 0.40, organic carbon content of 0.26%, and volumetric moisture content of 29.5%. Additional parameter values used in the model included a disconnectedness index of 10.0 and an intrinsic permeability of 1.65 x 10-^{10} cm^2. Of these parameters, porosity, density, and disconnectedness index represent default values for silty-clay, and organic carbon content represents the average measured value. The volumetric moisture content and the intrinsic permeability were derived during calibration of the model to a percolation rate of 4.3 inches/year. The percolation rate was derived using water balance data for the site (Geotrans 1992).

The SESOIL model was set up using three layers extending from the top of the HU2 to the top of the RGA at 45 ft bgs. The first layer of the model extended from top of the HU2 to the top of the confining zone and corresponds to the contaminated zone. This layer was divided into five sublayers and contaminant loading was performed in each of these sub layers which represented the back -calculated soil concentrations. The second layer extended from the top of the confining zone to the top of the RGA and formed the leaching zone. This layer was also divided into five sublayers for better resolutions. The third layer of 0.5 ft was used to read the output concentrations at the water table.

E1.6.1.3 Modeling Results

The results of contaminant fate and transport analysis for individual source areas are summarized below:

E1.6.1.3.1 Pit A

Table E1.24 summarizes the results of fate and transport analyses for Pit A. Presented in this table are the source term concentrations (i.e., either back-calculated soil concentrations or the observed soil concentrations representing the 95% UCL values), the predicted peak contributing concentrations in the UCRS groundwater beneath the source, and the corresponding time for peak concentrations. In addition, this table presents for comparison the current maximum concentrations in the UCRS groundwater and drinking water MCLs or risk-based concentrations (RBCs) (if a MCL is not available). As can be seen from this table, cadmium, chromium, ^{237}Np, and ^{99}Tc were predicted to reach the peak contributing concentrations exceeding groundwater Remedial Goal Options (RGOs). Predicted peak contributing concentrations of methylene chloride, chlorobenzene, and chloromethane among the organics also exceed their respective groundwater RGOs.

Table E1.24. Summary of Leachate Modeling Results for the COPCs[1] from the Burial Pit A

COPCs	Exposure concentration	Predicted Cgw,max[2] in the UCRS	Predicted Tmax	Observed Cgw,max in the UCRS	Groundwater RGOs	Comment
Metals[a]						
Cadmium	10.0	0.375	545	N/A	0.005	M
Chromium	55.0	1.95	415	0.91	0.10	M
Radionuclides[b]						
^{237}Np	1.8	119	338	0.4	1.31	R
^{99}Tc	18	66,441	5	99	276	R
Volatile Organic Compounds[c]						
Methylene chloride	5.69	12.0	4	N/A	5.00	M
Chlorobenzene	88.31	53.4	12	N/A	12.7	R
Chloromethane	2.19	2.27	4	N/A	1.33	R

[1] These COPCs represent the constituents that were selected for SESOIL modeling.
[2] It should be noted here that the predicted Cgw, max in the UCRS represent the peak leachate concentration before reaching the water table based on contaminant leaching from the existing source concentrations.
[a] Concentrations of all inorganic compounds are expressed in mg/kg or mg/L.
[b] Concentrations of radionuclides are expressed as pCi/g or pCi/L.
[c] Concentrations of organic compounds are expressed as µg/g or µg/L.
M = MCL R = Risk-based N/A = Not available

E1.6.1.3.2 Pit B/C

The results of fate and transport analyses for Pit B/C are summarized in Table E1.25. Presented in this table are the source term concentrations (i.e., either back-calculated soil concentrations or the observed soil concentrations representing the 95% UCL values), the predicted peak concentrations in the UCRS groundwater beneath the source, and the corresponding time for peak concentrations. In addition, this table presents for comparison the current maximum concentrations in the UCRS groundwater and drinking water MCLs or RBCs (if a MCL is not available). As can be seen from this table, arsenic, barium, cadmium, chromium, copper, mercury, ^{237}Np, and ^{99}Tc, were predicted to reach the peak contributing concentrations exceeding groundwater RGOs. Predicted peak contributing concentrations of benzene; methylene chloride; toluene; and 2,4-dimethylphenol among the organics also exceed their respective groundwater RGOs.

E1.6.1.3.3 F Pits

The results of fate and transport analyses for the F Pits are summarized in Table E1.26. Presented in this table are the source term concentrations (i.e., either back-calculated soil concentrations or the observed soil concentrations representing the 95% UCL values), the predicted peak concentrations in groundwater beneath the source, and the corresponding time for peak concentrations. In addition, this table presents for comparison the current maximum concentrations in the UCRS groundwater and drinking water MCLs or RBCs (if a MCL is not available). As can be seen from this table, only ^{99}Tc and ^{237}Np were predicted to reach the peak contributing concentrations exceeding groundwater RGOs.

Table E1.25. Summary of Leachate Modeling Results for the COPCs[1] from the Burial Pits B/C

COPCs	Exposure concentration	Predicted Cgw,max[2] in the UCRS	Predicted Tmax	Observed Cgw,max in the UCRS	Groundwater RGOs	Comment
Metals[a]						
Arsenic	41	2.48	254	0.28	0.05	M
Barium	232.22	13.61	784	4.3	2	M
Cadmium	165.1	6.96	524	N/A	0.005	M
Chromium	371.08	19.72	391	0.91	0.1	M
Copper	31,933	634	456	0.46	0.602	R
Mercury	2.04	0.009	114	0.0011	0.002	M
Radionuclides[b]						
^{237}Np	19.0	879	327	0.4	1.31	R
^{99}Tc	656.5	3,555,651	4	99	276	R
Volatile organic compounds[c]						
Benzene	34.7	62.2	6	12	5	M
Methylene chloride	20.52	60.5	4	N/A	5	M
Toluene	753.4	678.2	9	59	1,000	M
Semivolatile organic compounds[d]						
2,4,6-Trichlorphenol	41	3.25	215	N/A	3.99	R
2,4-Dimethylphenol	5,034	11,390	10	4.4	230	R
Hexachloroethane	34.0	0.8	585	NA	3.29	R

[1] These COPCs represent the constituents that were selected for SESOIL modeling.
[2] It should be noted that the predicted $C_{gw,max}$ in the UCRS represent the peak leachate concentration before reaching the water table based on contaminant leaching from the existing source concentrations.
[a] Concentrations of all inorganic compounds are expressed as mg/kg or mg/L.
[b] Concentrations of radionuclides are expressed as pCi/g or pCi/L.
[c] Concentrations of organic compounds are expressed as µg/g or µg/L.
M = MCL R = Risk-based N/A = Not available

Table E1.26. Summary of Leachate Modeling Results for the COPCs[1] from the Burial Pit F

COPCs	Exposure concentration	Predicted Cgw,max[2] in the UCRS	Predicted Tmax	Observed Cgw,max in the UCRS	Groundwater RGOs	Comment
Radionuclides[a]						
^{237}Np	0.04	1.73	338	0.4	1.31	R
^{99}Tc	4.17	26,430	5	99	276	R
Semivolatile organic compounds[b]						
4-Methylphenol	0.75	1.69	8	0.21	N/A	

[1] These COPCs represent the constituents that were selected for SESOIL modeling.
[2] It should be noted that the predicted $C_{gw,max}$ in the UCRS represent the peak leachate concentration before reaching the water table based on contaminant leaching from the existing source concentrations.
[a] Concentrations of radionuclides are expressed as pCi/g or pCi/L.
[b] Concentrations of organic compounds are expressed as µg/g or µg/L.
M = MCL R = Risk-based N/A = Not available

E1.6.1.3.4 Subsurface Source Outside of the Pits

The results of fate and transport analyses for Subsurface Source Outside of the Pits are summarized in Table E1.27. Presented in this table are the source term concentrations (i.e., either back-calculated soil concentrations or the observed soil concentrations representing the lesser of 95% UCL or maximum values), the predicted peak concentrations in groundwater beneath the source, and the corresponding time for peak concentrations. In addition, this table presents for comparison the current maximum concentrations in the UCRS groundwater and drinking water MCLs or RBCs (if a MCL is not available). As can be seen from this table, arsenic, barium, cadmium, chromium, ^{99}Tc, ^{237}NP, and methylene chloride were predicted to reach the peak contributing concentrations exceeding groundwater RGOs.

Table E1.27. Summary of Leachate Modeling Results for the COPCs[1] from the Subsurface Soil Outside Pits

COPCs	Exposure concentration	Predicted Cgw,max[2] in the UCRS	Predicted Tmax	Observed Cgw,max in the UCRS	Groundwater RGOs	Comment
Metals[a]						
Arsenic	3.143	1.06	265	0.28	0.05	M
Barium	104.3	8.92	827	4.3	2	M
Cadmium	1.85	0.37	557	N/A	0.005	M
Chromium	21.45	2.37	419	0.91	0.1	M
Radionuclides[b]						
^{237}Np	2.36	428.58	360	0.4	1.31	R
^{99}Tc	280.0	977,625	5	99	276	R
Volatile organic compounds[c]						
Methylene chloride	87.1	710.4	4	N/A	5	M

[1] These COPCs represent the constituents that were selected for SESOIL modeling.
[2] It should be noted that the predicted $C_{gw,max}$ in the UCRS represent the peak leachate concentration before reaching the water table based on contaminant leaching from the existing source concentrations.
[a] Concentrations of all inorganic compounds are expressed as mg/kg or mg/L.
[b] Concentrations of radionuclides are expressed as pCi/g or pCi/L.
[c] Concentrations of organic compounds are expressed as µg/g or µg/L.
M = MCL R = Risk-based N/A = Not available

E1.6.1.3.5 UCRS

As discussed in E1.6.1.2, SESOIL modeling for the UCRS used either the maximum leachate concentrations predicted by SESOIL modeling for the four source areas (Pit A, Pit B/C, F Pits, and Subsurface Source Outside of the Pits) or the maximum observed groundwater concentrations to predict the peak leachate concentration in the UCRS. The results of this transport modeling in the UCRS are summarized in Table E1.28. Presented in this table are source concentrations (i.e., either predicted maximum leachate concentrations based on SESOIL modeling of the sources (i.e., Pit A, Pit B/C, F Pits, and the Areas within SWMU 7 and 30 outside of Pits A, B, and C) or the maximum observed groundwater concentrations in the UCRS, whichever is greater), the predicted peak contributing concentrations in the leachate before reaching the RGA, and the corresponding time of peak concentrations. In addition, this table presents for comparison the current maximum concentrations in the RGA groundwater and drinking water MCLs or RBCs (if a MCL is not available). As can be seen from this table, the predicted peak contributing concentrations of 1,2-DCE; *cis*-1,2-DCE; 2,4 dimethylphenol; methylene chloride; TCE; vinyl chloride; ^{99}Tc; and mercury exceed their respective groundwater RGOs; therefore, these constituents were considered for lateral transport modeling in the RGA using AT123D (see Section E1.6.2). Mercury was dropped from this list. The maximum concentration of mercury, although slightly higher than its MCL, decreases to lower than its MCL with dilution.

Table E1.28. Summary of Leachate Modeling Results for the COPCs[1] from the UCRS

COPCs	Exposure concentration	Predicted Cgw,max[2] in the UCRS	Predicted Tmax	Observed Cgw,max in the UCRS	Groundwater RGOs	Comment
Metals[a]						
Mercury	0.09	0.0042	405	0.0012	0.002	M
Radionuclides[b]						
^{99}Tc	355.6	763,627	14	3,670	276	R
Volatile organic compounds[c]						
1,1,1-Trichloroethane	94.77	27.5	26	1.3	200	M
1,2-Dichloroethane	0.59	0.32	14	3	5	M
1,1-DCE	3.89	0.31	16	3.7		
1,2-DCE	1591.9	281.3	18	110	136	R
cis-l,2-DCE	406.1	133.7	13	140	149	R
4-Methyl 2-2-pentanone	0.09	0.09	10	2.9	N/A	
Acetone	2.54	2.73	9	430	1510	R
Benzene	1.93	0.48	16	N/A	5	M
Chloromethane	0.03	0.01	10	14	1.33	R
Methylene chloride	18.47	9.40	10	N/A	5	M
TCE	464.4	56.53	20	19,000	5	M
Vinyl chloride	362.7	15.21	12	N/A	2	M
Semivolatile organic compounds[d]						
2,4-Dimethylphenol	6189.3	1983.42	30	N/A	230	R

[1] These COPCs represent the constituents that were selected for SESOIL modeling.
[2] It should be noted that the predicted $C_{gw,max}$ in the UCRS represent the peak leachate concentration before reaching the water table based on contaminant leaching from the existing source concentrations.
[a] Concentrations of all inorganic compounds are expressed as mg/kg or mg/L.
[b] Concentrations of radionuclides are expressed as pCi/g or pCi/L.
[c] Concentrations of organic compounds are expressed as µg/g or µg/L.
M = MCL R = Risk-based N/A = Not available

E1.6.2 AT123D MODELING

AT123D is an analytical groundwater pollutant fate and transport model chosen to predict the future receptor concentrations for the contaminants. It computes the spatial-temporal concentration distribution of wastes in the aquifer system and predicts the transient spread of a contaminant plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D are advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the groundwater resulting from a mass release over a source area (point, line, area, or volume source). The model can handle instantaneous as well as continuous source loadings of chemicals of interest at the site. AT123D frequently is used by the scientific and technical community to perform quick and conservative estimates of groundwater plume movement in space and time. In RISKPRO, SESOIL and AT123D are linked so that mass loading to the groundwater predicted by SESOIL can be directly transferred to AT123D.

Six organic compounds and one radionuclide were selected for AT123D modeling in the RGA based on source loading from the UCRS predicted by SESOIL. Maximum concentrations at two receptor locations (PGDP boundary and DOE property boundary) were simulated for these constituents. Maximum concentrations at the end of 30 years of simulation also were predicted for these constituents.

E1.6.2.3 RGA

The results of fate and transport modeling in the RGA based on future contaminant loading from SWMUs 7 and 30 are summarized in Table E1.29. Presented in this table are the predicted peak contributing concentrations in groundwater beneath the source, predicted peak contributing concentrations at 30 years and in 100 years at the PGDP boundary in the direction of flow, and the peak contributing concentrations in 30 and 100 years at the DOE property boundary in the direction of flow. In addition, this table presents for comparison the current maximum concentrations in the RGA groundwater and drinking water MCLs or RBCs (if a MCL is not available). As can be seen from this table, ^{99}Tc is predicted to reach the peak contributing concentrations exceeding its groundwater RBC at all locations and for both 30- and 100-year scenarios. None of the organic COPCs are predicted to reach the peak contributing concentrations exceeding their respective groundwater RBCs; however, the predicted results for all the COPCs but ^{99}Tc are quite low, when compared to their maximum concentrations currently observed in the RGA. For ^{99}Tc, the observed maximum concentrations of 3,670 pCi/L falls within the predicted range of 1,996 pCi/L (30-year peak) to 21,686 pCi/L (100-year peak).

Table E1.29. Summary of Transport Modeling in the RGA Based on Future Contaminant Loading from SWMUs 7 and 30

Constituent	Unit	Predicted maximum concentration beneath the source	Predicted GW concentration at the PGDP boundary in the direction of flow		Predicted GW concentration at the DOE property boundary in the direction of flow	
			30 years	100 years	30 years	100 years
1,2-DCE	µg/L	27	16.8	24.3	5.2	5.2
cis-12-DCE	µg/L	12.3	4.6	11.3	1.5	2.7
TCE	µg/L	5.3	3.8	4.6	1.1	1.1
Methylene chloride	µg/L	0.8	0.14	0.8	0.05	0.19
Vinyl chloride	µg/L	1.0	0.15	0.96	0.06	.23
2,4-Dimethylphenol	µg/L	200	174	1.74	4.1	40.7
^{99}Tc	pCi/L	23,580	1996	21,686	1205	5077

Note: All the constituents that were identified as the initial contaminant migration COPCs in the source areas (i.e., SWMUs 7 and 30, and also the UCRS beneath the site) were modeled to the RGA. However, only the constituents that were predicted to arrive at the RGA with concentrations exceeding their groundwater MCLs/RBCs were modeled to the receptors using AT123D and are shown in this table. All the concentrations shown in this table represent only the contributed concentrations and do not account for the existing concentrations that already have contaminated the RGA groundwater.

Based on fate and transport analyses results, it appears that ^{99}Tc is the only constituent that will continue to be a major problem at the receptor locations. Therefore, ^{99}Tc was chosen for further fate and transport evaluations in order to address the source units within SWMUs 7 and 30, separately, in terms of contaminant contributions to the receptor locations. Vertical transport of ^{99}Tc from the individual source units through the UCRS to the RGA were performed using SESOIL. The results from the SESOIL modeling were used to create input for an AT123D model that was applied for predicting lateral migration of ^{99}Tc to the receptor locations. These results are summarized in Table E1.30. Concentration contributions from the individual source units are added to provide the total contributed concentrations based on future loading from SWMUs 7 and 30. The relative (%) contributions of individual source units are also shown (values in parentheses) in this table.

Table E1.30. Results of ^{99}Tc Modeling in the RGA Based on Future Contaminant Loading from the Individual Source Units within SWMUs 7 and 30

Constituent	Units	Predicted Maximum Concentration Beneath the Source	Predicted GW Concentration at the PGDP Boundary in the Direction of Flow		Predicted GW Concentration at the DOE Property Boundary in the Direction of Flow	
			30 years	100 years	30 years	100 years
Burial Pit A	pCi/L	60.8 (0.65)	3.1 (0.46)	34.2 (0.47)	1.3 (0.35)	6.3 (0.4)
Burial Pits B/C	pCi/L	3253.8 (35.02)	165.2 (24.79)	1822.8 (25.09)	71.2 (19.03)	291.3 (19.1)
Burial Pit F	pCi/L	12.7 (0.14)	0.6 (0.09)	6.5 (0.09)	0.2 (0.05)	1.0 (0.07)
Subsurface soils outside these pits	pCi/L	5962.5 (64.19)	497.4 (74.66)	5400.3 (74.35)	301.5 (80.67)	1228.0 (80.43)
Combined SWMUs 7 and 30	pCi/L	9289.8 (100.00)	666.3 (100.00)	7263.8 (100.00)	347.2 (100.00)	1526.6 (100.00)

Note: All the concentrations shown in this table represent only the contributed concentrations and do not account for the existing concentrations that are already present in the aquifer. Percent of total contribution from SWMUs 7 and 30 combined are shown in parentheses.

E1.7. MODELING APPEARING IN THE SITE-WIDE RISK ASSESSMENT MODEL AND ENVIRONMENTAL BASELINE REPORT

Groundwater fate and transport modeling and risk modeling for SWMUs 2, 3, 4, 5, 6, 7, and 30 was performed as part of the PGDP site-wide risk assessment model and environmental baseline (DOE 2003). This section summarizes the results of this modeling for these SWMUs and is taken from *Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003).

The models selected for groundwater modeling were SESOIL for soil leachability and AT123D for lateral transport in groundwater. The MODFLOW/MODPATH models were used to support the AT123D modeling. The COPC list for groundwater transport modeling was derived from the full list of significant COPCs. The results of this modeling include the chemical-specific maximum source contributions to cancer risk, hazard and dose for the SWMUs at four integrator points.

Four groundwater integrator points were determined to be relevant to the exposure conceptual site model and endstate goals. At each of these locations, it was assumed that residents could be exposed to contamination originating at PGDP through household use of groundwater, even though no water wells used for this purpose are present at these locations at this time. These integrator points are:

- **Integrator Point 1 (GW-NW-P).** This integrator point is located on the northwest side of the DOE reservation at the center of the current northwest TCE groundwater plume. Sources to this integrator point include SWMUs 2, 3, 5, 6, 7, and 30.

- **Integrator Point 2 (GW-SW-P).** This integrator point is located on the northwest side of the DOE reservation to the west of Integrator Point 1 at a point to which the center of the southwest TCE plume is expected to migrate. (The southwest plume has *not* reached this location.) Sources to this integrator point include SWMU 4.

- **Integrator Point 3 (GW-NE-P).** This integrator point is located on the northeast side of the DOE reservation at the center of the current northeast TCE plume.

- **Integrator Point 4 (GW-North).** This integrator point is located on the north side of the DOE reservation between Integrator Points 1 and 3 and is not associated with any currently identified plume.

E1.7.1 SESOIL MODELING

The SESOIL model is described in Section E1.6.1. The input data are divided into four types: climatic, chemical, soil, and application data. An overview of the parameters used for the site-wide risk assessment modeling follows. Specific parameters used are presented in Appendix E of *Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003)

E1.7.1.3 Climate Data

The climatic data file of SESOIL consists of an array of values for various climatic parameters. These monthly data span 1 year and are derived from Paducah. The climatic parameters are used within SESOIL to generate the hydrologic model responsible for contaminant transport.

E1.7.1.4 Chemical Data

The pollutant fate cycle of SESOIL uses several chemical transport and transformation processes that occur in the soil zone. The processes of volatilization/diffusion, adsorption/desorption, and biodegradation are used in SESOIL modeling for the purpose of the soil leachability analysis.

E1.7.1.5 Soil Data

The soil data file of SESOIL contains input parameters describing the physical characteristics of the subsurface soil. The parameters include soil bulk density, intrinsic permeability, soil disconnectedness index, Freundlich exponent, total porosity, and organic carbon content. The groundwater recharge rates (infiltration rates) were obtained from the PGDP site-wide groundwater model (DOE 1998b). These recharge rates were used in SESOIL modeling as a calibration target. The intrinsic permeability for the vadose zone is a critical model parameter in that it permits calibration to the target groundwater recharge rate. The intrinsic permeability was varied in iterative runs until the groundwater recharge rate predicted by SESOIL matched the recharge rate obtained from the groundwater model. Unit-specific data were not available for some of the parameters); therefore, EPA default values were used as input to the model. These parameters included the soil disconnectedness index and Freundlich exponent. There is no measurement method for the soil disconnectedness index (described below), nor is there a measured value of the related Freundlich exponent (used in calculating the adsorbed contaminant concentration). The soil disconnectedness index replaces moisture retention curves (or characteristic curves) used by other unsaturated zone leaching models. The soil disconnectedness index was calibrated for four different soil types ranging from sandy loam to clay (Hetrick et al. 1986). This parameter has a minor impact upon the groundwater recharge rate and is varied (within the range specified for the corresponding soil type) in the final stages of model calibration. The SESOIL default value was used for the Freundlich exponent.

E1.7.1.6 Application Parameters

The SESOIL application data describe the soil layer configuration and the initial contaminant concentrations in each model layer. The SESOIL model was arranged in layers and sublayers that facilitate contaminant loading at intervals closely approximating the actual waste placement in the disposal facility. They represent constituent loading or leaching zones, as appropriate. The initial loading concentrations (source term) for SESOIL layers are the soil concentrations observed at individual sites. The SESOIL model for any group of SWMUs contained four major layers with multiple sublayers to model leaching through the vadose zone. The thickness of the layers varied depending on depth to the RGA and thickness of the contaminated soil zone within the vadose zone. In these analyses in general, Layers 1 and 2 are assumed for source loading, and the remaining layers are assigned for leaching zones. The last sublayer of Layer 4 represents the interface of the vadose zone and the RGA beneath the site. The predicted leachate concentration is determined in this last sublayer of Layer 4. The simulations using SESOIL were continued until the maximum concentration in leachate beneath the source was attained or a maximum time period of 1,000 years was reached. The maximum predicted leachate concentrations were input into the AT123D model to predict the maximum groundwater concentration at the integrator points.

E1.7.2 AT123D MODELING

The AT123D model is described in Section E1.6.2. For the site-wide risk assessment modeling, AT123D was chosen to predict the future integrator point concentrations for the COPCs. Specific model input parameters for the AT123D are presented in Appendix E of *Site-Wide Risk Assessment Model and Environmental Baseline for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003).

E1.7.3 MODFLOW AND MODPATH MODELING

The MODFLOW/MODPATH models were used to identify the locations of the integrator points and estimate hydraulic gradients, flow distances, and hydraulic conductivities along SWMU-to-integrator flowpaths. This information was subsequently used to support the AT123D modeling effort. MODFLOW is a three-dimensional, finite-difference model capable of simulating both steady-state and transient head distribution for a saturated groundwater flow field. In contrast, MODPATH is a three-dimensional, particle-tracking model capable of using the steady-state, head distribution generated by MODFLOW to track flowpaths of particles released in the groundwater flow field modeled by MODFLOW.

The MODFLOW model used in this analysis was the site-wide groundwater flow model developed earlier by DOE (1998b). This model covers most of the DOE reservation except that portion above the Porter's Creek Clay terrace. It has been approved by both the PGDP Modeling Steering Committee and the Risk Assessment Working Group; therefore, this model was used without any modification. The parameters used in this model are summarized in the PGDP Quarterly Modeling Report (BJC 2001) and are not discussed further here.

As noted above, the MODPATH model was used to track flowpaths of particles released from a location by using the steady-state head distribution generated by MODFLOW. The key parameter of MODPATH is the particle depth at release. For grouping the SWMUs assigned to different integrator points, the mid-depth of Layer 3 was assumed to represent the average flow condition, and the particles were released from this depth of an aquifer.

E1.7.4 MODELING ASSUMPTIONS

A highly conservative approach was used for this analysis. Several assumptions were made in developing the mathematical models for this analysis. The important assumptions are listed below.

- Infiltration of water through vadose zone soil consists of one-dimensional, steady flow through soil with no dispersion and with uniform average soil properties. More complex flow could either increase or decrease contaminant mobility and transport to the RGA.
- The use of K_d and R_d (retardation factor) to describe the reaction term of the transport equation assumes that an equilibrium relationship exists between the solid- and solution-phase concentrations and that the relationship is linear and reversible.
- Most of the K_d values used in this analysis for the COPCs represent literature-based or calculated values and might not represent the actual site conditions.
- No biodegradation takes place in the vadose zone (i.e., SESOIL modeling assumes no decay) or in the groundwater (i.e., AT123D modeling without accounting for biodegradation).
- In case of radionuclides and organic compounds, ingrowth and decay are not considered.
- Flow and transport in the vadose zone are one-dimensional (i.e., take place in only the vertical direction).
- Initial condition is disregarded in the vadose zone modeling.
- Flow and transport are not affected by density variations.
- Areal distribution of soil contamination is not considered.
- The aquifer is assumed to be homogenous and isotropic.
- The integrator point is located at a nearest downgradient distance.

The inherent uncertainties associated with using these assumptions must be recognized. Because K_d values are highly sensitive to changes in the major chemistry of the solution phase, it is important that the values be measured or estimated under conditions that will represent, as closely as possible, those of the contaminant plume. It is also important to note that the contaminant plume will change over time and be affected by multiple solutes that are present at the site. Projected organic concentrations in the aquifer are uncertain because of the lack of site-specific data on constituent decay in the vadose zone and groundwater. Use of literature values could produce either over- or underestimation of constituents' concentrations in the aquifer. Deviations from assumed literature values could significantly affect contaminant fate predictions.

E1.7.5 COPC LIST USED IN GROUNDWATER TRANSPORT MODELING

The COPC list for soil and sediment that act as a source for contamination that might arrive at a groundwater integration point (i.e., a location downgradient from the source) was derived from the full list of significant COPCs by deleting those COPCs that could not reasonably be expected to migrate through the groundwater pathway and arrive at an integration point at a concentration greater than the screening levels. The COPCs not expected to migrate through the groundwater pathway were selected by considering each COPC's site-specific K_d and removing those inorganic chemical and radionuclide COPCs with a K_d greater than 500 L/kg and those organic compound COPCs with a K_d greater than 10 L/kg. Additionally, all radionuclides with a half-life less than 6 years (i.e., will pass through five half-lives in a 30-year period) were removed. The COPCs expected to migrate through the groundwater pathway are indicated in Table E1.31.

Table E1.31. COPC List for Groundwater Transport Modeling

Inorganic Chemicals		Organic Compounds		Radionuclides	
Significant COPC	**CAS Number**	**Significant COPC**	**CAS Number**	**Significant COPC**	**CAS Number**
Antimony	7440360	Acrylonitrile	107131	Neptunium-237+D	13994202
Arsenic	7440382	Benzene	71432	Strontium-90+D	10098972
Cadmium	7440439	Carbon tetrachloride	56235	Technetium-99	14133767
Chromium III	16065831	Chloroform	67663	Uranium-234	13966295
Chromium VI	18540299	1,1-Dichloroethene	75354	Uranium-235+D	15117961
Chromium (Total)	7440473	1,2-Dichloroethene (mixed)	540590	Uranium-238+D	7440611
Copper	7440508	*trans*-1,2-Dichloroethene	156605		
Iron	7439896	*cis*-1,2-Dichloroethene	156592		
Lead	7439921	Ethylbenzene	100414		
Manganese	7439965	Naphthalene	91203		
Mercury	7439976	Tetrachloroethene	127184		
Molybdenum	7439987	Trichloroethene	79016		
Nickel	7440020	Vinyl chloride	75014		
Selenium	7782492	Xylenes (mixture)	1330207		
Silver	7440224				
Thallium	7440280				
Uranium	NA				

Note: Table adapted from DOE 2003.
CAS=Chemical Abstracts Service.
NA = not applicable.
[a] The list of significant COPCs matches that presented in Table 3.1 [of DOE 2003], except individual organic compounds comprising the total PAHs, total PCBs, and total dioxins/furans groups are not listed.
[b] The COPCs not expected to migrate through the groundwater pathway were selected by considering each COPC's site-specific K_d and removing those inorganic chemical and radionuclide COPCs with a K_d greater than 500 L/kg and those organic compound COPCs with a K_d greater than 10 L/kg. Additionally, all radionuclides with a half-life less than 6 years (i.e., will pass through five half-lives in a 30-year period) were removed.

E1.7.6 MODELING RESULTS

Table E1.32 presents the chemical-specific maximum source contributions to cancer risk, hazard, and dose for SWMUs 2, 3, 4, 5, 6, 7, and 30 at the groundwater integrator points (DOE property boundary). The concentrations used to derive the risks and doses came from the maximum flux contribution information resulting from the groundwater modeling. The table also includes the expected maximum COPC concentrations predicted by the groundwater modeling.

Table E1.32. Maximum Cancer Risk, Hazard, and Dose for Sources Contributing at the DOE Property Boundary

COPC[a]	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30
	Concentrations (mg/L or pCi/L)						
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	1.80E-02	2.07E-02	1.50E-01	1.77E-01	6.95E-02	4.23E-01	0.00E+00
Copper	1.27E-02	8.28E-03	3.92E-01	7.10E-03	9.05E-03	1.18E+01	2.43E-02
Iron	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum	2.62E-03	2.11E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.20E-10	0.00E+00
Silver	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E-03	0.00E+00
Carbon tetrachloride	0.00E+00	0.00E+00	2.21E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chloroform	0.00E+00	0.00E+00	4.90E+02	0.00E+00	0.00E+00	9.86E-04	0.00E+00
Dichloroethene (mixed), 1,2-	0.00E+00	0.00E+00	6.34E+01	0.00E+00	0.00E+00	5.92E-03	0.00E+00
Dichloroethene, 1,1-	0.00E+00	0.00E+00	1.68E+01	2.33E-01	0.00E+00	0.00E+00	0.00E+00
Dichloroethene, cis-1,2-	1.98E+01	0.00E+00	2.15E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dichloroethene, trans-1,2-	0.00E+00	0.00E+00	9.24E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.41E-03	0.00E+00
Naphthalene	3.94E-03	6.01E-03	0.00E+00	3.50E-01	0.00E+00	6.32E-03	2.11E-02
Tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.58E-05	0.00E+00
Trichloroethene	8.06E+00	0.00E+00	4.10E+01	5.18E-04	2.19E-04	1.02E-03	5.70E-04
Vinyl chloride	6.08E-02	0.00E+00	2.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylenes (mixture)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.81E-02	0.00E+00
Neptunium-237+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium-90+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	4.83E+02	9.69E+01	2.08E+03	6.53E+01	3.60E+02	1.12E+04	4.79E+03
Uranium-234	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-235+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table E1.32. Maximum Cancer Risk, Hazard, and Dose for Sources Contributing at the DOE Property Boundary (Continued)

COPC[a]	SWMU 2	3	4	5	6	7	30
	Cancer Risk						
Antimony	NR	NR	NR	NR	NR	NR	NR
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	NR	NR	NR	NR	NR	NR	NR
Chromium	NR	NR	NR	NR	NR	NR	NR
Copper	NR	NR	NR	NR	NR	NR	NR
Iron	NR	NR	NR	NR	NR	NR	NR
Lead	NR	NR	NR	NR	NR	NR	NR
Manganese	NR	NR	NR	NR	NR	NR	NR
Mercury	NR	NR	NR	NR	NR	NR	NR
Molybdenum	NR	NR	NR	NR	NR	NR	NR
Nickel	NR	NR	NR	NR	NR	NR	NR
Selenium	NR	NR	NR	NR	NR	NR	NR
Silver	NR	NR	NR	NR	NR	NR	NR
Thallium	NR	NR	NR	NR	NR	NR	NR
Uranium	NR	NR	NR	NR	NR	NR	NR
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-05	0.00E+00
Carbon	0.00E+00	0.00E+00	1.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chloroform	0.00E+00	0.00E+00	2.25E+00	0.00E+00	0.00E+00	4.52E-06	0.00E+00
Dichloroethene (mixed), 1,2-	NR	NR	NR	NR	NR	NR	NR
Dichloroethene, 1,1-	0.00E+00	0.00E+00	3.58E-01	4.96E-03	0.00E+00	0.00E+00	0.00E+00
Dichloroethene, cis-1,2-	NR	NR	NR	NR	NR	NR	NR
Dichloroethene, trans-1,2-	NR	NR	NR	NR	NR	NR	NR
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-06	0.00E+00
Naphthalene	NR	NR	NR	NR	NR	NR	NR
Tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.59E-08	0.00E+00
Trichloroethene	4.66E-03	0.00E+00	2.37E-02	3.00E-07	1.27E-07	5.91E-07	3.29E-07
Vinyl	1.74E-03	0.00E+00	8.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylenes	NR	NR	NR	NR	NR	NR	NR
Neptunium-237+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium-90+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	3.45E-05	6.92E-06	1.49E-04	4.67E-06	2.57E-05	8.00E-04	3.42E-04
Uranium-234	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-235+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table E1.32. Maximum Cancer Risk, Hazard, and Dose for Sources Contributing at the DOE Property Boundary (Continued)

COPC[a]	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30
	Hazard Results						
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	1.02E-03	1.18E-03	8.54E-03	1.01E-02	3.95E-03	2.40E-02	0.00E+00
Copper	2.28E-02	1.49E-02	7.04E-01	1.27E-02	1.63E-02	2.12E+01	4.37E-02
Iron	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	NR	NR	NR	NR	NR	NR	NR
Manganese	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum	3.48E-02	2.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.25E-09	0.00E+00
Silver	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E+00	0.00E+00
Carbon tetrachloride	0.00E+00	0.00E+00	1.16E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chloroform	0.00E+00	0.00E+00	1.71E+06	0.00E+00	0.00E+00	3.44E+00	0.00E+00
Dichloroethene (mixed), 1,2-	0.00E+00	0.00E+00	2.57E+03	0.00E+00	0.00E+00	2.40E-01	0.00E+00
Dichloroethene, 1,1-	0.00E+00	0.00E+00	1.10E+02	1.52E+00	0.00E+00	0.00E+00	0.00E+00
Dichloroethene, cis-1,2-	7.26E+02	0.00E+00	7.89E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dichloroethene, trans-1,2-	0.00E+00	0.00E+00	1.69E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-02	0.00E+00
Naphthalene	1.38E+00	2.11E+00	0.00E+00	1.23E+02	0.00E+00	2.22E+00	7.42E+00
Tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-04	0.00E+00
Trichloroethene	5.04E+02	0.00E+00	2.56E+03	3.24E-02	1.37E-02	6.39E-02	3.56E-02
Vinyl chloride	1.99E+00	0.00E+00	9.48E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylenes (Mixture)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-01	0.00E+00
Neptunium-237+D	NR	NR	NR	NR	NR	NR	NR
Strontium-90+D	NR	NR	NR	NR	NR	NR	NR
Technetium-99	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR
Uranium-235+D	NR	NR	NR	NR	NR	NR	NR
Uranium-238+D	NR	NR	NR	NR	NR	NR	NR
	Dose Results[b]						
Neptunium-237+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium-90+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Technetium-99	4.93E-01	9.91E-02	2.13E+00	6.68E-02	3.68E-01	1.14E+01	4.90E+00
Uranium-234	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-235+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238+D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: Table adapted from DOE 2003.
"NR" = Result is not reported because no screening value is available.
[a] Only COPCs identified as being mobile through the groundwater pathway are listed.
[b] Does results are only applicable to radionuclides.

Most of the metals and radionuclides are not expected to migrate to the integrator points at any measurable concentrations. The only metal that that is predicted to have a higher concentration is chromium. SWMUs 7 and 5, and 4 might be contributing to the chromium problem at Integrator Points 4, 1, and 2, respectively. The only radionuclide that is predicted to have a higher concentration is ^{99}Tc. The contributing sources for ^{99}Tc are SWMU 4 for Integrator Point 2, and SWMUs 7 and 30 for Integrator Point 1. The chlorinated solvents are expected to migrate to their respective integrator points at significant concentrations from multiple SWMUs, including SWMUs 2 and 5 for Integrator Point 1 and SWMUs 4 and 1 for Integrator Point 2. None of the SWMUs is expected to contribute chlorinated solvents to either Integrator Points 3 or 4. Among the semivolatile organic compounds (SVOCs), major contribution of naphthalene is expected to move from SWMU 30 to Integrator Point 1.

The greatest contributors of the COPCs presenting the maximum potential cancer risks are as follows. (All values reported below are potential cancer risks to the resident that are projected to exist if only the reported source contributed contaminants to groundwater.)

- 1,1-DCE: SWMU 4 (3.58×10^{-1}) and SWMU 5 (4.96×10^{-3})
- Carbon tetrachloride: SWMU 4 (1.22×10^{-1})
- Chloroform: SWMU 4 (>Unity)
- TCE: SWMU 2 (4.66×10^{-3}) and SWMU 4 (2.37×10^{-2})
- Vinyl chloride: SWMU 2 (1.74×10^{-3}) and SWMU 4 (8.29×10^{-3})
- ^{99}Tc: SWMU 2 (3.45×10^{-5}), SWMU 3 (6.92×10^{-6}), SWMU 4 (1.49×10^{-4}), SWMU 5 (4.67×10^{-6}), SWMU 6 (2.75×10^{-5}), SWMU 7 (8.00×10^{-4}), and SWMU 30 (3.23×10^{-4}),

The greatest contributors of the COPCs presenting the maximum potential hazards are as follows. (All values reported below are potential hazards to the resident that are projected to exist if only the reported source contributed contaminants to groundwater.)

- *cis*-1,2-DCE: SWMU 2 (726) and SWMU 4 (789,000)
- *trans*-1,2-DCE: SWMU 4 (169,000)
- Carbon tetrachloride: SWMU 4 (11,600)
- Chloroform: SWMU 4 (>1,000,000)
- TCE: SWMU 2 (504)
- Naphthalene: SWMU 2 (1.38), SWMU 3 (2.11), SWMU 5 (123), SWMU 7 (2.22), and SWMU 30 (7.24)
- Copper: SWMU 7 (21.2).

Finally, the greatest contributors of the COPCs presenting the maximum potential dose (in mrem/year) from ^{99}Tc are SWMU 4 (2.13), SWMU 7 (11.4), and SWMU 30 (4.90). (As before, the dose values are potential doses to the resident that are projected to exist if only the reported source contributed contaminants to groundwater.)

The assumptions for groundwater modeling were discussed in Section E1.7.4. The inherent uncertainties associated with using the assumptions must be recognized. Because K_d values are highly sensitive to changes in the major chemistry of the solution phase, it is important that the values be measured or estimated under conditions that will represent, as closely as possible, those of a contaminant plume. It is also important to note that any contaminant plume predicted to occur will change over time and be affected by multiple solutes that are currently present or may be present in the future at the site. Projected organic concentrations in the aquifer are overestimated because site-specific data on constituent decay in the vadose zone and in the groundwater is lacking, and zero decay was assumed for all organic compounds.

Neither the SESOIL nor AT123D models account for the in-growth of radionuclides. This may have resulted in an underestimation of representative concentrations of decay products with mobility higher than the starting radionuclide, and an overestimation of representative concentrations of decay products with mobility lower than the starting radionuclide. Similarly, because decay will reduce the concentration of the starting radionuclide in the source, the representative concentrations of the starting radionuclide may be overestimated. Fortunately, most of the radionuclide COPCs included in the modeling either have very short half-lives relative to the time modeled (i.e., ^{90}Sr) or very long half-lives relative to the time modeled (i.e., ^{99}Tc, ^{238}U, etc.). Therefore, in general, the decay and in-growth of radiological constituents should have very little effect on the risk characterization.

The effects of heterogeneity, anisotropy, and spatial distribution of fractures are not addressed in these simulations. The present modeling study using SESOIL and AT123D does not address the effects of flow and contaminant transport across interfaces in a sharply varying heterogeneous media. The migration distance predicted by the model may be uncertain mainly because of homogenous and isotropic assumptions were used in these models whereas site data indicate otherwise.

As such, a conservative approach was used to address the uncertainties. Based upon the data available, the values of the model parameters were selected to ensure that contaminant transport was not underestimated. Such an approach can be expected to lead to overestimates of COPC concentrations in groundwater at the integrator points and, subsequently, to overestimates of the cancer risks, hazards, and doses estimated.

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APPENDIX E
ATTACHMENT 2

SOURCE TERM DEVELOPMENT

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E2.1. SOURCE TERM DEVELOPMENT

This attachment documents the development of Upper Continental Recharge System (UCRS) contaminant source terms for fate and transport modeling in the Burial Grounds Operable Unit (BGOU) Remedial Investigation (RI). The BGOU consists of Solid Waste Management Units (SWMUs) 2, 3, 4, 5, 6, 7, 30, and 145, as shown in Figure E2.1.

The BGOU RI assesses the risk posed by contaminants for each SWMU; consequently fate and transport assessment requires separate models for each SWMU (and each assessed contaminant within each SWMU). Model domains extend from ground surface down to the top of the Regional Gravel Aquifer (RGA), commonly in seven layers that are discretized into rows and columns of uniform spacing. Table E2.1 summarizes the source term model domains.

Table E2.1. Summary of the Source Term Model Domains

SWMU	Modeled Area (acres)	Depth (ft) Simulated in Model	Grid Block Size (ft x ft)	Table of SADA Source Characterization Results[a]
2	0.73	64	20 x 20	SWMU 2 results.xls
3	3.86	65	100 x 100	SWMU 3 results.xls
4	6.49	63	20 x 20	SWMU 4 results.xls
5	4.43	60	20 x 20	SWMU 5 results.xls
6	0.19	63	10 x 10	SWMU 6 results.xls
7	2.53	60	20 x 20	SWMU 7 results.xls
30	2.70	61	20 x 20	SWMU 30 results.xls
145	44.40	58	100 x 100	SWMU 145 results.xls

[a] These SADA files are contained on the CD under the SADA directory

The observed data (from analysis of the BGOU RI environmental samples and those of previous investigations) are scattered throughout the model domains. Modelers assigned a contaminant concentration to each cell of the model domains by interpolating the observed data using Spatial Analysis and Decision Assistance (SADA) (UT 2002).

The interpolation techniques in SADA are as follows:

- Nearest neighbor
- Natural neighbor
- Inverse distance
- Ordinary kriging
- Indicator kriging

Nearest neighbor interpolation was selected because it provided greater contrast of the interpolated concentrations among the model cells and greater ease of source delineation through visual inspection. The natural neighbor interpolation is more precise than the nearest neighbor interpolation, however, it is available only for two-dimensional interpolations. The inverse distance interpolation did not distinctly delineate the modeled contaminant plumes. Kriging interpolations in SADA involved variogram modeling. Modelers concluded that kriging interpolations were not suitable because semi-variogram values for the observed data did not follow monotonically increasing trends.

Source term development consisted of the following steps:

- Initial interpolation runs of the observed data within the model domain
- Visual inspection of the results of interpolation runs
- Selection of an acceptable interpolation
- Final interpolation
- Analysis (post processing) of the final interpolation

The model domain consisted of a surface soil (0–1 ft below surface) layer and 6 other layers down to the top of the RGA. Only the surface soil (Layer 0) was interpolated separately, because the majority of Layer 1 samples were sediments that were different in nature than the subsurface soils.

Figure E2.2 shows typical flood contours of the source zone in the UCRS developed from the SADA interpolation in plan view. Three-dimensional figures were created the show the spatial distribution of COCs under each SMWU (Figures E2.3–10). In addition, Figures E2.11 through E2.18 provide examples of the SADA nearest neighbor interpolation results for the layers with the highest total mass for COCs providing the majority of the risk or hazard at the SWMUs. Sample location circles were shaded to match legend scale on right side of figure. Due to the large number of maps created with SADA (882 total) only one individual soil layer per SWMU with highest total mass was illustrated.

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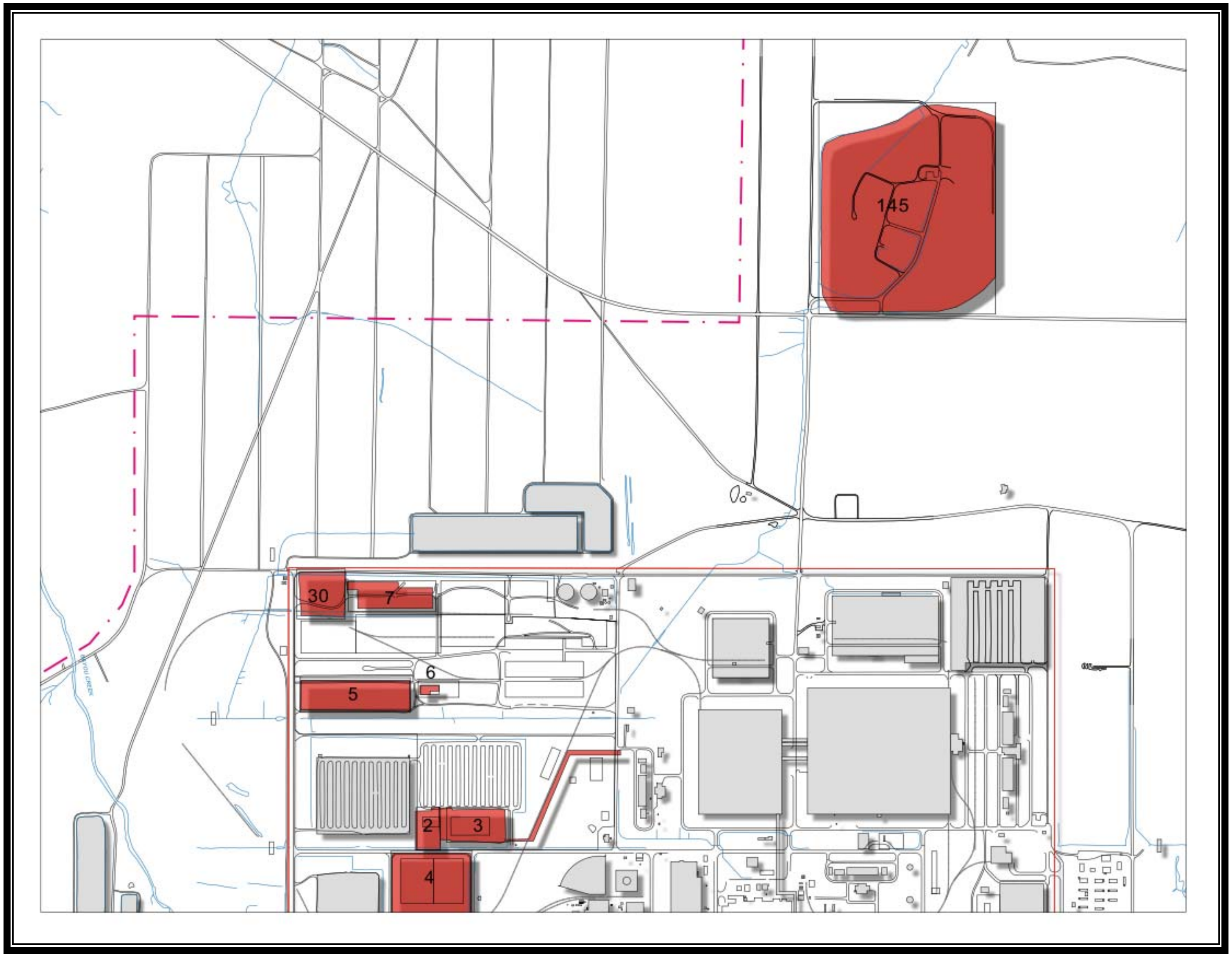

Figure E2.1. BGOU SWMUs

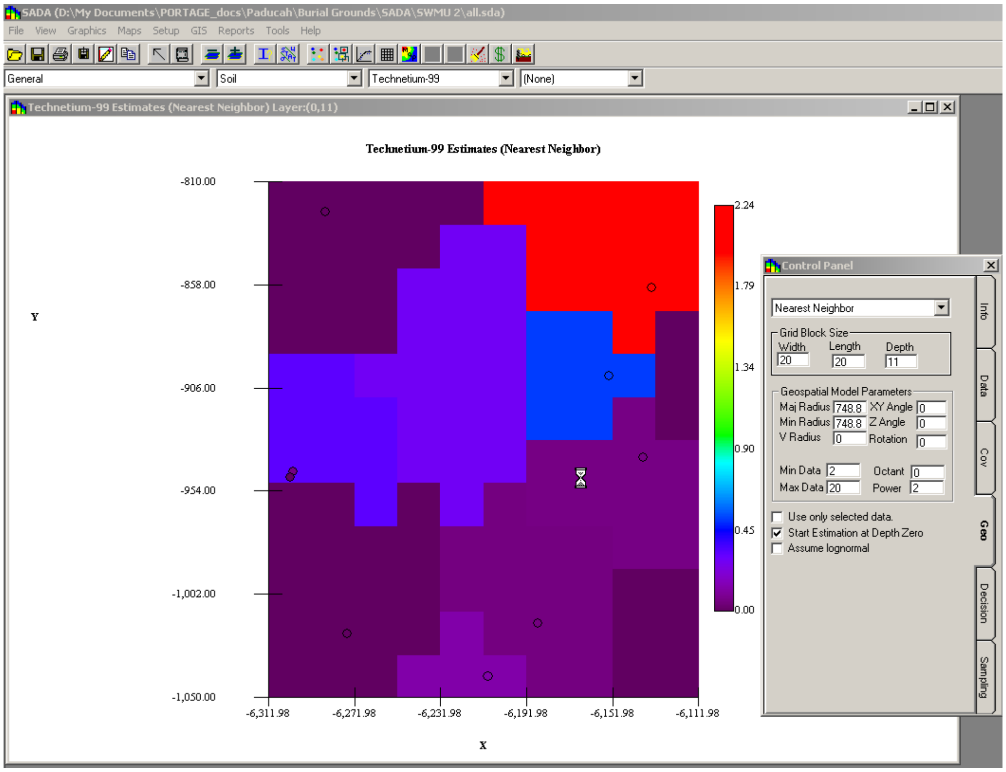

Figure E2.2. Typical SADA Nearest Neighbor Interpolation Map

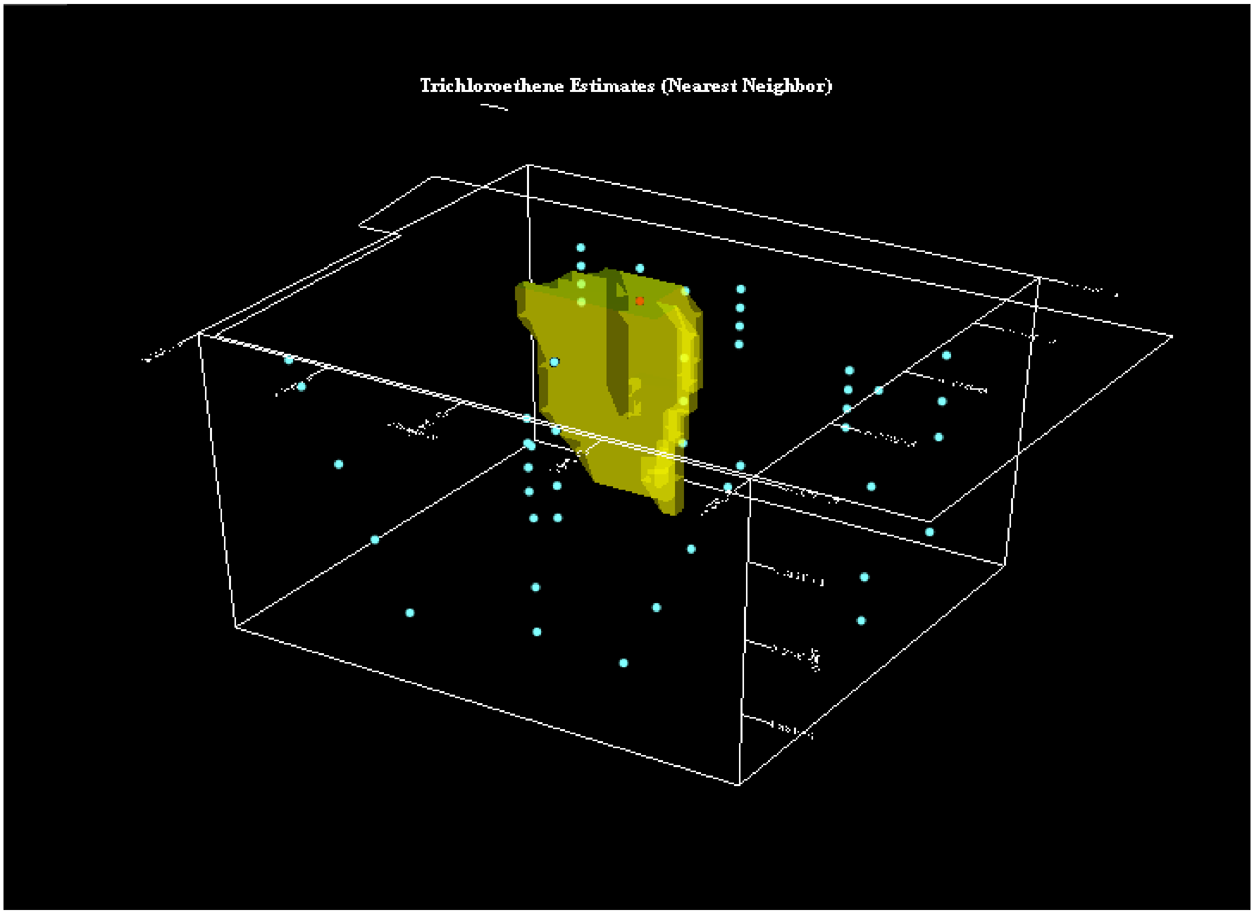

Figure E2.3. SWMU 2 TCE SADA Nearest Neighbor Interpolation Map (3-D)

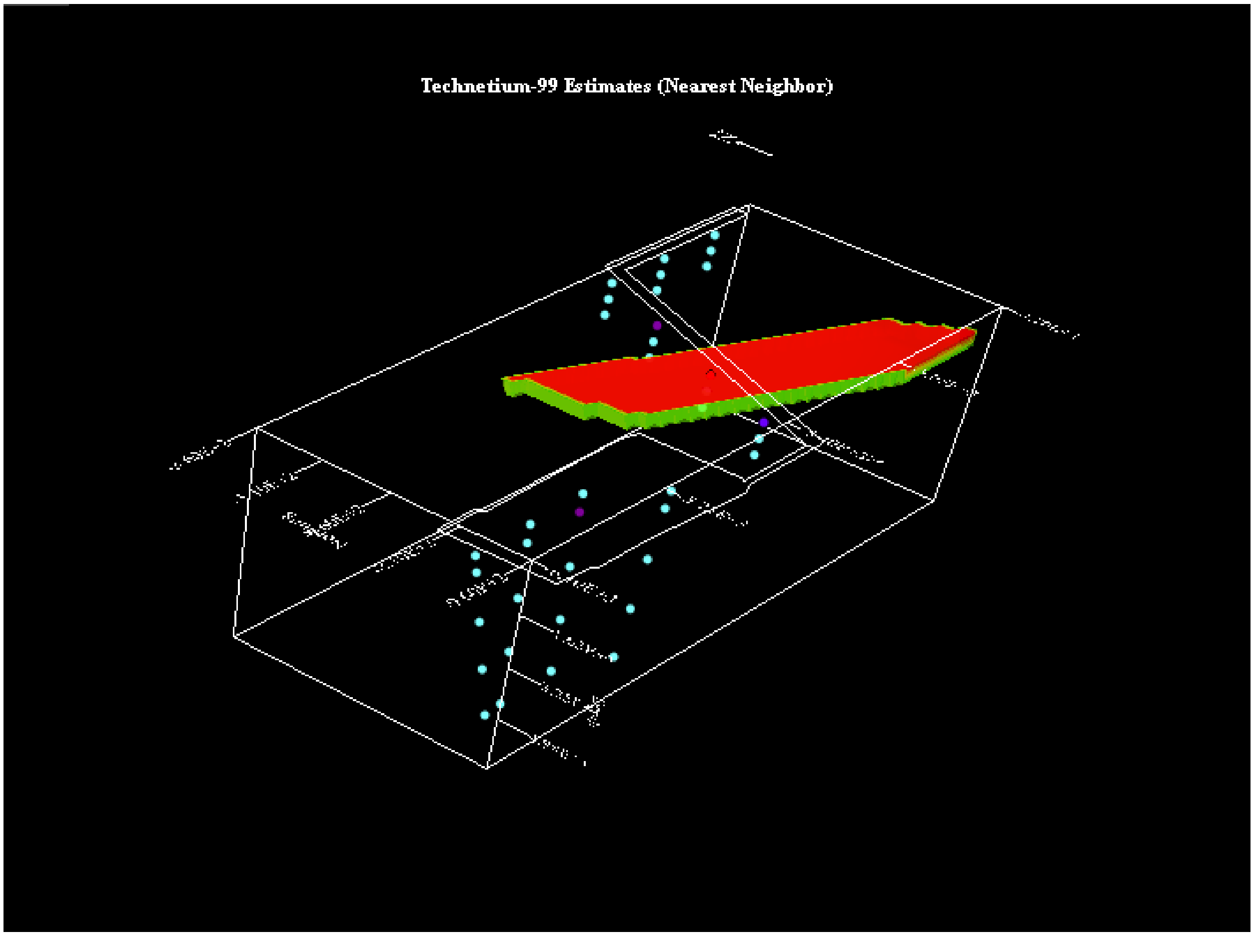

Figure E2.4. SWMU 3 Tc-99 SADA Nearest Neighbor Interpolation Map (3-D)

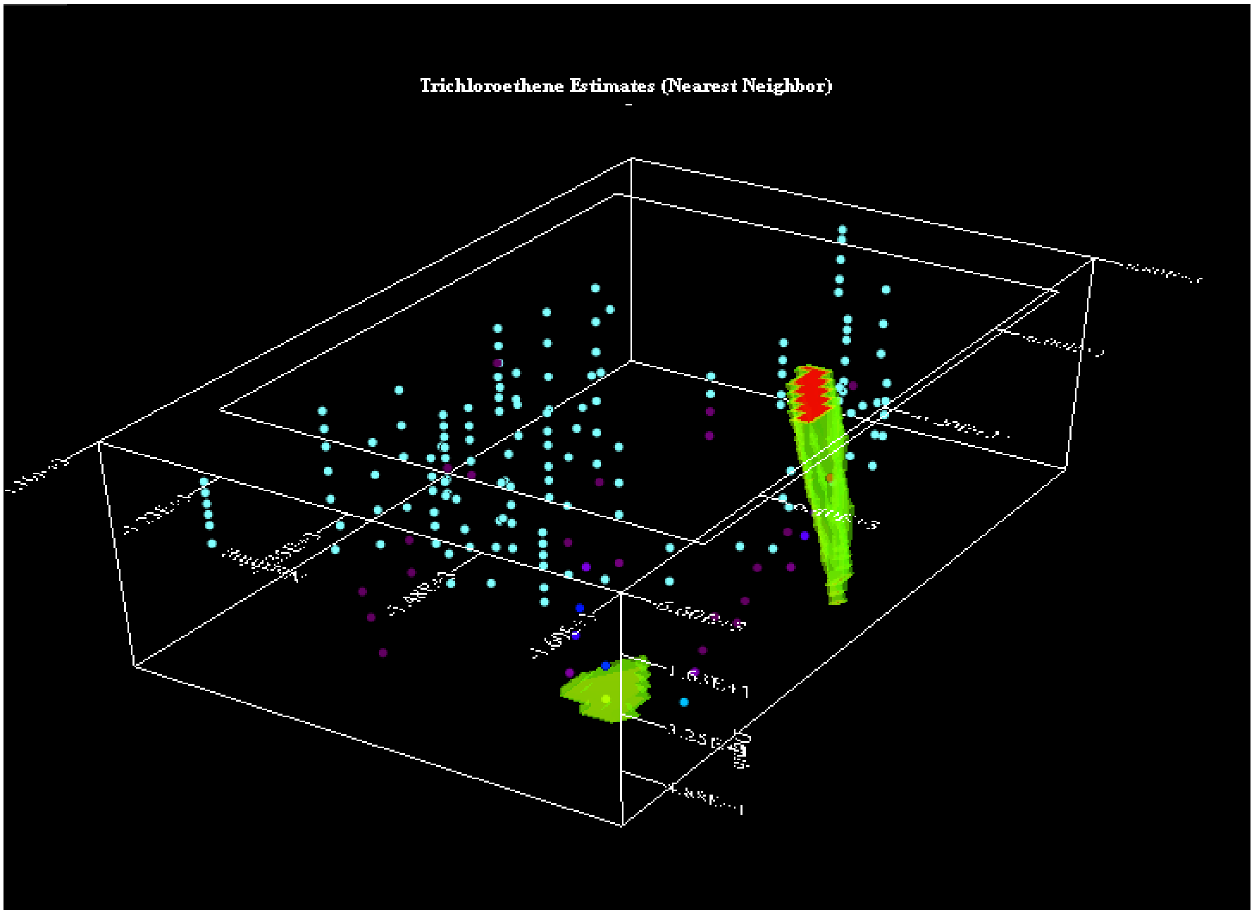

Figure E2.5. SWMU 4 TCE SADA Nearest Neighbor Interpolation Map (3-D)

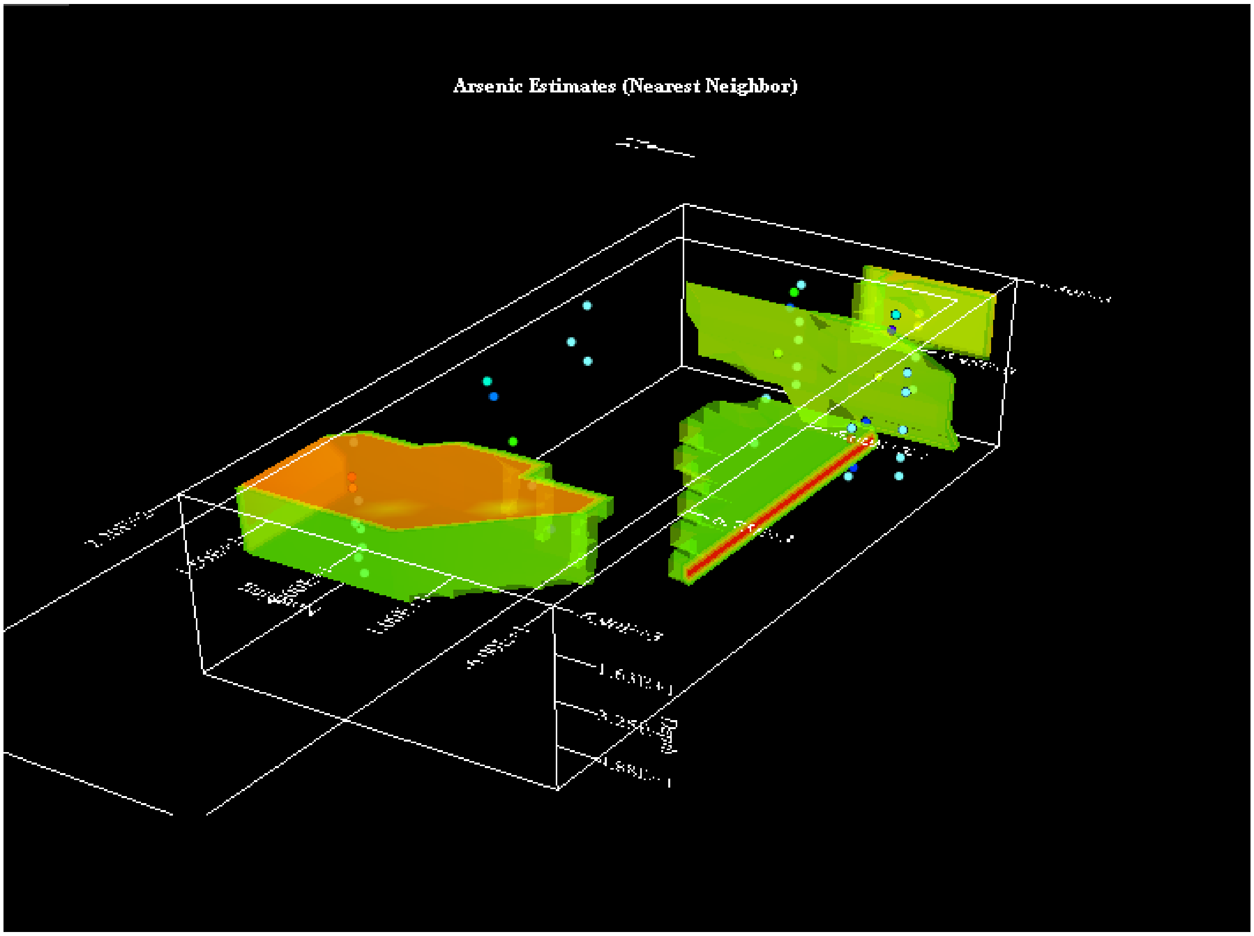

Figure E2.6. SWMU 5 Arsenic SADA Nearest Neighbor Interpolation Map (3-D)

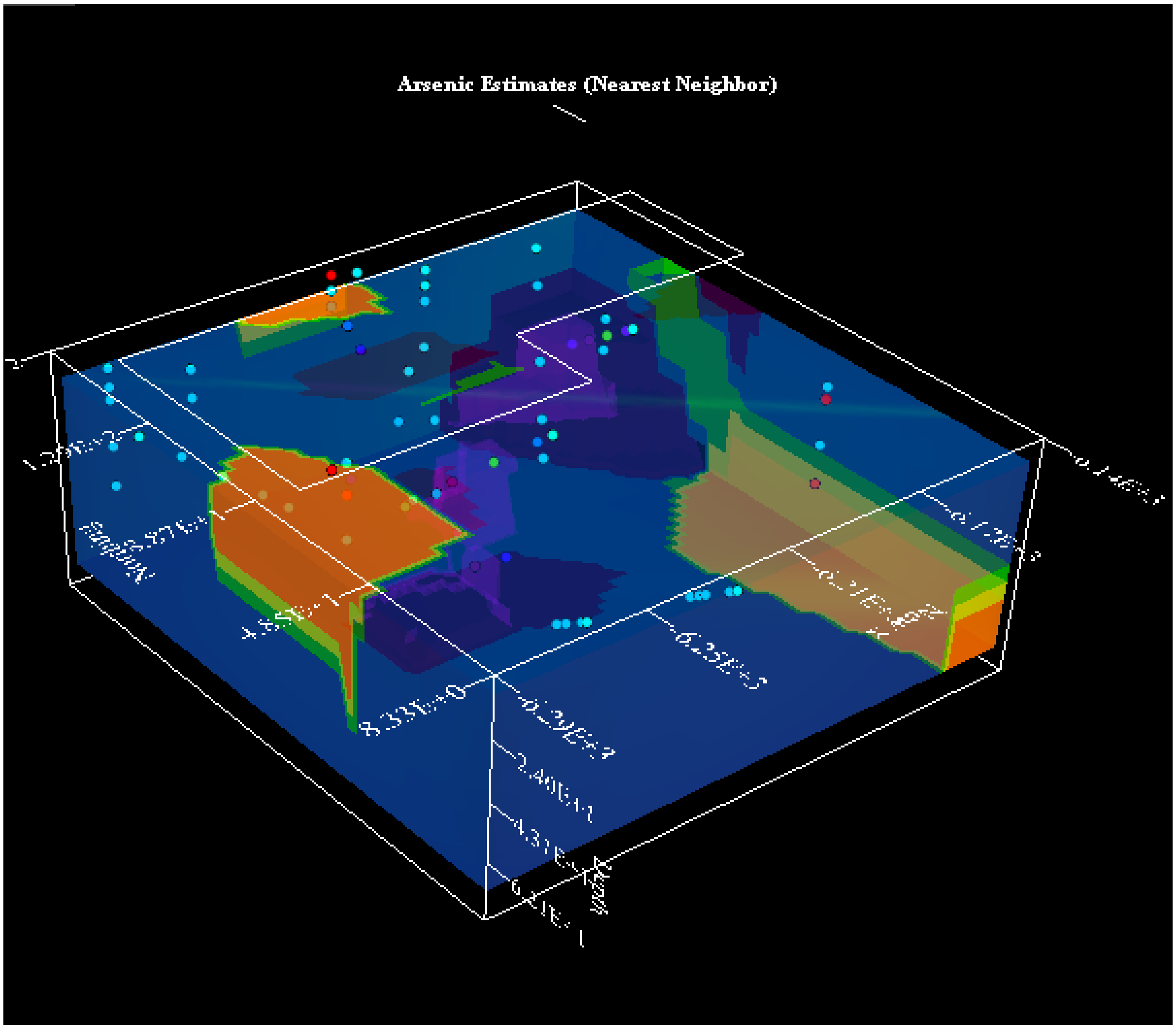

Figure E2.7. SWMU 6 Arsenic SADA Nearest Neighbor Interpolation Map (3-D)

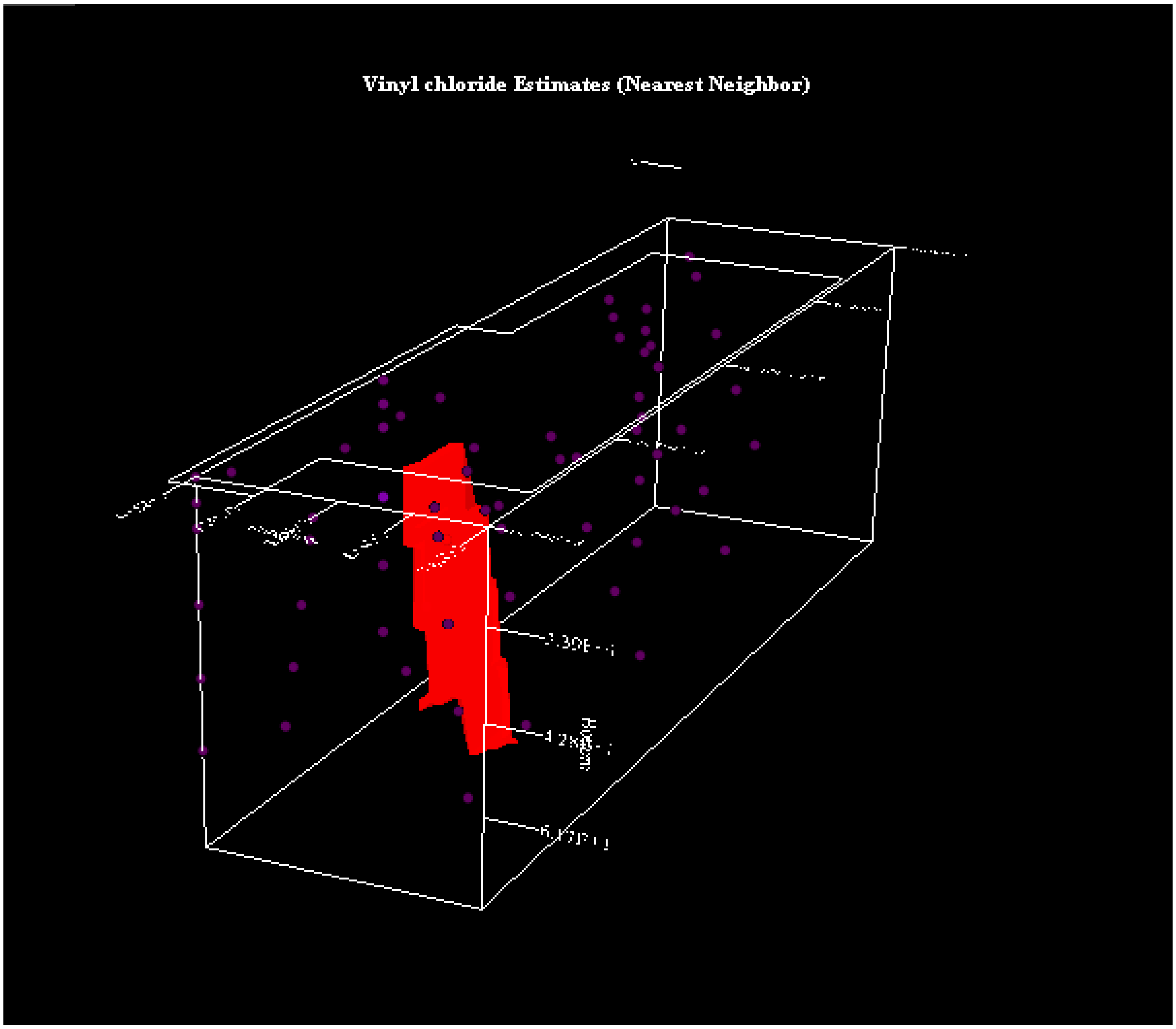

Figure E2.8. SWMU 7 Vinyl Chloride SADA Nearest Neighbor Interpolation Map (3-D)

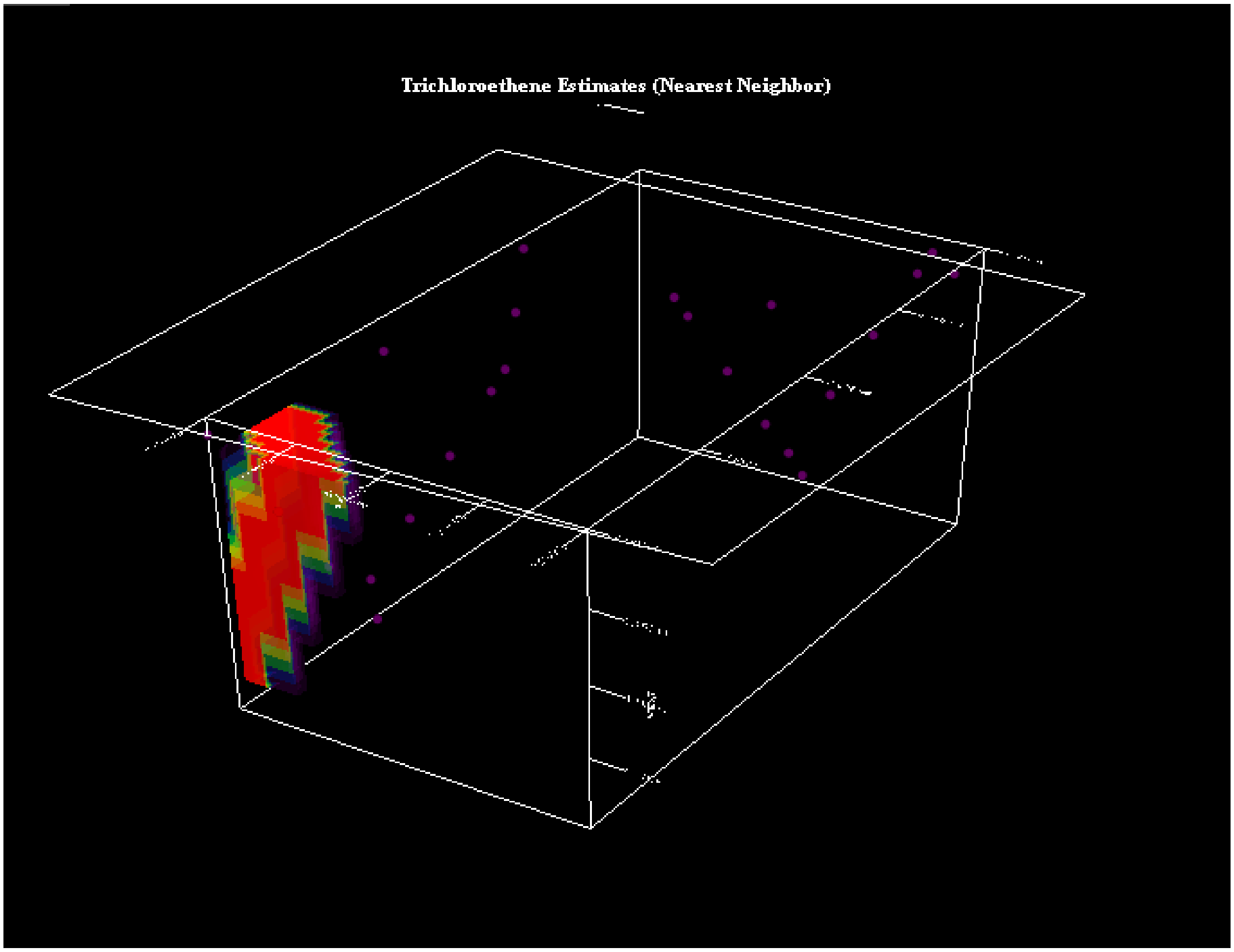

Figure E2.9. SWMU 30 TCE SADA Nearest Neighbor Interpolation Map (3-D)

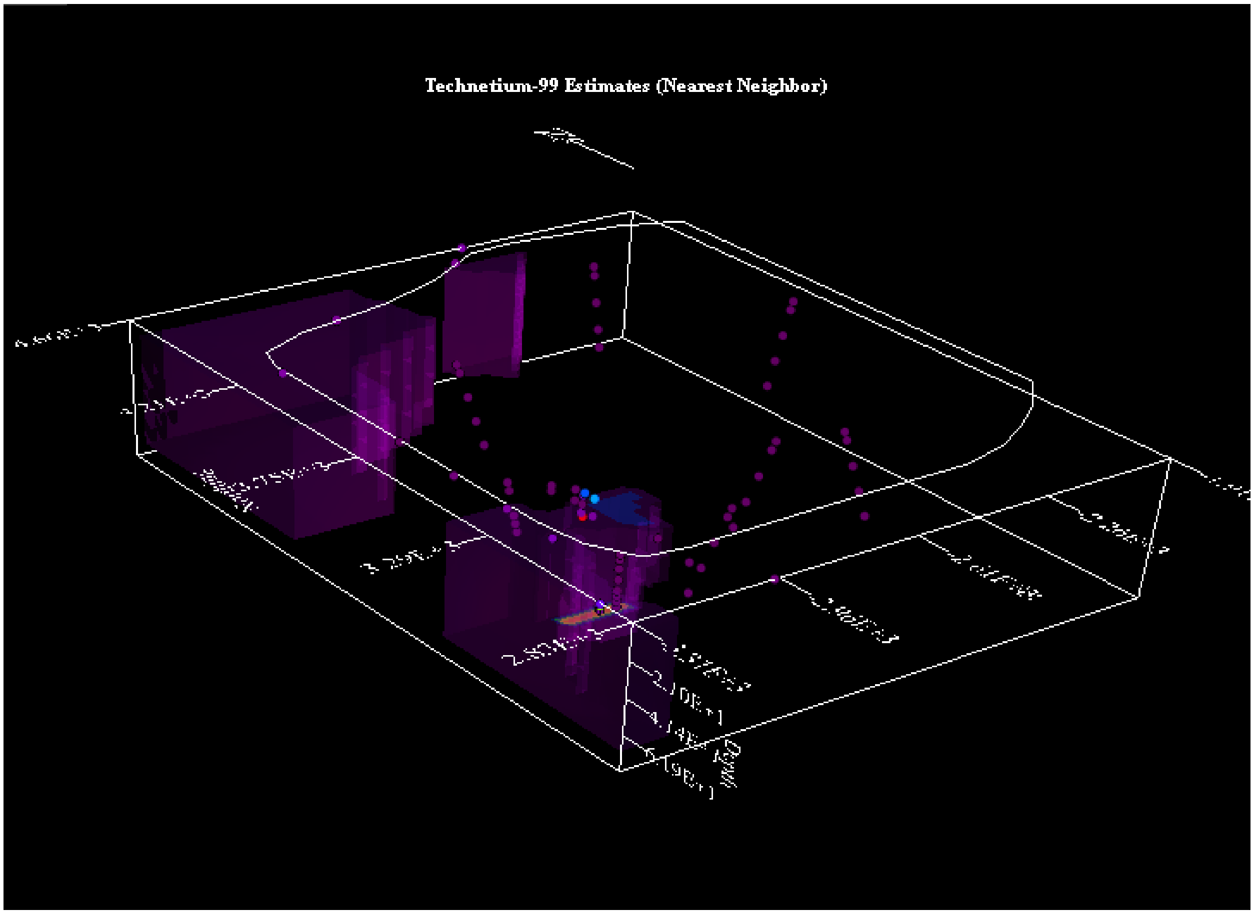

Figure E2.10. SWMU 145 Tc-99 SADA Nearest Neighbor Interpolation Map (3-D)

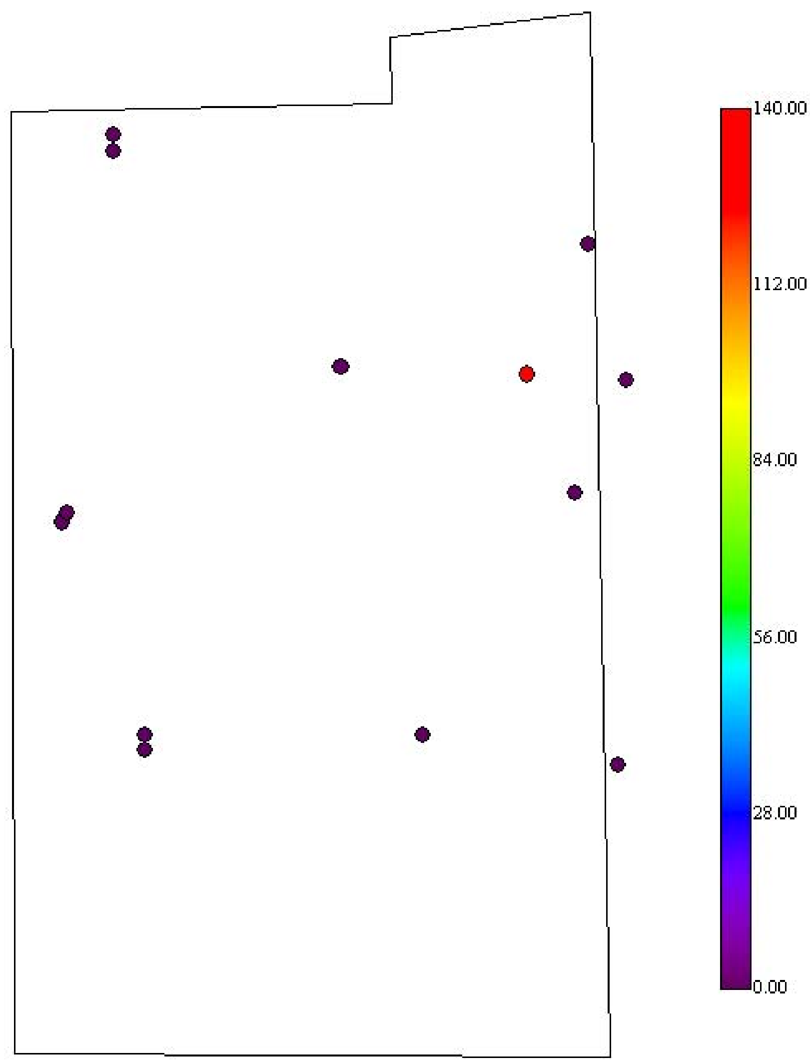

Figure E2.11. SWMU 2, TCE 10-20 ft bgs

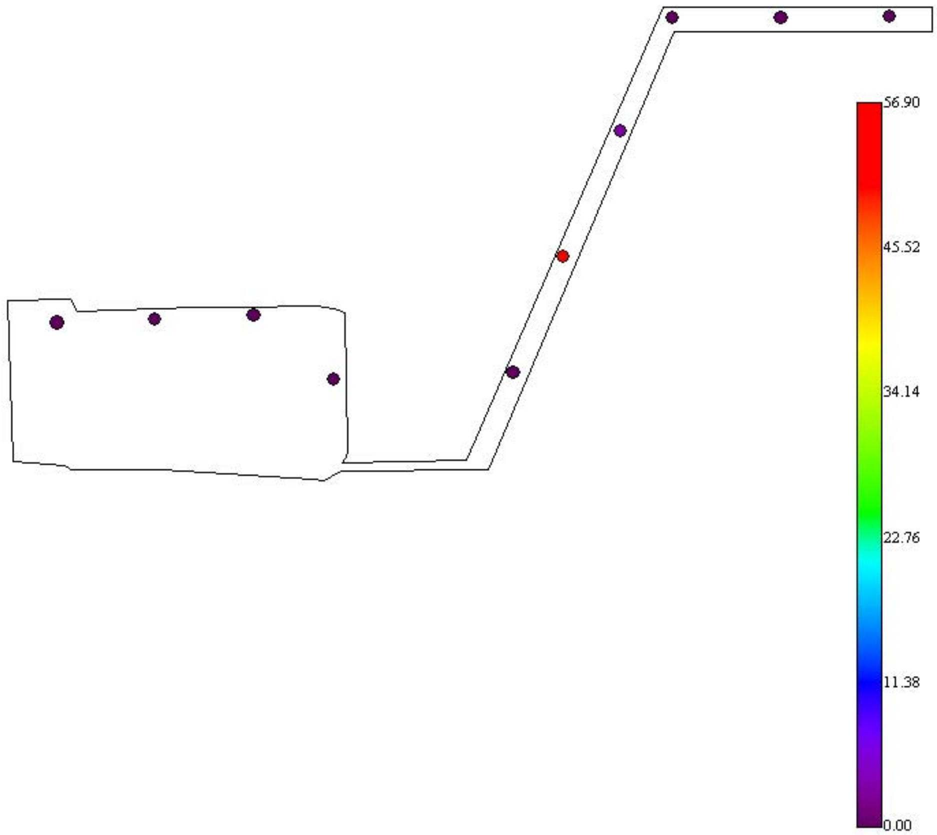

Figure E2.12. SWMU 3, ^{99}Tc 1-10 ft bgs

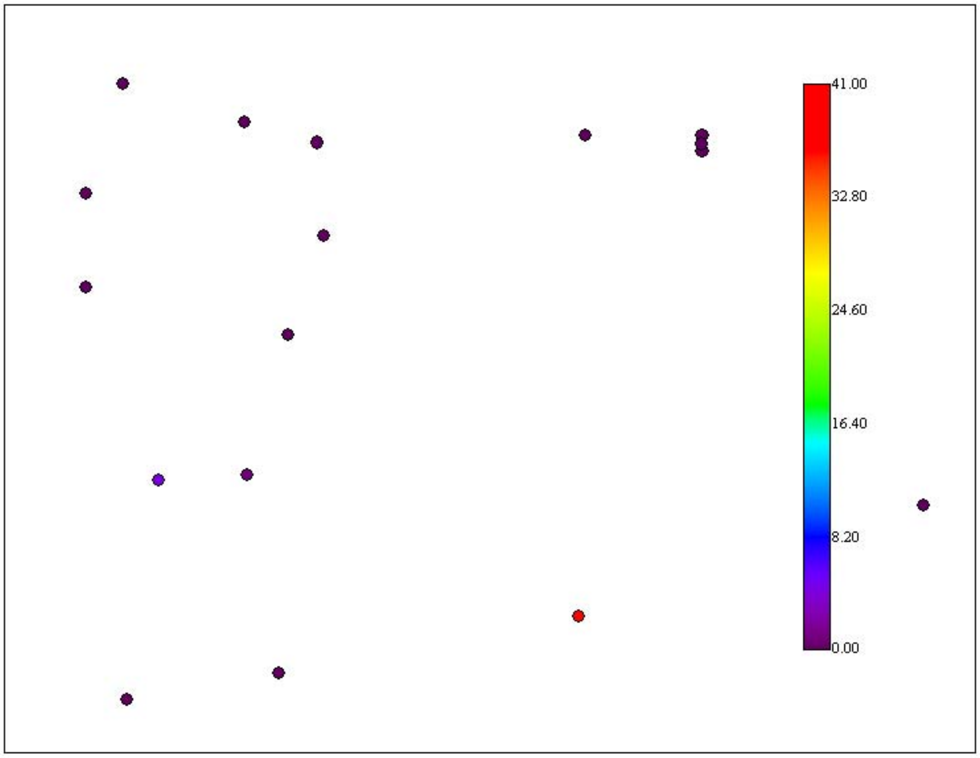

Figure E2.13. SWMU 4, TCE 30-40 ft bgs

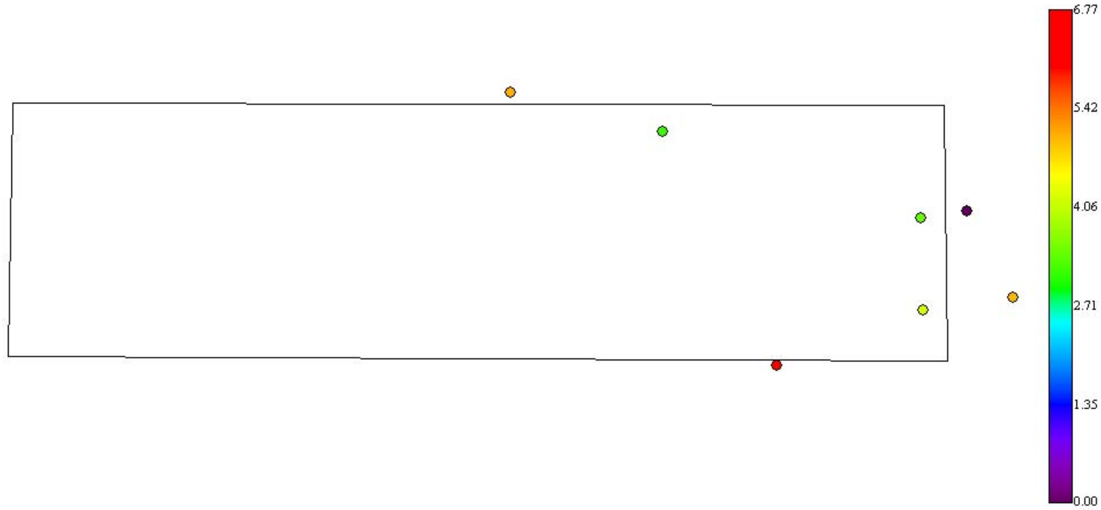

Figure E2.14. SWMU 5, Arsenic 20-30 ft bgs

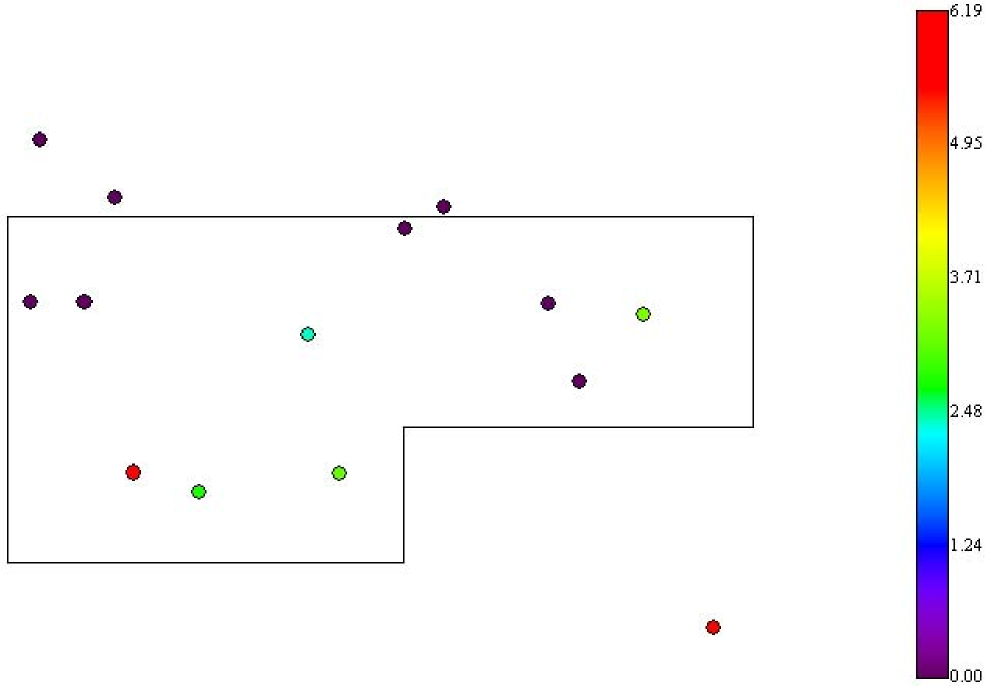

Figure E2.15. SWMU 6, Arsenic 20-30 ft bgs

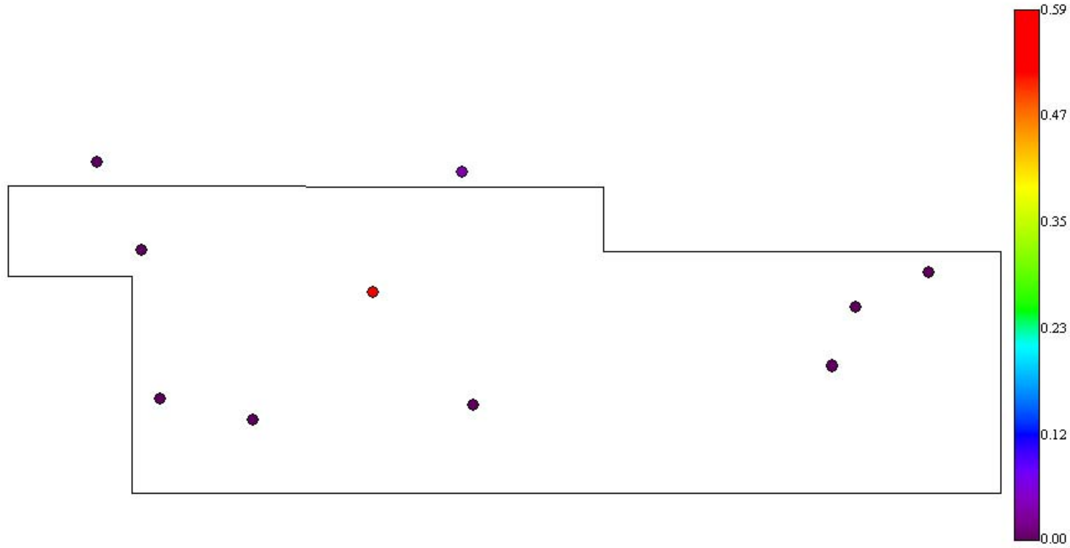

Figure E2.16. SWMU 7, Vinyl Chloride 30-40 ft bgs

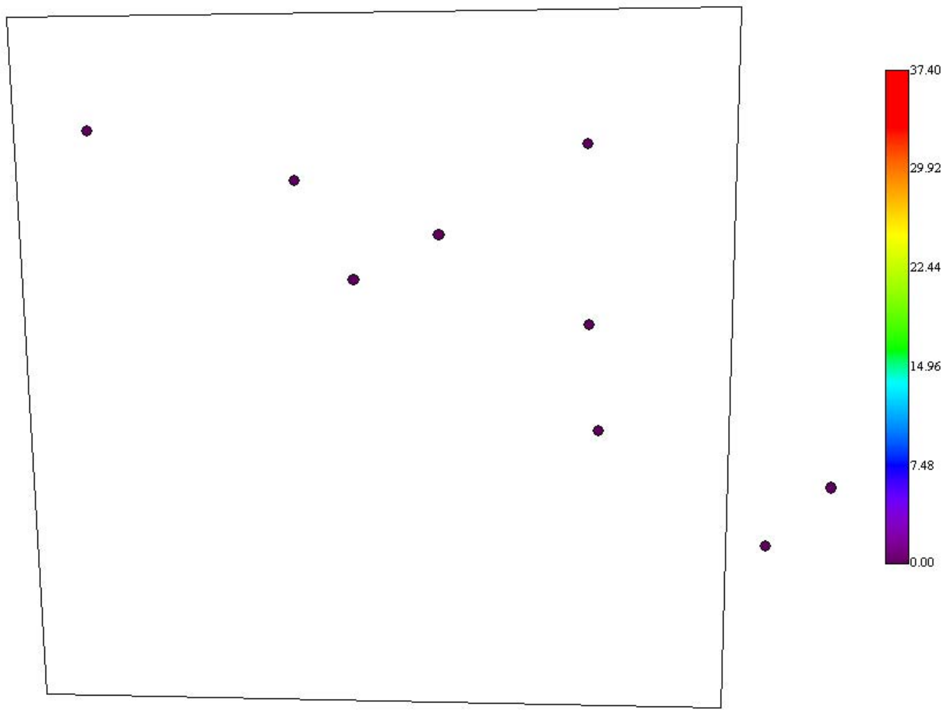

Figure E2.17. SWMU 30, TCE 1-10 ft bgs

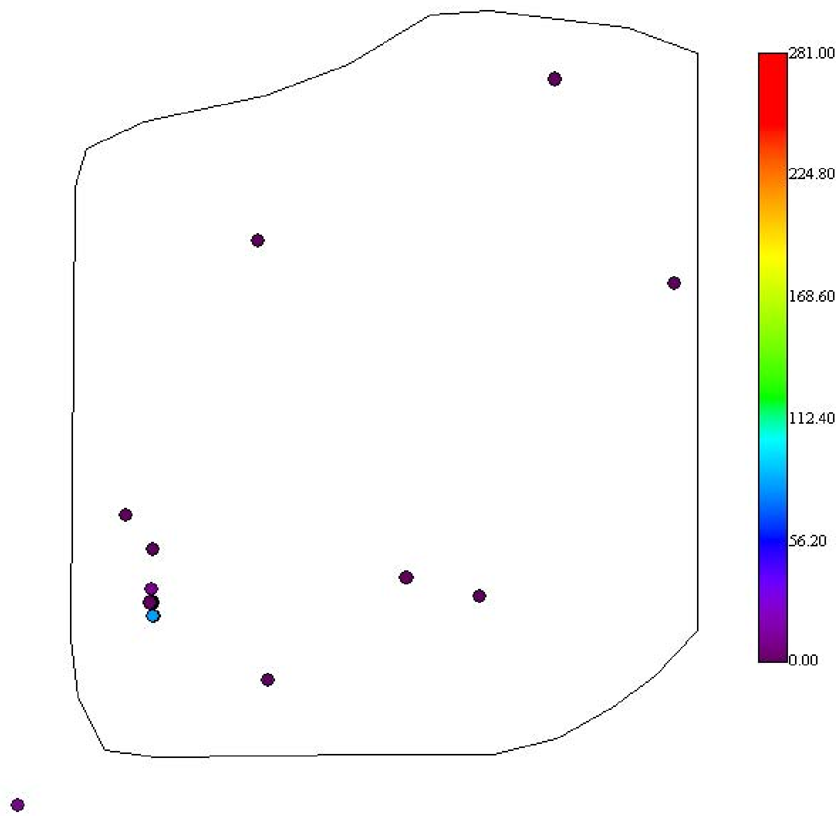

Figure E2.18. SWMU 145, ^{99}Tc 1-10 ft bgs

APPENDIX F

BASELINE HUMAN HEALTH RISK ASSESSMENT

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ACRONYMS

ABS	dermal absorption factor
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
BRA	baseline risk assessment
CAS	Chemical Abstract Service
CDI	chronic daily intake
COC	contaminant of concern
COPC	chemical of potential concern
CSM	conceptual site model
DAF	dilution attenuation factor
DCE	dichloroethene
DHHS	Department of Health and Human Services
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U. S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
GI	gastrointestinal tract
KDEP	Kentucky Department for Environmental Protection
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IARC	International Agency for Research on Cancer
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
LET	linear energy transfer
MCL	maximum contaminant level
MEPAS	Multimedia Environmental Pollution Assessment System
NAL	no action level
NCEA	National Center for Environmental Assessment
NSDD	North-South Diversion Ditch
OREIS	Oak Ridge Environmental Information System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
POC	pathway of concern
POE	point of exposure
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RAWG	Risk Assessment Working Group
RAIS	Risk Assessment Information System
RCRA	Resource Conservation and Recovery Act
RESRAD	RESidual RADioactive Materials
RfD	reference dose

RGA	Regional Gravel Aquifer
RGO	remedial goal option
RI	remedial investigation
RME	reasonable maximum exposure
SF	slope factor
SI	site investigation
SQL	sample quantitation limit
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TCA	trichloroethane
TCE	trichloroethene
TEF	toxicity equivalence factor
TVA	Tennessee Valley Authority
UCL	upper confidence limit
VOC	volatile organic compound
WAG	waste area grouping
WKWMA	West Kentucky Wildlife Management Area

BASELINE HUMAN HEALTH RISK ASSESSMENT

This baseline human health risk assessment (BHHRA) utilizes information collected during the recently completed remedial investigation (RI) of eight Burial Grounds Operable Unit (BGOU) Solid Waste Management Units (SWMUs), in addition to information collected during previous investigations (listed in Section F.1), to characterize the baseline risks posed to human health from contact with contaminants in soil and water at these SWMUs and at locations to which contaminants may migrate. The units included SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145 located at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky. A summary of the data used is presented in Attachment F1 to this appendix.

Part of Goal 2 for the BGOU RI, as presented in the BGOU work plan (DOE 2006a), was to determine if contaminants at the BGOU units are contributing to groundwater contamination; this risk assessment supports that goal by using modeled concentrations of contaminants to the Regional Gravel Aquifer (RGA) to support the refinement of an assessment of risks to human health and the environment through groundwater. The work plan also specified that the RI should include a risk assessment for residential, industrial, and recreational receptors. Risk assessments for each of those scenarios are presented here. The information collected during the RI, the earlier historical data, and the results of this BHHRA will be used to determine if sufficient data are available to evaluate risk and to determine if response actions to reduce risks are needed and, if needed, to screen among response action alternatives.

The methods and presentations used in this BHHRA are consistent with those presented in *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant,* DOE/OR/07-1506&D2 (DOE 2001) The Risk Methods Document integrates the human health risk assessment guidance from the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) and incorporates instructions contained in regulatory agency comments on earlier risk assessments performed for PGDP.

Consistent with the 2001 revision to the Risk Methods Document, this BHHRA is presented in nine sections. The first section reviews the results of previous risk assessments that are useful in understanding the risks posed to human health by contaminants at or migrating from the source areas. Identification of chemicals of potential concern (COPCs) is included in the second section. The third section documents the exposure assessment for the sources, including the characterization of the exposure setting, identification of exposure pathways, consideration of land use, determination of potential receptors, delineation of exposure points and routes [including development of the conceptual site model (CSM)], and calculation of chronic daily intakes (CDIs). The fourth section presents the toxicity assessment, including information on the noncarcinogenic (i.e., systemic toxicity or hazard) and carcinogenic effects of the COPCs and the uncertainties in the toxicity information. The fifth section reports the results of the risk characterization for current and future land use and identifies contaminants, pathways, and land use scenarios of concern. The sixth section contains qualitative and quantitative analyses of the uncertainties affecting the results of the BHHRA. The seventh section summarizes the methods used in the BHHRA and presents the BHHRA's conclusions and observations. The eighth section uses the results of the BHHRA to develop site-specific risk-based remedial goal options (RGOs). The ninth section contains references. The overall risk assessment process is presented in Figure F.1, which graphically displays the steps identified in the preceding section.

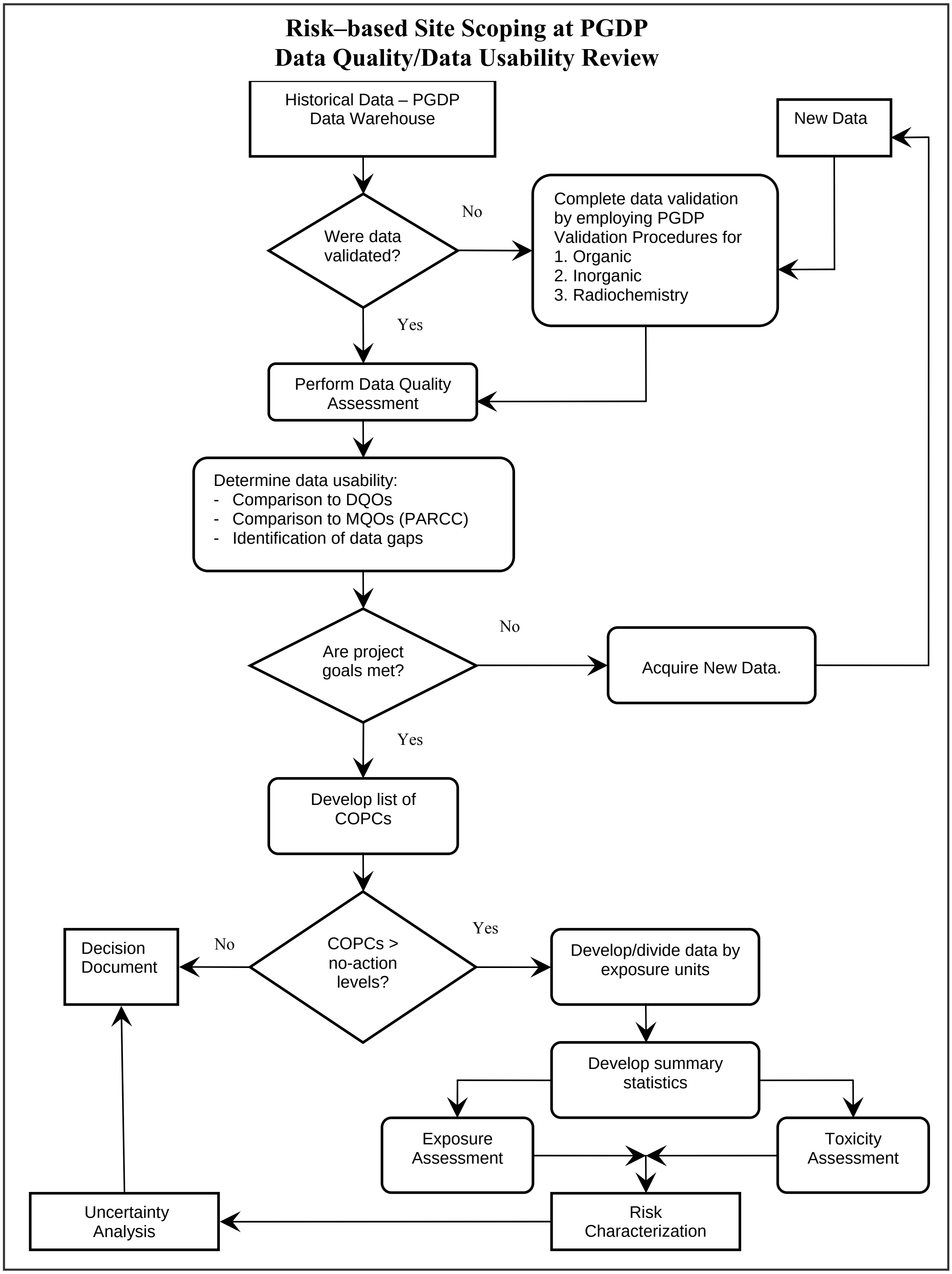

Figure F.1. HHRA Flow Chart

F.1. RESULTS OF PREVIOUS STUDIES

Four previous reports contain risk assessment results for one or more of the burial grounds considered in this RI. The results of these assessments are summarized here and are presented in more detail in Attachment F2 to this appendix. Since this RI collected additional data not previously available and the revised Risk Methods Document includes updated toxicity factors and exposure parameters, a direct comparison of this BHHRA with previous assessments was not made. Reports containing previous assessments and the year the assessment was completed are listed below:

- *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895/V1-V4&D1, U.S. Department of Energy, Paducah, KY (2000).

- *Feasibility Study for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/06-1644&D2, U.S. Department of Energy, Paducah, KY (1998).

- *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds Solid Waste Management Units 2 and 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1141&D2, U.S. Department of Energy, Paducah, KY (1994).

- *Data Summary and Interpretation Report for Interim Remedial Design at Solid Waste Management Unit 2 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1549&D1, U.S. Department of Energy, Paducah, KY (1997).

F.1.1 RESULTS OF REMEDIAL INVESTIGATION REPORT FOR WASTE AREA GROUPING 3 AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY

The Waste Area Grouping (WAG) 3 RI report BHHRA contains results for SWMU 4, SWMU 5, and SWMU 6 (DOE 2000). Scenarios assessed included the following:

- **Current industrial worker**
  Incidental ingestion of soil
  Dermal contact with soil
  Inhalation of vapors and particulates emitted from soil
  External exposure to ionizing radiation emitted from soil

- **Future industrial worker**
  Incidental ingestion of soil
  Dermal contact with soil
  Inhalation of vapors and particulates emitted from soil
  External exposure to ionizing radiation emitted from soil
  Ingestion of groundwater
  Dermal contact with groundwater while showering
  Inhalation of vapors emitted by groundwater while showering

- **Future excavation worker**
  Incidental ingestion of soil (soil and waste)
  Dermal contact with soil (soil and waste)

Inhalation of vapors and particulates emitted from soil (soil and waste)
External exposure to ionizing radiation emitted from soil (soil and waste)

- **Future recreational user**
  Ingestion of venison grazing on vegetation grown in contaminated soil
  Ingestion of rabbit grazing on vegetation grown in contaminated soil
  Ingestion of quail grazing on vegetation grown in contaminated soil

- **Future on-site rural resident**
  Incidental ingestion of soil
  Dermal contact with soil
  Inhalation of vapors and particulates emitted from soil
  External exposure to ionizing radiation emitted from soil
  Ingestion of groundwater
  Dermal contact with groundwater while showering
  Inhalation of vapors emitted by groundwater during household use
  Inhalation of vapors emitted by groundwater while showering
  Ingestion of vegetables grown in contaminated soil

- **Off-site rural resident (at PGDP security fence)**
  Ingestion of groundwater
  Dermal contact with groundwater while showering
  Inhalation of vapors emitted by groundwater during household use
  Inhalation of vapors emitted by groundwater while showering

For all SWMUs in WAG 3, the cumulative human health systemic toxicity and excess lifetime cancer risk (ELCR) exceed the accepted standards of KDEP and EPA for one or more land use scenarios when assessed using default exposure parameters. The land use scenarios for which risks exceed *de minimis* levels [i.e., for KDEP, a cumulative hazard index (HI) of 1 or a cumulative ELCR of 1.0E-06, and for EPA, an HI of 1 and a range of 1.0E-04–1.0E-06 for ELCR] are summarized in the WAG 3 report and Tables F2.13 through F2.15 in Attachment F2 of this appendix.

F.1.1.1 Lead

A striking feature of the results of the BHHRA is the exceedingly high HIs that have been computed for land use scenarios, SWMUs, and media in which lead was detected (HIs of up to 2,390,000). This finding may be attributed to the use of a very conservative (1.0E-07 mg/kg-day) reference dose (RfD) value provided by KDEP. Where lead was detected, it was the overwhelming risk driver. To accommodate any uncertainty associated with this finding, the systemic toxicity associated with contaminants at WAG 3 has been assessed throughout this BHHRA by both including and excluding lead as a COPC. This strategy allows the identification of other contaminants contributing to significant levels of systemic toxicity and highlights HIs that exceed the *de minimus* level (i.e., HI > 1) in the absence of lead.

In an effort to reduce the uncertainty surrounding assessment of systemic toxicity at WAG 3 SWMUs where lead is present, two further analytical approaches are included in this risk assessment. Risks to exposed children were estimated using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model, and the reasonable maximum exposure (RME) concentrations of lead in soil and groundwater samples were compared to KDEP and EPA screening values. Applying the biokinetic model for lead indicates that the concentrations at SWMUs 4, 5, and 6 in both RGA groundwater (159, 195, and 227 µg/L, respectively) and McNairy groundwater (2150, 708, and 698 µg/L, respectively) result in unacceptable blood level concentrations in a child. These groundwater concentrations result in the following percent probabilities for resulting in unacceptable child blood level concentrations:

- 66.92, 75.59, and 81.13 percent probability, respectively, for RGA groundwater at SWMUs 4, 5, and 6, and
- 99.97, 98.67, and 98.67 percent probability, respectively, for McNairy groundwater at the same locations.

These findings are consistent with the respective lead-driven HIs of 71,100, 218,000, and 253,000, respectively, at SWMUs 4, 5, and 6 applicable to a future child rural resident exposed to RGA groundwater and HIs of 2,390,000, 789,000, and 778,000, respectively, for the child exposed to McNairy groundwater.

The RME lead concentrations in RGA and McNairy groundwater at the subject locations also are greater than the KDEP and EPA screening level concentrations for this element (4 and 15 μg/L, respectively); therefore, when these findings are considered together, there is qualitative agreement on the potential hazards of prevailing lead concentrations in the groundwater at these SWMUs. Where lead was detected in subsurface soil, lead-driven HIs of greater than 1,000 for the future excavator contrast markedly with very low probabilities (<0.02%) of children with blood lead levels greater than 10 μg/dL, as determined by the IEUBK model. Furthermore, lead concentrations in subsurface soil at SWMUs 4 and 6 do not exceed the soil screening values specified by either agency. These findings point to a dichotomy between the findings of the IEUBK model for the metal in soil and the determinations of lead-driven systemic toxicity as indicated by the pathway-specific HIs.

F.1.1.2 Exposure Routes

Dermal contact with soil has been a driving exposure pathway in previous BHHRAs at PGDP, with most of this risk arising from contact with metals. This is a direct result of using dermal absorption factors that exceed gastrointestinal absorption values and may be overly conservative. In such circumstances, risk estimates from the dermal exposure route may be unrealistic and exceed the real risk posed by this route of exposure. Although chemical-specific dermal absorption factor (ABS) values were used when available, default ABS values were used for most chemicals because chemical-specific values are lacking. Chemical-specific ABS values are available for polychlorinated biphenyls (PCBs) and cadmium and were used in this BHHRA. Remedial decisions based on the dermal contact with soil exposure route should be carefully considered because of the uncertainty associated with risk from this exposure route. While the dermal pathway may represent an important route of contaminant uptake for persons exposed to soil at WAG 3, ingestion of groundwater appears to represent the most important mechanism of uptake of contaminants from the RGA aquifer and McNairy Formation, with ingestion of groundwater-irrigated vegetables also representing a significant pathway for the hypothetical on-site resident.

F.1.1.3 Current and Future Industrial Worker

Soil hazards (total HIs) for the current industrial worker exceed *de minimis* levels (HI >1 or ELCR >1.0E-06) at only one SWMU, SWMU 4 (HI = 3.62). The contaminants at SWMU 4 contributing more than 10% to total HI are chromium, iron, and vanadium, with dermal contact as the driving exposure route. Soil cancer risks (total ELCRs) for the current industrial worker exceed *de minimis* levels at SWMUs 4, 5, and 6 (ELCRs > 1.0E-04). The major contaminant in surface soils at all SWMUs is beryllium, with significant contributions from polyaromatic hydrocarbons (PAHs) at SWMUs 5 and 6. For all SWMUs, dermal contact is the driving exposure route. The future industrial land use scenario is identical to the current industrial land use scenario except that the future industrial land use scenario also evaluates use of groundwater. Groundwater HIs for the future industrial worker exceed *de minimis* levels at all SWMUs (16,000–216,000); however, these hazards are markedly reduced by excluding lead as a COPC (19.1–

75.9). Iron, manganese, vanadium, and trichloroethene (TCE) contribute more than 10% to total HIs, with ingestion as the driving exposure route. Iron is both widespread and predominant as a contaminant of concern (COC), contributing 61–80% to HI, depending on location. Groundwater ELCRs for the future industrial worker exceed *de minimis* levels at all SWMUs (>1.0E-04). Arsenic, beryllium, TCE, and radium-226 (^{226}Ra) contribute more than 10% to ELCR, with ingestion as the driving exposure route.

F.1.1.4 Future Excavation Worker

Total soil and waste HIs for the future excavation worker exceed *de minimis* levels at all SWMUs (2.16–1750), but fall below 3 when lead is excluded as a COPC. Chromium, iron, manganese, and vanadium are the contaminants contributing more than 10% to HI, with dermal contact as the driving exposure route. Total soil and waste ELCRs for the future excavator exceed *de minimis* levels at all SWMUs (> 1.0E-04). Total Uranium is the major contributor to ELCR at SWMU 4 (83%), with external exposure as the driving exposure route. Beryllium and Total PAHs contribute 10% or more to ELCR at SWMU 5, with dermal contact as the driving exposure route. Beryllium is the major contributor to ELCR at SWMU 6, with dermal contact as the driving exposure route.

F.1.1.5 Future Rural Resident

Soil HIs for the future rural resident exceed *de minimis* levels at all SWMUs, but are less than 100 when lead is excluded as a COPC. Aluminum, arsenic, chromium, iron, and nickel contribute more than 10% to total HIs, with dermal contact with soil and ingestion of vegetables raised in soil as the driving exposure routes. The uncertainty associated with the dermal pathway has been previously discussed. Exclusion of the vegetable pathway would reduce soil HIs for the rural resident by as much as 87%. Soil ELCRs for the future rural resident exceed *de minimis* levels at all SWMUs (> 1.0E-03). Beryllium and uranium-238 (^{238}U) contribute 10% or more to ELCR at SWMU 4, with ingestion of vegetables as the driving exposure route. Arsenic and Total PAHs contribute 10% or more to ELCR, with ingestion of vegetables as the driving exposure route. Beryllium and Total PAHs contribute 10% or more to ELCR at SWMU 6, with ingestion of vegetables as the driving exposure route. Exclusion of the vegetable pathway would reduce soil ELCRs for the rural resident by as much as 90%.

Groundwater HIs for the future rural resident exceed *de minimis* levels at all SWMUs (218,000–2,390,000) but are reduced by several orders of magnitude with lead excluded as a COPC (223−798). Iron, manganese, vanadium, carbon tetrachloride, and TCE contribute more than 10% to total HI, with ingestion of water and ingestion of vegetables irrigated with water as the driving exposure routes. As with the future industrial worker land use scenario, iron is both widespread and predominant as a COC, contributing 49–77% to HI, depending on location. Exclusion of the vegetable pathway would reduce groundwater HIs for the rural resident by as much as 40%. Groundwater ELCRs for the future rural resident exceed *de minimis* levels at all SWMUs (> 1.0E-03). Arsenic, beryllium, 1,1-dichloroethane, trichloroethane (TCA), ^{226}Ra, and technetium-99 (^{99}Tc) contribute more than 10% to ELCR, with ingestion of water and ingestion of vegetables irrigated with water as the driving exposure pathways. Exclusion of the vegetable pathway would reduce groundwater ELCRs for the rural resident by as much as 46%.

F.1.1.6 Future Recreational User

The future recreational user scenario is not of concern regarding total soil HI at any WAG 3 SWMU. In terms of cancer risks, total soil ELCR exceeds *de minimis* levels only at SWMU 5 (1.0E-05), where PAHs contribute 96% to risk, with ingestion of rabbit as the driving exposure route.

F.1.1.7 Modeled On-site and Off-site COCs

As noted previously, this baseline risk assessment (BRA) uses results of fate and transport modeling [Multimedia Environmental Pollution Assessment System (MEPAS)] to estimate the baseline risks posed to human health through contact with media impacted by contaminants migrating off-site from the various sources in WAG 3. The following chemicals are "priority COCs" for MEPAS-modeled off-site use of groundwater (i.e., rural residential use in the home). These COCs may migrate from a source at a SWMU in WAG 3 to an off-site location and present a chemical-specific HI or ELCR to the rural resident that is greater than 0.1 or 1.0E-06, respectively.

- SWMU 4—arsenic, cobalt, copper, iron, manganese, nickel, vanadium, 1,1-dichloroethene (DCE), 1,2-DCE, carbon tetrachloride, TCE, vinyl chloride, neptunium-237 (^{237}Np), plutonium-239 (^{239}Pu), ^{99}Tc, Total Uranium (assessed as ^{238}U), and ^{238}U

- SWMU 5—iron and manganese

- SWMU 6—iron and manganese

The RESidual RADioactive Materials (RESRAD) model was used to model both dose and excess cancer risk for radionuclides, accounting for in-growth of decay products. The following chemicals are "priority COCs" for modeled on-site soil use (i.e., industrial and excavator) and on-site groundwater use (i.e., rural residential use in the home). These chemicals are radionuclides that, through in-growth of decay products, present a chemical-specific ELCR that exceeds 1.0E-06 from exposure to surface and subsurface soil and waste at SWMUs in WAG 3 and radionuclides that may migrate from a source at a SWMU in WAG 3 to on-site RGA groundwater and present a chemical-specific ELCR to the rural resident that is greater than 1.0E-06:

- SWMU 4—thorium-230 (^{230}Th), Total Uranium (modeled as ^{238}U), and ^{238}U
- SWMU 5—^{226}Ra and ^{238}U
- SWMU 6— ^{237}Np, ^{99}Tc, and ^{238}U

F.1.2 RESULTS OF *REMEDIAL INVESTIGATION REPORT FOR SOLID WASTE MANAGEMENT UNITS 7 AND 30 OF WASTE AREA GROUPING 22 AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY* DOE/OR/07-1604/V1&D2

The following is a summary of the BHHRA found in the RI Addendum for the WAG 22, Burial Grounds Solid Waste Management Units 7 and 30 (DOE 1994). A complete summary of the BRA result can be found in WAG 22 report and in Attachment F2.

- **Current Industrial Worker**
  Soil ingestion
  Inhalation of volatile organic compounds (VOCs) or airborne soil particulates
  Dermal contact
  External exposure to ionizing radiation

- **Future Industrial Worker**
  Soil ingestion
  Inhalation of VOCs or airborne soil particulates
  Dermal contact
  External exposure to ionizing radiation

Ingestion of groundwater
Inhalation of VOCs released from groundwater while showering
Dermal contact with groundwater contaminants while showering

- **Future On-site Rural Resident**
  Soil ingestion
  Inhalation of VOCs or airborne soil particulates
  Dermal contact
  External exposure to ionizing radiation
  Ingestion of groundwater
  Inhalation of VOCs released from groundwater while showering
  Dermal contact with groundwater contaminants while showering
  Exposure to contaminated biota (i.e., garden vegetables)

- **Future Excavation Worker**
  Soil ingestion
  Inhalation of VOCs or airborne soil particulates
  Dermal contact
  External exposure to ionizing radiation

- **Future Recreational User**
  Ingestion of game species including deer, rabbit, and quail

The total ELCR values calculated using default exposure factors were > 1.0E-04 for all receptor scenarios except the recreational user. The total HI values calculated using default factors were > 1 for all scenarios. Total ELCR values calculated for the recreational user were within the 1.0E-04 to 1.0E-06 range.

F.1.2.1 Lead

The risk characterization for systemic toxicity (noncarcinogenic effects) determined that use of the provisional KDEP lead RfD resulted in a total exposure that was attributed primarily to lead exposure. Chemical-specific hazard quotients (HQs) indicated that the systemic toxicity calculated for lead overwhelmed the systemic toxicity calculated for other COPCs and, as a result, other COPCs' additive effect to the total exposure became negligible (i.e., the lead HQ was far greater than any other chemical-specific HQ). To gain greater perspective and allow better interpretation of the estimated noncarcinogenic hazard, quantitative results without lead included as a COPC were presented in the uncertainty discussion of the BHHRA. Results of the IEUBK modeling effort, conducted for the future on-site child resident, suggested that combined exposure to concentrations of lead in soil and groundwater at SWMU 7 or at SWMU 30 would result in an unacceptable probability (>5 percent) of the child blood lead level exceeding EPA's 10 µg/dL criterion (EPA 1991).

Results for the South Ditch suggested that lead is not a health concern for the child resident. Lead was not a soil COPC in the North Ditch. Representative concentrations of lead in soil and water also were compared to KDEP and EPA screening values (refer to Table 1.71 of Appendix A, Volume II of the WAG 22, SWMUs 7 and 30 RI). At SWMUs 7 and 30, representative concentrations of lead in surface and subsurface soil were greater than the KDEP value of 20 mg/kg, but less than the EPA value of 400 mg/kg. Concentrations of lead in groundwater at both SWMUs were greater than the KDEP and EPA criteria of 4 µg/L and 15 µg/L, respectively. Surface-water concentrations in the North and South Ditches and soil/sediment levels of lead in the South Ditch were less than state and federal criteria.

F.1.2.2 Exposure Routes

The dermal contact with soil exposure route poses considerable risk, and most of this risk comes from contact with metals in soil. In fact, for all land use scenarios evaluated, the systemic toxicity and the ELCR posed through the soil dermal exposure route exceeds that posed by the soil ingestion route. This is a direct result of using ABS values that may be too conservative because they exceed gastrointestinal absorption values. This observation indicates that the risk estimates from the dermal exposure route may be unrealistic and exceed the real risk posed by this route of exposure. Although chemical-specific ABS values were used when available, default ABS values were used for most chemicals because chemical-specific values are lacking. Chemical-specific ABS values were available for dioxins, PCBs, cadmium, and carbon disulfide and are used in this BHHRA. Remedial decisions based on the dermal contact with soil exposure route should be carefully considered because of the uncertainty associated with risk from this exposure route.

F.1.2.3 HI and ELCR Discussions

In the next subsections, soil hazards (HI) and ELCRs are compared to *de minimis* levels for each of the scenarios evaluated. Two types of HIs and ELCRs were calculated for this risk assessment and are summarized here. The first is the total HI/ELCR derived using all default exposure values and will be referred to as the default HI/ELCR. The second is the total site-specific or average HI/ELCR without groundwater, with EPA default dermal values, without lead, and without food pathways. These risk and hazard values are referred to as site-specific HI/ELCR. The values that will be discussed are those that exceed *de minimis* levels, HI > 0.1 and ELCR > 1.0E-06.

F.1.2.3.1 Current Industrial Worker

The default HI of 5.0E+03 for SWMU 7 and 4.0E+03 for SWMU 30 exceeded *de minimis* levels. The default ELCR of 4.0E-03 for both SWMUs and the site-specific ELCR, 1.0E-05 for both SWMUs exceeded *de minimis* levels. For both SWMUs 7 and 30, dermal contact with soil is the driving exposure route. The primary contributing COC for ELCR is beryllium, and the primary contributing COC for HI is iron.

F.1.2.3.2 Future Industrial Worker

The default HI of 5.0E+04 for SWMU 7 and 2.0E+04 for SWMU 30 and the site-specific HIs of 3.0E-01 for SWMU 7 and 2.0E-01 for SWMU 30 exceeded *de minimis* levels. The default ELCR of 6.0E-03 for SWMU 7 and 4.0E-03 for SWMU 30 and the site-specific ELCRs of 2.0E-04 for both SWMUs exceeded *de minimis* levels. For SWMU 7, the driving exposure route is dermal contact with soil for ELCR, with beryllium being the primary contributor. The driving exposure route for HI is ingestion of groundwater, and the primary contributor is Aroclor-1254. For SWMU 30, the driving exposure route is dermal contact with soil, with the contributing COCs as beryllium for ELCR and TCE for HI.

F.1.2.3.3 Future On-site Rural Resident

The default HI of 9.0E+05 for SWMU 7 and 5.0E+05 for SWMU 30 and the site-specific HIs of 2.0E+00 for both SWMUs exceeded *de minimis* levels. The default ELCR of 5.0E-02 for SWMU 7 and 4.0E-02 for SWMU 30 and the site-specific ELCRs of 1.0E-03 for SWMU 7 and 8.0E-04 for SWMU 30 exceeded *de minimis* levels. The future child rural resident scenario was evaluated to determine the pathway for HI. The driving pathway for HI is ingestion of vegetables from soil with 1,2-DCE (total) being the primary contributor for SWMU 7 and uranium being the primary contributor for SWMU 30. A combined child and adult rural resident was evaluated to determine the pathway for ELCR. The driving pathway also was ingestion of vegetables from soil, and beryllium was the primary contributor for both SWMUs.

F.1.2.3.4 Future Excavation Worker

The default HI of 7.0E+03 for SWMU 7 and 5.0E+03 for SWMU 30 exceeded *de minimis* levels. Only the default ELCR of 2.0E-03 for SWMU 7 and 1.0E-03 for SWMU 30 exceeded *de minimis* levels. For both SWMUs 7 and 30, the driving pathway was determined to be dermal contact with soil. Beryllium was the primary contributor for ELCR, and iron was the primary contributor for HI.

F.1.2.3.5 Future Recreational User

The default HI of 3.0E+00 for SWMU 7 and 2.0E+00 for SWMU 30 exceeded *de minimis* levels. The default ELCR of 1.0E-05 for both SWMUs exceeded *de minimis* levels. The future adult recreational user scenario was used to determine the pathway for ELCR. HI was not evaluated. The driving pathway for both SWMUs is ingestion of rabbit, and dibenz(a,h)anthracene was the primary contributor.

F.1.2.4 COCs

The COCs were identified in the BHHRA using the approach set forth in the PGDP Risk Methods Document (DOE 2001). The COCs were identified by applying the *de minimis* thresholds to the quantitative risk results for applicable use scenarios including the industrial worker, excavation worker, and off-site rural residential scenarios. A number of COPCs were not evaluated because no toxicity information was available. These COPCs were not retained as COCs in the BHHRA.

Chemicals of concern identified for SWMUs 7 and 30 include VOCs in groundwater; semivolatile organic compounds (SVOCs) in SWMU 7 soil, SWMU 30 soil, and drainage ditch sediments; Aroclor-1260 in SWMU 30 soil and drainage ditch sediments; metals in SWMU 7 soil, SWMU 30 soil, and drainage ditch sediments; and radionuclides in SWMU 7 soil, SWMU 30 soil, groundwater, and drainage ditch sediments. No COCs were identified for surface water in the ditches because surface-water flow in the ditches is intermittent and not available for exposure. The COCs identified are listed below:

VOCs: vinyl chloride;

SVOCs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene;

PCBs: PCB-1260;

Metals: aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, nickel, manganese, uranium, vanadium;

Radionuclides: ^{237}Np, ^{239}Pu, ^{99}Tc, uranium-234 (^{234}U), uranium-235 (^{235}U), uranium-235/236 ($^{235/236}$U), ^{238}U.

Only those pathways with HI > 0.1 or ELCR > 1 x 10^{-6} within a use scenario of concern were identified as an exposure pathway of concern (POC). If an exposure pathway was of concern, each medium involved in that pathway was deemed a medium of concern. Lastly, COCs were identified as those contaminants that had chemical-specific ELCRs summed over all exposure pathways within the use scenario of concern that were greater than or equal to 1 x 10^{-6} or whose HQs summed over all pathways within a use scenario of concern were greater than or equal to 0.1. Refer to the RI report for a complete discussion of POCs and the list of COCs based on this guidance.

F.1.3 RESULTS OF *REMEDIAL INVESTIGATION ADDENDUM FOR WASTE AREA GROUPING 22, BURIAL GROUNDS SOLID WASTE MANAGEMENT UNITS 2 AND 3 AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY*, DOE/OR/07-1141&D2

The following is a summary of the BRA found in the RI Addendum for the WAG 22, Burial Grounds Solid Waste Management Units 2 and 3 (DOE 1994). A complete summary of the BRA result can be found in WAG 22 report and in Tables F2.1 through F2.12 in Attachment F2.

- **Current Industrial Worker**
  Soil ingestion
  Dermal absorption
  Inhalation
  External exposure to ionizing radiation

- **Site-specific Industrial Worker**
  Soil ingestion
  Dermal absorption
  Inhalation
  External exposure to ionizing radiation

- **Future On-site and Off-site Rural Resident**
  Ingestion of groundwater contaminants from groundwater use
  Inhalation of VOCs from groundwater use

The future resident scenario exhibited a total ELCR value calculated using default exposure factors > 1.0E-04. The future resident scenario also exhibited total HIs with default factors > 1. Site-specific and current industrial worker scenarios exhibited total ELCR values that fell between 1.0E-04 and 1.0E-06. The site-specific and current industrial worker scenarios also exhibited HI values > 0.1.

F.1.3.1 Lead

Lead concentrations in soil were not evaluated as part of this investigation as lead toxicity values were not available at the time; however, lead in groundwater was detected above the maximum contaminant levels (MCLs). The IUEBK model was not used to evaluate these scenarios.

F.1.3.2 Exposure Routes

From the evaluation of the standard ELCR, soil ingestion was the driving exposure pathway and from the evaluation of the radiological ELCR, external exposure to ionizing radiation was the driving exposure pathway. Through the HI calculation, dermal absorption was the driving exposure pathway. The dominant driving exposure pathway for groundwater was ingestion of groundwater. Remedial decisions based on the dermal absorption exposure route should be carefully considered because of the uncertainty associated with risk from this exposure route.

F.1.3.3 HI and ELCR Discussions

In the next subsections soil hazards (HI) and ELCRs are compared to *de minimis* levels for each of the scenarios evaluated. The values that are discussed are those that exceed *de minimis* levels, HI > 0.1 and ELCR > 1.0E-06. The chemical ELCR and radiological ELCR are presented separately in the original document and each is compared to the *de minimis* level of 1.0E-06. The HI is compared to the *de minimis* level of 0.1.

F.1.3.3.1 Current Industrial Worker

The standard ELCR, 5.0E-06, exceeded *de minimis* levels and arsenic was the primary contributing COC. The driving exposure pathway was soil ingestion. The radiological ELCR, 1.0E-04, exceeded *de minimis* level, with ^{235}U being the primary contributor. The driving exposure pathway was external exposure to ionizing radiation. The HI did not exceed *de minimis* levels with a result of 0.07, and the driving exposure pathway was dermal absorption.

F.1.3.3.2 Site-specific Industrial Worker

The standard ELCR, 5.0E-07, did not exceed *de minimis* level with arsenic being the primary contributor. The driving exposure pathway was soil ingestion. The radiological ELCR, 1.0E-05, did exceed *de minimis* level, with ^{235}U being the primary contributor. The driving exposure pathway was external exposure to ionizing radiation. The HI did not exceed *de minimis* at a result of 0.07, and the driving exposure pathway was dermal absorption.

F.1.3.3.3 Future On-site and Off-site Rural Resident

The standard ELCR of 2.0E-03 exceeded *de minimis,* with N-nitroso-di-n-propylamine being the primary contributor. The radiological ELCR of 1.0E-05 exceeded *de minimis* with the primary contributor as ^{99}Tc. The HI exceeded de minimis and the primary contributor was manganese. The dominant exposure pathway was ingestion of groundwater.

F.1.3.4 COCs

The chemicals of concern were identified in the BHHRA using the approach set forth in the PGDP Risk Methods Document. The COCs were identified as those contaminants that had chemical-specific ELCRs summed over all exposure pathways within the use scenario of concern that were greater than or equal to 1×10^{-6} or whose HQs summed over all pathways within a use scenario of concern were greater than or equal to 0.1 for any of the scenarios evaluated: industrial worker, excavation worker, and off-site rural residential scenarios. A number of COPCs were not evaluated because no toxicity information was available. These COPCs were not retained as COCs in the BHHRA. The COCs identified are as listed below:

VOCs: TCE

Metals: arsenic, barium, beryllium, cadmium, chromium, manganese, nickel, silver, thallium, vanadium, uranium (total)

Radionuclides: ^{99}Tc.

Refer to the RI report for a complete discussion of POCs and the list of COCs based on this guidance.

F.1.4 *DATA SUMMARY AND INTERPRETATION REPORT FOR INTERIM REMEDIAL DESIGN AT SOLID WASTE MANAGEMENT UNIT 2 OF WASTE AREA GROUP 22 AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY*, DOE/OR/07-1549&D1

F.1.4.1 Screening Approach

This document presents a screening risk assessment for SWMU 2 based on an updated CSM, but, unlike the other documents summarized here, has no BRA. The preliminary remediation goals (PRGs) used for the screening were the residential and industrial PRGs from the 2001 Risk Assessments Methods document. The PRGs for groundwater were based on residential use. A summary of the COPCs from the comparison to PRGs presented in this document is detailed here.

F.1.4.2 Comparison to Industrial PRGs (based on HQ=1 and risk =1E-04)

Sediment COPCs:

- Arsenic, iron, and vanadium
- Cesium-137 (^{137}Cs), ^{235}U, ^{238}U, ^{239}Pu

Surface soil COPCs:

- Arsenic, beryllium, manganese, and vanadium
- PCBs
- ^{235}U and ^{238}U

F.1.4.3 Residential comparison to PRGs

Groundwater (RGA):

- All inorganic chemicals which were SAP analytes (particularly arsenic, beryllium, manganese)
- *trans*-1,2-DCE
- ^{238}U, ^{99}Tc, ^{239}Pu, ^{237}Np, and Americium-241 (^{241}Am)

Because this was a screening assessment, the process stopped at COPC selection and no additional determination of COCs was made in this document.

F.2. IDENTIFICATION OF COPCS

This subsection describes the process used to determine the list of COPCs used in the BHHRA. Specifically, this subsection describes the sources of data, the procedures used to screen the data, and the methods used to derive exposure point concentrations (EPCs) under both current and future conditions. Additionally, this section describes the site characterization data used in the exposure assessment performed in Section F.3.

F.2.1 SOURCES OF DATA

Data used in the BHHRA describing current contaminant concentrations in surface and subsurface soil and groundwater at SWMUs 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145 were derived from the recently completed BGOU RI sampling, as well as historical data acquired from the PGDP Oak Ridge Environmental Information System (OREIS) database. The nature and extent of contamination in subsurface soil is described in Section 4 of this RI. Attachment F4 to this appendix contains the nature and extent of contamination in the surface soil used in the risk assessment.

F.2.2 GENERAL DATA EVALUATION CONSIDERATIONS

This section describes the data evaluation steps that were used to ensure that the groundwater data were appropriate for use in BHHRAs. A general description of the seven steps used and their outcome in relation to the BGOU RI BHHRA data set is provided in this section. A graphical presentation of this process is shown in Figure F.2.

F.2.2.1 Evaluation of Sampling

Data were examined to ensure that sampling methods were adequate for determining the nature and extent of contamination and were representative of site conditions. It was determined that samples of the BGOU RI and those selected from the PGDP OREIS database were collected using appropriate methods that were consistent with each project's work plan.

F.2.2.2 Evaluation of Analytical Methods

Methods used to collect and analyze the selected groundwater and subsurface soil samples were evaluated to determine if they were those approved by EPA. As described in work plans and project reports, the analytical methods used for surface and subsurface soil samples and groundwater samples meet these requirements.

F.2.2.3 Evaluation of Sample Quantitation Limits

The sample quantitation limits (SQLs) used in the analyses of the selected soil and groundwater samples were examined to determine if these limits were below the concentration at which the contaminant may pose a risk to human health. Generally, the SQLs for each analyte met this goal. Table F.1 presents a comparison between each undetected analyte's maximum SQLs for soil for the complete BGOU data set and the analyte's residential use no action screening value. As shown in that table, acrolein and Cobalt-60 have SQLs that exceed their screening value. The implications of this finding upon risk characterization (presented in this BHHRA) are discussed in Section 6.

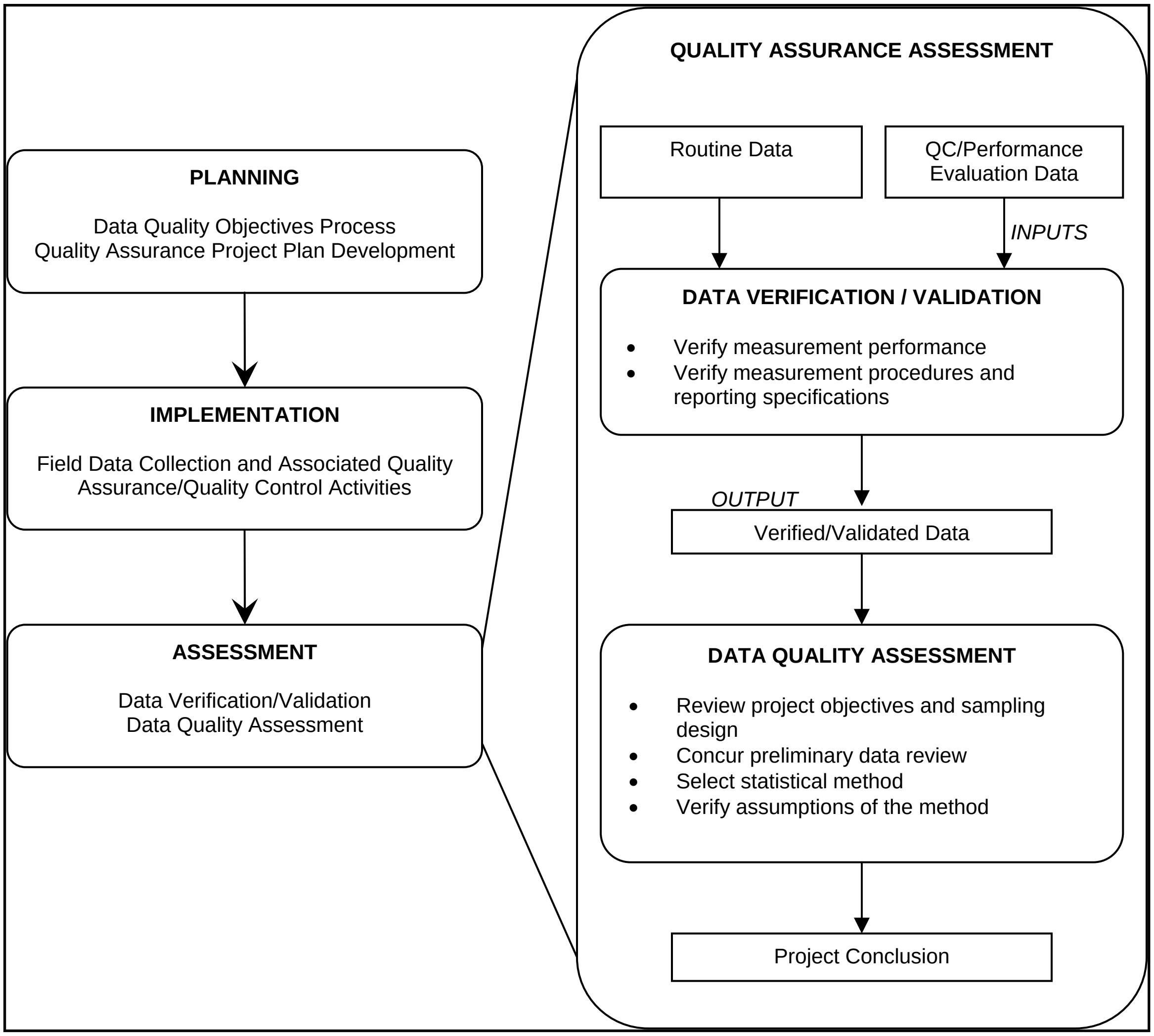

Figure F.2. Data Evaluation Steps

Table F.1. Comparison Between Undetected Analyte's Maximum SQLs and Residential Use No Action Screening Value for Water Use[a]

Analyte	Frequency of Detection[b]	Maximum SQL	HI-based No Action Screening Value[c]	ELCR-based No Action Screening Value[c]	HI Screening Value Exceeded?	ELCR Screening Value Exceeded?	Units
Organic Compounds							
1,1,1-TCA	0/14	5.0E-03	2.32E+01	na	No	No	mg/kg
1,1,2,2-Tetrachloroethane	0/49	5.0E-03	1.99E+01	1.04E+02	No	No	mg/kg
1,1,2-TCA	0/49	5.0E-03	1.42E+00	7.13E+00	No	No	mg/kg
1,2,3-Trichloropropane	0/46	5.0E-03	4.13E-01	2.01E+00	No	No	mg/kg
1,2-Dibromo-3-chloropropane	0/41	5.0E-03	4.09E-02	2.15E-01	No	No	mg/kg
1,2-Dibromoethane	0/55	5.0E-03	4.80E+01	2.74E+01	No	No	mg/kg
1,2-Dichloropropane	0/55	5.0E-03	4.00E+01	na	No	No	mg/kg
1,2-Dimethylbenzene	0/5	5.0E-03	2.32E+01	na	No	No	mg/kg
2-Chloroethyl vinyl ether	0/5	5.0E-03	na	na	No	No	mg/kg
2-Hexanone	0/49	5.0E-03	na	na	No	No	mg/kg
4-Methyl-2-pentanone	0/49	5.0E-03	na	na	No	No	mg/kg
Acrolein	0/46	5.0E-03	4.29E-03	na	Yes	No	mg/kg
Acrylonitrile	0/46	5.0E-03	2.72E-01	na	No	No	mg/kg
Bromoform	0/49	5.0E-03	3.68E+01	na	No	No	mg/kg
Carbon disulfide	0/39	5.0E-03	1.57E+01	na	No	No	mg/kg
Chlorobenzene	0/49	5.0E-03	4.47E+01	na	No	No	mg/kg
Chloroethane	0/49	5.0E-03	na	na	No	No	mg/kg
Dibromomethane	0/46	5.0E-03	4.09E-02	na	No	No	mg/kg
Dichlorodifluoromethane	0/46	5.0E-03	5.20E+00	3.28E+02	No	No	mg/kg
Ethyl methacrylate	0/46	5.0E-03	9.97E+01	na	No	No	mg/kg
Ethylbenzene	0/46	5.0E-03	6.33E+01	na	No	No	mg/kg
Styrene	0/49	5.0E-03	1.28E+02	na	No	No	mg/kg
Total Xylene	0/44	1.0E-03	1.07E+02	9.47E+01	No	No	mg/kg
trans-1,4-Dichloro-2-butene	0/46	5.0E-03	na	na	No	No	mg/kg
Trichlorofluoromethane	0/46	5.0E-03	1.93E+02	na	No	No	mg/kg
Vinyl acetate	0/10	5.0E-03	2.13E+01	1.04E+02	No	No	mg/kg
Radionuclides							
Cobalt-60	0/72	1.0E-02	na	2.63E-03	No	Yes	pCi/g

[a] Results shown are over all soil samples collected within the boundary of the BGOU.
[b] Number of detected results over total number of samples used in the BHHRA.
[c] Risk-based screening values are taken from Appendix A of the Risk Methods Document. The HI-based value is that for the child resident. The ELCR-based value is that for lifetime exposure. HI and ELCR target values used for the screening values are 0.1 and 1×10^{-6}, respectively.
"na "= no screening level available

Consistent with the Risk Methods Document, if the maximum SQL for an analyte over all samples within a medium exceeded the no action screening value, then the data for that analyte was deemed of uncertain quality, and a qualitative assessment for that analyte was performed. In developing the qualitative assessment for such chemicals, the maximum SQL for the chemical is used in the qualitative assessment if historical or process knowledge indicated that the chemical potentially could be present. If historical or process knowledge indicates that the chemical is not expected to be present, one-half of the SQL is used in the qualitative assessment (EPA 1991). The qualitative analysis is presented in Section 6.

F.2.2.4 Evaluation of Data Qualifiers and Codes

The soil and groundwater data used in the BHHRA were tagged with various qualifiers and codes. Tagged data were evaluated following rules in Exhibits 5-4 and 5-5 of the Risk Assessment Guidance for Superfund (RAGS). Generally, this resulted in the retention of all results for which the identity of the analyte was certain even if there was substantial uncertainty in the analyte concentration within an individual sample. The qualifiers and codes attached to the soil data used in the BHHRA are defined in Table F.2 (Note: consistent with the Risk Methods Document, radionuclides with negative activity values were used in the calculation of EPCs in this BHHRA.)

F.2.2.5 Elimination of Chemicals Not Detected

Consistent with the Risk Methods Document, any analyte passing the earlier screens and not detected in at least one sample using an appropriate SQL was eliminated from the data set. These data are not considered further in this BHHRA.

F.2.2.6 Examination of Toxicity of Detected Analytes

Each analyte's maximum detected concentration in the data set was compared to that analyte's residential use no action human health risk-based screening value for soil in the Risk Methods Document. Consistent with the Risk Methods Document, this screen was not applied to those analytes known to accumulate significantly in biota (i.e., not used for analytes with a bioaccumulation factor for fish greater than 100).

F.2.2.7 Examination of Analyte Maximum Concentrations for Essential Human Nutrients Detected in Site Samples to Recommended Dietary Allowances for Children

Seven analytes known to be essential nutrients and known to be toxic only at extremely high concentrations were removed from the groundwater data set. These analytes were calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium. Consistent with the Risk Methods Document, no other analytes were removed from the data set based upon the essential nutrient screen.

F.2.2.8 Comparison of Analyte Maximum Concentrations and Activities Detected in Site Samples to Analyte Concentrations and Activities Detected in Background Samples

Consistent with the 2008 revision[1] to the Risk Methods Document, a background screen was used to develop the BHHRA data set. Table F.3 shows the current PGDP background concentration for surface and subsurface soils used in the screening process.

F.2.3 RISK ASSESSMENT SPECIFIC DATA EVALUATION

This section discusses details associated with building the surface dataset, the subsurface dataset, and groundwater modeling data set used to examine current and future risks to human health presented in this BHHRA.

F.2.3.1 Current Conditions

The specific processes used to evaluate data and calculate EPCs under current conditions are described in this section. The analyte's names were checked to ensure that names and Chemical Abstract Services (CAS) numbers were uniform. This activity was performed so that the analyte names and CAS numbers in the data set matched those used in the PGDP toxicity database presented in the Risk Methods Document.

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[1] The 2001 Risk Methods document is undergoing revision during 2007 and 2008. The new version has not received final approval, but the values and methods in the new draft version are consistent with state and federal guidance and were developed by consensus by a Risk Assessment Working Group (RAWG) that included representatives from EPA, KDEP, and DOE.

Table F.2. Definitions of Qualifiers and Codes Present in the OREIS Data Set Used for the BHHRA of the Groundwater Samples from the Burial Grounds Operable Unit Remedial Investigation

Qualifier	Definition	Data Used?
Field = RSLT_PRE (Result Prefix Qualifier)		
Blank	Result not qualified.	Yes
<	The actual value is below the instrument detection limit.	Yes
Field = VALIDATI (Validation Qualifier)		
Blank	Result not qualified.	Yes
=	Validated result that is detected and unqualified.	Yes
DJ	Detected above the reported detection limit, the reported detection limit is approximated due to quality deficiency; Positively identified, the associated numerical value is the approximate concentration of the analyte in the sample.	
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.	Yes
R	Result rejected due to quality deficiency.	No
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.	Yes
UJ	The analyte, compound, or radionuclide was not detected above the reported detection limit, and the reported detection limit is approximated due to quality deficiency.	Yes
X	Not validated; refer to RSLTQUAL field for more information.	Yes
XV	Not validated; refer to RSLTQUAL field for more information.	Yes
Field = RSLTQUAL (Result Qualifier)		
Blank	Result not qualified.	Yes
*	Duplicate analysis is not within control limits.	Yes
A	SVOA/VOA: TIC (Tentatively Identified Compound) was suspected aldol condensation product; PPCB/SVOA/VOA: Suspected aldol-condensation product (pre-05/30/03 definition); RADS: Analyzed but not detected at the analyte quantitation limit.	Yes
B	Inorganic: The result is less than the project contract required detection limit, but greater than the instrument detection limit.	Yes
D	Identified at secondary dilution.	Yes
E	Inorganic: Estimated value; matrix interference.	Yes
	Organic: Concentration exceeds calibration range of gas chromatograph/mass spectrometer.	Yes
J	Estimated value, tentatively identified compound, or less than specified detection limit.	Yes
M	METAL: Duplicate injection precision not met; RADS: Matrix Spike recovery is < 80% or > 120% (pre-05/30/03 definition).	Yes
N	Inorganic: Spike recovery not within control limits.	Yes
	Organic: Applied to TIC results, except generic characteristics.	Yes
T	Tracer recovery is less than 20% or greater than 105%.	Yes
U	Not detected.	Yes
W	METAL: Post-digestion spike for atomic absorption out of control limit.	Yes
X	Flag one; defined in COMMENTS field.	Yes
Y	Chemical yield exceeds acceptance limits; Organic: matrix spike, matrix spike duplicate recovery, and/or relative percent difference failed acceptance criteria.	Yes

Table F.3. Provisional Background Concentrations for Surface and Subsurface Soil at PGDP

Analyte	Background Value[b]	
	Surface	Subsurface
Inorganic Chemicals (mg/kg)[a]		
Aluminum	13,000	12,000
Antimony	0.21	0.21
Arsenic	12	7.9
Barium	200	170
Beryllium	0.67	0.69
Cadmium	0.21	0.21
Calcium	200,000	6,100
Chromium (III)	16	43
Cobalt	14	13
Copper	19	25
Cyanide (CN^-)[c]	---	---
Iron	28,000	28,000
Lead	36	23
Magnesium	7,700	2,100
Manganese	1,500	820
Mercury	0.2	0.13
Nickel	21	22
Potassium	1,300	950
Selenium	0.8	0.7
Silver	2.3	2.7
Sodium	320	340
Sulfide[d]	---	---
Thallium	0.21	0.34
Tin[d]	---	---
Uranium	4.9	4.6
Vanadium	38	37
Zinc	65	60
Radionuclide (pCi/g)		
Cesium-137	0.49	0.28
Neptunium-237[e]	0.1	---
Plutonium-238[e]	0.073	---
Plutonium-239[e]	0.025	---
Potassium-40	16	16
Radium-226	1.5	1.5
Strontium-90[e]	4.7	---
Technetium-99	2.5	2.8
Thorium-228	1.6	1.6
Thorium-230	1.5	1.4
Thorium-232	1.5	1.5
Uranium-234	2.5	2.4
Uranium-235	0.14	0.14
Uranium-238	1.2	1.2

Table F.3 Provisional Background Concentrations for Surface and Subsurface Soil at PGDP (Continued)

Notes:	Cells with dashes (---) indicate data are not available or not applicable. Values contained in this table have not been approved for all uses by the Risk Assessment Working Group. Therefore, the values presented here are provisional values and subject to change. Issues to be resolved in forthcoming meetings include the data set from which these values were derived and the statistical methods used to analyze the data set.
a	Includes inorganic chemicals found on Target Analyte List as defined by EPA in 1988 CLP Statement of Work and Resource Conservation and Recovery Act (RCRA) Appendix IX list of constituents.
b	Value for use in screening to determine if inorganic chemical or radionuclide detected at naturally occurring concentration in surface or subsurface soil. Details on the derivation of the background concentrations for antimony, beryllium, cadmium, thallium, uranium, and all radionuclides are in DOE 2001. Details on the derivation of the background concentration for all other inorganic chemicals are in DOE 2001.
c	Cyanide is not expected to be naturally occurring in soil at PGDP; background values were not derived.
d	Data are not adequate to calculate a background concentration in soil for this analyte.
e	Concentrations for these radionuclides in subsurface soil were not derived.

F.2.3.2 Evaluation of Concentrations for Soil

The following describes the processes that were used in the surface and subsurface COPC selection. For this screening and the subsequent BRA, surface soil was defined as 0–1 ft bgs and subsurface soil was defined as 0–10 ft bgs. All surface samples at the sites were evaluated together as soil whether the sample came from the SWMU surface or the surrounding ditches.

- *Convert units of measure to a consistent basis.* The units of measure used for analyte classes (i.e., inorganic chemicals, organic compounds, and radionuclides) were assigned consistent units of measure. The units of measure used were mg/kg for inorganic chemicals and organic compounds and pCi/g for radionuclides. This activity was performed so that the units of measure in the data set matched those found in the equations that are used to calculate CDIs as part of the BHHRA.

- *Categorize all sample results as detects or nondetects.* Each result was coded either detected or nondetected based upon the data qualifier codes present in the data set. Any data assigned a "U" or "UJ" qualifier was considered to be nondetected. This coding subsequently was used to calculate the frequency of detection statistics and to assign surrogate values to results listed as nondetects.

- *Analyze duplicate samples.* Duplicate samples were available for some sample analyses. In cases where the value from the original sample and its duplicate were both detected values, the greater of the results from the original sample and its duplicate was retained in the data set. In cases where one value was a detected value and the other was a nondetect, the detected value was retained in the data set. Finally, when both values were listed as nondetects, the lesser of the two values was retained in the data set.

- *Compare maximum detected concentrations to human health screening values.* The maximum detected result for each analyte within an area (i.e., SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145) was compared to no action level (NAL) screening values for soil use as part of the toxicity screen. Analytes with a maximum detected value less than the analyte's NAL were not retained as COPCs. The values used to screen surface soil were the direct contact residential child NAL values taken from Appendix A of the 2001 Risk Methods Document. The KDEP screening levels for lead previously used as the NALs no longer are in effect; therefore, the EPA residential screening levels for lead in soil (400 mg/kg) was used to screen lead to determine if it is a COPC. To screen the subsurface soil for the excavation worker the maximum detected value was compared to the excavation worker NALs from the 2001 Risk Methods Document. As described in Appendix B of the Risk Methods Document, the excavation worker NALs are considered appropriate for screening subsurface soil within the industrialized area at PGDP. These values also are considered appropriate for receptors with high soil exposure, such as maintenance workers. For all scenarios, PCBs and PAHs were screened and evaluated in the BHHRA using the Total PCB values and Total PAH values calculated following the Risk Methods Document.

- *Compare maximum detected concentrations to PDGP background soil levels for metals and radionuclides.* The maximum detected result for each analyte within an area (i.e., SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145) was compared to the background levels of metals and radionuclides that have been negotiated with the EPA and the Kentucky Natural Resources and Environmental Protection Cabinet. (Surface background levels were used for all but the excavation worker where subsurface background levels were used for screening.) Analytes with a maximum detected value less than the analyte's associated background value are not retained as COPCs. The background concentrations used for screening are shown above in Table F.3

- If the number of detections in a sample set is less than 5% of the total number of analyses, then the analyte is not considered a COPC provided that the data set is adequate to characterize the site.

- *Remove essential nutrients from the data sets.* Results for the seven essential nutrients listed earlier were removed from the data sets.

- *Remove protactinium-234m (^{234m}Pa), potassium-40 (^{40}K), and thorium-234 (^{234}Th) from the data sets.* All results for ^{234m}Pa were removed to prevent double-counting its contribution to cancer risk through use of a toxicity value for ^{238}U that includes its short-lived progeny. All ^{40}K and ^{234}Th results were removed to be consistent with the Risk Methods Document and earlier BHHRAs prepared for PGDP.

Analytes retained as COPCs under current conditions are presented for each SWMU in Tables F.4 through F.18. These tables include a listing of all detected analytes in soil samples. In addition to the analyte's name, human health risk-based screening value, and background value, each table also contains the analyte's frequency of detection, whether it was chosen as a COPC, and a footnote indicating the basis for exclusion (if applicable). The last column lists the EPC for use in the risk and hazard calculation. The EPC is determined consistent with the Risk Methods Document currently under revision. If more than 9 samples of an analyte were determined to be detects, then all the data (detects and nondetects) were entered into ProUCL and the best fit 95% upper confidence limit (UCL) was determined and used for the risk and hazard calculations. When 9 or fewer of the samples were detect, then the maximum concentration in the data set was used for the calculations.

F.2.3.3 Evaluation of Modeled Concentrations for Groundwater

Groundwater modeling was done in a similar manner as the process described above for surface/subsurface soil except, that the soil screening levels (SSLs) calculated using PGDP NALs were used for screening instead of a residential NAL. SSLs are risk-based soil concentrations considered to be protective of groundwater (DOE 2001). Analytes retained as COPCs under current conditions are presented for each SWMU in Tables F.19 through F.26. Selected analytes then were modeled as described in Section 5 of the main text and Appendix E.

After the modeling was completed, the calculated analyte concentration in the RGA groundwater was compared to the resident child NAL from the 2001 Risk Methods Document and the provisional groundwater backgrounds shown in the 2001 Risk Method Document in Table A.13. Analyte concentrations in groundwater that exceeded both the NAL and background values then were carried through the risk assessment and risk and hazards were calculated for the Rural Resident Groundwater User at the following locations: at the SWMU boundary, at the plant boundary, at the property boundary, at the Little Bayou Seeps (when particle modeling showed a contribution to the seep), and at a well located near the Ohio River.

This risk assessment uses the modeled groundwater concentrations at all points of exposure (POEs). A screening of measured concentrations in the groundwater against NALs and action levels is presented in Appendix E of the BGOU work plan. A list of COCs from that screening of measured groundwater is reproduced in Section F. 7.4.3.

Table F.4. Summary of COPC Screening for Detected Analytes – SWMU 2 Surface Soils COPCs

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.10E+04	7.32E+02	1.30E+04	mg/kg	3	3	N[B]	
Antimony	5.00E-01	6.35E-02	2.10E-01	mg/kg	3	1	Y	5.00E-01
Arsenic[I]	3.00E+01	1.32E-01	1.20E+01	mg/kg	3	3	Y	3.00E+01
Barium	1.60E+02	3.70E+01	2.00E+02	mg/kg	3	3	N[B]	
Beryllium	1.80E+00	1.60E-01	6.70E-01	mg/kg	4	4	Y	1.80E+00
Cadmium	4.50E-01	2.64E+00	2.10E-01	mg/kg	3	2	N[A]	
Calcium	5.60E+03	NA[C]	2.00E+05	mg/kg	3	3	N[D]	
Chromium[I]	3.00E+01	6.05E+01	1.60E+01	mg/kg	4	4	N[A]	
Cobalt	1.10E+01	2.09E+02	1.40E+01	mg/kg	3	3	N[A,B]	
Copper	3.00E+01	6.81E+01	1.90E+01	mg/kg	3	3	N[A,B]	
Iron	4.20E+04	3.14E+02	2.80E+04	mg/kg	3	3	Y	4.20E+04
Lead	2.90E+01	4.00E+02[F]	3.60E+01	mg/kg	3	3	N[A,B]	
Magnesium	1.60E+03	NA[C]	7.70E+03	mg/kg	3	3	N[D]	
Manganese	5.40E+02	7.46E+00	1.50E+03	mg/kg	3	3	N[B]	
Mercury[I]	4.30E-01	1.58E-01	2.00E-01	mg/kg	4	2	Y	4.30E-01
Nickel[I]	3.70E+01	3.40E+01	2.10E+01	mg/kg	3	3	Y	3.70E+01
Potassium	1.00E+03	NA[C]	1.30E+03	mg/kg	3	3	N[D]	
Selenium	1.70E+00	1.21E+01	8.00E-01	mg/kg	3	3	N[A]	
Sodium	1.80E+02	NA[C]	3.20E+02	mg/kg	3	3	N[D]	
Thallium	4.50E+00	NA[C]	2.10E-01	mg/kg	3	3	Y	4.50E+00
Uranium	2.80E+02	2.16E+00	4.90E+00	mg/kg	3	3	Y	9.43E+02
Vanadium	3.40E+01	5.62E-01	3.80E+01	mg/kg	3	3	N[B]	
Zinc	1.40E+02	4.01E+02	6.50E+01	mg/kg	3	3	N[A]	
PCB-1260	5.00E-01	5.74E-02	NA	mg/kg	4	3	Y	5.00E-01
2-Methylnaphthalene	6.90E-01	NA[C]	NA	mg/kg	3	2	Y	6.90E-01
4-Methylphenol	6.10E-02	NA[C]	NA	mg/kg	3	1	N[C]	
Benz(a)anthracene	1.30E-01	6.70E-02	NA	mg/kg	3	2	N[A]	
Benzo(a)pyrene	1.40E-01	6.70E-03	NA	mg/kg	3	1	Y	1.40E-01

Table F.4. Summary of COPC Screening for Detected Analytes – SWMU 2 Surface Soils COPCs (Continued)

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Benzo(b)fluoranthene	2.70E-01	6.70E-02	NA	mg/kg	3	2	Y	2.70E-01
Benzo(ghi)perylene	1.50E-01	NA[C]	NA	mg/kg	3	1	Y	1.50E-01
Chrysene	1.70E-01	6.700E+00	NA	mg/kg	3	2	Y	
Dibenzofuran	1.80E-01	2.93E+00	NA	mg/kg	3	2	N[A]	
Fluoranthene	3.40E-01	3.430E+01	NA	mg/kg	3	2	N[A]	
Naphthalene	3.60E-01	3.47E+00	NA	mg/kg	3	2	N[A]	
Phenanthrene	5.70E-01	NA[C]	NA	mg/kg	3	3	N[C]	
Pyrene	2.90E-01	2.57E+01	NA	mg/kg	3	2	N[A]	
Total PAHs[G]	1.80E-01	6.70E-03	NA	mg/kg	NA[E]	NA	Y	1.80E-01
Total PCBs[H,I]	1.10E+00	5.74E-02	NA	mg/kg	NA[E]	NA	Y	1.60E+00
Americium-241	8.70E-01	8.36E-01	NA	pCi/g	8	8	**Y**	8.70E-01
Cesium-137	5.10E+01	1.28E-02	4.90E-01	pCi/g	8	8	**Y**	5.10E+01
Neptunium-237	3.10E-01	4.05E-02	1.00E-01	pCi/g	8	8	**Y**	3.10E-01
Plutonium-239	1.61E+01	2.22E+00	2.50E-02	pCi/g	8	8	**Y**	1.61E+01
Technetium-99	1.46E+01	6.74E+01	2.50E+00	pCi/g	8	8	**N[A]**	
Thorium-230	1.59E+01	2.85E+00	1.50E+00	pCi/g	8	8	**Y**	1.59E+01
Uranium-234	5.19E+01	3.81E+00	2.50E+00	pCi/g	8	8	**Y**	2.53E+01
Uranium-235/236	7.70E+00	5.91E-02	1.40E-01	pCi/g	8	8	**Y**	7.70E+00
Uranium-238	3.14E+02	2.61E-01	1.20E+00	pCi/g	8	8	**Y**	3.02E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.5. Summary of COPC Screening for Detected Analytes – SWMU 2 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.10E+04	5.25E+03	1.20E+04	mg/kg	5	5	**N[B]**	
Antimony	5.00E-01	4.92E-01	2.10E-01	mg/kg	5	1	**Y**	5.00E-01
Arsenic[I]	3.00E+01	3.24E-01	7.90E+00	mg/kg	5	5	**Y**	3.00E+01
Barium	1.60E+02	2.72E+02	1.70E+02	mg/kg	5	5	**N[A,B]**	
Beryllium	1.80E+00	1.26E+00	6.90E-01	mg/kg	5	3	**Y**	1.80E+00
Cadmium	4.50E-01	1.52E+01	2.10E-01	mg/kg	5	2	**N[A]**	
Calcium	1.42E+03	NA[C]	6.10E+03	mg/kg	2	2	**N[D]**	
Chromium[I]	3.00E+01	4.76E+02	4.30E+01	mg/kg	5	5	**N[A,B]**	
Cobalt	1.10E+01	1.11E+03	1.30E+01	mg/kg	5	4	**N[A,B]**	
Copper	3.00E+01	4.27E+02	2.50E+01	mg/kg	5	5	**N[A]**	
Iron	4.20E+04	2.17E+03	2.80E+04	mg/kg	5	5	**Y**	4.20E+04
Lead	2.90E+01	4.00E+02[F]	2.30E+01	mg/kg	5	5	**N[A]**	
Magnesium	1.60E+03	NA[C]	2.10E+03	mg/kg	5	5	**N[D]**	
Manganese	5.40E+02	5.66E+01	8.20E+02	mg/kg	5	5	**N[A,B]**	
Mercury[I]	4.30E-01	1.17E+00	1.30E-01	mg/kg	5	3	**N[A]**	
Nickel[I]	3.70E+01	2.16E+02	2.20E+01	mg/kg	5	5	**N[A]**	
Potassium	1.00E+03	NA[C]	9.50E+02	mg/kg	3	3	**N[D]**	
Selenium	1.70E+00	7.13E+01	7.00E-01	mg/kg	5	3	**N[A]**	
Sodium	4.45E+02	NA[C]	3.40E+02	mg/kg	5	4	**N[D]**	
Thallium	4.50E+00	NA[C]	3.40E-01	mg/kg	5	3	**Y**	4.50E+00
Uranium	2.80E+02	1.130E+01	4.60E+00	mg/kg	5	4	**Y**	2.80E+02
Vanadium	3.40E+01	4.40E+00	3.70E+01	mg/kg	5	5	**N[B]**	
Zinc	1.40E+02	2.66E+03	6.00E+01	mg/kg	5	4	**N[A]**	
Total PCBs[H,I]	9.00E-02[K]	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	4.70E+00
Benzo(a)pyrene	1.40E-01	2.32E-02	NA	mg/kg	3	1	**Y**	1.40E-01
Benzo(a)anthracene	1.30E-01	2.32E-01	NA	mg/kg	3	1	**N[A]**	
Benzo(b)fluoranthene	2.70E-01	2.32E-01	NA	mg/kg	3	2	**Y**	2.70E-01
Benzo(ghi)perylene	1.50E-01	NA[C]	NA	mg/kg	3	1	**N[A]**	
Chrysene	1.70E-01	2.32E+01	NA	mg/kg	3	2	**N[A]**	
Fluoranthene	3.40E-01	2.42E+02	NA	mg/kg	3	2	**N[A]**	
Phenanthrene	5.70E-01	NA[C]	NA	mg/kg	3	2	**N[C]**	
Total PAHs[G]	1.80E-01	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	**1.80E-01**
Dibenzofuran	1.80E-01	2.10E+01	NA	mg/kg	3	2	**N[A]**	
Americium-241	8.70E-01	1.74E+00	NA	pCi/g	51	47	**N[A]**	
Cesium-137	5.10E+01	1.15E-01	2.80E-01	pCi/g	51	15	**Y**	1.51E+01
Neptunium-237	3.10E-01	3.28E-01	NA	pCi/g	52	47	**N[A]**	
Plutonium-239	1.61E+01	1.63E+00	NA	pCi/g	52	45	**Y**	4.34E+00
Technetium-99	1.46E+01	5.79E+01	2.80E+00	pCi/g	52	45	**N[A]**	
Thorium-230	1.59E+01	2.22E+00	1.40E+00	pCi/g	50	50	**Y**	3.26E+00
Uranium-234	1.55E+02	2.84E+00	2.40E+00	pCi/g	52	49	**Y**	2.85E+01
Uranium-235/236	2.58E+01	4.55E-01	1.40E-01	pCi/g	46	46	**Y**	9.51E+00
Uranium-238	9.47E+02	1.17E+00	1.20E+00	pCi/g	52	49	**Y**	3.34E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[K] Value represents method detection limit as there were no detections for Total PCB in accordance with the PGDP Risk Methods Document (2001)

Table F.6. Summary of COPC Screening for Detected Analytes – SWMU 3 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	8.57E+03	7.32E+02	1.30E+04	mg/kg	6	6	N[B]	
Antimony	1.57E+01	6.35E-02	2.10E-01	mg/kg	6	4	Y	1.57E+01
Arsenic[I]	7.62E+00	1.32E-01	1.20E+01	mg/kg	6	6	N[B]	
Barium	8.77E+01	3.70E+01	2.00E+02	mg/kg	6	6	N[B]	
Calcium	3.52E+04	NA[C]	2.00E+05	mg/kg	6	5	N[D]	
Chromium[I]	1.25E+01	6.05E+01	1.60E+01	mg/kg	6	6	N[A,B]	
Cobalt	6.41E+00	2.09E+02	1.40E+01	mg/kg	6	6	N[A,B]	
Copper	1.06E+01	6.81E+01	1.90E+01	mg/kg	6	6	N[A]	
Iron	1.57E+04	3.14E+02	2.80E+04	mg/kg	6	6	N[B]	
Lead	1.27E+01	4.00E+02[F]	3.60E+01	mg/kg	6	6	N[A,B]	
Magnesium	2.50E+03	NA[C]	7.70E+03	mg/kg	6	6	N[D]	
Manganese	5.58E+02	7.46E+00	1.50E+03	mg/kg	6	6	N[B]	
Mercury[I]	2.40E-02	1.58E-01	2.00E-01	mg/kg	6	2	N[A,B]	
Nickel[I]	1.07E+01	3.40E+01	2.10E+01	mg/kg	6	6	N[A,B]	
Sodium	1.12E+02	NA[C]	3.20E+02	mg/kg	6	2	N[D]	
Uranium	4.30E+01	2.16E+00	4.90E+00	mg/kg	6	4	Y	4.30E+01
Vanadium	3.37E+01	5.62E-01	3.80E+01	mg/kg	6	6	N	
Zinc	3.18E+01	4.01E+02	6.50E+01	mg/kg	6	5	N[A,B]	
Total PCB[G,I]	9.00E-02[H]	5.74E-02	NA	mg/kg	NA[E]	NA	N[D]	
TCE	6.33E-03	7.41E-01	NA	mg/kg	5	1	N[A]	
Cesium-137	3.44E-01	1.28E-02	4.90E-01	pCi/g	6	1	N[B]	
Plutonium-239/240[I]	5.62E-02	2.22E+00	2.50E-02	pCi/g	6	1	N[A]	
Technetium-99	2.16E+01	6.74E+01	2.50E+00	pCi/g	6	3	N[A]	
Thorium-228	4.22E-01	4.18E-03	1.60E+00	pCi/g	6	6	N[B]	
Thorium-230	4.60E-01	2.85E+00	1.50E+00	pCi/g	6	6	N[A,B]	
Uranium-234	9.58E-01	3.81E+00	2.50E+00	pCi/g	6	6	N[A,B]	
Uranium-238	5.99E+00	2.61E-01	1.20E+00	pCi/g	6	6	Y	5.99E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB as it represents a group of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[H] Value represents method detection limit as there were no detections for Total PCB in accordance with the PGDP Risk Methods Document (2001)
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.7. Screening for Detected Analytes – SWMU 3 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.18E+04	5.25E+03	1.20E+04	mg/kg	23	23	**N**[B]	
Antimony	1.57E+01	4.920E-01	2.10E-01	mg/kg	23	7	**Y**	1.57E+01
Arsenic[I]	7.62E+00	3.24E-01	7.90E+00	mg/kg	23	23	**N**[B]	
Barium	1.22E+02	2.72E+02	1.70E+02	mg/kg	23	23	**N**[A,B]	
Calcium	3.56E+04	NA[C]	6.10E+03	mg/kg	23	24	**N**[D]	
Chromium[I]	1.79E+01	4.76E+02	4.30E+01	mg/kg	23	23	**N**[A,B]	
Cobalt	9.20E+00	1.11E+03	1.30E+01	mg/kg	23	23	**N**[A,B]	
Copper	1.59E+01	4.27E+02	2.50E+01	mg/kg	23	23	**N**[A,B]	
Iron	2.57E+04	2.17E+03	2.80E+04	mg/kg	23	23	**N**[B]	
Lead	2.39E+01	4.00E+02[F]	2.30E+01	mg/kg	23	23	**N**[A]	
Magnesium	2.50E+03	NA[C]	2.10E+03	mg/kg	23	23	**N**[D]	
Manganese	5.58E+02	5.66E+01	8.20E+02	mg/kg	23	23	**N**[B]	
Mercury[I]	2.40E-02	1.17E+00	1.30E-01	mg/kg	23	3	**N**[A,B]	
Molybdenum	6.21E+00	6.600E+01	NA	mg/kg	23	5	**N**[A]	
Nickel[I]	1.61E+01	2.16E+02	2.20E+01	mg/kg	23	22	**N**[A,B]	
Sodium	2.49E+02	NA[C]	3.40E+02	mg/kg	23	13	**N**[D]	
Uranium	8.36E+01	1.13E+01	4.60E+00	mg/kg	23	12	**Y**	1.89E+01
Vanadium	3.37E+01	4.40E+00	3.70E+01	mg/kg	23	23	**N**[A]	
Zinc	4.15E+01	2.660E+03	6.00E+01	mg/kg	23	19	**N**[A,B]	
Total PCB[G,I]	9.00E-02[H]	1.68E-01	NA	mg/kg	NA[E]	NA	**N**[A]	
TCE	6.33E-03	3.25E+01	NA	mg/kg	22	1	**N**[A]	
Cesium-137	4.56E-01	1.15E-01	2.80E-01	pCi/g	23	2	**Y**	4.56E-01
Plutonium-239/240[I]	5.62E-02	1.63E+00	NA	pCi/g	46	2	**N**[A]	
Technetium-99	5.69E+01	5.79E+01	2.80E+00	pCi/g	23	7	**N**[A]	
Thorium-228	4.84E-01	3.57E-02	1.60E+00	pCi/g	23	23	**N**[B]	
Thorium-230	5.73E-01	2.22E+00	1.40E+00	pCi/g	23	22	**N**[A,B]	
Thorium-232	5.54E-01	1.95E+00	1.50E+00	pCi/g	23	23	**N**[A,B]	
Uranium-234	3.02E+00	2.84E+00	2.40E+00	pCi/g	23	13	**Y**	5.25E-01
Uranium-238	2.24E+01	1.17E+00	1.20E+00	pCi/g	23	14	**Y**	9.24E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB as it represents a group of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[H] Value represents method detection limit as there were no detections for Total PCB in accordance with the PGDP Risk Methods Document (2001)
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.8. Summary of COPC Screening for Detected Analytes – SWMU 4 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL	Background Concentration	Units	# of Analyses	# of Detects	COPC	EPC
Aluminum	1.29E+04	7.32E+02	1.30E+04	mg/kg	13	13	**N**[B]	
Arsenic[I]	1.38E+01	1.32E-01	1.20E+01	mg/kg	13	3	**Y**	1.38E+01
Barium	2.00E+02	3.70E+01	2.00E+02	mg/kg	13	13	**N**[B]	
Beryllium	1.11E+00	1.60E-01	6.70E-01	mg/kg	13	11	**Y**	7.32E-01
Calcium	1.34E+04	NA[C]	2.00E+05	mg/kg	13	13	**N**[D]	
Chromium[I]	2.96E+02	6.05E+01	1.60E+01	mg/kg	13	13	**Y**	1.33E+02
Cobalt	7.54E+00	2.09E+02	1.40E+01	mg/kg	13	13	**N**[A,B]	
Copper	3.01E+01	6.81E+01	1.90E+01	mg/kg	13	13	**N**[A]	
Iron	4.19E+04	3.14E+02	2.80E+04	mg/kg	13	13	**Y**	2.19E+04
Lead	2.57E+01	4.00E+02[F]	3.60E+01	mg/kg	13	13	**N**[A,B]	
Magnesium	1.90E+03	NA[C]	7.70E+03	mg/kg	13	13	**N**[D]	
Manganese	1.30E+03	7.46E+00	1.50E+03	mg/kg	13	13	**N**[B]	
Nickel[I]	1.53E+02	3.40E+01	2.10E+01	mg/kg	13	11	**Y**	7.19E+01
Potassium	9.43E+02	NA[C]	1.30E+03	mg/kg	13	13	**N**[D]	
Sodium	3.20E+02	NA[C]	3.20E+02	mg/kg	13	5	**N**[D]	
Vanadium	4.78E+01	5.62E-01	3.80E+01	mg/kg	13	13	**Y**	2.97E+01
Zinc	9.37E+01	4.01E+02	6.50E+01	mg/kg	13	13	**N**[A]	
Total PCB[H,I]	8.98E-01	5.74E-02	NA	mg/kg	NA[E]	NA	**Y**	8.98E-01
Total PAH[G]	4.60E-01[K]	6.70E-03	NA	mg/kg	NA[E]	NA	**Y**	4.60E-01
Cesium-137	3.90E-01	1.28E-02	4.90E-01	pCi/g	19	6	**N**[B]	
Neptunium-237	2.66E-01	4.05E-02	1.00E-01	pCi/g	19	6	**Y**	2.66E-01
Plutonium-239/240[I]	2.71E+01	2.22E+00	2.50E-02	pCi/g	12	2	**Y**	2.71E+01
Technetium-99	3.93E+01	6.74E+01	2.50E+00	pCi/g	18	2	**N**[A]	
Thorium-230	9.90E-01	2.85E+00	1.50E+00	pCi/g	6	4	**N**[A,B]	
Uranium-234	3.01E+01	3.81E+00	2.50E+00	pCi/g	6	6	**Y**	3.01E+01
Uranium-238	5.55E+01	2.61E-01	1.20E+00	pCi/g	6	6	**Y**	5.55E+01

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[K] Value represents method detection limit as there were no detections for Total PAHs in accordance with the PGDP Risk Methods Document (2001)

Table F.9. Summary of COPC Screening for Detected Analytes – SWMU 4 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.90E+04	5.25E+03	1.20E+04	mg/kg	39	39	**Y**	1.14E+04
Arsenic[I]	1.71E+01	3.24E-01	7.90E+00	mg/kg	39	10	**Y**	8.92E+00
Barium	3.13E+02	2.72E+02	1.70E+02	mg/kg	39	39	**Y**	1.21E+02
Beryllium	1.11E+00	1.26E+00	6.90E-01	mg/kg	39	31	**Y**	6.94E-01
Calcium	1.31E+05	NA[C]	6.10E+03	mg/kg	39	39	**N[D]**	
Chromium[I]	2.96E+02	4.76E+02	4.30E+01	mg/kg	39	39	**N[A]**	
Cobalt	1.76E+01	1.11E+03	1.30E+01	mg/kg	39	39	**N[A]**	
Copper	4.64E+01	4.27E+02	2.50E+01	mg/kg	39	39	**N[A]**	
Iron	4.19E+04	2.17E+03	2.80E+04	mg/kg	39	39	**Y**	1.73E+04
Lead	3.02E+01	4.00E+02[F]	2.30E+01	mg/kg	39	3	**N[A]**	
Magnesium	2.65E+03	NA[C]	2.10E+03	mg/kg	39	39	**N[D]**	
Manganese	1.52E+03	5.66E+01	8.20E+02	mg/kg	39	39	**Y**	5.02E+02
Mercury[I]	4.50E-01	1.17E+00	1.30E-01	mg/kg	39	1	**N**	
Nickel[I]	1.53E+02	2.16E+02	2.20E+01	mg/kg	39	35	**N**	
Potassium	2.39E+03	NA[C]	9.50E+02	mg/kg	39	39	**N[D]**	
Sodium	1.13E+03	NA[C]	3.40E+02	mg/kg	39	31	**N[D]**	
Vanadium	4.78E+01	4.40E+00	3.70E+01	mg/kg	39	39	**Y**	2.51E+01
Zinc	9.37E+01	2.66E+03	6.00E+01	mg/kg	39	38	**N[A]**	
Bis(2-ethylhexyl)phthalate	2.62E-01	1.01E+01	NA	mg/kg	38	2	**N[A]**	
Diethyl phthalate	2.80E+00	1.15E+04	NA	mg/kg	38	1	**N[A]**	
Di-n-butyl phthalate	9.40E-01	1.52E+03	NA	mg/kg	38	4	**N[A]**	
Total PCB[H,I]	1.00E-01[K]	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	3.12E+01
Total PAH[G]	4.10E-01	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	4.10E-01
TCE	4.00E-03	3.25E+00	NA	mg/kg	88	1	**N[A]**	
Americium-241	8.90E-01	1.74E+00	NA	pCi/g	25	1	**N**	
Cesium-137	1.81E+02	1.15E-01	2.80E-01	pCi/g	25	8	**Y**	1.81E+02
Neptunium-237	5.78E+00	3.28E-01	NA	pCi/g	25	15	**Y**	2.07E+00
Plutonium-239/240[I]	2.71E+01	1.63E+00	NA	pCi/g	26	10	**Y**	8.04E+00
Radium-226	2.51E+00	3.30E-02	1.50E+00	pCi/g	16	8	**Y**	2.51E+00
Technetium-99	2.69E+02	5.79E+01	2.80E+00	pCi/g	49	15	**Y**	4.96E+01
Thorium-230	6.87E+01	2.22E+00	1.40E+00	pCi/g	8	6	**Y**	6.87E+01
Uranium-234	6.90E+01	2.84E+00	2.40E+00	pCi/g	19	19	**Y**	3.25E+01
Uranium-238	1.26E+02	1.17E+00	1.20E+00	pCi/g	19	19	**Y**	3.92E+01

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[K] Value represents method detection limit as there were no detections for Total PCB in accordance with the PGDP Risk Methods Document (2001)

Table F.10. Summary of COPC Screening for Detected Analytes – SWMU 5 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.38E+04	7.32E+02	1.30E+04	mg/kg	25	25	**Y**	8.86E+03
Arsenic[I]	1.22E+01	1.32E-01	1.20E+01	mg/kg	25	7	**Y**	1.22E+01
Barium	1.25E+02	3.70E+01	2.00E+02	mg/kg	25	25	**N[B]**	
Beryllium	7.90E-01	1.60E-01	6.70E-01	mg/kg	25	10	**Y**	6.19E-01
Calcium	2.07E+05	NA[C]	2.00E+05	mg/kg	25	25	**N[D]**	
Chromium[I]	2.05E+01	6.05E+01	1.60E+01	mg/kg	25	25	**N[A]**	
Cobalt	7.19E+00	2.09E+02	1.40E+01	mg/kg	25	24	**N[A,B]**	
Copper	1.12E+01	6.81E+01	1.90E+01	mg/kg	25	25	**N[A,B]**	
Iron	2.69E+04	3.14E+02	2.80E+04	mg/kg	25	25	**N[B]**	
Lead	3.19E+01	4.00E+02[F]	3.60E+01	mg/kg	25	1	**N[A]**	
Magnesium	4.78E+03	NA[C]	7.70E+03	mg/kg	25	25	**N[D]**	
Manganese	5.99E+02	7.46E+00	1.50E+03	mg/kg	25	25	**N[B]**	
Nickel[I]	1.35E+02	3.40E+01	2.10E+01	mg/kg	25	24	**Y**	3.39E+01
Potassium	9.42E+02	NA[C]	1.30E+03	mg/kg	13	13	**N[D]**	
Sodium	3.25E+02	NA[C]	3.20E+02	mg/kg	11	13	**N[D]**	
Uranium	2.79E+02	2.16E+00	4.90E+00	mg/kg	12	2	**Y**	2.79E+02
Vanadium	3.54E+01	5.62E-01	3.80E+01	mg/kg	25	25	**N[B]**	
Zinc	1.63E+02	4.01E+02	6.50E+01	mg/kg	25	19	**N[A]**	
Total PCB[H,I]	1.00E-01[K]	5.74E-02	NA	mg/kg	NA[E]	NA	**Y**	3.06E-01
Total PAH[G]	1.11E+02	6.70E-03	NA	mg/kg	NA[E]	NA	**Y**	1.11E+02
2-Methylnaphthalene	7.30E+00	NA[C]	NA	mg/kg	56	2	**N[C]**	
3-Nitrobenzenamine	9.45E+00	NA[C]	NA	mg/kg	56	1	**N[C]**	
Acenaphthene	3.20E+01	4.90E+01	NA	mg/kg	56	18	**N**	
Acenaphthylene	9.45E+00	NA[C]	NA	mg/kg	56	2	**N[C]**	
Anthracene	4.00E+01	5.26E+02	NA	mg/kg	56	20	**N[A]**	
Benz(a)anthracene	1.30E+02	6.70E-02	NA	mg/kg	61	31	**Y**	2.49E+01
Benzo(a)pyrene	8.00E+01	6.70E-03	NA	mg/kg	56	30	**Y**	1.89E+01
Benzo(b)fluoranthene	1.70E+02	6.70E-02	NA	mg/kg	55	29	**Y**	3.33E+01
Benzo(ghi)perylene	2.80E+01	NA[C]	NA	mg/kg	56	26	**N**	
Benzo(k)fluoranthene	1.17E+01	6.70E-01	NA	mg/kg	15	6	**Y**	3.43E+00
Bis(2-ethylhexyl)phthalate	5.70E+00	2.84E+00	NA	mg/kg	56	18	**Y**	4.76E+00
Carbazole	7.10E+01	6.14E+00	NA	mg/kg	56	11	**Y**	5.46E+00
Chrysene	9.50E+01	6.70E+00	NA	mg/kg	56	30	**Y**	1.40E+01
Dibenz(a,h)anthracene	7.49E-01	6.70E-03	NA	mg/kg	15	2	**Y**	7.49E-01
Dibenzofuran	3.52E+00	2.93E+00	NA	mg/kg	15	3	**Y**	3.52E+00
Di-n-butyl phthalate	1.70E+00	2.64E+02	NA	mg/kg	15	3	**N[A]**	
Fluoranthene	5.33E+01	3.43E+01	NA	mg/kg	15	7	**Y**	5.33E+02
Fluorene	2.80E+01	5.01E+01	NA	mg/kg	56	15	**N[A]**	
Indeno(1,2,3-cd)pyrene	3.70E+01	6.70E-02	NA	mg/kg	56	25	**Y**	4.31E+00
Naphthalene	1.60E+01	3.47E+00	NA	mg/kg	56	3	**Y**	1.60E+01
Phenanthrene	6.40E+01	NA[C]	NA	mg/kg	56	31	**N[C]**	
Pyrene	1.50E+02	2.57E+01	NA	mg/kg	56	35	**Y**	3.16E+01
1,1-DCE	2.80E+00	2.76E-02	NA	mg/kg	18	1	**N[A]**	

Table F.10. Summary of COPC Screening for Detected Analytes – SWMU 5 Surface Soils (Continued)

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Cesium-137	7.41E-02	1.28E-02	4.90E-01	pCi/g	25	12	**N[B]**	
Technetium-99	1.73E+01	6.74E+01	2.50E+00	pCi/g	25	7	**N[A]**	
Thorium-228	4.22E-01	4.18E-03	1.60E+00	pCi/g	12	12	**N[B]**	
Thorium-230	7.28E-01	2.85E+00	1.50E+00	pCi/g	12	11	**N[A,B]**	
Thorium-232	5.06E-01	2.61E+00	1.50E+00	pCi/g	12	12	**N[A,B]**	
Uranium-234	6.41E-01	3.81E+00	2.50E+00	pCi/g	12	1	**N[A,B]**	
Uranium-235/236	8.83E-01	5.91E-02	1.40E-01	pCi/g	40	13	**N[B]**	
Uranium-238	1.68E+00	2.61E-01	1.20E+00	pCi/g	12	12	**Y**	1.38E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[K] Value represents method detection limit as there were no detections for Total PCB in accordance with the PGDP Risk Methods Document (2001)

Table F.11. Summary of COPC Screening for Detected Analytes – SWMU 5 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.38E+04	5.25E+03	1.20E+04	mg/kg	29	29	**Y**	8.61E+03
Arsenic[I]	1.22E+01	3.24E-01	7.90E+00	mg/kg	29	9	**Y**	1.22E+01
Barium	1.41E+02	2.72E+02	1.70E+02	mg/kg	29	29	**N[A,B]**	
Beryllium	7.90E-01	1.26E+00	6.90E-01	mg/kg	29	10	**N[A]**	
Calcium	2.07E+05	NA[C]	6.10E+03	mg/kg	28	28	**N[D]**	
Chromium[I]	2.05E+01	4.76E+02	4.30E+01	mg/kg	29	29	**N[A,B]**	
Cobalt	1.43E+01	1.11E+03	1.30E+01	mg/kg	29	28	**N[A]**	
Copper	1.12E+01	4.27E+02	2.50E+01	mg/kg	29	29	**N[A,B]**	
Iron	2.69E+04	2.17E+03	2.80E+04	mg/kg	29	29	**N[B]**	
Lead	3.19E+01	4.00E+02[F]	2.30E+01	mg/kg	29	4	**N[A]**	
Magnesium	4.78E+03	NA[C]	2.10E+03	mg/kg	29	29	**N[D]**	
Manganese	6.90E+02	5.66E+01	8.20E+02	mg/kg	29	29	**N[B]**	
Nickel[I]	1.35E+02	2.16E+02	2.20E+01	mg/kg	29	28	**N[A]**	
Potassium	9.42E+02	NA[C]	9.50E+02	mg/kg	13	13	**N[D]**	
Sodium	3.25E+02	NA[C]	3.40E+02	mg/kg	16	14	**N[D]**	
Uranium	2.79E+02	1.13E+01	4.60E+00	mg/kg	31	3	**Y**	2.79E+02
Vanadium	3.54E+01	4.40E+00	3.70E+01	mg/kg	28	28	**N[B]**	
Zinc	1.63E+02	2.66E+03	6.00E+01	mg/kg	28	24	**N[A]**	
Total PCB[H,I]	3.06E-01	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	3.06E-01
Total PAH[G]	1.12E+02	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	1.12E+02
2-Methylnaphthalene	7.30E+00	NA[C]	NA	mg/kg	56	2	**N[C]**	

Table F.11. Summary of COPC Screening for Detected Analytes – SWMU 5 Subsurface Soils (Continued)

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
3-Nitrobenzenamine	9.45E+00	NA[C]	NA	mg/kg	56	1	**N**[C]	
Acenaphthene	3.20E+01	3.50E+02	NA	mg/kg	56	18	**N**[A]	
Acenaphthylene	9.45E+00	NA[C]	NA	mg/kg	56	2	**N**[C]	
Anthracene	4.00E+01	3.34E+03	NA	mg/kg	56	20	**N**[A]	
Benz(a)anthracene	1.30E+02	2.32E-01	NA	mg/kg	56	30	**Y**	2.49E+01
Benzo(a)pyrene	8.00E+01	2.32E-02	NA	mg/kg	56	31	**Y**	1.89E+01
Benzo(b)fluoranthene	1.70E+02	2.32E-01	NA	mg/kg	56	30	**Y**	3.33E+01
Benzo(ghi)perylene	2.80E+01	NA[C]	NA	mg/kg	56	26	**N**[C]	
Benzo(k)fluoranthene	1.17E+01	2.32E+00	NA	mg/kg	15	6	**Y**	1.17E+01
Bis(2-ethylhexyl)phthalate	5.70E+00	1.01E+01	NA	mg/kg	56	18	**Y**	4.76E+00
Carbazole	7.10E+01	1.77E+01	NA	mg/kg	56	11	**Y**	5.46E+00
Chrysene	9.50E+01	2.32E+01	NA	mg/kg	56	30	**Y**	1.40E+01
Dibenz(a,h)anthracene	7.49E-01	2.32E-02	NA	mg/kg	15	2	**Y**	7.49E-01
Dibenzofuran	3.52E+00	2.10E+01	NA	mg/kg	15	3	**N**[A]	
Di-n-butyl phthalate	1.70E+00	1.52E+03	NA	mg/kg	15	3	**N**[A]	
Fluoranthene	5.33E+01	2.42E+02	NA	mg/kg	15	7	**N**[A]	
Fluorene	2.80E+01	3.38E+02	NA	mg/kg	56	15	**N**[A]	
Indeno(1,2,3-cd)pyrene	3.70E+01	2.32E-01	NA	mg/kg	56	25	**Y**	4.31E+00
Naphthalene	1.60E+01	3.04E+01	NA	mg/kg	56	3	**N**[A]	
Phenanthrene	6.40E+01	NA[C]	NA	mg/kg	56	31	**N**[C]	
Pyrene	1.50E+02	1.81E+02	NA	mg/kg	56	35	**N**[A]	
1,1-DCE	2.80E+00	1.19E-01	NA	mg/kg	18	1	**N**[D]	
Cesium-137	7.41E-02	1.15E-01	2.80E-01	pCi/g	26	12	**N**[B]	
Technetium-99	1.73E+01	5.79E+01	2.80E+00	pCi/g	26	7	**N**[A]	
Thorium-228	4.22E-01	3.57E-02	1.60E+00	pCi/g	13	13	**N**[B]	
Thorium-230	7.28E-01	2.22E+00	1.40E+00	pCi/g	13	12	**N**[A,B]	
Thorium-232	5.06E-01	1.95E+00	1.50E+00	pCi/g	13	13	**N**[A,B]	
Uranium-234	6.41E-01	2.84E+00	2.40E+00	pCi/g	13	1	**N**[A,B]	
Uranium-235/236	7.33E-02	4.55E-01	1.40E-01	pCi/g	40	13	**N**[A,B]	
Uranium-238	1.68E+00	1.17E+00	1.20E+00	pCi/g	13	13	**Y**	1.38E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.12. Summary of COPC Screening for Detected Analytes – SWMU 6 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL[I]	Background Concentration	Units	# of Analyses	# of Detects	COPC[I]	EPC[I]
Aluminum	1.12E+04	7.32E+02	1.30E+04	mg/kg	15	15	**N**[B]	
Arsenic[H]	6.38E+00	1.32E-01	1.20E+01	mg/kg	15	2	**N**[B]	
Barium	9.92E+01	3.70E+01	2.00E+02	mg/kg	15	15	**N**[B]	
Beryllium	7.30E-01	1.60E-01	6.70E-01	mg/kg	15	9	**Y**	7.30E-01
Calcium	1.46E+05	NA[C]	2.00E+05	mg/kg	15	15	**N**[D]	
Chromium[H]	1.44E+01	6.05E+01	1.60E+01	mg/kg	15	15	**N**[A,B]	
Cobalt	6.85E+00	2.09E+02	1.40E+01	mg/kg	15	14	**N**[A,B]	
Copper	2.13E+01	6.81E+01	1.90E+01	mg/kg	15	15	**N**[A,B]	
Iron	1.96E+04	3.14E+02	2.80E+04	mg/kg	15	15	**N**[B]	
Magnesium	4.41E+03	NA[C]	7.70E+03	mg/kg	15	15	**N**[D]	
Manganese	5.99E+02	7.46E+00	1.50E+03	mg/kg	15	15	**N**[B]	
Nickel[H]	4.32E+01	3.40E+01	2.10E+01	mg/kg	15	13	**Y**	1.58E+01
Potassium	8.21E+02	NA[C]	1.30E+03	mg/kg	8	8	**N**[D]	
Sodium	2.34E+02	NA[C]	3.20E+02	mg/kg	8	6	**N**[D]	
Uranium	1.14E+02	2.16E+00	4.90E+00	mg/kg	15	1	**Y**	1.14E+02
Vanadium	2.48E+01	5.62E-01	3.80E+01	mg/kg	15	15	**N**[B]	
Zinc	1.28E+02	4.01E+02	6.50E+01	mg/kg	15	14	**N**[A]	
Total PCB[G,H]	6.00E-02	5.74E-02	NA	mg/kg	NA[E]	NA	**Y**	6.00E-02
Total PAH[F]	4.99E-01	6.70E-03	NA	mg/kg	NA[E]	NA	**Y**	4.99E-01
Anthracene	1.56E-01	5.26E+02	NA	mg/kg	18	1	**N**[A]	
Benz(a)anthracene	2.55E-01	6.70E-02	NA	mg/kg	18	2	**N**[A]	
Benzo(a)pyrene	4.02E-01	6.70E-03	NA	mg/kg	18	2	**Y**	4.02E-01
Benzo(b)fluoranthene	5.00E-01	6.70E-02	NA	mg/kg	18	2	**Y**	5.00E-01
Benzo(ghi)perylene	1.24E-01	NA[C]	NA	mg/kg	18	1	**N**[C]	
Benzo(k)fluoranthene	5.00E-01	6.70E-01	NA	mg/kg	11	2	**N**[A]	
Bis(2-ethylhexyl)phthalate	4.20E-01	2.84E+00	NA	mg/kg	18	1	**N**[A]	
Chrysene	4.17E-01	6.70E+00	NA	mg/kg	18	2	**N**[A]	
Di-n-butyl phthalate	1.70E+00	2.64E+02	NA	mg/kg	11	3	**N**[A]	
Fluoranthene	6.36E-01	3.43E+01	NA	mg/kg	11	2	**N**[A]	
Indeno(1,2,3-cd) pyrene	1.59E-01	6.70E-02	NA	mg/kg	18	2	**Y**	1.59E-01
Phenanthrene	4.61E-01	NA[C]	NA	mg/kg	18	1	**N**[C]	
Pyrene	6.63E-01	2.57E+01	NA	mg/kg	18	2	**N**[A]	
Cesium-137	5.23E-02	1.28E-02	4.90E-01	pCi/g	21	6	**N**[B]	
Technetium-99	1.88E+01	6.74E+01	2.50E+00	pCi/g	15	3	**N**[A]	
Thorium-228	4.06E-01	4.18E-03	1.60E+00	pCi/g	7	7	**N**[B]	
Thorium-230	5.41E-01	2.85E+00	1.50E+00	pCi/g	7	7	**N**[A,B]	
Thorium-232	4.57E-01	2.61E+00	1.50E+00	pCi/g	7	7	**N**[A,B]	
Uranium-235	6.80E+00	5.91E-02	1.40E-01	pCi/g	16	8	**Y**	6.80E+00
Uranium-238	1.38E+00	2.61E-01	1.20E+00	pCi/g	7	6	**Y**	1.38E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[G] Total PCB maximum concentration and EPC reported as sum of all detected aroclors
[H] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[I] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.13. Summary of COPC Screening for Detected Analytes – SWMU 6 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[I]	Background Concentration	Units	# of Analyses	# of Detects	COPC[I]	EPC[I]
Aluminum	1.12E+04	5.25E+03	1.20E+04	mg/kg	31	31	N[B]	
Arsenic	6.38E+00	3.24E-01	7.90E+00	mg/kg	31	4	N[B]	
Barium	9.92E+01	2.72E+02	1.70E+02	mg/kg	31	31	N[A,B]	
Beryllium	2.62E+00	1.26E+00	6.90E-01	mg/kg	23	12	Y	8.18E-01
Chromium	1.44E+01	4.76E+02	4.30E+01	mg/kg	31	31	N[A,B]	
Cobalt	6.85E+00	1.11E+03	1.30E+01	mg/kg	31	30	N[A]	
Copper	2.13E+01	4.27E+02	2.50E+01	mg/kg	31	31	N[A,B]	
Iron	1.96E+04	2.17E+03	2.80E+04	mg/kg	31	31	N[B]	
Magnesium	4.41E+03	NA[C]	2.10E+03	mg/kg	31	31	N[D]	
Manganese	5.99E+02	5.66E+01	8.20E+02	mg/kg	31	31	N[B]	
Nickel	4.32E+01	2.16E+02	2.20E+01	mg/kg	31	22	N[A]	
Uranium	1.14E+02	1.13E+01	4.60E+00	mg/kg	11	2	Y	1.14E+02
Vanadium	2.48E+01	4.40E+00	3.70E+01	mg/kg	31	31	N[B]	
Zinc	1.28E+02	2.66E+03	6.00E+01	mg/kg	31	30	N[A]	
Total PCB[G,H]	6.00E-02[J]	1.68E-01	NA	mg/kg	NA[E]	NA	N[A]	6.00E-02
Total PAH[F]	4.99E-01	2.32E-02	NA	mg/kg	NA[E]	NA	Y	4.99E-01
Anthracene	1.56E-01	3.34E+03	NA	mg/kg	32	1	N[A]	
Benz(a)anthracene	2.55E-01	2.32E-01	NA	mg/kg	32	2	N[A]	
Benzo(a)pyrene	4.02E-01	2.32E-02	NA	mg/kg	32	2	Y	4.02E-01
Benzo(b)fluoranthene	5.00E-01	2.32E-01	NA	mg/kg	32	2	Y	5.00E-01
Benzo(ghi)perylene	1.24E-01	NA[C]	NA	mg/kg	32	1	N[C]	
Benzo(k)fluoranthene	5.00E-01	2.32E+00	NA	mg/kg	25	2	N[A]	
Bis(2-ethylhexyl)phthalate	4.20E-01	1.01E+01	NA	mg/kg	32	1	N[A]	
Chrysene	4.17E-01	2.32E+01	NA	mg/kg	32	2	N[A]	
Di-n-butyl phthalate	1.70E+00	1.52E+03	NA	mg/kg	25	3	N[A]	
Fluoranthene	6.36E-01	2.42E+02	NA	mg/kg	25	2	N[A]	
Indeno(1,2,3-cd)pyrene	1.59E-01	2.32E-01	NA	mg/kg	32	2	Y	1.59E-01
Phenanthrene	4.61E-01	NA[C]	NA	mg/kg	32	1	N[C]	
Pyrene	6.63E-01	1.81E+02	NA	mg/kg	32	2	N[A]	
Cesium-137	5.23E-02	1.15E-01	2.80E-01	pCi/g	21	6	N[A,B]	
Technetium-99	1.88E+01	5.79E+01	2.80E+00	pCi/g	30	3	N[A]	
Thorium-228	4.06E-01	3.57E-02	1.60E+00	pCi/g	7	7	N[B]	
Thorium-230	5.41E-01	2.22E+00	1.40E+00	pCi/g	7	7	N[A,B]	
Thorium-232	4.57E-01	1.95E+00	1.50E+00	pCi/g	7	7	N[A,B]	
Uranium-235	6.80E+00	4.55E-01	1.40E-01	pCi/g	27	9	Y	6.80E+00
Uranium-238	1.38E+00	1.17E+00	1.20E+00	pCi/g	7	6	Y	1.38E+00

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[G] Total PCB maximum concentration and EPC reported as sum of all detected aroclors
[H] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[I] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[J] Value represents method detection limit as there were no detections for Total PCB in accordance with the PDGP Risk Methods Document (2001)

Table F.14. Summary of COPC Screening for Detected Analytes – SWMU 7 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.40E+04	7.32E+02	1.30E+04	mg/kg	14	14	**Y**	9.10E+03
Antimony	1.70E+00	6.35E-02	2.10E-01	mg/kg	14	12	**Y**	9.82E-01
Arsenic[H]	1.60E+01	1.32E-01	1.20E+01	mg/kg	14	14	**Y**	6.91E+00
Barium	1.20E+02	3.70E+01	2.00E+02	mg/kg	12	7	**N[B]**	
Beryllium	1.30E+00	1.60E-01	6.70E-01	mg/kg	16	10	**Y**	6.15E-01
Cadmium	1.30E+00	2.64E+00	2.10E-01	mg/kg	14	6	**N[A]**	
Calcium	2.10E+05	NA[C]	2.00E+05	mg/kg	14	14	**N[D]**	
Chromium[H]	5.58E+01	6.05E+01	1.60E+01	mg/kg	16	16	**N[A]**	
Cobalt	1.10E+01	2.09E+02	1.40E+01	mg/kg	14	12	**N[A,B]**	
Copper	9.90E+01	6.81E+01	1.90E+01	mg/kg	14	14	**Y**	6.73E+01
Iron	3.00E+04	3.14E+02	2.80E+04	mg/kg	14	14	**Y**	1.92E+04
Lead	1.20E+02	4.00E+02	3.60E+01	mg/kg	14	13	**N[A]**	
Magnesium	3.30E+03	NA[C]	7.70E+03	mg/kg	14	14	**N[D]**	
Manganese	5.99E+02	7.46E+00	1.50E+03	mg/kg	14	14	**N[B]**	
Mercury[H]	9.20E-02	1.58E-01	2.00E-01	mg/kg	14	9	**N[A,B]**	
Nickel[H]	1.40E+02	3.40E+01	2.10E+01	mg/kg	14	14	**Y**	5.13E+01
Potassium	5.30E+02	NA[C]	1.30E+03	mg/kg	12	3	**N[D]**	
Selenium	8.80E-01	1.21E+01	8.00E-01	mg/kg	14	3	**N[A]**	
Sodium	1.70E+02	NA[C]	3.20E+02	mg/kg	14	3	**N[D]**	
Thallium	2.00E+00	1.07E-01	2.10E-01	mg/kg	14	4	**Y**	2.00E+00
Uranium	1.27E+03	2.16E+00	4.90E+00	mg/kg	16	12	**Y**	3.59E+02
Vanadium	5.20E+01	5.62E-01	3.80E+01	mg/kg	14	14	**Y**	2.81E+01
Zinc	2.40E+02	4.01E+02	6.50E+01	mg/kg	14	14	**N[A]**	
Total PCB[G,H,I]	1.48E+01	5.74E-02	NA	mg/kg	NA[E]	NA	Y	1.81E+01
Total PAH[F]	6.37E+00	6.70E-03	NA	mg/kg	NA[E]	NA	**Y**	6.37E+00
2-Methylnaphthalene	1.50E-01	NA[C]	NA	mg/kg	11	1	**N[C]**	
3-Methylcholanthrene	1.10E-01	NA[C]	NA	mg/kg	3	1	**N[C]**	
Acenaphthene	4.40E-01	4.90E+01	NA	mg/kg	11	1	**N[A]**	
Acenaphthylene	1.90E-02	NA[C]	NA	mg/kg	11	1	**N[C]**	
Anthracene	6.90E-01	5.26E+02	NA	mg/kg	11	3	**N[A]**	
Benz(a)anthracene	4.30E+00	6.70E-02	NA	mg/kg	11	7	**Y**	4.30E+00
Benzo(a)pyrene	4.10E+00	6.70E-03	NA	mg/kg	11	7	**Y**	4.10E+00
Benzo(b)fluoranthene	5.20E+00	6.70E-02	NA	mg/kg	11	7	**Y**	5.20E+00
Benzo(ghi)perylene	3.80E+00	NA[C]	NA	mg/kg	11	3	**N[C]**	
Benzo(k)fluoranthene	1.70E+00	6.70E-01	NA	mg/kg	11	6	**Y**	1.70E+00
Benzoic acid	1.50E-01	1.06E+04	NA	mg/kg	11	2	**N[A]**	
Bis(2-ethylhexyl)phthalate	3.90E-01	2.84E+00	NA	mg/kg	11	2	**N[A]**	
Chrysene	4.20E+00	6.70E+00	NA	mg/kg	11	7	**N[A]**	

Table F.14. Summary of COPC Screening for Detected Analytes – SWMU 7 Surface Soils (Continued)

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Dibenz(a,h)anthracene	9.20E-01	6.70E-03	NA	mg/kg	11	1	**Y**	9.20E-01
Dibenzofuran	2.40E-01	2.93E+00	NA	mg/kg	11	1	**N[A]**	
Fluoranthene	7.90E+00	3.43E+01	NA	mg/kg	11	8	**N[A]**	
Fluorene	4.10E-01	5.01E+01	NA	mg/kg	11	1	**N[A]**	
Indeno(1,2,3-cd)pyrene	3.80E+00	6.70E-02	NA	mg/kg	11	3	**Y**	3.80E+00
Naphthalene	5.60E-02	3.47E+00	NA	mg/kg	11	1	**N[A]**	
Pentachlorophenol	6.90E-02	6.46E-01	NA	mg/kg	11	1	**N[A]**	
Phenanthrene	5.10E+00	NA[C]	NA	mg/kg	11	6	**N[C]**	
Pyrene	9.00E+00	2.57E+01	NA	mg/kg	11	8	**N[A]**	
Cesium-137	1.83E-01	1.28E-02	4.90E-01	pCi/g	5	3	**N[B]**	
Technetium-99	4.06E+02	6.74E+01	2.50E+00	pCi/g	17	17	**Y**	1.21E+02
Thorium-228	3.36E+00	4.18E-03	1.60E+00	pCi/g	6	4	**Y**	3.36E+00
Thorium-230	3.94E+00	2.85E+00	1.50E+00	pCi/g	17	17	**Y**	2.14E+00
Thorium-232	5.33E-01	2.61E+00	1.50E+00	pCi/g	6	2	**N[A,B]**	
Neptunium-237	7.20E-01	4.05E-02	1.00E-01	pCi/g	19	14	**Y**	3.20E-01
Plutonium-239/240[H]	6.80E-01	2.22E+00	2.50E-02	pCi/g	19	16	**Y**	2.54E-01
Uranium-234	3.18E+02	3.81E+00	2.50E+00	pCi/g	18	18	**Y**	7.69E+01
Uranium-235/236	6.03E+00	5.91E-02	1.40E-01	pCi/g	16	16	**Y**	3.50E+00
Uranium-238	2.39E+03	2.61E-01	1.20E+00	pCi/g	18	18	**Y**	4.80E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[I] Total PCB maximum concentration as actual analytical value and EPC reported as sum of all detected aroclors
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.15. Summary of COPC Screening for Detected Analytes – SWMU 7 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.60E+04	5.25E+03	1.20E+04	mg/kg	37	37	**Y**	8.89E+03
Antimony	1.70E+00	4.92E-01	2.10E-01	mg/kg	37	11	**Y**	9.84E-01
Arsenic[I]	1.60E+01	3.24E-01	7.90E+00	mg/kg	37	28	**Y**	4.56E+00
Barium	1.80E+02	2.72E+02	1.70E+02	mg/kg	37	33	**N[A]**	
Beryllium	1.30E+00	1.26E+00	6.90E-01	mg/kg	39	10	**Y**	4.20E-01
Cadmium	1.30E+00	1.52E+01	2.10E-01	mg/kg	37	6	**N[A]**	
Calcium	2.10E+05	NA[C]	6.10E+03	mg/kg	37	37	**N[D]**	
Chromium[I]	5.58E+01	4.76E+02	4.30E+01	mg/kg	37	37	**N[A]**	
Cobalt	1.10E+01	1.11E+03	1.30E+01	mg/kg	37	32	**N[A,B]**	
Copper	9.90E+01	4.27E+02	2.50E+01	mg/kg	37	37	**N[A]**	
Iron	3.00E+04	2.17E+03	2.80E+04	mg/kg	37	37	**Y**	1.49E+04
Lead	1.20E+02	4.00E+02[F]	2.30E+01	mg/kg	37	33	**N[A]**	
Magnesium	3.30E+03	NA[C]	2.10E+03	mg/kg	37	33	**N[D]**	
Manganese	1.20E+03	5.66E+01	8.20E+02	mg/kg	37	37	**Y**	3.92E+02
Mercury[I]	9.20E-02	1.17E+00	1.30E-01	mg/kg	37	12	**N[A,B]**	
Nickel[I]	1.40E+02	2.16E+02	2.20E+01	mg/kg	37	37	**N[A]**	
Potassium	5.30E+02	NA[C]	9.50E+02	mg/kg	20	3	**N[D]**	
Selenium	8.80E-01	7.13E+01	7.00E-01	mg/kg	37	4	**N[A]**	
Sodium	3.30E+02	NA[C]	3.40E+02	mg/kg	37	16	**N[D]**	
Thallium	2.00E+00	NA[C]	3.40E-01	mg/kg	37	4	**Y**	2.00E+00
Uranium	1.17E+03	1.13E+01	4.60E+00	mg/kg	39	15	**Y**	1.46E+02
Vanadium	5.20E+01	4.40E+00	3.70E+01	mg/kg	37	36	**Y**	2.21E+01
Zinc	2.40E+02	2.66E+03	6.00E+01	mg/kg	37	34	**N[A]**	
Total PCB[H,I]	1.48E+01	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	1.81E+01
Total PAH[G]	6.37E+00	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	6.37E+00
1,2,4-Trichlorobenzene	7.70E-02	8.30E+01	NA	mg/kg	34	2	**N[A]**	
1,4-Dichlorobenzene	7.00E-02	5.35E+00	NA	mg/kg	42	2	**N[A]**	
2-Methylnaphthalene	1.50E-01	NA[C]	NA	mg/kg	34	1	**N[C]**	
3-Methylcholanthrene	1.10E-01	NA[C]	NA	mg/kg	17	1	**N[C]**	
Acenaphthene	4.40E-01	3.50E+02	NA	mg/kg	34	2	**N[A]**	
Acenaphthylene	1.90E-02	NA[C]	NA	mg/kg	34	1	**N[D]**	
Anthracene	6.90E-01	3.34E+03	NA	mg/kg	34	3	**N[A]**	
Benz(a)anthracene	4.30E+00	2.32E-01	NA	mg/kg	34	7	**Y**	4.30E+00
Benzo(a)pyrene	4.10E+00	2.32E-02	NA	mg/kg	34	7	**Y**	4.10E+00
Benzo(b)fluoranthene	5.20E+00	2.32E-01	NA	mg/kg	17	7	**Y**	5.20E+00
Benzo(ghi)perylene	3.80E+00	NA[C]	NA	mg/kg	17	3	**N[C]**	
Benzo(k)fluoranthene	1.70E+00	2.32E+00	NA	mg/kg	34	6	**N[A]**	
Benzoic acid	1.50E-01	6.07E+04	NA	mg/kg	34	2	**N[A]**	
Bis(2-ethylhexyl)phthalate	3.90E-01	1.01E+01	NA	mg/kg	34	2	**N[A]**	
Chrysene	4.20E+00	2.32E+01	NA	mg/kg	34	7	**N[A]**	
Dibenz(a,h)anthracene	9.20E-01	2.32E-02	NA	mg/kg	34	1	**N[D]**	
Dibenzofuran	2.40E-01	2.10E+01	NA	mg/kg	34	1	**N[A]**	
Fluoranthene	7.90E+00	2.42E+02	NA	mg/kg	34	8	**N[A]**	
Fluorene	4.10E-01	3.38E+02	NA	mg/kg	34	1	**N[A]**	

Table F.15. Summary of COPC Screening for Detected Analytes – SWMU 7 Subsurface Soils (Continued)

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Indeno(1,2,3-cd)pyrene	3.80E+00	2.32E-01	NA	mg/kg	34	3	**Y**	3.80E+00
Naphthalene	5.60E-02	3.04E+01	NA	mg/kg	34	1	**N[A]**	
Pentachlorophenol	6.90E-02	2.07E+00	NA	mg/kg	34	1	**N[A]**	
Phenanthrene	5.10E+00	NA[C]	NA	mg/kg	34	6	**N[C]**	
Pyrene	9.00E+00	1.81E+02	NA	mg/kg	34	8	**N[A]**	
1,1,1-TCA	6.77E-02	1.78E+02	NA	mg/kg	25	1	**N[A]**	
1,1,2-TCA	1.49E-01	1.45E+00	NA	mg/kg	25	1	**N[A]**	
1,1-Dichloroethane	3.78E-01	1.97E+02	NA	mg/kg	25	2	**N[A]**	
1,1-DCE	1.11E+00	1.19E-01	NA	mg/kg	25	1	**N[D]**	
1,2-Dichloroethane	1.63E-02	6.65E-01	NA	mg/kg	25	1	**N[A]**	
cis-1,2-DCE	3.25E-02	1.71E+01	NA	mg/kg	25	4	**N[A]**	
TCE	1.08E-02	3.25E+00	NA	mg/kg	25	2	**N[A]**	
Vinyl chloride	7.50E-03	1.41E-01	NA	mg/kg	25	2	**N[A]**	
Americium-241	2.00E+00	1.74E+00	NA	pCi/g	20	2	**Y**	2.00E+00
Cesium-137	1.83E-01	1.15E-01	2.80E-01	pCi/g	20	2	**N[B]**	
Radium-226	8.30E-01	3.30E-02	1.50E+00	pCi/g	5	3	**N[B]**	
Technetium-99	4.06E+02	5.79E+01	2.80E+00	pCi/g	40	30	**Y**	1.29E+02
Thorium-228	3.36E+00	3.57E-02	1.60E+00	pCi/g	21	21	**Y**	1.35E+00
Thorium-230	3.94E+00	2.22E+00	1.40E+00	pCi/g	39	37	**Y**	1.57E+00
Thorium-232	5.40E-01	1.95E+00	1.50E+00	pCi/g	21	20	**N[A,B]**	
Neptunium-237	7.20E-01	3.28E-01	NA	pCi/g	42	25	**Y**	1.60E-01
Plutonium-239	6.80E-01	1.63E+00	NA	pCi/g	42	26	**N[A]**	
Uranium-234	3.18E+02	2.84E+00	2.40E+00	pCi/g	50	46	**Y**	5.57E+01
Uranium-235/236	4.21E+01	4.55E-01	1.40E-01	pCi/g	45	34	**Y**	3.82E+00
Uranium-238	2.39E+03	1.17E+00	1.20E+00	pCi/g	50	45	**Y**	3.15E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.16. Summary of COPC Screening for Detected Analytes – SWMU 30 Surface Soils

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.60E+04	7.32E+02	1.30E+04	mg/kg	8	8	**Y**	1.60E+04
Antimony	3.00E+00	6.35E-02	2.10E-01	mg/kg	10	8	**Y**	3.00E+00
Arsenic[I]	8.90E+00	1.32E-01	1.20E+01	mg/kg	10	8	**N[B]**	
Barium	1.70E+02	3.70E+01	2.00E+02	mg/kg	8	3	**N[B]**	
Beryllium	8.50E-01	1.60E-01	6.70E-01	mg/kg	8	8	**Y**	8.50E-01
Cadmium	2.80E+00	2.64E+00	2.10E-01	mg/kg	10	6	**Y**	2.80E+00
Calcium	2.40E+05	NA[C]	2.00E+05	mg/kg	8	8	**N[D]**	
Chromium[I]	4.57E+01	6.05E+01	1.60E+01	mg/kg	9	9	**N[A]**	
Cobalt	8.90E+00	2.09E+02	1.40E+01	mg/kg	8	8	**N[A,B]**	
Copper	1.70E+02	6.81E+01	1.90E+01	mg/kg	8	8	**Y**	1.70E+02
Iron	2.40E+04	3.14E+02	2.80E+04	mg/kg	8	8	**N[B]**	
Lead	7.10E+01	4.00E+02[F]	3.60E+01	mg/kg	10	8	**N[A]**	
Magnesium	2.20E+03	NA[C]	7.70E+03	mg/kg	8	8	**N[D]**	
Manganese	4.90E+02	7.46E+00	1.50E+03	mg/kg	8	8	**N[B]**	
Mercury[I]	1.70E-01	1.58E-01	2.00E-01	mg/kg	10	7	**N[B]**	
Nickel[I]	5.70E+02	3.40E+01	2.10E+01	mg/kg	10	10	**Y**	5.70E+02
Potassium	1.10E+03	NA[C]	1.30E+03	mg/kg	8	8	**N[D]**	
Selenium	6.60E-01	1.21E+01	8.00E-01	mg/kg	10	1	**N[A,B]**	
Sodium	8.80E+01	NA[C]	3.20E+02	mg/kg	8	7	**N[D]**	
Thallium	1.80E+00	1.07E-01	2.10E-01	mg/kg	10	5	**Y**	1.80E+00
Uranium	1.40E+03	2.16E+00	4.90E+00	mg/kg	8	5	**Y**	1.40E+03
Vanadium	3.40E+01	5.62E-01	3.80E+01	mg/kg	8	8	**N[B]**	
Zinc	7.50E+02	4.01E+02	6.50E+01	mg/kg	8	8	**N[A]**	
Total PCB[H,I]	2.00E-01	5.74E-02	NA	mg/kg	NA[E]	NA	**Y**	1.52E+01
Total PAH[G]	1.25E+01	6.70E-03	NA	mg/kg	NA[E]	NA	**Y**	1.25E+01
2-Methylnaphthalene	2.70E-01	NA[C]	NA	mg/kg	8	2	**N[C]**	
3-Methylcholanthrene	2.20E-01	NA[C]	NA	mg/kg	8	1	**N[C]**	
Acenaphthene	1.70E+00	4.90E+01	NA	mg/kg	8	4	**N**	
Acenaphthylene	9.10E-02	NA[C]	NA	mg/kg	8	4	**N[C]**	
Acetophenone	1.30E-02	2.47E-02	NA	mg/kg	8	1	**N[A]**	
Anthracene	3.20E+00	5.26E+02	NA	mg/kg	8	5	**N[A]**	
Benz(a)anthracene	9.10E+00	6.70E-02	NA	mg/kg	8	7	**Y**	3.20E+00
Benzo(a)pyrene	8.40E+00	6.70E-03	NA	mg/kg	8	6	**Y**	9.10E+00
Benzo(b)fluoranthene	9.60E+00	6.70E-02	NA	mg/kg	8	6	**Y**	8.40E+00
Benzo(ghi)perylene	5.20E+00	NA[C]	NA	mg/kg	8	6	**N[C]**	
Benzo(k)fluoranthene	4.30E+00	6.70E-01	NA	mg/kg	8	6	**Y**	4.30E+00
Benzoic acid	4.30E-02	1.06E+04	NA	mg/kg	8	2	**N[A]**	
Bis(2-ethylhexyl)phthalate	6.20E-01	2.84E+00	NA	mg/kg	8	2	**N[A]**	
Chrysene	9.90E+00	6.70E+00	NA	mg/kg	8	7	**N[A]**	9.90E+00
Dibenz(a,h)anthracene	1.60E+00	6.70E-03	NA	mg/kg	8	5	**Y**	1.60E+00
Dibenzofuran	8.30E-01	2.93E+00	NA	mg/kg	8	3	**N[A]**	
Di-n-butyl phthalate	1.00E-01	2.64E+02	NA	mg/kg	8	2	**N[A]**	
Fluoranthene	2.00E+01	3.43E+01	NA	mg/kg	8	7	**N[A]**	
Fluorene	1.30E+00	5.01E+01	NA	mg/kg	8	3	**N[A]**	
Indeno(1,2,3-cd)pyrene	5.40E+00	6.70E-02	NA	mg/kg	8	6	**Y**	5.40E+00

Table F.16. Summary of COPC Screening for Detected Analytes – SWMU 30 Surface Soils (Continued)

Analyte	Maximum Concentration	Resident Child NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Naphthalene	3.10E-01	3.47E+00	NA	mg/kg	8	1	**N[A]**	
Phenanthrene	1.70E+01	NA[C]	NA	mg/kg	8	7	**N[C]**	
Technetium-99	3.60E+02	6.74E+01	2.50E+00	pCi/g	8	8	**Y**	3.60E+02
Thorium-230	4.88E+00	2.85E+00	1.50E+00	pCi/g	8	8	**Y**	4.88E+00
Neptunium-237	1.68E+00	4.05E-02	1.00E-01	pCi/g	8	8	**Y**	1.68E+00
Plutonium-239	6.20E-01	2.22E+00	2.50E-02	pCi/g	8	7	**N[A]**	
Uranium-234	1.15E+02	3.81E+00	2.50E+00	pCi/g	8	8	**Y**	1.15E+02
Uranium-235/236	1.66E+01	5.91E-02	1.40E-01	pCi/g	8	8	**Y**	1.66E+01
Uranium-238	5.65E+02	2.61E-01	1.20E+00	pCi/g	8	8	**Y**	5.65E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.17. Summary of COPC Screening for Detected Analytes – SWMU 30 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.90E+04	5.25E+03	1.20E+04	mg/kg	16	16	**Y**	1.29E+04
Antimony	3.00E+00	4.92E-01	2.10E-01	mg/kg	18	8	**Y**	3.00E+00
Arsenic[I]	8.90E+00	3.24E-01	7.90E+00	mg/kg	16	11	**Y**	5.28E+00
Barium	1.70E+02	2.72E+02	1.70E+02	mg/kg	16	11	**N[A]**	
Beryllium	8.50E-01	1.26E+00	6.90E-01	mg/kg	16	8	**N[A]**	
Cadmium	2.80E+00	1.52E+01	2.10E-01	mg/kg	16	3	**N[A]**	
Calcium	2.40E+04	NA[C]	6.10E+03	mg/kg	16	16	**N[D]**	
Chromium[I]	4.90E+01	4.76E+02	4.30E+01	mg/kg	16	16	**N[A]**	
Cobalt	1.40E+01	1.11E+03	1.30E+01	mg/kg	16	15	**N[A]**	
Copper	1.70E+02	4.27E+02	2.50E+01	mg/kg	16	16	**N[A]**	
Iron	2.90E+04	2.17E+03	2.80E+04	mg/kg	16	16	**Y**	1.93E+04
Lead	7.10E+01	4.00E+02[F]	2.30E+01	mg/kg	18	16	**N[A]**	4.27E+01
Magnesium	2.20E+03	NA[C]	2.10E+03	mg/kg	16	16	**N[D]**	
Manganese	1.20E+03	5.66E+01	8.20E+02	mg/kg	16	16	**Y**	5.11E+02
Mercury[I]	1.70E-01	1.17E+00	1.30E-01	mg/kg	18	10	**N[A,B]**	
Nickel[I]	5.70E+02	2.16E+02	2.20E+01	mg/kg	18	18	**Y**	4.35E+02
Selenium	1.00E+00	7.13E+01	7.00E-01	mg/kg	18	4	**N[A]**	
Sodium	1.78E+02	NA[C]	3.40E+02	mg/kg	16	5	**N[D]**	
Thallium	1.80E+00	NA[C]	3.40E-01	mg/kg	18	2	**Y**	1.80E+00
Uranium	1.40E+03	1.13E+01	4.60E+00	mg/kg	16	7	**Y**	1.40E+03
Vanadium	4.00E+01	4.40E+00	3.70E+01	mg/kg	16	15	**Y**	2.68E+01
Zinc	7.50E+02	2.66E+03	6.00E+01	mg/kg	16	16	**N[A,B]**	
Total PCB[H,I]	2.00E-01	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	1.53E+01

Table F.17. Summary of COPC Screening for Detected Analytes – SWMU 30 Subsurface Soils (Continued)

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
1,2,4-Trichlorobenzene	3.30E-02	8.30E+01	NA	mg/kg	17	1	**N[A]**	
1,4 Dichlorobenzene	2.50E-02	5.35E+00	NA	mg/kg	22	1	**N[A]**	
2-Chlorophenol	2.30E-02	2.12E+01	NA	mg/kg	17	1	**N[A]**	
2-Methylnaphthalene	2.70E-01	NA[C]	NA	mg/kg	17	2	**N[C]**	
3-Methylcholanthrene	2.20E-01	NA[C]	NA	mg/kg	13	1	**N[C]**	
Acenaphthene	1.70E+00	3.50E+02	NA	mg/kg	13	5	**N[A]**	
Acenaphthylene	9.10E-02	NA[C]	NA	mg/kg	17	3	**N[C]**	
Anthracene	3.20E+00	3.34E+03	NA	mg/kg	15	5	**N[A]**	
Acetophenone	1.30E-02	2.25E+01	NA	mg/kg	13	1	**N[A]**	
Benz(a)anthracene	9.10E+00	2.32E-01	NA	mg/kg	17	10	**Y**	1.81E+00
Benzo(a)pyrene	8.40E+00	2.32E-02	NA	mg/kg	17	7	**Y**	8.40E+00
Benzo(b)fluoranthene	9.60E+00	2.32E-01	NA	mg/kg	17	8	**Y**	9.60E+00
Benzo(ghi)perylene	5.20E+00	NA[C]	NA	mg/kg	17	5	**N[C]**	
Benzo(k)fluoranthene	4.30E+00	2.32E+00	NA	mg/kg	17	7	**Y**	4.30E+00
Benzoic acid	4.30E-02	6.07E+04	NA	mg/kg	17	2	**N[A]**	
Bis(2-ethylhexyl)phthalate	6.20E-01	1.01E+01	NA	mg/kg	17	2	**N[A]**	
Chrysene	9.90E+00	2.32E+01	NA	mg/kg	17	10	**N[A]**	
Dibenz(a,h)anthracene	1.60E+00	2.32E-02	NA	mg/kg	17	4	**Y**	1.60E+00
Dibenzofuran	8.30E-01	2.10E+01	NA	mg/kg	17	4	**N[A]**	
Di-n-butyl phthalate	1.00E-01	1.52E+03	NA	mg/kg	17	2	**N[A]**	
Fluoranthene	2.00E+01	2.42E+02	NA	mg/kg	17	12	**N[A]**	
Fluorene	1.30E-01	3.38E+02	NA	mg/kg	17	3	**N[A]**	
Indeno(1,2,3-cd)pyrene	5.40E+00	2.32E-01	NA	mg/kg	17	6	**Y**	5.40E+00
Naphthalene	3.10E-01	3.04E+01	NA	mg/kg	17	1	**N[A]**	
Phenanthrene	1.70E+01	NA[C]	NA	mg/kg	17	9	**N[C]**	
Pyrene	2.30E+01	1.81E+02	NA	mg/kg	13	11	**N[A]**	
Total PAH[G]	1.25E+01	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	1.25E+01
Technetium-99	3.60E+02	5.79E+01	2.80E+00	pCi/g	17	13	**Y**	2.47E+02
Thorium-228	4.65E-01	3.57E-02	1.60E+00	pCi/g	4	4	**Y**	4.65E-01
Thorium-230	4.88E+00	2.22E+00	1.40E+00	pCi/g	17	17	**Y**	2.56E+00
Thorium-232	4.55E-01	1.95E+00	1.50E+00	pCi/g	4	4	**N[A,B]**	
Neptunium-237	1.68E+00	3.28E-01	NA	pCi/g	17	10	**Y**	4.45E-01
Plutonium-239	6.20E-01	1.63E+00	NA	pCi/g	17	11	**N[A]**	
Uranium-234	1.15E+02	2.84E+00	2.40E+00	pCi/g	19	17	**Y**	6.81E+01
Uranium-235/236	1.66E+01	4.55E-01	1.40E-01	pCi/g	17	13	**Y**	1.14E+01
Uranium-238	5.65E+02	1.17E+00	1.20E+00	pCi/g	19	17	**Y**	2.02E+02

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable

Table F.18. Summary of COPC Screening for Detected Analytes – SWMU 145 Subsurface Soils

Analyte	Maximum Concentration	Excavation Worker NAL[J]	Background Concentration	Units	# of Analyses	# of Detects	COPC[J]	EPC[J]
Aluminum	1.27E+04	5.25E+03	1.20E+04	mg/kg	8	5	**Y**	1.27E+04
Antimony[I]	1.81E+01	4.92E-01	2.10E-01	mg/kg	8	5	**Y**	1.81E+01
Arsenic[I]	1.15E+01	3.24E-01	7.90E+00	mg/kg	17	12	**Y**	6.94E+00
Barium	3.00E+02	2.72E+02	1.70E+02	mg/kg	17	17	**Y**	1.34E+02
Beryllium	1.86E+00	1.26E+00	6.90E-01	mg/kg	17	7	**Y**	1.86E+00
Calcium	2.09E+04	NA[C]	6.10E+03	mg/kg	14	14	**N[D]**	
Chromium[I]	2.63E+01	4.76E+02	4.30E+01	mg/kg	17	17	**N[A,B]**	
Cobalt	5.96E+00	1.11E+03	1.30E+01	mg/kg	8	2	**N[A,B]**	
Copper	8.18E+01	4.27E+02	2.50E+01	mg/kg	8	8	**N[A]**	
Iron	1.55E+04	2.17E+03	2.80E+04	mg/kg	5	5	**N[B]**	
Lead	4.67E+01	4.00E+02[F]	2.30E+01	mg/kg	17	12	**N[A]**	
Magnesium	2.07E+03	NA[C]	2.10E+03	mg/kg	8	4	**N[D]**	
Manganese	6.71E+02	5.66E+01	8.20E+02	mg/kg	8	7	**N[B]**	
Mercury	2.04E-02	1.17E+00	1.30E-01	mg/kg	17	4	**N[A,B]**	
Molybdenum	3.39E+00	6.60E+01	NA	mg/kg	7	1	**N[A]**	
Nickel	9.89E+01	2.16E+02	2.20E+01	mg/kg	7	7	**N[A]**	
Potassium	6.86E+02	NA[C]	9.50E+02	mg/kg	2	2	**N[D]**	
Sodium	2.28E+02	NA[C]	3.40E+02	mg/kg	10	6	**N[D]**	
Uranium	5.93E+02	1.13E+01	4.60E+00	mg/kg	17	11	**Y**	6.75E+01
Vanadium	2.43E+01	4.40E+00	3.70E+01	mg/kg	8	4	**N[B]**	
Zinc	6.52E+01	2.66E+03	6.00E+01	mg/kg	12	8	**N[A]**	
Total PCB[H,I]	3.30E-01	1.68E-01	NA	mg/kg	NA[E]	NA	**Y**	1.44E+01
Total PAH[G]	4.80E-01[K]	2.32E-02	NA	mg/kg	NA[E]	NA	**Y**	4.80E-01
Cesium-137	7.10E-01	1.15E-01	2.80E-01	mg/kg	17	9	**Y**	2.38E-01
Neptunium-237	3.00E-02	3.28E-01	NA	mg/kg	17	2	**N[A]**	
Plutonium-239/240[I]	1.56E-01	1.63E+00	NA	mg/kg	17	2	**N[A]**	
Radium-226	1.60E-01	3.30E-02	1.50E+00	mg/kg	7	1	**N[B]**	
Stronium-90	4.00E+00	2.59E+00	NA	mg/kg	7	2	**Y**	4.00E+00
Technetium-99	8.20E+01	5.79E+01	2.80E+00	mg/kg	17	5	**Y**	8.20E+01
Thorium-228	4.61E-01	3.57E-02	1.60E+00	mg/kg	21	19	**N[B]**	
Thorium-230	4.50E+00	2.22E+00	1.40E+00	mg/kg	18	18	**Y**	1.73E+00
Thorium-232	5.38E-01	1.95E+00	1.50E+00	mg/kg	21	19	**N[A,B]**	
Uranium-234	4.70E-01	2.84E+00	2.40E+00	mg/kg	27	19	**N[A,B]**	
Uranium-235/236	2.20E+00	4.55E-01	1.40E-01	mg/kg	19	19	**Y**	6.91E-01
Uranium-238	3.26E+02	1.17E+00	1.20E+00	mg/kg	27	20	**Y**	8.05E+01

[A] Maximum concentration was below NAL
[B] Maximum concentration was below background concentration
[C] Compound does not have a NAL
[D] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Lead NAL from Draft PGDP Risk Methods Document (2008)
[G] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[H] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[I] These lower, more conservative NALs were used for the following compounds with more than 1 NAL listed in Table A.17 of the PGDP Risk Methods Document (2001): arsenic, inorganic; chromium (total); mercury, inorganic salts; nickel soluble salts; PCBs (total) (high risk); ^{239}Pu
[J] NAL = no action level, COPC = contaminant of potential concern, EPC = exposure point concentration, NA = not applicable
[K] Value represents method detection limit as there were no detections for PAHs in accordance with the PGDP Risk Methods Document (2001)

Table F.19. Summary of COPC Screening for Detected Analytes – SWMU 2 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Metals (mg/kg)					
Aluminum	NA[G]		1.10E+04	5/5	No
Arsenic	1.05E-03	Yes	3.00E+01	21/21	Yes
Barium	NA[G]		3.50E+02	21/21	No
Beryllium	2.11E+00	No	1.80E+00	22/23	No
Calcium[B]	NA[G]		2.40E+03	3/3	No
Chromium	3.17E+06	No	3.00E+01	21/21	No
Cobalt	NA[G]		4.74E+00	3/3	No
Copper	NA[G]		7.80E+00	3/3	No
Iron	NA[G]		4.10E+04	3/3	No
Lead	NA[G]		2.90E+01	4/4	No
Magnesium[B]	NA[G]		1.60E+03	3/3	No
Manganese	2.26E+00	Yes	1.20E+03	21/21	Yes
Mercury	2.22E-02	Yes	1.40E-01	1/3	Yes
Nickel	1.98E+00	Yes	3.70E+01	21/21	Yes
Potassium[B]	NA[G]		9.40E+02	2/2	No
Sodium[B]	NA[G]		2.01E+02	3/3	No
Thallium	NA[G]		4.50E+00	12/21	No
Uranium	NA[G]		1.50E+03	12/50	Yes
Vanadium	9.25E+00	Yes	3.80E+01	21/21	Yes
Zinc	2.78E+01	Yes	1.40E+02	3/3	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	4.35E+00	NA[E]	Yes
Total PAH[D]	NA[G]		1.67E-01	NA[E]	Yes
alpha-Chlordane	NA[G]		7.80E-04	1/3	No
delta-BHC	NA[G]		6.50E-03	1/6	No
gamma-Chlordane	NA[G]		3.00E-03	2/3	No
Benzo(a)pyrene	1.95E-03	Yes	1.40E-01	1/3	Yes
Benzo(b)fluoranthene	NA[G]		2.70E-01	2/3	No
Benzo(ghi)perylene	NA[G]		1.50E-01	1/3	No
Dibenzofuran	NA[G]		1.80E-01	2/3	No
Naphthalene	1.21E-03	Yes	1.80E-01	1/2	Yes
Phenanthrene	NA[G]		5.70E-01	2/3	No
Pyrene	3.81E+00	No	2.00E-01	1/2	Yes
cis-1,2-DCE	NA[G]		1.30E+02	4/23	No
Methylene chloride	NA[G]		1.30E-03	3/4	No
TCE	9.69E-04	Yes	1.40E+02	8/50	Yes
Vinyl Chloride	1.17E-05	Yes	1.40E+00	1/21	Yes
Radionuclides (pCi/g)					
Americium-241	3.89E+07	No	4.65E+00	54/55	No
Cesium-137[F]	NA[G]		5.10E+01	16/55	No
Neptunium-237	6.20E+03	No	3.10E-01	51/54	No
Plutonium-238	4.62E+04	No	1.30E-01	1/1	No
Plutonium-239	4.46E+00	Yes	1.61E+01	21/55	Yes
Technetium-99	2.63E+01	No	1.46E+01	54/54	Yes
Uranium-234	1.22E+01	Yes	1.55E+02	55/55	Yes
Uranium-235/236	1.14E+01	Yes	2.58E+01	55/55	Yes
Uranium-238	8.62E+00	Yes	9.47E+02	55/55	Yes

Table F.19. Summary of COPC Screening for Detected Analytes – SWMU 2 Groundwater (Continued)

[A] Based on a residential child with dilution attenuation factor (DAF) = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as actual analytical value and EPC reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake per Section 5 of main text and Appendix E
[G] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.20. Summary of COPC Screening for Detected Analytes – SWMU 3 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Metals (mg/kg)					
Aluminum	NA[F]		1.18E+04	55/55	No
Antimony	2.54E-02	Yes	1.57E+01	6/55	Yes
Arsenic	1.05E-03	Yes	1.37E+01	50/55	Yes
Barium	NA[F]		1.27E+02	57/57	No
Beryllium	2.11E+00	No	1.06E+00	5/55	No
Calcium[B]	NA[F]		3.56E+04	56/57	No
Chromium	3.17E+06	No	3.57E+01	57/57	No
Cobalt	NA[F]		2.00E+01	42/58	No
Copper	NA[F]		3.00E+01	57/57	No
Iron	NA[F]		4.20E+04	57/57	No
Lead	NA[F]		2.39E+01	56/56	No
Magnesium[B]	NA[F]		2.50E+03	57/57	No
Manganese	2.26E+00	Yes	6.44E+02	57/57	Yes
Mercury	2.22E-02	Yes	2.40E-02	9/56	Yes
Nickel	1.98E+00	Yes	1.61E+01	11/56	Yes
Sodium[B]	NA[F]		4.45E+02	24/56	No
Thallium	NA[F]		6.10E-01	1/57	No
Uranium	NA[F]		8.36E+01	19/58	Yes
Vanadium	9.25E+00	Yes	3.37E+01	56/57	Yes
Zinc	2.78E+01	Yes	5.00E+01	31/57	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02		7.10E-04	NA[D]	No
TCE	9.69E-04	Yes	4.28E-01	4/56	Yes
Radionuclides (pCi/g)					
Americium-241	3.89E+07	No	8.00E-02	2/57	No
Cesium-137[E]	NA[F]		4.56E-01	2/55	No
Plutonium-239	4.46E+00	No	5.62E-02	3/57	No
Technetium-99	2.63E+01	Yes	5.69E+01	8/57	Yes
Uranium-234	1.22E+01	No	3.02E+00	25/57	No
Uranium-238	8.62E+00	Yes	2.24E+01	29/57	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as method detection limit as there were no detections for Total PCB
[D] Detection frequencies are not applicable to Total PCB as it represents a group of compounds
[E] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake, per Section 5 of main text and Appendix E
[F] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.21. Summary of COPC Screening for Detected Analytes – SWMU 4 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Inorganic Chemicals (Metals) (mg/kg)					
Aluminum	NA[G]		1.90E+04	139/139	No
Arsenic	1.05E-03	Yes	1.71E+01	16/138	Yes
Barium	NA[G]		3.13E+02	139/139	No
Beryllium	2.11E+00	No	2.02E+00	96/139	No
Calcium[B]	NA[G]		1.31E+05	138/138	No
Chromium	3.17E+06	No	2.96E+02	139/139	No
Cobalt	NA[G]		3.16E+01	137/139	No
Copper	NA[G]		4.64E+01	134/139	No
Iron	NA[G]		4.19E+04	139/139	No
Lead	NA[G]		3.02E+01	4/139	No
Magnesium[B]	NA[G]		2.65E+03	138/139	No
Manganese	2.26E+00	Yes	2.70E+03	138/139	Yes
Mercury	2.22E-02	Yes	4.50E-01	1/139	No
Nickel	1.98E+00	Yes	1.53E+02	95/139	Yes
Potassium[B]	NA[G]		2.39E+03	139/139	No
Sodium[B]	NA[G]		3.15E+03	83/139	No
Uranium	NA[G]		2.05E+04	8/36	Yes
Vanadium	9.25E+00	Yes	7.55E+01	139/139	Yes
Zinc	2.78E+01	Yes	9.37E+01	116/139	Yes
Organic Compounds (mg/kg)					
Total PCB[c]	4.92E-02	Yes	2.83E+01	NA[E]	Yes
Total PAH[D]	NA[G]		4.10E-01	NA[E]	Yes
PCB-1254	7.67E-03	Yes	2.70E+01	7/184	Yes
PCB-1260	2.49E-02	Yes	5.00E-01	7/184	Yes
Bis(2-ethylhexyl)phthalate	NA[G]		7.47E-01	6/139	No
Diethyl phthalate	NA[G]		2.80E+00	2/139	No
Di-n-butyl phthalate	NA[G]		6.10E+00	22/139	No
1,1,2-TCA	NA[G]		2.10E-02	1/115	No
1,1-DCE	1.95E-05	Yes	1.40E-02	1/339	Yes
Chloroform	8.32E-06	Yes	0.012	1/113	No
cis-1,2-DCE	7.80E-04	Yes	9.8	23/338	Yes
trans-1,2-DCE	1.86E-03	Yes	0.45	1/339	No
TCE	9.69E-04	Yes	4.10E+01	47/335	Yes
Vinyl chloride	1.17E-05	Yes	0.29	7/339	Yes
Radionuclides (pCi/g)					
Cesium-137[F]	NA[G]		1.81E+02	8/179	No
Technetium-99	2.63E+01	Yes	2.69E+02	15/200	Yes
Neptunium-237	6.20E+03	No	5.78E+00	13/47	No
Plutonium-239	4.46E+00	Yes	2.71E+01	10/48	Yes
Uranium-234	1.22E+01	Yes	6.90E+01	21/29	Yes
Uranium-235	1.14E+01	No	4.20E+00	1/171	No
Uranium-238	8.62E+00	Yes	1.26E+02	21/29	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake, per Section 5 of main text and Appendix E
[G] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.22. Summary of COPC Screening for Detected Analytes – SWMU 5 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Metals (mg/kg)					
Aluminum	NA[G]		1.64E+04	84/84	No
Arsenic	1.05E-03	Yes	1.22E+01	24/85	Yes
Barium	NA[G]		3.43E+02	85/85	No
Beryllium	2.11E+00	Yes	2.59E+00	41/84	No
Calcium[B]	NA[G]		2.07E+05	84/84	No
Chromium	3.17E+06	No	2.96E+02	84/85	No
Cobalt	NA[G]		2.85E+01	69/84	No
Copper	NA[G]		1.44E+01	82/84	No
Iron	NA[G]		3.29E+04	84/84	No
Lead	NA[G]		2.00E+02	18/85	No
Magnesium[B]	NA[G]		4.78E+03	84/84	No
Manganese	2.26E+00	Yes	1.75E+03	84/84	Yes
Mercury	2.22E-02	Yes	3.60E-02	1/85	No
Nickel	1.98E+00	Yes	1.35E+02	69/85	Yes
Potassium[B]	NA[G]		1.89E+03	55/55	No
Selenium	3.92E-02	Yes	1.23E+00	2/85	Yes
Silver	6.67E-02	Yes	5.14E+00	1/85	No
Sodium[B]	NA[G]		3.89E+02	37/72	No
Uranium	NA[G]		2.17E+02	6/29	Yes
Vanadium	9.25E+00	Yes	5.69E+01	84/84	Yes
Zinc	2.78E+01	Yes	1.63E+02	54/84	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	3.06E-01	NA[E]	Yes
Total PAH[D]	NA[G]		1.15E+02	NA[E]	Yes
Acenaphthene	1.92E-01	Yes	3.20E+01	18/96	Yes
Acenaphthylene	NA[G]		9.45E+00	2/96	No
Anthracene	4.53E+00	Yes	4.00E+01	20/96	Yes
Benz(a)anthracene	NA[G]		1.30E+02	30/96	No
Benzo(a)pyrene	1.95E-03	Yes	8.00E+01	30/96	Yes
Benzo(b)fluoranthene	NA[G]		1.70E+02	29/96	No
Benzo(ghi)perylene	NA[G]		2.80E+01	26/97	No
Benzo(k)fluoranthene	NA[G]		1.17E+01	6/55	No
Bis(2-ethylhexyl)phthalate	NA[G]		5.70E+00	23/96	No
Carbazole	NA[G]		7.10E+01	10/96	No
Chrysene	NA[G]		9.50E+01	30/96	No
Dibenz(a,h)anthracene	NA[G]		7.49E-01	2/55	Yes
Dibenzofuran	NA[G]		3.52E+00	3/55	No
Di-n-butyl phthalate	NA[G]		7.30E+00	27/55	No
Fluoranthene	4.67E+00	Yes	2.00E+01	3/34	No
Fluorene	2.66E-01	Yes	2.80E+01	16/96	Yes
2-Methylnaphthalene	NA[G]		7.30E+00	2/96	No
Naphthalene	1.21E-03	Yes	1.60E+01	3/96	Yes
Phenanthrene	NA[G]		6.40E+01	31/96	No
Pyrene	3.81E+00	Yes	1.50E+02	35/96	Yes
1,1-DCE	1.95E-05	Yes	2.80E+00	1/102	Yes
TCE	9.69E-04	Yes	5.10E-03	12/102	Yes
Radionuclides (pCi/g)					
Cesium-137[F]	NA[G]		2.80E+00	23/61	No
Technetium-99	2.63E+01	No	1.73E+01	52/90	Yes
Uranium-234	1.22E+01	No	1.47E+00	11/40	No
Uranium-235	1.14E+01	No	6.40E+00	10/31	No
Uranium-238	8.62E+00	No	2.26E+00	21/40	No

Table F.22. Summary of COPC Screening for Detected Analytes – SWMU 5 Groundwater (Continued)

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake, per Section 5 of main text and Appendix E
[G] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.23. Summary of COPC Screening for Detected Analytes – SWMU 6 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Metals (mg/kg)					
Aluminum	NA[F]		2.25E+04	85/85	No
Arsenic	1.05E-03	Yes	6.38E+00	25/85	Yes
Barium	NA[F]		1.53E+02	85/85	No
Beryllium	2.11E+00	Yes	3.07E+00	41/85	Yes
Chromium	3.17E+06	No	1.16E+02	85/85	No
Cobalt	NA[F]		1.56E+02	76/85	No
Copper	NA[F]		2.13E+01	82/85	No
Iron	NA[F]		5.87E+04	85/85	No
Lead	NA[F]		3.54E+01	24/85	No
Magnesium	NA[F]		4.41E+03	85/85	No
Manganese[B]	2.26E+00	Yes	1.55E+03	85/85	Yes
Nickel	1.98E+00	Yes	6.86E+01	52/85	Yes
Uranium	NA[F]		1.23E+00	16/33	Yes
Vanadium	9.25E+00	Yes	7.91E+01	84/85	Yes
Zinc	2.78E+01	Yes	1.28E+02	57/85	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	6.00E-02	NA[E]	Yes
Total PAH[D]	NA[F]		4.99E-01	NA[E]	Yes
Anthracene	4.53E+00	No	1.56E-01	1/62	No
Benz(a)anthracene	NA[F]		2.55E-01	2/62	No
Benzo(a)pyrene	1.95E-03	Yes	4.02E-01	1/62	Yes
Benzo(b)fluoranthene	NA[F]		5.00E-01	2/62	No
Benzo(ghi)perylene	NA[F]		1.24E-01	2/62	No
Bis(2-ethylhexyl)phthalate	NA[F]		6.00E-01	3/62	No
Fluoranthene	4.67E+00	No	6.36E-01	2/55	No
Pyrene	3.81E+00	No	6.63E-01	2/62	No
Acetone	NA[F]		8.50E-02	6/48	No
TCE	9.69E-04	Yes	1.01E-02	5/115	Yes
Radionuclides (pCi/g)					
Technetium-99	2.63E+01	No	1.88E+01	3/90	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as method detection limit as there were no detections for Total PCB
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.24. Summary of COPC Screening for Detected Analytes – SWMU 7 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Metals (mg/kg)					
Aluminum	NA[G]		1.60E+04	83/83	No
Arsenic	1.05E-03	Yes	1.60E+01	72/83	Yes
Barium	NA[G]		1.80E+02	83/83	No
Beryllium	2.11E+00	No	1.55E+00	29/85	No
Cadmium	5.02E-02	Yes	1.30E+00	12/83	Yes
Calcium[B]	NA[G]		2.10E+05	83/83	No
Chromium	3.17E+06	No	5.58E+01	83/85	No
Cobalt	NA[G]		1.77E+01	56/83	No
Copper	NA[G]		9.90E+01	70/83	No
Iron	NA[G]		3.47E+04	83/83	No
Lead	NA[G]		1.20E+02	83/83	No
Magnesium[B]	NA[G]		3.30E+03	83/83	No
Manganese	2.26E+00	Yes	1.20E+03	83/83	Yes
Mercury	2.22E-02	Yes	9.20E-02	22/85	Yes
Nickel	1.98E+00	Yes	1.40E+02	58/83	Yes
Potassium[B]	NA[G]		8.70E+02	20/20	No
Selenium	3.92E-02	Yes	8.80E-01	8/83	Yes
Sodium[B]	NA[G]		4.00E+02	47/83	No
Silver	6.67E-02	Yes	1.90E+00	7/83	No
Thallium	NA[G]		2.00E+00	17/83	No
Tin	NA[G]		1.50E+01	20/20	No
Uranium	NA[G]		1.27E+03	31/85	Yes
Vanadium	9.25E+00	Yes	5.20E+01	76/83	Yes
Zinc	2.78E+01	Yes	2.40E+02	47/83	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	1.81E+01	NA[E]	Yes
Total PAH[D]	NA[G]		6.37E+00	NA[E]	Yes
PCB-1254	7.67E-03	Yes	1.30E-01	4/86	Yes
PCB-1260	2.49E-02	Yes	2.45E+00	13/86	Yes
1,2,4-Trichlorobenzene	NA[G]		7.70E-02	2/80	No
1,4-Dichlorobenzene	NA[G]		7.00E-02	2/88	No
2,4,6-Trichlorophenol	NA[G]		4.10E-02	2/160	No
2-Methylphenol	NA[G]		2.00E-02	1/17	No
3-Methylcholanthrene	NA[G]		1.10E-01	1/17	No
4-Methylphenol	NA[G]		1.60E-02	1/17	No
Acenaphthene	1.92E-01	Yes	4.40E-01	2/80	Yes
Acenaphthylene	NA[G]		1.90E-02	1/80	No
Benz(a)anthracene	NA[G]		4.30E+00	7/80	No
Benzo(a)pyrene	1.95E-03	Yes	4.10E+00	7/80	Yes
Benzo(b)fluoranthene	NA[G]		5.20E+00	7/80	No
Benzo(ghi)perylene	NA[G]		3.80E+00	3/80	No
Benzo(k)fluoranthene	NA[G]		1.70E+00	6/80	No
Bis(2-ethylhexyl)phthalate	NA[G]		3.90E-01	2/80	No
Chrysene	NA[G]		4.20E+00	7/80	No
Dibenz(a,h)anthracene	NA[G]		9.20E-01	1/80	Yes
Di-n-octylphthalate	NA[G]		7.20E-02	1/80	No
Fluoranthene	4.67E+00	Yes	7.90E+00	8/80	No
Fluorene	2.66E-01	Yes	4.10E-01	1/80	Yes
Hexachloroethane	NA[G]		3.40E-02	1/80	No
Indeno(1,2,3-cd)pyrene	NA[G]		3.80E+00	3/80	No
Naphthalene	1.21E-03	Yes	5.60E-02	1/80	Yes
Pentachlorophenol	NA[G]		6.90E-02	1/80	No

Table F.24. Summary of COPC Screening for Detected Analytes – SWMU 7 Groundwater (Continued)

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Organic Compounds (mg/kg)(Continued)					
Pyrene	3.81E+00	Yes	9.00E+00	9/80	Yes
1,1,1-TCA	NA[G]		1.59E+02	2/71	No
1,1,2-TCA	NA[G]		1.49E+02	2/71	No
1,1-DCE	1.95E-05	Yes	1.66E+00	4/71	Yes
1,2-Dichloroethane	NA[G]		1.63E+01	2/71	No
Acetone	NA[G]		8.37E+01	10/71	No
cis-1,2-DCE	7.80E-04	Yes	6.84E-01	15/71	No
Methylene chloride	NA[G]		5.70E+00	5/71	No
Tetrachloroethene	3.38E-04	Yes	6.20E-03	1/71	No
Vinyl chloride	1.17E-05	Yes	5.85E-01	5/71	Yes
Radionuclides (pCi/g)					
Americium-241	3.89E+07	No	2.00E+00	3/64	No
Cesium-137[F]	NA[G]	No	1.83E-01	3/64	No
Neptunium-237	6.20E+03	No	7.20E-01	26/86	No
Plutonium-239	4.46E+00	No	6.80E-01	19/86	No
Technetium-99	2.63E+01	Yes	4.06E+02	37/84	Yes
Uranium-234	1.22E+01	Yes	3.18E+02	59/94	Yes
Uranium-235	1.14E+01	No	6.03E+00	22/22	No
Uranium-238	8.62E+00	Yes	2.39E+03	53/94	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake, per Section 5 of main text and Appendix E
[G] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.25. Summary of COPC Screening for Detected Analytes – SWMU 30 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Inorganic Chemicals (Metals) (mg/kg)					
Aluminum	NA[F]		1.90E+04	33/33	No
Arsenic	1.05E-03	Yes	1.20E+01	30/33	Yes
Barium	NA[F]		1.70E+02	35/35	No
Beryllium	2.11E+00	No	1.48E+00	15/33	No
Cadmium	5.02E-02		2.80E+00	6/35	Yes
Calcium[B]	NA[F]		2.40E+04	33/33	No
Chromium	3.17E+06	No	4.90E+01	35/35	No
Cobalt	NA[F]		1.40E+01	25/33	No
Copper	NA[F]		1.70E+02	32/33	No
Iron	NA[F]		2.90E+04	33/33	No
Lead	NA[F]		7.10E+01	33/35	No
Magnesium[B]	NA[F]		2.20E+03	33/33	No
Manganese	2.26E+00	Yes	1.20E+03	33/33	Yes
Mercury	2.22E-02	Yes	1.70E-01	12/35	Yes
Nickel	1.98E+00	Yes	5.70E+02	29/33	Yes
Potassium[B]	NA[F]		1.50E+03	12/12	No
Selenium	3.92E-02	Yes	1.00E+00	28/35	Yes
Sodium[B]	NA[F]		1.87E+02	9/33	No
Thallium	NA[F]		1.80E+00	5/35	No
Uranium	NA[F]		1.40E+03	16/33	Yes
Vanadium	9.25E+00	Yes	4.00E+01	32/33	Yes

Table F.25. Summary of COPC Screening for Detected Analytes – SWMU 30 Groundwater (Continued)

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Zinc	2.78E+01	Yes	7.50E+02	11/33	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	7.60E-01	NA[E]	Yes
Total PAH[D]	NA[F]		1.25E+01	NA[E]	Yes
PCB-1260	2.49E-02	Yes	1.50E+01	12/36	Yes
Acenaphthene	1.92E-01	Yes	1.70E+00	5/34	Yes
Acenaphthylene	NA[F]		9.10E-02	3/34	No
Anthracene	4.53E+00	No	3.20E+00	3/34	No
Benz(a)anthracene	NA[F]		9.10E+00	10/34	No
Benzo(a)pyrene	1.95E-03	Yes	8.40E+00	7/34	Yes
Benzo(b)fluoranthene	NA[F]		9.60E+00	8/34	No
Benzo(ghi)perylene	NA[F]		5.20E+00	6/34	No
Benzo(k)fluoranthene	NA[F]		4.30E+00	7/34	No
Benzoic acid	NA[F]		5.00E+02	7/34	No
Bis(2-ethylhexyl)phthalate	NA[F]		6.20E-01	2/34	No
2-Chlorophenol	NA[F]		2.30E-02	1/34	No
Chrysene	NA[F]		9.90E+00	9/34	No
Dibenz(a,h)anthracene	NA[F]		1.60E+00	30/34	Yes
Dibenzofuran	NA[F]		8.30E-01	3/34	No
Di-n-butyl phthalate	NA[F]		1.00E-01	2/34	No
Fluoranthene	NA[F]		2.00E+01	3/34	No
Fluorene	NA[F]		1.30E+00	3/34	Yes
Indeno(1,2,3-cd)pyrene	NA[F]		5.40E+00	6/34	No
2-Methylnaphthalene	NA[F]		2.70E-01	2/34	No
Naphthalene	NA[F]		3.10E-01	1/34	Yes
Phenanthrene	NA[F]		1.70E+01	9/34	No
Pyrene	3.81E+00	Yes	2.30E+01	11/34	Yes
1,2,4-Trichlorobenzene	NA[F]		3.30E-02	1/54	No
1,1-DCE	1.95E-05	Yes	5.00E-03	1/28	Yes
1,4-Dichlorobenzene	NA[F]		2.50E-02	1/39	No
Acetone	NA[F]		1.80E-02	3/26	No
TCE	9.69E-04	Yes	3.74E-02	1/28	Yes
Radionuclides (pCi/g)					
Neptunium-237	6.20E+03	No	1.68E+00	9/33	No
Plutonium-239	4.46E+00	No	6.20E-01	11/33	No
Technetium-99	2.63E+01	Yes	3.60E+02	13/34	Yes
Uranium-234	1.22E+01	Yes	1.15E+02	27/34	Yes
Uranium-235	1.14E+01	Yes	1.66E+01	14/34	Yes
Uranium-238	8.62E+00	Yes	5.65E+02	24/36	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)

Table F.26. Summary of COPC Screening for Detected Analytes – SWMU 145 Groundwater

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Inorganic Chemicals (Metals)(mg/kg)					
Aluminum	NA[F]		1.62E+04	74/74	No
Antimony	2.54E-02	Yes	2.02E+01	18/74	Yes
Arsenic	1.05E-03	Yes	2.19E+01	52/79	Yes
Barium	NA[F]		3.00E+02	88/88	No

Table F.26. Summary of COPC Screening for Detected Analytes – SWMU 145 Groundwater (Continued)

Analyte	Soil SSL Protective of Groundwater[A]	Exceed SSL	Maximum Detection	Detection Frequency	Included as COPC
Beryllium	2.11E+00	No	2.08E+00	50/89	No
Cadmium	5.02E-02	Yes	2.47E+00	13/89	Yes
Calcium[B]	NA[F]		8.30E+04	74/74	No
Chromium	3.17E+06	No	1.20E+02	89/89	No
Cobalt	NA[F]		2.05E+01	70/89	No
Copper	NA[F]		1.35E+02	72/74	No
Iron	NA[F]		3.14E+04	74/74	No
Lead	NA[F]		4.67E+01	68/88	No
Magnesium[B]	NA[F]		2.35E+03	74/74	No
Manganese	2.26E+00	Yes	1.90E+03	74/74	Yes
Mercury	2.22E-02	Yes	4.70E-01	31/89	Yes
Molybdenum	NA[F]		3.39E+00	13/32	No
Nickel	1.98E+00	Yes	1.01E+02	65/74	Yes
Potassium[B]	NA[F]		1.30E+03	32/34	No
Selenium	3.92E-02	Yes	1.10E+00	2/86	Yes
Sodium[B]	NA[F]		6.93E+02	46/70	No
Silver	6.67E-02	Yes	1.96E+01	3/88	No
Thallium	NA[F]		1.20E+00	14/74	No
Uranium	NA[F]		3.11E+02	26/55	Yes
Vanadium	9.25E+00	Yes	6.52E+01	54/74	Yes
Zinc	2.78E+01	Yes	2.61E+02	52/79	Yes
Organic Compounds (mg/kg)					
Total PCB[C]	4.92E-02	Yes	1.44E+01	NA[E]	Yes
Total PAH[D]	NA[F]		5.31E-02	NA[E]	Yes
PCB-1260	2.49E-02	Yes	1.25E+01	3/90	Yes
Benz(a)anthracene	NA[F]		5.00E-02	1/14	No
Benzo(a)pyrene	1.95E-03	Yes	4.40E-02	1/13	Yes
Benzo(b)fluoranthene	NA[F]		4.00E-02	1/13	No
Chrysene	NA[F]		6.70E-02	1/13	No
Di-n-butyl phthalate	NA[F]		8.10E-01	1/9	No
Fluoranthene	4.67E+00	No	1.30E-01	1/9	No
Phenanthrene	NA[F]		1.10E-01	1/13	No
Pyrene	3.81E+00	No	8.40E-02	1/13	No
1,2-Dimethylbenzene	NA[F]		3.60E-02	2/62	No
2-Butanone	NA[F]		1.13E-02	3/64	No
4-Methyl-2-pentanone	NA[F]		1.50E-02	1/64	No
Acetone	NA[F]		1.16E-01	20/64	No
Ethylbenzene	4.48E-03	Yes	1.80E-02	3/64	No
m,p-Xylene	6.35E-02	No	0.022	2/62	No
Toluene	NA[F]		0.037	5/63	No
Methylene chloride	NA[F]		3.00E-03	2/64	No
Radionuclides (pCi/g)					
Americium-241	3.89E+07	No	1.10E+01	13/79	No
Cesium-137[G]	NA[F]	No	5.34E-01	14/67	No
Neptunium-237	6.20E+03	No	1.22E+00	18/86	No
Plutonium-239	4.46E+00	Yes	1.01E+01	21/75	Yes
Technetium-99	2.63E+01	Yes	2.81E+02	26/79	Yes
Uranium-234	1.22E+01	Yes	2.54E+02	58/86	Yes
Uranium-235	1.14E+01	Yes	1.66E+01	25/71	Yes
Uranium-238	8.62E+00	Yes	3.26E+02	59/86	Yes

[A] Based on a residential child with DAF = 1 (DOE 2001)
[B] Compound is considered an essential nutrient and has been excluded as a COPC in accordance with the PGDP Risk Methods Document (2001)
[C] Total PCB maximum concentration reported as sum of all detected aroclors
[D] Total PAH reported as benzo(a)pyrene toxicity equivalence factor (TEF)
[E] Detection frequencies are not applicable to Total PCB and Total PAH as they represent groups of compounds
[F] SSL not listed in Table A.7 of PGDP Risk Methods Document (2001)
[G] Not applicable as the radionuclide does not reach groundwater within 10,000 years precluding receptor uptake, per Section 5 of the main text and Appendix E

F.3. EXPOSURE ASSESSMENT

This section describes the exposure assessment used to determine the pathways of exposure that were considered for the surface and subsurface soil at the source units that are part of the BGOU RI. Specifically, the exposure assessment process is delineated, the exposure settings of the BGOU are described, the routes of exposure are outlined, and the daily intakes and doses are derived. The ultimate products presented in this section are the CSM for the BGOU and the CDIs used when calculating ELCR and HI in Section 5.

F.3.1 DESCRIPTION OF THE EXPOSURE ASSESSMENT PROCESS

Exposure is the contact of an organism with a chemical or physical agent. The magnitude of exposure (i.e., dose) is determined by measuring or estimating the amount of an agent available at exchange boundaries (e.g., gut, skin, etc.) during a specified period. Exposure assessment is a process that uses information about the exposure setting and human activities to develop CSMs under current and potential future conditions.

The first step in the exposure assessment is to characterize the exposure setting. This includes describing the activities of the human population (on or near a site) that may affect the extent of exposure and the physical characteristics of the site. During this process, sensitive subpopulations that may be present at the site or that may be exposed to contamination migrating from the site also are considered. Generally, site characterization results in a qualitative evaluation of the site and the surrounding population.

The second step in the exposure assessment is to identify exposure pathways. Exposure pathways describe the path a contaminant travels from its source to an individual. A complete exposure pathway includes all links between the source and the exposed population; therefore, a complete pathway consists of a source of release, a mechanism of release, a transport medium, a point of potential human contact, and an exposure route.

The third step in the exposure assessment is to calculate dose by quantifying the magnitude, frequency, and duration of exposure for the populations for the exposure pathways selected for quantitative evaluation. This step involves using the EPCs developed for each COPC to quantify the pathway-specific CDIs for that COPC.

F.3.2 CHARACTERIZATION OF THE EXPOSURE SETTING

The first step in evaluating exposure is to characterize surface features, meteorology, geology, demography and land use, ecology, hydrology, and hydrogeology of the area inhabited by potential receptors. These aspects are discussed in Chapter 3 of this RI report. Physical descriptions of SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145 are summarized within this exposure assessment to support later discussions of the conceptual model and its uncertainties.

F.3.2.1 C-749 Uranium Burial Ground (SWMU 2)

The C-749 Uranium Burial Ground (SWMU 2) is located within the west-central portion of the plant, north of Virginia Avenue. SWMU 2 encompasses an area of approximately 32,000 ft^2, with approximate dimensions of 160 ft by 200 ft. Records indicate that when the burial ground was in use, pits were excavated to an estimated depth of 7 to 17 ft. After the burial ground no longer was in use, the area was covered with a 6-inch thick clay cap and an 18-inch thick soil layer covered with vegetation (DOE 1995).

F.3.2.2 C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3)

The C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3) includes 1.2 acres located in the west-central portion of the plant area. The unit originally was constructed as a rectangular, aboveground, surface impoundment measuring 387 ft by 137 ft with a floor area of approximately 53,000 ft^2. The floor of the surface impoundment was constructed of well-tamped earth and clay dikes to a height of 6 ft. The C-404 impoundment was designed with an overflow weir at its southwest corner. From the weir, the surface impoundment effluent flowed west in a ditch [not the North-South Diversion Ditch (NSDD)] and eventually discharged into Kentucky Pollutant Discharge Elimination System Outfall 015

In March 2003, an additional 37,000 ft^2 of area were added to the SWMU when a northeast-southwest ditch just east of SWMU 3 was included as part of the SWMU. This ditch was impacted by the discharge of a now-abandoned pipeline with historic leachate flow into the NSDD (DOE 2003). When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. The sump was used to pump leachate into an underground transfer line. The transfer line discharged into a northeast-southwest ditch just east of C-404. From this ditch, the leachate flowed into the NSDD. The date of termination of the leachate discharge from the underground transfer line to the NSDD has not been determined. However, it is known that, prior to landfill closure in 1986, this underground transfer line into the NSDD was not in operation, and leachate from the C-404 Landfill was being collected in the sump for treatment at C-400. The wastewater from the treatment of the leachate was discharged to C-403 and, ultimately, to the NSDD. At some time following closure of C-404 Landfill, treatment of leachate from C-404 at C-400 was discontinued and treatment of the leachate was transferred to the C-752 Remedial Action Waste Holding Facility.

F.3.2.3 C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4)

The C-747 Contaminated Burial Yard and the C-748-B Burial Area (SWMU 4) is located in the western section of the plant area. SWMU 4 (which covers an area of approximately 286,700 ft^2) is bounded on the north by Virginia Avenue, on the east by 6th Street, on the west by 4th Street, and on the south by an active railroad spur. This SWMU is an open grass field that, at one time, was used for the burial and disposal of various waste materials in designated burial cells. There have been no permanent structures built on the site. SWMU 4 is bounded on three sides (north, east, and west) by shallow drainage swales that direct surface runoff to the northwest corner of the site. There is an elevation difference of approximately 10 ft between the highest point in the SWMU and the adjacent drainage swales. The entire burial yard was covered with 2 to 3 ft of soil material and a 6-inch clay cap was placed over the area in 1982 (DOE 1998a).

F.3.2.4 C-746-F Burial Yard (SWMU 5)

The C-746-F Burial Yard is located in the northwestern section of PGDP. SWMU 5 (which covers an area of approximately 197,400 ft^2) is located adjacent to the C-746-P Scrap Yard to the north and SWMU 6 to the east. Disposal pits were located on a grid system. Documentation of the size of these grids ranges from 10 ft by 10 ft cells to 20 ft by 20 ft cells excavated to a depth of 6 to 15 ft bgs. Waste placed in the yard disposal pits was covered with 2 to 3 ft of soil. SWMU 5 is fenced to limit access to authorized personnel only. The ground surface is covered with short grasses and various flowering herbaceous plants (DOE 1998a). The suspected burial area within this SWMU starts approximately 120 ft east of the western boundary of the SWMU and extends to the eastern boundary of the SWMU.

F.3.2.5 C-747-B Burial Ground (SWMU 6)

The C-747-B Burial Ground is located in the northwestern section of the plant area east of SWMU 5. SWMU 6 was in operation from 1960 to 1976. The entire burial area covers an area of approximately 13,500 ft^2, which is divided into five separate burial cells (Areas H, I, J, K, and L). The following are the dimensions of each of the cells.

- Area H—This disposal site covers an area of about 12 ft by 15 ft and is about 6 ft deep. A 3 ft cover of soil was placed on top of the buried drums.
- Area I—This discard pit is approximately 8 ft by 35 ft and is about 8 ft deep. The waste was covered with about 5 ft of soil.
- Area J—This burial site is about 4,000 ft^2 (37 ft by 110 ft) and was excavated to a depth of about 6 ft. The area was covered with about 3 ft of soil.
- Area K—This disposal site consists of an area of about 12 ft by 15 ft and is about 6 ft deep. A 3 ft cover of soil was placed on top of the buried drums.
- Area L—This burial area is about 20 ft by 30 ft and about 6 ft deep. The disposed waste was covered with about 3 ft of soil.

This area is relatively flat and is bounded to the north by the roadbed of an abandoned railroad track, to the east by a 5-ft-wide by 4-ft-deep drainage ditch that drains into Ditch 001, and unnamed gravel roads to the west and south. The ground surface is covered by medium to tall grasses (up to 3 ft high).

F.3.2.6 C-747-A Burial Ground (SWMU 7)

The C-747-A area is located in the northwest corner of PGDP. SWMU 7 comprises the eastern two-thirds of C-747-A. The SWMU is bounded on the north and south sides by perimeter ditches, on the west side by the C-747-A Burn Area (SWMU 30), and on the east side by the C-746-E Contaminated Scrap Yard. SWMU 7 covers approximately 240,900 ft^2 and includes five discrete burial pit areas (Burial Pits B, C, D, F, and G) (DOE 1998b).

Records indicate the burial pits were excavated to a depth of 6 to 7 ft bgs, filled with wastes, and covered with approximately 3 ft of earth; however, the Phase II Site Investigation (SI) discovered waste to a depth of 10 ft on the west side of Burial Pit B, and borings sampled waste to a minimum depth of 8 ft in Burial Pit C (Union Carbide 1978). A stockpile of radiologically-contaminated scrap drums, locally known as Drum Mountain, formerly was located on the southeast corner.

The land surface slopes within SWMU 7. Burial Pits B and C form a slight hill on the north side of SWMU 7, and Burial Pit F forms a lesser mound on the south side of the SWMU. Pit D underlies a level area north of where Drum Mountain once was located. Shallow drainage swales occur on the west side of Burial Pit B and between Burial Pits C and D. The ground surface is covered by grassy vegetation, except where gravel roads extend through the site.

The surface water that drains from SWMU 7 into the surrounding ditches is carried west through Outfall 001 into Bayou Creek. In 2002, a sedimentation basin was constructed to contain runoff from PGDP scrap yards. Runoff now flows into the sedimentation basin and is released periodically into Outfall 001.

F.3.2.7 C-747-A Burn Area (SWMU 30)

SWMU 30 includes the western one-third of C-747-A. It consists of an historical burn-and-burial pit (Burial Pit A) and the location of a former incinerator. The SWMU is bounded on the north and south sides by ditches, on the west side by an unnamed paved road, and on the east side by the C-747-A Burial Ground (SWMU 7). The unit encompasses approximately 128,000 ft^2. The pit is reported to have been excavated to a depth of 12 ft and covered with 4 ft of earth. The land surface slopes gently, and a slight mound rises over Burial Pit A. SWMU 30 is bordered by drainage ditches on the north and south side. Grassy vegetation covers the ground, except where gravel roads extend through the site.

F.3.2.8 Area P (SWMU 145)

Area P (SWMU 145) is located north of PGDP and is defined by encompassing SWMUs 9 and 10 (the C-746-S&T Landfills, respectively). The SWMU is approximately 44 acres and began operation in the early 1950s. Currently, the C-746-S&T Landfills are located on top of SWMU 145 (DOE 1999b). The boundaries of the area are not well defined outside of the area utilized by the C-746-S&T Landfills.

F.3.2.9 Demography and Land Use

As shown in the physical descriptions presented above, current land use of all sources investigated during the BGOU RI is industrial. Under current use, because of access restrictions, only plant workers and authorized visitors are allowed access to the source areas. As discussed in the PGDP Site Management Plan (DOE 2004a), foreseeable future land use of the area is expected to be industrial as well.

At present, both recreational and residential land uses occur in areas surrounding PGDP. Recreational use occurs in the Western Kentucky Wildlife Management Area (WKWMA). The WKWMA is used primarily for hunting and fishing, but other activities include horseback riding, field trials, hiking, and bird watching. An estimated 5,000 fishermen visit the area annually, according to the Kentucky Department of Fish and Wildlife Resources manager of the WKWMA. Residential use near the plant and in areas to which the groundwater from the BGOU may migrate is rural residential and includes agricultural activities. However, current response actions have eliminated exposure to contaminated groundwater by these rural residents. More urban residential use occurs in the villages of Heath, Grahamville, and Kevil, which are within 3 miles of U.S. Department of Energy (DOE) property boundaries, but outside of the area projected to be potentially impacted by the BGOU. The closest major urban area is the municipality of Paducah, Kentucky, which has a population of approximately 26,000 and is approximately 10 miles from PGDP. Other municipalities in the region near PGDP are Cape Girardeau, Missouri, which is approximately 40 miles west of the plant; and the cities of Metropolis and Joppa, Illinois, which are across the Ohio River from PGDP. Total population within a 50-mile radius of the plant is approximately 732,000 people, with about 88,500 people living within 10 miles. The population of McCracken County, in which PGDP lies, is estimated at 65,000 people.

In the area near PGDP and in western Kentucky, in general, the economy has historically been agriculturally based; however, industry has increased in recent years. PGDP is a major employer with approximately 1,400 workers. Another major employer near PGDP is the Tennessee Valley Authority (TVA) Shawnee Steam Plant, which employs approximately 260 individuals.

F.3.3 IDENTIFICATION OF EXPOSURE PATHWAYS

Exposure pathways describe how a contaminant travels from its source to an individual. A complete exposure pathway includes all links between the source and the exposed population. That is, a complete pathway consists of the source of release, a mechanism of release, a transport medium, a point of potential human contact, and an exposure route. The following discussions focus on points of potential human contact, types of receptors, and exposure routes that are relevant to exposure to contaminated soil and groundwater. All surface samples at the sites were evaluated together as soil whether the sample came from the SWMU surface or the surrounding ditches. All surface samples were combined because the area of the sites is small and under some potential future uses there may not be the distinction between SWMU surface and ditch. At the burial grounds, there is potential for receptors to contact buried waste as well. Only data for soil and sediment were used in the risk assessment. Due to the lack of source sampling data, only a qualitative assessment can be done for the risks associated with contact with the buried waste. This qualitative assessment and the uncertainties associated with it are covered in the uncertainty section.

F.3.3.1 Points of Human Contact – Land Use Considerations

As discussed earlier, the potential sources to the BGOU are in an industrial area located within a large industrial facility; therefore, the current land use is industrial. Per KDEP and EPA agreement (Risk Methods Document), industrial land use limits the current exposure scenario to an industrial worker (with exposure to the first foot of surface soil) and an excavation worker (with potential exposure to soil in the 0-10 ft bgs depth). The current scenarios do not include any current use of groundwater drawn from the RGA at the sources.

Also as discussed earlier, the current land use can be expected to continue in the foreseeable future, and the most plausible future land use of the BGOU also is industrial. In the future, the expected exposure frequencies and durations may be higher than duration and frequency of the current exposure. Additionally, use of groundwater drawn from the RGA at the sources is not expected; however, uses of areas surrounding PGDP indicate that it would be prudent to examine a range of land uses to provide managers with estimates of the risk that may be posed to humans under alternate uses, however unlikely. In addition, consideration of a range of land uses is consistent with requirements outlined in the Risk Methods Document. Additional possible future land uses considered in earlier BHHRAs of the source areas were recreational and rural residential. Recreational and residential scenarios would include use of groundwater drawn from the RGA and potential exposure to groundwater at the seeps at Little Bayou Creek in addition to soil exposure. Baseline risks under each of these uses are presented for each of the SWMUs in this appendix.

F.3.3.2 Potential Receptor Populations

As noted above, the potential receptor population under current conditions at the source units are the industrial worker and the excavation worker. The current industrial worker evaluation differs from the future industrial worker only by a lower frequency of exposure equivalent to the current maintenance schedule for these areas (16 days for current maintenance versus 250 days for future default scenario). The current worker evaluation is presented in the uncertainty section, while the default future worker is presented in depth in this BHHRA. No current excavation worker scenario is considered because there are no current excavation exposures at the site on which to base the exposure for the current scenario. The future excavation worker using default values is presented in this BHHRA.The potential receptor populations under future conditions in BGOU areas also include recreational and residential exposures. The receptor populations for these scenarios contain age cohorts. For the recreational users, the cohorts include the child (aged 1 to 7), teen (aged 8 to 20), and the adult (older than 21). For rural residents, the cohorts include children (aged 1 to 7) and older individuals (termed adults in this and previous BHHRAs). The recreational user and the rural resident population also may contain sensitive subpopulations such as pregnant women, young children (aged 0 to 1), the elderly, and the infirm. In this and earlier BHHRAs, exposure by these subpopulations is not quantified because much of the information that is needed is not available; however, these subpopulations are considered qualitatively in the uncertainty discussions.

Finally, this and earlier assessments assume that the recreational user is a rural resident who has repeated access to the study area. Recreational users not residing in the study area are not considered separately because nearby residents were determined to be the individuals most likely to take part in recreational activities at PGDP on a continual basis. In addition, the exposure assessment determined that little information useful in remedy selection would be obtained by including a separate visiting recreational user in the assessment.

F.3.3.3 Delineation of exposure point/exposure routes

As discussed, human health risks are assessed by determining POEs and exposure routes. POEs are locations where human receptors can contact contaminated media. Exposure routes are the processes by which human receptors contact contaminated media. The exposure routes considered during the exposure assessment for all BHHRAs per the Risk Methods Document are listed in the following paragraphs. This material also presents reasons for selecting or not selecting each exposure route for each of the potentially exposed populations in this BHHRA. The exposure routes evaluated and those that were quantitatively assessed in this BHHRA are described below.

Ingestion Groundwater as a Drinking Water Source. Residential and industrial use of groundwater is common in western Kentucky. Potential receptors for this pathway are rural residents. This exposure route is assessed quantitatively in this BHHRA.

Inhalation of Volatile Constituents Emitted While Using Groundwater. As noted previously, residential and industrial use of groundwater is common in western Kentucky. Rural residents are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Dermal Contact With Groundwater While Showering. As noted earlier, residential and industrial use of groundwater is common in western Kentucky. Rural residents are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Inhalation Of Vapor Released From The Ground Water Into Home Basements. This exposure route was modeled quantitatively in this BHHRA for rural residents. Potentially, industrial workers also could be exposed through this route. Because the resident has an exposure time of 24 hrs/day for this exposure route, the rural resident quantitative assessment is protective of any potential worker exposure.

Inhalation of Volatile Organic Compounds During Irrigation with Contaminated Groundwater. In the Midwest, irrigation of farmland with groundwater using center pivot irrigation is common. Rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where migration may occur in the future and because earlier assessments have shown that risk from this exposure route is minimal, this exposure route is not assessed quantitatively in this BHHRA.

Incidental Ingestion of Contaminated Soil. Industrial processes at potential sources in the BGOU units have contaminated the soil. Recreational users may ingest soil while recreating, and residents may ingest soil while gardening. Industrial workers may ingest soil while working outdoors, and excavation workers may ingest soil while digging. Recreational users, rural residents, industrial workers, and excavation workers are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Dermal Contact with Contaminated Soil. Industrial processes at potential sources in the BGOU have contaminated the soil. Recreational users may get soil on their skin while recreating, and residents may get soil on their skin while gardening. Industrial workers may get soil on their skin while working outdoors, while excavation workers may get soil on their skin while digging. Recreational users, rural residents, industrial workers, and excavation workers are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Inhalation Of Particulates Emitted From Contaminated Soil. Industrial processes at potential sources in the BGOU units have contaminated the soil, and this soil may release particulates to the air when the soil is disturbed when dry. Recreational users may inhale these particulates while recreating, and residents may inhale these particulates while gardening. Industrial workers may inhale these particulates while working outdoors, and excavation workers may inhale these particulates while digging. Recreational users, rural residents, industrial workers, and excavation workers are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Inhalation of Volatile Constituents Emitted from Contaminated Soil. Industrial processes at potential sources in the BGOU units have contaminated the soil. Some of these contaminants may be volatile and released to the air as vapors. Recreational users may inhale these vapors while recreating, and residents may inhale these vapors while gardening. Industrial workers may inhale these vapors while working outdoors, and excavation workers may inhale these vapors while digging. Recreational users, rural residents, industrial workers, and excavation workers are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

External Exposure to Ionizing Radiation Emitted from Contaminated Soil. Industrial processes at potential sources in the BGOU units have contaminated the soil. Radionuclides present in contaminated soil will, in turn, undergo decay and emit ionizing radiation. Recreational users may be exposed to this ionizing radiation while recreating, and residents may be exposed to it while gardening. Industrial workers may be exposed to the ionizing radiation while working outdoors, and excavation workers may be exposed to it while digging. Recreational users, rural residents, industrial workers, and excavation workers are potential receptors for this exposure route. This exposure route is assessed quantitatively in this BHHRA.

Dermal Contact with Water While Swimming or Wading in Privately Owned Fish Ponds Filled with Groundwater. Contamination found in BGOU soils has a reasonable potential of contaminating surface waters through dissolution into the groundwater. Contaminants also may be contacted through suspension of fine particles in the ponds, also originating from groundwater. Recreational use of these ponds by residents may reasonably be expected to occur. During recreational use (e.g., swimming or wading), dermal contact with water could occur. Rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA.

Incidental Ingestion of Sediment While Swimming or Wading in Privately Owned Fishponds Filled with Groundwater. The rationale for considering ponds is presented previously. In addition, recreational use of these ponds by residents may reasonably be expected to occur. During recreational activities, incidental ingestion of sediment contaminated by constituents in groundwater is possible. Rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA.

External Exposure to Ionizing Radiation Emitted by Contaminants in Groundwater While Swimming or Wading in Privately Owned Fish Ponds Filled with Groundwater. The rationale for considering ponds is presented previously. During use of these ponds by residents, exposure to ionizing radiation emitted by radionuclides in water could occur. Rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA.

External Exposure to Ionizing Radiation Emitted by Contaminants in Sediment While Swimming or Wading in Privately Owned Fish Ponds Filled with Groundwater. The rationale for considering ponds is presented previously. During use of these ponds by residents, exposure to ionizing radiation emitted by radionuclides in groundwater and sediment could occur. Rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA.

Consumption of Fish Raised in Privately Owned Fish Ponds Filled with Groundwater. The fish raised in ponds would be exposed to contaminants in groundwater and may accumulate some contaminants in their edible tissues. These fish, caught in either a "pay-to-fish" or a commercial pond by residents, could reasonably be expected to be consumed. Recreational users (i.e., visitors) and rural residents are potential receptors for this exposure route. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA.

Incidental Ingestion of Surface Water in Creeks or Ponds. Open bodies of water, such as Bayou Creek or settling ponds, are attractive for recreation (e.g., swimming and wading). Although such bodies of water are not included in the assessment of the source areas, contaminants may migrate from the sources to these creeks or ponds. Recreational users and industrial workers are potential receptors for this exposure route. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the Surface Water Operable Unit (SWOU).

Dermal Contact with Surface Water While Swimming or Wading in Creeks or Ponds. Open bodies of water, such as Bayou Creek or settling ponds, are attractive for recreation (e.g., swimming and wading). Although such bodies of water are not included in this assessment of the source areas, contaminants may migrate from sources to these bodies of water. Recreational users and industrial workers are potential receptors for this exposure route. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the SWOU.

Incidental Ingestion of Sediment While Swimming or Wading in Creeks or Ponds. Open bodies of water, such as Bayou Creek or settling ponds, are attractive for recreation (e.g., swimming and wading). Although such bodies of water are not included in this assessment of the source areas, contaminants may migrate from sources to these bodies of water. Recreational users and industrial workers are potential receptors for this exposure route. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the SWOU.

External Exposure to Ionizing Radiation Emitted by Contaminants in Surface Water While Swimming or Wading in Creeks or Ponds. Open bodies of water, such as Bayou Creek or settling ponds, are attractive for recreation (e.g., swimming and wading). Although such bodies of water are not included in this assessment of the source areas, contaminants may migrate from sources to these bodies of water. Recreational users and industrial workers are potential receptors for this exposure route. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the SWOU.

External Exposure to Ionizing Radiation Emitted by Contaminants in Sediment While Swimming or Wading in Creeks or Ponds. Open bodies of water, such as Bayou Creek or settling ponds, are attractive for recreation (e.g., swimming and wading). Although such bodies of water are not included in this assessment of the source areas, contaminants may migrate from sources to these bodies of water. Recreational users and industrial workers are potential receptors for this exposure route. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the SWOU.

Consumption of Fish Taken from Creeks and Ponds Containing Contaminated Surface Water. Fish living in Bayou Creek or settling ponds may accumulate contaminants in surface water in their edible tissues. Although such bodies of water are not included in this assessment of the source areas, contaminants may migrate from sources to these bodies of water. Recreational users and residents may catch and consume fish from the potentially impacted surface water bodies. Potential receptors for this route of exposure are recreational users. This exposure route is not assessed quantitatively in this BHHRA because earlier BHHRAs have concluded that mixing with surface water results in risks that are insignificant. Additionally, risks associated with surface water will be evaluated as part of the SWOU.

Consumption of Vegetables and Produce Raised in Contaminated Soil. As noted in Section 2 of Appendix 5 of the Risk Methods Document, crop farming and gardening are common activities near PGDP, and this land use pattern could be expanded to the source areas in the future after the industrial infrastructure is removed. Because industrial use of the source areas has resulted in contaminated soil, plants raised in this soil may, in turn, accumulate these contaminants. Finally, humans may consume this contaminated produce. Potential receptors for this route of exposure are rural residents. This exposure route was considered in earlier BHHRAs, but is not reassessed in this BHHRA because new data are not available. The results of the previous analysis are in the RI report for SWMUs 7 and 30 of WAG 22 (DOE 1998b). The potential impact of excluding the contribution from this pathway is addressed qualitatively in the uncertainty section.

Consumption of Beef from Cattle Contaminated by Consuming Vegetation (Pasture and Concentrates) Irrigated with Groundwater; Consuming Soil, Contaminated Through Irrigation or Industrial Use, While on Pasture; and Drinking Groundwater. During interviews, Agriculture Extension Agents for Ballard and McCracken counties indicated that small scale cow-calf operations are common in western Kentucky. (See Section 2 of Appendix 5 of the Risk Methods Document.) They further noted that slaughtering feeder cattle for home consumption is common. In the study area, such beef may be contaminated by incidental ingestion of soil while on pasture, by consumption of contaminated vegetation (pasture and concentrate), and by ingestion of contaminated groundwater. Residents may eat this beef; therefore, potential receptors for this route of exposure are rural residents. This exposure route was considered in earlier BHHRAs, but is not reassessed in this BHHRA because new soil data are not available, and only modeled groundwater data are available in this BHHRA in areas where this activity may occur in the future. The potential impact of excluding the contribution from this pathway is addressed qualitatively in the uncertainty section.

Consumption of Dairy Products (I.E., Milk) from Cows Contaminated by Consuming Vegetation (Pasture or Concentrates) Irrigated with Groundwater; Consuming Soil, Contaminated Through Industrial Use, While on Pasture; and Drinking Groundwater. During interviews, Agriculture Extension Agents for Ballard and McCracken counties noted that dairy farming still occurs in their counties. (See Section 2 of Appendix 5 of the Risk Methods Document.) Furthermore, the agents stated that these cattle are fed stored feed and are allowed to graze on pasture. As noted previously, the soil at source units is contaminated, and the vegetation may become contaminated. Dairy cattle raised at the sources after the industrial infrastructure is removed may become contaminated through incidental ingestion of soil while on pasture, consumption of contaminated vegetation, and ingestion of contaminated groundwater. Products made from milk from these cows could, in turn, be consumed by residents; therefore, potential receptors for this route of exposure are rural residents. This exposure route was considered in earlier BHHRAs, but is not reassessed in this BHHRA because new soil data are not available, and only modeled groundwater data are available in this BHHRA in areas where this activity may occur in the future. The potential impact of excluding the contribution from this pathway is addressed qualitatively in the uncertainty section.

Consumption of Poultry Given Groundwater to Drink. During interviews, Agriculture Extension Agents for Ballard and McCracken counties noted that commercial broiler production did occur in their counties, but not near PGDP. (See Section 2 of Appendix 5 of the Risk Methods Document.) (Home flocks for both meat and eggs were noted as being uncommon.) Furthermore, they stated that broilers were fed bought (not locally raised) feed, that normal resident time in poultry houses was 2 months, and that commercial distribution of the product occurs. However, the agents did note that the birds are most likely watered with groundwater; therefore, broilers may become contaminated through ingestion of contaminated groundwater. For this exposure assessment, the receptor assumed to consume the contaminated poultry is the rural resident. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA. The potential impact of excluding the contribution from this pathway is addressed qualitatively in the uncertainty section.

Consumption of Pork from Swine Fed Contaminated Feed and Watered with Groundwater. During interviews, Agriculture Extension Agents for Ballard and McCracken counties noted that both large commercial and small hog farms exist in their counties. (See Section 2 of Appendix 5 of the Risk Methods Document.) Furthermore, they indicated that swine on both types of farms were fed locally raised feed and, on the smaller farms, that farm-raised pork was consumed by farmers. Any swine raised may be contaminated through consumption of contaminated feed and groundwater, and this pork may be eaten by rural residents; therefore, rural residents are potential receptors for this pathway. Because only modeled groundwater data are available for this BHHRA in areas where this activity may occur in the future, this exposure route is not assessed quantitatively in this BHHRA. The potential impact of excluding the contribution from this pathway is addressed qualitatively in the uncertainty section.

Consumption of Game Contaminated by Consumption of Vegetation Grown in Contaminated Soil and Ingestion of Groundwater. As indicated in the Risk Methods Document and discussed earlier, the taking of game is common around the study area. Potential game species include deer, rabbits, squirrel, doves, ducks, geese, quail, and wild turkey. Each of these species may be contaminated by consumption of contaminated vegetation, soil, or groundwater. Potential receptors for this route of exposure are recreational users. This exposure route is assessed quantitatively in this BHHRA.

As demonstrated above, a total of 28 routes of exposure, including those that consider biota, are possible for the BGOU:

- Ingestion of soil by an industrial worker .... Table F.27
- Dermal contact with soils by an industrial worker .... Table F.28
- Inhalation of vapors from soils by an industrial worker .... Table F.29
- Exposure to ionizing radiation from soil by an industrial worker .... Table F.30
- Ingestion of soil by an excavation worker .... Table F.31
- Dermal contact with soils by an excavation worker .... Table F.32
- Inhalation of vapors from soils by an in excavation worker .... Table F.33
- Exposure to ionizing radiation by an excavation worker .... Table F.34

- Ingestion of sediment by a recreation user .... Table F.35
- Dermal contact with sediment by a recreation user..................................... Table F.36
- Inhalation of vapors from sediment by a recreation user .... Table F.37
- Exposure to ionizing radiation by a recreation user .... Table F.38
- Ingestion of game by a recreation user – (see Risk Methods Document, Appendix D)
- Ingestion of soil by a rural resident .... Table F.39
- Dermal contact with soils by a rural resident .... Table F.40
- Inhalation of vapors from soils by a rural resident...................................... Table F.41
- Exposure to ionizing radiation by a rural resident...................................... Table F.42
- Ingestion of water while using groundwater as a drinking water source ..... Table F.43
- Dermal contact with groundwater while showering.................................... Table F.44
- Inhalation of volatiles in groundwater while showering .... Table F.45
- Inhalation of volatiles in groundwater during household use....................... Table F.46
- Inhalation of volatiles as a result of vapor intrusion into home basements.. Table 5.14

CDIs, which are calculated for inorganic and organic constituents, and radionuclide intakes, calculated for radionuclides, represent the exposure to a COPC as mass contacted per unit body weight per unit time for the applicable receptor (EPA 1991). Doses, which apply only to radionuclide COPCs, represent the activity of a COPC in contact with an exchange boundary (EPA 1991). Unless otherwise noted, CDIs, RIs and doses are calculated using the values presented in Tables F.27 through F.46, and are from the 2001 approved version of the Risk Methods Document. Values obtained from the draft 2008 revision of the Risk Methods Document are footnoted. Values in these tables marked as "chemical-specific" were obtained from tables in Appendix B and Appendix D of the draft 2008 Risk Methods Document. The dermal absorption (ABS) factors used are from the draft 2008 Risk Methods Document as well. Because these factors apply only to COPCs evaluated for dermal toxicity, these ABS factors are presented in Tables F.152 and F.153 along with the dermal toxicity values.

Table F.27. Ingestion of Soil by an Industrial Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF*EF*ED*IR*FI/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_s*CF_{rad}*EF*ED*IR*FI]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Conversion Factor =CF	1.00E-06	kg/mg
Exposure Frequency =EF	250	d/yr
Exposure Duration = ED	25	yr
Ingestion Rate = IR	50	mg/d
Fraction Ingested = FI	1	unitless
Conversion Faction = CF_{rad}	1.00E-03	g/mg

Table F.28. Dermal Contact with Soil by an Industrial Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF_d*SA*ABS*AF*EF*ED/(BW*AT)]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Conversion Factor = CF_d	1.00E-02	kg-cm^2/mg-m^2
Absorption factor = ABS	Chemical-specific	unitless
Surface Area = SA	0.47	m^2/d
Adherence Factor = AF	1	mg/cm^2
Exposure Frequency =EF	250	d/yr
Exposure Duration = ED	25	Yr

Table F.29. Inhalation of Vapors from Soil by an Industrial Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*EF*ED*ET*(1/VF +1/PEF)*IR_{air} /(BW * AT)]		
Radionuclide Intake (pCi) = RI = [A_s*EF*ED*ET*CF*(1/VF + 1/PEF)*IRair]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Exposure Frequency = EF	250	d/yr
Exposure Duration = ED	25	yr
Exposure Time = ET	8	hr/d
Volatilization Factor = VF	Chemical-specific	m^3/kg
Particle Emission Factor = PEF	6.2E+08	m^3/kg
Inhalation Rate = IR_{air}	2.5	m^3/hr
Conversion Factor = CF	1.00E+03	g/kg

Table F.30. External Exposure to Ionizing Radiation by an Industrial Worker

Dose (pCi-year/g) = [A_s*ED*EF*(1-S_e)*T_e]		
Parameter	**Value Used**	**Units**
Activity in soil = A_s	Chemical-specific	pCi/g
Exposure Frequency =EF	250/365	d/d
Exposure Duration = ED	25	yr
Gamma Shielding Factor = S_e	0.2	unitless
Gamma Exposure time Factor = T_e	8/24	hr/hr

Table F.31. Ingestion of Soil by an Excavation Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF*EF*ED*IR*FI/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_s*CF_{rad}*EF*ED*IR*FI]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Exposure Frequency = EF	185	d/yr
Exposure Duration = ED	25	yr
Ingestion Rate = IR	480	mg/d
Fraction Ingested = FI	1	unitless
Conversion Faction = CF	1.00E-06	kg/mg
Conversion Faction = CF_{rad}	1.00E-03	g/mg

Table F.32. Dermal Contact with Soil by an Excavation Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF_d*SA*ABS*AF*EF*ED/(BW*AT)]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Conversion Factor =CF_d	1.00E-02	kg-cm^2/mg-m^2
Absorption factor= ABS	Chemical-specific	unitless
Surface Area = SA	0.47	m^2/d
Adherence Factor = AF	1	mg/cm^2
Exposure Frequency =EF	185	d/yr
Exposure Duration = ED	25	yr

Table F.33. Inhalation of Vapors from Soil by an Excavation Worker

Chronic Daily Intake (mg/kg-day) = CDI = [C*EF*ED*ET*(1/VF +1/PEF)*IR_{air}/(BW * AT)]		
Radionuclide Intake (pCi) = RI = [A_s*EF*ED*ET*CF*(1/VF + 1/PEF)*IRair]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Exposure Frequency =EF	185	d/yr
Exposure Duration = ED	25	yr
Exposure Time = ET	8	hr/d
Volatilization Factor = VF	Chemical-specific	m^3/kg
Particle Emission Factor = PEF	6.2E+08	m^3/kg
Inhalation Rate = IR_{air}	2.5	m^3/hr
Conversion Factor =CF	1.00E+03	g/kg

Table F.34. External Exposure to Ionizing Radiation by an Excavation Worker

Dose (pCi-yr/g) = [A_s*ED*EF*(1-S_e)*T_e]		
Parameter	**Value Used**	**Units**
Activity in soil = A_s	Chemical-specific	pCi/g
Exposure Frequency =EF	185/365	d/d
Exposure Duration = ED	25	yr
Gamma Shielding Factor = S_e	0.2	unitless
Gamma Exposure time Factor = T_e	8/24	Hr/hr

Table F.35. Ingestion of Soil by a Recreational User

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF*EF*ED*ET*CF_2*IR*FI*ET/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_s*CF_{rad}*EF*ED*ET*CF_2*IR*FI]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in Soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70 (adult)	kg
	43 (teen)	kg
	15 (child)	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Exposure Frequency =EF	104 (adult)	d/yr
	140 (teen and child)	d/yr
Exposure Duration = ED	12 (adult)[a]	yr
	12 (teen)	yr
	6 (child)	yr
Exposure Time = ET	5	hr/day
Conversion Factor =CF	1.00E-06	kg/mg
Conversion Factor = CF_2	1/24	day/hr
Ingestion Rate = IR	100 (adult and teen)	mg/d
	200 (child)	mg/d
Fraction Ingested = FI	1	unitless
Conversion Factor =CF_{rad}	1.00E-03	g/mg

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.36. Dermal Contact with Soil by a Recreational User

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Conversion factor-dermal = CF_d	0.01	(kg-cm^2)/(mg-m^2)
Surface area= SA	0.57(adult) [a, b]	m^2/day
	0.75(teen) [a, b]	m^2/day
	0.28(child) [a, b]	m^2/day
Adherence factor =AF	1	mg/cm^2
Absorption factor= ABS	Chemical-specific	unit less
Exposure frequency = EF	104 (adult)	day/yr
	140 (teen)	day/yr
	140 (child)	day/yr
Exposure duration = ED	12 (adult) [a,]	years
	12 (teen)	years
	6 (child)	years
Body weight = BW	70 (adult)	kg
	43 (teen)	kg
	15(child	kg
Averaging time = AT	70 × 365 (carcinogenic)	yr × day/yr
	ED × 365 (noncarcinogenic)	yr × day/yr

[a]Value from 2008 draft revision of the Risk Methods Document.
[b] Includes face, forearms, lower legs and hands for adults; arms, hands, legs, and feet for teens; and face, forearms, hands, lower legs, and feet for children

Table F.37. Inhalation of Vapors from Soil by a Recreational User

Chronic Daily Intake (mg/kg-day) = CDI = [C*EF*ED*ET*(1/VF +1/PEF)*IR_{air} /(BW * AT)]		
Radionuclide Intake (pCi) = RI = [A_s*EF*ED*ET*CF*(1/VF + 1/PEF)*IRair]		
Parameter	**Value Used**	**Units**
Concentration in Soil = C	Chemical-specific	mg/kg
Activity in Soil = A_s	Chemical-specific	pCi/g
Exposure frequency = EF	104 (adult)	day/yr
	140 (teen)	day/yr
	140 (child)	day/yr
Exposure duration = ED	12(adult) [a]	yr
	12 (teen)	yr
	6 (child)	yr
Exposure time = ET	5	hour/day
Conversion factor = CF	10^3	g/kg
Volatilization factor = VF	Chemical-specific	m^3/kg
Particulate emission factor = PEF	9.3E+08 [a]	m^3/kg
Total inhalation rate = IR_{air}	2.5	m^3/hr
Body weight = BW	70 (adult)	kg
	43 (teen)	kg
	15 (child)	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.38. External Exposure to Ionizing Radiation by a Recreational User

Dose (pCi-yr/g) = [A_s*ED*EF*(1-Se)*Te]		
Parameter	**Value Used**	**Units**
Activity in Soil = $\mathbf{A_s}$	Chemical-specific	pCi/g
Exposure duration = **ED**	12 (adult) [a]	yr
	12 (teen)	yr
	6 (child)	yr
Exposure frequency = **EF**	104/365 (adult)	day/day
	140/365 (teen)	day/day
	140/365 (child)	day/day
Gamma shielding factor = **Se**	0.2	unitless
Gamma exposure time factor = **Te**	5/24	hr/hr

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.39. Ingestion of Soil by a Rural Resident

Chronic Daily Intake (mg/kg-day) = CDI = [C*CF*EF*ED*IR*FI/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_s*CF_{rad}*EF*ED*IR*FI]		
Parameter	**Value Used**	**Units**
Concentration in Soil=C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr × day/yr
	ED x 365(noncarcinogenic)	yr × day/yr
Conversion Factor =CF	1.00E-06	kg/mg
Exposure Frequency =EF	350	d/yr
Exposure Duration = ED	24 (adult) [a]	Yr
	6 (child)	Yr
Ingestion Rate = IR	100 (adult)	mg/d
	200 (child)	mg/d
Fraction Ingested = FI	1	Unitless
Conversion Factor =CF_{rad}	1.00E-03	g/mg

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.40. Dermal Contact with Soil by a Rural Resident

Chronic Daily Intake (mg/kg-day) = CDI= [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]		
Parameter	**Value Used**	**Units**
Concentration in Soil=C	Chemical-specific	mg/kg
Body Weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging Time = AT	70 x 365(carcinogenic)	yr-day/yr
	ED x 365(noncarcinogenic)	yr-day/yr
Conversion Factor =CF_d	1.00E-02	kg-cm^2/mg-m^2
Absorption factor= ABS	Chemical-specific	unitless
Surface Area = SA	0.57 (adult) [a,b]	m^2/d
	0.28 (child) [a,b]	m^2/d
Adherence Factor = AF	1	mg/cm^2
Exposure Frequency =EF	350	d/yr
Exposure Duration = ED	24 (adult) [a]	yr
	6 (child)	yr

[a]Value from 2008 draft revision of the Risk Methods Document
[b] Includes face, forearms, hands and lower legs for adult; face, forearms, hands, lower legs and feet for children.

Table F.41. Inhalation of Vapors from Soil by Rural Resident

Chronic Daily Intake (mg/kg-day) = CDI = [C*EF*ED*ET*(1/VF +1/PEF)*IR_{air} / (BW * AT)]		
Radionuclide Intake (pCi) = RI = [A_s*EF*ED*ET*CF*(1/VF + 1/PEF)*IRair]		
Parameter	**Value Used**	**Units**
Concentration in Soil=C	Chemical-specific	mg/kg
Activity in soil = A_s	Chemical-specific	pCi/g
Body Weight = BW	70 (adult)	kg
	15 (child)	
Averaging Time = AT	70 x 365(carcinogenic)	yr × day/yr
	ED x 365(noncarcinogenic)	yr × day/yr
Exposure Frequency =EF	350	day/yr
Exposure Duration = ED	24 (adult) [a]	yr
	6 (child)	
Exposure Time = ET	24	hr/d
Volatilization factor = VF	Chemical-specific	m^3/kg
Particle Emission Factor = PEF	9.3E+08 [a]	m^3/kg
Inhalation Rate = IR_{air}	0.833[a]	m^3/hr
Conversion Factor =CF	1.00E+03	g/kg

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.42. External Exposure to Ionizing Radiation from Soil by Rural Resident

Dose (pCi-yr/g) = [A_s*ED*EF*(1-S_e)*T_e]		
Parameter	**Value Used**	**Units**
Activity in soil = $\mathbf{A_s}$	Chemical-specific	pCi/g
Exposure Frequency =EF	350/365	d/d
Exposure Duration = ED	24 (adult)[a]	yr
	6 (child)	yr
Gamma Shielding Factor = S_e	0.2	unitless
Gamma Exposure time Factor = T_e	24/24	hr/hr

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.43. Ingestion of Groundwater by a Rural Resident

Chronic Daily Intake (mg/kg-day) = CDI = [C_w*IR*EF*ED/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_w*IR*EF*ED]		
Parameter	**Value Used**	**Units**
Chemical concentration in water = C_w	Chemical-specific	mg/L
Radiological activity in water = A_w	Chemical-specific	pCi/L
Ingestion rate = IR	2 (adult)	L/day
	1.5 (child)[a]	L/day
Exposure frequency = EF	350	day/yr
Exposure duration = ED	24 (adult)[a]	day
	6 (child)	day
Body weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging time = AT	70 x 365(carcinogenic)	yr × day/yr
	ED x 365(noncarcinogenic)	yr × day/yr

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.44. Dermal Contact with Water While Showering by a Rural Resident

Parameter	Value Used	Units
Chronic Daily Intake (mg/kg-day)$_{inorganic}$ = CDI$_{inorganic}$ = [C_w*SA*K_p*CF*EF*ED*ET/(BW*AT)]		
Chronic Daily Intake (mg/kg-day)$_{organic}$ = CDI$_{organic}$ = [C_w*$DA_{eventfactor}$*SA*CF*ED*EF*EV/(BW*AT)]		
Chemical concentration in water = C_w	Chemical-specific	mg/L
Skin surface area exposed = SA	1.815[b]	m^2
	0.65 [a,b]	m^2
Skin permeability constant = K_p	Chemical-specific	cm/hr
Absorbed dose factor per event = $DA_{eventfactor}$	Chemical-specific[a]	L/cm^2-event
Conversion factor (inorganic) = CF	10	(L-m)/(cm-m^3)
Conversion factor (organic) = CF	10^3	cm^2/m^2
Exposure frequency = EF	350	baths/yr
Exposure duration = ED	24 (adult) [a]	day
	6 (child)	day
Exposure time = ET	0.2	hr/bath
Event = EV	1	Event/day
Body weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging time = AT	70 x 365 (carcinogenic)	yr × day/yr
	ED x 365 (noncarcinogenic)	yr × day/yr

[a]Value from 2008 draft revision of the Risk Methods Document
[b] Entire surface area of body for both adult and child

Table F.45. Inhalation of Volatile Organic Compounds in Water While Showering by a Rural Resident

Parameter	Value Used	Units
Chronic Daily Intake (mg/kg-day) = CDI = [C_{shower}*IR_{air}*EF*ED*ET/(BW*AT)]		
Radionuclide Intake (pCi) = RI = [A_{gw}*IR_{air}*ED*EF*IEF]		
C_{shower} = [((C_{amax}/2)*t_1)+(C_{amax}*t_2)]/(t_1+t_2)		
C_{amax} = (C_{gw}*f*F_w*t_1)/V_a		
Chemical concentration in groundwater = C_{gw}	Chemical-specific	mg/L
Radionuclide activity in groundwater = A_{gw}	Chemical-specific	pCi/L
Time-adjusted concentration in shower = C_{shower}	Chemical-specific	mg/m^3
Indoor inhalation rate = IR_{air}	0.833 [a]	m^3/hr
Exposure frequency = EF	350	day/yr
Exposure duration = ED	24 (adult) [a]	day
	6 (child)	day
Exposure time = ET	0.2	hr/day
Inhalation exposure factor = IEF	Chemical-specific	(L-hr)/(m^3-day)
Maximum air concentration = C_{amax}	Chemical-specific	mg/m^3
Time of shower = t_1	0.1	hr
Time after shower = t_2	0.1	hr
Fraction volatilized = f	0.75	unitless
Water flow rate = F_w	890	L/hr
Bathroom volume = V_a	11	m^3
Body weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging time = AT	70 x 365 (carcinogenic)	yr × day/yr
	ED x 365 (noncarcinogenic)	yr × day/yr

[a]Value from 2008 draft revision of the Risk Methods Document

Table F.46. Inhalation of Volatile Organic Compounds in Water During Household Use by a Rural Resident

Chronic Daily Intake (mg/kg-day) = CDI = $[C_{house}*IR_{air}*EF*ED*ET/(BW*AT)]$

Radionuclide Intake (pCi) = RI = $[A_{gw}*IR_{air}*ED*EF*IEF]$

$C_{house} = C_{gw}*WHF*f/(HV*ER*MC)$

Parameter	Value Used	Units
Chemical concentration in groundwater = C_{gw}	Chemical-specific	mg/L
Radionuclide activity in groundwater = A_{gw}	Chemical-specific	pCi/L
Concentration in household air = C_{house}	Chemical-specific	mg/m^3
Indoor inhalation rate = IR_{air}	0.833	m^3/hr
Exposure frequency = EF	350	day/yr
Exposure duration = ED	24 (adult) [a]	day
	6 (child)	day
Exposure time = ET	24 [a]	hr/day
Inhalation exposure factor = IEF	Chemical-specific	$(L\text{-}hr)/(m^3\text{-}day)$
Water flow rate = WHF	890	L/day
Fraction volatilized = f	0.5	unitless
House volume = HV	450	m^3/change
Exchanged rate = ER	10	changes/day
Mixing coefficient = MC	0.5	unitless
Body weight = BW	70 (adult)	kg
	15 (child)	kg
Averaging time = AT	70 x 365 (carcinogenic)	yr × day/yr
	ED x 365 (noncarcinogenic)	yr × day/yr

[a]Value from 2008 draft revision of the Risk Methods Document

F.3.3.4 Development of Conceptual Site Models

Using the information presented in the previous subsections, a CSM was developed for the BGOU. This CSM (Figure F.3) illustrates the sources, pathways of migration, and routes of exposure relevant to this BHHRA. For this screening and the subsequent BRA, surface soil was defined as 0–1 ft bgs and subsurface soil was defined as 0–10 ft bgs. Surface soil was used to evaluate direct exposure for residential, recreational, and industrial receptors. Subsurface soil was used to evaluate direct exposure for excavation worker. Table F.47 shows the media evaluated for each land use scenario for each SWMU.

Table F.47. Land Uses And Media Assessed For Each Source Area Included in the RI for the BGOU

	Location							
	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30	SWMU 145
Future On-site Industrial Worker								
Surface Soil	X	X	X	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Subsurface Soil	X	X	X	X	X	X	X	X
Future Recreational User								
Game (Soil)	X	X	X	X	X	X	X	NA
Surface Soil	X	X	X	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Soil	X	X	X	X	X	X	X	NA
Groundwater [a]	X	X	X	X	X	X	X	X
Vapor Intrusion [c]	X	X	X	X	X	X	X	X
Future Off-site Rural Resident								
Groundwater [b]	X	X	X	X	X	X	X	X
Vapor Intrusion [c]	X	X	X	X	X	X	X	X
Future On-site Terrestrial Biota								
Soil	P	NA	NA	X	X	X	X	NA
Surface Water	NA	NA	NA	NA	NA	X	X	NA

Notes: Scenarios that were assessed in this RI BRA are marked with an X. Scenarios assessed in previous BRAs are marked with a P. Scenarios not assessed because the scenario is not applicable, or for which the medium is not present, are marked with an NA.
[a] The earlier BHHRAs assessed risks from use of water drawn from the RGA separately from use of water drawn from the McNairy Formation. The risks assessed in this RI BRA are for use of water drawn from the RGA.
[b] Modeling results were used to assess groundwater risk to the off-site rural resident. POEs are at the PGDP plant boundary, at the PGDP property boundary, Little Bayou Seeps and in a groundwater well at the Ohio River. These POEs are presented in Fig. 5.1
[c] Vapor intrusion was modeled for residential basements.

F.3.4 QUANTIFICATION OF EXPOSURE

F.3.4.1 Calculation of EPCs of COPCs

The EPCs for COPCs in soil (includes all surface media) were calculated from sampling results to determine current and potential future risks at the eight source locations. Then the CDIs were calculated with the intake equations presented in Subsection F.3.3.3. The calculation of these soil EPCs did not account for potential decreases or increases in COPC concentrations over time. These potential changes in concentration were considered, but for soil the change in concentration over the 30 year timeframe used for a risk assessment will not significantly alter the EPCs for the COPCs. The EPCs for COPCs in surface and subsurface soils based on sampling data are presented above in Tables F.4 through F.18. EPCs for groundwater used to determine potential future risks for residential use of groundwater at four POEs (i.e., plant boundary, property boundary, Ohio River, and seeps at Little Bayou Creek) were developed from modeling and are not repeated in this section. The modeled concentrations in groundwater over time at the four POEs (unit boundary, plant boundary, property boundary, and Ohio River) are provided in the figures in Section 5. The maximum modeled groundwater concentration over the 1,000 year timeframe (see Appendix E for details of the modeling) at each POE was used as the EPC for calculation of the groundwater CDI.

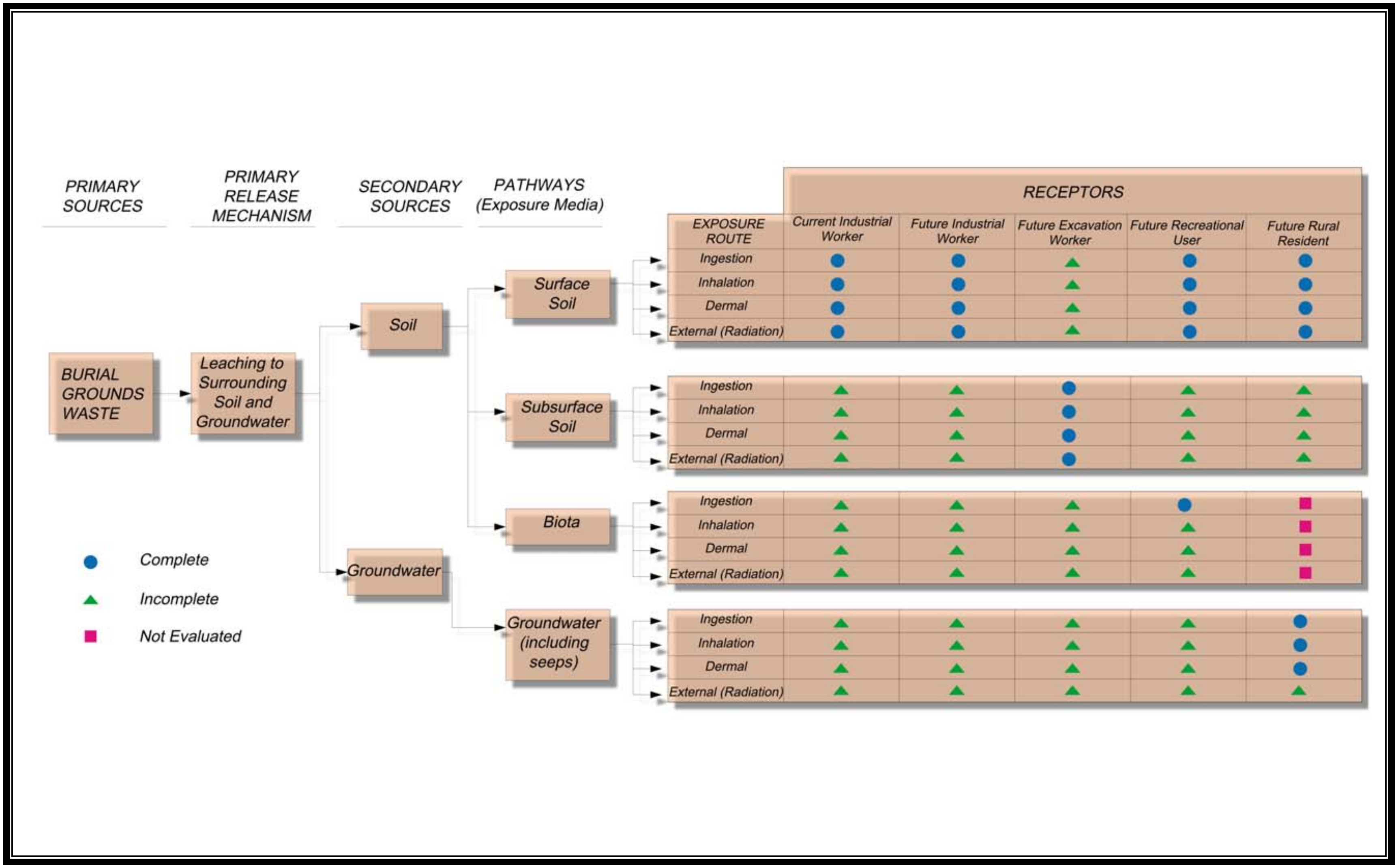

Figure F.3. Conceptual Site Model for BGOU

The EPCs presented in Tables F.4 to F.18 were determined following the rules presented in the updated Risk Methods Document. These rules are as follows:

If results from fewer than ten samples were available, or if ten or more sample results were available but there were less than ten detections, the EPC is the maximum detected concentration.

If results from more than 10 samples were available and ten or more of those results were detections, then a distribution check was performed, and the EPC was the lesser of the maximum detected concentration and the 95% UCL as calculated by ProUCL using both the detects and the non-detects.

F.3.4.2 Chronic Daily Intakes

All exposure estimates in this BHHRA represent normalized exposure rates that are evaluated for sources of uncertainty such as variability in data, modeling results, and/or parameter assumptions. Specifically, in this BHHRA, the exposure estimates are an estimation of the RME that can be expected to occur under current or future site conditions. An RME estimate is a conservative estimate of exposure that falls within the upper bound of the range of all possible exposure estimates. In situations where populations are exposed through multiple pathways, RME estimates are calculated for both individual and multiple exposure pathways. Risk estimates for soil and groundwater were calculated separately.

Consistent with the Risk Methods Document, the focus of the exposure assessment for this BHHRA is to determine chronic intake or dose. The chronic exposure estimate is used because it allows for estimation of health consequences that result from long-term or unrestricted exposure to contaminants.

Using the human exposure models, CSM, and the EPCs, the CDIs of soil for each of the COPCs were determined. These CDIs for soils are presented in Tables F.48 through F.126. In this presentation, the CDIs used to estimate HI (i.e., noncarcinogenic effects) are presented first, and the values used to estimate ELCR follow. Within each of these broader classifications, CDIs are presented by receptor and exposure route.

Using the human exposure models for groundwater, the CSM, and the EPCs, the CDIs of groundwater for each of the COPCs were determined. These CDIs are presented in Tables F.127 through F.150. In this presentation, the CDIs used to estimate HI (i.e., noncarcinogenic effects) are presented first, and the values used to estimate ELCR follow.

F.3.5 SUMMARY OF EXPOSURE ASSESSMENT

Consistent with the data collected during the RI, the receptors selected for assessment are the excavation worker, industrial worker, recreational user, and rural resident.

Note: *Excavation worker CDIs presented in the following tables were calculated using subsurface soil EPCs due to the nature of excavation activities. All remaining receptor (industrial worker, recreational user and rural resident) CDIs were calculated using surface soil EPCs.*

Table F.48. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 2 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01	1.74E-06	1.70E-08		
Arsenic	3.00E+01	1.04E-04	3.06E-05		
Beryllium	1.80E+00	6.26E-06	6.13E-08	4.20E-10	
Iron	4.20E+04	1.46E-01	1.43E-03		
Thallium	4.50E+00	1.56E-05	1.53E-07		
Uranium	2.80E+02	9.73E-04	9.53E-06		
Organic Chemicals					
Total PAHs	1.80E-01				
Total PCBs	4.70E+00				
Radionuclides					
Cesium-137	1.51E+01				
Plutonium-239/240	4.34E+00				
Thorium-230	3.26E+00				
Uranium-234	2.85E+01				
Uranium-235	9.51E+00				
Uranium-238	3.34E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.5. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.49. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 2 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01				
Arsenic	3.00E+01	3.72E-05	1.09E-05	2.50E-09	
Beryllium	1.80E+00			1.50E-10	
Iron	4.20E+04				
Thallium	4.50E+00				
Uranium	2.80E+02				
Organic Chemicals					
Total PAHs	1.80E-01	2.23E-07	2.84E-07	9.60E-10	
Total PCBs	4.70E+00	5.83E-06	8.00E-06	1.17E-06	
Radionuclides					
Cesium-137	1.51E+01	3.35E+04		2.25E+00	5.10E+01
Plutonium-239/240	4.34E+00	9.63E+03		6.48E-01	1.47E+01
Thorium-230	3.26E+00	7.24E+03		4.86E-01	1.10E+01
Uranium-234	2.85E+01	6.33E+04		4.25E+00	9.63E+01
Uranium-235	9.51E+00	2.11E+04		1.42E+00	3.21E+01
Uranium-238	3.34E+02	7.41E+05		4.98E+01	1.13E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.5. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.50. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 2 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01	2.45E-07	2.30E-08		
Arsenic	3.00E+01	1.47E-05	4.14E-05		
Beryllium	1.80E+00	8.81E-07	8.28E-08	5.68E-10	
Iron	4.20E+04	2.05E-02	1.93E-03		
Mercury	4.30E-01	2.10E-07	1.98E-08		
Nickel	3.70E+01	1.81E-05	1.70E-06		
Thallium	4.50E+00	2.20E-06	2.07E-07		
Uranium	9.43E+02	4.61E-04	4.34E-05		
Organic Compounds					
2-methylnaphthalene	6.90E-01	3.38E-07	3.17E-07		
Total PAHs	1.80E-01				
Total PCBs	1.60E+00				
Radionuclides					
Americium-241	8.70E-01				
Cesium-137	5.10E+01				
Neptunium-237	3.10E-01				
Plutonium-239/240	1.61E+01				
Thorium-230	1.59E+01				
Uranium-234	2.53E+01				
Uranium-235	7.70E+00				
Uranium-238	3.02E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.51. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 2 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01				
Arsenic	3.00E+01	5.24E-06	1.48E-05	3.38E-09	
Beryllium	1.80E+00			2.03E-10	
Iron	4.20E+04				
Mercury	4.30E-01				
Nickel	3.70E+01			4.17E-09	
Thallium	4.50E+00				
Uranium	9.43E+02				
Organic Compounds					
2-methylnaphthalene	6.90E-01				
Total PAHs	1.80E-01	3.15E-08	3.84E-07	1.30E-09	
Total PCBs	1.60E+00	2.80E-07	3.68E-06	5.38E-07	
Radionuclides					
Americium-241	8.70E-01	2.72E+02		1.75E-01	3.97E+00
Cesium-137	5.10E+01	1.59E+04		1.03E+01	2.33E+02
Neptunium-237	3.10E-01	9.69E+01		6.25E-02	1.42E+00
Plutonium-239/240	1.61E+01	5.03E+03		3.25E+00	7.35E+01
Thorium-230	1.59E+01	4.97E+03		3.21E+00	7.26E+01
Uranium-234	2.53E+01	7.89E+03		5.09E+00	1.15E+02
Uranium-235	7.70E+00	2.41E+03		1.55E+00	3.52E+01
Uranium-238	3.02E+02	9.44E+04		6.09E+01	1.38E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.52. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 2 Child Recreation User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	5.00E-01	5.33E-07	6.62E-11	NA	1.45E-10	3.58E-08	1.72E-10
Arsenic	3.00E+01	3.20E-05	1.92E-07	NA	4.23E-07	6.44E-05	1.03E-08
Beryllium	1.80E+00	1.92E-06	5.21E-09	NA	1.16E-08	1.29E-07	6.19E-10
Iron	4.20E+04	4.47E-02	2.43E-03	1.61E-01	5.42E-03	3.01E-03	1.44E-05
Mercury	4.30E-01	4.58E-07	5.66E-08	3.50E-08	1.13E-07	3.08E-08	4.44E-06
Nickel	3.70E+01	3.94E-05	8.62E-07	NA	1.82E-06	2.65E-06	1.27E-08
Thallium	4.50E+00	4.79E-06	5.10E-07	NA	1.14E-06	3.22E-07	1.55E-09
Uranium	9.43E+02	1.00E-03	8.57E-07	5.43E-03	1.90E-06	6.75E-05	3.24E-07
Organic Compounds							
2-Methylnaphthalene	6.90E-01	7.35E-07	6.86E-10	NA	1.44E-09	4.94E-07	5.57E-06

[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.53. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 2 Teen Recreation User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	5.00E-01	9.29E-08	2.23E-11	NA	1.21E-10	3.35E-08	5.99E-11
Arsenic	3.00E+01	5.58E-06	6.49E-08	NA	3.54E-07	6.02E-05	3.60E-09
Beryllium	1.80E+00	3.35E-07	1.76E-09	NA	9.72E-09	1.20E-07	2.16E-10
Iron	4.20E+04	7.81E-03	8.20E-04	1.38E-01	4.54E-03	2.81E-03	5.04E-06
Mercury	4.30E-01	7.99E-08	1.91E-08	3.01E-08	9.45E-08	2.88E-08	1.55E-06
Nickel	3.70E+01	6.88E-06	2.91E-07	NA	1.53E-06	2.48E-06	4.44E-09
Thallium	4.50E+00	8.36E-07	1.72E-07	NA	9.54E-07	3.01E-07	5.40E-10
Uranium	9.43E+02	1.75E-04	2.89E-07	4.67E-03	1.59E-06	6.31E-05	1.13E-07
Organic Compounds							
2-Methylnaphthalene	6.90E-01	1.28E-07	2.31E-10	NA	1.21E-09	4.62E-07	1.94E-06

[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.54. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 2 Adult Recreation User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	5.00E-01	4.24E-08	1.37E-11	NA	1.50E-10	1.16E-08	2.74E-11
Arsenic	3.00E+01	2.54E-06	3.99E-08	NA	4.38E-07	2.09E-05	1.64E-09
Beryllium	1.80E+00	1.53E-07	1.08E-09	NA	1.20E-08	4.18E-08	9.85E-11
Iron	4.20E+04	3.56E-03	5.04E-04	1.66E-01	5.61E-03	9.74E-04	2.30E-06
Mercury	4.30E-01	3.65E-08	1.17E-08	3.63E-08	1.17E-07	9.98E-09	7.07E-07
Nickel	3.70E+01	3.14E-06	1.78E-07	NA	1.89E-06	8.58E-07	2.02E-09
Thallium	4.50E+00	3.82E-07	1.06E-07	NA	1.18E-06	1.04E-07	2.46E-10
Uranium	9.43E+02	8.00E-05	1.78E-07	5.62E-03	1.97E-06	2.19E-05	5.16E-08
Organic Compounds							
2-Methylnaphthalene	6.90E-01	5.85E-08	1.42E-10	NA	1.49E-09	1.60E-07	8.87E-07

[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.55. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 2 Recreational User

COPC		Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)								
Arsenic	3.00E+01	4.13E-06	4.01E-08	NA	2.35E-07	1.94E-05	1.78E-09	NA
Beryllium	1.80E+00	2.48E-07	1.09E-09	NA	6.44E-09	3.88E-08	1.07E-10	NA
Nickel	3.70E+01	5.10E-06	1.80E-07	NA	1.01E-06	7.99E-07	2.20E-09	NA
Uranium	9.43E+02	1.30E-04	1.79E-07	3.03E-03	1.05E-06	2.04E-05	5.60E-08	NA
Organic Compounds								
Total PAHs	1.80E-01	2.48E-08	3.38E-09	1.53E-05	2.00E-08	5.05E-07	6.87E-10	NA
Total PCBs	1.60E+00	2.20E-07	2.44E-08	2.06E-06	1.44E-07	4.83E-06	2.85E-07	NA
Radionuclides								
Americium-241	8.70E-01	8.35E+01	2.07E-02	NA	1.68E-01		4.41E-02	1.50E+00
Cesium-137	5.10E+01	4.90E+03	1.23E+04	NA	2.05E+04		2.58E+00	8.77E+01
Neptunium-237	3.10E-01	2.98E+01	2.32E-01	NA	1.84E+00		1.57E-02	5.33E-01
Plutonium-239/240	1.61E+01	1.55E+03	9.53E-02	5.84E+03	7.77E-01		8.15E-01	2.77E+01
Thorium-230	1.59E+01	1.53E+03	9.78E-01	NA	7.94E+00		8.05E-01	2.74E+01
Uranium-234	2.53E+01	2.42E+03	4.86E+00	1.17E+05	3.92E+01		1.28E+00	4.34E+01
Uranium-235	7.70E+00	7.39E+02	2.05E+00	3.88E+04	1.65E+01		3.90E-01	1.32E+01
Uranium-238	3.02E+02	2.90E+04	8.59E+01	1.35E+06	6.88E+02		1.53E+01	5.20E+02

[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.56. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 2 Rural Resident Child

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01	6.39E-06	8.95E-08		
Arsenic	3.00E+01	3.84E-04	1.61E-04		
Beryllium	1.80E+00	2.30E-05	3.22E-07	2.47E-09	
Iron	4.20E+04	5.37E-01	7.52E-03		
Mercury	4.30E-01	5.50E-06	7.70E-08		
Nickel	3.70E+01	4.73E-04	6.62E-06		
Thallium	4.50E+00	5.75E-05	8.05E-07		
Uranium	9.43E+02	1.21E-02	1.69E-04		
Organic Compounds					
2-methylnaphthalene	6.90E-01	8.82E-06	1.24E-06		
Total PAHs	1.80E-01				
Total PCBs	1.60E+00				
Radionuclides					
Americium-241	8.70E-01				
Cesium-137	5.10E+01				
Neptunium-237	3.10E-01				
Plutonium-239/240	1.61E+01				
Thorium-230	1.59E+01				
Uranium-234	2.53E+01				
Uranium-235	7.70E+00				
Uranium-238	3.02E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.57. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 2 Rural Resident Adult

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01	6.85E-07	3.90E-08		
Arsenic	3.00E+01	4.11E-05	7.03E-05		
Beryllium	1.80E+00	2.47E-06	1.41E-07	5.30E-10	
Iron	4.20E+04	5.75E-02	3.28E-03		
Mercury	4.30E-01	5.89E-07	3.36E-08		
Nickel	3.70E+01	5.07E-05	2.89E-06		
Thallium	4.50E+00	6.16E-06	3.51E-07		
Uranium	9.43E+02	1.29E-03	7.36E-05		
Organic Compounds					
2-methylnaphthalene	6.90E-01	9.45E-07	5.39E-07		
Total PAHs	1.80E-01				
Total PCBs	1.60E+00				
Radionuclides					
Americium-241	8.70E-01				
Cesium-137	5.10E+01				
Neptunium-237	3.10E-01				
Plutonium-239/240	1.61E+01				
Thorium-230	1.45E+01				
Uranium-234	2.53E+01				
Uranium-235	7.70E+00				
Uranium-238	3.02E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.58. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 2 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	5.00E-01				
Arsenic	3.00E+01	4.70E-05	3.79E-05	6.56E-09	
Beryllium	1.80E+00			3.94E-10	
Iron	4.20E+04				
Mercury	4.30E-01				
Nickel	3.70E+01				
Thallium	4.50E+00				
Uranium	9.43E+02				
Organic Compounds					
2-methylnaphthalene	6.90E-01				
Total PAHs	1.80E-01	2.82E-07	9.85E-07	2.58E-09	
Total PCBs	1.60E+00	2.50E-06	9.43E-06	1.05E-06	
Radionuclides					
Americium-241	8.70E-01	1.10E+03		1.96E-01	2.00E+01
Cesium-137	5.10E+01	6.43E+04		1.15E+01	1.17E+03
Neptunium-237	3.10E-01	3.91E+02		7.00E-02	7.13E+00
Plutonium-239/240	1.61E+01	2.03E+04		3.63E+00	3.71E+02
Thorium-230	1.59E+01	2.00E+04		3.59E+00	3.66E+02
Uranium-234	2.53E+01	3.18E+04		5.70E+00	5.81E+02
Uranium-235	7.70E+00	9.70E+03		1.74E+00	1.77E+02
Uranium-238	3.02E+02	3.81E+05		6.82E+01	6.95E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.4. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.59. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 3 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01	5.46E-05	5.34E-07		
Uranium	1.89E+01	6.57E-05	6.43E-07		
Radionuclides					
Cesium-137	4.56E-01				
Uranium-234	5.25E-01				
Uranium-238	9.24E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.7. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.60. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 3 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01				
Uranium	1.89E+01				
Radionuclides					
Cesium-137	4.56E-01	1.01E+03		6.80E-02	1.54E+00
Uranium-234	5.25E-01	1.17E+03		7.83E-02	1.77E+00
Uranium-238	9.24E+00	2.05E+04		1.38E+00	3.12E+01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.7. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.61. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 3 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01	7.68E-06	7.22E-07		
Uranium	4.30E+01	2.10E-05	1.98E-06		
Radionuclides					
Uranium-238	5.90E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.62. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 3 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01				
Uranium	4.30E+01				
Radionuclides					
Uranium-238	5.99E+00	1.87E+03		1.21E+00	2.74E+01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.63. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 3 Child Recreation User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	1.57E+01	1.67E-05	2.08E-09	NA	4.55E-09	1.12E-06	5.40E-09
Uranium	4.30E+01	4.58E-05	3.91E-08	2.53E-04	8.65E-08	3.08E-06	1.48E-08

[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.64. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 3 Teen Recreation User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	1.57E+01	2.92E-06	7.01E-10	NA	3.81E-09	1.05E-06	1.88E-09
Uranium	4.30E+01	7.99E-06	1.32E-08	2.18E-04	7.25E-08	2.88E-06	5.16E-09

[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.65. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 3 Adult Recreation User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Antimony	1.57E+01	1.33E-06	4.31E-10	NA	4.71E-09	3.64E-07	8.59E-10
Uranium	4.30E+01	3.65E-06	8.10E-09	2.62E-04	8.96E-08	9.98E-07	2.35E-09

[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.66. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 3 Recreation User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Radionuclides								
Uranium-238	5.99E+00	0.00E+00	1.70E+00	3.12E+04	1.36E+01		5.94E-11	0.00E+00

[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.67. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 3 Rural Resident Child

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01	2.01E-04	2.81E-06		
Uranium	4.30E+01	5.50E-04	7.70E-06		
Radionuclides					
Uranium-238	5.99E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.68. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 3 Rural Resident Adult

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01	2.15E-05	1.23E-06		
Uranium	4.30E+01	5.89E-05	3.36E-06		
Radionuclides					
Uranium-238	5.99E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.69. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 3 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Antimony	1.57E+01				
Uranium	4.30E+01				
Radionuclides					
Uranium-238	5.99E+00	7.55E+03		1.35E+00	1.38E+02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.6. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.70. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 4 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.14E+04	3.97E-02	3.89E-04	2.67E-06	
Arsenic	8.92E+00	3.10E-05	9.10E-06		
Barium	1.21E+02	4.19E-04	4.10E-06	2.82E-08	
Beryllium	6.94E-01	2.41E-06	2.36E-08	1.62E-10	
Iron	1.73E+04	6.00E-02	5.87E-04		
Manganese	5.02E+02	1.75E-03	1.71E-05	1.17E-07	
Vanadium	2.51E+01	8.73E-05	8.55E-07		
Organic Compounds					
Total PAHs	4.10E-01				
Total PCBs	3.12E+01				
Radionuclides					
Cesium-137	1.81E+02				
Neptunium-237	2.07E+00				
Plutonium-239/240	8.04E+00				
Radium-226	2.51E+00				
Technetium-99	4.96E+01				
Thorium-230	6.87E+01				
Uranium-234	3.25E+01				
Uranium-238	3.92E+01				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.9. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.71. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 4 Excavation Worker

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.14E+04				
Arsenic	8.92E+00	1.11E-05	3.25E-06	7.44E-10	
Barium	1.21E+02				
Beryllium	6.94E-01			5.79E-11	
Iron	1.73E+04				
Manganese	5.02E+02				
Vanadium	2.51E+01				
Organic Compounds					
Total PAHs	4.10E-01	5.09E-07	6.48E-07	2.19E-09	
Total PCBs	3.12E+01	3.87E-05	5.31E-05	7.76E-06	
Radionuclides					
Cesium-137	1.81E+02	4.02E+05		2.70E+01	6.12E+02
Neptunium-237	2.07E+00	4.60E+03		3.09E-01	7.00E+00
Plutonium-239	8.04E+00	1.78E+04		1.20E+00	2.72E+01
Radium-226	2.51E+00	5.57E+03		3.74E-01	8.48E+00
Technetium-99	4.96E+01	1.10E+05		7.39E+00	1.67E+02
Thorium-230	6.87E+01	1.53E+05		1.02E+01	2.32E+02
Uranium-234	3.25E+01	7.21E+04		4.84E+00	1.10E+02
Uranium-238	3.92E+01	8.70E+04		5.85E+00	1.32E+02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.9. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.72. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 4 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Arsenic	1.38E+01	6.75E-06	1.90E-05		
Beryllium	7.32E-01	3.58E-07	3.37E-08	2.31E-10	
Chromium	1.33E+02	6.51E-05	6.12E-06		
Iron	2.19E+04	1.07E-02	1.01E-03		
Nickel	7.19E+01	3.52E-05	3.31E-06		
Vanadium	2.97E+01	1.45E-05	1.37E-06		
Organic Compounds					
Total PAHs	4.60E-01				
Total PCB	8.98E-01				
Radionuclides					
Neptunium-237	2.66E-01				
Plutonium-239/240	2.71E+01				
Uranium-234	3.01E+01				
Uranium-238	5.55E+01				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.73. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 4 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Arsenic	1.38E+01	2.41E-06	6.80E-06	1.56E-09	
Beryllium	7.32E-01			8.25E-11	
Chromium	1.33E+02			1.50E-08	
Iron	2.19E+04				
Nickel	7.19E+01			8.11E-09	
Vanadium	2.97E+01				
Organic Compounds					
Total PAHs	4.60E-01	8.04E-08	9.82E-07	3.32E-09	
Total PCBs	8.98E-01	1.57E-07	2.06E-06	3.02E-07	
Radionuclides					
Neptunium-237	2.66E-01	8.31E+01		5.36E-02	1.21E+00
Plutonium-239/240	2.71E+01	8.47E+03		5.46E+00	1.24E+02
Uranium-234	3.01E+01	9.41E+03		6.07E+00	1.37E+02
Uranium-238	5.55E+01	1.73E+04		1.12E+01	2.53E+02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.74. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 4 Child Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Arsenic	1.38E+01	1.47E-05	8.85E-08	NA	1.94E-07	2.96E-05	4.74E-09
Beryllium	7.32E-01	7.80E-07	2.12E-09	NA	4.72E-09	5.24E-08	2.52E-10
Chromium	1.33E+02	1.42E-04	3.84E-06	NA	8.44E-06	9.52E-06	4.57E-08
Iron	2.19E+04	2.33E-02	1.27E-03	8.37E-02	2.82E-03	1.57E-03	7.53E-06
Nickel	7.19E+01	7.66E-05	1.67E-06	NA	3.54E-06	5.15E-06	2.47E-08
Vanadium	2.97E+01	3.16E-05	2.12E-07	NA	4.72E-07	2.13E-06	1.02E-08

[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.75. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 4 Teen Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Arsenic	1.38E+01	2.56E-06	2.98E-08	NA	1.63E-07	2.77E-05	1.65E-09
Beryllium	7.32E-01	1.36E-07	7.15E-10	NA	3.95E-09	4.90E-08	8.78E-11
Chromium	1.33E+02	2.47E-05	1.29E-06	NA	7.07E-06	8.90E-06	1.59E-08
Iron	2.19E+04	4.07E-03	4.28E-04	7.21E-02	2.37E-03	1.47E-03	2.63E-06
Nickel	7.19E+01	1.34E-05	5.65E-07	NA	2.96E-06	4.81E-06	8.62E-09
Vanadium	2.97E+01	5.52E-06	7.13E-08	NA	3.96E-07	1.99E-06	3.56E-09

[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.76. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 4 Adult Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Arsenic	1.38E+01	1.17E-06	1.83E-08	NA	2.01E-07	9.61E-06	7.55E-10
Beryllium	7.32E-01	6.21E-08	4.39E-10	NA	4.89E-09	1.70E-08	4.00E-11
Chromium	1.33E+02	1.13E-05	7.95E-07	NA	8.74E-06	3.09E-06	7.28E-09
Iron	2.19E+04	1.86E-03	2.63E-04	8.67E-02	2.92E-03	5.08E-04	1.20E-06
Nickel	7.19E+01	6.10E-06	3.47E-07	NA	3.66E-06	1.67E-06	3.93E-09
Vanadium	2.97E+01	2.52E-06	4.38E-08	NA	4.89E-07	6.89E-07	1.62E-09

[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.77. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 4 Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)								
Arsenic	1.38E+01	1.90E-06	1.85E-08	NA	1.08E-07	8.94E-06	8.20E-10	
Beryllium	7.32E-01	1.01E-07	4.42E-10	NA	2.62E-09	1.58E-08	4.35E-11	
Chromium	1.33E+02	1.83E-05	8.01E-07	NA	4.68E-06	2.87E-06	7.90E-09	
Nickel	7.19E+01	9.90E-06	3.49E-07	NA	1.96E-06	1.55E-06	4.27E-09	
Organic Compounds								
Total PAHs	4.60E-01	6.34E-08	8.65E-09	3.25E-05	5.12E-08	1.29E-06	1.76E-09	
Total PCBs	8.98E-01	1.24E-07	1.37E-08	1.20E-06	8.11E-08	2.71E-06	1.60E-07	
Radionuclides								
Neptunium-237	2.66E-01	2.55E+01	1.99E-01	NA	1.58E+00		1.35E-02	4.58E-01
Plutonium-239/240	2.71E+01	2.60E+03	1.60E-01	9.82E+03	1.31E+00		1.37E+00	4.66E+01
Uranium-234	3.01E+01	2.89E+03	5.79E+00	1.39E+05	4.67E+01		1.52E+00	5.18E+01
Uranium-238	5.55E+01	5.33E+03	1.58E+01	2.52E+05	1.26E+02		2.81E+00	9.55E+01

[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.78. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 4 Rural Resident Child

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Arsenic	1.38E+01	1.76E-04	7.41E-05		
Beryllium	7.32E-01	9.36E-06	1.31E-07	1.01E-09	
Chromium	1.33E+02	1.70E-03	2.38E-05		
Iron	2.19E+04	2.80E-01	3.92E-03		
Nickel	7.19E+01	9.19E-04	1.29E-05		
Vanadium	2.97E+01	3.80E-04	5.32E-06		
Organic Compounds					
Total PAHs	4.60E-01				
Total PCBs	8.98E-01				
Radionuclides					
Neptunium-237	2.66E-01				
Plutonium-239/240	2.71E+01				
Uranium-234	3.01E+01				
Uranium-238	5.55E+01				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.79. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 4 Rural Resident Adult

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Arsenic	1.38E+01	1.89E-05	3.23E-05		
Beryllium	7.32E-01	1.00E-06	5.72E-08	2.16E-10	
Chromium	1.33E+02	1.82E-04	1.04E-05		
Iron	2.19E+04	3.00E-02	1.71E-03		
Nickel	7.19E+01	9.85E-05	5.61E-06		
Vanadium	2.97E+01	4.07E-05	2.32E-06		
Organic Compounds					
Total PAHs	4.60E-01				
Total PCBs	8.98E-01				
Radionuclides					
Neptunium-237	2.66E-01				
Plutonium-239/240	2.71E+01				
Uranium-234	3.01E+01				
Uranium-238	5.55E+01				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.80. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 4 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Arsenic	1.38E+01	2.16E-05	1.74E-05	3.02E-09	
Beryllium	7.32E-01			1.60E-10	
Chromium	1.33E+02			2.91E-08	
Iron	2.19E+04				
Nickel	7.19E+01			1.57E-08	
Vanadium	2.97E+01				
Organic Compounds					
Total PAHs	4.60E-01	7.20E-07	2.52E-06	6.47E-09	
Total PCBs	8.98E-01	1.41E-06	5.29E-06	5.89E-07	
Radionuclides					
Neptunium-237	2.66E-01	3.35E+02		6.00E-02	6.12E+00
Plutonium-239/240	2.71E+01	3.41E+04		6.12E+00	6.24E+02
Uranium-234	3.01E+01	3.79E+04		6.79E+00	6.93E+02
Uranium-238	5.55E+01	6.99E+04		1.25E+01	1.28E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.8. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.81. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 5 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.61E+03	2.99E-02	2.93E-04	2.01E-06	
Arsenic	1.22E+01	4.24E-05	1.25E-05		
Uranium	2.79E+02	9.70E-04	9.49E-06		
Organic Compounds					
Total PAHs	1.12E+02				
Total PCBs	3.06E-01				
Carbazole	5.46E+00				
Radionuclides					
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.11. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.82. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 5 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.61E+03				
Arsenic	1.22E+01	1.51E-05	4.45E-06	1.02E-09	
Uranium	2.79E+02				
Organic Compounds					
Total PAHs	1.12E+02	1.39E-04	1.77E-04	5.97E-07	
Total PCBs	3.06E-01	3.80E-07	5.21E-07	3.11E-08	
Carbazole	5.46E+00	6.77E-06	6.63E-07		
Radionuclides					
Uranium-238	1.38E+00	3.06E+03		2.06E-01	4.66E+00

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.11. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.83. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 5 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.86E+03	4.33E-03	4.07E-04	2.80E-06	
Arsenic	1.22E+01	5.97E-06	1.68E-05		
Beryllium	6.19E-01	3.03E-07	2.85E-08	1.95E-10	
Nickel	3.39E+01	1.66E-05	1.56E-06		
Uranium	2.79E+02	1.36E-04	1.28E-05		
Organic Compounds					
Total PAHs	1.11E+02				
Total PCBs	3.06E-01				
Bis(2ethylhexyl)phthalate	4.76E+00	2.33E-06	2.19E-06		
Carbazole	5.46E+00				
Dibenzofuran	3.52E+00	1.72E-06	1.62E-06		
Fluoranthene	5.33E+02	2.61E-04	3.19E-03	8.72E-05	
Naphthalene	1.60E+01	7.83E-06	9.57E-05	1.52E-04	
Pyrene	3.16E+01	1.55E-05	1.89E-04	5.74E-06	
Radionuclides					
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.84. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 5 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.86E+03				
Arsenic	1.22E+01	2.13E-06	6.01E-06	1.38E-09	
Beryllium	6.19E-01			6.98E-11	
Nickel	3.39E+01			3.82E-09	
Uranium	2.79E+02				
Organic Compounds					
Total PAHs	1.11E+02	1.94E-05	2.37E-04	8.00E-07	
Total PCBs	3.06E-01	5.35E-08	7.04E-07	1.03E-07	
Bis(2-ethylhexyl)phthalate	4.76E+00	8.32E-07	7.82E-07	4.93E-08	
Carbazole	5.46E+00	9.53E-07	8.96E-07		
Dibenzofuran	3.52E+00				
Fluoranthene	5.33E+02				
Naphthalene	1.60E+01				
Pyrene	3.16E+01				
Radionuclides					
Uranium-238	1.38E+00	4.31E+02		2.78E-01	6.30E+00

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.85. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 5 Child Recreational User

		Exposure Route - Chronic Daily Intake[b]					
COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	8.86E+03	9.44E-03	3.77E-05	NA	8.41E-05	6.34E-04	3.04E-06
Arsenic	1.22E+01	1.30E-05	7.83E-08	NA	1.72E-07	2.62E-05	4.19E-09
Beryllium	6.19E-01	6.60E-07	1.79E-09	NA	3.99E-09	4.43E-08	2.13E-10
Nickel	3.39E+01	3.61E-05	7.90E-07	NA	1.67E-06	2.43E-06	1.17E-08
Uranium	2.79E+02	2.97E-04	2.54E-07	1.61E-03	5.61E-07	2.00E-05	9.59E-08
Organic Compounds							
Bis(2-ethylhexyl)phthalate	4.76E+00	5.07E-06	3.20E-08	NA	6.99E-08	3.41E-06	1.51E-07
Dibenzofuran	3.52E+00	3.75E-06	5.05E-09	NA	1.07E-08	2.52E-06	1.21E-09
Fluoranthene	5.33E+02	5.68E-04	3.58E-06	2.91E-03	7.83E-06	4.96E-03	9.56E-05
Naphthalene	1.60E+01	1.70E-05	6.05E-09	4.80E-05	1.23E-08	1.49E-04	1.67E-04
Pyrene	3.16E+01	3.37E-05	2.13E-07	9.76E-05	4.64E-07	2.94E-04	6.29E-06

[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.86. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 5 Teen Recreational User

		Exposure Route - Chronic Daily Intake[b]					
COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	8.86E+03	1.65E-03	1.27E-05	NA	7.05E-05	5.93E-04	1.06E-06
Arsenic	1.22E+01	2.27E-06	2.64E-08	NA	1.44E-07	2.45E-05	1.46E-09
Beryllium	6.19E-01	1.15E-07	6.05E-10	NA	3.34E-09	4.14E-08	7.42E-11
Nickel	3.39E+01	6.30E-06	2.66E-07	NA	1.40E-06	2.27E-06	4.07E-09
Uranium	2.79E+02	5.18E-05	8.55E-08	1.39E-03	4.70E-07	1.87E-05	3.35E-08
Organic Compounds							
Bis(2-ethylhexyl)phthalate	4.76E+00	8.85E-07	1.08E-08	NA	5.86E-08	3.18E-06	5.28E-08
Dibenzofuran	3.52E+00	6.54E-07	1.70E-09	NA	9.00E-09	2.35E-06	4.22E-10
Fluoranthene	5.33E+02	9.90E-05	1.21E-06	2.51E-03	6.56E-06	4.64E-03	3.33E-05
Naphthalene	1.60E+01	2.97E-06	2.04E-09	4.13E-05	1.03E-08	1.39E-04	5.83E-05
Pyrene	3.16E+01	5.87E-06	7.17E-08	8.40E-05	3.89E-07	2.75E-04	2.19E-06

[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.87. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 5 Adult Recreational User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	8.86E+03	7.51E-04	7.80E-06	NA	8.71E-05	2.06E-04	4.85E-07
Arsenic	1.22E+01	1.03E-06	1.62E-08	NA	1.78E-07	8.49E-06	6.67E-10
Beryllium	6.19E-01	5.25E-08	3.71E-10	NA	4.13E-09	1.44E-08	3.39E-11
Nickel	3.39E+01	2.88E-06	1.64E-07	NA	1.73E-06	7.87E-07	1.86E-09
Uranium	2.79E+02	2.37E-05	5.26E-08	1.67E-03	5.81E-07	6.47E-06	1.53E-08
Organic Compounds							
Bis(2-ethylhexyl)phthalate	4.76E+00	4.04E-07	6.63E-09	NA	7.24E-08	1.10E-06	2.41E-08
Dibenzofuran	3.52E+00	2.98E-07	1.05E-09	NA	1.11E-08	8.17E-07	1.93E-10
Fluoranthene	5.33E+02	4.52E-05	7.42E-07	3.02E-03	8.11E-06	1.61E-03	1.52E-05
Naphthalene	1.60E+01	1.36E-06	1.25E-09	4.97E-05	1.28E-08	4.83E-05	2.66E-05
Pyrene	3.16E+01	2.68E-06	4.40E-08	1.01E-04	4.81E-07	9.53E-05	1.00E-06

[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.88. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 5 Recreational User

COPC	Exposure Route - Chronic Daily Intake[b]							
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)								
Arsenic	1.22E+01	1.68E-06	1.63E-08	NA	9.54E-08	7.90E-06	7.25E-10	
Beryllium	6.19E-01	8.52E-08	3.74E-10	NA	2.21E-09	1.34E-08	3.68E-11	
Organic Compounds								
Total PAHs	1.11E+02	1.53E-05	2.09E-06	6.83E-03	1.23E-05	3.11E-04	4.24E-07	
Total PCBs	3.06E-01	4.21E-08	4.67E-09	4.70E-07	2.76E-08	9.25E-07	5.45E-08	
Bis(2-ethylhexyl)phthalate	4.76E+00	6.56E-07	6.68E-09	NA	3.88E-08	1.03E-06	2.62E-08	
Carbazole	5.46E+00	7.51E-07	9.61E-10	NA	5.35E-09	1.18E-06	1.61E-07	
Radionuclides								
Uranium-238	1.38E+00	1.32E+02	3.92E-01	1.06E+04	3.14E+00		6.98E-02	2.37E+00

[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.89. Chronic Daily Intakes (Non-Carcinogenic)from Soil for SWMU 5 Child Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.86E+03	1.13E-01	1.59E-03	1.22E-05	
Arsenic	1.22E+01	1.56E-04	6.55E-05		
Beryllium	6.19E-01	7.91E-06	1.11E-07	8.51E-10	
Nickel	3.39E+01	4.34E-04	6.07E-06		
Uranium	2.79E+02	3.57E-03	4.99E-05		
Organic Compounds					
Total PAHs	1.11E+02				
Total PCBs	3.06E-01				
Bis(2-ethylhexyl)phthalate	4.76E+00	6.09E-05	8.52E-06		
Carbazole	5.46E+00				
Dibenzofuran	3.52E+00	4.50E-05	6.30E-06		
Fluoranthene	5.33E+02	6.81E-03	1.24E-02	3.82E-04	
Naphthalene	1.60E+01	2.05E-04	3.72E-04	6.68E-04	
Pyrene	3.16E+01	4.04E-04	7.35E-04	2.51E-05	
Radionuclides					
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.90. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 5 Adult Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.86E+03	1.21E-02	6.92E-04	2.61E-06	
Arsenic	1.22E+01	1.67E-05	2.86E-05		
Beryllium	6.19E-01	8.48E-07	4.83E-08	1.82E-10	
Nickel	3.39E+01	4.65E-05	2.65E-06		
Uranium	2.79E+02	3.82E-04	2.18E-05		
Organic Compounds					
Total PAHs	1.11E+02				
Total PCBs	3.06E-01				
Bis(2-ethylhexyl)phthalate	4.76E+00	6.52E-06	3.72E-06		
Carbazole	5.46E+00				
Dibenzofuran	3.52E+00	4.82E-06	2.75E-06		
Fluoranthene	5.33E+02	7.30E-04	5.41E-03	8.19E-05	
Naphthalene	1.60E+01	2.19E-05	1.62E-04	1.43E-04	
Pyrene	3.16E+01	4.33E-05	3.21E-04	5.39E-06	
Radionuclides					
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.91. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 5 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.86E+03				
Arsenic	1.22E+01	1.91E-05	1.54E-05	2.67E-09	
Beryllium	6.19E-01	9.69E-07	2.61E-08	1.35E-10	
Nickel	3.39E+01	5.31E-05	1.43E-06	1.35E-10	
Uranium	2.79E+02	4.37E-04	1.17E-05	6.10E-08	
Organic Compounds					
Total PAHs	1.11E+02	1.74E-04	6.08E-04	1.56E-06	
Total PCBs	3.06E-01	4.79E-07	1.80E-06	2.01E-07	
Bis(2-ethylhexyl)phthalate	4.76E+00	7.45E-06	2.00E-06	9.64E-08	
Carbazole	5.46E+00	8.54E-06	2.30E-06		
Dibenzofuran	3.52E+00				
Fluoranthene	5.33E+02				
Naphthalene	1.60E+01				
Pyrene	3.16E+01				
Radionuclides					
Uranium-238	1.38E+00	1.74E+03		3.11E-01	3.17E+01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.10. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.92. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 6 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	8.18E-01	2.84E-06	2.78E-08	1.91E-10	
Uranium	1.14E+02	3.96E-04	3.88E-06		
Organic Compounds					
Total PAHs	4.99E-01				
Total PCBs	6.00E-02				
Radionuclides					
Uranium-235	1.25E+00				
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.13. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.93. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 6 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	8.18E-01			6.82E-11	
Uranium	1.14E+02				
Organic Compounds					
Total PAHs	4.99E-01	6.19E-07	7.88E-07	2.66E-09	
Total PCBs	6.00E-02	7.45E-08	1.02E-07	1.49E-08	
Radionuclides					
Uranium-235	6.80E+00	1.51E+04		1.01E+00	2.30E+01
Uranium-238	1.38E+00	3.06E+03		2.06E-01	4.66E+00

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.13. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.94. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 6 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	7.30E-01	3.57E-07	3.36E-08	2.30E-10	
Nickel	1.58E+01	7.73E-06	7.27E-07		
Uranium	1.14E+02	5.58E-05	5.24E-06		
Organic Compounds					
Total PAHs	4.99E-01				
Total PCBs	6.00E-02				
Radionuclides					
Uranium-235	1.25E+00				
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.95. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 6 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	7.30E-01			8.23E-11	
Nickel	1.58E+01			1.78E-09	
Uranium	1.14E+02				
Organic Compounds					
Total PAHs	4.99E-01	8.72E-08	1.07E-06	3.60E-09	
Total PCBs	6.00E-02	1.05E-08	1.38E-07	2.02E-08	
Radionuclides					
Uranium-235	6.80E+00	2.13E+03		1.37E+00	3.11E+01
Uranium-238	1.38E+00	4.31E+02		2.78E-01	6.30E+00

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.96. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 6 Child Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b]					
		Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Beryllium	7.30E-01	7.78E-07	2.11E-09	NA	4.71E-09	5.23E-08	2.51E-10
Nickel	1.58E+01	1.68E-05	3.68E-07	NA	7.78E-07	1.13E-06	5.43E-09
Uranium	1.14E+02	1.21E-04	1.04E-07	6.61E-04	2.29E-07	8.16E-06	3.92E-08

[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.97. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 6 Teen Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b]					
		Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Beryllium	7.30E-01	1.36E-07	7.13E-10	NA	3.94E-09	4.88E-08	8.75E-11
Nickel	1.58E+01	2.94E-06	1.24E-07	NA	6.52E-07	1.06E-06	1.89E-09
Uranium	1.14E+02	2.12E-05	3.50E-08	5.69E-04	1.92E-07	7.63E-06	1.37E-08

[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day
NA =not all factors are available for calculations for this pathway for this analyte

Table F.98. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 6 Adult Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b]					
		Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Beryllium	7.30E-01	6.19E-08	4.38E-10	NA	4.87E-09	1.69E-08	3.99E-11
Nickel	1.58E+01	1.34E-06	7.62E-08	NA	8.05E-07	3.67E-07	8.64E-10
Uranium	1.14E+02	9.67E-06	2.15E-08	6.85E-04	2.38E-07	2.64E-06	6.24E-09

[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.99. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 6 Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b]						
		Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)								
Beryllium	7.30E-01	1.01E-07	4.41E-10	NA	2.61E-09	1.58E-08	4.34E-11	NA
Nickel	1.58E+01	2.18E-06	7.68E-08	NA	4.31E-07	3.41E-07	9.38E-10	NA
Organic Compounds								
Total PAHs	4.99E-01	6.87E-08	9.38E-09	3.49E-05	5.55E-08	1.40E-06	1.90E-09	NA
Total PCBs	6.00E-02	8.26E-09	9.16E-10	1.68E-07	5.42E-09	1.81E-07	1.07E-08	NA
Radionuclides								
Uranium-235	6.80E+00	6.53E+02	1.81E+00	3.48E+04	1.45E+01	NA	3.44E-01	1.17E+01
Uranium-238	1.38E+00	1.32E+02	3.92E-01	1.06E+04	3.14E+00	NA	6.98E-02	2.37E+00

[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.100. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 6 Child Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	7.30E-01	9.33E-06	1.31E-07	1.00E-09	
Nickel	1.58E+01	2.02E-04	2.83E-06		
Uranium	1.14E+02	1.46E-03	2.04E-05		
Organic Compounds					
Total PAHs	4.99E-01				
Total PCBs	6.00E-02				
Radionuclides					
Uranium-235	1.25E+00				
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.101. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 6 Adult Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	7.30E-01	1.00E-06	5.70E-08	2.15E-10	
Nickel	1.58E+01	2.16E-05	1.23E-06		
Uranium	1.14E+02	1.56E-04	8.90E-06		
Organic Compounds					
Total PAHs	4.99E-01				
Total PCBs	6.00E-02				
Radionuclides					
Uranium-235	1.25E+00				
Uranium-238	1.38E+00				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.102. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 6 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Beryllium	7.30E-01			1.60E-10	
Nickel	1.58E+01			3.46E-09	
Uranium	1.14E+02				
Organic Compounds					
Total PAHs	4.99E-01	7.81E-07	2.73E-06	7.02E-09	
Total PCBs	6.00E-02	9.39E-08	3.54E-07	3.94E-08	
Radionuclides					
Uranium-235	6.80E+00	8.57E+03		1.53E+00	1.56E+02
Uranium-238	1.38E+00	1.74E+03		3.11E-01	3.17E+01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.12. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.103. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 7 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.89E+03	3.09E-02	3.02E-04	9.47E-06	
Antimony	9.84E-01	3.42E-06	3.35E-08		
Arsenic	4.56E+00	1.59E-05	4.66E-06		
Beryllium	4.20E-01	1.46E-06	1.43E-08	9.81E-11	
Iron	1.49E+04	5.18E-02	5.07E-04		
Manganese	3.92E+02	1.36E-03	1.34E-05	9.17E-08	
Thallium	2.00E+00	6.95E-06	6.81E-08		
Uranium	1.46E+02	5.07E-04	4.96E-06		
Vanadium	2.21E+01	7.68E-05	7.52E-07		
Organic Compounds					
Total PAHs	6.37E+00				
Total PCBs	1.81E+01				
Radionuclides					
Americium-241	2.00E+00				
Neptunium-237	1.60E-01				
Technetium-99	1.29E+02				
Thorium-228	1.35E+00				
Thorium-230	1.57E+00				
Uranium-234	5.57E+01				
Uranium-235	3.82E+00				
Uranium-238	3.15E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.15. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.104. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 7 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	8.89E+03				
Antimony	9.84E-01				
Arsenic	4.56E+00	5.67E-06	1.66E-06	3.81E-10	
Beryllium	4.20E-01			3.50E-11	
Iron	1.49E+04				
Manganese	3.92E+02				
Thallium	2.00E+00				
Uranium	1.46E+02				
Vanadium	2.21E+01				
Organic Compounds					
Total PAHs	6.37E+00	7.91E-06	1.01E-05	3.40E-08	
Total PCBs	1.81E+01	2.25E-05	3.08E-05	4.50E-06	
Radionuclides					
Amerecium-241	2.00E+00	4.44E+03		2.98E-01	6.76E+00
Neptunium-237	1.60E-01	3.55E+02		2.39E-02	5.41E-01
Technetium-99	1.29E+02	2.86E+05		1.92E+01	4.36E+02
Thorium-228	1.35E+00	2.99E+03		2.01E-01	4.56E+00
Thorium-230	1.57E+00	3.49E+03		2.35E-01	5.31E+00
Uranium-234	5.57E+01	1.24E+05		8.31E+00	1.88E+02
Uranium-235	3.82E+00	8.48E+03		5.70E-01	1.29E+01
Uranium-238	3.15E+02	6.99E+05		4.70E+01	1.06E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.15. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.105. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 7 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	9.10E+03	4.45E-03	4.19E-04	2.87E-06	
Antimony	9.82E-01	4.80E-07	4.52E-08		
Arsenic	6.91E+00	3.38E-06	9.53E-06		
Beryllium	6.15E-01	3.01E-07	2.83E-08	1.94E-10	
Copper	6.73E+01	3.29E-05	3.09E-06		
Iron	1.92E+04	9.39E-03	8.83E-04		
Nickel	5.13E+01	2.51E-05	2.36E-06		
Thallium	2.00E+00	9.78E-07	9.20E-08		
Uranium	3.59E+02	1.76E-04	1.65E-05		
Vanadium	2.81E+01	1.37E-05	1.29E-06		
Organic Compounds					
Total PAHs	6.37E+00				
Total PCBs	1.81E+01				
Radionuclides					
Neptunium-237	3.20E-01				
Plutonium-239/240	2.54E-01				
Technetium-99	1.21E+02				
Thorium-228	3.36E+00				
Thorium-230	2.14E+00				
Uranium-234	7.69E+01				
Uranium-235	3.50E+00				
Uranium-238	4.80E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.106. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 7 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	9.10E+03				
Antimony	9.82E-01				
Arsenic	6.91E+00	1.21E-06	3.40E-06	7.79E-10	
Beryllium	6.15E-01			6.93E-11	
Copper	6.73E+01				
Iron	1.92E+04				
Nickel	5.13E+01			5.78E-09	
Thallium	2.00E+00				
Uranium	3.59E+02				
Vanadium	2.81E+01				
Organic Compounds					
Total PAHs	6.37E+00	1.11E-06	1.36E-05	4.59E-08	
Total PCBs	1.81E+01	3.16E-06	4.16E-05	6.08E-06	
Radionuclides					
Neptunium-237	3.20E-01	1.00E+02		6.45E-02	1.46E+00
Plutonium-239/240	2.54E+00	7.94E+02		5.12E-01	1.16E+00
Technetium-99	1.21E+02	3.78E+04		2.44E+01	5.53E+02
Thorium-228	3.36E+00	1.05E+03		6.77E-01	1.53E+01
Thorium-230	2.14E+00	6.68E+02		4.31E-01	9.75E+00
Uranium-234	7.69E+01	2.40E+04		1.55E+01	3.51E+02
Uranium-235	3.50E+02	1.09E+05		7.06E+01	1.60E+01
Uranium-238	4.80E+02	1.50E+05		9.67E+01	2.19E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.107. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 7 Child Recreational User

		Exposure Route - Chronic Daily Intake[b]					
COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	9.10E+03	9.70E-03	3.87E-05	NA	8.64E-05	6.52E-04	3.13E-06
Antimony	9.82E-01	1.05E-06	1.30E-10	NA	2.85E-10	7.03E-08	3.38E-10
Arsenic	6.91E+00	7.36E-06	4.43E-08	NA	9.74E-08	1.48E-05	2.37E-09
Beryllium	6.15E-01	6.55E-07	1.78E-09	NA	3.97E-09	4.40E-08	2.11E-10
Copper	6.73E+01	7.17E-05	6.71E-06	1.08E-03	1.35E-05	4.82E-06	2.31E-08
Iron	1.92E+04	2.05E-02	1.11E-03	7.34E-02	2.48E-03	1.37E-03	6.60E-06
Nickel	5.13E+01	5.47E-05	1.19E-06	NA	2.52E-06	3.67E-06	1.76E-08
Thallium	2.00E+00	2.13E-06	2.27E-07	NA	5.06E-07	1.43E-07	6.87E-10
Uranium	3.59E+02	3.82E-04	3.26E-07	2.07E-03	7.22E-07	2.57E-05	1.23E-07
Vanadium	2.81E+01	2.99E-05	2.00E-07	NA	4.47E-07	2.01E-06	9.66E-09

[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.108. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 7 Teen Recreational User

		Exposure Route - Chronic Daily Intake[b]					
COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	9.10E+03	1.69E-03	1.30E-05	NA	7.24E-05	6.09E-04	1.09E-06
Antimony	9.82E-01	1.82E-07	4.39E-11	NA	2.39E-10	6.57E-08	1.18E-10
Arsenic	6.91E+00	1.28E-06	1.49E-08	NA	8.16E-08	1.39E-05	8.28E-10
Beryllium	6.15E-01	1.14E-07	6.01E-10	NA	3.32E-09	4.11E-08	7.37E-11
Copper	6.73E+01	1.25E-05	2.26E-06	9.32E-04	1.13E-05	4.50E-06	8.06E-09
Iron	1.92E+04	3.57E-03	3.75E-04	6.32E-02	2.07E-03	1.28E-03	2.30E-06
Nickel	5.13E+01	9.53E-06	4.03E-07	NA	2.12E-06	3.43E-06	6.15E-09
Thallium	2.00E+00	3.72E-07	7.65E-08	NA	4.24E-07	1.34E-07	2.40E-10
Uranium	3.59E+02	6.67E-05	1.10E-07	1.78E-03	6.05E-07	2.40E-05	4.30E-08
Vanadium	2.81E+01	5.22E-06	6.75E-08	NA	3.74E-07	1.88E-06	3.37E-09

[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.109. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 7 Adult Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	9.10E+03	7.72E-04	8.02E-06	NA	8.95E-05	2.11E-04	4.98E-07
Antimony	9.82E-01	8.33E-08	2.69E-11	NA	2.95E-10	2.28E-08	5.37E-11
Arsenic	6.91E+00	5.86E-07	9.18E-09	NA	1.01E-07	4.81E-06	3.78E-10
Beryllium	6.15E-01	5.22E-08	3.69E-10	NA	4.11E-09	1.43E-08	3.36E-11
Copper	6.73E+01	5.70E-06	1.39E-06	1.12E-03	1.39E-05	1.56E-06	3.68E-09
Iron	1.92E+04	1.63E-03	2.30E-04	7.60E-02	2.56E-03	4.45E-04	1.05E-06
Nickel	5.13E+01	4.35E-06	2.47E-07	NA	2.61E-06	1.19E-06	2.81E-09
Thallium	2.00E+00	1.70E-07	4.70E-08	NA	5.24E-07	4.64E-08	1.09E-10
Uranium	3.59E+02	3.04E-05	6.76E-08	2.14E-03	7.48E-07	8.33E-06	1.96E-08
Vanadium	2.81E+01	2.38E-06	4.15E-08	NA	4.63E-07	6.52E-07	1.54E-09

[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.110. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 7 Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b] Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)								
Arsenic	6.91E+00	9.52E-07	9.25E-09	NA	5.40E-08	4.47E-06	4.10E-10	
Beryllium	6.15E-01	8.47E-08	3.72E-10	NA	2.20E-09	1.33E-08	3.65E-11	
Nickel	5.13E+01	7.06E-06	2.49E-07	NA	1.40E-06	1.11E-06	3.05E-09	
Organic Compounds								
Total PAHs	6.37E+00	8.77E-07	1.20E-07	3.96E-04	7.09E-07	1.79E-05	2.43E-08	
Total PCBs	1.81E+01	2.49E-06	2.76E-07	2.23E-05	1.63E-06	5.47E-05	3.23E-06	
Radionuclides								
Neptunium-237	3.20E-01	3.07E+01	2.40E-01	NA	1.90E+00		1.62E-02	5.51E-01
Plutonium-239/240	2.54E-01	2.44E+01	1.50E-03	8.33E+01	1.23E-02		1.29E-02	4.37E-01
Technetium-99	1.21E+02	1.16E+04	4.45E+03	NA	1.42E+04		6.13E+00	2.08E+02
Thorium-228	3.36E+00	3.23E+02	2.57E+02	NA	1.92E+03		1.70E-01	5.78E+00
Thorium-230	2.14E+00	2.05E+02	1.31E-01	NA	1.07E+00		1.08E-01	3.68E+00
Uranium-234	7.69E+01	7.38E+03	1.48E+01	3.48E+05	1.19E+02		3.90E+00	1.32E+02
Uranium-235	3.50E+00	3.36E+02	9.32E-01	2.01E+04	7.48E+00		1.77E-01	6.02E+00
Uranium-238	4.80E+02	4.60E+04	1.36E+02	2.15E+06	1.09E+03	NA	2.43E+01	8.25E+02

[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.111. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 7 Child Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	9.10E+03	1.16E-01	1.63E-03	1.25E-05	
Antimony	9.82E-01	1.26E-05	1.76E-07		
Arsenic	6.91E+00	8.83E-05	3.71E-05		
Beryllium	6.15E-01	7.86E-06	1.10E-07	8.45E-10	
Copper	6.73+01	8.60E-04	1.20E-05		
Iron	1.92E+04	2.45E-01	3.44E-03		
Nickel	5.13E+01	6.56E-04	9.18E-06		
Thallium	2.00E+00	2.56E-05	3.58E-07		
Uranium	3.59E+02	4.59E-03	6.42E-05		
Vanadium	2.81E+01	3.59E-04	5.03E-06		
Organic Compounds					
Total PAHs	6.37E+00				
Total PCBs	1.81E+01				
Radionuclides					
Neptunium-237	3.20E-01				
Plutonium-239/240	2.54E-01				
Technetium-99	1.21E+02				
Thorium-228	3.36E+00				
Thorium-230	2.14E+00				
Uranium-234	7.69E+01				
Uranium-235	3.50E+00				
Uranium-238	4.80E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.112. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 7 Adult Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	9.10E+03	1.25E-02	7.11E-04	2.68E-06	
Antimony	9.82E-01	1.35E-06	7.67E-08		
Arsenic	6.91E+00	9.47E-06	1.62E-05		
Beryllium	6.15E-01	8.42E-07	4.80E-08	1.81E-10	
Copper	6.73E+01	9.21E-05	5.25E-06		
Iron	1.92E+04	2.63E-02	1.50E-03		
Nickel	5.13E+01	7.03E-05	4.01E-06		
Thallium	2.00E+00	2.74E-06	1.56E-07		
Uranium	3.59E+02	4.92E-04	2.80E-05		
Vanadium	2.81E+01	3.85E-05	2.19E-06		
Organic Compounds					
Total PAHs	6.37E+00				
Total PCBs	1.81E+01				
Radionuclides					
Neptunium-237	3.20E-01				
Plutonium-239/240	2.54E-01				
Technetium-99	1.21E+02				
Thorium-228	3.36E+00				
Thorium-230	2.14E+00				
Uranium-234	7.69E+01				
Uranium-235	3.50E+00				
Uranium-238	4.80E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.113. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 7 Rural Resident

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	9.10E+03				
Antimony	9.82E-01				
Arsenic	6.91E+00	1.08E-05	8.73E-06	1.51E-09	
Beryllium	6.15E-01			1.35E-10	
Copper	6.73E+01				
Iron	1.92E+04				
Nickel	5.13E+01			1.12E-08	
Thallium	2.00E+00				
Uranium	3.59E+02				
Vanadium	2.81E+01				
Organic Compounds					
Total PAHs	6.37E+00	9.97E-06	3.49E-05	8.96E-08	
Total PCBs	1.81E+01	2.83E-05	1.07E-04	1.19E-05	
Radionuclides					
Neptunium-237	3.20E-01	4.03E+02		7.22E-02	7.36E+00
Plutonium-239/240	2.54E-01	3.20E+02		5.73E-02	5.85E+00
Technetium-99	1.21E+02	1.52E+05		2.72E+01	2.77E+03
Thorium-228	3.36E+00	4.23E+03		7.58E-01	7.73E+01
Thorium-230	2.14E+00	2.69E+03		4.82E-01	4.92E+01
Uranium-234	7.69E+01	9.69E+04		1.74E+01	1.77E+03
Uranium-235	3.50E+00	4.41E+03		7.90E-01	8.05E+01
Uranium-238	4.80E+02	6.04E+05		1.08E+02	1.10E+04

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.14. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.114. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 30 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.29E+04	4.49E-02	4.40E-04	3.02E-06	
Antimony	3.00E+00	1.04E-05	1.02E-07		
Arsenic	5.28E+00	1.84E-05	5.39E-06		
Iron	1.93E+04	6.72E-02	6.58E-04		
Manganese	5.11E+02	1.77E-03	1.74E-05	1.19E-07	
Nickel	4.35E+02	1.51E-03	1.48E-05		
Thallium	1.80E+00	6.26E-06	6.13E-08		
Uranium	1.40E+03	4.87E-03	4.76E-05		
Vanadium	2.68E+01	9.31E-05	9.12E-07		
Organic Compounds					
Total PAHs	1.25E+01				
Total PCBs	1.53E+01				
Radionuclides					
Neptunium-237	4.45E-01				
Technetium-99	2.47E+02				
Thorium-228	4.65E-01				
Thorium-230	2.56E+00				
Uranium-234	6.81E+01				
Uranium-235	1.14E+01				
Uranium-238	2.02E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.17. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.115. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 30 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.29E+04				
Antimony	3.00E+00				
Arsenic	5.28E+00	6.55E-06	1.93E-06	4.40E-10	
Iron	1.93E+04				
Manganese	5.11E+02				
Nickel	4.35E+02			3.63E-08	
Thallium	1.80E+00				
Uranium	1.40E+03				
Vanadium	3.40E+01				
Organic Compounds					
Total PAHs	1.25E+01	1.55E-05	1.98E-05	6.67E-08	
Total PCBs	1.53E+01	1.90E-05	2.60E-05	3.81E-06	
Radionuclides					
Neptunium-237	4.45E-01	9.88E+02		6.64E-02	1.50E+00
Technetium-99	2.47E+02	5.48E+05		3.69E+01	8.35E+02
Thorium-228	4.65E-01	1.03E+03		6.94E-02	1.57E+00
Thorium-230	2.56E+00	5.68E+03		3.82E-01	8.65E+00
Uranium-234	6.81E+01	1.51E+05		1.02E+01	2.30E+02
Uranium-235	1.14E+01	2.53E+04		1.70E+00	3.85E+01
Uranium-238	2.02E+02	4.48E+05		3.01E+01	6.83E+02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.17. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.116. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 30 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.60E+04	7.83E-03	7.36E-04	5.05E-06	
Antimony	3.00E+00	1.47E-06	1.38E-07		
Beryllium	8.50E-01	4.16E-07	3.91E-08	2.68E-10	
Cadmium	2.80E+00	1.37E-06	1.29E-07		
Copper	1.70E+02	8.32E-05	7.82E-06		
Nickel	5.70E+02	2.79E-04	2.62E-05		
Thallium	1.80E+00	8.81E-07	8.28E-08		
Uranium	1.40E+03	6.85E-04	6.44E-05		
Organic Compounds					
Total PAHs	1.25E+01				
Total PCBs	1.52E+01				
Radionuclides					
Neptunium-237	1.68E+00				
Technetium-99	3.60E+02				
Thorium-230	4.88E+00				
Uranium-234	1.15E+02				
Uranium-235	1.66E+01				
Uranium-238	5.65E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.117. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 30 Industrial Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.60E+04				
Antimony	3.00E+00				
Beryllium	8.50E-01			9.58E-11	
Cadmium	2.80E+00			3.16E-10	
Copper	1.70E+02				
Nickel	5.70E+02			6.43E-08	
Thallium	1.80E+00				
Uranium	1.40E+03				
Organic Compounds					
Total PAHs	1.25E+01	2.18E-06	2.67E-05	9.01E-08	
Total PCBs	1.52E+01	2.66E-06	3.50E-05	5.11E-06	
Radionuclides					
Neptunium-237	1.68E+00	5.25E+02		3.39E-01	7.67E+00
Technetium-99	3.60E+02	1.13E+05		7.26E+01	1.64E+03
Thorium-230	4.88E+00	1.53E+03		9.84E-01	2.23E+01
Uranium-234	1.15E+02	3.59E+04		2.32E+01	5.25E+02
Uranium-235	1.66E+01	5.19E+03		3.35E+00	7.58E+01
Uranium-238	5.65E+02	1.77E+05		1.14E+02	2.58E+03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.118. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 30 Child Recreational User

COPC	Exposure Point Concentration[a]	Exposure Route - Chronic Daily Intake[b]					
		Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	1.60E+04	1.70E-02	6.80E-05	NA	1.52E-04	1.15E-03	5.50E-06
Antimony	3.00E+00	3.20E-06	3.97E-10	NA	8.70E-10	2.15E-07	1.03E-09
Beryllium	8.50E-01	9.06E-07	2.46E-09	NA	5.48E-09	6.09E-08	2.92E-10
Cadmium	2.80E+00	2.98E-06	9.51E-09	1.43E-05	1.93E-08	2.00E-07	9.62E-10
Copper	1.70E+02	1.81E-04	1.70E-05	2.73E-03	3.40E-05	1.22E-05	5.84E-08
Nickel	5.70E+02	6.07E-04	1.33E-05	NA	2.81E-05	4.08E-05	1.96E-07
Thallium	1.80E+00	1.92E-06	2.04E-07	NA	4.56E-07	1.29E-07	6.19E-10
Uranium	1.40E+03	1.49E-03	1.27E-06	8.06E-03	2.82E-06	1.00E-04	4.81E-07

[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.119. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 30 Teen Recreational User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	1.60E+04	2.97E-03	2.29E-05	NA	1.27E-04	1.07E-03	1.92E-06
Antimony	3.00E+00	5.58E-07	1.34E-10	NA	7.29E-10	2.01E-07	3.60E-10
Beryllium	8.50E-01	1.58E-07	8.30E-10	NA	4.59E-09	5.69E-08	1.02E-10
Cadmium	2.80E+00	5.20E-07	3.21E-09	1.23E-05	1.62E-08	1.87E-07	3.36E-10
Copper	1.70E+02	3.16E-05	5.72E-06	2.35E-03	2.85E-05	1.14E-05	2.04E-08
Nickel	5.70E+02	1.06E-04	4.48E-06	NA	2.35E-05	3.81E-05	6.83E-08
Thallium	1.80E+00	3.35E-07	6.88E-08	NA	3.82E-07	1.20E-07	2.16E-10
Uranium	1.40E+03	2.60E-04	4.29E-07	6.94E-03	2.36E-06	9.37E-05	1.68E-07

[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.120. Chronic Daily Intakes (Non-Carcinogenic) from Soil and Game for SWMU 30 Adult Recreational User

COPC	Exposure Route - Chronic Daily Intake[b]						
	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation
Inorganic Chemicals (Metals)							
Aluminum	1.60E+04	1.36E-03	1.41E-05	NA	1.57E-04	3.71E-04	8.75E-07
Antimony	3.00E+00	2.54E-07	8.23E-11	NA	9.01E-10	6.96E-08	1.64E-10
Beryllium	8.50E-01	7.21E-08	5.10E-10	NA	5.68E-09	1.97E-08	4.65E-11
Cadmium	2.80E+00	2.37E-07	1.97E-09	1.48E-05	2.00E-08	6.50E-08	1.53E-10
Copper	1.70E+02	1.44E-05	3.51E-06	2.83E-03	3.52E-05	3.94E-06	9.30E-09
Nickel	5.70E+02	4.83E-05	8.68E-09	NA	9.17E-08	1.32E-05	3.12E-08
Thallium	1.80E+00	1.53E-07	4.23E-08	NA	4.72E-07	4.18E-08	9.85E-11
Uranium	1.40E+03	1.19E-04	2.64E-07	8.34E-03	2.92E-06	3.25E-05	7.66E-08

[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg.
[b] Units for intakes for metals and organic compounds are mg/(kg-day).
NA =not all factors are available for calculations for this pathway for this analyte

Table F.121. Chronic Daily Intakes (Carcinogenic) from Soil and Game for SWMU 30 Recreational User

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure
		Exposure Route - Chronic Daily Intake[b]						
Inorganic Chemicals (Metals)								
Beryllium	8.50E-01	1.17E-07	5.14E-10	NA	3.04E-09	1.83E-08	5.05E-11	
Cadmium	2.80E+00	3.86E-07	1.98E-09	8.00E-06	1.07E-08	6.04E-08	1.66E-10	
Nickel	5.70E+02	7.85E-05	1.91E-06	NA	6.46E-06	1.23E-05	3.39E-08	
Organic Compounds								
Total PAHs	1.25E+01	1.72E-06	2.35E-07	7.73E-04	1.39E-06	3.51E-05	4.77E-08	
Total PCBs	1.52E+01	2.09E-06	2.32E-07	1.88E-05	1.37E-06	4.59E-05	2.71E-06	
Radionuclides								
Neptunium-237	1.68E+00	1.61E+02	1.26E+00	NA	9.96E+00		8.51E-02	2.89E+00
Technetium-99	3.60E+02	3.46E+04	1.32E+04	NA	4.23E+04		1.82E+01	6.19E+02
Thorium-230	4.88E+00	4.68E+02	3.00E-01	NA	2.44E+00		2.47E-01	8.40E+00
Uranium-234	1.15E+02	1.10E+04	2.21E+01	5.18E+05	1.79E+02		5.82E+00	1.98E+02
Uranium-235	1.66E+01	1.59E+03	4.42E+00	7.86E+04	3.55E+01		8.41E-01	2.86E+01
Uranium-238	5.65E+02	5.42E+04	1.61E+02	2.53E+06	1.29E+03		2.86E+01	9.72E+02

[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.
NA =not all factors are available for calculations for this pathway for this analyte

Table F.122. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 30 Child Rural Resident

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure
		Exposure Route-Chronic Daily Intake[b]			
Inorganic Chemicals (Metals)					
Aluminum	1.60E+04	2.05E-01	2.86E-03	2.20E-05	
Antimony	3.00E+00	3.84E-05	5.37E-07		
Beryllium	8.50E-01	1.09E-05	1.52E-07	1.17E-09	
Cadmium	2.80E+00	3.58E-05	5.01E-07		
Copper	1.70E+02	2.17E-03	3.04E-05		
Nickel	5.70E+02	7.29E-03	1.02E-04		
Thallium	1.80E+00	2.30E-05	3.22E-07		
Uranium	1.40E+03	1.79E-02	2.51E-04		
Organic Compounds					
Total PAHs	1.25E+01				
Total PCBs	1.52E+01				
Radionuclides					
Neptunium-237	1.68E+00				
Technetium-99	3.60E+02				
Thorium-230	4.88E+00				
Uranium-234	1.15E+02				
Uranium-235	1.66E+01				
Uranium-238	5.65E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.123. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 30 Adult Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.60E+04	2.19E-02	1.25E-03	4.71E-06	
Antimony	3.00E+00	4.11E-06	2.34E-07		
Beryllium	8.50E-01	1.16E-06	6.64E-08	2.50E-10	
Cadmium	2.80E+00	3.84E-06	2.19E-07		
Copper	1.70E+02	2.33E-04	1.33E-05		
Nickel	5.70E+02	7.81E-04	4.45E-05		
Thallium	1.80E+00	2.47E-06	1.41E-07		
Uranium	1.40E+03	1.92E-03	1.09E-04		
Organic Compounds					
Total PAHs	1.25E+01				
Total PCBs	1.52E+01				
Radionuclides					
Neptunium-237	1.68E+00				
Technetium-99	3.60E+02				
Thorium-230	4.88E+00				
Uranium-234	1.15E+02				
Uranium-235	1.66E+01				
Uranium-238	5.65E+02				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.124. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 30 Rural Resident

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.60E+04				
Antimony	3.00E+00				
Beryllium	8.50E-01			1.86E-10	
Cadmium	2.80E+00			6.13E-10	
Copper	1.70E+02				
Nickel	5.70E+02			1.25E-07	
Thallium	1.80E+00				
Uranium	1.40E+03				
Organic Compounds					
Total PAHs	1.25E+01	1.96E-05	6.84E-05	1.76E-07	
Total PCBs	1.52E+01	2.38E-05	8.96E-05	9.98E-06	
Radionuclides					
Neptunium-237	1.68E+00	2.12E+03		3.79E-01	3.87E+01
Technetium-99	3.60E+02	4.54E+05		8.13E+01	8.28E+03
Thorium-230	4.88E+00	6.15E+03		1.10E+00	1.12E+02
Uranium-234	1.15E+02	1.45E+05		2.60E+01	2.65E+03
Uranium-235	1.66E+01	2.09E+04		3.75E+00	3.82E+02
Uranium-238	5.65E+02	7.12E+05		1.28E+02	1.30E+04

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.16. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.125. Chronic Daily Intakes (Non-Carcinogenic) from Soil for SWMU 145 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.27E+04	4.41E-02	4.32E-04	2.97E-06	
Antimony	1.81E+01	6.29E-05	6.16E-07		
Arsenic	6.94E+00	2.41E-05	7.09E-06		
Barium	1.34E+02	4.66E-04	4.56E-06	3.13E-08	
Beryllium	1.86E+00	6.46E-06	6.33E-08	4.34E-10	
Uranium	6.75E+01	2.35E-04	2.30E-06		
Organic Compounds					
Total PAHs	4.80E-01				
Total PCBs	1.44E+01				
Radionuclides					
Cesium-137	2.38E-01				
Strontium-90	4.00E+00				
Technetium-99	8.20E+01				
Thorium-230	1.73E+00				
Uranium-235	6.91E-01				
Uranium-238	8.05E+01				

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.18. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.126. Chronic Daily Intakes (Carcinogenic) from Soil for SWMU 145 Excavation Worker

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion	Dermal	Inhalation	External Exposure
Inorganic Chemicals (Metals)					
Aluminum	1.27E+04				
Antimony	1.81E+01				
Arsenic	6.94E+00	8.61E-06	2.53E-06	5.79E-10	
Barium	1.34E+02				
Beryllium	1.86E+00			1.55E-10	
Uranium	6.75E+01				
Organic Compounds					
Total PAHs	4.80E-01	5.96E-07	7.58E-07	2.56E-09	
Total PCBs	1.44E+01	1.79E-05	2.45E-05	3.58E-06	
Radionuclides					
Cesium-137	2.38E-01	5.28E+02		3.55E-02	8.04E-01
Strontium-90	4.00E+00	8.88E+03		5.97E-01	1.35E+01
Technetium-99	8.20E+01	1.82E+05		1.22E+01	2.77E+02
Thorium-230	1.73E+00	3.83E+03		2.58E-01	5.84E+00
Uranium-235	6.91E-01	1.53E+03		1.03E-01	2.33E+00
Uranium-238	8.05E+01	1.79E+05		1.20E+01	2.72E+02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.18. Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.127. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 2

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.54E-02	3.39E-03	2.94E-06		
Manganese	7.16E-01	6.87E-02	5.95E-05		
Uranium	9.86E-03	9.45E-04	8.19E-07		
Organic Compounds					
cis-1,2-DCE	1.15E+01	1.10E+00	3.89E-02	5.57E-01	4.36E+00
Acenaphthene	6.01E-03	5.76E-04	2.27E-04	4.94E+00	2.28E-03
Naphthalene	9.38E-04	8.99E-05	1.63E-05	8.77E-02	3.56E-04
TCE	1.48E+00	1.42E-01	6.64E-03	7.17E-02	5.61E-01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.19. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.128. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 2

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.54E-02	9.70E-04	1.76E-06		
Manganese	7.16E-01	1.96E-02	3.56E-05		
Uranium	8.86E-03	2.70E-04	4.90E-07		
Organic Compounds					
cis-1,2-DCE	1.15E+01	3.15E-01	2.33E-02	1.19E-01	9.34E-01
Acenaphthene	6.01E-03	1.65E-04	1.36E-04	1.06E+00	4.88E-04
Naphthalene	9.38E-04	2.57E-05	9.76E-06	1.88E-02	7.62E-05
TCE	1.48E+00	4.05E-02	3.97E-03	1.54E-02	1.20E-01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.19. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.129. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 2

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.54E-02	3.33E-04	6.04E-07		
Organic Compounds					
TCE	1.48E+00	1.39E-02	1.36E-03	5.27E-03	4.12E-02
Radionuclides					
Technetium-99	1.02E+02	1.71E+06			
Uranium-234	1.66E+00	2.65E+04			
Uranium-238	1.81E+00	3.04E+04			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.19. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.130. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 3

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.29E-02	3.15E-03	2.73E-06		
Manganese	8.95E-01	8.58E-02	7.44E-05		
Uranium	4.89E-02	4.69E-03	4.06E-06		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.20. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.131. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 3

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.29E-02	9.01E-04	1.64E-06		
Manganese	8.95E-01	2.45E-02	4.45E-05		
Uranium	4.89E-02	1.34E-03	2.43E-06		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.20. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.132. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 3

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	3.29E-02	5.79E-04	7.95E-07		
Radionuclides					
Technetium-99	5.56E+03	1.11E+08			
Uranium-238	1.59E+01	3.16E+05			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.20. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.133. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 4

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	1.70E-03	1.47E-06		
Manganese	5.76E-01	5.52E-02	4.79E-05		
Organic Compounds					
cis-1,2-DCE	6.68E-01	6.41E-02	2.26E-03	3.24E-02	2.53E-01
TCE	1.18E+00	1.13E-01	5.28E-03	5.72E-02	4.47E-01
Vinyl Chloride	2.61E-02	2.50E-03	5.40E-05	2.70E-04	9.90E-03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.21. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.134. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 4

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	4.85E-04	8.80E-07		
Manganese	5.76E-01	1.58E-02	2.86E-05		
Organic Compounds					
cis-1,2-DCE	6.68E-01	1.83E-02	1.35E-03	6.91E-03	5.43E-02
TCE	1.18E+00	3.23E-02	3.16E-03	1.22E-02	9.59E-02
Vinyl Chloride	2.61E-02	7.15E-04	3.23E-05	2.70E-04	2.12E-03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.21. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.135. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 4

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	3.12E-04	4.28E-07		
Organic Compounds					
TCE	1.18E+00	2.08E-02	1.54E-03	9.10E-03	7.12E-02
Vinyl Chloride	2.61E-02	4.60E-04	1.05E-02	2.01E-04	1.58E-03
Radionuclides					
Technetium-99	9.01E+03	1.80E+08			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.21. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.136. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 5

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	9.25E-03	8.87E-04	7.69E-07		
Manganese	1.01E+00	9.68E-02	8.39E-05		
Organic Compounds					
Naphthalene	5.55E-03	5.32E-04	9.66E-05	2.69E-04	2.10E-03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.22. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.137. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 5

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	9.25E-03	2.53E-04	4.60E-07		
Manganese	1.01E+00	2.77E-02	5.02E-05		
Organic Compounds					
Naphthalene	5.55E-03	1.52E-04	5.78E-05	5.76E-05	4.51E-04

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.22. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.138. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 5

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	9.25E-03	1.63E-04	2.24E-07		
Radionuclides					
Technetium-99	1.27E+02	2.53E+06			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.22. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.139. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 6

COPC	Exposure Point Concentration	Exposure Route-Chronic Daily Intake Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
		NO COPCs[1]			

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.140. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 6

COPC	Exposure Point Concentration	Exposure Route-Chronic Daily Intake Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
		NO COPCS[1]			

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.141. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 6

COPC	Exposure Point Concentration	Exposure Route-Chronic Daily Intake Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
		NO COPCs[1]			

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.142. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 7

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.78E-02	1.71E-03	1.48E-06		
Manganese	3.32E-01	3.18E-02	2.76E-05		
Uranium	3.46E-03	3.32E-04	2.88E-07		
Organic Compounds					
1,1-DCE	8.98E-02	8.61E-03	3.23E-04	4.35E-03	3.40E-02
cis-1,2-DCE	2.35E-02	2.25E-03	7.95E-05	1.14E-03	8.91E-03
Total PCBs	5.23E-05	5.02E-06	5.09E-05	2.54E-06	1.98E-05
TCE	1.09E-02	1.05E-03	4.89E-05	5.28E-04	4.13E-03
Vinyl Chloride	1.35E-02	1.29E-03	2.79E-05	6.54E-04	5.12E-03
Radionuclides					

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.24. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.143. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 7

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b]			
		Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.78E-02	4.88E-04	8.85E-07		
Manganese	3.32E-01	9.10E-03	1.65E-05		
Uranium	3.46E-03	9.48E-05	1.72E-07		
Organic Compounds					
1,1-DCE	8.98E-02	2.46E-03	1.93E-04	9.30E-04	7.30E-03
cis-1,2-DCE	2.35E-02	6.44E-04	4.76E-05	2.43E-04	1.91E-03
Total PCBs	5.23E-05	1.43E-06	3.05E-05	5.41E-07	4.25E-06
TCE	1.09E02	2.99E-04	2.93E-05	1.13E-04	8.86E-04
Vinyl Chloride	1.35E-02	3.70E-04	1.67E-05	1.40E-04	1.10E-03

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.24. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.144. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 7

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.78E-02	3.14E-04	4.30E-07		
Organic Compounds					
1,1-DCE	8.98E-02	1.58E-03	9.39E-05	6.93E-04	5.42E-03
Total PCBs	5.23E-05	9.21E-07	1.48E-05	4.04E-07	3.16E-06
TCE	1.09E-02	1.92E-04	1.42E-05	8.41E-05	6.58E-04
Vinyl Chloride	1.35E-02	2.38E-04	8.12E-06	1.04E-04	8.15E-04
Radionuclides					
Technetium-99	9.09E+02	1.81E+07			
Uranium-234	7.90E+00	1.58E+05			
Uranium-238	7.59E+00	1.51E+05			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.24. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.145. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 30

		Exposure Route-Chronic Daily Intake[b]			
COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	1.70E-03	1.47E-06		
Manganese	3.78E-01	3.62E-02	3.14E-05		
Selenium	1.51E-02	1.45E-03	1.25E-06		
Uranium	8.40E-03	8.05E-04	6.98E-07		
Organic Compounds					
1,1-DCE	6.05E-02	5.80E-03	2.17E-04	2.93E-03	2.29E-02
TCE	7.12E-01	6.83E-02	3.20E-03	3.45E-02	2.70E-01

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.25. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.146. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 30

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	4.85E-04	8.80E-07		
Manganese	3.78E-01	1.04E-02	1.88E-05		
Selenium	1.51E-02	4.14E-04	7.51E-07		
Uranium	8.40E-03	2.30E-04	4.18E-07		
Organic Compounds					
1,1-DCE	6.05E-02	5.00E-02	5.00E-02	5.71E-02	5.71E-02
TCE	7.12E-01	1.95E-02	1.91E-03	7.40E-03	5.78E-02

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.25. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.147. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 30

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	1.77E-02	3.12E-04	4.28E-07		
Organic Compounds					
1,1- DCE	6.05E-02	1.07E-03	6.32E-05	4.66E-04	3.66E-03
TCE	7.12E-01	1.25E-02	9.29E-04	5.50E-03	4.29E-02
Radionuclides					
Technetium-99	2.87E+02	5.73E+06			
Uranium-234	4.00E+00	7.96E+04			
Uranium-238	5.91E+00	1.18E+05			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.25. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.148. Chronic Daily Intakes (Non-Carcinogenic) for Child Residential Groundwater User at SWMU 145

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Antimony	7.99E-02	7.66E-03	6.64E-06		
Arsenic	6.21E-02	5.95E-03	5.16E-06		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.26. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.149. Chronic Daily Intakes (Non-Carcinogenic) for Adult Residential Groundwater User at SWMU 145

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Antimony	7.99E-02	2.19E-03	3.97E-06		
Arsenic	6.21E-02	1.70E-03	3.09E-06		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.26. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.150. Chronic Daily Intakes (Carcinogenic) for Residential Groundwater User at SWMU 145

COPC	Exposure Point Concentration[a]	Exposure Route-Chronic Daily Intake[b] Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation
Inorganic Compounds					
Arsenic	6.21E-02	1.09E-03	1.50E-06		
Radionuclides					
Technetium-99	1.01E+04	2.02E+08			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] EPCs are from Table F.26. Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

F.4. TOXICITY ASSESSMENT

This section summarizes the potential toxicological effects of the COPCs on exposed populations. Many of the toxicological summaries were obtained from the *Risk Assessment Information System* (RAIS) prepared by the Toxicology and Risk Analysis Section of Oak Ridge National Laboratory for DOE (DOE 2004b). This site also lists toxicity values taken from the EPA's Integrated Risk Information System (IRIS) database (EPA 2004a), National Center for Environmental Assessment (NCEA), and Health Effects Assessment Summary Tables (HEAST) database (EPA 1998). This list formed the basis of the toxicity values reported in this section. For those chemicals not profiled in RAIS, a brief summary of information drawn from Agency for Toxic Substances and Disease Registry (ATSDR) or other library research sources is included in this section. The last paragraph of each profile contains the toxicity values used in this BHHRA.

The toxicity information considered in the assessment of potential carcinogenic risks includes (1) a weight-of-evidence classification and (2) a slope factor (SF). The weight-of-evidence classification qualitatively describes the likelihood that an agent is a human carcinogen, based on the available data from animal and human studies. A chemical may be placed in one of three groups to indicate its potential for carcinogenic effects: Group A, a known human carcinogen; Group B, a probable human carcinogen; and Group C, a possible human carcinogen. Group B is divided into Subgroups B1 and B2. Assignment of a chemical to Subgroup B1 indicates that the judgment that the chemical is a probable human carcinogen is based on limited human data, and assignment of a chemical to Subgroup B2 indicates that the judgment that the chemical is a probable human carcinogen is based on animal data because human data are lacking or inadequate. Chemicals that cannot be classified as human carcinogens because of a lack of data are categorized in Group D, and those for which there is evidence of noncarcinogenicity in humans are categorized in Group E.

The slope factor for chemicals is defined as a plausible upperbound estimate of the probability of a response (i.e., development of cancer) per unit intake of a chemical over a lifetime (EPA 1989). Slope factors are specific for each chemical and route of exposure. Slope factors currently are available for ingestion and inhalation pathways. The slope factors used for oral and inhalation routes of exposure for the COPCs considered in this report are shown in Table F.151.

Table F.151. Toxicity Values For Chronic Exposure to Carcinogens Via the Ingestion and Inhalation Exposure Routes

COPC[a]	Class	Oral Slope Factor[b]	Oral Slope Factor Source[c]	Oral Unit Risk[d]	Inhalation Slope Factor[e]	Inhalation Slope Factor Source[c]	Inhalation Unit Risk[f]	Types of Cancers
				Inorganic Chemicals (Metals)				
Aluminum	D							
Antimony	D							
Arsenic	A	1.50E+00	a	5.00E-05	1.50E+01	a	4.30E-03	Respiratory system tumors
Beryllium	B2				8.40E+00	a	2.40E-3	Respiratory system tumors
Chromium VI	D,A				4.20E+01	a	1.20E-02	Lung tumors
Copper	D							
Iron	NA							
Manganese	D							
Mercury	D							

Table F.151. Toxicity Values For Chronic Exposure to Carcinogens Via the Ingestion and Inhalation Exposure Routes (Continued)

COPC[a]	Class	Oral Slope Factor[b]	Oral Slope Factor Source[c]	Oral Unit Risk[d]	Inhalation Slope Factor[e]	Inhalation Slope Factor Source[c]	Inhalation Unit Risk[f]	Types of Cancers
Inorganic Chemicals (Metals)(Continued)								
Nickel	NA				9.10E-01			
Selenium	D							
Thallium	D							
Uranium	NA							
Vanadium	NA							
Zinc	D							
Organic Compounds								
1,1-DCE	C	6.00E-01	a	1.70E-05	1.75E-01	a	5.00E-05	Kidney, adenocarcinoma
1,2-DCE, *cis*-	D							
Acenaphthene	NA							
Total PCBs	B2	2.00E+00	a		2.00E+00	a	5.70E-01	liver
Total PAHs[h]	B2	7.30E+00	a	2.10E-01	3.08E+00	a	8.80E-01	skin
Bis(2-ethylhexyl)phthalate	B2	1.40E-02	a		8.40E-03	a		liver
Carbazole		2.00E-02	a	5.70E-04				
Dibenzofuran	NA							
Naphthalene	NA							
TCE[i]	C-B2	3.22E-01	a		3.22E-01	a	1.10E-01	Liver and lung cancer
Vinyl Chloride	A	1.50E+00	a	4.20E-02	3.08E-02	a	8.80E-05	Liver, lung, digestive, track, and brain tumors
Radionuclides								
	ICRP[g] Lung Class							
Cesium-137	F	4.33E-11	a		1.19E-11	a		
Neptunium-237	M	1.62E-10	a		1.77E-08	a		Various
Plutonium 239/240	M	2.76E-10	a		3.33E-08	a		
Radium-226		7.30E-10			1.16E-08			
Technetium-99	M	7.66E-12	a		1.41E-11	a		Various
Thorium-228	S	8.09E-10	a		1.43E-07	a		
Thorium-230	S	2.02E-10	a		2.85E-08	a		Various
Uranium-234	M	1.58E-10	a		1.14E-08	a		Various
Uranium-235	M	1.63E-10	a		1.01E-08	a		
Uranium-238	M	3.10E-10	a		9.35E-09	a		Various

Note: Blank cells indicate that data are not available or are not appropriate.
[a] All COPCs are listed.
[b] The units for the oral slope factors are $(mg/kg \times day)^{-1}$ for nonradionuclides and risk/pCi for radionuclides.
[c] Source codes are defined as follows:
a: Risk Assessment Information System
[d] The units for the oral unit risks are $(mg/L)^{-1}$
[e] The units for the inhalation slope factors are $(mg/kg \times day)^{-1}$ for nonradionuclides and risk/pCi for radionuclides.
[f] The units for inhalation unit risks are $m^3/\mu g$.
[g] ICRP Publication 72 is referenced in the HEAST user's guide (ICRP, 1996). Lung class absorption types are defined as follows:
S = slow (particulate)
M = medium (particulate)
F = fast (particulate)
[h] As benzo(a) pryrene TEF
[i] Value used is from KDEP (2004) review of TCE slope factors. The slope factors used in previous assessments were 0.052 for the oral slope factor and 0.002 for the inhalation slope factor. This issue is discussed further in the uncertainty section.

Toxicity values used in risk calculations also include the chronic RfD, which is used to estimate the potential for systemic toxicity or noncarcinogenic risk. The chronic RfD is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA 1989). RfD values are specific to the route of exposure. The RfDs used for oral and inhalation routes of exposure for the COPCs considered in this report are presented in Table F.152.

Table F.152. Toxicity Values for Chronic Exposure to Noncarcinogens Via the Ingestion and Inhalation Exposure Routes

COPC[a]	Oral Reference Dose[b]	Oral Reference Dose Source[c]	Inhalation Reference Dose[d]	Inhalation Reference Concentration[e]	Inhalation Reference Concentration Source[c]	RfD basis (vehicle)[f]	Target Organ Critical Effect	Confidence Level[f]	Uncertainty Factor/Modifying Factor[f]
				Inorganic Chemicals (Metals)					
Aluminum	1.00E+00	x	1.43E-03	5.00E-03	x	(I)LOAEL (O)LOAEL	Nervous system	(I)Low (O)Low	(I)UF=300 (I)MF=1 (O)UF=100 (O)MF=1
Antimony	4.00E-04	a				(O)LOAEL	GI	(O)Low	(O)UF=1000 (O)MF=1
Arsenic	3.00E-04	a				(O)NOAEL/ LOAEL	Skin	Medium	(O)UF=3 (O)MF=1
Beryllium	2.00E-03	a	5.71E-06		a	(O)NOAEL	NA	Low	(O)=100
Chromium	1.50E+00	a				NOAEL	GI, lungs	Low	(O)UF=100 (O)MF=10
Copper	3.70E-02	b				NA	GI, liver, kidney	NA	NA
Iron	3.00E-01	a				NA	NA	NA	NA
Manganese	2.4 E-02	a	1.43E-05	5.00E-05	a	(I)LOAEL (O)NOAEL	CNS	(I)Medium (O)Medium	(I)UF=1000 (I)MF=1 (O)UF=1 (O)MF=1
Mercury			8.57E-05	3.00E-04	a	(I)LOAEL	CNS	(I)Medium	(I)UF=30 (I)MF None
Nickel	2.00E-02	a				NOAEL/ LOAEL	Decreased organ and body weight	Medium	(O)UF=300 (O)MF=1
Selenium	5.00E-03	a				NOAEL/ LOAEL	Lungs (selenosis)	High	(O)UF=3 (O)MF=1
Thallium	8.00E-05	a				NOAEL	Increased levels of SGOT and LDH	Low	(O)UF=300 (O)MF=1
Uranium	6.00E-04	a,e				LOAEL	Kidney	NA	(O)UF=100 (O)MF=1
Vanadium	7.00E-03	b				NOAEL	Kidney, liver	NA	(O)UF=100 (O)MF=1
Zinc	3.00E-01	a				LOAEL	Lung, GI	Medium	(O)UF=3 (O)MF=1
				Organic Compounds					
1,1-DCE	9.00E-03	a	9.00E-03	3.15E-02	ex	LOAEL	Liver	Medium	(O)UF=1000 (O)MF=1

Table F.152. Toxicity Values for Chronic Exposure to Noncarcinogens Via the Ingestion and Inhalation Exposure Routes (Continued)

COPC[a]	Oral Reference Dose[b]	Oral Reference Dose Source[c]	Inhalation Reference Dose[d]	Inhalation Reference Concentration[e]	Inhalation Reference Concentration Source[c]	RfD basis (vehicle)[f]	Target Organ Critical Effect[g]	Confidence Level[h]	Uncertainty Factor/Modifying Factor[i]
1,2-DCE, *cis-*	1.00E-02	b	1.00E-02	3.49E-02	ex	NOAEL	Blood	Low	(O)UF=3000 (O)MF=1
TCE	6.00E-03	v	6.00E-03	2.09E-02	ex	NA	Liver, kidney, CNS	NA	NA
Vinyl Chloride	3.00E-03	a	2.86E-02	1.00E-01	a	(I)NOAEL/ LOAEL (O)NOAEL / LOAEL	Liver, kidney, CNS	Medium	(I)UF=30 (I)MF=1 (O)UF=3 (I)MF=1
Bis(2-ethylhexyl) phthalate	2.00E-02	a				LOAEL	Liver	Medium	(O)UF=1000 (O)MF=1
Dibenzofuran	2.00E-03	v							
Fluoranthene	4.00E-02	a	4.00E-02	1.40E-01	b	NOAEL	Liver Blood	Low	(O)UF=3000 (O)MF=1
Naphthalene	2.00E-02	a	8.57E-04	3.00E-03	a	(O)NOAEL (I)LOAEL	Decreased body weight Respirator y	(O)Low (I)Medium	(O)UF=3000 (O)MF=1 (I)UF=3000 (I)MF=1
2-methyl naphthalene	4.00E-03	a				BMD_{05}	Pulmonary alveolar proteinosis	Low	(O)UF=1000 (O)MF=1
Pyrene	3.00E-02	a	3.00E-02	1.05E-01	b	NOAEL	Kidney	Low	(O)UF=3000 (O)MF=1

Notes: Blank cells indicate that data are not available or are not appropriate. NA=information not readily available at this time; GI=gastrointestinal; CNS=central nervous system

[a] All COPCs are listed.

[b] The units for the oral reference doses are mg/(kg × day).

[c] Source codes are defined as follows:

a: *Integrated Risk Information System* (IRIS) (EPA 2004a)

b: *Health Effects Assessment Summary Tables* (HEAST) (EPA 1998)

e: Also see Soil Screening Guidance for Radionuclides: User's Guide.

ex: Value is extrapolated from the oral reference dose.

u: The inhalation slope factor was calculated from inhalation unit risk as described in *RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance)* (November 1995).

v: A provisional value provided to DOE's Oak Ridge Operations by EPA's Superfund Health Risk Technical Support Center.

w: This value was withdrawn from IRIS or HEAST but is used in the assessment per guidance in the Risk Methods Document.

x: A provisional value from EPA National Center for Environmental Assessment (NCEA).

[d] The units for the inhalation reference doses are mg/(kg × day).

[e] The units for the inhalation reference concentrations are mg/m^3.

[f] O=oral; I=inhalation; UF=uncertainty factor; MF=modifying factor; NA=not available.

For the dermal routes of exposure (i.e., dermal exposure to contaminated water during swimming or bathing or dermal contact with contaminated soil), it is necessary to consider the absorbed dose received by a receptor. This is reflected by the addition of an absorption coefficient in the equations used to calculate the CDI for these pathways. Because the CDI is expressed as an absorbed dose, it is necessary to use RfDs and slope factors that also are expressed in terms of absorbed dose. Currently, EPA has not produced lists of RfDs and slope factors based on absorbed dose but have produced guidance concerning the estimation of absorbed dose RfDs and slope factors from administered dose RfDs and slope factors. This guidance is found in *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2004b) and states, "that to convert an administered dose slope factor to an absorbed dose slope factor, the administered dose slope factor is divided by the gastrointestinal (GI) absorption efficiency of the contaminant." Alternatively, to convert an administered dose RfD to an absorbed dose RfD, the administered dose RfD is multiplied by the GI absorption efficiency of the contaminant. The absorbed dose slope factors and RfDs and the information used in their derivation are presented in Tables F.153 and F.154, respectively.

Table F.153. Toxicity Values for Chronic Dermal Contact Exposure to Carcinogens

COPC[a]	Dermal Slope Factor[b]	Dermal Slope Factor Source[d]	Dermal ABS Factor[e]
	Inorganic Chemicals (Metals)		
Aluminum			0.001
Antimony			0.001
Arsenic	3.66E+00	a	0.03
Beryllium [f]			0.001
Chromium			0.001
Copper			0.001
Iron			0.001
Manganese			0.001
Mercury			0.001
Nickel			0.001
Selenium			0.001
Thallium			0.001
Uranium			0.001
Vanadium			0.001
Zinc			0.001
	Organic Compounds		
1,1-DCE			0.01
1,2-DCE, *cis*-			0.01
Benzo (a) pryrene	2.35E+01	a	0.13
Total PAHs	2.35E+01	a	0.13
Total PCBs	2.22E+00	a	0.14
Bis(2-ethylhexyl)phthalate	7.37E-02	a	0.01
Carbazole	2.86E-02	a	0.01
Dibenzofuran			0.01
Naphthalene			0.13
TCE	2.67E+00	a	0.01
Vinyl Chloride	1.50E+00	a	0.01
	Radionuclides		
	External Exposure Slope Factor[c]		
Cesium-137	2.76E-08	a	NA
Neptunium-237	7.97E-07	a	NA
Plutonium 239/240	2.00E-10	a	NA
Radium-226			NA
Technetium-99	8.14E-11	a	NA
Thorium-228	7.76E-06	a	NA
Thorium-230	8.19E-10	a	NA
Uranium-234	2.52E-10	a	NA
Uranium-235	5.43E-07	a	NA
Uranium-238	1.14E-07	a	NA

Note: Blank cells indicate that data are not available or are not appropriate.
[a] All COPCs are listed.
[b] The units for these dermal dose slope factors are $(mg/kg \times d)^{-1}$ for nonradionuclides. Absorbed cancer slope factors are calculated by dividing the administered cancer slope factor by GI absorption factor; this value is used in the BHHRA to calculate contribution to cancer risk from dermal exposure.
[c] The units for external dose for radionuclides are in (risk/yr per pCi/g soil)
[d] Sources for dermal slope factor:
a: Risk assessment information system (RAIS)
[e] All dermal ABS factors from 2008 Risk Methods Document (DOE 2008)
[f] Dermal slope factor for beryllium has been removed.

Table F.154. Toxicity Values for Chronic Exposure to Noncarcinogens Via the Dermal Contact Exposure Route

COPC[a]	Dermal Reference Dose[b]	Dermal ABS[c]
Inorganic Chemicals (Metals)		
Aluminum	1.00E-01	0.001
Antimony	8.00E-06	0.001
Arsenic	1.23E-04	0.03
Beryllium	2.00E-05	0.001
Chromium	7.50E-03	0.001
Copper	1.20E-02	0.001
Iron	4.50E-02	0.001
Manganese [d]	5.60E-03	0.001
Mercury	2.10E-05	0.001
Nickel	5.40E-03	0.001
Selenium	2.20E-03	0.001
Thallium	1.60E-05	0.001
Uranium [e]	5.10E-04	0.001
Vanadium	7.00E-05	0.001
Zinc	6.00E-02	0.001
Organic Compounds		
1,1-DCE	5.00E-02	0.01
1,2-DCE, *cis*-	1.00E-02	0.01
Total PCBs	1.80E-05	0.14
Bis(2-ethylhexyl)phthalate	3.80E-03	0.01
Dibenzofuran [f]	1.60E-03	0.01
Fluoranthene	1.24E-02	0.13
Naphthalene	1.60E-02	0.13
Pyrene	9.30E-03	0.13
TCE [g]	4.50E-05	0.01
Vinyl Chloride	3.00E-03	0.01

Note: Blank cells indicate that data are not available or are not appropriate.
[a] All COPCs are listed.
[b] The units for the absorbed doses are mg/(kg × day).
[c] All dermal reference dose were obtained from the 2008 Risk Methods Document (DOE 2008)
[d] IRIS no longer separates manganese values for chronic oral RfDs into water and diet RfDs. The chronic oral RfD for the total oral intake of manganese is 1.40E-01. However, when assessing exposure to manganese from drinking water or soil, IRIS recommends using a modifying factor of 3, thereby lowering the RfD to 4.67E-02, which has been rounded to 4.6E-02. Rounding to 4.7E-02 is more accurate, but makes the value less conservative (DOE 2004b).
[e] Uranium Source: 40 *CFR* Part 141 (2000).
[f] Provisional value to be used for DOE-ORR projects (DOE 2004b).
[g] These toxicity values present EPA's most current evaluation of the potential health risks from exposure to TCE (EPA 2001). EPA Region IX and Region III have adopted these toxicity values as well.

F.4.1 INORGANIC COMPOUNDS

F.4.1.1 Aluminum (CAS 007429-90-5) (RAIS)

Aluminum is a silver-white, flexible metal with a vast number of uses. It makes up about 8% of the earth's crust. The aluminum content of seawater ranges from 3 to 2,400 µg/L. Aluminum metal is used as a structural material in the construction, automotive, and aircraft industries; in the production of metal alloys; and in the electrical industry in power lines, insulated cables, and wiring. Other uses of aluminum metal include cooking utensils, decorations, fencing, highway signs, cans, food packaging, foil, and dental crowns and dentures. Aluminum powder is used in paints and fireworks, and natural aluminum minerals are used in water purification, sugar refining, and in the brewing and paper industries. Aluminum borate is used in the production of glass and ceramics, and aluminum chloride is used to make rubber, lubricants, wood preservatives, and cosmetics. Aluminum chlorohydrate is the active ingredient in antiperspirants and deodorants, while aluminum hydroxide is used as a pharmaceutical to lower plasma phosphorus levels of patients with kidney failure. Until recently, aluminum has existed in forms not available to humans and most other species; however, acid rain has increased the availability of aluminum to biological systems and has resulted in destructive effects to fish and plant species. It is unknown if humans are susceptible to this increased bioavailability. It is poorly absorbed and efficiently eliminated; however, when absorption does occur, aluminum is distributed mainly in bone, liver, testes, kidneys, and brain. Aluminum may be involved in Alzheimer's disease (dialysis dementia) and in Amyotrophic Lateral Sclerosis and Parkinsonism-Dementia Syndromes of Guam. Aluminum content of brain, muscle, and bone increases in Alzheimer's patients. Neurofibrillary tangles are found in patients suffering from aluminum encephalopathy and Alzheimer's disease. Symptoms of "dialysis dementia" include speech disorders, dementia, convulsions, and myoclonus. Neurological effects also have been observed in rats orally exposed to aluminum compounds.

The respiratory system appears to be the primary target following inhalation exposure to aluminum. Alveolar proteinosis has been observed in guinea pigs, rats, and hamsters exposed to aluminum powders. Rats and guinea pigs exposed to aluminum chlorohydrate exhibited an increase in alveolar macrophages, increased relative lung weight, and multifocal granulomatous pneumonia. Male rats exposed to aluminum (as aluminum chloride) via gavage for 6 months exhibited decreased spermatozoa counts and sperm motility and testicular histological and histochemical changes. Male rats exposed to drinking water containing aluminum (as aluminum potassium sulfate) for a lifetime exhibited increases in unspecified malignant and nonmalignant tumors, and similarly exposed female mice exhibited an increased incidence of leukemia. Rats and guinea pigs exposed via inhalation to aluminum chlorohydrate developed lung granulomas, while granulomatous foci developed in similarly exposed male hamsters.

Aluminum has been placed in the EPA weight-of-evidence classification D, not classifiable as to human carcinogenicity. No slope factors, therefore, were used in this BHHRA.

Chronic RfDs for aluminum also are available in RAIS. The oral and inhalation RfDs of 1.00E+00 and 1.43E-03 mg/(kg × day), respectively, were used in the BHHRA. The GI absorption factor is 10 % and the corresponding absorbed dose RfD is 1.00E-01 mg/(kg × day).

F.4.1.2 Antimony (CAS 007440-36-0) (RAIS)

Antimony is a naturally occurring silvery-white metal that is found in the earth's crust. Antimony ores are mined and then mixed with other metals to form antimony alloys or combined with oxygen to form antimony oxide. Little antimony is currently mined in the United States. It is brought into this country from other countries for processing; however, there are companies in the United States that produce antimony as a by-product of smelting lead and other metals. Antimony is used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, and pewter. Antimony oxide is added to textiles and plastics to prevent them from catching fire. It also is used in paints, ceramics, and fireworks, and as enamels for plastics, metal, and glass.

Metallic antimony and a few trivalent antimony compounds are the most significant regarding exposure potential and toxicity. Antimony is a common urban air pollutant, occurring at an average concentration of 0.001 $\mu g/m^3$. Exposure to antimony may occur via inhalation and by ingestion of contaminated food.

Acute oral and inhalation exposure of humans and animals to high doses of antimony or antimony-containing compounds (antimonials) may cause gastrointestinal disorders (vomiting, diarrhea), respiratory difficulties, and death at extremely high doses. Subchronic and chronic oral exposure may affect hematologic parameters. Long-term oral exposure to high doses of antimony or antimonials has been shown to adversely affect longevity in animals. Long-term occupational exposure of humans has resulted in electrocardiac disorders, respiratory disorders, and possibly increased mortality. Antimony levels for these occupational exposure evaluations ranged from 2.2 to 11.98 mg Sb/m^3. Based on limited data, occupational exposure of women to metallic antimony and several antimonials has reportedly caused alterations in the menstrual cycle and an increased incidence of spontaneous abortions.

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified antimony as to its human carcinogenicity.

Chronic RfDs for antimony also are available in RAIS. The oral RfD used in the BHHRA is 4.00E-04 (mg/kg-day). The GI absorption factor is 2% and the corresponding absorbed dose RfD is 8.00E-06 (mg/kg-day).

F.4.1.3 Arsenic (CAS 007440-38-2) (RAIS)

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds. Inorganic arsenic compounds are mainly used to preserve wood. Organic arsenic compounds are used as pesticides, primarily on cotton plants. Arsenic cannot be destroyed in the environment. It can only change its form. Arsenic in air will settle to the ground or is washed out of the air by rain. Many arsenic compounds can dissolve in water. Fish and shellfish can accumulate arsenic, but the arsenic in fish is mostly in a form that is not harmful. The toxicity of inorganic arsenic depends on its valence state and also on the physical and chemical properties of the compound in which it occurs.

Water soluble inorganic arsenic compounds are absorbed through the GI tract and lungs; distributed primarily to the liver, kidney, lung, spleen, aorta, and skin; and excreted mainly in the urine at rates as high as 80%. Symptoms of acute inorganic arsenic poisoning in humans are nausea, anorexia, vomiting, epigastric and abdominal pain, and diarrhea. Dermatitis (exfoliative erythroderma), muscle cramps, cardiac abnormalities, hepatotoxicity, bone marrow suppression and hematologic abnormalities (anemia), vascular lesions, and peripheral neuropathy (motor dysfunction, paresthesia) also have been reported. Oral doses as low as 20-60 µg/kg/day have been reported to cause toxic effects in some individuals. Severe exposures can result in acute encephalopathy, congestive heart failure, stupor, convulsions, paralysis, coma, and death. The acute lethal dose to humans has been estimated to be about 0.6 mg/kg/day.

General symptoms of chronic arsenic poisoning in humans are weakness, general debility and lassitude, loss of appetite and energy, loss of hair, hoarseness of voice, loss of weight, and mental disorders. Primary target organs are the skin (hyperpigmentation and hyperkeratosis), nervous system (peripheral neuropathy), and vascular system. Anemia, leukopenia, hepatomegaly, and portal hypertension also have been reported. In addition, possible reproductive effects include a high male to female birth ratio.

Epidemiological studies have revealed an association between arsenic concentrations in drinking water and increased incidences of skin cancers, as well as cancers of the liver, bladder, respiratory, and GI tracts. Occupational exposure studies have shown a clear correlation between exposure to arsenic and lung cancer mortality. Several studies have shown that inorganic arsenic can increase the risk of lung cancer, skin cancer, bladder cancer, liver cancer, kidney cancer, and prostate cancer. The World Health Organization, the DHHS, and the EPA have determined that inorganic arsenic is a human carcinogen and is classified A, human carcinogen.

Cancer slope factors for arsenic are available from EPA's IRIS. The values used in the BHHRA are 1.50E+00, 1.50E+01, and 3.66E+00 $[mg/(kg \times day)]^{-1}$ for the oral, inhalation, and dermal exposure routes, respectively. The slope factor for the dermal exposure route was calculated by assuming a GI absorption factor of 41%.

Chronic RfDs for arsenic also are available in RAIS. The values used in the BHHRA were 3.00E-04 and 1.23E-04 mg/(kg × day) for the oral and dermal routes, respectively. The dermal RfD was calculated by assuming a GI absorption factor of 41%.

F.4.1.4 Beryllium (CAS 007440-41-7) (RAIS)

Beryllium is a metallic element. Pure beryllium is a hard, grayish metal. In nature, beryllium can be found in compounds in mineral rocks, coal, soil, and volcanic dust. Beryllium compounds have no particular smell. Beryllium occurs naturally in the earth's crust at concentrations ranging from 2-10 ppm. It is also released into the atmosphere from coal combustion at concentrations of ~0.01-0.1 ng/m^3, most likely as beryllium oxide. Beryllium occurs in house dust, surface water, food, and soil. The general population is exposed to beryllium every day. Cigarette smokers can be exposed to nearly twice the amount of beryllium as nonsmokers. Beryllium compounds are commercially mined, and the beryllium purified for use in electrical parts, machine parts, ceramics, aircraft parts, nuclear weapons, and mirrors. Currently, beryllium has many industrial uses (e.g., in brake systems of airplanes, for neutron monochromatization, as window material for x-ray tubes, and in radiation detectors). The commercially important compound, beryllium oxide, is used in the electronics industry as a substrate for transistors and silicon chips, coil cores, and laser tubes.

Limited data indicate that the oral toxicity of beryllium is low in humans. No adverse effects were noted in mice given 5 ppm beryllium in the drinking water in a lifetime bioassay. In contrast, the toxicity of inhaled beryllium is well-documented. Humans inhaling "massive" doses of beryllium compounds may develop acute berylliosis. ATSDR estimated that, based on existing data, the disease could develop at levels ranging from approximately 2-1000 µg Be/m^3. This disease usually develops shortly after exposure and is characterized by rhinitis, pharyngitis, and/or tracheobronchitis, and may progress to severe pulmonary symptoms. The severity of acute beryllium toxicity correlates with exposure levels, and the disease is now rarely observed in the United States because of improved industrial hygiene. Humans inhaling beryllium also may develop chronic berylliosis which, in contrast to acute berylliosis, is highly variable in onset, is more likely to be fatal and can develop a few months to >=20 years after exposure.

Epidemiologic studies have suggested that beryllium and its compounds could be human carcinogens. Studies in workers exposed to beryllium, mostly via inhalation, have shown significant increases in observed over expected lung cancer incidences. The U.S. EPA, in evaluating the total database for the association of lung cancer with occupational exposure to beryllium, noted several limitations, but concluded that the results must be considered to be at least suggestive of a carcinogenic risk to humans. In laboratory studies, beryllium sulfate caused increased incidences of pulmonary tumors in rats and rhesus monkeys.

Based on sufficient evidence for animals and inadequate evidence for humans, beryllium has been placed in the EPA weight-of-evidence classification B2, probable human carcinogen.

A chronic RfD for the oral route of exposure from RAIS was used in the BHHRA. The values used in the BHHRA are 2.00E-03, 5.71E-06, and 2.00E-05 (mg/kg-day) for the oral, inhalation, and dermal routes, respectively. The dermal RfD was calculated assuming a GI absorption factor of 1 %.The cancer slope factor for beryllium from RAIS was used in the BHHRA. The value used was 4.30E+00, 8.40E+00, and 4.30E+02$[mg/(kg \times day)]^{-1}$ for the oral, inhalation, and dermal routes of exposure. The value for the oral and dermal slope factor was withdrawn by NCEA and the Federal Facility Agreement parties have agreed not to include the withdrawn slope factor for beryllium in BHHRAs for PGDP.

F.4.1.5 Chromium III (CAS 16065-83-1) and Chromium VI (CAS 18540-29-9) (RAIS)

Elemental chromium does not occur in nature, but it is present in ores, primarily chromite. Chromium can be found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium is present in the environment in several different forms (oxidation states). The most common forms are chromium (0), chromium (III), and chromium (VI). No taste or odor is associated with chromium compounds. Chromium (III) occurs naturally in the environment and is an essential nutrient that helps the body use sugar, protein, and fat. Chromium (VI) and chromium (0) generally are produced by industrial processes. The metal chromium, chromium (0), is used for making steel. Chromium (VI) and chromium (III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Chromium enters the body through the lungs, digestive tract and, to a lesser extent, the skin. Inhalation is the most important route for occupational exposure. Non-occupational exposure occurs via ingestion of chromium-containing food and water. Breathing high levels of chromium (VI) can cause irritation to the nose, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium (VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium (VI) or chromium (III). Allergic reactions consisting of severe redness and swelling of the skin have been noted.

Several studies have shown that chromium (VI) compounds can increase the risk of lung cancer when inhaled. Animal studies also have shown an increased risk of cancer. There also is evidence for an increased risk of developing nasal, pharyngeal, and GI carcinomas. Based on sufficient evidence for humans and animals, Chromium (VI) has been placed in the EPA weight-of-evidence classification A: human carcinogen. Chromium (III) is most appropriately designated a Group D – Not classified as to its human carcinogenicity; however, the classification of chromium (VI) as a known human carcinogen raises a concern for the carcinogenic potential of trivalent chromium.

The cancer slope factor for chromium (VI) from RAIS was used in the BHHRA. The value used was 4.20E+01 $[mg/(kg \times day)]^{-1}$ for the inhalation route of exposure. Slope factors for the oral and dermal routes of exposure are not available.

Consistent with the Risk Methods Document, the chronic RfDs from RAIS associated with Chromium (III) were used in the BHHRA. The values used were 1.50E+00 and 7.50E-03 mg/(kg × day) for the oral and dermal routes, respectively. The dermal RfD was calculated by assuming a GI absorption factor of 2 %.

F.4.1.6 Copper (CAS 007440-50-8) (RAIS)

Copper is a reddish metal that occurs naturally in the environment in plants and animals. Copper is an essential element for all living things including humans. Copper is extensively mined in the United States and is used to make wire, sheet metal, pipes, and pennies. It also is used in farming to treat some plant diseases; in water treatment; and to preserve wood, leather, and fabrics. Also, because of its high electrical and thermal conductivity and other properties such as malleability, metallic copper is widely used in the manufacture of electrical equipment.

Copper is an essential trace element that is widely distributed in animal and plant tissues. Copper is necessary for good health and can be absorbed by the oral, inhalation, and dermal routes of exposure. Very large doses, however, can be harmful. In humans, ingestion of gram quantities of copper salts may cause GI, hepatic, and renal effects with symptoms such as severe abdominal pain, vomiting, diarrhea, hemolysis, hepatic necrosis, hematuria, proteinuria, hypotension, tachycardia, convulsions, coma, and death. Acute inhalation exposure to copper dust or fumes at concentrations of 0.075-0.12 mg Cu/m3 may cause metal fume fever with symptoms such as cough, chills and muscle ache. Skin contact with copper can result in an allergic reaction, usually skin irritation or a skin rash.

No suitable bioassays or epidemiological studies are available to assess the carcinogenicity of copper. U.S. EPA, therefore, has placed copper in weight-of-evidence group D, not classifiable as to human carcinogenicity. No slope factors, therefore, were used in this BHHRA.

The chronic RfDs for the oral and dermal routes of exposure from RAIS was used in the BHHRA. The oral and dermal RfDs used were 4.00E-02 and 1.20E-02 (mg/kg-day), respectively. The GI absorption factor used was 30%.

F.4.1.7 Iron (CAS 007439-89-6)

Iron is one of the most abundant metals in the environment and is used in many industrial processes. It is an essential element in the human diet. More than 80% of the iron present in the body is involved in the support of red blood cell production. In addition, it is also an essential component of myoglobin and various enzymes. Iron deficiency is the most common cause of anemia (Goodman and Gilman 1985). Exposure to excessive levels of iron may cause GI damage and dysfunction and enlargement of the liver and pancreas (Goodman and Gilman 1985).

Iron has not been classified by EPA with regard to cancer weight-of-evidence. No slope factors were used in this BHHRA.

Chronic RfDs also have not been released by EPA in IRIS or HEAST; however, oral and dermal RfDs of 3.00E-01 and 4.50E-02 mg/(kg × day), respectively, were used in the BHHRA based on a provisional value from NCEA. The GI absorption factor used was 15%.

F.4.1.8 Manganese (CAS 007439-96-5) (RAIS)

Manganese is a silver-colored, naturally occurring metal that is found in many types of rocks and makes up about 0.10% of the earth’s crust. Manganese is not found alone, but combines with other substances such as oxygen, sulfur, or chlorine. Manganese also can be combined with carbon to make organic manganese compounds, including pesticides (e.g., maneb or mancozeb) and methylcyclopentadienyl manganese tricarbonyl, a fuel additive in some gasolines. Manganese is an essential trace element and is necessary for good health. Normal nutritional requirements of manganese are satisfied through the diet, which is the normal source of the element, with minor contributions from water and air. The National Research Council recommends a dietary allowance of 2-5 mg/day for a safe and adequate intake of manganese for an adult human. Manganese can be found in several food items, including grains, cereals, and tea.

Manganese can elicit a variety of serious toxic responses upon prolonged exposure to elevated concentrations, either orally or by inhalation. The central nervous system is the primary target. Initial symptoms are headache, insomnia, disorientation, anxiety, lethargy, and memory loss. These symptoms progress with continued exposure and eventually include motor disturbances, tremors, and difficulty in walking, symptoms similar to those seen with Parkinsonism. These motor difficulties are often irreversible. Some individuals exposed to very high levels of manganese for long periods of time at work developed mental and emotional disturbances and slow and clumsy body movements. This combination of symptoms is a disease called “manganism.”

There are no human cancer data available for manganese. Manganese has been placed in the EPA weight-of-evidence classification D: not classifiable as to human carcinogenicity. No slope factors, therefore, were used in this BHHRA.

The oral, inhalation, and dermal RfDs from RAIS used in the BHHRA were 1.40E-01 and 1.43E-05, and 5.60E-03 mg/(kg × day), respectively. The GI absorption factor is 4% and the corresponding absorbed dose RfD is 5.60E-03 mg/(kg × day).

F.4.1.9 Mercury (CAS 007439-97-6) (RAIS)

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid; if heated, it is a colorless, odorless gas. Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds; methylmercury is the most common organic mercury compound and is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make. Metallic mercury is used to produce chlorine gas and caustic soda and is also used in thermometers, dental fillings, electrical switches, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury reaches the brain in these forms. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

No data were available regarding the carcinogenicity of mercury in humans or animals. EPA has placed inorganic mercury in weight-of-evidence classification D, not classifiable as to human carcinogenicity. Other forms of mercury are possible human carcinogens.

A chronic RfD for the oral route of exposure from RAIS was used in the BHHRA. The values used in the BHHRA are 3.00E-04 and 2.10E-05 (mg/kg-day) for the oral and dermal routes, respectively. The dermal RfD was calculated assuming a GI absorption factor of 7%.

F.4.1.10 Nickel (CAS 007440-02-0 for soluble nickel salts) (RAIS)

Nickel is a very abundant element in the environment. It is found primarily combined with oxygen (oxides) or sulfur (sulfides), found in all soils, and is emitted from volcanoes. Pure nickel is a hard, silvery-white metal that is combined with other metals to form mixtures called alloys. Some of the metals that nickel can be alloyed with are iron, copper, chromium, and zinc. These alloys are used to make metal coins and jewelry and in industry. Nickel compounds also are used for nickel plating, to color ceramics, to make some batteries, and as substances known as catalysts that increase the rate of chemical reactions. Nickel and its compounds have no characteristic odor or taste. Nickel forms included in this profile are nickel carbonyl, CAS number 13463-39-3; nickel refinery dust, no CAS number; nickel subsulfide, CAS number 12035-72-2; and nickel soluble salts, no CAS number.

Nickel is required to maintain health in animals. A small amount of nickel is probably essential for humans, although a lack of nickel has not been found to affect the health of humans. The absorption of nickel is dependent on its physicochemical form, with water-soluble forms being more readily absorbed. The most common adverse health effect of nickel in humans is an allergic reaction. Humans can become sensitive to nickel when jewelry or other nickel-containing items are in direct contact with the skin. Once a person is sensitized to nickel, further contact will produce a reaction; the most common reaction is a skin rash at the site of contact. Less frequently, some humans who are sensitive to nickel have asthma attacks or other reactions following exposure to nickel in food, water, or dust. Lung effects, including chronic bronchitis and reduced lung function, have been observed in workers who breathed large amounts of nickel. Current levels of nickel in workplace air are much lower than in the past, and today few workers show symptoms of nickel exposure. Humans who are not sensitive to it must eat very large amounts of nickel to show adverse health effects. In large doses (>0.5 g), some forms of nickel may be acutely toxic to humans when taken orally. Workers who accidentally drank water containing very high levels of nickel (100,000 times more than in normal drinking water) had stomachaches and effects on their blood and kidneys.

Epidemiologic studies have shown that occupational inhalation exposure to nickel dust (primarily nickel subsulfide) at refineries has resulted in increased incidences of pulmonary and nasal cancer. Inhalation studies using rats also have shown nickel subsulfide or nickel carbonyl to be carcinogenic. Based on these data, the EPA has classified nickel subsulfide and nickel refinery dust in weight-of-evidence group A; human carcinogen. Based on an increased incidence of pulmonary carcinomas and malignant tumors in animals exposed to nickel carbonyl by inhalation or by intravenous injection, this compound had been placed in weight-of-evidence group B2: probable human carcinogen. The U.S. EPA has not evaluated soluble salts of nickel as a class of compounds for potential human carcinogenicity. Because the form of nickel of concern to this BHHRA was soluble salts, no slope factors were used in this BHHRA.

A chronic RfD for the oral and dermal routes of exposure from RAIS was used in the BHHRA. The RfDs used in the BHHRA for the oral and dermal routes of exposure were 2.00E-02 and 5.40E-03 mg/(kg × day), respectively. The dermal route RfD was based on a GI absorption factor of 27%.

F.4.1.11 Selenium (CAS 007782-49-2) (RAIS)

Selenium is a metal commonly found in rocks and soil; much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium and oxygen combine to form several compounds. Selenium sulfide is a bright red-yellow powder used in anti-dandruff shampoo. Industrially produced hydrogen selenide is a colorless gas with a disagreeable odor. It is probably the only selenium compound that might pose a health concern in the workplace. Selenium dioxide is an industrially produced compound that dissolves in water to form selenious acid. Selenious acid can be found in gun bluing (a solution used to clean the metal parts of a gun). Selenium is an essential trace element important in many biochemical processes that take place in human cells. Recommended human dietary allowances for selenium for adults is about 40-70 µg.

In humans, acute oral exposures can result in excessive salivation, garlic odor to the breath, shallow breathing, diarrhea, pulmonary edema, and death. Other reported signs and symptoms of acute selenosis include tachycardia, nausea, vomiting, abdominal pain, abnormal liver function, muscle aches and pains, irritability, chills, and tremors. The exact levels at which these effects occur are not known. GI absorption in animals and humans of various selenium compounds ranges from about 44% to 95% of the ingested dose. If too much selenium is ingested over long periods of time, brittle hair and deformed nails can develop. Upon contact with skin, selenium compounds have caused rashes, swelling, and pain.

Respiratory tract absorption rates of 97% and 94% for aerosols of selenious acid have been reported for dogs and rats, respectively. In humans, inhalation of selenium or selenium compounds primarily affects the respiratory system. Dusts of elemental selenium and selenium dioxide can cause irritation of the skin and mucous membranes of the nose and throat, coughing, nosebleed, loss of sense of smell, dyspnea, bronchial spasms, bronchitis, and chemical pneumonia.

Studies of laboratory animals and humans show that most selenium compounds probably do not cause cancer. In fact, human studies suggest that lower-than-normal selenium levels in the diet might increase the risk of cancer. Other forms of selenium may, however, be carcinogenic according to the DHHS. Selenium sulfide produced a significant increase in the incidence of lung and liver tumors in rats and mice. EPA has placed selenium and selenious acid in Group D, not classifiable as to carcinogenicity in humans, while selenium sulfide is placed in Group B2, probable human carcinogen. Selenium sulfide is very different from the selenium compounds found in foods and in the environment. Selenium sulfide has not caused cancer in animals when it is placed on the skin, and the use of anti-dandruff shampoos containing selenium sulfide is considered safe.

Chronic RfDs from RAIS were available for selenium. The RfDs used in the BHHRA for the oral and dermal routes of exposure were 5.00E-03 and 2.20E-03 mg/(kg × day), respectively. The dermal route RfD was based on a GI absorption factor of 44%.

F.4.1.12 Thallium (CAS 007440-28-0) (RAIS)

Pure thallium is a bluish-white metal that is found in trace amounts in the earth's crust. In the past, thallium was obtained as a by-product from smelting other metals; however, it has not been produced in the United States since 1984. Currently, all the thallium is obtained from imports and from thallium reserves. In its pure form, thallium is odorless and tasteless. It can also be found combined with other substances such as bromine, chlorine, fluorine, and iodine. When it's combined, it appears colorless-to-white or yellow. The EPA has evaluated the toxicity of the following thallium compounds: thallic oxide, CAS number 1314-32-5; thallium acetate, CAS number 563-68-8; thallium carbonate, CAS number 6533-73-9; thallium chloride, CAS number 7791-12-0; thallium nitrate, CAS number 10102-45-1; thallium selenite, CAS number 12039-52-0; and thallium sulfate CAS number 7446-18-6. Thallium is used mostly in manufacturing electronic devices, switches, and closures, primarily for the semiconductor industry. It also has limited use in the manufacture of special glass and for certain medical procedures.

Exposure to high levels of thallium can result in harmful health effects. A study on workers exposed on the job over several years reported nervous system effects, such as numbness of fingers and toes, from breathing thallium. Humans who ingested large amounts of thallium over a short time have reported vomiting, diarrhea, temporary hair loss, and effects on the nervous system, lungs, heart, liver, and kidneys as well as death. It is not known what the effects are from ingesting low levels of thallium over a long time. Birth defects were not reported in the children of mothers exposed to low levels from eating vegetables and fruits contaminated with thallium. Studies in rats, however, exposed to high levels of thallium, showed adverse developmental effects.

Data suitable for evaluating the carcinogenicity of thallium to humans or animals by ingestion, inhalation, or other routes of exposure were not found. Thallium sulfate, selenite, nitrate, chloride, carbonate, acetate, and thallic oxide have been placed in EPA's weight-of evidence Group D, not classifiable as to human carcinogenicity based on inadequate human and animal data. The DHHS and the IARC, have not classified pure thallium as to its human carcinogenicity. No studies are available in humans or animals on the carcinogenic effects of breathing, ingesting, or touching thallium.

Chronic RfDs from RAIS were available for thallium chloride. The RfDs used in the BHHRA for the oral and dermal routes of exposure were 8.00E-05 and 1.60E-05 (mg/kg-day), respectively. The dermal route RfD was based on a GI absorption factor of 20%.

F.4.1.13 Uranium (metal and soluble salts) (CAS 007440-61-1)

Uranium is a hard, silvery white amphoteric metal and is a radioactive element. In its natural state it consists of three isotopes: ^{234}U, ^{235}U, and ^{238}U. More than 100 uranium minerals exist; those of commercial importance are the oxides and oxygenous salts. The processing of uranium ore generally involves extraction then leaching either by an acid or a carbonate method. In addition, the metal may be obtained from its halides by fused salt electrolysis. The primary use of natural uranium is in nuclear energy as a fuel for nuclear reactors, in plutonium production, and as feeds for gaseous diffusion plants; it is also a source of radium salts. Uranium compounds are used in staining glass, glazing ceramics, and enameling; in photographic processes; for alloying steels; and as a catalyst for chemical reactions, radiation shielding, and aircraft counterweights (Sittig 1985).

The primary route of exposure to uranium metals and salts is through dermal contact. Uranium soluble compounds act as a poison to cause kidney damage under acute exposure and pneumoconiosis or pronounced blood changes under chronic exposure conditions. Furthermore, it is difficult to separate the toxic chemical effects of uranium and its compounds from their radiation effects. The chronic radiation effects are similar to those produced by ionizing radiation. Reports now confirm that carcinogenicity is related to dose and exposure time. Cancer of the lung, osteosarcoma, and lymphoma have all been reported (Sittig 1985). An EPA weight-of-evidence classification for uranium metal was not located in the available literature. Slope factors for uranium metal also were not available for use in the BHHRA.

Chronic RfDs from RAIS were available for uranium metal (listed as uranium soluble salts). The oral and dermal RfD used in the BHHRA were 6.00E-04 and 5.10E-4 mg/(kg $\times$ day), respectively. A GI absorption factor of 85% was used to derive the dermal RfD.

F.4.1.14 Vanadium (CAS 007440-62-2 for metal) (RAIS)

Vanadium is a compound that occurs in nature as a white-to-gray metal and is often found as crystals. Pure vanadium has no smell and usually combines with other elements such as oxygen, sodium, sulfur, or chloride, which greatly alter toxicity. Vanadium and vanadium compounds can be found in the earth’s crust and in rocks, some iron ores, and crude petroleum deposits. Vanadium is mostly combined with other metals to make special metal mixtures called alloys. Most of the vanadium used in the United States, vanadium oxide, is used to make steel for automobile parts, springs, and ball bearings. Vanadium oxide is a yellow-orange powder, dark-gray flakes, or yellow crystals. Vanadium also is mixed with iron to make important parts for aircraft engines. Small amounts of vanadium are used in making rubber, plastics, ceramics, and other chemicals.

Exposure to high levels of vanadium can cause harmful health effects. Vanadium compounds are poorly absorbed through the digestive system (0.5-2% of dietary amount), but slightly more readily absorbed through the lungs (20-25%). The major effects from breathing high levels of vanadium are on the lungs, throat, and eyes. Workers who breathed it for short and long periods sometimes had lung irritation, coughing, wheezing, chest pain, runny nose, and a sore throat. These effects stopped soon when removed from the contaminated air. Similar effects have been observed in animal studies. No other significant health effects of vanadium have been found in humans. The health effects in humans of ingesting vanadium are not known. Animals that ingested very large doses have died. Lower, but still high, levels of vanadium in the water of pregnant animals resulted in minor birth defects. Some animals that breathed or ingested vanadium over a long term had minor kidney and liver changes.

There is no evidence that any vanadium compound is carcinogenic; however, very few adequate studies are available for evaluation. No increase in tumors was noted in a long-term animal study where the animals were exposed to vanadium in the drinking water. The DHHS, the IARC, and EPA have not classified vanadium as to its human carcinogenicity.

Chronic RfDs from RAIS were available for vanadium. The RfDs used in the BHHRA for the oral and dermal routes of exposure were 7.00E-03 and 7.00E-05 mg/(kg × day), respectively. The dermal route RfD was based on a GI absorption factor of 1%.

F.4.1.15 Zinc (CAS 007440-66-6 for metal) (RAIS)

Pure zinc is a bluish-white, shiny metal. Zinc is one of the most common elements in the earth's crust and is found in air, soil, and water, and is present in all foods. Zinc has many commercial uses as coatings to prevent rust, in dry -cell batteries, and mixed with other metals to make alloys like brass and bronze. A zinc and copper alloy is used to make pennies in the United States. Zinc combines with other elements to form zinc compounds; common zinc compounds found at hazardous waste sites include zinc chloride, zinc oxide, zinc sulfate, zinc phosphide, zinc cyanide, and zinc sulfide. Zinc compounds are widely used in industry to make paint, rubber, dye, wood preservatives, and ointments.

Zinc is an essential element, with recommended daily allowances ranging from 5 mg for infants to 15 mg for adult males. Too little zinc can cause health problems, but too much zinc also is harmful.

The digestive tract absorbs 20% to 80 % of ingested zinc based on the chemical compound ingested. Harmful health effects generally begin at levels in the 100 to 250 mg/day range. Eating large amounts of zinc, even for a short time, can cause stomach cramps, nausea, and vomiting. Taken longer, it can cause anemia, pancreas damage, and lower levels of high-density lipoprotein cholesterol (the good form of cholesterol). Breathing large amounts of zinc (as dust or fumes) can cause a specific short-term disease called metal fume fever. This is believed to be an immune response affecting the lungs and body temperature. The long-term effects of breathing high levels of zinc or the effects on human reproduction are not known. Rats that were fed large amounts of zinc became infertile or had smaller babies. Irritation also was observed on the skin of rabbits, guinea pigs, and mice when exposed to some zinc compounds. Skin irritation will probably occur in humans.

No case studies or epidemiologic evidence has been presented to suggest that zinc is carcinogenic in humans by the oral or inhalation route. In animal studies, zinc sulfate in drinking water or zinc oleate in the diet of mice for a period of one year did not result in a statistically significant increase in tumors; however, in a 3-year, 5-generation study on tumor-resistant and tumor-susceptible strains of mice, exposure to zinc in drinking water resulted in increased frequencies of tumors. EPA has placed zinc in weight-of-evidence Group D: not classifiable as to human carcinogenicity due to inadequate evidence in humans and animals. There were no slope factors available for zinc in this BHHRA.

Chronic RfDs from RAIS were available for zinc. The RfDs used in the BHHRA for the oral and dermal routes of exposure were 3.00E-01 and 6.00E-02 mg/(kg × day), respectively. The dermal route RfD was based on a GI absorption factor of 20%.

F.4.2 ORGANIC COMPOUNDS

F.4.2.1 Total PCBs (high risk) (RAIS)

PCBs are inert, thermally and physically stable, and have dielectric properties. In the environment, the behavior of PCB mixtures is directly correlated to the degree of chlorination. They have been used in closed systems such as heat transfer liquids, hydraulic fluids and lubricants, and in open systems such as plasticizers, surface coatings, inks, adhesives, pesticide extenders, and for microencapsulation of dyes for carbonless duplicating papers. Aroclor is strongly sorbed to soil and remains immobile when leached with water; however, the mixture is highly mobile in the presence of organic solvents. PCBs are resistant to chemical degradation by oxidation or hydrolysis. PCBs have high bioconcentration factors and tend to accumulate in the fat of fish, birds, mammals, and humans.

PCBs are absorbed after oral, inhalation, or dermal exposure and are stored in adipose tissue. The major route of PCB excretion is in the urine and feces; however, more important is the elimination in human milk. Accidental human poisonings and data from occupational exposure to PCBs suggest initial dermal and mucosal disturbances followed by systemic effects that may manifest themselves several years post-exposure. Initial effects are enlargement and hypersecretion of the Meibomian gland of the eye, swelling of the eyelids, pigmentation of the fingernails and mucous membranes, fatigue, and nausea. These effects were followed by hyperkeratosis, darkening of the skin, acneform eruptions, edema of the arms and legs, neurological symptoms, such as headache and limb numbness, and liver disturbance.

Data are suggestive but not conclusive concerning the carcinogenicity of PCBs in humans; however, hepatocellular carcinomas in three strains of rats and two strains of mice have led the EPA to classify PCBs as group B2, probable human carcinogen.

Cancer slope factors for the total class of PCBs (based on high risk) are available from RAIS. The slope factors used in the BHHRA for the oral, inhalation, and dermal exposure routes are 2.00E+00, 2.20E+00, and 2.00E+00 $[mg/(kg \times day)]^{-1}$, respectively. The slope factor for the dermal exposure route was calculated by assuming a GI absorption factor of 90%.

Chronic RfDs for PCB-1254 are available from RAIS. This RfD was used for calculating noncarcinogenic hazard for Total PCBs. The values used in the BHHRA for the oral, and dermal routes were 2.00E-05 and 1.80E-05 mg/(kg × day). The dermal RfD was derived using a GI absorption factor of 90%.

F.4.2.2 Total PAHs

Total PAHs are evaluated in this BRA by weighting the concentration of each PAH to convert it to benzo(a) pyrene equivalents as described in the 2001 Risk Methods Document and then evaluating the sum of the concentrations based on the toxicity of benzo(a)pyrene. The PAHs included in this calculation for the PAH class are benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene.

Benzo[a]pyrene is one of many chemicals known as PAHs. It exists as yellowish plates and needles. Benzo[a]pyrene is practically insoluble in water but is soluble in benzene, toluene, xylene and sparingly soluble in alcohol and methanol. No current commercial production or use of benzo[a]pyrene is known. It occurs ubiquitously in products of incomplete combustion and in fossil fuels. It has been identified in surface water, tap water, rain water, groundwater, waste water, and sewage sludge. Benzo[a]pyrene is primarily released to the air and removed from the atmosphere by photochemical oxidation and dry deposition to land or water. Biodegradation is the most important transformation process in soil or sediment.

No data are available on the systemic (noncarcinogenic) effects of benzo[a]pyrene in humans. Benzo[a]pyrene is readily absorbed following inhalation, oral, and dermal routes of administration. Following inhalation exposure, benzo[a]pyrene is rapidly distributed to several tissues in rats. The metabolism of benzo[a]pyrene is complex and includes the formation of a proposed ultimate carcinogen, benzo[a]pyrene 7,8 diol-9,10-epoxide. Dietary administration of doses as low as 10 mg/kg during gestation caused reduced fertility and reproductive capacity in mice offspring, and treatment by gavage with 120 mg/kg/day during gestation caused stillbirths, resorptions, and malformations.

Numerous epidemiologic studies have shown a clear association between exposure to various mixtures of PAHs containing benzo[a]pyrene (e.g., coke oven emissions, roofing tar emissions, and cigarette smoke) and increased risk of lung cancer and other tumors. Each of the mixtures also contained other potentially carcinogenic PAHs; therefore, it is not possible to evaluate the contribution of benzo[a]pyrene to the carcinogenicity of these mixtures. Based on United States EPA guidelines, benzo[a]pyrene was assigned to weight-of-evidence group B2, probable human carcinogen.

Cancer slope factors for benzo[a]pyrene are available from RAIS. The slope factors used in the BHHRA for the oral, inhalation, and dermal exposure routes are 7.30E+00, 2.51E-01, and 2.35E+01 $[\text{mg/(kg} \times \text{day)}]^{-1}$, respectively. The slope factor for the dermal exposure route was calculated by assuming a GI absorption factor of 31%.

F.4.2.3 Carbazole

Information on the specific toxic effects of carbazole is not available. For this risk assessment, the assessment of the noncarcinogenic effects of carbazole is based on the EPA HEAST provisional toxicity value.

F.4.2.4 Dibenzofuran (CAS 000132-64-9) (RAIS)

Exposure to dibenzofuran may occur from inhalation of contaminated air, or ingesting contaminated drinking water or food. No information is available on the acute (short-term), chronic (long-term), reproductive, developmental, and carcinogenic effects of dibenzofuran in humans or animals. Health effects information is available on the polychlorinated dibenzofurans; however, the EPA has noted that the biological activity of various chlorinated dibenzofurans varies greatly, thus, risk assessment by analogy to any of these more widely studied compounds would not be recommended. EPA has classified dibenzofuran as a Group D, not classifiable as to human carcinogenicity.

Chronic oral and dermal RfDs for dibenzofuran are available from RAIS. The values used in the BHHRA for the oral, and dermal routes were 2.00E-03 and 1.60E-03 mg/(kg × day), respectively. The dermal RfD was derived using a GI absorption factor of 80%.

F.4.2.5 *Cis*- and *trans*-1,2-DCE (CAS 000156-59-2 and CAS 000156-60-5) (RAIS)

1,2-DCE, also called 1,2-dichloroethylene, is a highly flammable, colorless liquid with a sharp, harsh odor. It is used to produce solvents and in chemical mixtures. Very small amounts of 1,2-DCE may be smelled in air (about 17 ppm). There are two forms of 1,2-DCE: *cis*-1,2-DCE and *trans*-1,2-DCE. Sometimes both forms are present as a mixture. Commercial use is not extensive, but *trans*-1,2-DCE and mixtures of *cis*- and *trans*-1,2-DCE have been used as intermediates in the production of other chlorinated solvents and compounds, as well as low temperature extraction solvents for dyes, perfumes, and lacquers. Additionally, *cis*- and *trans*-1,2-DCE react violently with potassium hydroxide, sodium, and sodium hydroxide and form shock-sensitive explosives when combined with dinitrogen tetraoxide. Both forms of 1,2-DCE are degradation products of TCE.

Humans are exposed to 1,2-DCE primarily by inhalation, but exposure also can occur by oral and dermal routes. Breathing high levels of 1,2-DCE can cause nauseous, drowsiness, and tiredness in humans; very high levels can cause death. Breathing high levels of *trans*-1,2-DCE caused liver and lung damage in animals, and the effects were more severe with longer exposure times. Animals that breathed very high levels of *trans*-1,2-DCE had damaged hearts. Animals that ingested extremely high doses of *cis*- or *trans*-

1,2-DCE died. Lower doses of *cis*-1,2-DCE caused effects on the blood, such as decreased numbers of red blood cells, and also on the liver.

No cancer bioassays or epidemiological studies were available to assess the carcinogenicity of 1,2-DCE. EPA has placed both *cis*- and *trans*-1,2-DCE in weight-of-evidence group D, not classifiable as to human carcinogenicity, based on the lack of or negative human or animal cancer data. No cancer slope factors for *cis*- or *trans*-1,2-DCE are available; therefore, carcinogenicity from exposure could not be quantified in the BHHRA.

The oral and dermal chronic RfDs for *cis*-1,2-DCE used in the BHHRA are 1.00E-02 and 1.00E-02 mg/(kg × day), respectively. The oral and dermal chronic RfDs for *trans*-1,2-DCE used in the BHHRA are 2.00E-02 and 2.00E-02 mg/(kg × day), respectively. The oral RfDs for *cis*- and *trans*-1,2-DCE were from EPA's HEAST and IRIS, respectively. Inhalation RfDs used in the BHHRA were extrapolated from the oral RfDs. These inhalation RfDs were 6.00E-02 and 1.70E-02 (mg/kg × day) for *cis*- and *trans*-1,2-DCE, respectively. The dermal RfDs were derived from the oral toxicity value using a GI absorption factor of 100%.

F.4.2.6 Fluoranthene

Fluoranthene is a PAH. It exists as pale yellow needles or plates. Fluoranthene is almost insoluble in water, but is soluble in alcohol, ether, benzene, and acetic acid. Fluoranthene can be produced by the pyrolysis of organic raw materials such as coal and petroleum at high temperatures; it is also known to occur naturally as a product of plant biosynthesis. Fluoranthene is a constituent of coal tar and petroleum-derived asphalt. Currently, there is no known production or use of this compound.

Fluoranthene can be absorbed through dermal exposure and based on similar PAHs, would be expected to be absorbed from the digestive tract and lungs. Although a large body of literature exists on the toxicity and carcinogenicity of PAHs, toxicity data for fluoranthene are very limited. No human data were available that addressed the toxicity of fluoranthene. Toxicity studies in animals have shown that fluoranthene exposure can cause eye irritation, nephropathy, increased liver weights, and increased liver enzyme levels.

No oral or inhalation bioassays were available to assess the carcinogenicity of fluoranthene to humans; bioassays by other exposure routes generally gave negative results. Studies involving topical application to the skin of mice and subcutaneous injection in mice provided no evidence of carcinogenicity. Fluoranthene also was inactive in mouse skin initiation and promotion assays. Based on no human data and inadequate data from animal bioassays, EPA has placed fluoranthene in weight-of-evidence group D, not classifiable as to human carcinogenicity.

Chronic RfDs for Fluoranthene are available from EPA's IRIS. The values used in the BHHRA for the oral, and dermal routes were 4.00E-02 and 1.24E-02 mg/(kg × day). The dermal RfD was derived using a GI absorption factor of 31%.

F.4.2.7 Naphthalene (CAS 000091-20-3)

Naphthalene is a white solid that is found naturally in fossil fuels and that exhibits a typical mothball odor. Naphthalene is a polycyclic aromatic hydrocarbon composed of two fused benzene rings. Burning tobacco or wood produces naphthalene. It occurs in crude oil, from which it may be recovered directly as white flakes; it can also be isolated from cracked petroleum, coke-oven emissions, or from high-temperature carbonization of bituminous coal. The major products made from naphthalene are moth repellents. It is also used for making dyes, resins, leather, tanning agents, and the insecticide carbaryl.

Naphthalene can be absorbed by the oral, inhalation, and dermal routes of exposure and can cross the placenta in amounts sufficient to cause fetal toxicity. Exposure to large amounts of naphthalene may damage or destroy some red blood cells, causing a low level until the body replaces the destroyed cells. People, particularly children, have developed this problem after eating naphthalene-containing mothballs or deodorant blocks. Some of the symptoms of this problem are fatigue, lack of appetite, restlessness, and pale skin. Exposure to large amounts of naphthalene may also cause neurotoxic effects (confusion, lethargy, listlessness, vertigo), gastrointestinal distress, hepatic effects (jaundice, hepatomegaly, elevated serum enzyme levels), renal effects, and ocular effects (cataracts, optical atrophy). The estimated lethal dose of naphthalene is 5-15 g for adults and 2-3 g for children. Animals sometimes develop cloudiness in their eyes after swallowing naphthalene. It is not clear if this also develops in people. When mice were repeatedly exposed to naphthalene vapors for 2 years, their noses and lungs became inflamed and irritated.

Available cancer bioassays were insufficient to assess the carcinogenicity of naphthalene. Using EPA's 1996 Proposed Guidelines for Carcinogen Risk Assessment, the human carcinogenic potential of naphthalene via the oral or inhalation routes "cannot be determined" at this time based on human and animal data. There is suggestive evidence (observations of benign respiratory tumors and one carcinoma in female mice only exposed to naphthalene by inhalation) that naphthalene may cause cancer. Additional support includes increase in respiratory tumors associated with exposure to 1-methylnaphthalene.

Chronic RfDs for naphthalene are available from RAIS. The values used in the BHHRA for the oral, inhalation, and dermal routes were 2.00E-02, 8.57E-04, and 1.60E-02 mg/(kg × day). The dermal RfD was derived using a GI absorption factor of 80%.

F.4.2.8 Pyrene (CAS 000129-00-0) (RAIS)

Pyrene, also known as benzo(def)phenanthrene, is a PAH with four aromatic carbon rings. Pure pyrene is a colorless crystalline solid at ambient temperature; the presence of tetracene, a common contaminant, gives it a yellow color. Pyrene can be derived from coal tar, but there is no commercial production or known commercial use of this compound. Pyrene from coal tar has been used as the starting material for the synthesis of benzo[a]pyrene.

Human exposure to pyrene occurs primarily through inhalation of tobacco smoke and polluted air and by ingestion of water polluted by combustion effluents. Pyrene is common in the environment as a product of incomplete combustion and has been identified in water, food, and in the air. Although a large body of literature exists on the toxicity and carcinogenicity of other PAHs, toxicity data for pyrene are limited. No human data were available that addressed the toxicity of pyrene. Subchronic oral exposure to pyrene produced nephropathy, decreased kidney weights, increased liver weights, and slight hematological changes in mice and produced fatty livers in rats. A single intraperitoneal injection of pyrene produced swelling and congestion of the liver and increased serum aspartate amino transferase and bilirubin levels in rats. No data were available concerning the toxic effects of inhalation exposure to pyrene.

No oral or inhalation bioassays were available to assess the carcinogenicity of pyrene in humans. Many studies involving different routes of pyrene exposure were done on animals. None of these studies saw an increase in tumor rates, but there is evidence that pyrene enhances the tumor causing ability of benzo[a]pyrene. Based on no human data and inadequate data from animal bioassays, EPA has placed pyrene in weight-of-evidence group D, not classifiable as to human carcinogenicity.

Chronic RfDs for pyrene are available from EPA’s IRIS. The values used in the BHHRA for the oral and dermal routes were 3.00E-02 and 9.30E-03 mg/(kg × day). The dermal RfD was derived using a GI absorption factor of 31%.

F.4.2.9 TCE (CAS 000079-01-6) (RAIS)

TCE, also known as trichloroethylene, is a colorless, highly volatile liquid that is miscible with water and a number of organic solvents. TCE is a man-made chemical and is not known to occur naturally. It is mainly used as a solvent in industrial degreasing and cleaning of metals, but it also is used as a solvent for waxes, fats, resins, oils, and in numerous other applications. Prior to 1977, TCE had been used as an anesthetic, grain fumigant, disinfectant, and extractant of spice oleoresins in food and of caffeine in the production of decaffeinated coffee. The evaluation of the toxicity of TCE is complicated by the presence or absence of other chemicals. Industrial grade TCE usually contains stabilizers that are known to be toxic such as triethylamine, triethanolamine, epichlorohydrin, or stearates. In the absence of stabilizers, TCE readily decomposes. These decomposition products also are toxic.

Human and animal data indicate that exposure to TCE can result in toxic effects on a number of organs and systems, including the liver, kidney, blood, skin, immune system, reproductive system, nervous system, and cardiovascular system. Breathing small amounts of TCE may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage. Drinking large amounts of TCE may cause nausea, liver damage, unconsciousness, impaired heart function, or death. Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Skin contact with TCE for short periods may cause skin rashes.

Epidemiologic studies have been inadequate to determine if a correlation exists between exposure to TCE and increased cancer risk in humans. Some human studies with exposure over long periods to high levels of TCE in drinking water or in workplace air have found evidence of increased cancer; however, these results are inconclusive because the cancer could have been caused by other chemicals. Some studies with mice and rats have suggested that high levels of TCE may cause liver or lung cancer. Although EPA's Science Advisory Board recommended a weight-of-evidence classification of C-B2 continuum (C = possible human carcinogen; B2 = probable human carcinogen), the agency has not adopted a current position on the weight-of-evidence classification. In an earlier evaluation, TCE was assigned to weight-of-evidence Group B2, probable human carcinogen. The IARC has determined that TCE is not classifiable as to human carcinogenicity.

Cancer slope factors for TCE are available from RAIS. The slope factors from EPA for the oral, inhalation, and dermal exposure routes are 4.00E-01, 4.00E-01, and 2.67E+00 $[mg/(kg \times day)]^{-1}$, respectively. The slope factor for the dermal exposure route was calculated by assuming a GI absorption factor of 15%. Cancer slope factors also are available from the review done by KDEP (KDEP 2004). The slope factors from KDEP for the oral exposure route is 3.22E-01 $(mg/kg \times day)^{-1}$ Following guidance in the draft revised Risk Methods Document, the KDEP oral slope factor was used as the slope factor for both the oral and inhalation routes in this BHHRA. Uncertainties related to the selection of toxicity values among the 2001 Risk Methods Document, the EPA value, and the KDEP value is discussed in the uncertainty section.

Chronic RfDs for TCE are available from RAIS. The values used in the BHHRA for the oral, dermal, and inhalation routes were 3.00E-04, 1.14E-02, and 4.50E-05 mg/(kg × day). The dermal RfD was derived using a GI absorption factor of 15%.

F.4.2.10 Vinyl Chloride (CAS 000075-01-4) (RAIS)

Vinyl chloride, also known as chloroethene, is a halogenated aliphatic hydrocarbon. It is a colorless gas with a mild sweetish odor that is slightly soluble in water and soluble in hydrocarbons, oil, alcohol, chlorinated solvents, and most common organic liquids. Vinyl chloride is produced by thermal cracking of ethylene chloride and does not occur naturally. It is used primarily as an intermediate in the manufacture of PVC; limited quantities are used as a refrigerant and as an intermediate in the production of chlorinated compounds. It is a biodegradation product of TCE, tetrachloroethylene, and 1,1,1-TCA. Vinyl chloride may leach into groundwater from spills, landfills, and industrial sources.

Vinyl chloride is rapidly absorbed from the digestive tract and lungs. Breathing high levels of vinyl chloride can cause dizziness or sleepiness. Breathing very high levels can cause passing out, and breathing extremely high levels can cause death. Humans exposed to vinyl chloride in air for long periods of time can develop changes to the structure of their livers. Workers exposed to vinyl chloride have developed nerve damage and immune reactions. Other workers have developed problems with the blood flow in their hands: the tips of their fingers turn white and hurt when they are in cold temperatures. Sometimes, the bones in the tips of their fingers have broken down. The effects of drinking high levels of vinyl chloride are unknown. If vinyl chloride is spilled on skin, numbness, redness, and blisters may occur. Animal studies have shown that long-term (365 days or longer) exposure to vinyl chloride can damage the sperm and testes. It has not been proven that vinyl chloride causes birth defects in humans, but animal studies have shown that breathing vinyl chloride can harm unborn offspring and also may cause increases in early miscarriages.

Studies show that vinyl chloride causes liver cancer in humans. On the basis of sufficient evidence for carcinogenicity in human epidemiology studies, vinyl chloride is considered to best fit the weight-of-evidence Category "A," according to current EPA Risk Assessment Guidelines. Agents classified into this category are considered known human carcinogens. This classification is supported by positive evidence for carcinogenicity in animal bioassays including several species and strains, and strong evidence for genotoxicity.

Cancer slope factors for vinyl chloride are available from EPA's IRIS. The slope factors used in the BHHRA for the oral, inhalation, and dermal exposure routes are and 1.50E+00, 3.08E-02 and 1.50E+00 $[mg/(kg \times day)]^{-1}$, respectively. The slope factor for the dermal exposure route was calculated by assuming a GI absorption factor of 100%.

Chronic RfDs for vinyl chloride are available from RAIS. The values used in the BHHRA for the oral, inhalation, and dermal routes were 3.00E-03, 2.86E-02, and 3.00E-03 mg/(kg × day), respectively. The dermal RfD was derived using a GI absorption factor of 100%.

F.4.3 RADIONUCLIDES

Radionuclides are unstable atoms of chemical elements that will emit charged particles or energy or both to achieve a more stable state. These charged particles are termed "alpha and beta radiation"; energy is termed "neutral gamma rays." Interaction of these charged particles (and gamma rays) with matter will produce ionization events, or radiation, which may cause living cell tissue damage. Because the deposition of energy by ionizing radiation is a random process, sufficient energy may be deposited (in a critical volume) within a cell and result in cell modification or death. In addition, ionizing radiation has sufficient energy that interactions with matter will produce an ejected electron and a positively charged ion (known as free radicals) that are highly reactive and may combine with other elements, or compounds within a cell, to produce toxins or otherwise disrupt the overall chemical balance of the cell. These free radicals also can react with deoxyribonucleic acid (DNA), causing genetic damage, cancer induction, or even cell death.

Radionuclides are characterized by the type and energy level of the radiation emitted. Radiation emissions fall into two major categories: particulate (electrons, alpha particles, beta particles, and protons) or electromagnetic radiation (gamma and x-rays). Therefore, all radionuclides are classified by the EPA as Group A carcinogens based on their property of emitting ionizing radiation and on the extensive weight of evidence provided by epidemiological studies of humans with cancers induced by high doses of radiation. Alpha particles are emitted at a characteristic energy level for differing radionuclides. The alpha particle has a charge of +2 and a comparably large size. Alpha particles have the ability to react (and/or ionize) with other molecules, but they have very little penetrating power and lack the ability to pass through a piece of paper or human skin. However, alpha-emitting radionuclides are of concern when there is a potential for inhalation or ingestion of the radionuclide. Alpha particles are directly ionizing and deposit their energy in dense concentrations [termed high linear energy transfer (LET)], resulting in short paths of highly localized ionization reactions. The probability of cell damage increases as a result of the increase in ionization events occurring in smaller areas; this also may be the reason for increased cancer incidence caused by inhalation of radon gas. In addition, the cancer incidence in smokers may be directly attributed to the naturally occurring alpha emitter, polonium-210, in common tobacco products.

Beta emissions generally refer to beta negative particle emissions. Radionuclides with an excess of neutrons achieve stability by beta decay. Beta radiation, like alpha radiation, is directly ionizing but, unlike alpha activity, beta particles deposit their energy along a longer track length (low LET), resulting in more space between ionization events. Beta-emitting radionuclides can cause injury to the skin and superficial body tissue, but are most destructive when inhaled or ingested. Many beta emitters are similar chemically to naturally occurring essential nutrients and will, therefore, tend to accumulate in certain specific tissues. For example, strontium-90 is chemically similar to calcium and, as a result, accumulates in the bones, where it causes continuous exposure. The health effects of beta particle emissions depend upon the target organ. Those seeking the bones would cause a prolonged exposure to the bone marrow and affect blood cell formation, possibly resulting in leukemia, other blood disorders, or bone cancers. Those seeking the liver would result in liver diseases or cancer, while those seeking the thyroid would cause thyroid and metabolic disorders. In addition, beta radiation may lead to damage of genetic material (DNA), causing hereditary defects.

Gamma emissions are the energy that has been released from transformations of the atomic nucleus. Gamma emitters and x-rays behave similarly, but differ in their origin: gamma emissions originate in nuclear transformations, and x-rays result from changes in the orbiting electron structure. Radionuclides that emit gamma radiation can induce internal and external effects. Gamma rays have high penetrating ability in living tissue and are capable of reaching all internal body organs. Without such sufficient shielding as lead, concrete, or steel, gamma radiation can penetrate the body from the outside and does not require ingestion or inhalation to penetrate sensitive organs. Gamma rays are characterized as low-LET radiation, as is beta radiation; however, the behavior of beta radiation differs from that of gamma radiation in that beta particles deposit most of their energy in the medium through which they pass, while gamma rays often escape the medium because of higher energies, thereby creating difficulties in determining actual internal exposure. For this reason, direct whole-body measurements are necessary to detect gamma radiation, while urine/fecal analyses are usually effective in detecting beta radiation.

People receive gamma radiation continuously from naturally occurring radioactive decay processes going on in the earth's surface, from radiation naturally occurring inside their bodies, from the atmosphere as fallout from nuclear testing or explosions, and from space or cosmic sources. Cesium-137 (from nuclear fallout) decays to barium-137, the highest contributor to fallout-induced gamma radiation. Beta radiation from the soil is a less penetrating form of radiation, but has many contributing sources. Potassium-40, ^{137}Cs, lead-214, and bismuth-214 are among the most common environmental beta emitters. Tritium is also a beta emitter but contributes little to the soil beta radiation because of the low energy of its emission and its low concentration in the atmosphere. Alpha radiation also is emitted by the soil, but is not measurable more than a few centimeters from the ground surface. The majority of alpha emissions are attributable to radon-222 and radon-220 and their decay products. This contributes to what is called background exposure to radiation.

The general health effects of radiation can be divided into stochastic (related to dose) and nonstochastic (not related to dose) effects. The risk of development of cancer from exposure to radiation is a stochastic effect. Examples of nonstochastic effects include acute radiation syndrome and cataract formation, which occur only at high levels of exposures.

Radiation can damage cells in different ways. It can cause damage to DNA within the cell, and the cell either may not be able to recover from this type of damage or may survive but function abnormally. If an abnormally functioning cell divides and reproduces, a tumor or mutation in the tissue may develop. The rapidly dividing cells that line the intestines and stomach and the blood cells in bone marrow are extremely sensitive to this damage. Organ damage results from the damage caused to the individual cells. This type of damage has been reported with doses of 10 to 500 rads (0.1 to 5.0 gray, in SI units). Acute radiation sickness is seen only after doses of >50 rads (0.5 gray), which is a dose rate usually achieved only in a nuclear accident.

When the radiation-damaged cells are reproductive cells, genetic damage can occur in the offspring of the person exposed. The developing fetus is especially sensitive to radiation. The type of malformation that may occur is related to the stage of fetal development and the cells that are differentiating at the time of exposure. Radiation damage to children exposed in the womb is related to the dose the pregnant mother receives. Mental retardation is a possible effect of fetal radiation exposure.

The most widely studied population that has had known exposure to radiation is the atomic bomb survivors of Hiroshima and Nagasaki, Japan. Data indicate an increase in the rate of leukemia and cancers in this population. However, the rate at which cancer incidence is significantly affected by low radiation exposures, such as results of exposure to natural background and industrially contaminated sites, is still undergoing study and is uncertain. In studies conducted to determine the rate of cancer and leukemia increase, as well as genetic defects, several radionuclides must be considered.

F.4.3.1 Americium-241 (CAS 014596-10-2) (EPA)

Americium is a man-made metal produced when plutonium atoms absorb neutrons in nuclear reactors and in nuclear weapons detonations. Americium has several different isotopes, all of which are radioactive. The most important isotope is ^{241}Am. Americium is a silver-white, crystalline metal that is solid under normal conditions. All isotopes of americium are radioactive. Americium-241 primarily emits alpha particles, but also emits gamma rays. A mixture of ^{241}Am and beryllium emits neutrons. Americium-241 has a half-life of 432.7 years.

People may be directly exposed to gamma radiation from ^{241}Am by walking on contaminated land. They may also be exposed to both alpha and gamma radiation by breathing in americium contaminated dust, or drinking contaminated water. Because ^{241}Am was widely dispersed globally during the testing of nuclear weapons, only very minute amounts of it are found in the soil, plants, and water. Living near a weapons testing or production facility may increase your chance of exposure to ^{241}Am. People who live or work near a contaminated site, such as a former weapons production facility, may ingest ^{241}Am with food and water, or may inhale it as part of resuspended dust.

Once in the body, ^{241}Am tends to concentrate in the bone, liver, and muscle. It can stay in the body for decades and continue to expose the surrounding tissues to radiation, and increase your risk of developing cancer.

When inhaled, some ^{241}Am remains in the lungs, depending upon the particle size and the chemical form of the americium compound. The chemical forms that dissolve easily may pass into the bloodstream from the lungs. The chemical forms that dissolve less easily tend to remain in the lungs, or are coughed up through the lung's natural defense system, and swallowed. From the stomach swallowed americium may dissolve and pass into the bloodstream. However, undissolved material passes from the body through the feces. Americium-241 poses a significant risk if ingested (swallowed) or inhaled. It can stay in the body for decades and continue to expose the surrounding tissues to both alpha and gamma radiation, increasing the risk of developing cancer.

Oral, inhalation and external exposure cancer slope factors used in the BHHRA ^{241}Am are 9.10E-11 risk/pCi, 2.81E-08 risk/pCi and 2.76E-08 risk/yr per pCi/g soil, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA. Oral and inhalation RfDs are available in EPA's IRIS.

F.4.3.2 Cesium-137 (EPA)

Radioactive ^{137}Cs is produced when uranium and plutonium absorb neutrons and undergo fission. Examples of the uses of this process are nuclear reactors and nuclear weapons. The splitting of uranium and plutonium in fission creates numerous fission products. Cesium-137 is one of the more well-known fission products. Cesium, as well as ^{137}Cs, is a soft, malleable, silvery white metal. Cesium is one of only three metals that is a liquid near room temperature (83 °F). The half-life of ^{137}Cs is 30 years

People may also be exposed from contaminated sites: Walking on ^{137}Ce contaminated soil could result in external exposure to gamma radiation. Leaving the contaminated area would prevent additional exposure. Coming in contact with waste materials at contaminated sites could also result in external exposure to gamma radiation. Leaving the area would also end the exposure. If ^{137}Ce contaminated soil becomes air-borne as dust, breathing the dust would result in internal exposure. Because the radiation emitting material is then in the body, leaving the site would not end the exposure. Drinking ^{137}Ce contaminated water, also would place the ^{137}Ce inside the body, where it would expose living tissue to gamma and beta radiation.

People may ingest ^{137}Cs with food and water, or may inhale it as dust. If ^{137}Cs enters the body, it is distributed fairly uniformly throughout the body's soft tissues, resulting in exposure of those tissues. Slightly higher concentrations of the metal are found in muscle, while slightly lower concentrations are found in bone and fat. Compared to some other radionuclides, ^{137}Cs remains in the body for a relatively short time. It is eliminated through the urine. Exposure to ^{137}Cs may also be external (that is, exposure to its gamma radiation from outside the body).

Like all radionuclides, exposure to radiation from ^{137}Cs results in increased risk of cancer. Everyone is exposed to very small amounts of ^{137}Cs in soil and water as a result of atmospheric fallout. Exposure to waste materials, from contaminated sites, or from nuclear accidents can result in cancer risks much higher than typical environmental exposures.

If exposures are very high, serious burns, and even death, can result. Instances of such exposure are very rare. One example of a high-exposure situation would be the mishandling a strong industrial ^{137}Cs source. The magnitude of the health risk depends on exposure conditions. These include such factors as strength of the source, length of exposure, distance from the source, and whether there was shielding between you and the source (such as metal plating).

Oral, inhalation and external exposure cancer slope factors used in the BHHRA for ^{137}Cs are 5.85E-14 risk/pCi, 4.11E-14 risk/pCi and risk/yr per pCi/g soil, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA. Oral and inhalation RfDs are available in EPA's IRIS.

F.4.3.3 Neptunium-237 (CAS 013994-20-2)

Specific literary information for ^{237}Np is limited. However, available literature states that during neutron bombardment, ^{237}Np breaks down to ^{238}Pu , which produces small masses of high capacity energy that is useful for satellites and spacecraft (Moskalev et al. 1979).

The most common route of ^{237}Np exposure is inhalation of aerosols. According to studies conducted on rats, acute effects include injury to the liver and kidney and circulation disorders. Long-term effects include osteosarcomas and lung cancer. Extremely high doses cause immediate or premature death by destruction of the lungs (Moskalev et al. 1979).

Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{237}Np are 6.74E-11 risk/pCi, 1.77E-08 risk/pCi, and 7.97E-07 [(risk × g)/(pCi × yr)], respectively. The slope factors for ^{237}Np include ingrowth of short-lived degradation products. A dermal cancer slope factor was not calculated because this route of exposure is not considered significant for radionuclides and is not evaluated in the BHHRA. Oral, dermal, and inhalation RfDs are not available for this element; therefore, systemic toxicity due to exposure to ^{237}Np is not quantified in the BHHRA.

F.4.3.4 Plutonium-239 (CAS 015117-48-3) (EPA)

Plutonium is created from uranium in nuclear reactors. When ^{238}U absorbs a neutron, it becomes ^{239}U which ultimately decays to ^{239}Pu. Different isotopes of uranium and different combinations of neutron absorptions and radioactive decay, create different isotopes of plutonium.

Plutonium is a silvery-grey metal that becomes yellowish when exposed to air. It is solid under normal conditions, and is chemically reactive. Plutonium has at least 15 different isotopes, all of which are radioactive. The most common ones are ^{238}Pu, ^{239}Pu, and ^{240}Pu. Plutonium-238 has a half-life of 87.7 years. Plutonium-239 has a half-life of 24,100, and ^{240}Pu has a half-life 6,560 years. The isotope ^{238}Pu gives off useable heat, because of its radioactivity.

Plutonium-239 is used to make nuclear weapons. For example, the bomb dropped on Nagasaki, Japan, in 1945, contained ^{239}Pu. The plutonium in the bomb undergoes fission in an arrangement that assures enormous energy generation and destructive potential.

All isotopes of plutonium undergo radioactive decay. As plutonium decays, it releases radiation and forms other radioactive isotopes. For example, ^{238}Pu emits an alpha particle and becomes ^{234}U; ^{239}Pu emits an alpha particle and becomes ^{235}U. This process happens slowly since the half-lives of plutonium isotopes tend to be relatively long; ^{238}Pu has a half-life of 87.7 years; ^{239}Pu has a half-life is 24,100 years, and ^{240}Pu has a half-life of 6,560 years. The decay process continues until a stable, non-radioactive element is formed.

People who live near nuclear weapons production or testing sites may have increased exposure to plutonium, primarily through particles in the air, but possibly from water as well. Plants growing in contaminated soil can absorb small amounts of plutonium.

People may inhale plutonium as a contaminant in dust. It also can be ingested with food or water. Most people have extremely low ingestion and inhalation of plutonium. However, people who live near government weapons production or testing facilities may have increased exposure. Plutonium exposure external to the body poses very little health risk.

The stomach does not absorb plutonium very well, and most plutonium swallowed with food or water passes from the body through the feces. When inhaled, plutonium can remain in the lungs depending upon its particle size and how well the particular chemical form dissolves. The chemical forms that dissolve less easily may lodge in the lungs or move out with phlegm, and either be swallowed or spit out. But, the lungs may absorb chemical forms that dissolve more easily and pass them into the bloodstream.

Once in the bloodstream, plutonium moves throughout the body and into the bones, liver, or other body organs. Plutonium that reaches body organs generally stays in the body for decades and continues to expose the surrounding tissue to radiation.

External exposure to plutonium poses very little health risk, since plutonium isotopes emit alpha radiation, and almost no beta or gamma radiation. In contrast, internal exposure to plutonium is an extremely serious health hazard. It generally stays in the body for decades, exposing organs and tissues to radiation, and increasing the risk of cancer. Plutonium is also a toxic metal, and may cause damage to the kidneys.

Oral, inhalation and external exposure cancer slope factors used in the BHHRA for ^{239}Pu are 3.33E-08 risk/pCi , 1.21E-10 risk/pCi and 2.00E-10 risk/yr per pCi/g soil, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA.

F.4.3.5 Radium-226 (CAS 013982-63-3) (EPA)

Radium forms when isotopes of uranium or thorium decay in the environment. Most radium (^{226}Ra) originates from the decay of the plentiful ^{238}U. In the natural environment, radium occurs at very low levels in virtually all rock, soil, water, plants, and animals. When uranium (or thorium) occurs in high levels in rock, radium often is found in high levels.

Radium is a naturally radioactive, silvery-white metal when freshly cut. It blackens on exposure to air. The various isotopes of radium originate from the radioactive decay of uranium or thorium. Radium-226 is found in the ^{238}U decay series, and ^{228}Ra and ^{224}Ra are found in the Thorium-232 (^{232}Th) decay series.

Radium-226, the most common isotope, is an alpha emitter, with accompanying gamma radiation, and has a half-life of about 1600 years. ^{228}Ra, is principally a beta emitter and has a half-life of 5.76 years. Radium-224, an alpha emitter, has a half life of 3.66 days. Radium decays to form isotopes of the radioactive gas radon, which is not chemically reactive. Stable lead is the final product of this lengthy radioactive decay series.

Radium is a radiation source in some industrial radiography devices, a technology similar to x-ray imaging used in industry to inspect for flaws in metal parts. When radium is mixed with beryllium it becomes a good source of neutrons, useful in well logging devices and research. Radium also has been added to the tips of lightening rods, improving their effectiveness by ionizing the air around it.

Radium occurs naturally in the environment. As a decay product of uranium and thorium, it is common in virtually all rock, soil, and water. Usually concentrations are very low. However, geologic processes can form concentrations of naturally radioactive elements, especially uranium and radium. Radium and its salts are soluble in water. As a result, groundwater in areas where concentrations of radium are high in surrounding bedrock typically has relatively high radium content.

People can also be exposed to radium if it is released into the air from the burning of coal or other fuels. Certain occupations can also lead to high exposures to radium, such as working in a uranium mine or in a plant that processes ores. Phosphate rocks typically contain relatively high levels of both uranium and radium and can be a potential source of exposure in areas where phosphate is mined.

People may swallow radium with food and water, or may inhale it as part of dust in the air. Radium can also be produced in the body from "parent" radionuclides (uranium and thorium) that have been inhaled or swallowed, but this is not a significant source.

Most radium that is swallowed (about 80%) promptly leaves the body through the feces. The other 20% enters the bloodstream and accumulates preferentially in the bones. Some of this radium is excreted through the feces and urine over a long time; however, a portion will remain in the bones throughout the person's lifetime.

Radium emits several different kinds of radiation, in particular, alpha particles and gamma rays. Alpha particles are generally only harmful if emitted inside the body. However, both internal and external exposure to gamma radiation is harmful. Gamma rays can penetrate the body, so gamma emitters like radium can result in exposures even when the source is a distance away.

Long-term exposure to radium increases the risk of developing several diseases. Inhaled or ingested radium increases the risk of developing such diseases as lymphoma, bone cancer, and diseases that affect the formation of blood, such as leukemia and aplastic anemia. These effects usually take years to develop. External exposure to radium's gamma radiation increases the risk of cancer to varying degrees in all tissues and organs.

Oral, inhalation and external exposure cancer slope factors used in the BHHRA for ^{226}Ra are 1.15E-08 risk/pCi , 2.95E-10 risk/pCi and 2.29E-08 risk/yr per pCi/g soil, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA.

F.4.3.6 Technetium-99 (CAS 014133-76-7) (EPA)

Technetium is a radioactive element that occurs in a number of isotopic forms. Technetium is found in some extraterrestrial material (i.e., stars); however, no appreciable amounts have been found in nature due to the relatively short half-lives of its radioactive isotopes (Kutegov et al. 1968). While no isotopes of technetium are stable, the existence of three technetium isotopes is well established. Two common forms of technetium, ^{97}Tc and ^{98}Tc, have half-lives of 2.6×10^6 and 1.5×10^6 years, respectively. The third isotope, ^{99}Tc, has a half-life of 2.12×10^5 years. None, however, possesses a half-life sufficiently long to allow technetium to occur naturally (Boyd 1959). Technetium is made artificially for industrial use, and natural technetium, particularly ^{99}Tc, has been identified and isolated from the spontaneous fission of uranium, as well as other fissionable material or via the irradiation of molybdenum (Venugopal and Luckey 1978; Clarke and Podbielski 1988).

Technetium is an emitter of beta particles of low specific activity (Boyd 1959). It does not release nuclear energy at a rate sufficient to make the element attractive for the conventional applications of radioactivity (Boyd 1959). ^{99}Tc is the only long-lived isotope that is readily available and is the isotope on which most of the chemistry of technetium is based. Although gamma radiation has not been associated with ^{99}Tc, the secondary X rays may become important with larger amounts of the element.

Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{99}Tc are 2.75E-12 risk/pCi, 1.41E-11 risk/pCi, and 8.14E-11 ([risk × g]/[pCi × yr]), respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA. Oral, dermal, and inhalation RfDs are not available for this element; therefore, systemic toxicity due to exposure to ^{99}Tc is not quantified in the BHHRA.

F.4.3.7 Thorium (CAS 014274-82-9 for Thorium-228, CAS 014269-63-7 for Thorium-230, and CAS 007440-29-1 for Thorium-232, EPA and ATSDR)

Thorium is a soft, silvery white metal. Pure thorium will remain shiny for months in air, but if it contains impurities, it tarnishes to black when exposed to air. When heated, thorium oxide glows bright white, a property that makes it useful in lantern mantles. It dissolves slowly in water. Thorium-232 has a half-life of 14 billion ($14x10^9$) years, and decays by alpha emission, with accompanying gamma radiation. Thorium-232 is the top of a long decay series that contains key radionuclides such as ^{228}Ra, its direct decay product, and ^{220}Rn. Two other isotopes of thorium, which can be significant in the environment, are ^{230}Th and thorium-228 (^{228}Th). Both belong to other decay series. They also decay by alpha emission, with accompanying gamma radiation, and have half-lives of 75,400 years and 1.9 years, respectively. Only a small portion of naturally occurring thorium exists as ^{230}Th. More than 99% of natural thorium exists in the form of ^{232}Th. Thorium-230 breaks down into two parts-a small part called "alpha" radiation and a large part called the decay product. The decay product also is not stable and continues to break down through a series of decay products until a stable product is formed. During these decay processes, radioactive substances are produced. These include radium and radon. These substances give off radiation, including alpha and beta particles, and gamma radiation. The half-life for ^{230}Th is 75,400 years.

Small amounts of thorium are present in all rocks, soil, water, plants, and animals. Soil contains an average of about 6 parts of thorium per million parts of soil (6 ppm). Where high concentrations occur in rock, thorium may be mined and refined, producing waste products such as mill tailings. If not properly controlled, wind and water can introduce the tailings into the wider environment. Commercial and federal facilities that have processed thorium also may have released thorium to the air, water, or soil. Man-made thorium isotopes are rare and almost never enter the environment.

Since thorium is naturally present in the environment, people are exposed to tiny amounts in air, food, and water. The amounts usually are very small and pose little health hazard. Thorium is also present in many consumer products such as ceramic glazes, lantern mantles, and welding rods. People who live near a facility that mines or mills thorium or manufactures products with thorium may receive higher exposures. Also, people who work with thorium in various industries may receive higher exposures.

People may inhale contaminated dust, or swallow thorium with food or water. Living near a thorium-contaminated site or working in an industry where thorium is used increases the chance of exposure to thorium.

If inhaled as dust, some thorium may remain in the lungs for long periods of time, depending on the chemical form. If ingested, thorium typically leaves the body through feces and urine within several days. The small amount of thorium left in the body will enter the bloodstream and be deposited in the bones where it may remain for many years. There is some evidence that the body may absorb thorium through the skin, but that would not likely be the primary means of entry.

The principal concern from low to moderate level exposure to ionizing radiation is increased risk of cancer. Studies have shown that inhaling thorium dust causes an increased risk of developing lung cancer and cancer of the pancreas. Bone cancer risk also is increased because thorium may be stored in bone.

Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{228}Th are 1.32E-07 risk/pCi , 6.40E-11 risk/pCi and 7.76E-06 risk/yr per pCi/g soil, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA. Oral and inhalation RfDs are available in EPA's IRIS. Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{230}Th are 9.10E-11 risk/pCi, 2.85E-08 risk/pCi, and 8.19E-10 (risk × g)/(pCi × yr), respectively. A dermal cancer slope factor was not calculated because this route of exposure is not considered significant for radionuclides and is not evaluated in the BHHRA. Oral, dermal, and inhalation RfDs are not available for this element; therefore, systemic toxicity due to exposure to americium is not quantified in the BHHRA. Oral and inhalation exposure cancer slope factors used in the BHHRA for ^{232}Th are 8.47E-11 risk/pCi and 4.33E-08 risk/pCi, respectively. A dermal cancer slope factor was not calculated because this route of exposure is not evaluated in the BHHRA.

F.4.3.8 Uranium (CAS 007440-62-2 for metal, CAS 013966-29-5 for Uranium-234, CAS 015117-96-1 for Uranium-235, and CAS 007440-61-1 for Uranium-238) (ATSDR)

Uranium is a mildly radioactive element that occurs widely in the earth's crust. It is found in all soils, most rocks, and, in lesser concentrations, in water, vegetation, and animals, including humans. Uranium emits a low level of alpha particles and a much lower level of gamma rays. Alpha particles are unable to penetrate skin, but can travel short distances in the body if ingested or inhaled. Consequently, uranium represents a significant carcinogenic hazard only when taken into the body, where alpha particle energy is absorbed by small volumes of tissue. Although the penetrating (gamma) radiation of uranium is not considered to be significant (ATSDR 1989), one of its daughter radionuclides is a strong gamma emitter; therefore, gamma radiation may be a concern in areas containing uranium.

Natural uranium contains the uranium isotopes ^{238}U (which averages 99.27% of total uranium mass), ^{235}U (0.725), and ^{234}U (0.0056%), each of which undergoes radioactive decay. Natural uranium, therefore, contains the radionuclide daughter products from the decay of ^{238}U and ^{235}U (Bowen 1979; ATSDR 1989). The half-lives of the isotopes are 200,000, 700 million, and 5 billion years for ^{234}U, ^{235}U, and ^{238}U, respectively.

Uranium is a radioactive element, but it also is a metallic element. Toxicological effects from the ingestion of uranium are the result of the action of uranium as a metal and its radioactive properties. The primary toxic chemical effect of uranium is seen in kidney damage. Studies in rabbits, mice, and dogs showed effects on the kidney to be dose-related. Fetal skeletal abnormalities and fetal death were found in pregnant mice exposed to 6 mg/kg or uranyl acetate dihydrate.

The primary human exposure studies to uranium have been studies of uranium miners or uranium factory workers. These studies have shown an increase in lung cancer deaths among these workers, which may be attributable to the decay of uranium into radon and its daughters. These workers are exposed to high levels of uranium dust and fumes and other radioactive elements in confined conditions (ATSDR 1989).

Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{234}U are 7.00E-11 risk/pCi, 1.14E-08 risk/pCi, and 2.52E-10 ([risk × g]/[pCi × yr]), respectively. Oral, inhalation, and external exposure cancer slope factors used in the BHHRA for ^{238}U are 8.71E-11 risk/pCi, 9.25E-09 risk/pCi, and 1.14E-07 [(risk × g)/(pCi × yr)], respectively. The slope factors for ^{238}U include ingrowth of short-lived degradation products. A dermal cancer slope factor was not calculated for the uranium isotopes because this route of exposure is not considered significant for radionuclides and is not evaluated in the BHHRA. Oral, dermal, and inhalation RfDs are available for uranium and are listed earlier in this section.

F.4.4 CHEMICALS FOR WHICH NO EPA TOXICITY VALUES ARE AVAILABLE

Over all COPCs identified for RGA groundwater associated with the BGOU, oral RfD values exist for all of the inorganic chemical COPCs except silicon. Oral RfDs exist for all of the organic COPCs included.

All the inorganic chemical COPCs, except aluminum, barium, and manganese lack inhalation RfD values. Absorbed dose RfD values exist for all of the inorganic chemical COPCs included in the BHHRA. Absorbed dose RfDs exist for all organic compound COPCs included in the BHHRA except vinyl chloride.

Arsenic is the only inorganic chemical COPC with an oral slope factor. The organic compound COPCs without an oral slope factor are *cis*-1,2-DCE and *trans*-1,2-DCE.

EPA-approved inhalation slope factors are available for only a few of the COPCs. Inorganic chemical COPCs with inhalation slope factors are arsenic and chromium. Most organic compound COPCs have an approved inhalation slope factor. Those without an inhalation slope factor are *cis*-1,2-DCE; *trans*-1,2-DCE.

COPCs with absorbed dose slope factors mirror those with oral slope factors. The COPCs without absorbed dose slope factors are arsenic; *cis*-1,2-DCE; *trans*-1,2-DCE. All radionuclide COPCs have oral, inhalation, and external exposure slope factors.

During the screening, a number of chemicals were identified as not having a NAL. These chemicals also had no toxicity values for any routes of exposure and therefore are addressed in the uncertainty section. These chemicals are 3-methylcholanthrene, 4-methylphenol, benzo(g,h,i)perylene, 3-nitorbenzeneaniline, acenaphthene, phenanthrene, and thallium. These analytes are discussed further in the uncertainty section.

F.4.5 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

Standard EPA RfDs and slope factors were used to estimate potential noncarcinogenic and carcinogenic health effects from exposure to detected chemical contaminants. Considerable uncertainty is associated with the methodology applied to derive slope factors and RfDs. EPA working groups review all relevant human and animal studies for each compound and select the studies pertinent to the derivation of the specific RfD and slope factor. These studies often involve data from experimental studies in animals, high exposure levels, and exposures under acute or occupational conditions. Extrapolation of these data to humans under low-dose, chronic conditions introduces uncertainties. The magnitude of these uncertainties is addressed by applying uncertainty factors to the dose response data for each applicable uncertainty. These factors are incorporated to provide a margin of safety for use in human health assessments. For TCE, there is currently no IRIS slope factor, but several draft slope factors are available. The oral slope factor from the EPA draft reassessment is 4.00E-01 $(mg/kg \times day)^{-1}$ and the KDEP oral slope factor is 3.22E-01 $(mg/kg \times day)^{-1}$ These slope factors are significantly higher than the ones used in previous BHHRAs for PGDP. The KDEP oral slope factor was used in this BHHRA, but neither that value nor the EPA one has received final approval.

The dose-response relationship between cancer and ionizing radiation has been evaluated in many reports. Risk factors are extrapolated from the cancer risk established using the Japanese Atomic Bomb Survivors database and a relative risk projection model. EPA's methodology for estimating radionuclide carcinogenic risks currently is being reevaluated.

F.4.6 SUMMARY OF TOXICITY ASSESSMENT

A breakdown of the COPCs and their available toxicity information by SWMU is provided in the following subsections.

F.4.6.1 SWMU 2 COPC Toxicity Summary

SWMU 2 soil samples contain 19 COPCs. Eight are inorganic chemicals, all of which have toxicity information; three (2-methylnaphthalene, Total PAH and Total PCBs) are organic compounds, for which the individual components all have toxicity information; and eight are radionuclides, all of which have toxicity information.

F.4.6.2 SWMU 3 COPC Toxicity Summary

SWMU 3 soil samples contain five COPCs. Two are inorganic chemicals, both of which have toxicity information; and three are radionuclides, all of which have toxicity information.

F.4.6.3 SWMU 4 COPC Toxicity Summary

SWMU 4 soil samples contain 19 COPCs. Nine are inorganic chemicals, all of which have toxicity information; two (Total PAH and Total PCBs) are organic compounds, for which the individual components all have toxicity information; and eight are radionuclides, all of which have toxicity information.

F.4.6.4 SWMU 5 COPC Toxicity Summary

SWMU 5 soil samples contain 14 COPCs. Five are inorganic chemicals, all of which have toxicity information; eight are organic compounds, all of which have toxicity information; and one is a radionuclide, which has toxicity information.

F.4.6.5 SWMU 6 COPC Toxicity Summary

SWMU 6 soil samples contain seven COPCs. Three are inorganic chemicals, all of which have toxicity information; two (Total PAH and Total PCBs) are organic compounds, for which the individual components all have toxicity information; and two are radionuclides, both of which have toxicity information.

F.4.6.6 SWMU 7 COPC Toxicity Summary

SWMU 7 soil samples contain 22 COPCs. Eleven are inorganic chemicals, all of which have toxicity information; two (Total PAH and PCBs) are organic compounds, for which the individual components all have toxicity information; and nine are radionuclides, all of which have toxicity information.

F.4.6.7 SWMU 30 COPC Toxicity Summary

SWMU 30 soil samples contain 21 COPCs. Twelve are inorganic chemicals, all of which have toxicity information; two (Total PAH and PCBs) are organic compounds, for which the individual components all have toxicity information; and seven are radionuclides, all of which have toxicity information.

F.4.6.8 SWMU 145 COPC Toxicity Summary

SWMU 145 subsurface soil samples contain 14 COPCs. Six are inorganic chemicals, all of which have toxicity information; two (Total PAH and PCBs) are organic compounds, for which the individual components all have toxicity information; and six are radionuclides, all of which have toxicity information.

F.5. RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process. In this step, the information from the exposure and toxicity assessments is integrated to quantitatively estimate both carcinogenic health risks and noncarcinogenic hazard potential. For this assessment, risk is defined as both the lifetime probability of excess cancer incidence for carcinogens and the estimate of daily intake exceeding intake that may lead to toxic effects for noncarcinogens.

F.5.1 DETERMINATION OF POTENTIAL FOR NONCANCER EFFECTS

In this BHHRA, the numeric estimate of the potential for noncancer effects posed by a single chemical within one pathway of exposure is derived as the ratio of the CDI of a chemical, from a single pathway to the appropriate RfD. This ratio also is referred to as a HQ. This value is calculated as shown in the following equation:

$$\mathbf{HQ = \frac{CDI}{RfD}}$$

where:

HQ is the hazard quotient, dimensionless
CDI is the chronic daily intake of a particular chemical, mg/(kg × day)
RfD is the chronic reference dose for a particular chemical and pathway, mg/(kg × day)

When performing this calculation, the proper RfD was used for each CDI. For CDIs that reflect ingestion, the RfD used was that for administered dose. For CDIs that reflect absorption, as in dermal contact, the RfD used was that for absorbed dose. Finally, for CDIs that reflect inhalation exposure, the RfD used was that for inhalation. Similarly, the RfD that was appropriate for the duration of exposure was used. For all adult exposures, the period of exposure was greater than 7 years; therefore, the chronic RfD was used. For all exposures to children, regardless of duration, the chronic RfD was used (Risk Methods Document).

If several chemicals may reach a receptor through a common pathway, guidance (RAGS, Risk Methods Document) recommends adding the HQs of all chemicals reaching the receptor through the common pathway to calculate a pathway HI. This can be represented by the following equation:

$$\text{Pathway HI} = HQ_1 + HQ_2 + HQ_3 + ... + HQ_n$$

where:

Pathway HI is the sum of the individual chemical HQs, dimensionless
HQ_1 to HQ_n are the individual chemical hazard quotients relevant to the pathway, dimensionless

Similarly, guidance (Risk Methods Document) recommends summing the pathway HIs for all pathways relevant to an individual receptor to develop a total HI. The total HI is not an estimate of the systemic toxicity posed by all contaminants that may reach the receptor, but can be used to estimate if a toxic effect may result if all contaminants reaching the receptor have additive effects over all pathways. This can be represented as in the following equation:

$$\text{Total HI} = HI_1 + HI_2 + HI_3 + ... + HI_n$$

where:

Total HI is the sum of all pathways relevant to a single receptor, dimensionless
HI_1 to HI_n are the individual pathway HIs

Note that the HQ, the pathway HI, and the total HI do not define a dose-response relationship. That is, the magnitude of the HQ or HI does not represent a statistical probability of incurring an adverse effect. If the HQ is less than 1, the estimated exposure to a substance may be judged to be below a level that could present a toxic effect. If the HQ is greater than 1, a toxic effect may or may not result depending on the assumptions used to develop the CDI and assumptions used in deriving the RfD. Similarly, if the pathway HI is less than 1, then the estimated exposure to multiple chemicals contributing to the pathway HI should not be expected to present a toxic effect. If the pathway HI is greater than 1, then exposure may or may not result in a toxic effect depending on what assumptions were used to develop the pathway and how the chemicals included in the pathway interact. Finally, if the total HI is less than 1, then the estimated exposure to multiple chemicals over multiple pathways should not be expected to result in a toxic effect. If the total HI is greater than 1, then a toxic effect may or may not result depending on the rigor used to develop the CSM for all pathways and the interaction between pathways and individual chemicals.

F.5.2 DETERMINATION OF EXCESS LIFETIME CANCER RISK

Estimates of the potential for cancer induction are measured by calculating estimates of ELCR. Generally, ELCR can be defined as the incremental increase in the probability that a receptor may develop cancer if the receptor is exposed to chemicals or radionuclides or both. ELCRs are specific to the CSM used to define the routes and magnitude of exposure. The magnitude of the ELCRs could vary markedly if the exposure assumptions used to develop the CSM are varied.

F.5.2.1.1 Chemical Excess Cancer Risk

The numeric estimate of the ELCR resulting from exposure to a single chemical carcinogen is derived by multiplying the CDI through a particular pathway by the slope factor appropriate to that pathway. The resulting value is referred to as a chemical-specific ELCR. This value is calculated as shown in the following equation:

$$\textbf{Chemical} - \textbf{specific ELCR} = \textbf{CDI} \times \textbf{SF}$$

where:

Chemical specific ELCR is an estimate of the excess lifetime probability of developing cancer that results because of exposure to the specific chemical, dimensionless
CDI is the chronic daily intake of the chemical [mg/(kg × day)]
SF is the slope factor for the specific chemical $[(mg/(kg \times day)]^{-1}$

As with the calculation used to derive HQs, the proper slope factor was used for each CDI when performing this calculation. For CDIs that reflect ingestion, the slope factor was that for an administered dose. For CDIs that reflect absorption, the slope factor was that for absorbed dose. Finally, for CDIs that reflect inhalation exposure, the slope factor was that for inhalation.

If several chemicals may reach a receptor through a common pathway, the chemical specific ELCRs of all chemicals reaching the receptor through the common pathway are summed to calculate a pathway ELCR. This can be represented by the following equation:

$$\textbf{Pathway ELCR} = \textbf{ELCR}_1 + \textbf{ELCR}_2 + \textbf{ELCR}_3 + \ldots + \textbf{ELCR}_n$$

where:

Pathway ELCR is the sum of the chemical-specific ELCRs, dimensionless
$ELCR_1$ to $ELCR_n$ are the chemical-specific ELCRs relevant to the pathway; dimensionless

Similarly, the pathway ELCRs for all pathways relevant to an individual receptor are summed to develop a total ELCR. The total ELCR is not an actuarial estimate of an individual developing cancer, but can be used to estimate the total ELCR that may result if all contaminants reaching the receptor have additive effects over all pathways. This can be represented as in the following equation:

$$\textbf{Total ELCR} = \textbf{ELCR}_{\textbf{P1}} + \textbf{ELCR}_{\textbf{P2}} + \textbf{ELCR}_{\textbf{P3}} + \textbf{...} + \textbf{ELCR}_{\textbf{Pn}}$$

where:

Total ELCR is the sum of all pathways relevant to a single receptor, dimensionless
$ELCR_{P1}$ to $ELCR_{P2}$ is the individual pathway ELCRs

Unlike the HQ, the pathway HI, and the total HI; the chemical-specific ELCR, the pathway ELCR, and total ELCR define a dose-response relationship. That is, the ELCRs represent a statistical probability of the increased risk of developing cancer that exists in receptors exposed under the assumptions used in the calculation of the CDI.

F.5.2.1.2 Radionuclide Excess Cancer Risk

Calculation of cancer risk due to exposure to radionuclides through ingestion or inhalation is conceptually similar to calculation of risks for chemical carcinogens. In performing this calculation, ELCR due to exposure to a particular radionuclide within a specific pathway is calculated by multiplying the intake of the radionuclide by the route-specific cancer slope factor. This can be represented by the following equation:

$$\textbf{Radionuclide} - \textbf{specific ELCR} = \textbf{CDI} \times \textbf{SF}$$

where:

Radionuclide specific ELCR is an estimate of the excess lifetime probability of developing cancer that results because of exposure to the specific radionuclide, dimensionless
CDI is the ingestion and inhalation chronic daily intake of the radionuclide, pCi
SF is the ingestion and inhalation slope factor for the specific radionuclide, risk/pCi
(Note: For external exposure, the units for CDI and SF are pCi-year/g and risk-g/pCi-year, respectively.)

As with the calculation used to derive chemical-specific ELCRs, the proper slope factor was used for each CDI when performing this calculation. For CDIs that reflect ingestion, the slope factor was that for ingestion. Similarly, for CDIs that reflect inhalation exposure, the slope factor was that for inhalation.

Both the pathway ELCR for radionuclides and the total ELCR from exposure to multiple radionuclides within a pathway and over multiple pathways, respectively, are calculated as illustrated for chemical carcinogens in Subsection F.5.2.1. These equations will not be presented in this risk assessment. The uncertainties related to this method of determining ELCR from exposure to radionuclides is discussed in detail in Section F.6.

In this risk assessment, ELCRs from exposure to chemicals and radionuclides were summed within pathways and over all pathways to indicate the potential health risk to a receptor that may be exposed to radionuclides and chemicals over all pathways. The uncertainties associated with combining radionuclide and chemical ELCRs are discussed in detail in Section F.6.

F.5.3 RISK CHARACTERIZATION FOR SOIL

This subsection presents the systemic toxicity (HI) and ECLR for soil exposure at each source area. Both HI and ELCR are presented for the following receptors:

- Future excavation worker
- Future industrial worker
- Child recreational receptor
- Teen recreational receptor
- Adult recreational receptor
- Child residential receptor
- Adult residential receptor

The results of the quantitative risk assessment are presented in Tables F.155 through F.233 and include a) risks by contaminant for each pathway, b) risks by contaminant for all pathways (shown in "Total" column), c) total pathway risks for all contaminants (shown across "Total" row, and d) total risk for all contaminants across all pathways (bold value in "Total" row).[2]

F.5.3.1 Systemic Toxicity (Direct Exposure to Soil)

Tables F.155 through F.204 summarize the computed HIs for soil exposure for each receptor. Total HIs greater than 1 were observed for the following pathways by SWMU:

- *Excavation Worker:* SWMUs 2, 5, 7, and 30;
- *Industrial Worker:* SWMUs 2 and 30;
- *Child Recreational Receptor:* SWMUs 2, 5, 6, 7, and 30;
- *Teen Recreational Receptor:* SWMUs 2, 5, 6, 7, and 30;
- *Adult Recreational Receptor:* SWMUs 2, 5, 6, 7, and 30;
- *Child Residential Receptor:* 2, 3, 4, 5, 6, 7, and 30; and
- *Adult Residential Receptor:* SWMUs 2, 5, 7, and 30.

Ingestion of uranium is the primary driver of the HIs. At SWMU 3, Total Uranium, and antimony contribute equally to elevated hazards.

F.5.3.2 Excess Lifetime Cancer Risk (Direct Exposure to Soil)

Tables F.205 through F.233 summarize the computed lifetime cancer risks for soil exposure for all receptors. ELCRs greater than 1×10^{-6} were observed at all SWMUs for all receptors. ELCRs greater than 1×10^{-4} were observed for the following pathways by SWMU:

- *Excavation Worker:* SWMUs 2, 4, 5, 7, 30, and 145;
- *Industrial Worker:* SWMUs 2, 5, 7 and 30;
- *Recreational Receptor (combined for child, teen and adult):* SWMUs 2, 4, 5, 6, 7, and 30; and
- *Residential Receptor (combined for child and adult):* SWMUs 2, 4, 5, 6, 7, and 30.

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[2] All scenarios were evaluated for all SWMUs, with the exception of SWMU 145; only the excavation worker scenario was evaluated for SWMU 145.

Dermal contact with Total PAHs was a primary risk driver at SWMUs 5, 7, and 30. Ingestion of Total PAHs was a primary risk driver at SWMU 6. External exposure to ^{238}U and ^{137}Cs were the primary risk drivers at SWMUs 2, 3, and 4. Ingestion of Total PCBs was a primary risk driver at SWMU 145.

Table F.155. HI (Excavation Worker) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	5.00E-01	4.34E-03	2.13E-03		6.47E-03	0.22%
Arsenic	3.00E+01	3.48E-01	2.49E-01		5.97E-01	20.1%
Beryllium	1.80E+00	3.13E-03	3.06E-03	7.36E-05	6.26E-03	0.2%
Iron	4.20E+04	4.87E-01	3.18E-02		5.18E-01	17.4%
Thallium	4.50E+00	1.95E-01	9.57E-03		2.05E-01	6.9%
Uranium	2.80E+02	1.62E+00	1.87E-02		1.64E+00	55.2%
Total		2.66E+00	3.14E-01	7.36E-05	**2.97E+00**	**100.0%**
Percent of Total		89.4%	10.6%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.156. HI (Excavation Worker) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	1.57E+01	1.36E-01	6.68E-02		2.03E-01	64.7%
Uranium	1.89E+01	1.09E-01	1.26E-03		1.11E-01	35.3%
Total		2.46E-01	6.80E-02		**3.14E-01**	**100.0%**
Percent of Total		78.3%	21.7%			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.157. HI (Excavation Worker) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.14E+04	3.97E-02	3.89E-03	1.87E-03	4.55E-02	9.3%
Arsenic	8.92E+00	1.03E-01	7.40E-02		1.77E-01	36.2%
Barium	1.21E+02	2.10E-03	2.93E-04	1.97E-04	2.59E-03	0.5%
Beryllium	6.94E-01	1.21E-03	1.18E-03	2.84E-05	2.42E-03	0.5%
Iron	1.73E+04	2.00E-01	1.30E-02		2.13E-01	43.5%
Manganese	5.02E+02	1.25E-02	3.05E-03	8.20E-03	2.37E-02	4.8%
Vanadium	2.51E+01	1.25E-02	1.22E-02		2.47E-02	5.0%
Total		3.71E-01	1.08E-01	1.03E-02	**4.89E-01**	**100%**
Percent of Total		75.9%	22.0%	2.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.158. HI (Excavation Worker) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	8.61E+03	2.99E-02	2.93E-03	1.41E-03	3.43E-02	1.8%
Arsenic	1.22E+01	1.41E-01	1.01E-01		2.43E-01	12.7%
Uranium	2.79E+02	1.62E+00	1.86E-02		1.63E+00	85.5%
Organic Compounds						
Bis(2-ethylhexyl)phthalate	4.76E+00	8.27E-04	4.26E-04		1.25E-03	0.1%
Total		1.79E+00	1.23E-01	1.41E-03	**1.91E+00**	**100.0%**
Percent of Total		93.5%	6.4%	0.07%	100%	

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.159. HI (Excavation Worker) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Beryllium	8.18E-01	1.42E-03	1.39E-03	3.35E-05	1.44E-03	0.4%
Uranium	1.14E+02	6.60E-01	7.61E-03		6.68E-01	99.6%
Total		6.62E-01	9.00E-03	3.35E-05	**6.71E-01**	**100.0%**
Percent of Total		98.7%	1.3%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.160. HI (Excavation Worker) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	8.89E+03	3.09E-02	3.02E-03	1.45E-03	3.54E-02	2.7%
Antimony	9.84E-01	8.55E-03	4.19E-03		1.27E-02	1.0%
Arsenic	4.56E+00	5.29E-02	3.79E-02		9.08E-02	6.9%
Beryllium	4.20E-01	7.30E-04	7.15E-04	1.72E-05	1.46E-03	0.1%
Iron	1.49E+04	1.73E-01	1.13E-02		1.84E-01	14.0%
Manganese	3.92E+02	9.74E-03	2.38E-03	6.41E-03	1.85E-02	1.4%
Thallium	2.00E+00	8.69E-02	4.25E-03		9.11E-02	7.0%
Uranium	1.46E+02	8.45E-01	9.73E-03		8.54E-01	65.2%
Vanadium	2.21E+01	1.10E-02	1.07E-02		2.17E-02	1.7%
Total		1.22E+00	8.42E-02	7.88E-03	**1.31E+00**	**100.0%**
Percent of Total		93.0%	6.4%	0.6%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.161. HI (Excavation Worker) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.29E+04	4.49E-02	4.40E-03	2.11E-03	5.14E-02	0.6%
Antimony	3.00E+00	2.61E-02	1.28E-02		3.88E-02	0.4%
Arsenic	5.28E+00	6.12E-02	4.38E-02		1.05E-01	1.2%
Iron	1.93E+04	2.24E-01	1.46E-02		2.39E-01	2.7%
Manganese	5.11E+02	1.27E-02	3.10E-03	8.34E-03	2.41E-02	0.3%
Nickel	4.35E+02	7.55E-02	2.74E-03		7.83E-02	0.9%
Thallium	1.80E+00	7.82E-02	3.83E-03		8.20E-02	0.9%
Uranium	1.40E+03	8.11E+00	9.34E-02		8.20E+00	92.7%
Vanadium	2.68E+01	1.33E-02	1.30E-02		2.63E-02	0.3%
Total		8.65E+00	1.92E-01	1.05E-02	**8.85E+00**	**100.0%**
Percent of Total		97.7%	2.2%	0.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.162. HI (Excavation Worker) SWMU 145

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.27E+04	4.41E-02	4.32E-03	2.07E-03	5.05E-02	6.1%
Antimony	1.81E+01	1.57E-01	7.70E-02		2.34E-01	28.3%
Arsenic	6.94E+00	8.04E-02	5.76E-02		1.38E-01	16.7%
Barium	1.34E+02	2.33E-03	3.26E-04	2.19E-04	2.87E-03	0.3%
Beryllium	1.86E+00	3.23E-03	3.16E-03	7.61E-05	6.47E-03	0.8%
Uranium	6.75E+01	3.91E-01	4.50E-03		3.96E-01	47.8%
Total		6.78E-01	1.47E-01	2.37E-03	**8.28E-01**	**100.0%**
Percent of Total		82.0%	17.8%	0.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.163. HI (Industrial Worker) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	5.00E-01	6.12E-04	2.87E-03		3.49E-03	0.2%
Arsenic	3.00E+01	4.89E-02	3.36E-01		3.85E-01	27.5%
Beryllium	1.80E+00	4.40E-04	4.14E-03	9.95E-05	4.68E-03	0.3%
Iron	4.20E+04	6.85E-02	4.29E-02		1.11E-01	7.9%
Mercury	4.30E-01	7.01E-04	9.42E-04		1.64E-03	0.1%
Nickel	3.70E+01	9.05E-04	3.15E-04		1.22E-03	0.1%
Thallium	4.50E+00	2.75E-02	1.29E-02		4.05E-02	2.9%
Uranium	9.43E+02	7.69E-01	8.50E-02		8.54E-01	60.9%
Total		9.17E-01	4.86E-01	9.95E-05	**1.40E+00**	**100.0%**
Percent of Total		65.4%	34.6%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.164. HI (Industrial Worker) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	1.57E+01	1.92E-02	9.03E-02		1.09E-01	73.8%
Uranium	4.30E+01	3.51E-02	3.88E-03		3.89E-02	26.2%
Total		5.43E-02	9.41E-02		**1.48E-01**	**100.0%**
Percent of Total		36.6%	63.4%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.165. HI (Industrial Worker) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Arsenic	1.38E+01	2.25E-02	1.55E-01		1.77E-01	67.6%
Beryllium	7.32E-01	1.79E-04	1.68E-03	4.05E-05	1.90E-03	0.7%
Chromium	1.33E+02	4.34E-05	8.16E-04		8.59E-04	0.3%
Iron	2.19E+04	3.57E-02	2.24E-02		5.81E-02	22.2%
Nickel	7.19E+01	1.76E-03	6.12E-04		2.37E-03	0.9%
Vanadium	2.97E+01	2.08E-03	1.95E-02		2.16E-02	8.2%
Total		6.23E-02	2.00E-01	4.05E-05	**2.62E-01**	100.0%
Percent of Total		23.8%	76.2%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.166. HI (Industrial Worker) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	8.86E+03	4.33E-03	4.07E-03	1.96E-03	1.04E-02	1.2%
Arsenic	1.22E+01	1.99E-02	1.37E-01		1.57E-01	17.5%
Beryllium	6.19E-01	1.51E-04	1.42E-03	3.42E-05	1.61E-03	0.2%
Nickel	3.39E+01	8.30E-04	2.89E-04		1.12E-03	0.1%
Uranium	2.79E+02	2.27E-01	2.52E-02		2.53E-01	28.2%
Organic Compounds						
Bis(2-ethylhexyl)phthalate	4.76E+00	1.16E-04	5.76E-04		6.93E-04	0.1%
Dibenzofuran	3.52E+00	8.61E-04	1.01E-03		1.87E-03	0.2%
Fluoranthene	5.33E+02	6.52E-03	2.57E-01		2.66E-01	29.7%
Naphthalene	1.60E+01	3.91E-04	5.98E-03		1.84E-01	20.6%
Pyrene	3.16E+01	5.15E-04	2.03E-02		2.10E-02	2.3%
Total		2.61E-01	4.53E-01	1.82E-01	**8.96E-01**	**100.0%**
Percent of Total		29.1%	50.5%	20.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.167. HI (Industrial Worker) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Beryllium	7.30E-01	1.79E-04	1.68E-03	4.04E-05	1.90E-03	1.8%
Nickel	1.58E+01	3.86E-04	1.35E-04		5.21E-04	0.5%
Uranium	1.14E+02	9.30E-02	1.03E-02		1.03E-01	97.7%
Total		9.35E-02	1.21E-02	4.04E-05	**1.06E-01**	**100.0%**
Percent of Total		88.5%	11.4%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.168. HI (Industrial Worker) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	9.10E+03	4.45E-03	4.19E-03	2.01E-03	1.06E-02	2.0%
Antimony	9.82E-01	1.20E-03	5.65E-03		6.85E-03	1.3%
Arsenic	6.91E+00	1.13E-02	7.75E-02		8.88E-02	16.9%
Beryllium	6.15E-01	3.18E-04	2.99E-03	7.19E-05	1.60E-03	0.3%
Copper	6.73E+01	8.23E-04	2.58E-04		1.08E-03	0.2%
Iron	1.92E+04	3.13E-02	1.96E-02		5.09E-02	9.7%
Nickel	5.13E+01	1.25E-03	4.37E-04		1.69E-03	0.3%
Thallium	2.00E+00	1.22E-02	5.75E-03		1.80E-02	3.4%
Uranium	3.59E+02	2.93E-01	3.24E-02		3.25E-01	61.9%
Vanadium	2.81E+01	1.96E-03	1.85E-02		2.04E-02	3.9%
Total		3.57E-01	1.66E-01	2.04E-03	**5.25E-01**	100.0%
Percent of Total		68.1%	31.6%	0.4%	100.0%	

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.169. HI (Industrial Worker) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.60E+04	7.83E-03	7.36E-03	3.53E-03	1.87E-02	1.4%
Antimony	3.00E+00	3.67E-03	1.72E-02		2.09E-02	1.5%
Beryllium	8.50E-01	2.08E-04	1.95E-03	4.70E-05	2.21E-03	0.2%
Cadmium	2.80E+00	1.37E-03	1.29E-02		1.42E-02	1.0%
Copper	1.70E+02	2.08E-03	6.52E-04		2.73E-03	0.2%
Nickel	5.70E+02	1.39E-02	4.85E-03		1.88E-02	1.4%
Thallium	1.80E+00	1.10E-02	5.17E-03		1.62E-02	1.2%
Uranium	1.40E+03	1.14E+00	1.26E-01		1.27E+00	93.1%
Total		1.18E+00	1.76E-01	3.58E-03	**1.36E+00**	**100.0%**
Percent of Total		86.8%	13.0%	0.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.170. HI (Child Recreational User) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	5.00E-01	1.33E-03	1.66E-07		3.62E-07	4.47E-03		5.81E-03	0.0%
Arsenic	3.00E+01	1.07E-01	6.41E-04		1.41E-03	5.24E-01		6.32E-01	5.1%
Beryllium	1.80E+00	9.59E-04	2.61E-06		5.80E-06	6.44E-03	1.08E-04	7.52E-03	0.1%
Iron	4.20E+04	1.49E-01	8.11E-03	5.35E-01	1.81E-02	6.68E-02		7.77E-01	6.3%
Mercury	4.30E-01	1.53E-03	1.89E-04	1.17E-04	3.76E-04	1.47E-03		3.67E-03	0.0%
Nickel	3.70E+01	1.97E-03	4.31E-05		9.10E-05	4.91E-04		2.60E-03	0.0%
Thallium	4.50E+00	5.99E-02	6.38E-03		1.42E-02	2.01E-02		1.01E-01	0.8%
Uranium	9.43E+02	1.67E+00	1.43E-03	9.05E+00	3.16E-03	1.32E-01		1.09E+01	87.6%
Organic Compounds									
2-Methylnaphthalene	6.90E-01	1.84E-04	1.71E-07		3.60E-07	1.54E-04		3.39E-04	0.0%
Total		2.00E+00	1.68E-02	9.58E+00	3.73E-02	7.56E-01	1.08E-04	**1.24E+01**	100.0%
% of Total		16.1%	0.1%	77.3%	0.3%	6.1%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.171. HI (Child Recreational User) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	1.57E+01	4.18E-02	5.20E-06		1.14E-05	1.41E-01		1.82E-01	26.6%
Uranium	4.30E+01	7.64E-02	6.52E-05	4.22E-01	1.44E-04	6.04E-03		5.04E-01	73.4%
Total		1.18E-01	7.04E-05	4.22E-01	1.56E-04	1.47E-01	0.00E+00	**6.87E-01**	100.0%
% of Total		17.2%	0.0%	61.4%	0.0%	21.3%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.172. HI (Child Recreational User) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Arsenic	1.38E+01	4.90E-02	2.95E-04		6.48E-04	2.41E-01		2.91E-01	39.3%
Beryllium	7.32E-01	3.90E-04	1.06E-06		2.36E-06	2.62E-03	4.41E-05	3.06E-03	0.4%
Chromium	1.33E+02	9.45E-05	2.56E-06		5.62E-06	1.27E-03		1.37E-03	0.2%
Iron	2.19E+04	7.78E-02	4.23E-03	2.79E-01	9.41E-03	3.48E-02		4.05E-01	54.7%
Nickel	7.19E+01	3.83E-03	8.37E-05		1.77E-04	9.53E-04		5.04E-03	0.7%
Vanadium	2.97E+01	4.52E-03	3.02E-05		6.74E-05	3.04E-02		3.50E-02	4.7%
Total		1.36E-01	4.64E-03	2.79E-01	1.03E-02	3.11E-01	4.41E-05	**7.41E-01**	100.0%
% of Total		18.3%	0.6%	37.7%	1.4%	42.0%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.173. HI (Child Recreational User) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	8.86E+03	9.44E-03	3.77E-05		8.41E-05	6.34E-03	2.13E-03	1.80E-02	0.4%
Arsenic	1.22E+01	4.33E-02	2.61E-04		5.73E-04	2.13E-01		2.57E-01	6.1%
Beryllium	6.19E-01	3.30E-04	8.96E-07		2.00E-06	2.22E-03	3.73E-05	2.59E-03	0.1%
Nickel	3.39E+01	1.81E-03	3.95E-05		8.35E-05	4.50E-04		2.38E-03	0.1%
Uranium	2.79E+02	4.95E-01	4.23E-04	2.68E+00	9.36E-04	3.92E-02		3.22E+00	76.0%
Organic Compounds									
Bis(2-ethylhexyl)phthalate	4.76E+00	2.54E-04	1.60E-06		3.50E-06	8.97E-04		1.16E-03	0.0%
Dibenzofuran	3.52E+00	1.88E-03	2.52E-06		5.37E-06	1.58E-03		3.46E-03	0.1%
Fluoranthene	5.33E+02	1.42E-02	8.96E-05	7.28E-02	1.96E-04	4.00E-01	2.39E-03	4.90E-01	11.6%
Naphthalene	1.60E+01	8.52E-04	3.02E-07	2.40E-03	6.17E-07	9.31E-03	1.95E-01	2.08E-01	4.9%
Pyrene	3.16E+01	1.12E-03	7.08E-06	3.25E-03	1.55E-05	3.16E-02	2.10E-04	3.62E-02	0.9%
Total		5.69E-01	8.63E-04	2.76E+00	1.90E-03	7.05E-01	2.00E-01	**4.24E+00**	100.0%
% of Total		13.4%	0.0%	65.2%	0.0%	16.6%	4.7%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.174. HI (Child Recreational User) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Beryllium	7.30E-01	3.89E-04	1.06E-06		2.35E-06	2.61E-03	4.39E-05	3.05E-03	0.2%
Nickel	1.58E+01	8.42E-04	1.84E-05		3.89E-05	2.09E-04		1.11E-03	0.1%
Uranium	1.14E+02	2.02E-01	1.73E-04	1.10E+00	3.82E-04	1.60E-02		1.32E+00	99.7%
Total		2.04E-01	1.92E-04	1.10E+00	4.24E-04	1.88E-02	4.39E-05	**1.33E+00**	100.0%
% of Total		15.4%	0.0%	83.2%	0.0%	1.4%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.175. HI (Child Recreational User) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	9.10E+03	9.70E-03	3.87E-05		8.64E-05	6.52E-03	2.19E-03	1.85E-02	0.4%
Antimony	9.82E-01	2.62E-03	2.17E-07		4.74E-07	8.79E-03		1.14E-02	0.2%
Arsenic	6.91E+00	2.45E-02	1.48E-04		3.25E-04	1.21E-01		1.46E-01	3.1%
Beryllium	6.15E-01	3.28E-04	8.91E-07		1.98E-06	2.20E-03	3.70E-05	2.57E-03	0.1%
Copper	6.73E+01	1.79E-03	1.68E-04		3.36E-04	4.01E-04		2.70E-03	0.1%
Iron	1.92E+04	6.82E-02	3.71E-03	2.45E-01	8.25E-03	3.05E-02		3.55E-01	7.5%
Nickel	5.13E+01	2.73E-03	5.97E-05		1.26E-04	6.80E-04		3.60E-03	0.1%
Thallium	2.00E+00	2.66E-02	2.83E-03		6.33E-03	8.95E-03		4.47E-02	0.9%
Uranium	3.59E+02	6.37E-01	5.44E-04	3.45E+00	1.20E-03	5.04E-02		4.14E+00	87.0%
Vanadium	2.81E+01	4.28E-03	2.86E-05		6.38E-05	2.87E-02		3.31E-02	0.7%
Total		7.78E-01	7.53E-03	3.69E+00	1.67E-02	2.58E-01	2.22E-03	**4.76E+00**	100.0%
% of Total		16.4%	0.2%	77.7%	0.4%	5.4%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.176. HI (Child Recreational User) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	1.60E+04	1.70E-02	6.80E-05		1.52E-04	1.15E-02	3.85E-03	3.26E-02	0.2%
Antimony	3.00E+00	7.99E-03	1.32E-06		2.90E-06	2.68E-02		3.48E-02	0.2%
Beryllium	8.50E-01	4.53E-04	1.23E-06		2.74E-06	3.04E-03	5.12E-05	3.55E-03	0.0%
Cadmium	2.80E+00	2.98E-03	9.51E-06	1.43E-02	1.93E-05	2.00E-02		3.74E-02	0.2%
Copper	1.70E+02	4.53E-03	4.24E-04	6.83E-02	8.50E-04	1.01E-03		7.51E-02	0.5%
Nickel	5.70E+02	3.04E-02	6.64E-04		1.40E-03	7.56E-03		4.00E-02	0.2%
Thallium	1.80E+00	2.40E-02	2.55E-03		5.70E-03	8.05E-03		4.03E-02	0.2%
Uranium	1.40E+03	2.49E+00	2.12E-03	1.34E+01	4.70E-03	1.97E-01		1.61E+01	98.4%
Total		2.57E+00	5.84E-03	1.35E+01	1.28E-02	2.75E-01	3.90E-03	**1.64E+01**	100.0%
% of Total		15.7%	0.0%	82.5%	0.1%	1.7%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.177. HI (Teen Recreational User) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	5.00E-01	2.32E-04	5.58E-08		3.04E-07	4.18E-03		4.41E-03	0.0%
Arsenic	3.00E+01	1.86E-02	2.16E-04		1.18E-03	4.90E-01		5.09E-01	5.5%
Beryllium	1.80E+00	1.67E-04	8.79E-07		4.86E-06	6.02E-03	3.78E-05	6.23E-03	0.1%
Iron	4.20E+04	2.60E-02	2.73E-03	4.61E-01	1.51E-02	6.24E-02		5.67E-01	6.1%
Mercury	4.30E-01	2.66E-04	6.36E-05	1.00E-04	3.15E-04	1.37E-03		2.12E-03	0.0%
Nickel	3.70E+01	3.44E-04	1.45E-05		7.63E-05	4.58E-04		8.93E-04	0.0%
Thallium	4.50E+00	1.05E-02	2.15E-03		1.19E-02	1.88E-02		4.33E-02	0.5%
Uranium	9.43E+02	2.92E-01	4.82E-04	7.79E+00	2.65E-03	1.24E-01		8.21E+00	87.9%
Organic Compounds									
2-Methylnaphthalene	6.90E-01	3.21E-05	5.78E-08		3.02E-07	1.44E-04	NA	1.77E-04	0.0%
Total		3.48E-01	5.66E-03	8.25E+00	3.13E-02	7.07E-01	3.78E-05	**9.34E+00**	100.0%
% of Total		3.7%	0.1%	88.3%	0.3%	7.6%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.178. HI (Teen Recreational User) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	1.57E+01	7.29E-03	1.75E-06		9.53E-06	1.31E-01		1.39E-01	26.6%
Uranium	4.30E+01	1.33E-02	2.20E-05	3.63E-01	1.21E-04	5.64E-03		3.82E-01	73.4%
Total		2.06E-02	2.37E-05	3.63E-01	1.30E-04	1.37E-01	0.00E+00	**5.21E-01**	100.0%
% of Total		4.0%	0.0%	69.7%	0.0%	26.3%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.179. HI (Teen Recreational User) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Arsenic	1.38E+01	8.55E-03	9.95E-05		5.43E-04	2.25E-01		2.34E-01	41.5%
Beryllium	7.32E-01	6.80E-05	3.57E-07		1.98E-06	2.45E-03	1.54E-05	2.53E-03	0.4%
Chromium	1.33E+02	1.65E-05	8.63E-07		4.71E-06	1.19E-03		1.21E-03	0.2%
Iron	2.19E+04	1.36E-02	1.43E-03	2.40E-01	7.89E-03	3.26E-02		2.96E-01	52.4%
Nickel	7.19E+01	6.68E-04	2.82E-05		1.48E-04	8.91E-04		1.74E-03	0.3%
Vanadium	2.97E+01	7.88E-04	1.02E-05		5.65E-05	2.84E-02		2.92E-02	5.2%
Total		2.37E-02	1.57E-03	2.40E-01	8.64E-03	2.91E-01	1.54E-05	**5.65E-01**	100.0%
% of Total		4.2%	0.3%	42.5%	1.5%	51.5%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.180. HI (Teen Recreational User) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	8.86E+03	1.65E-03	1.27E-05		7.05E-05	5.93E-03	7.43E-04	8.40E-03	0.3%
Arsenic	1.22E+01	7.56E-03	8.80E-05		4.80E-04	1.99E-01		2.07E-01	6.5%
Beryllium	6.19E-01	5.75E-05	3.02E-07		1.67E-06	2.07E-03	1.30E-05	2.14E-03	0.1%
Nickel	3.39E+01	3.15E-04	1.33E-05		6.99E-05	4.20E-04		8.19E-04	0.0%
Uranium	2.79E+02	8.64E-02	1.43E-04	2.31E+00	7.84E-04	3.66E-02		2.43E+00	75.9%
Organic Compounds									
Bis(2-ethylhexyl)phthalate	4.76E+00	4.42E-05	5.40E-07		2.93E-06	8.38E-04		8.86E-04	0.0%
Dibenzofuran	3.52E+00	3.27E-04	8.51E-07		4.50E-06	1.47E-03		1.80E-03	0.1%
Fluoranthene	5.33E+02	2.48E-03	3.02E-05	6.27E-02	1.64E-04	3.74E-01	8.33E-04	4.40E-01	13.7%
Naphthalene	1.60E+01	1.49E-04	1.02E-07	2.06E-03	5.17E-07	8.70E-03	6.80E-02	7.89E-02	2.5%
Pyrene	3.16E+01	1.96E-04	2.39E-06	2.80E-03	1.30E-05	2.96E-02	7.31E-05	3.26E-02	1.0%
Total		9.92E-02	2.91E-04	2.38E+00	1.59E-03	6.58E-01	6.97E-02	**3.21E+00**	100.0%
% of Total		3.1%	0.0%	74.1%	0.0%	20.5%	2.2%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.181. HI (Teen Recreational User) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Beryllium	7.30E-01	6.78E-05	3.56E-07		1.97E-06	2.44E-03	1.53E-05	2.53E-03	0.3%
Nickel	1.58E+01	1.47E-04	6.20E-06		3.26E-05	1.96E-04		3.81E-04	0.0%
Uranium	1.14E+02	3.53E-02	5.83E-05	9.49E-01	3.20E-04	1.50E-02		1.00E+00	99.7%
Total		3.55E-02	6.48E-05	9.49E-01	3.55E-04	1.76E-02	1.53E-05	**1.00E+00**	100.0%
% of Total		3.5%	0.0%	94.7%	0.0%	1.8%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.182. HI (Teen Recreational User) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	9.10E+03	1.69E-03	1.30E-05		7.24E-05	6.09E-03	7.63E-04	8.63E-03	0.2%
Antimony	9.82E-01	4.56E-04	7.31E-08		3.98E-07	8.21E-03		8.67E-03	0.2%
Arsenic	6.91E+00	4.28E-03	4.98E-05		2.72E-04	1.13E-01		1.17E-01	3.3%
Beryllium	6.15E-01	5.71E-05	3.00E-07		1.66E-06	2.06E-03	1.29E-05	2.13E-03	0.1%
Copper	6.73E+01	3.12E-04	5.65E-05		2.82E-04	3.75E-04		1.03E-03	0.0%
Iron	1.92E+04	1.19E-02	1.25E-03	2.11E-01	6.92E-03	2.85E-02		2.59E-01	7.3%
Nickel	5.13E+01	4.77E-04	2.01E-05		1.06E-04	6.36E-04		1.24E-03	0.0%
Thallium	2.00E+00	4.65E-03	9.56E-04		5.30E-03	8.36E-03		1.93E-02	0.5%
Uranium	3.59E+02	1.11E-01	1.83E-04	2.97E+00	1.01E-03	4.71E-02		3.13E+00	87.5%
Vanadium	2.81E+01	7.46E-04	9.64E-06		5.35E-05	2.69E-02		2.77E-02	0.8%
Total		1.36E-01	2.54E-03	3.18E+00	1.40E-02	2.41E-01	7.76E-04	**3.57E+00**	100.0%
% of Total		3.8%	0.1%	89.0%	0.4%	6.7%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.183. HI (Teen Recreational User) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	1.60E+04	2.97E-03	2.29E-05		1.27E-04	1.07E-02	1.34E-03	1.52E-02	0.1%
Antimony	3.00E+00	1.39E-03	4.47E-07		2.43E-06	2.51E-02		2.65E-02	0.2%
Beryllium	8.50E-01	7.90E-05	4.15E-07		2.30E-06	2.84E-03	1.78E-05	2.94E-03	0.0%
Cadmium	2.80E+00	5.20E-04	3.21E-06	1.23E-02	1.62E-05	1.87E-02		3.16E-02	0.3%
Copper	1.70E+02	7.90E-04	1.43E-04	5.88E-02	7.12E-04	9.48E-04		6.14E-02	0.5%
Nickel	5.70E+02	5.30E-03	2.24E-04		1.18E-03	7.06E-03		1.38E-02	0.1%
Thallium	1.80E+00	4.18E-03	8.60E-04		4.77E-03	7.53E-03		1.73E-02	0.1%
Uranium	1.40E+03	4.34E-01	7.15E-04	1.16E+01	3.93E-03	1.84E-01		1.22E+01	98.6%
Total		4.49E-01	1.97E-03	1.16E+01	1.07E-02	2.57E-01	1.36E-03	**1.24E+01**	100.0%
% of Total		3.6%	0.0%	94.2%	0.1%	2.1%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.184. HI (Adult Recreational User) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	5.00E-01	1.06E-04	3.43E-08		3.75E-07	1.45E-03		1.56E-03	0.0%
Arsenic	3.00E+01	8.48E-03	1.33E-04		1.46E-03	1.70E-01		1.80E-01	1.7%
Beryllium	1.80E+00	7.63E-05	5.40E-07		6.01E-06	2.09E-03	1.72E-05	2.19E-03	0.0%
Iron	4.20E+04	1.19E-02	1.68E-03	5.54E-01	1.87E-02	2.17E-02		6.08E-01	5.9%
Mercury	4.30E-01	1.22E-04	3.91E-05	1.21E-04	3.89E-04	4.75E-04		1.15E-03	0.0%
Nickel	3.70E+01	1.57E-04	8.92E-06		9.43E-05	1.59E-04		4.19E-04	0.0%
Thallium	4.50E+00	4.77E-03	1.32E-03		1.47E-02	6.53E-03		2.74E-02	0.3%
Uranium	9.43E+02	1.33E-01	2.96E-04	9.37E+00	3.28E-03	4.29E-02		9.55E+00	92.1%
Organic Compounds									0.0%
2-Methylnaphthalene	6.90E-01	1.46E-05	3.55E-08		3.73E-07	5.00E-05		6.51E-05	0.0%
Total		1.59E-01	3.48E-03	9.93E+00	3.87E-02	2.45E-01	1.72E-05	**1.04E+01**	100.0%
% of Total		1.5%	0.0%	95.7%	0.4%	2.4%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.185. HI (Adult Recreational User) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Antimony	1.57E+01	3.33E-03	1.08E-06		1.18E-05	4.55E-02		4.89E-02	9.9%
Uranium	4.30E+01	6.08E-03	1.35E-05	4.37E-01	1.49E-04	1.96E-03		4.45E-01	90.1%
Total		9.41E-03	1.46E-05	4.37E-01	1.61E-04	4.75E-02	0.00E+00	**4.94E-01**	100.0%
% of Total		1.9%	0.0%	88.4%	0.0%	9.6%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.186. HI (Adult Recreational User) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Arsenic	1.38E+01	3.90E-03	6.11E-05		6.71E-04	7.81E-02		8.27E-02	20.1%
Beryllium	7.32E-01	3.10E-05	2.20E-07		2.44E-06	8.49E-04	7.01E-06	8.90E-04	0.2%
Chromium	1.33E+02	7.52E-06	5.30E-07		5.82E-06	4.11E-04		4.25E-04	0.1%
Iron	2.19E+04	6.19E-03	8.76E-04	2.89E-01	9.75E-03	1.13E-02		3.17E-01	76.9%
Nickel	7.19E+01	3.05E-04	1.73E-05		1.83E-04	3.09E-04		8.14E-04	0.2%
Vanadium	2.97E+01	3.60E-04	6.26E-06		6.98E-05	9.84E-03		1.03E-02	2.5%
Total		1.08E-02	9.61E-04	2.89E-01	1.07E-02	1.01E-01	7.01E-06	**4.12E-01**	100.0%
% of Total		2.6%	0.2%	70.1%	2.6%	24.4%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.187. HI (Adult Recreational User) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	8.86E+03	7.51E-04	7.80E-06		8.71E-05	2.06E-03	3.39E-04	3.24E-03	0.1%
Arsenic	1.22E+01	3.45E-03	5.40E-05		5.94E-04	6.90E-02		7.31E-02	2.3%
Beryllium	6.19E-01	2.62E-05	1.86E-07		2.07E-06	7.18E-04	5.93E-06	7.53E-04	0.0%
Nickel	3.39E+01	1.44E-04	8.18E-06		8.64E-05	1.46E-04		3.84E-04	0.0%
Uranium	2.79E+02	3.94E-02	8.76E-05	2.78E+00	9.69E-04	1.27E-02		2.83E+00	89.4%
Organic Compounds									
Bis(2-ethylhexyl)phthalate	4.76E+00	2.02E-05	3.32E-07		3.62E-06	2.91E-04		3.15E-04	0.0%
Dibenzofuran	3.52E+00	1.49E-04	5.23E-07		5.56E-06	5.10E-04		6.66E-04	0.0%
Fluoranthene	5.33E+02	1.13E-03	1.86E-05	7.54E-02	2.03E-04	1.30E-01	3.80E-04	2.07E-01	6.5%
Naphthalene	1.60E+01	6.78E-05	6.26E-08	2.48E-03	6.39E-07	3.02E-03	3.10E-02	3.66E-02	1.2%
Pyrene	3.16E+01	8.93E-05	1.47E-06	3.37E-03	1.60E-05	1.02E-02	3.34E-05	1.38E-02	0.4%
Total		4.53E-02	1.79E-04	2.86E+00	1.97E-03	2.28E-01	3.18E-02	**3.17E+00**	100.0%
% of Total		1.4%	0.0%	90.3%	0.1%	7.2%	1.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.188. HI (Adult Recreational User) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Beryllium	7.30E-01	3.10E-05	2.19E-07		2.44E-06	8.47E-04	6.99E-06	8.87E-04	0.1%
Nickel	1.58E+01	6.70E-05	3.81E-06		4.03E-05	6.79E-05		1.79E-04	0.0%
Uranium	1.14E+02	1.61E-02	3.58E-05	1.14E+00	3.96E-04	5.19E-03		1.16E+00	99.9%
Total		1.62E-02	3.98E-05	1.14E+00	4.39E-04	6.10E-03	6.99E-06	**1.16E+00**	100.0%
% of Total		1.4%	0.0%	98.0%	0.0%	0.5%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.189. HI (Adult Recreational User) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	9.10E+03	7.72E-04	8.02E-06		8.95E-05	2.11E-03	3.48E-04	3.33E-03	0.1%
Antimony	9.82E-01	2.08E-04	4.49E-08		4.91E-07	2.85E-03		3.06E-03	0.1%
Arsenic	6.91E+00	1.95E-03	3.06E-05		3.36E-04	3.91E-02		4.14E-02	1.0%
Beryllium	6.15E-01	2.61E-05	1.84E-07		2.05E-06	7.13E-04	5.89E-06	7.48E-04	0.0%
Copper	6.73E+01	1.43E-04	3.47E-05		3.48E-04	1.30E-04		6.56E-04	0.0%
Iron	1.92E+04	5.43E-03	7.68E-04	2.53E-01	8.55E-03	9.90E-03		2.78E-01	7.0%
Nickel	5.13E+01	2.18E-04	1.24E-05		1.31E-04	2.20E-04		5.81E-04	0.0%
Thallium	2.00E+00	2.12E-03	5.87E-04		6.55E-03	2.90E-03		1.22E-02	0.3%
Uranium	3.59E+02	5.07E-02	1.13E-04	3.57E+00	1.25E-03	1.63E-02		3.64E+00	91.2%
Vanadium	2.81E+01	3.40E-04	5.92E-06		6.61E-05	9.31E-03		9.73E-03	0.2%
Total		6.19E-02	1.56E-03	3.83E+00	1.73E-02	8.36E-02	3.54E-04	**3.99E+00**	100.0%
% of Total		1.6%	0.0%	95.9%	0.4%	2.1%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.190. HI (Adult Recreational User) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion–Soil	Ingestion–Deer	Ingestion–Quail	Ingestion–Rabbit	Dermal	Inhalation	Total	% of Total
Inorganic Chemicals (Metals)									
Aluminum	1.60E+04	1.36E-03	1.41E-05		1.57E-04	3.71E-03	6.12E-04	5.85E-03	0.0%
Antimony	3.00E+00	6.36E-04	2.74E-07		3.00E-06	8.70E-03		9.34E-03	0.1%
Beryllium	8.50E-01	3.60E-05	2.55E-07		2.84E-06	9.86E-04	8.14E-06	1.03E-03	0.0%
Cadmium	2.80E+00	2.37E-04	1.97E-06	1.48E-02	2.00E-05	6.50E-03		2.16E-02	0.2%
Copper	1.70E+02	3.60E-04	8.78E-05	7.07E-02	8.80E-04	3.29E-04		7.24E-02	0.5%
Nickel	5.70E+02	2.42E-03	4.34E-07		4.59E-06	2.45E-03		4.87E-03	0.0%
Thallium	1.80E+00	1.91E-03	5.28E-04		5.90E-03	2.61E-03		1.09E-02	0.1%
Uranium	1.40E+03	1.98E-01	4.39E-04	1.39E+01	4.86E-03	6.37E-02		1.42E+01	99.1%
Total		2.05E-01	1.07E-03	1.40E+01	1.18E-02	8.90E-02	6.20E-04	**1.43E+01**	100.0%
% of Total		1.4%	0.0%	97.9%	0.1%	0.6%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.191. HI (Child Resident) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	5.00E-01	1.60E-02	1.12E-02		2.72E-02	0.1%
Arsenic	3.00E+01	1.28E+00	1.31E+00		2.59E+00	10.0%
Beryllium	1.80E+00	1.15E-02	1.61E-02	4.33E-04	2.80E-02	0.1%
Iron	4.20E+04	1.79E+00	1.67E-01		1.96E+00	7.6%
Mercury	4.30E-01	1.83E-02	3.67E-03		2.20E-02	0.1%
Nickel	3.70E+01	2.37E-02	1.23E-03		2.49E-02	0.1%
Thallium	4.50E+00	7.19E-01	5.03E-02		7.70E-01	3.0%
Uranium	9.43E+02	2.01E+01	3.31E-01		2.04E+01	79.0%
Organic Compounds						
2-methylnaphthalene	6.90E-01	2.21E-03	3.86E-04		2.59E-03	0.0%
Total		2.40E+01	1.89E+00	4.33E-04	**2.58E+01**	**100.0%**
% of Total		92.7%	7.3%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.192. HI (Child Resident) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	1.57E+01	5.02E-01	3.51E-01		8.53E-01	47.8%
Uranium	1.71E+01	9.16E-01	1.51E-02		9.31E-01	52.2%
Total		1.42E+00	3.66E-01		**1.78E+00**	**100.0%**
Percent of Total		79.5%	20.5%			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.193. HI (Child Resident) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Arsenic	1.38E+01	5.88E-01	6.02E-01		1.19E+00	49.5%
Beryllium	7.32E-01	4.68E-03	6.55E-03	1.76E-04	1.14E-02	0.5%
Chromium	1.33E+02	1.13E-03	3.17E-03		4.31E-03	0.2%
Iron	2.19E+04	9.33E-01	8.71E-02		1.02E+00	42.4%
Nickel	7.19E+01	4.60E-02	2.38E-03		4.83E-02	2.0%
Vanadium	2.97E+01	5.42E-02	7.59E-02		1.30E-01	5.4%
Total		1.63E+00	7.78E-01	1.76E-04	**2.41E+00**	**100.0%**
Percent of Total		67.7%	32.3%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.194. HI (Child Resident) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	8.86E+03	1.13E-01	1.59E-02	8.51E-03	1.38E-01	1.5%
Arsenic	1.22E+01	5.20E-01	5.33E-01		1.05E+00	11.2%
Beryllium	6.19E-01	3.96E-03	5.54E-03	1.49E-04	9.65E-03	0.1%
Nickel	3.39E+01	2.17E-02	1.12E-03		2.28E-02	0.2%
Uranium	2.79E+02	5.95E+00	9.79E-02		6.04E+00	64.4%
Organic Compounds						
Bis(2-ethylhexyl)phthalate	4.76E+00	3.04E-03	2.24E-03		5.29E-03	0.1%
Dibenzofuran	3.52E+00	2.25E-02	3.94E-03		2.64E-02	0.3%
Fluoranthene	5.33E+02	1.70E-01	1.00E+00	9.55E-03	1.18E+00	12.6%
Naphthalene	1.60E+01	1.02E-02	2.33E-02	7.80E-01	8.13E-01	8.7%
Pyrene	3.16E+01	1.35E-02	7.91E-02	8.38E-04	9.34E-02	1.0%
Total		6.82E+00	1.76E+00	7.99E-01	**9.38E+00**	**100.0%**
Percent of Total		72.7%	18.8%	8.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.195. HI (Child Resident) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Beryllium	7.30E-01	4.67E-03	6.53E-03	1.76E-04	1.14E-02	0.5%
Nickel	1.58E+01	1.01E-02	5.24E-04		1.06E-02	0.4%
Uranium	1.14E+02	2.43E+00	4.00E-02		2.47E+00	99.1%
Total		2.44E+00	4.71E-02	1.76E-04	**2.49E+00**	**100.0%**
Percent of Total		98.1%	1.9%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.196. HI (Child Resident) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	9.10E+03	1.16E-01	1.63E-02	8.75E-03	1.41E-01	1.4%
Antimony	9.82E-01	3.14E-02	2.20E-02		5.34E-02	0.5%
Arsenic	6.91E+00	2.94E-01	3.02E-01		5.96E-01	6.0%
Beryllium	6.15E-01	3.93E-03	5.50E-03	1.48E-04	9.58E-03	0.1%
Copper	6.73E+01	2.15E-02	1.00E-03		2.25E-02	0.2%
Iron	1.92E+04	8.18E-01	7.64E-02		8.95E-01	9.0%
Nickel	5.13E+01	3.28E-02	1.70E-03		3.45E-02	0.3%
Thallium	2.00E+00	3.20E-01	2.24E-02		3.42E-01	3.4%
Uranium	3.59E+02	7.65E+00	1.26E-01		7.77E+00	77.8%
Vanadium	2.81E+01	5.13E-02	7.19E-02		1.23E-01	1.2%
Total		9.34E+00	6.45E-01	8.89E-03	**9.99E+00**	**100.0%**
Percent of Total		93.5%	6.5%	0.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.197. HI (Child Resident) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.60E+04	2.05E-01	2.86E-02	1.54E-02	2.49E-01	0.8%
Antimony	3.00E+00	9.59E-02	6.71E-02		1.63E-01	0.5%
Beryllium	8.50E-01	5.43E-03	7.61E-03	2.05E-04	1.32E-02	0.0%
Cadmium	2.80E+00	3.58E-02	5.01E-02		8.59E-02	0.3%
Copper	1.70E+02	5.43E-02	2.54E-03		5.69E-02	0.2%
Nickel	5.70E+02	3.64E-01	1.89E-02		3.83E-01	1.2%
Thallium	1.80E+00	2.88E-01	2.01E-02		3.08E-01	1.0%
Uranium	1.40E+03	2.98E+01	4.91E-01		3.03E+01	96.0%
Total		3.09E+01	6.86E-01	1.56E-02	**3.16E+01**	**100.0%**
Percent of Total		97.8%	2.2%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.198. HI (Adult Resident) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	5.00E-01	1.71E-03	4.88E-03		6.59E-03	0.2%
Arsenic	3.00E+01	1.37E-01	5.71E-01		7.08E-01	20.9%
Beryllium	1.80E+00	1.23E-03	7.03E-03	9.28E-05	8.35E-03	0.2%
Iron	4.20E+04	1.92E-01	7.29E-02		2.65E-01	7.8%
Mercury	4.30E-01	1.96E-03	1.60E-03		3.56E-03	0.1%
Nickel	3.70E+01	2.53E-03	5.35E-04		3.07E-03	0.1%
Thallium	4.50E+00	7.71E-02	2.20E-02		9.90E-02	2.9%
Uranium	9.43E+02	2.15E+00	1.44E-01		2.30E+00	67.7%
Organic Compounds						
2-methylnaphthalene	6.90E-01	2.36E-04	1.68E-04		4.05E-04	0.0%
Total		2.57E+00	8.25E-01	9.28E-05	**3.39E+00**	**100.00%**
Percent of Total		75.7%	24.3%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.199. HI (Adult Resident) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Antimony	1.57E+01	5.38E-02	1.53E-01		2.07E-01	66.4%
Uranium	4.30E+01	9.82E-02	6.58E-03		1.05E-01	33.6%
Total		1.52E-01	1.60E-01		**3.12E-01**	**100.0%**
Percent of Total		48.7%	51.3%			

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.200. HI (Adult Resident) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Arsenic	1.38E+01	6.30E-02	2.63E-01		3.26E-01	63.4%
Beryllium	7.32E-01	5.01E-04	2.86E-03	3.78E-05	3.40E-03	0.7%
Chromium	1.33E+02	1.21E-04	1.38E-03		1.51E-03	0.3%
Iron	2.19E+04	1.00E-01	3.80E-02		1.38E-01	26.9%
Nickel	7.19E+01	4.92E-03	1.04E-03		5.96E-03	1.2%
Vanadium	2.97E+01	5.81E-03	3.31E-02		3.89E-02	7.6%
Total		1.74E-01	3.39E-01	3.78E-05	**5.14E-01**	**100.0%**
Percent of Total		33.9%	66.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.201. HI (Adult Resident) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	8.86E+03	1.21E-02	6.92E-03	1.82E-03	2.09E-02	1.3%
Arsenic	1.22E+01	5.57E-02	2.32E-01		2.88E-01	17.2%
Beryllium	6.19E-01	4.24E-04	2.42E-03	3.19E-05	2.87E-03	0.2%
Nickel	3.39E+01	2.32E-03	4.90E-04		2.81E-03	0.2%
Uranium	2.79E+02	6.37E-01	4.27E-02		6.80E-01	40.7%
Organic Compounds						
Bis(2-ethylhexyl)phthalate	4.76E+00	3.26E-04	9.78E-04		1.30E-03	0.1%
Dibenzofuran	3.52E+00	2.41E-03	1.72E-03		4.13E-03	0. 2%
Fluoranthene	5.33E+02	1.83E-02	4.36E-01	2.05E-03	4.57E-01	27.3%
Naphthalene	1.60E+01	1.10E-03	1.02E-02	1.67E-01	1.78E-01	10.7%
Pyrene	3.16E+01	1.44E-03	3.45E-02	1.80E-04	3.61E-02	2.2%
Total		7.31E-01	7.69E-01	1.71E-01	**1.67E+00**	**100.0%**
Percent of Total		43.8%	46.0%	10.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.202. HI (Adult Resident) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Beryllium	7.30E-01	5.00E-04	2.85E-03	3.76E-05	3.39E-03	1.2%
Nickel	1.58E+01	1.08E-03	2.28E-04		1.31E-03	0.5%
Uranium	1.14E+02	2.60E-01	1.75E-02		2.78E-01	98.3%
Total		2.62E-01	2.05E-02	3.76E-05	**2.82E-01**	**100.0%**
Percent of Total		92.7%	7.3%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.203. HI (Adult Resident) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	9.10E+03	1.25E-02	7.11E-03	1.87E-03	2.14E-02	1.7%
Antimony	9.82E-01	3.36E-03	9.58E-03		1.29E-02	1.0%
Arsenic	6.91E+00	3.16E-02	1.32E-01		1.63E-01	12.7%
Beryllium	6.15E-01	4.21E-04	2.40E-03	3.17E-05	2.85E-03	0.2%
Copper	6.73E+01	2.30E-03	4.38E-04		2.74E-03	0.2%
Iron	1.92E+04	8.77E-02	3.33E-02		1.21E-01	9.4%
Nickel	5.13E+01	3.51E-03	7.42E-04		4.26E-03	0.3%
Thallium	2.00E+00	3.42E-02	9.76E-03		4.40E-02	3.4%
Uranium	3.59E+02	8.19E-01	5.49E-02		8.74E-01	68.1%
Vanadium	2.81E+01	5.50E-03	3.13E-02		3.68E-02	2.9%
Total		1.00E+00	2.81E-01	1.91E-03	**1.28E+00**	**100.0%**
Percent of Total		77.9%	21.9%	0.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.204. HI (Adult Resident) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	Total Hazard	Percent of Total
Inorganic (metals)						
Aluminum	1.60E+04	2.19E-02	1.25E-02	3.29E-03	3.77E-02	1.0%
Antimony	3.00E+00	1.03E-02	2.93E-02		3.96E-02	1.1%
Beryllium	8.50E-01	5.82E-04	3.32E-03	4.38E-05	3.94E-03	0.1%
Cadmium	2.80E+00	3.84E-03	2.19E-02		2.57E-02	0.7%
Copper	1.70E+02	5.82E-03	1.11E-03		6.93E-03	0.2%
Nickel	5.70E+02	3.90E-02	8.24E-03		4.73E-02	1.3%
Thallium	1.80E+00	3.08E-02	8.78E-03		3.96E-02	1.1%
Uranium	1.40E+03	3.20E+00	2.14E-01		3.41E+00	94.4%
Total		3.31E+00	2.99E-01	3.34E-03	**3.61E+00**	**100.0%**
Percent of Total		91.6%	8.3%	0.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.205. ELCR (Excavation Worker) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	3.00E+01	5.59E-05	4.00E-05	3.78E-08		9.59E-05	16.3%
Beryllium	1.80E+00			1.26E-09		1.26E-09	0.0%
Organic Compounds							
Total PAHs	1.80E-01	1.63E-06	6.70E-06	2.96E-09		8.33E-06	1.4%
Total PCBs	4.70E+00	1.17E-05	1.78E-05	2.34E-06		3.18E-05	5.4%
Radionuclides							
Cesium-137	1.51E+01	1.45E-06		2.68E-11	1.30E-04	1.32E-04	22.4%
Plutonium-239/240	4.34E+00	2.66E-06		2.16E-08	2.93E-09	2.68E-06	0.5%
Thorium-230	3.26E+00	1.46E-06		1.39E-08	9.02E-09	1.48E-06	0.3%
Uranium-234	2.85E+01	1.00E-05		4.85E-08	2.43E-08	1.01E-05	1.7%
Uranium-235	9.51E+00	3.44E-06		1.43E-08	1.74E-05	2.09E-05	3.6%
Uranium-238	3.34E+02	1.56E-04		4.66E-07	1.29E-04	2.85E-04	48.5%
Total		2.44E-04	6.45E-05	2.94E-06	2.76E-04	**5.88E-04**	**100.0%**
Percent of Total		41.5%	11.0%	0.5%	47.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.206. ELCR (Excavation Worker) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Radionuclides							
Cesium-137	4.56E-01	4.38E-08		8.10E-13	3.93E-06	3.97E-06	33.0%
Uranium-234	5.25E-01	1.84E-07		8.93E-10	4.47E-10	1.85E-07	1.5%
Uranium-238	9.24E+00	4.31E-06		1.29E-08	3.56E-06	7.88E-06	65.4%
Total		4.53E-06		1.38E-08	7.49E-06	**1.20E-05**	100.0%
Percent of Total		37.7%		0.1%	62.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.207. ELCR (Excavation Worker) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	8.92E+00	1.66E-05	1.19E-05	1.12E-08		2.85E-05	1.4%
Beryllium	6.94E-01			4.86E-10		4.86E-10	0.0%
Organic Compounds							
Total PAHs	4.10E-01	3.72E-06	1.53E-05	6.74E-09		1.90E-05	0.9%
Total PCBs	3.12E+01	7.75E-05	1.18E-04	1.55E-05		2.11E-04	10.6%
Radionuclides							
Cesium-137	1.81E+02	1.74E-05		3.21E-10	1.56E-03	1.58E-03	78.9%
Neptunium-237	2.07E+00	7.45E-07		5.47E-09	5.58E-06	6.33E-06	0.3%
Plutonium-239/240	8.04E+00	4.93E-06		3.99E-08	5.43E-09	4.97E-06	0.2%
Radium-226	2.51E+00	4.07E-06		4.42E-09	7.20E-05	7.61E-05	3.8%
Technetium-99	4.96E+01	8.43E-07		1.04E-10	1.36E-08	8.57E-07	0.4%
Thorium-230	6.87E+01	3.08E-05		2.92E-07	1.90E-07	3.13E-05	1.6%
Uranium-234	3.25E+01	1.14E-05		5.52E-08	2.76E-08	1.15E-05	0.6%
Uranium-238	3.92E+01	1.83E-05		5.47E-08	1.47E-05	3.30E-05	1.7%
Total		1.86E-04	1.45E-04	1.60E-05	1.65E-03	**2.00E-03**	**100.0%**
Percent of Total		9.3%	7.3%	0.8%	82.6%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.208. ELCR (Excavation Worker) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	1.22E+01	2.27E-05	1.63E-05	1.54E-08		3.90E-05	0.75%
Organic Compounds							
Total PAHs	1.12E+02	1.01E-03	4.17E-03	1.84E-06		5.18E-03	99.2%
Total PCBs	3.06E-01	7.60E-07	1.16E-06	6.22E-08		1.98E-06	0.04%
Carbazole	5.46E+00	1.35E-07	1.90E-08			1.54E-07	0.00%
Radionuclides							
Uranium-238	1.38E+00	6.43E-07	NA	1.92E-09	5.31E-07	1.18E-06	0.02%
Total		1.04E-03	4.18E-03	1.92E-06	5.31E-07	**5.23E-03**	**100.00%**
Percent of Total		19.9%	80.1%	0.04%	0.01%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.209. ELCR (Excavation Worker) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Beryllium	8.18E-01			5.73E-10		5.73E-10	0.00%
Organic Compounds							
Total PAHs	4.99E-01	4.52E-06	1.86E-05	8.20E-09		2.31E-05	58.9%
Radionuclides							
Uranium-235	6.80E+00	2.46E-06	NA	1.02E-08	1.25E-05	1.49E-05	38.1%
Uranium-238	1.38E+00	6.43E-07	NA	1.92E-09	5.31E-07	1.18E-06	3.0%
Total		7.63E-06	1.86E-05	2.09E-08	1.30E-05	**3.92E-05**	**100.0%**
Percent of Total		19.4%	47.3%	0.1%	33.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.210. ELCR (Excavation Worker) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	4.56E+00	8.50E-06	6.09E-06	5.75E-09		1.46E-05	1.9%
Beryllium	4.20E-01	NA	NA	2.94E-10		2.94E-10	0.0%
Organic Compounds							
Total PAHs	6.37E+00	5.77E-05	2.37E-04	1.05E-07		2.95E-04	38.3%
Total PCBs	1.81E+01	4.49E-05	6.84E-05	9.00E-06		1.22E-04	15.9%
Radionuclides							
Americium-241	2.00E+00	9.63E-07	NA	8.38E-09	1.87E-07	1.16E-06	0.2%
Neptunium-237	1.60E-01	5.75E-08	NA	4.23E-10	4.31E-07	4.89E-07	0.1%
Technetium-99	1.29E+02	2.19E-06	NA	2.71E-10	3.55E-08	2.23E-06	0.3%
Thorium-228	1.35E+00	2.42E-06	NA	2.88E-08	3.54E-05	3.78E-05	4.9%
Thorium-230	1.57E+00	7.05E-07	NA	6.68E-09	4.35E-09	7.16E-07	0.1%
Uranium-234	5.57E+01	1.95E-05	NA	9.48E-08	4.74E-08	1.97E-05	2.6%
Uranium-235	3.82E+00	1.38E-06	NA	5.76E-09	7.01E-06	8.40E-06	1.1%
Uranium-238	3.15E+02	1.47E-04	NA	4.39E-07	1.21E-04	2.68E-04	34.8%
Total		2.85E-04	3.11E-04	9.70E-06	1.64E-04	**7.71E-04**	**100%**
Percent of Total		37.0%	40.4%	1.3%	21.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.211. ELCR (Excavation Worker) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	5.28E+00	9.83E-06	7.05E-06	6.65E-09		1.69E-05	1.8%
Nickel	4.35E+02			3.30E-08		3.30E-08	0.0%
Organic Compounds							
Total PAHs	1.25E+01	1.13E-04	4.65E-04	2.05E-07		5.79E-04	61.5%
Total PCBs	1.53E+01	3.80E-05	5.78E-05	7.61E-06		1.03E-04	11.0%
Radionuclides							
Neptunium-237	4.45E-01	1.60E-07		1.18E-09	1.20E-06	1.36E-06	0.1%
Technetium-99	2.47E+02	4.20E-06		5.20E-10	6.79E-08	4.27E-06	0.5%
Thorium-228	4.65E-01	8.26E-07		9.92E-09	1.22E-05	1.30E-05	1.4%
Thorium-230	2.56E+00	1.15E-06		1.09E-08	7.08E-09	1.17E-06	0.1%
Uranium-234	6.81E+01	2.39E-05		1.16E-07	5.80E-08	2.41E-05	2.6%
Uranium-235	1.14E+01	4.13E-06		1.72E-08	2.09E-05	2.51E-05	2.7%
Uranium-238	2.02E+02	9.42E-05		2.82E-07	7.78E-05	1.72E-04	18.3%
Total		2.90E-04	5.30E-04	8.29E-06	1.12E-04	**9.40E-04**	**100.0%**
Percent of Total		30.8%	56.4%	0.9%	11.9%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.212. ELCR (Excavation Worker) SWMU 145

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	6.94E+00	1.29E-05	9.26E-06	8.74E-09		2.22E-05	10.2%
Beryllium	1.86E+00			1.30E-09		1.30E-09	0.0%
Organic Compounds							
Total PAHs	4.80E-01	4.35E-06	1.79E-05	7.89E-09		2.22E-05	10.2%
Total PCBs	1.44E+01	3.57E-05	5.44E-05	7.16E-06		9.73E-05	44.7%
Radionuclides							
Cesium-137	2.38E-01	2.29E-08		4.23E-13	2.05E-06	2.07E-06	1.0%
Strontium-90	4.00E+00	1.28E-06		6.74E-11	2.65E-07	1.54E-06	0.71%
Technetium-99	8.20E+01	1.39E-06		1.71E-10	2.26E-08	1.42E-06	0.65%
Thorium-230	1.73E+00	7.74E-07		7.34E-09	4.78E-09	7.87E-07	0.36%
Uranium-235	6.91E-01	2.50E-07		1.04E-09	1.27E-06	1.52E-06	0.70%
Uranium-238	8.05E+01	3.75E-05		1.12E-07	3.10E-05	6.87E-05	31.5%
Total		9.43E-05	8.15E-05	7.30E-06	3.46E-05	**2.18E-04**	**100.0%**
Percent of Total		43.3%	37.4%	3.4%	15.9%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.213. ELCR (Industrial Worker) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	3.00E+01	7.86E-06	5.41E-05	5.11E-08		6.20E-05	7.1%
Beryllium	1.80E+00			1.70E-09		1.70E-09	0.0%
Nickel	3.70E+01			3.80E-09		3.80E-09	0.0%
Organic Compounds							
Total PAHs	1.80E-01	2.30E-07	9.05E-06	4.00E-09		9.28E-06	1.1%
Total PCBs	1.60E+00	5.59E-07	8.18E-06	1.08E-06		9.81E-06	1.1%
Radionuclides							
Americium-241	8.70E-01	5.90E-08		4.93E-09	1.10E-07	1.74E-07	0.0%
Cesium-137	5.10E+01	6.90E-07		1.22E-10	5.94E-04	5.95E-04	67.7%
Neptunium-237	3.10E-01	1.57E-08		1.11E-09	1.13E-06	1.14E-06	0.1%
Plutonium-239/240	1.61E+01	1.39E-06		1.08E-07	1.47E-08	1.51E-06	0.2%
Thorium-230	1.59E+01	1.00E-06		9.14E-08	5.95E-08	1.15E-06	0.1%
Uranium-234	2.53E+01	1.25E-06		5.80E-08	2.91E-08	1.33E-06	0.2%
Uranium-235	7.70E+00	3.92E-07		1.57E-08	1.91E-05	1.95E-05	2.2%
Uranium-238	3.02E+02	1.98E-05		5.70E-07	1.57E-04	1.78E-04	20.2%
Total		3.33E-05	7.13E-05	1.99E-06	7.72E-04	**8.78E-04**	**100.0%**
Percent of Total		3.8%	8.1%	0.2%	87.9%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.214. ELCR (Industrial Worker) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Radionuclides							
Uranium-238	5.99E+00	3.93E-07		1.13E-08	3.12E-06	3.52E-06	100.0%
Total		3.93E-07		1.13E-08	3.12E-06	**3.52E-06**	**100.00%**
Percent of Total		11.2%		0.3%	88.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.215. ELCR (Industrial Worker) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	1.38E+01	3.62E-06	2.49E-05	2.35E-08		2.85E-05	29.9%
Beryllium	7.32E-01			6.93E-10		6.93E-10	0.0%
Chromium	1.33E+02			6.30E-07		6.30E-07	0.7%
Nickel	7.19E+01			7.38E-09		7.38E-09	0.0%
Organic Compounds							
Total PAHs	4.60E-01	5.87E-07	2.31E-05	1.02E-08		2.37E-05	24.9%
Total PCBs	8.98E-01	3.14E-07	4.59E-06	6.04E-07		5.51E-06	5.8%
Radionuclides							
Neptunium-237	2.66E-01	1.35E-08		9.49E-10	9.68E-07	9.82E-07	1.0%
Plutonium-239/240	2.71E+01	2.34E-06		1.82E-07	2.47E-08	2.54E-06	2.7%
Uranium-234	3.01E+01	1.49E-06		6.92E-08	3.46E-08	1.59E-06	1.7%
Uranium-238	5.55E+01	3.64E-06		1.05E-07	2.81E-05	3.19E-05	33.4%
Total		1.20E-05	5.26E-05	1.63E-06	2.92E-05	**9.54E-05**	**100.0%**
Percent of Total		12.6%	55.1%	1.7%	30.6%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.216. ELCR (Industrial Worker) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	1.22E+01	3.20E-06	2.20E-05	2.08E-08		2.52E-05	0.44%
Beryllium	6.19E-01			5.86E-10		5.86E-10	0.00%
Nickel	3.39E+01			3.48E-09		3.48E-09	0.00%
Organic Compounds							
Total PAHs	1.11E+02	1.42E-04	5.58E-03	2.46E-06		5.73E-03	99.5%
Total PCBs	3.06E-01	1.07E-07	1.56E-06	2.06E-07		1.87E-06	0.03%
Bis(2-ethylhexyl)phthalate	4.76E+00	1.16E-08	5.76E-08	4.14E-10		6.97E-08	0.00%
Carbazole	5.46E+00	1.91E-08	2.56E-08			4.47E-08	0.00%
Radionuclides							
Uranium-238	1.38E+00	9.06E-08	NA	2.60E-09	7.18E-07	8.12E-07	0.01%
Total		1.45E-04	5.60E-03	2.70E-06	7.18E-07	**5.75E-03**	**100.0%**
Percent of Total		2.5%	97.4%	0.05%	0.01%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.217. ELCR (Industrial Worker) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Beryllium	7.30E-01			6.91E-10		6.91E-10	0.00%
Nickel	1.58E+01			1.62E-09		1.62E-09	0.01%
Organic Compounds							
Total PAHs	4.99E-01	6.36E-07	2.51E-05	1.11E-08		2.57E-05	58.3%
Total PCBs	6.00E-02	2.10E-08	3.07E-07	4.03E-08		3.68E-07	0.83%
Radionuclides							
Uranium-235	6.80E+00	3.46E-07	NA	1.38E-08	1.69E-05	1.72E-05	39.0%
Uranium-238	1.38E+00	9.05E-08	NA	2.60E-09	7.18E-07	8.11E-07	1.8%
Total		1.09E-06	2.54E-05	7.02E-08	1.76E-05	**4.41E-05**	**100.0%**
Percent of Total		2.5%	57.5%	0.16%	39.8%	100.0%	

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.
[b] Units for intakes for metals and organic compounds are mg/(kg-day). Units for intakes for radionuclides are pCi.

Table F.218. ELCR (Industrial Worker) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	6.91E+00	1.81E-06	1.25E-05	1.18E-08		1.43E-05	1.6%
Beryllium	6.15E-01			5.82E-10		5.82E-10	0.0%
Nickel				5.26E-09		5.26E-09	0.0%
Organic Compounds							
Total PAHs	6.37E+00	8.13E-06	3.20E-04	1.41E-07		3.29E-04	37.7%
Total PCBs	1.81E+01	6.33E-06	9.24E-05	1.22E-05		1.11E-04	12.7%
Radionuclides							
Neptunium-237	3.20E-01	1.62E-08		1.14E-09	1.16E-06	1.18E-06	0.1%
Plutonium-239/240	2.54E+00	2.19E-08		1.71E-09	2.32E-10	2.38E-08	0.0%
Technetium-99	1.21E+02	2.90E-07		3.44E-10	4.50E-08	3.35E-07	0.0%
Thorium-228	3.36E+00	8.49E-07		9.69E-08	1.19E-04	1.20E-04	13.8%
Thorium-230	2.14E+00	1.35E-07		1.23E-08	7.99E-09	1.55E-07	0.0%
Uranium-234	7.69E+01	3.80E-06		1.77E-07	8.85E-08	4.06E-06	0.5%
Uranium-235	3.50E+02	1.78E-07		7.13E-09	8.68E-06	8.86E-06	1.0%
Uranium-238	4.80E+02	3.15E-05		9.04E-07	2.50E-04	2.82E-04	32.4%
Total		5.30E-05	4.25E-04	1.35E-05	3.79E-04	**8.70E-04**	**100%**
Percent of Total		6.1%	48.8%	1.6%	43.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.219. ELCR (Industrial Worker) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Beryllium	8.50E-01			8.05E-10		8.05E-10	0.0%
Cadmium	2.80E+00			1.99E-09		1.99E-09	0.0%
Nickel	5.70E+02			5.85E-08		5.85E-08	0.0%
Organic Compounds							
Total PAHs	1.25E+01	1.59E-05	6.28E-04	2.78E-07		6.45E-04	57.3%
Total PCBs	1.50E+01	5.24E-06	7.66E-05	1.01E-05		9.19E-05	8.2%
Radionuclides							
Neptunium-237	1.68E+00	8.51E-08		6.00E-09	6.11E-06	6.21E-06	0.6%
Technetium-99	3.60E+02	8.62E-07		1.02E-09	1.34E-07	9.97E-07	0.1%
Thorium-230	4.88E+00	3.08E-07		2.80E-08	1.82E-08	3.54E-07	0.0%
Uranium-234	1.15E+02	5.68E-06		2.64E-07	1.32E-07	6.07E-06	0.5%
Uranium-235	1.66E+01	8.46E-07		3.38E-08	4.12E-05	4.20E-05	3.7%
Uranium-238	5.65E+02	3.71E-05		1.07E-06	2.94E-04	3.32E-04	29.5%
Total		6.61E-05	7.06E-04	1.20E-05	3.42E-04	**1.13E-03**	**100.0%**
Percent of Total		5.9%	62.7%	1.1%	30.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.220. ELCR (Recreational Users) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total	% of Total
Inorganic Chemicals (Metals)										
Arsenic	3.00E+01	6.20E-06	6.02E-08		3.52E-07	7.11E-05	2.69E-08		7.77E-05	11.2%
Beryllium	1.80E+00						8.98E-10		8.98E-10	0.0%
Nickel	3.70E+01						2.00E-09		2.00E-09	0.0%
Organic Compounds										
Total PAHs	1.80E-01	1.81E-07	2.47E-08	1.12E-04	1.46E-07	1.19E-05	2.12E-09		1.24E-04	17.8%
Total PCBs	1.60E+00	4.41E-07	4.89E-08	4.12E-06	2.89E-07	1.07E-05	5.70E-07		1.62E-05	2.3%
Radionuclides										
Americium-241	8.70E-01	1.81E-08	2.77E-12		2.26E-11		1.24E-09	4.13E-08	6.07E-08	0.0%
Cesium-137	5.10E+01	2.12E-07	4.61E-07		7.69E-07		3.07E-11	2.24E-04	2.25E-04	32.4%
Neptunium-237	3.10E-01	4.82E-09	2.11E-11		1.67E-10		2.78E-10	4.25E-07	4.30E-07	0.1%
Plutonium-239/240	1.61E+01	4.27E-07	1.66E-11	1.02E-06	1.35E-10		2.72E-08	5.54E-09	1.48E-06	0.2%
Thorium-230	1.59E+01	3.08E-07	1.16E-10		9.44E-10		2.29E-08	2.24E-08	3.55E-07	0.1%
Uranium-234	2.53E+01	3.83E-07	4.64E-10	1.12E-05	3.74E-09		1.46E-08	1.09E-08	1.16E-05	1.7%
Uranium-235	7.70E+00	1.30E-07	2.00E-10	3.79E-06	1.61E-09		3.94E-09	7.19E-06	1.11E-05	1.6%
Uranium-238	3.02E+02	4.44E-06	1.04E-08	1.64E-04	8.33E-08		1.43E-07	5.93E-05	2.28E-04	32.7%
Total		1.27E-05	6.06E-07	2.96E-04	1.65E-06	9.37E-05	8.15E-07	2.91E-04	**6.96E-04**	100.0%
% of Total		1.8%	0.1%	42.5%	0.2%	13.5%	0.1%	41.8%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.221. ELCR (Recreational Users) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Radionuclides										
Uranium-238	5.99E+00	1.21E-07	2.06E-10	3.77E-06	1.65E-09		2.84E-09	1.17E-06	5.07E-06	100.0%
Total		1.21E-07	2.06E-10	3.77E-06	1.65E-09	0.00E+00	2.84E-09	1.17E-06	**5.07E-06**	100.0%
% of Total		2.4%	0.0%	74.4%	0.0%	0.0%	0.1%	23.2%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.222. ELCR (Recreational Users) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Inorganic Chemicals (Metals)										
Arsenic	1.38E+01	2.85E-06	2.77E-08	NA	1.62E-07	3.27E-05	1.24E-08		3.57E-05	9.6%
Beryllium	7.32E-01						3.65E-10		3.65E-10	0.0%
Chromium	1.33E+02						3.32E-07		3.32E-07	0.1%
Nickel	7.19E+01						3.89E-09		3.89E-09	0.0%
Organic Compounds										
Total PAHs	4.60E-01	4.62E-07	6.31E-08	2.38E-04	3.74E-07	3.04E-05	5.41E-09		2.69E-04	72.0%
Total PCBs	8.98E-01	2.47E-07	2.74E-08	2.40E-06	1.62E-07	6.03E-06	3.20E-07		9.18E-06	2.5%
Radionuclides										
Neptunium-237	2.66E-01	4.14E-09	1.81E-11		1.44E-10		2.38E-10	3.65E-07	3.69E-07	0.1%
Plutonium-239/240	2.71E+01	7.18E-07	2.79E-11	1.71E-06	2.28E-10		4.57E-08	9.33E-09	2.48E-06	0.7%
Uranium-234	3.01E+01	4.57E-07	5.53E-10	1.33E-05	4.46E-09		1.74E-08	1.31E-08	1.37E-05	3.7%
Uranium-238	5.55E+01	1.12E-06	1.91E-09	3.05E-05	1.53E-08		2.63E-08	1.09E-05	4.26E-05	11.4%
Total		5.86E-06	1.21E-07	2.85E-04	7.18E-07	6.91E-05	7.63E-07	1.13E-05	**3.73E-04**	100.0%
% of Total		1.6%	0.0%	76.5%	0.2%	18.5%	0.2%	3.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.223. ELCR (Recreational Users) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Inorganic Chemicals (Metals)										
Arsenic	1.22E+01	2.52E-06	2.45E-08		1.43E-07	2.89E-05	1.09E-08		3.16E-05	0.1%
Beryllium	6.19E-01						3.09E-10		3.09E-10	0.0%
Organic Compounds										
Total PAHs	1.11E+02	1.12E-04	1.52E-05	4.98E-02	9.01E-05	7.33E-03	1.30E-06		5.74E-02	99.9%
Total PCBs	3.06E-01	8.43E-08	9.34E-09	9.41E-07	5.52E-08	2.05E-06	1.09E-07		3.25E-06	0.0%
Bis(2-ethylhexyl)phthalate	4.76E+00	9.18E-09	9.35E-11		5.43E-10	7.57E-08	2.20E-10		8.57E-08	0.0%
Carbazole	5.46E+00	1.50E-08	1.92E-11		1.07E-10	3.37E-08			4.88E-08	0.0%
Radionuclides										
Uranium-238	1.38E+00	2.78E-08	4.74E-11	1.28E-06	3.80E-10	NA	6.53E-10	2.70E-07	1.58E-06	0.0%
Total		1.14E-04	1.53E-05	4.98E-02	9.03E-05	7.37E-03	1.43E-06	2.70E-07	**5.74E-02**	100.0%
% of Total		0.2%	0.0%	86.8%	0.2%	12.8%	0.0%	0.0%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.224. ELCR (Recreational Users) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Inorganic Chemicals (Metals)										
Beryllium	7.30E-01	NA	NA	NA	NA	NA	3.64E-10	NA	3.64E-10	0.0%
Nickel	1.58E+01	NA	NA	NA	NA	NA	8.54E-10	NA	8.54E-10	0.0%
Organic Compounds										
Total PAHs	4.99E-01	5.02E-07	6.85E-08	2.55E-04	4.05E-07	3.30E-05	5.87E-09	NA	2.89E-04	95.9%
Total PCBs	6.00E-02	1.65E-08	1.83E-09	3.36E-07	1.08E-08	4.03E-07	2.14E-08	NA	7.90E-07	0.3%
Radionuclides										
Uranium-235	6.80E+00	1.06E-07	1.77E-10	3.40E-06	1.42E-09	NA	3.48E-09	6.35E-06	9.86E-06	3.3%
Uranium-238	1.38E+00	2.78E-08	4.74E-11	1.28E-06	3.80E-10	NA	6.53E-10	2.70E-07	1.58E-06	0.5%
Total		6.52E-07	7.05E-08	2.60E-04	4.18E-07	3.34E-05	3.26E-08	6.62E-06	**3.01E-04**	100.0%
% of Total		0.2%	0.0%	86.3%	0.1%	11.1%	0.0%	2.2%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.225. ELCR (Recreational Users) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Inorganic Chemicals (Metals)										
Arsenic	6.91E+00	1.43E-06	1.39E-08		8.11E-08	1.64E-05	6.20E-09		1.79E-05	0.5%
Beryllium	6.15E-01						3.07E-10		3.07E-10	0.0%
Nickel	5.13E+01						2.77E-09		2.77E-09	0.0%
Organic Compounds										
Total PAHs	6.37E+00	6.40E-06	8.74E-07	2.89E-03	5.17E-06	4.21E-04	7.49E-08		3.32E-03	83.7%
Total PCBs	1.81E+01	4.99E-06	5.53E-07	4.47E-05	3.27E-06	1.21E-04	6.45E-06		1.81E-04	4.6%
Radionuclides										
Neptunium-237	3.20E-01	4.98E-09	2.18E-11		1.73E-10		2.87E-10	4.39E-07	4.44E-07	0.0%
Plutonium-239/240	2.54E-01	6.73E-09	2.62E-13	1.45E-08	2.13E-12		4.28E-10	8.74E-11	2.17E-08	0.0%
Technetium-99	1.21E+02	8.90E-08	1.78E-08		5.69E-08		8.64E-11	1.69E-08	1.81E-07	0.0%
Thorium-228	3.36E+00	2.61E-07	1.08E-07		8.10E-07		2.43E-08	4.49E-05	4.61E-05	1.2%
Thorium-230	2.14E+00	4.14E-08	1.56E-11		1.27E-10		3.08E-09	3.01E-09	4.77E-08	0.0%
Uranium-234	7.69E+01	1.17E-06	1.41E-09	3.32E-05	1.14E-08		4.44E-08	3.34E-08	3.45E-05	0.9%
Uranium-235	3.50E+00	5.48E-08	9.10E-11	1.96E-06	7.30E-10		1.79E-09	3.27E-06	5.29E-06	0.1%
Uranium-238	4.80E+02	9.67E-06	1.65E-08	2.60E-04	1.32E-07		2.27E-07	9.41E-05	3.64E-04	9.2%
Total		2.41E-05	1.58E-06	3.23E-03	9.53E-06	5.59E-04	6.84E-06	1.43E-04	**3.97E-03**	100.0%
% of Total		0.6%	0.0%	81.3%	0.2%	14.1%	0.2%	3.6%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.226. ELCR (Recreational Users) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion - Soil	Ingestion - Deer	Ingestion - Quail	Ingestion - Rabbit	Dermal	Inhalation	External Exposure	Total Risk	% of Total
Inorganic Chemicals (Metals)										
Beryllium	8.50E-01						4.24E-10		4.24E-10	0.0%
Cadmium	2.80E+00		7.54E-10	3.04E-06	4.07E-09		1.05E-09		3.05E-06	0.0%
Nickel	5.70E+02						3.08E-08		3.08E-08	0.0%
Organic Compounds										
Total PAHs	1.25E+01	1.26E-05	1.72E-06	5.64E-03	1.02E-05	8.26E-04	1.47E-07		6.49E-03	90.8%
Total PCBs	1.52E+01	4.19E-06	4.64E-07	3.75E-05	2.74E-06	1.02E-04	5.42E-06		1.52E-04	2.1%
Radionuclides										
Neptunium-237	1.68E+00	2.61E-08	1.15E-10		9.07E-10		1.51E-09	2.30E-06	2.33E-06	0.0%
Technetium-99	3.60E+02	2.65E-07	5.30E-08		1.69E-07		2.57E-10	5.04E-08	5.38E-07	0.0%
Thorium-230	4.88E+00	9.46E-08	3.57E-11		2.90E-10		7.04E-09	6.88E-09	1.09E-07	0.0%
Uranium-234	1.15E+02	1.74E-06	2.11E-09	4.94E-05	1.71E-08		6.64E-08	4.99E-08	5.13E-05	0.7%
Uranium-235	1.66E+01	2.60E-07	4.31E-10	7.67E-06	3.46E-09		8.49E-09	1.55E-05	2.34E-05	0.3%
Uranium-238	5.65E+02	1.14E-05	1.94E-08	3.06E-04	1.56E-07		2.68E-07	1.11E-04	4.28E-04	6.0%
Total		3.05E-05	2.26E-06	6.04E-03	1.32E-05	9.28E-04	5.95E-06	1.29E-04	**7.15E-03**	100.0%
% of Total		0.4%	0.0%	84.5%	0.2%	13.0%	0.1%	1.8%		

[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.227. ELCR (Rural Resident) SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	3.00E+01	7.05E-05	1.39E-04	9.91E-08		2.09E-04	4.9%
Beryllium	1.80E+00			3.31E-09		3.31E-09	0.0%
Nickel	3.70E+01			7.37E-09		7.37E-09	0.0%
Organic Compounds		-	-	-	-	-	-
Total PAHs	1.80E-01	2.06E-06	2.32E-05	7.79E-09		2.53E-05	0.6%
Total PCBs	1.60E+00	5.01E-06	2.10E-05	2.10E-06		2.81E-05	0.7%
Radionuclides							
Americium-241	8.70E-01	2.38E-07		5.52E-09	5.53E-07	7.96E-07	0.0%
Cesium-137	5.10E+01	2.78E-06		1.37E-10	2.99E-03	3.00E-03	70.5%
Neptunium-237	3.10E-01	6.33E-08		1.24E-09	5.69E-06	5.75E-06	0.1%
Plutonium-239/240	1.61E+01	5.60E-06		1.21E-07	7.41E-08	5.79E-06	0.1%
Thorium-230	1.59E+01	4.05E-06		1.02E-07	3.00E-07	4.45E-06	0.1%
Uranium-234	2.53E+01	5.03E-06		6.50E-08	1.46E-07	5.24E-06	0.1%
Uranium-235	7.70E+00	1.58E-06		1.76E-08	9.62E-05	9.78E-05	2.3%
Uranium-238	3.02E+02	8.00E-05		6.38E-07	7.93E-04	8.73E-04	20.5%
Total		1.77E-04	1.83E-04	3.17E-06	3.89E-03	**4.25E-03**	**100.0%**
Percent of Total		4.2%	4.3%	0.1%	91.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.228. ELCR (Rural Resident) SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Radionuclides							
Uranium-238	5.99E+00	1.58E-06		1.26E-08	1.57E-05	1.73E-05	100.0%
Total		1.58E-06		1.26E-08	1.57E-05	**1.73E-05**	**100.0%**
Percent of Total		9.2%	0.0%	0.1%	90.8%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.229. ELCR (Rural Resident) SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	1.38E+01	3.24E-05	6.38E-05	4.56E-08		9.62E-05	26.8%
Beryllium	7.32E-01			1.35E-09		1.35E-09	0.0%
Chromium	1.33E+02			1.22E-06		1.22E-06	0.3%
Nickel	7.19E+01			1.43E-08		1.43E-08	0.0%
Organic Compounds							
Total PAHs	4.60E-01	5.26E-06	5.93E-05	1.99E-08		6.46E-05	18.0%
Total PCBs	8.98E-01	2.81E-06	1.18E-05	1.18E-06		1.58E-05	4.4%
Radionuclides							
Neptunium-237	2.66E-01	5.43E-08		1.06E-09	4.88E-06	4.93E-06	1.4%
Plutonium-239/240	2.71E+01	9.42E-06		2.04E-07	1.25E-07	9.75E-06	2.7%
Uranium-234	3.01E+01	5.99E-06		7.75E-08	1.75E-07	6.24E-06	1.7%
Uranium-238	5.55E+01	1.47E-05		1.17E-07	1.46E-04	1.60E-04	44.7%
Total		7.06E-05	1.35E-04	2.88E-06	1.51E-04	**3.59E-04**	**100.0%**
Percent of Total		19.7%	37.5%	0.8%	42.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.230. ELCR (Rural Resident) SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	1.22E+01	2.86E-05	5.64E-05	4.03E-08		8.51E-05	0.54%
Beryllium	6.19E-01			1.14E-09		1.14E-09	0.00%
Nickel	3.39E+01			6.75E-09		6.75E-09	0.00%
Organic Compounds							
Total PAHs	1.11E+02	1.27E-03	1.43E-02	4.81E-06		1.56E-02	99.4%
Total PCBs	3.06E-01	9.58E-07	4.01E-06	4.02E-07		5.37E-06	0.03%
Bis(2-ethylhexyl) phthalate	4.76E+00	3.13E-08	9.39E-08	3.74E-10		1.26E-07	0.00%
Carbazole	5.46E+00	1.71E-07	6.57E-08			2.37E-07	0.01%
Radionuclides							
Uranium-238	1.38E+00	3.65E-07		2.91E-09	3.62E-06	3.99E-06	0.03%
Total		1.30E-03	1.44E-02	5.26E-06	3.62E-06	**1.57E-02**	**100.0%**
Percent of Total		8.3%	91.7%	0.03%	0.02%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.231. ELCR (Rural Resident) SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Beryllium	7.30E-01			1.34E-09		1.34E-09	0.0%
Nickel	1.58E+01			3.15E-09		3.15E-09	0.0%
Organic Compounds							
Total PAHs	4.99E-01	5.70E-06	6.43E-05	2.16E-08		7.01E-05	43.4%
Total PCBs	6.00E-02	1.88E-07	7.86E-07	7.88E-08		1.05E-06	0.7%
Radionuclides							
Uranium-235	6.80E+00	1.40E-06		1.55E-08	8.50E-05	8.64E-05	53.5%
Uranium-238	1.38E+00	3.65E-07		2.91E-09	3.62E-06	3.99E-06	2.5%
Total		7.65E-06	6.51E-05	1.23E-07	8.86E-05	**1.61E-04**	**100.0%**
Percent of Total		4.7%	40.3%	0.1%	54.9%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.232. ELCR (Rural Resident) SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Arsenic	6.91E+00	1.62E-05	3.19E-05	2.28E-08		4.82E-05	1.5%
Beryllium	6.15E-01			1.13E-09		1.13E-09	0.0%
Nickel	5.13E+01			1.02E-08		1.02E-08	0.0%
Organic Compounds							
Total PAHs	6.37E+00	7.28E-05	8.21E-04	2.76E-07		8.94E-04	27.0%
Total PCBs	1.81E+01	5.67E-05	2.37E-04	2.38E-05		3.17E-04	9.6%
Radionuclides							
Neptunium-237	3.20E-01	6.53E-08		1.28E-09	5.87E-06	5.94E-06	0.2%
Plutonium-239/240	2.54E-01	8.83E-08		1.91E-09	1.17E-09	9.14E-08	0.0%
Technetium-99	1.21E+02	1.16E-06		3.84E-10	2.26E-07	1.39E-06	0.0%
Thorium-228	3.36E+00	3.42E-06		1.08E-07	6.00E-04	6.04E-04	18.2%
Thorium-230	2.14E+00	5.44E-07		1.37E-08	4.03E-08	5.98E-07	0.0%
Uranium-234	7.69E+01	1.53E-05		1.98E-07	4.46E-07	1.60E-05	0.5%
Uranium-235	3.50E+00	7.19E-07		7.98E-09	4.37E-05	4.45E-05	1.3%
Uranium-238	4.80E+02	1.27E-04		1.01E-06	1.26E-03	1.39E-03	41.8%
Total		2.94E-04	1.09E-03	2.54E-05	1.91E-03	**3.32E-03**	**100.0%**
Percent of Total		8.9%	32.9%	0.8%	57.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

Table F.233. ELCR (Rural Resident) SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion	Dermal	Inhalation	External Exposure	Total Risk	Percent of Total
Inorganic (metals)							
Beryllium	8.50E-01			1.56E-09		1.56E-09	0.0%
Cadmium	2.80E+00			3.86E-09		3.86E-09	0.0%
Nickel	5.70E+02			1.13E-07		1.13E-07	0.0%
Organic Compounds							
Total PAHs	1.25E+01	1.43E-04	1.61E-03	5.41E-07		1.75E-03	44.7%
Total PCBs	1.52E+01	4.76E-05	1.99E-04	2.00E-05		2.67E-04	6.8%
Radionuclides							
Neptunium-237	1.68E+00	3.43E-07		6.71E-09	3.08E-05	3.12E-05	0.8%
Technetium-99	3.60E+02	3.47E-06		1.15E-09	6.74E-07	4.15E-06	0.1%
Thorium-230	4.88E+00	1.24E-06		3.14E-08	9.20E-08	1.37E-06	0.0%
Uranium-234	1.15E+02	2.29E-05		2.96E-07	6.67E-07	2.39E-05	0.6%
Uranium-235	1.66E+01	3.41E-06		3.78E-08	2.07E-04	2.11E-04	5.4%
Uranium-238	5.65E+02	1.49E-04		1.19E-06	1.48E-03	1.63E-03	41.6%
Total		3.71E-04	1.81E-03	2.22E-05	1.72E-03	**3.93E-03**	**100.0%**
Percent of Total		9.5%	46.1%	0.6%	43.9%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/kg. Units for radionuclides are pCi/g.

F.5.3.3 Vapor Intrusion into Basements from Soil

Exposure of on-site residents to vapors from soil contaminants intruding into basements is a potential pathway. To examine potential risks and hazards, vapor intrusion modeling was completed and examined for three POEs: the property boundary, the plant boundary, and a future on-site resident. The HQs and ELCRs for the modeled vapor concentrations are presented in Table E.3.35 of Appendix E. Modeled concentrations for the on-site POE showed an HQ greater than 0.1 for vapor intrusion from TCE, *cis*-1,2-DCE, vinyl chloride, or mercury intrusion for the following:

- SWMU 2: TCE, and *cis*-1,2-DCE
- SWMU 3: mercury
- SWMU 4: TCE, *cis*-1,2-DCE, and vinyl chloride
- SWMU 7: 1,1-DCE, mercury, and vinyl chloride
- SWMU 30: mercury, 1,1-DCE, and TCE
- SWMU 145: mercury

ELCRs for the on-site POE were greater than 1E-06 for several SWMUs based on modeled contaminant concentrations. The following summarizes those SWMUs exhibiting elevated risks based on modeled soil concentrations.

- SWMUs 2: TCE
- SWMU 3: TCE
- SWUM 4: TCE and vinyl chloride
- SWMU 7: TCE, vinyl chloride, and 1,1-DCE
- SWMU 30: TCE and 1,1-DCE.

Vapor intrusion into basements also was modeled at the plant boundary and property boundary. At the plant boundary all HIs were below 0.1. ELCRs were below 1E-06 for all SWMUs except for SWMUs 2, 4, 7, and 30. The following lists the risk driver for each.

- SWMU 2: TCE
- SWMU 4: TCE and vinyl chloride
- SWMU 7: 1,1-DCE
- SWMU 30: TCE and 1,1-DCE

At the property boundary all HIs were below 0.1. The ELCR for TCE exceeded *de minimus* risk levels at the property boundary for TCE at SWMUs 2 , 4, and 30. All other risks/hazards were below *de minimums* levels at the property boundary. The quantitative assessment of potential risks and hazards due to exposure to vapor intrusion is summarized in Table 5.14. Table F.263 includes which SWMUs exceeded *de minimus* risk and hazard thresholds for vapor intrusion modeling for the on-site receptor and the receptor at the property boundary.

F.5.4 RISK CHARACTERIZATION FOR RESIDENTIAL USE OF GROUNDWATER DRAWN FROM THE RGA

This subsection presents the risk for residential use of groundwater drawn from the RGA. Tables and discussion in this subsection provide the total HI or ELCR for the each source area and list the major exposure routes and COPCs contributing to the total HI or ELCR. Environmental data for each source area was used to model groundwater concentrations at the POEs (see Section 5 and Appendix E for details of the groundwater modeling). The groundwater assessment is conducted only for the residential scenario, but was conducted for all SWMUs including SWMU 145. Characterization of risks from groundwater at off-site POEs (plant boundary, property boundary, and Ohio River) are discussed in Section F.5.5.

F.5.4.1 Systemic Toxicity (Groundwater Use)

Tables F.234 through F.249 summarize the HIs for the modeled groundwater concentrations at each SWMU for the child and adult resident. As shown in these tables, the total scenario HIs are greater than 1 for the all of the SWMUs except SWMU 6 for both the child and adult resident. The source with the greatest HI for the child receptor is SWMU 2, which has a HI=1300, with the major contribution coming from ingestion of water containing TCE (52.1%) and *cis*-1,2-DCE (46.8%). The source with the greatest HI for the adult is SWMU 2, which has a HI=379, with the major contribution coming from ingestion of water (45%) and household inhalation (27.5%). The major contributors are TCE (37%) and *cis*-1,2-DCE (62%).

Table F.234. HI Child Residential Groundwater Use at SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	3.54E-02	1.13E+01	2.39E-02			1.13E+01	0.9%
Manganese	7.16E-01	1.49E+00	3.23E-02			1.52E+00	0.1%
Uranium	9.86E-03	1.58E+00	1.68E-03			1.58E+00	0.1%
Organic Compounds							
cis-1,2-DCE	1.15E+01	1.10E+02	3.89E+00	5.59E+01	4.37E+02	6.07E+02	46.8%
Naphthalene	9.38E-04	4.50E-03	1.02E-03	5.31E-02	4.15E-01	4.74E-01	0.0%
TCE	1.48E+00	4.73E+02	1.48E+02	6.29E+00	4.92E+01	6.76E+02	52.1%
Total Hazard		5.98E+02	1.52E+02	6.22E+01	4.87E+02	1.30E+03	**100.00%**
% of Total Hazard		46.0%	11.7%	4.8%	37.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.235. HI Child Residential Groundwater Use at SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	3.29E-02	1.05E+01	2.22E-02			1.05E+01	47.9%
Manganese	8.95E-01	3.58E+00	7.75E-02			3.65E+00	16.6%
Uranium	4.89E-02	7.82E+00	7.97E-03			7.82E+00	35.5%
Total Hazard		2.19E+01	1.08E-01	0.00E+00	0.00E+00	**2.20E+01**	**100.0%**
% of Total Hazard		99.5%	0.5%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.236. HI Child Residential Groundwater Use at SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.77E-02	5.66E+00	1.20E-02			5.67E+00	1.0%
Manganese	5.76E-01	1.20E+00	2.60E-02			1.23E+00	0.2%
Organic Compounds							
cis-1,2-DCE	6.68E-01	6.41E+00	2.26E-01	3.25E+00	2.54E+01	3.53E+01	6.1%
TCE	1.18E+00	3.77E+02	1.17E+02	5.02E+00	3.92E+01	5.39E+02	92.5%
Vinyl Chloride	2.61E-02	8.34E-01	1.80E-02	9.45E-03	3.46E-01	1.21E+00	0.2%
Total Hazard		3.91E+02	1.18E+02	8.27E+00	6.50E+01	5.82E+02	100.0%
% of Total Hazard		67.2%	20.2%	1.4%	11.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.237. HI Child Residential Groundwater Use at SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	9.25E-03	2.96E+00	6.25E-03			2.96E+00	37.5%
Manganese	1.01E+00	2.11E+00	4.56E-02			2.15E+00	27.2%
Organic Compounds							
Naphthalene	5.55E-03	2.66E-02	6.04E-03	3.14E-01	2.45E+00	2.80E+00	35.4%
Total Hazard		5.09E+00	5.79E-02	3.14E-01	2.45E+00	**7.91E+00**	**100.0%**
% of Total Hazard		64.3%	0.7%	4.0%	31.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.

[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.238. HI Child Residential Groundwater Use at SWMU 6

COPC	Exposure Point Concentration	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
			NO COPCS[1]				

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.239. HI Child Residential Groundwater Use at SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.78E-02	5.69E+00	1.20E-02			5.70E+00	30.2%
Manganese	3.32E-01	6.92E-01	1.50E-02			7.07E-01	3.7%
Uranium	3.46E-03	5.53E-01	5.64E-04			5.54E-01	2.9%
Organic Compounds							
1,1-DCE	8.98E-02	1.72E-01	6.45E-03	7.62E-02	5.96E-01	8.51E-01	4.5%
cis-1,2-DCE	2.35E-02	2.25E-01	7.95E-03	1.14E-01	8.94E-01	1.24E+00	6.6%
Total PCBs	5.23E-05	2.51E-01	2.83E+00	1.27E-01	9.94E-01	4.20E+00	22.3%
TCE	1.09E-02	3.48E+00	1.09E+00	4.63E-02	3.63E-01	4.98E+00	26.4%
Vinyl Chloride	1.35E-02	4.32E-01	9.30E-03	2.29E-02	1.79E-01	6.43E-01	3.4%
Total Hazard		1.15E+01	3.97E+00	3.87E-01	3.03E+00	**1.89E+01**	**100.0%**
% of Total Hazard		60.9%	21.0%	2.0%	16.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.

[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.240. HI Child Residential Groundwater Use at SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.77E-02	5.66E+00	1.20E-02			5.67E+00	1.7
Manganese	3.78E-01	7.88E-01	1.71E-02			8.05E-01	0.2%
Selenium	1.51E-02	2.90E-01	5.70E-04			2.90E-01	0.1%
Uranium	8.40E-03	1.34E+00	1.37E-03			1.34E-01	0.4%
Organic Compounds							
1,1-DCE	6.05E-02	1.16E-01	4.35E-03	5.13E-02	4.01E-01	5.73E-01	0.2%
TCE	7.12E-01	2.28E+02	7.10E+01	3.03E+00	2.37E+01	3.25E+02	97.4%
Total Hazard		2.36E+02	7.10E+01	3.08E+00	2.41E+01	3.34E+02	**100.0%**
% of Total Hazard		70.6%	21.3%	0.9%	7.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.241. HI Child Residential Groundwater Use at SWMU 145

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Antimony	7.99E-02	1.92E+01	8.30E-01			2.00E+01	50.1%
Arsenic	6.21E-02	1.98E+01	4.20E-02			1.99E+01	49.9%
Total Hazard		3.90E+01	8.72E-01	0.00E+00	0.00E+00	**3.99E+01**	**100.0%**
% of Total Hazard		97.8%	2.2%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.242. HI Adult Residential Groundwater Use at SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	3.54E-02	3.23E+00	1.43E-02			3.25E+00	0.9%
Manganese	7.16E-01	4.26E-01	1.93E-02			4.46E-01	0.1%
Uranium	9.86E-03	4.50E-01	9.61E-04			4.51E-01	0.1%
Organic Compounds							
cis-1,2-DCE	1.15E+01	3.15E+01	2.33E+00	1.20E+01	9.37E+01	1.40E+02	36.8%
Naphthalene	9.38E-04	1.28E-03	6.10E-04	1.14E-02	8.89E-02	1.02E-01	0%
TCE	1.48E+00	1.35E+02	8.83E+01	1.35E+00	1.05E+01	2.35E+02	62.1%
Total Hazard		1.71E+02	9.07E+01	1.33E+01	1.04E+02	3.79E+02	**100.00%**
% of Total Hazard		45.0%	23.9%	3.5%	27.5%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.243. HI Adult Residential Groundwater Use at SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	3.29E-02	3.00E+00	1.33E-02			3.02E+00	47.7%
Manganese	8.95E-01	1.02E+00	4.64E-02			1.07E+00	16.9%
Uranium	4.89E-02	2.23E+00	4.77E-03			2.24E+00	35.4%
Total Hazard		6.26E+00	6.44E-02	0.00E+00	0.00E+00	**6.32E+00**	**100.0%**
% of Total Hazard		99.0%	1.0%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.244. HI Adult Residential Groundwater Use at SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.77E-02	1.62E+00	7.16E-03			1.62E+00	0.8%
Manganese	5.76E-01	3.43E-01	1.56E-02			3.59E-01	0.2%
Organic Compounds							
cis-1,2-DCE	6.68E-01	1.83E+00	1.35E-01	6.94E-01	5.44E+00	8.10E+00	4.1%
TCE	1.18E+00	1.08E+02	7.02E+01	1.07E+00	8.41E+00	1.87E+02	94.7%
Vinyl Chloride	2.61E-02	2.38E-01	1.08E-02	9.45E-03	7.41E-02	3.33E-01	0.2%
Total Hazard		1.12E+02	7.03E+01	1.77E+00	1.39E+01	**1.98E+02**	**100.0%**
% of Total Hazard		56.5%	35.6%	0.9%	7.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.245. HI Adult Residential Groundwater Use at SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	9.25E-03	8.45E-01	3.74E-03			8.48E-01	40.8%
Manganese	1.01E+00	6.02E-01	2.73E-02			6.29E-01	30.2%
Organic Compounds							
Naphthalene	5.55E-03	7.60E-03	3.61E-03	6.72E-02	5.26E-01	6.05E-01	29.0%
Total Hazard		1.45E+00	3.46E-02	6.72E-02	5.26E-01	**2.08E+00**	**100.0%**
% of Total Hazard		69.8%	1.7%	3.2%	25.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.246. HI Adult Residential Groundwater Use at SWMU 6

COPC	Exposure Point Concentration	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
			NO COPCS[1]				

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.247. HI Adult Residential Groundwater Use at SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.78E-02	1.63E+00	7.20E-03			1.63E+00	25.5%
Manganese	3.32E-01	1.98E-01	8.97E-03			2.07E-01	3.2%
Uranium	3.46E-03	1.58E-01	3.37E-04			1.58E-01	2.5%
Organic Compounds							
1,1-DCE	8.98E-02	4.92E-02	3.86E-03	1.63E-02	1.28E-01	1.97E-01	3.1%
cis-1,2-DCE	2.35E-02	6.44E-02	4.76E-03	2.44E-02	1.92E-01	2.85E-01	4.5%
Total PCBs	5.23E-05	7.16E-02	1.69E+00	2.71E-02	2.13E-01	2.01E+00	31.4%
TCE	1.09E-02	9.95E-01	6.50E-01	9.90E-03	7.77E-02	1.73E+00	27.1%
Vinyl Chloride	1.35E-02	1.23E-01	5.57E-03	4.89E-03	3.84E-02	1.72E-01	2.7%
Total Hazard		3.29E+00	2.37E+00	8.26E-02	6.48E-01	**6.39E+00**	**100.0%**
% of Total Hazard		51.4%	37.2%	1.3%	10.1%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.248. HI Adult Residential Groundwater Use at SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Arsenic	1.77E-02	1.62E+00	7.16E-03			1.62E+00	1.4%
Manganese	3.78E-01	2.25E-01	1.02E-02			2.35E-01	0.2%
Selenium	1.51E-02	8.27E-02	3.41E-04			8.31E-02	0.1%
Uranium	8.40E-03	3.84E-01	8.19E-04			3.84E-01	0.3%
Organic Compounds							
1,1-DCE	6.05E-02	5.00E-01	2.50E-01	3.99E-01	3.99-01	1.55E+00	1.3%
TCE	7.12E-01	6.50E+01	4.25E+01	6.49E-01	5.07E+00	1.13E+02	96.7%
Total Hazard		6.78E+01	4.27E+01	1.05E+00	5.47E+00	**1.17E+02**	**100.0%**
% of Total Hazard		57.9%	36.5%	0.9%	4.7%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.249. HI Adult Residential Groundwater Use at SWMU 145

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Hazard	Percent of Total Hazard
Inorganic Compounds							
Antimony	7.99E-02	5.47E+00	4.97E-01			5.97E+00	51.2%
Arsenic	6.21E-02	5.67E+00	2.51E-02			5.70E+00	48.8%
Total Hazard		1.11E+01	5.22E-01	0.00E+00	0.00E+00	**1.17E+01**	**100.0%**
% of Total Hazard		95.5%	4.5%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

F.5.4.2 Excess Lifetime Cancer Risk (Groundwater Use)

Tables F.250 through F.257 summarize the ELCRs for the modeled groundwater exposure above each SWMU for the rural resident over a lifetime. As shown in these tables, the total ELCRs (bold value in "Total Risk" column) are greater than both 1×10^{-6} and 1×10^{-4} for all of the SWMUs except SWMU 6, which has no groundwater COCs. The source with the greatest ELCR is SWMU 2, which has an ELCR of 4.69×10^{-2}. The major pathway is inhalation of vapor during household water use (61.3%). The major contribution is from TCE (98%).

Table F.250. ELCR Residential Groundwater Use at SWMU 2

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	3.54E-02	9.35E-04	3.13E-06			9.38E-04	2.0%
Organic Compounds							
TCE	1.48E+00	8.39E-03	5.16E-03	3.68E-03	2.88E-02	3.09E-02	98.0%
Radionuclides							
Technetium-99	1.02E+02	5.60E-06				5.60E-06	0.0%
Uranium-234	1.58E+00	2.23E-06				2.23E-06	0.0%
Uranium-238	1.81E+00	2.68E-06				2.68E-06	0.0%
Total Risk		9.34E-03	5.16E-03	3.68E-03	2.88E-02	**4.69E-02**	**100.0%**
% of Total Risk		19.9%	11.0%	7.8%	61.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.251. ELCR Residential Groundwater Use at SWMU 3

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	3.29E-02	8.69E-04	2.91E-06			8.72E-04	72.4%
Radionuclides							
Technetium-99	5.56E+03	3.05E-04				3.05E-04	25.3%
Uranium-238	1.59E+01	2.76E-05				2.76E-05	2.3%
Total Risk		1.20E-03	2.91E-06	0.00E+00	0.00E+00	**1.20E-03**	**100.0%**
% of Total Risk		99.8%	0.2%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.252. ELCR Residential Groundwater Use at SWMU 4

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	1.77E-02	4.68E-04	1.57E-06			4.69E-04	0.9%
Organic Compounds							
TCE	1.18E+00	6.69E-03	4.10E-03	2.93E-03	2.29E-02	3.67E-02	67.7%
Vinyl Chloride	2.61E-02	6.90E-04	1.58E-02	6.20E-06	4.85E-05	1.65E-02	30.5%
Radionuclides							
Technetium-99	9.01E+03	4.94E-04	NA	NA	NA	4.94E-04	0.9%
Total Risk		8.34E-03	1.99E-02	2.94E-03	2.30E-02	**5.41E-02**	100.0%
% of Total Risk		15.4%	36.7%	5.4%	42.4%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.253. ELCR Residential Groundwater Use at SWMU 5

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	9.25E-03	2.44E-04	8.18E-07			2.45E-04	97.2%
Radionuclides							
Technetium-99	1.27E+02	6.97E-06				6.97E-06	2.8%
Total Risk		2.51E-04	8.18E-07	0.00E+00	0.00E+00	**2.52E-04**	**100.0%**
% of Total Risk		99.7%	0.3%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.254. ELCR Residential Groundwater Use at SWMU 6

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
			NO COPCs[1]				

[1]Modeling analysis (Appendix E) did not show any of the identified COPCs at this site as migrating to groundwater.

Table F.255. ELCR Residential Groundwater Use at SWMU 7

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	1.78E-02	4.70E-04	1.57E-06			4.72E-04	15.1%
Organic Compounds							
1,1-DCE	8.98E-02	9.49E-04	5.63E-05	1.21E-04	9.48E-04	2.08E-03	66.4%
Total PCBs	5.23E-05	3.68E-07	6.58E-06	1.41E-07		7.09E-06	0.2%
TCE	1.09E-02	6.18E-05	3.80E-05	2.71E-05		1.27E-04	4.1%
Vinyl Chloride	1.35E-02	3.57E-04	1.22E-05	3.21E-06		3.72E-04	11.9%
Radionuclides							
Technetium-99	9.09E+02	4.99E-05				4.99E-05	1.6%
Uranium-234	7.94E+00	1.11E-05				1.11E-05	0.4%
Uranium-238	7.59E+00	1.32E-05				1.32E-05	0.4%
Total Risk		1.91E-03	1.15E-04	1.52E-04	9.48E-04	**3.13E-03**	**100.0%**
% of Total Risk		61.2%	3.7%	4.9%	30.3%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.256. ELCR Residential Groundwater Use at SWMU 30

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	1.77E-02	4.68E-04	1.57E-06			4.69E-04	2.0%
Organic Compounds							
1,1-DCE	6.05E-02	6.39E-04	3.79E-05	8.16E-05	6.41E-04	1.40E-03	5.8%
TCE	7.12E-01	4.04E-03	2.48E-03	1.77E-03	1.38E-02	2.21E-02	92.1%
Radionuclides							
Technetium-99	2.87E+02	1.57E-05				1.57E-05	0.1%
Uranium-234	3.99E+00	5.63E-06				5.63E-06	0.0%
Uranium-238	5.91E+00	1.03E-05				1.03E-05	0.0%
Total Risk		5.18E-03	2.52E-03	1.85E-03	1.45E-02	**2.40E-02**	**100.0%**
% of Total Risk		21.6%	10.5%	7.7%	60.2%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

Table F.257. ELCR Residential Groundwater Use at SWMU 145

COPC	Exposure Point Concentration[a]	Ingestion of Water	Dermal Contact	Shower Inhalation	Household Inhalation	Total Risk	Percent of Total Risk
Inorganic Compounds							
Arsenic	6.21E-02	1.64E-03	5.49E-06			1.65E-03	74.8%
Radionuclides							
Technetium-99	1.01E+04	5.54E-04				5.54E-04	25.2%
Total Risk		2.19E-03	5.49E-06	0.00E+00	0.00E+00	**2.20E-03**	**100.0%**
% of Total Risk		99.8%	0.25%	0.0%	0.0%		

Blank cells indicate that the exposure route is not appropriate to the COPC.
[a] Units for metals and organic compounds are mg/L. Units for radionuclides are pCi/L.

F.5.5 RISK CHARACTERIZATION FOR RESIDENTIAL USE OF GROUNDWATER AT FUTURE MODELED CONCENTRATIONS AT BOUNDARY AND RIVER POES

This subsection discusses the potential future risks to a hypothetical resident using RGA groundwater contaminated by migration of COPCs from the SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 6, SWMU 7, SWMU 30, and SWMU 145 sources. As discussed in Section 2 of this BHHRA, the POEs to which contaminants were modeled were the PGDP plant boundary, PGDP property boundary, and near either the Little Bayou Seeps or the Ohio River. Information about the methods used in the model is provided in Section 5 and Appendix E of this RI.

Table F.258 presents the chemical-specific HIs for the child and adult rural residents from exposure to the modeled peak concentration over the 1,000 year timeframe of the COPCs in the RGA at the POEs based on household use of groundwater. The major contributors are arsenic, TCE and *cis*-1,2-dicloroethene. Table F.259 presents the chemical-specific ELCRs for a rural resident from exposure to maximum modeled concentrations over the 1,000 year time frame of contaminants in the RGA groundwater at the POEs based on household use of water. The major contributors to ELCR are TCE, vinyl chloride, and ^{99}Tc. Table F.260 presents the chemical-specific ELCRs for a rural resident from exposure to maximum modeled concentrations of contaminants in the RGA at the seeps at Little Bayou Creek. Peak concentrations for contaminants in groundwater emerging at the seeps were modeled based on contaminants migrating from SWMUs 3, 7, and 30.

Tables F.258 through F.260 show the predicted peak concentrations for individual contaminants. Different contaminants migrate at different rates; therefore, the total HI or ELCR in groundwater at a given time may be less than the sum of the risks of individual peaks. Figures F.4 to F.17 show the total hazard and total risks from the predicted concentrations of all COCs at each time step in the model for each SWMU except SWMU 6 (which had no modeled COCs). These hazards and risks are calculated using the site-specific RGOs for residential use of groundwater; the development of the RGOs is discussed in Section F.8.

Table F.258. HIs for Peak Modeled Water Concentrations at the Plant Boundary, Property Boundary, and near the Ohio River for Household Use of Groundwater Water Contaminated by COPC Migration from the BGOU SWMUs

	HI (child) at POE			HI (adult) at POE		
COPC[a]	Plant Boundary	Property Boundary	Near Ohio River	Plant Boundary	Property Boundary	Near Ohio River
SWMU 2						
Arsenic	9.32E-01	2.67E-06	NA	2.67E-01	7.66E-07	NA
Manganese	4.04E-05	NA	NA	1.20E-05	NA	NA
Uranium	1.35E-01	NA	NA	3.81E-06	NA	NA
cis-1,2-DCE	9.19E+01	4.53E+01	1.79E+01	1.60E+01	1.04E+01	4.10E+00
Naphthalene	1.43E-01	4.18E-02	1.73E-02	3.08E-02	9.01E-03	3.73E-03
TCE	9.91E+01	5.03E+01	4.61E+00	3.45E+01	1.75E+01	2.59E+00
SWMU 3						
Arsenic	3.98E-01	NA	--	1.12E-01	NA	--
Manganese	8.69E-10	NA	--	2.54E-10	NA	--
Uranium	3.63E-11	NA	--	1.04E-11	NA	--
SWMU 4						
Arsenic	8.65E-01	1.57E-03	NA	2.48E-01	4.49E-04	NA
Manganese	1.07E-02	NA	NA	3.12E-03	NA	NA
cis-1,2-DCE	1.04E+01	4.72E+00	5.70E-01	2.38E+00	1.08E+00	3.84E-01
TCE	1.93E+02	9.77E+01	3.27E+01	6.70E+01	3.40E+01	1.22E+01
Vinyl Chloride	2.83E-01	1.20E-01	2.77E-02	7.58E-02	3.23E-02	9.97E-03
SWMU 5						
Arsenic	5.70E-01	4.07E-02	NA	1.63E-01	1.16E-02	NA
Manganese	1.85E-01	4.90E-11	NA	5.41E-02	1.43E-11	NA
Naphthalene	4.95E-01	1.88E-01	5.45E-02	1.07E-01	4.05E-02	1.18E-02
SWMU 6 [a]						
NA	NA	NA	NA	NA	NA	--
SWMU 7						
Arsenic	4.04E+00	7.53E-01	--	1.16E+00	2.16E-01	--
Manganese	5.13E-01	2.24E-06	--	1.50E-01	6.54E-07	--
Uranium	4.05E-01	4.29E-07	--	1.16E-01	1.23E-07	--
1,1-DCE	7.81E-01	1.04E-01	--	1.81E-01	2.41E-02	--
cis-1,2-DCE	1.14E+00	1.65E-01	--	2.61E-01	3.80E-02	--
Total PCBs	2.48E+00	2.45E-01	--	1.18E+00	1.17E-01	--
TCE	4.51E+00	6.49E-01	--	1.57E+00	2.26E-01	--
Vinyl Chloride	5.90E-01	5.76E-02	--	1.58E-01	1.54E-02	--
SWMU 30						
Arsenic	3.75E+00	7.50E-01	--	1.07E+00	2.15E-01	--
Manganese	5.35E-01	6.07E-04	--	1.56E-01	1.77E-04	--
Selenium	1.59E-01	1.77E-02	--	4.57E-02	5.07E-03	--
Uranium	7.70E-01	3.86E-04	--	2.20E-01	1.10E-04	--
1,1-DCE	5.60E-01	4.18E-02	--	1.30E-01	9.68E-03	--
TCE	3.11E+02	2.68E+01	--	1.08E+02	9.33E+00	--
SWMU 145						
Antimony	---[b]	3.78E-04	NA	---[b]	1.13E-04	NA
Arsenic	---[b]	5.16E-01	NA	---[b]	1.48E-01	NA

-- = not a POE for groundwater from this SWMU.
NA = not applicable. Modeling results indicate that the constituent does not contribute significantly to groundwater at this point within the 1,000 year modeling time period, and therefore is insignificant at these POEs.
[a] None of the modeled constituents migrated from SWMU 6 at concentrations with a significant HI.
[b] Exposure point not modeled because SWMU 145 lies outside the plant boundary.

Table F.259. ELCRs for Peak Modeled Water Concentrations at the Plant Boundary, Property Boundary, and near the Ohio River for Household Use of Groundwater Water Contaminated by COPC Migration from BGOU SWMUs

	ELCR at POE		
COPC	**Plant Boundary**	**Property Boundary**	**Near Ohio River**
SWMU 2			
Arsenic	7.71E-05	2.21E-10	NA
TCE	6.74E-03	3.42E-03	1.28E-03
Technetium-99	8.72E-07	4.42E-07	1.71E-07
Uranium-234	2.47E-11	NA	NA
Uranium-238	3.53E-11	NA	NA
SWMU3			
Arsenic	3.23E-05	NA	NA
Technetium-99	9.92E-05	7.46E-05	NA
Uranium-238	1.27E-16	NA	NA
SWMU 4			
Arsenic	7.15E-05	1.30E-07	NA
TCE	1.99E-02	6.65E-03	2.38E-03
Vinyl Chloride	1.92E-04	7.44E-05	2.30E-05
Technetium-99	1.37E-04	6.58E-05	2.08E-05
SWMU 5			
Arsenic	4.72E-05	3.37E-06	NA
Technetium-99	2.74E-06	1.45E-06	4.78E-07
SWMU 6			
NA [b]	NA	NA	NA
SWMU 7			
Arsenic	3.34E-04	6.23E-05	NA
1,1-DCE	1.90E-03	2.54E-04	NA
Total PCBs	4.84E-06	4.78E-07	NA
TCE	3.07E-04	4.38E-05	NA
Vinyl Chloride	3.65E-04	3.56E-05	NA
Technetium-99	4.52E-05	1.48E-05	NA
Uranium-234	8.17E-06	1.30E-12	NA
Uranium-238	9.69E-06	1.02E-11	NA
SWMU 30			
Arsenic	3.10E-04	6.20E-05	NA
1,1-DCE	1.37E-03	1.02E-04	NA
TCE	2.11E-02	1.83E-03	NA
Technetium-99	1.45E-05	3.88E-06	NA
Uranium-234	3.88E-06	2.03E-09	NA
Uranium-238	7.07E-06	3.44E-09	NA
SWMU 145			
Arsenic	---[c]	4.27E-05	NA
Technetium-99	---[c]	1.01E-04	5.29E-05

NA = not applicable. Modeling results indicate that the constituent does not contribute significantly to groundwater at this point within the 1,000-year modeling time period, and therefore is insignificant at these POEs.

[a] Total ELCRs are calculated by summing chemical-specific ELCRs derived using maximum concentrations because all COPCs are expected to reach their maximum concentration at the POEs at approximately the same time.

[b] Results for SWMU 6, none of the constituents modeled migrated at concentrations with a significant ELCR.

[c] Exposure point not modeled because SWMU 145 lies outside the plant boundary.

Table F.260. HIs and ELCRs for Residential Groundwater Use at the Little Bayou Creek Seeps

	COPC	HI (child)	HI (adult)	ELCR
SWMU 3 Seep	Technetium-99	NA	NA	4.41E-05
SWMU 7	1,1-DCE	3.81E-02	8.82E-03	9.29E-05
	cis-1,2-DCE	8.45E-02	1.91E-02	NA
	Total PCBs	1.06E-07	5.06E-08	2.07E-13
	TCE	2.31E-01	8.05E-02	1.57E-05
	Vinyl Chloride	1.97E-02	5.26E-03	1.21E-05
	Technetium-99	NA	NA	7.26E-06
SWMU 30 Seep	Selenium	6.05E-03	1.73E-03	NA
	1,1-DCE	1.25E-02	2.89E-03	3.05E-05
	TCE	8.95E+00	3.12E+00	6.09E-04
	Technetium-99	NA	NA	1.60E-06

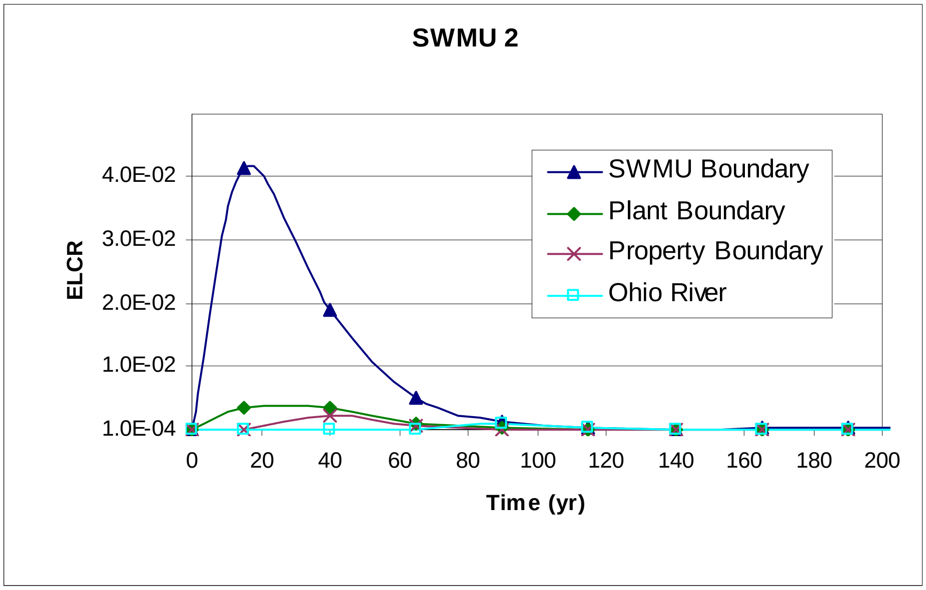

Figure F.4. Total ELCR from All Carcinogenic COCs at SWMU 2

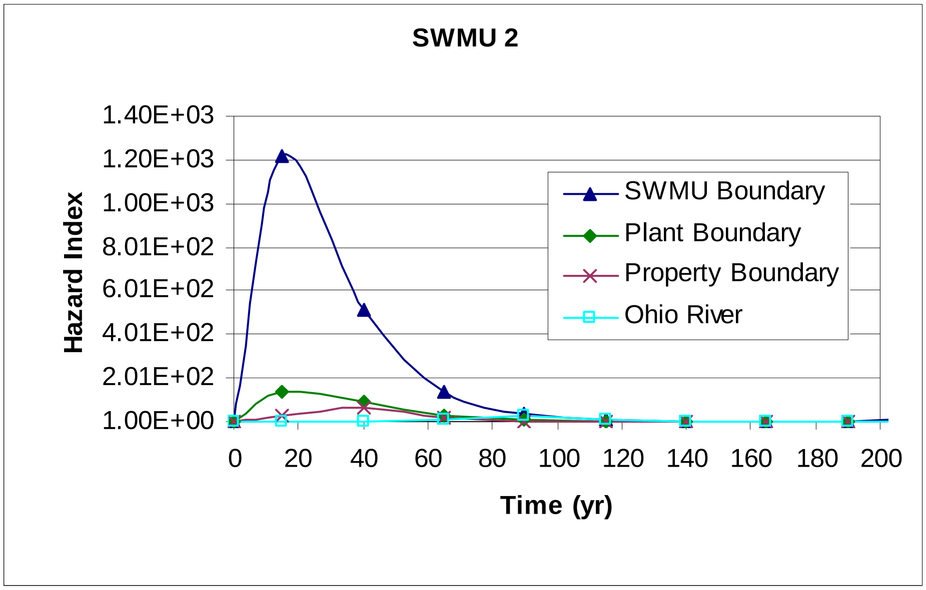

Figure F.5. Total HI from All Noncarcinogenic COCs at SWMU 2

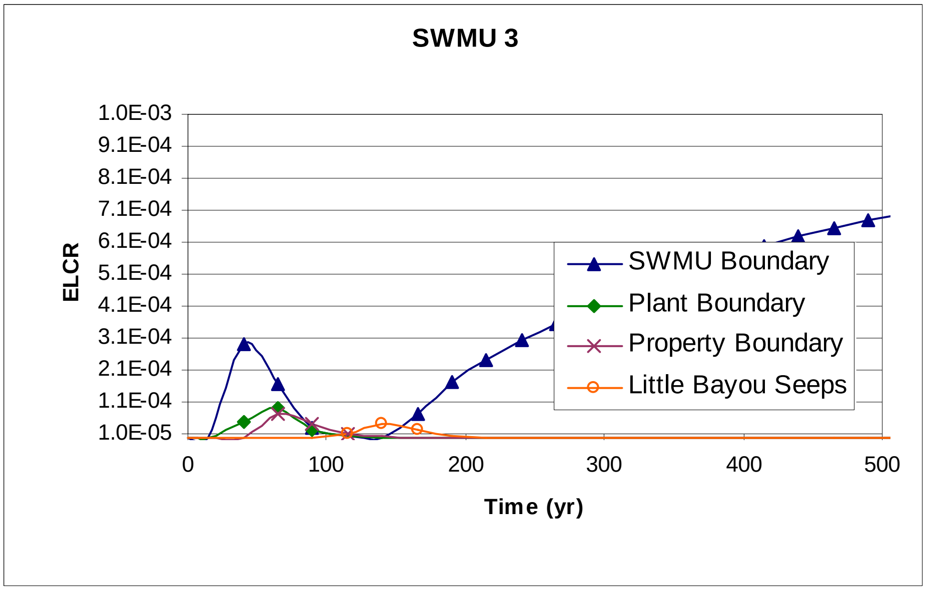

Figure F.6. Total ELCR from All Carcinogenic COCs at SWMU 3

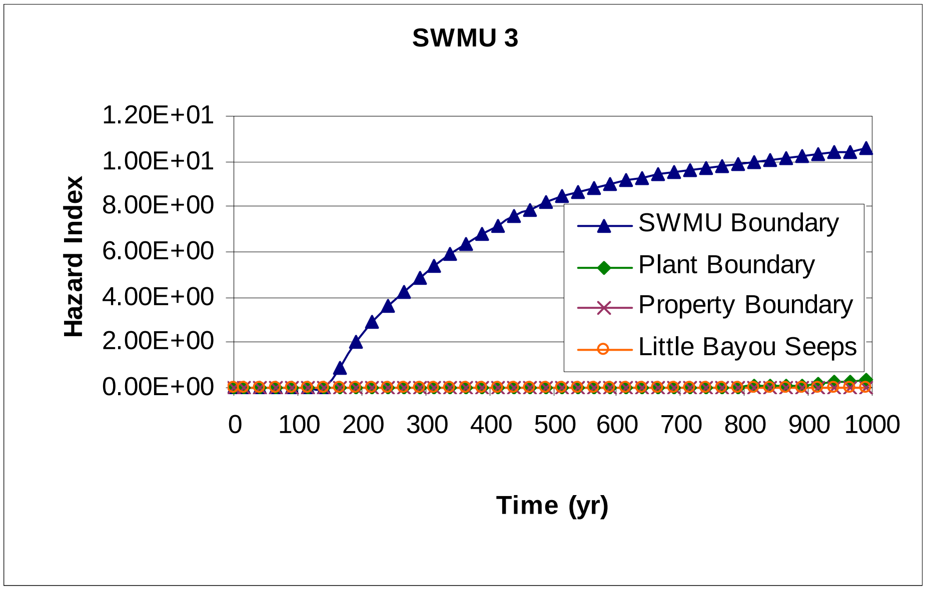

Figure F.7. Total HI from All Noncarcinogenic COCs at SWMU 3

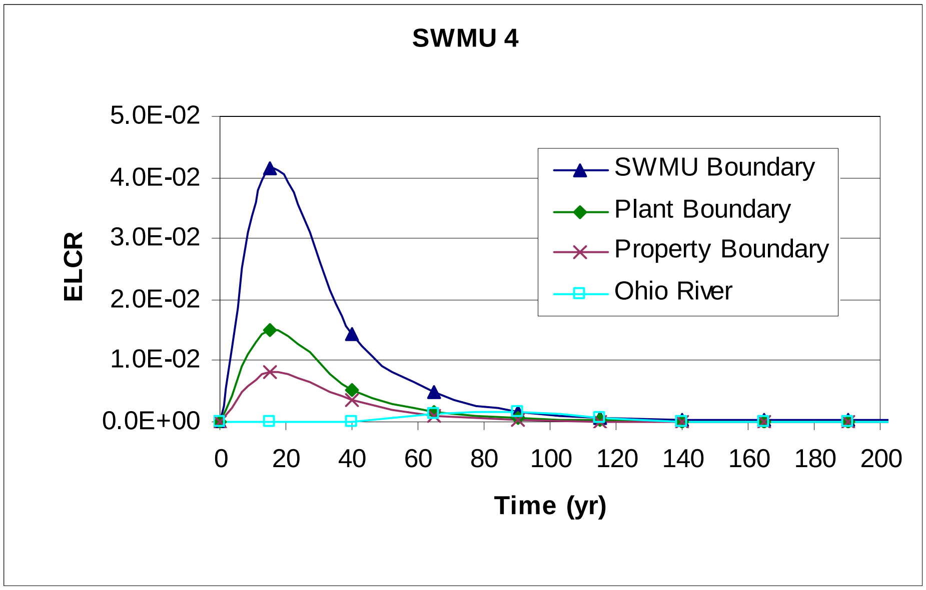

Figure F.8. Total ELCR from All Carcinogenic COCs at SWMU 4

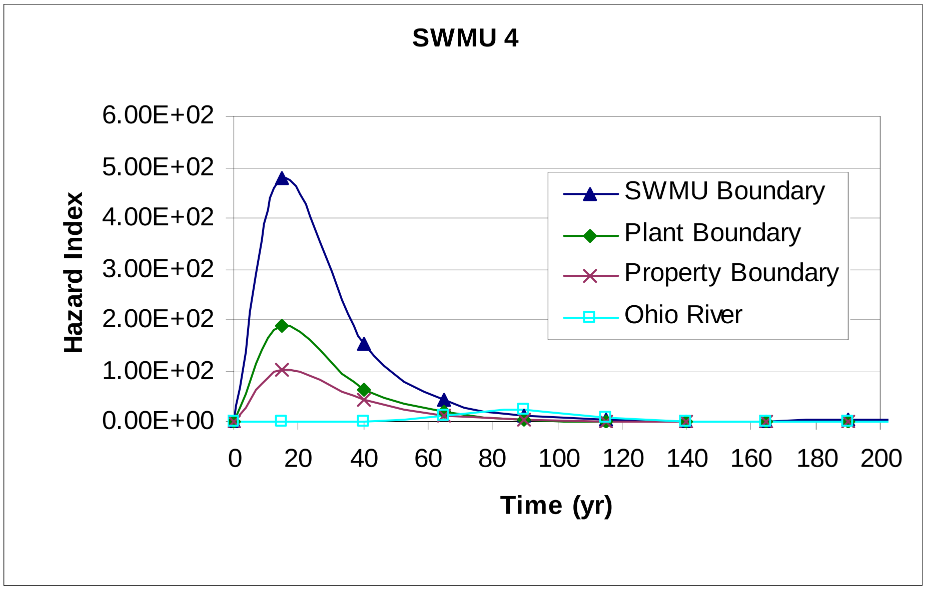

Figure F.9. Total HI from All Noncarcinogenic COCs at SWMU 4

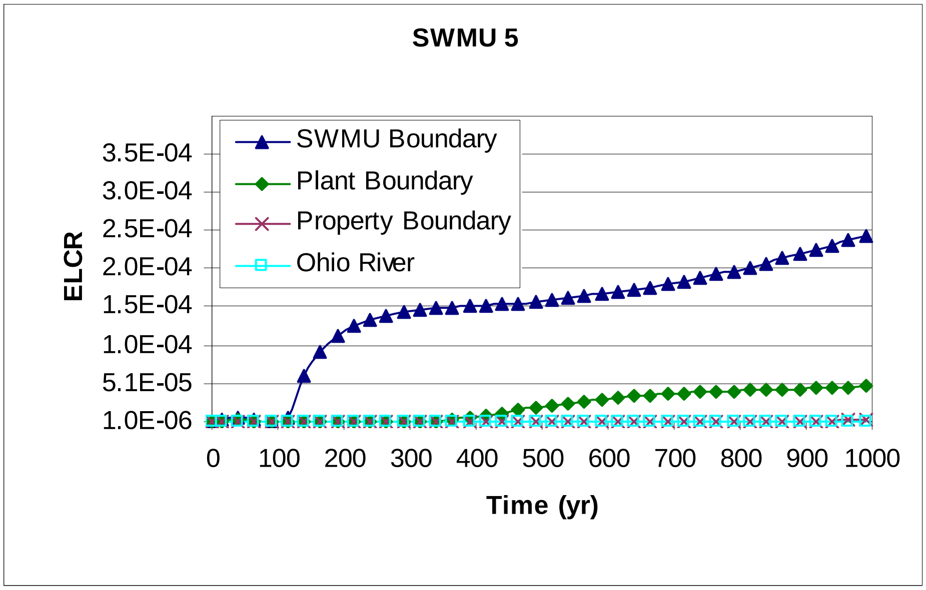

Figure F.10. Total ELCR from All Carcinogenic COCs at SWMU 5

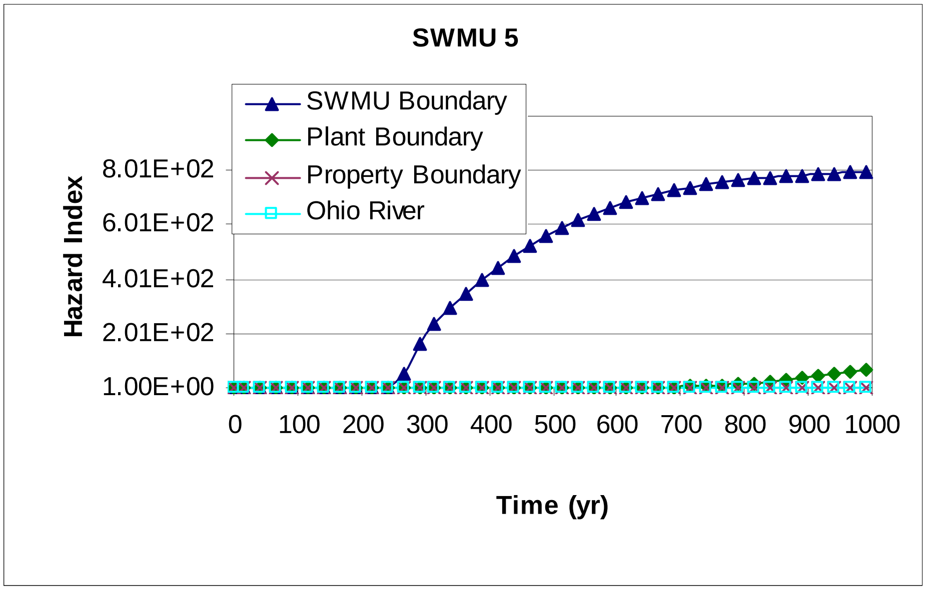

Figure F.11. Total HI from All Noncarcinogenic COCs at SWMU 5

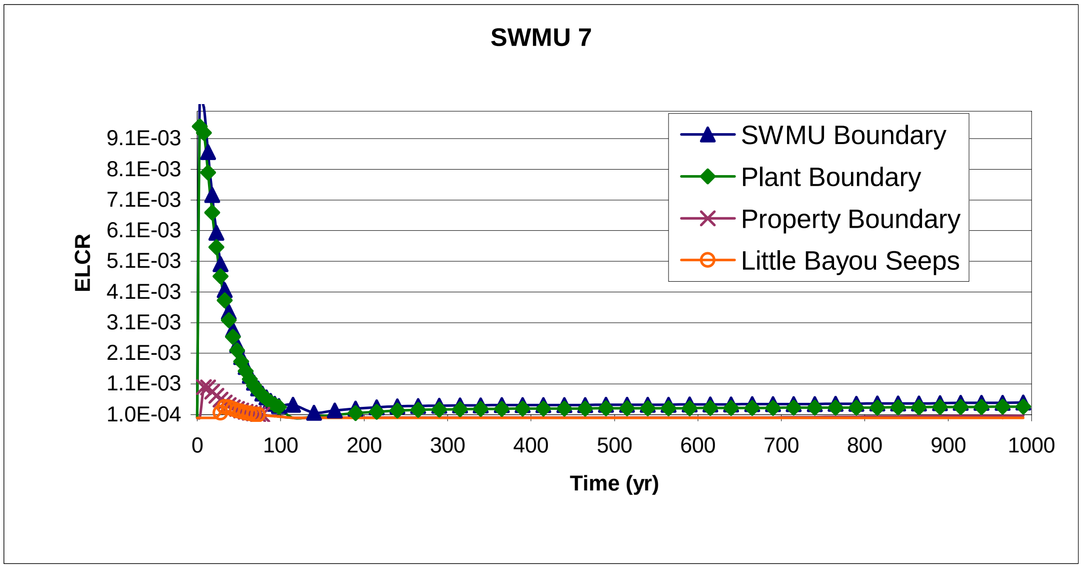

Figure F.12. Total ELCR from All Carcinogenic COCs at SWMU 7

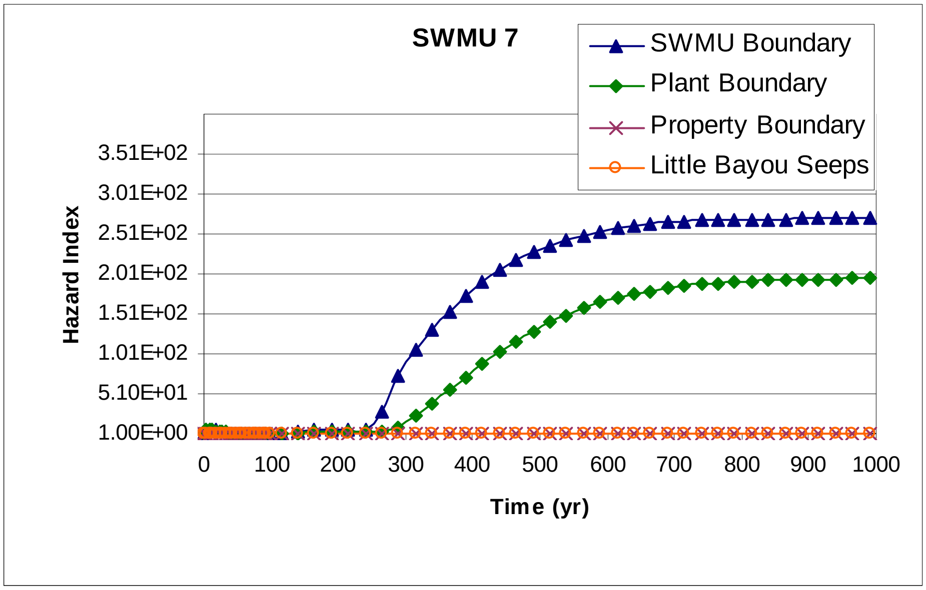

Figure F.13. Total HI from All Noncarcinogenic COCs at SWMU 7

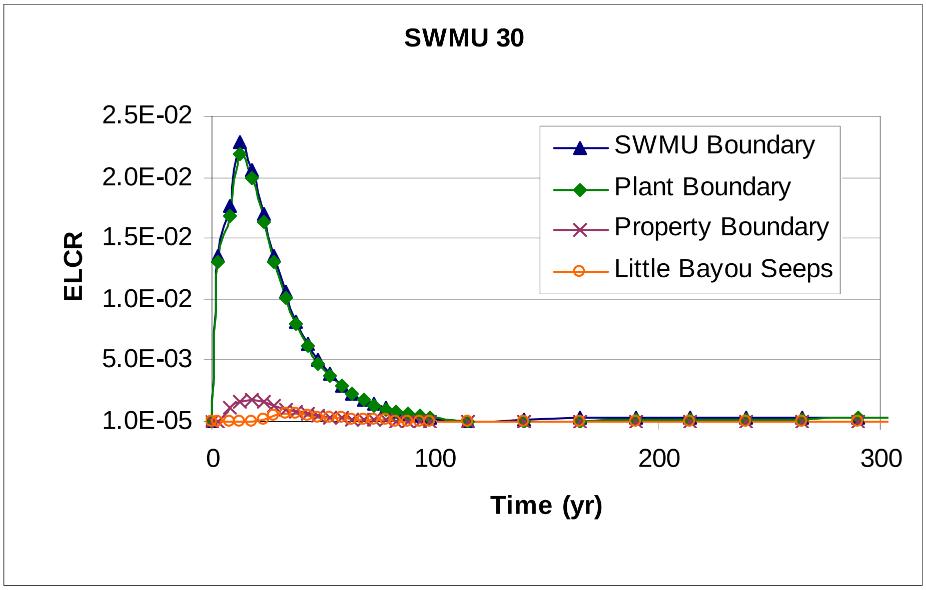

Figure F.14. Total ELCR from All Carcinogenic COCs at SWMU 30

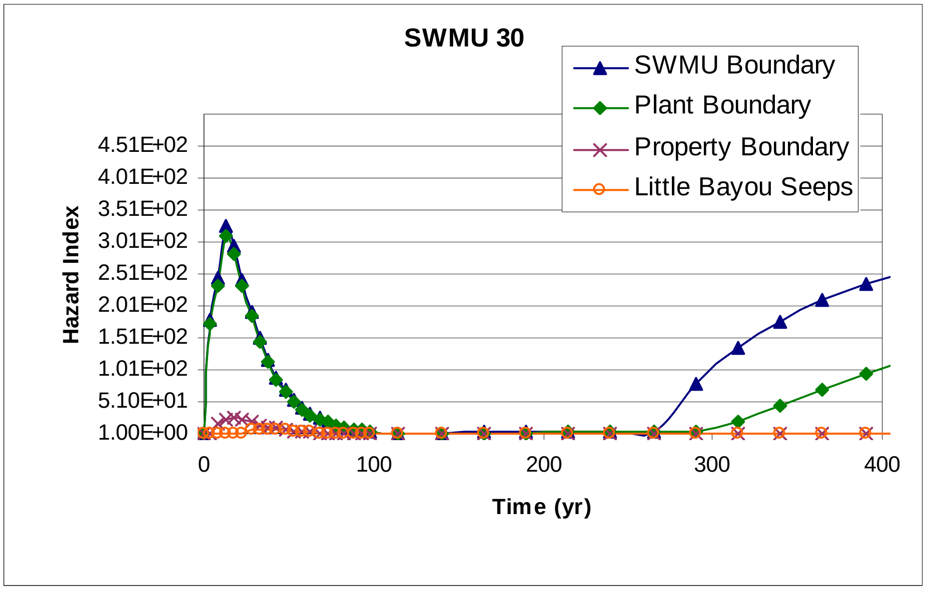

Figure F.15. Total HI from All Noncarcinogenic COCs at SWMU 30

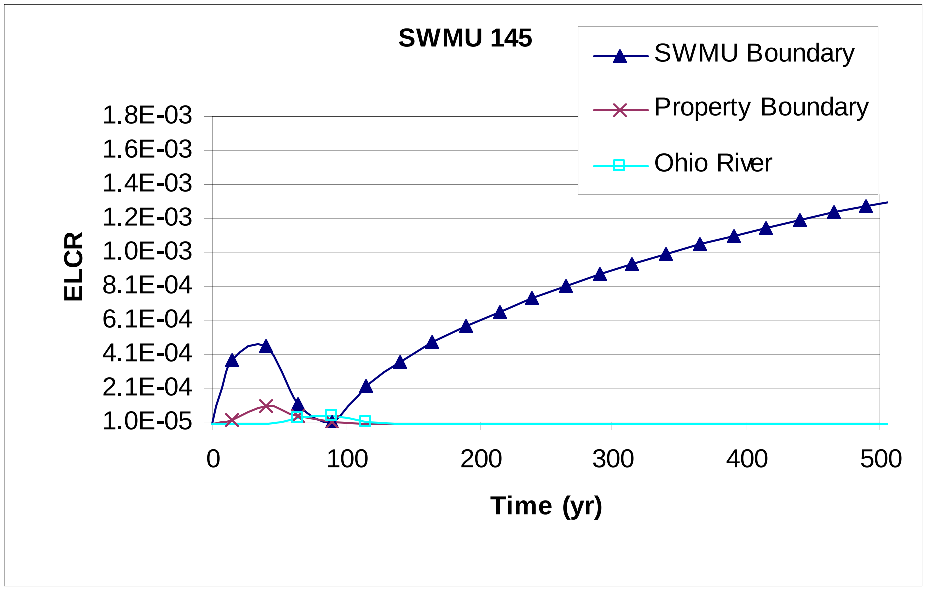

Figure F.16. Total ELCR from All Carcinogenic COCs at SWMU 145

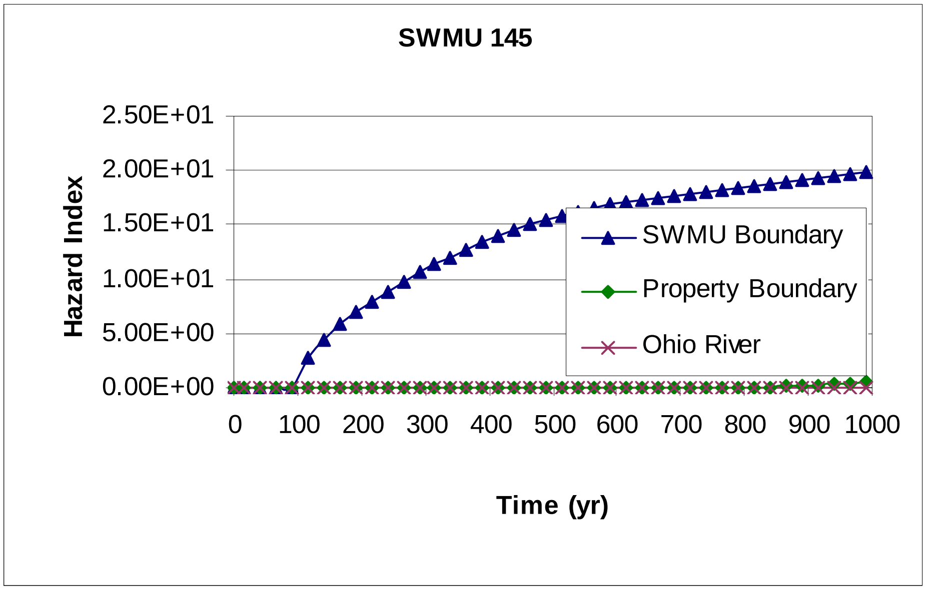

Figure F.17. Total HI from All Noncarcinogenic COCs at SWMU 145

The values for total hazard or risk for all COCs calculated from the RGOs for residential groundwater use and the time at which the total risk or hazard peaks are provided in Tables F.261 and F.262.

As shown in Table F.261, the total HI for the child exceeded one for all SWMUs at the SWMU boundary. The total HI for the child for migration from the SWMU 2, SWMU 4, SWMU 5, SWMU 7, and SWMU 30 sources exceeds a HI of 1 at the plant boundary. The total HI for the child for migration from SWMU 2, SWMU 4, and SWMU 30 exceeds an HI of 1 at the property boundary. The total HI for the child for migration from SWMU 2 and SWMU 4 exceeds an HI of 1 at the Ohio River. The total HI for the child for migration from SWMU 7 and SWMU 30 exceeds an HI of 1 at the Ohio River.

As shown in Table F.262, the total ELCRs resulting from COPC migration are above or equal to 1×10^{-6} at the SWMU boundary, the plant boundary, and the PGDP property boundary POEs for all sources. The total ELCRs were greater than 1 x 10^{-6} at the Little Bayou Seeps for SWMUs 3, 7, and 30. In addition, total ELCRs were greater than 1 x 10^{-6} at the Ohio River for SWMU 2, SWMU 4, and SWMU 145.

F.5.6 IDENTIFICATION OF LAND USE SCENARIOS, PATHWAYS, MEDIA, AND COCS

This subsection outlines those chemicals, land use scenarios, exposure pathways, and media for each source area. Section F.8 presents the RGOs for each location and land use scenario.

Table F.261. Maximum Total HIs for Residential Groundwater Use at Each POE

	SWMU Boundary		Plant Boundary		Property Boundary		Little Bayou Seeps		Ohio River	
SWMU	Time (yr)	Peak Hazard	Time (yr)	Peak Hazard	Time (yr)	Peak Hazard	Time (yr)	Peak Hazard	Time (yr)	Peak Hazard
2	20	1.24E+03	20	1.87E+02	30	9.30E+01	na	na	80	3.46E+01
3	1000	10.5	1000	0.391	0	0	0	0	na	na
4	5	565	10	201	15	101	na	na	75	36.7
5	1000	792	1000	68.5	1000	4.07E-02	na	na	0	0
7	1000	270	1000	195	1000	0.998	36	3.46E-01	na	na
30	13	325	14	311	17	26.8	36	8.96	na	na
145	1000	19.9	na	na	1000	5.16E-01	na	na	0	0

Table F.262. Maximum Total ELCRs for Residential Groundwater Use at Each POE

	SWMU Boundary		Plant Boundary		Property Boundary		Little Bayou Seeps		Ohio River	
SWMU	Time (yr)	Peak Risk	Time (yr)	Peak Risk	Time (yr)	Peak Risk	Time (yr)	Peak Risk	Time (yr)	Peak Risk
2	20	4.60E-02	25	6.74E-03	30	3.42E-03	na	na	85	1.28E-03
3	1000	8.75E-04	55	9.94E-05	70	7.49E-05	140	4.42E-05	na	na
4	5	5.32E-02	10	1.69E-02	15	8.25E-03	na	na	75	2.81E-03
5	1000	2.46E-04	1000	4.73E-05	1000	3.38E-06	na	na	155	4.79E-07
7	3	1.05E-02	4	9.65E-03	9	1.02E-03	34	3.56E-04	na	na
30	13	2.29E-02	14	2.19E-02	17	1.89E-03	36	6.29E-04	na	na
145	1000	1.65E-03	na	na	40	1.01E-04	na	na	80	5.30E-05

F.5.6.1 Land Use Scenarios of Concern

To make a determination whether land use scenarios are of concern, quantitative risk and hazard results were compared to risk and hazard benchmarks for each land use scenario. The benchmarks used for this comparison were a) 1 for HI and b) 1×10^{-6} for ELCR. Land use scenarios with total HIs exceeding the benchmark of 1 are deemed land use scenarios of concern for non-cancer hazard. Land use scenarios with a total ELCR exceeding the benchmark of 1×10^{-6} are deemed land use scenarios of concern for cancer risk. The following are land uses of concern for BGOU at the SWMUs indicated.

- Industrial: SWMUS 2, 3, 4, 5, 6, 7, and 30
- Excavation: SWMUS 2, 3, 4, 5, 6, 7, 30, and 145
- Recreational: SWMUS 2, 3, 4, 5, 6, 7, and 30
- On-Site Residential: SWMUS 2, 3, 4, 5, 6, 7, 30, and 145
- Off-Site Residential: SWMUS 2, 3, 4, 5, 7, 30, and 145

Table F.263 outlines all land use scenarios for all SWMUs that exceed *de minimus* risk or hazard levels.

F.5.6.2 Contaminants of Concern (Soil)

To make a determination about whether contaminants are of concern, quantitative risk and hazard results over all pathways were compared to risk and hazard benchmarks for land use scenarios of concern. The benchmarks used for this comparison were a) 0.1 for HI and b) 1×10^{-6} for ELCR.

Contaminants with chemical-specific HIs or ELCRs exceeding these benchmarks were deemed COCs.[3] Priority COCs are contaminants whose chemical-specific HI is greater than 1 or whose ELCR is greater than 1×10^{-4} for one or more scenarios. The following are priority COCs found in soil at individual SWMUs.

- SWMU 2 – arsenic, iron, uranium, ^{137}Cs, and ^{238}U
- SWMU 3 – none
- SWMU 4 – arsenic, iron, Total PAHs, Total PCBs, ^{137}Cs, and ^{238}U
- SWMU 5 – arsenic, uranium, Total PAHs, and fluoranthene
- SWMU 6 – uranium, Total PAHs
- SWMU 7 – uranium, Total PAHs, Total PCBs, ^{228}Th, and ^{238}U
- SWMU 30 – uranium, Total PAHs, Total PCBs, ^{235}U, and ^{238}U
- SWMU 145 – none

[3] Lead was eliminated in the initial screening; therefore, analysis using IEUBK was not required.

Table F.263. Scenarios for Which Human Health Risk Exceeds *De Minimis* Levels[a]

Scenario	Location							
	SWMU 2	**SWMU 3**	**SWMU 4**	**SWMU 5**	**SWMU 6**	**SWMU 7**	**SWMU 30**	**SWMU 145**
Results for excess lifetime cancer risk:								
Future On-site Industrial Worker								
Exposure to Surface Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/ Subsurface Soil	X	X	X	X	X	X	X	X
Future On-site Recreational User								
Exposure to Game	X	X	X	X	X	X	X	NA
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	---	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	---	X	---	---	---	X	---
Result for Systematic Toxicity [b]								
Future On-site Industrial Worker								
Exposure to Soil	X	---	---	---	---	---	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/ Subsurface Soil	X	---	---	X	---	X	X	---
Future On-site Recreational User								
Exposure to Game	X	---	---	X	X	X	X	NA
Exposure to Soil	X	---	---	---	---	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	X	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	---	X	X	NA	X	X	---
Vapor Intrusion [c]	---	---	---	---	---	---	---	---

Notes: Scenarios where risk exceeds *de minimis* levels are marked with an X. Scenarios where risk did not exceed *de minimis* levels are marked with a ---.
NA indicates that the scenario/land use combination was not assessed because the scenario is not applicable, or the medium is not present.
[a] Consistent with the PGDP Risk Methods Document (DOE 2001), the *de minimis* levels used are a cumulative ELCR of 1×10^{-6} and a cumulative HI of 0.1.
[b]Systemic toxicity results summarized here for the resident and recreational user are for the child. The off-site POE considered is the property boundary.
[c]Based on results of preliminary deterministic contaminant transport modeling. The POE is the property boundary. X indicates that the location contains a source of unacceptable off-site contamination, and --- indicates that the location is not a source of off-site contamination

F.5.6.3 Contaminants of Concern (Groundwater – Modeled from Soil)

Similarly for groundwater, to determine whether contaminants are of concern, quantitative risk, and hazard results over all pathways were compared to risk and hazard benchmarks for land use scenarios of concern. The benchmarks used for this comparison were a) 0.1 for HI and b) 1×10^{-6} for ELCR.

Contaminants with chemical-specific HIs or ELCRs exceeding these benchmarks were deemed COCs. Priority COCs are contaminants whose chemical-specific HI is greater than 1 or whose ELCR is greater than 1×10^{-4} for one or more scenarios. The following presents priority COCs found in groundwater at individual SWMUs.

- SWMU 2 – arsenic; manganese; uranium; *cis*-1,2-DCE; and TCE
- SWMU 3 – arsenic, manganese, uranium, and ^{99}Tc
- SWMU 4 – arsenic; manganese; *cis*-1,2-DCE; TCE; vinyl chloride; and ^{99}Tc
- SWMU 5 – arsenic, manganese, and naphthalene
- SWMU 6 – none
- SWMU 7 – arsenic; 1,1-DCE; *cis*-1,2-DCE; Total PCBs;TCE; vinyl chloride
- SWMU 30 – arsenic; 1,1-DCE; TCE
- SWMU 145 – antimony, arsenic, and ^{99}Tc

"Priority COCs" are identified in this section as an aid to risk managers during decision making. Table F.264 summarizes the COCs for both soil and groundwater.

F.5.6.4 Pathways of Concern

To determine whether pathways are of concern, the quantitative risks and hazards for each exposure route are summed over all contaminants and compared to benchmarks for land use scenarios of concern. The benchmarks used for this comparison were a) 0.1 for HI and b) 1×10^{-6} for ELCR. Exposure routes with HIs and ELCRs exceeding these benchmarks are considered POCs. These POCs are shown by SWMU in Table F.263. Each of the pathways included in the BHHRA is a POC for at least one SWMU.

F.5.6.5 Media of Concern

Media of concern are those media that appear in at least one POC. Because they contribute to at least one POC, soil and RGA groundwater are media of concern for all eight SWMUs. Table F.264 provides specific information concerning how each media contributes to risks and hazards for BGOU.

F.5.6.6 Summary of Risk Characterization

Tables F.265 to F.272 present summaries of the risk characterization by location considered in the BHHRA. They present land use scenarios of concern, COCs, and POCs. In addition, each table lists the following:

- Receptor risks for each land use scenario of concern;
- Percent contribution by pathway to the total risk; and
- Percent contribution each COC contributes to the total risk.

Table F.264. COCs for SWMU and Exposure Medium[a]

COC[b]	SWMU 2		SWMU 3		SWMU 4		SWMU 5		SWMU 6		SWMU 7		SWMU 30		SWMU 145	
	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR
Inorganic Compounds																
Aluminum							S				S		S			
Antimony			S										S		GW	
Arsenic	S,GW	S,GW	GW	GW	S,GW	S,GW	S,GW	S,GW			S,GW	S,GW	GW	GW	GW	GW
Beryllium										S						
Chromium						S					S					
Copper																
Iron	S				S						S					
Manganese	GW		GW		GW		GW				GW		GW			
Nickel													S			
Selenium													GW			
Thallium	S										S		S			
Uranium	S,GW		S,GW				S		S		S,GW		S,GW			
Vanadium					S						S					
Zinc																
Organic Compounds																
1,1-DCE											GW	GW	GW	GW		
cis-1,2-DCE	GW				GW						GW					
Fluoranthene							S									
Naphthalene	GW						S, GW									
TCE	GW	GW			GW	GW					GW	GW	GW	GW		
Vinyl Chloride					GW	GW					GW	GW				
Total PAHs		S				S		S		S		S		S		
Total PCBs		S				S		S		S	GW	S, GW		S		

Table F.264. COCs for Each SWMU and Exposure Medium[a] (Continued)

COC[b]	SWMU 2		SWMU 3		SWMU 4		SWMU 5		SWMU 6		SWMU 7		SWMU 30		SWMU 145	
	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR	Total Hazard Child	Total ELCR
Radionuclides																
Cesium-137		S														
Neptunium-237		S				S						S		S		
Plutonium-239 [b]		S				S										
Radium-226																
Technetium-99		GW		GW		GW		GW				S,GW		S,GW		GW
Thorium-228												S				
Thorium-230		S												S		
Uranium-234		S,GW				S						S,GW		S,GW		
Uranium-235		S								S		S		S		
Uranium-238		S,GW		S, GW		S		S		S		S,GW		S,GW		

[a] Only COPCs that exceed a chemical-specific HI of 0.1 or a chemical-specific ELCR of 1×10^{-6} within a scenario of concern are for the child resident for HI and combined resident for ELCR.
[b] Plutonium-239/240 included with Plutonium-239.
"S" indicates exposure to soil is the primary pathway
"GW" indicates exposure to groundwater is the primary pathway.

Table F.265. Summary of Risk Characterization for SWMU 2

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	8.78E-04	Arsenic Total PAH Total PCB ^{137}Cs ^{237}Np $^{239/240}$Pu ^{230}Th ^{234}U ^{235}U ^{238}U	7.1 1.1 1.1 67.7 0.1 0.2 0.1 0.2 2.2 20.2	Ingestion Dermal Inhalation External exposure	3.8 8.1 0.2 87.9	1.40E+00	Arsenic Iron Uranium	27.5 7.9 60.9	Ingestion Dermal	65.4 34.6
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.58E+01	Arsenic Iron Thallium Uranium	10.0 7.6 3.0 79.0	Ingestion Dermal	92.7 7.3
Future adult rural resident at current concentrations (Surface Soil)	4.25E-03	Arsenic Total PAH Total PCB ^{137}Cs ^{237}Np $^{239/240}$Pu ^{230}Th ^{234}U ^{235}U ^{238}U	4.9 0.6 0.7 70.5 0.1 0.1 0.1 0.1 2.3 20.5	Ingestion Dermal Inhalation External exposure	4.2 4.3 0.1 91.5	3.39E+00	Arsenic Iron Uranium	20.9 7.8 67.7	Ingestion Dermal	75.7 24.3
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	1.30E+03	Arsenic Manganese Uranium *cis*-1,2-DCE Naphthalene TCE	0.9 0.1 0.1 46.8 0.0 52.1	Ingestion Dermal Shower inhalation Household inhalation	46.0 11.7 4.8 37.5

Table F.265. Summary of Risk Characterization for SWMU 2 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	4.69E-02	Arsenic TCE ^{99}Tc ^{234}U ^{238}U	2.0 98.0 0.0 0.0 0.0	Ingestion Dermal Shower inhalation Household inhalation	19.9 11.0 7.8 61.3	3.79E+02	Arsenic Manganese Uranium *cis*-1,2-DCE Naphthalene TCE	0.9 0.1 0.1 36.8 0.0 62.1	Ingestion Dermal Shower inhalation Household inhalation	45.0 23.9 3.5 27.5
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.92E+02	Arsenic *cis*-1,2-DCE Naphthalene TCE	0.5 48 0.1 52	Ingestion Dermal Shower inhalation Household inhalation	45 12.4 5.4 38
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	6.82E-03	Arsenic TCE	1.1 98.9	Ingestion Dermal Shower inhalation Household inhalation	19.2 11.1 7.9 61.8	5.08E+01	Arsenic *cis*-1,2-DCE Naphthalene TCE	0.5 31.5 0.1 67.9	Ingestion Dermal Shower inhalation Household inhalation	62 27 1.2 10
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	9.56E+01	*cis*-1,2-DCE TCE	47.4 52.6	Ingestion Dermal Shower inhalation Household inhalation	45.4 11.8 4.9 38.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	3.42E-03	TCE	100	Ingestion Dermal Shower inhalation Household inhalation	18.3 11.2 8.0 62.5	2.79E+01	*cis*-1,2-DCE TCE	37.3 62.7	Ingestion Dermal Shower inhalation Household inhalation	44.4 24.1 3.6 27.9
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	2.25E+01	*cis*-1,2-DCE TCE	79.4 20.5	Ingestion Dermal Shower inhalation Household inhalation	16.2 18.8 7.4 57.7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	1.28E-03	TCE	100	Ingestion Dermal Shower inhalation Household inhalation	18.3 11.2 8.0 62.5	6.7E+00	*cis*-1,2-DCE TCE	61.2 38.7	Ingestion Dermal Shower inhalation Household inhalation	15.5 37.7 5.3 41.5

Table F.265. Summary of Risk Characterization for SWMU 2 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.24E+01	Arsenic Iron Uranium	5.1 6.3 87.6	Ingestion of soil Dermal Game Ingestion (Quail)	16.1 6.1 77.3
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	9.34E+00	Arsenic Iron Uranium	5.5 6.1 87.9	Ingestion of soil Dermal Game Ingestion (Quail)	3.7 7.6 88.3
Future adult recreational user at current concentrations	6.96E-04	Arsenic Total PAH Total PCB ^{137}Cs $^{239/240}$Pu ^{234}U ^{235}U ^{238}U	11.2 17.8 2.3 32.4 0.2 1.7 1.6 32.7	Ingestion of soil Ingestion of quail Ingestion of rabbit Dermal External exposure	1.8 42.5 0.2 13.5 41.8	1.04E+01	Arsenic Iron Uranium	1.7 5.9 92.1	Ingestion of soil Dermal Game Ingestion (Quail)	1.5 2.4 95.7
Future excavation worker at current concentrations (Subsurface Soil)	5.88E-04	Arsenic Total PAH Total PCB ^{137}Cs $^{239/240}$Pu ^{230}Th ^{234}U ^{235}U ^{238}U	16.3 1.4 5.4 22.4 0.5 0.3 1.7 3.6 48.5	Ingestion Dermal Inhalation External exposure	41.5 11.0 0.5 47.0	2.97E+00	Arsenic Iron Thallium Uranium	20.1 17.4 6.9 55.2	Ingestion Dermal	89.4 10.6

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.266. Summary of Risk Characterization for SWMU 3

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	3.52E-06	^{238}U	100	External exposure	88.5	1.48E-01	Antimony	73.8	*No POC with HI greater than or equal to 0.1	
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	1.78E+00	Antimony Uranium	47.8 52.2	Ingestion Dermal	79.5 20.5
Future adult rural resident at current concentrations (Surface Soil)	1.73E-05	^{238}U	100	Ingestion External exposure	9.2 90.8	3.12E-01	Antimony Uranium	66.4 33.6	Ingestion Dermal	48.7 51.3
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	2.20E+01	Arsenic Manganese Uranium	47.9 16.6 35.5	Ingestion Dermal	99.5 0.5
Future adult rural resident at current concentrations (RGA groundwater only)	1.20E-03	Arsenic ^{99}Tc ^{238}U	72.4 25.3 2.3	Ingestion Dermal	99.8 0.2	6.32E+00	Arsenic Manganese Uranium	47.7 16.9 35.4	Ingestion	99.0
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	3.98E-01	Arsenic	100	Ingestion	97.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	1.32E-04	Arsenic ^{99}Tc	24.6 75.4	Ingestion	99.9	1.12E-01	Arsenic	100	Ingestion	99.6
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA		*No applicable COCs			
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	7.46E-05	^{99}Tc	100	Ingestion	100		*No applicable COCs			

Table F.266. Summary of Risk Characterization for SWMU 3 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA		*No applicable COCs			
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	4.41E-05	^{99}Tc	100.0				*No applicable COCs			
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	6.87E-01	Antimony Uranium	26.6 73.4	Ingestion Dermal Ingestion of quail	17.2 21.3 61.4
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	5.21E-01	Antimony Uranium	26.6 73.4	Ingestion of quail Dermal	69.7 26.3
Future adult recreational user at current concentrations	5.07E-06	^{238}U	100	Ingestion of quail External exposure	74.4 23.2	4.94E-01	Uranium	90.1	Ingestion of quail	88.4
Future excavation worker at current concentrations (Subsurface Soil)	1.20E-05	^{137}Cs ^{238}U	33.0 65.4	Ingestion External exposure	37.7 62.2	3.14E-01	Antimony Uranium	64.7 35.3	Ingestion Dermal	78.3 21.7

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.267. Summary of Risk Characterization for SWMU 4

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	9.54E-05	Arsenic Total PAH Total PCB $^{239/240}Pu$ ^{234}U ^{238}U	29.9 24.9 5.8 2.7 1.7 33.4	Ingestion Dermal Inhalation External exposure	12.6 55.1 1.7 30.6	2.62E-01	Arsenic	67.6	Dermal	76.2
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.41E+00	Arsenic Iron Vanadium	49.5 42.4 5.4	Ingestion Dermal	67.7 32.3
Future adult rural resident at current concentrations (Surface Soil)	3.59E-04	Arsenic Chromium Total PAH Total PCB ^{237}Np $^{239/240}Pu$ ^{234}U ^{238}U	26.8 0.3 18.0 4.4 1.4 2.7 1.7 44.7	Ingestion Dermal Inhalation External exposure	19.7 37.5 0.8 42.0	5.14E-01	Arsenic Iron	63.4 26.9	Ingestion Dermal	33.9 66.0
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	5.82E+02	Arsenic Manganese *cis*-1,2-DCE TCE Vinyl Chloride	1.0 0.2 6.1 92.5 0.2	Ingestion Dermal Shower inhalation Household inhalation	67.2 20.2 1.4 11.2
Future adult rural resident at current concentrations (RGA groundwater only)	5.41E-02	Arsenic TCE Vinyl chloride ^{99}Tc	0.9 67.7 30.5 0.9	Ingestion Dermal Shower inhalation Household inhalation	15.4 36.7 5.4 42.4	1.98E+02	Arsenic Manganese *cis*-1,2-DCE TCE Vinyl chloride	0.8 0.2 4.1 94.7 0.2	Ingestion Dermal Shower inhalation Household inhalation	56.5 35.6 0.9 7.0
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	2.04E+02	Arsenic *cis*-1,2-DCE TCE Vinyl chloride	0.4 4.6 94.4 0.1	Ingestion Dermal Shower inhalation Household inhalation	67.5 20.6 1.4 10.6

Table F.267. Summary of Risk Characterization for SWMU 4 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.03E-02	Arsenic TCE Vinyl chloride ^{99}Tc	0.4 98.0 0.9 0.7	Ingestion Dermal Shower inhalation Household inhalation	13.6 7.2 5.2 74.0	6.97E+01	Arsenic *cis*-1,2-DCE TCE	0.4 3.0 96.6	Ingestion Dermal Shower inhalation Household inhalation	56.5 36.1 0.8 6.6
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	1.03E+02	*cis*-1,2-DCE TCE Vinyl chloride	4.6 95.3 0.1	Ingestion Dermal Shower inhalation Household inhalation	67.6 20.8 1.3 10.3
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	6.79E-03	TCE Vinyl chloride ^{99}Tc	97.9 1.1 1.0	Ingestion Dermal Shower inhalation Household inhalation	19.8 11.0 7.8 61.3	3.51E+01	*cis*-1,2-DCE TCE	3.1 96.8	Ingestion Dermal Shower inhalation Household inhalation	56.4 36.3 0.8 6.4
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	3.33E+01	*cis*-1,2-DCE TCE	1.7 98.2	Ingestion Dermal Shower inhalation Household inhalation	74.6 22.9 1.4 1.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	2.43E-03	TCE Vinyl chloride ^{99}Tc	98.2 0.9 0.9	Ingestion Dermal Shower inhalation Household inhalation	19.6 11.0 7.9 61.5	1.26E+01	*cis*-1,2-DCE TCE	3.0 96.9	Ingestion Dermal Shower inhalation Household inhalation	56.4 36.3 0.8 6.4
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	7.41E-01	Arsenic Iron	39.3 54.7	Ingestion of soil Game ingestion (quail) Dermal	18.3 37.7 42.0
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	5.65E-01	Arsenic Iron	41.5 52.4	Game Ingestion (quail) Dermal	42.5 51.5
Future adult recreational user at current concentrations	3.73E-04	Arsenic Total PAH Total PCB ^{239}Pu ^{234}U ^{238}U	9.6 72.0 2.5 0.7 3.7 11.4	Ingestion of soil Ingestion of game (quail) Dermal External exposure	1.6 76.5 18.5 3.0	4.12E-01	Iron	76.9	Game ingestion (quail) Dermal	70.1 24.4

Table F.267. Summary of Risk Characterization for SWMU 4 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future excavation worker at current concentrations (Subsurface Soil)	2.00E-03	Arsenic	1.4	Ingestion	9.3	4.89E-01	Arsenic	36.2	Ingestion	75.9
		Total PAH	0.9	Dermal	7.3		Iron	43.5	Dermal	22.0
		Total PCB	10.6	Inhalation	0.8					
		^{137}Cs	78.9	External exposure	82.6					
		^{237}Np	0.3							
		$^{239/240}Pu$	0.2							
		^{226}Ra	3.8							
		^{230}Th	1.6							
		^{234}U	0.6							
		^{238}U	1.7							

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.268. Summary of Risk Characterization for SWMU 5

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	5.75E-03	Arsenic Total PAH Total PCB	0.4 99.5 0.03	Ingestion Dermal Inhalation	2.5 97.4 0.1	8.96E-01	Arsenic Uranium Fluoranthene Naphthalene	17.5 28.2 29.7 20.6	Ingestion Dermal Inhalation	29.1 50.5 20.3
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	9.38E+00	Aluminum Arsenic Uranium Fluoranthene Naphthalene	1.5 11.2 64.4 12.6 8.7	Ingestion Dermal Inhalation	72.7 18.8 8.5
Future adult rural resident at current concentrations (Surface Soil)	1.57E-02	Arsenic Total PAH Total PCB ^{238}U	0.5 99.4 0.0 0.0	Ingestion Dermal Inhalation External Exposure	8.3 91.7 0.03 0.02	1.67E+00	Arsenic Uranium Fluoranthene Naphthalene	17.2 40.7 27.3 10.7	Ingestion Dermal Inhalation	43.8 46.0 10.2
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	7.91E+00	Arsenic Manganese Naphthalene	37.5 27.2 35.4	Ingestion Shower inhalation Household inhalation	64.3 4.0 31.0
Future adult rural resident at current concentrations (RGA groundwater only)	2.52E-04	Arsenic ^{99}Tc	97.2 2.8	Ingestion	99.7	2.08E+00	Arsenic Manganese Naphthalene	40.8 30.2 29.0	Ingestion Household inhalation	69.8 25.3
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.25E+00	Arsenic Manganese Naphthalene	45.6 14.8 39.6	Ingestion Household inhalation	60.4 34.7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	4.99E-05	Arsenic ^{99}Tc	94.5 5.5	Ingestion	99.7	3.24E-01	Arsenic Naphthalene	50.3 33.0	Ingestion	66.5

Table F.268. Summary of Risk Characterization for SWMU 5 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	2.28E-01	Naphthalene	82.2	Household inhalation	72.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	4.81E-06	Arsenic ^{99}Tc	69.9 30.1	Ingestion	99.8	<0.1	NE	NE	NE	NE
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA		*No COC with HI greater than or equal to 0.1		*No POC with HI greater than or equal to 0.1	
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		*No COC with ELCR greater than or equal to 10E-6		*No POC with ELCR greater than or equal to10E-6			*No COC with HI greater than or equal to 0.1		*No POC with HI greater than or equal to 0.1	
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	4.24E+00	Arsenic Uranium Fluoranthene Naphthalene	6.1 76.0 11.6 4.9	Ingestion of soil Ingestion of game (quail) Dermal Inhalation	13.4 65.2 16.6 4.7
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	3.21E+00	Arsenic Uranium Fluoranthene	6.5 75.9 13.7	Ingestion of game (quail) Dermal	74.1 20.5
Future adult recreational user at current concentrations	5.74E-02	Arsenic Total PAH Total PCB ^{238}U	0.1 99.9 <0.1 <0.1	Ingestion of soil Ingestion of deer Ingestion of quail Ingestion of rabbit Dermal Inhalation	0.2 <0.1 86.8 0.2 12.8 <0.1	3.17E+00	Uranium Fluoranthene	89.4 6.5	Ingestion of game (quail) Dermal	90.3 7.2
Future excavation worker at current concentrations (Subsurface Soil)	5.23E-03	Arsenic Total PAH Total PCB ^{238}U	0.8 99.2 0.04 0.02	Ingestion Dermal Inhalation	19.9 80.1 0.04	1.91E+00	Arsenic Uranium	12.7 85.5	Ingestion Dermal	93.5 6.4

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.269. Summary of Risk Characterization for SWMU 6

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	4.41E-05	Total PAH ^{235}U	58.3 39.0	Ingestion Dermal External exposure	2.5 57.5 39.8	1.06E-01	Uranium	97.7	No POC with HI greater than or equal to 0.1.	
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	2.49E+00	Uranium	99.1	Ingestion	98.1
Future adult rural resident at current concentrations (Surface Soil)	1.61E-04	Total PAH Total PCB ^{235}U ^{238}U	43.4 0.7 53.5 2.5	Ingestion Dermal External exposure	4.7 40.3 54.9	2.82E-01	Uranium	98.3	Ingestion	92.7
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at current concentrations (RGA groundwater only)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	Exposure route not applicable.	---	---	---	---
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	Exposure route not applicable.	---	---	---	---	Exposure route not applicable.	---	---	---	---
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.33E+00	Uranium	99.7	Ingestion of soil Ingestion of game (quail)	15.4 83.2

Table F.269. Summary of Risk Characterization for SWMU 6 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	1.00E+00	Uranium	99.7	Ingestion of game (quail)	94.7
Future adult recreational user at current concentrations	3.01E-04	Total PAH ^{235}U ^{238}U	95.9 3.3 0.5	Ingestion-quail Dermal External exposure	86.3 11.1 2.2	1.16E+00	Uranium	99.9	Ingestion of game (quail)	98.0
Future excavation worker at current concentrations (Subsurface Soil)	3.92E-05	Total PAH ^{235}U ^{238}U	58.9 38.1 3.0	Ingestion Dermal External exposure	19.4 47.3 33.2	6.71E-01	Beryllium Uranium	0.4 99.6	Ingestion	98.7

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.270. Summary of Risk Characterization for SWMU 7

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations(Surface Soil)	8.70E-04	Arsenic Total PAH Total PCB ^{237}Np ^{228}Th ^{234}U ^{235}U ^{238}U	1.6 37.7 12.7 0.1 13.8 0.5 1.0 32.4	Ingestion Dermal Inhalation External exposure	6.1 48.8 1.6 43.5	5.25E-01	Uranium	61.9	Ingestion Dermal	68.1 31.6
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	9.99E+00	Aluminum Arsenic Iron Thallium Uranium Vanadium	1.4 6.0 9.0 3.4 77.8 1.2	Ingestion Dermal	93.5 6.5
Future adult rural resident at current concentrations (Surface Soil)	3.32E-03	Arsenic Total PAH Total PCB ^{237}Np ^{99}Tc ^{228}Th ^{234}U ^{235}U ^{238}U	1.5 27.0 9.6 0.2 0.0 18.2 0.5 1.3 41.8	Ingestion Dermal Inhalation External exposure	8.9 32.9 0.8 57.5	1.28E+00	Arsenic Iron Uranium	12.7 9.4 68.1	Ingestion Dermal	77.9 21.9
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	1.89E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	30.2 3.7 2.9 4.5 6.6 22.3 26.4 3.4	Ingestion Dermal contact Inhalation while showering Inhalation household use	60.9 21.0 2.0 16.0
Future adult rural resident at current concentrations (RGA groundwater only)	3.13E-03	Arsenic 1,1-DCE Total PCBs TCE Vinyl chloride ^{99}Tc ^{234}U ^{238}U	15.1 66.4 0.2 4.1 11.9 1.6 0.4 0.4	Ingestion Dermal contact Inhalation while showering Inhalation during household use	61.2 3.7 4.9 30.3	6.39E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	25.5 3.2 2.5 3.1 4.5 31.4 27.1 2.7	Ingestion Dermal contact Inhalation household use	51.4 37.2 10.1

Table F.270. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	1.45E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	27.9 3.6 2.8 5.4 7.9 17.2 31.2 4.1	Ingestion Dermal contact Inhalation while showering Inhalation household use	62.3 18.7 2.2 16.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.98E-03	Arsenic 1,1-DCE Total PCBs TCE Vinyl chloride ^{99}Tc ^{234}U ^{238}U	11.2 63.9 0.2 10.3 12.3 1.5 0.3 0.3	Ingestion Dermal contact Inhalation while showering Inhalation during household use	55.4 3.4 4.7 36.5	4.78E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	24.2 3.1 2.4 3.8 5.5 24.8 32.9 3.3	Ingestion of groundwater Dermal contact Inhalation household use	53.8 33.8 11.0
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	1.97E+00	Arsenic 1,1-DCE *cis*-1,2-DCE Total PCBs TCE	38.1 5.3 8.4 12.4 32.9	Ingestion Dermal contact Inhalation household use	66.3 15.8 15.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	4.11E-04	Arsenic 1,1-DCE TCE Vinyl chloride ^{99}Tc	15.1 61.8 10.7 8.7 3.6	Ingestion Dermal contact Inhalation while showering Inhalation during household use	56.7 3.2 4.5 35.5	6.36E-01	Arsenic Total PCBs TCE	33.9 18.4 35.5	Ingestion Dermal contact	58.8 29.3
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA	3.73E-01	TCE	61.0	Ingestion Inhalation household use	52.5 30.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	1.28E-04	1,1-DCE TCE Vinyl chloride ^{99}Tc	72.6 12.3 9.5 5.7	Ingestion Dermal contact Inhalation while showering Inhalation during household use	49.6 3.6 5.3 41.4	1.15E-01	No COPC with HI greater than or equal to 0.1.	---	No POC with HI greater than or equal to 0.1.	---

Table F.270. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	4.76E+00	Arsenic Iron Uranium	3.1 7.5 87.0	Ingestion of soil Ingestion of game (quail) Dermal	16.4 77.7 5.4
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	3.57E+00	Arsenic Iron Uranium	3.3 7.3 87.5	Ingestion of soil Ingestion of game (quail) Dermal	3.8 89.0 6.7
Future adult recreational user at current concentrations	3.97E-03	Arsenic Total PAH Total PCB ^{228}Th ^{234}U ^{235}U ^{238}U	0.5 83.7 4.6 1.2 0.9 0.1 9.2	Ingestion of soil Ingestion of deer Ingestion of quail Ingestion of rabbit Dermal Inhalation External exposure	0.6 <0.1 81.3 0.2 14.1 0.2 3.6	3.99E+00	Iron Uranium	7.0 91.2	Ingestion of game (quail)	95.9
Future excavation worker at current concentrations (Subsurface Soil)	7.71E-04	Arsenic Total PAH Total PCB ^{241}Am ^{99}Tc ^{228}Th ^{234}U ^{235}U ^{238}U	1.9 38.3 15.9 0.2 0.3 4.9 2.6 1.1 34.8	Ingestion Dermal Inhalation External exposure	37.0 40.4 1.3 21.3	1.31E+00	Iron Uranium	14.0 65.2	Ingestion	93.0

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern

Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.

NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.

[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.271. Summary of Risk Characterization for SWMU 30

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (Surface Soil)	1.13E-03	Total PAH Total PCB ^{237}Np ^{234}U $^{235/236}$U ^{238}U	57.3 8.2 0.6 0.5 3.7 29.5	Ingestion Dermal Inhalation External exposure	5.9 62.7 1.1 30.3	1.36E+00	Uranium	93.1	Ingestion Dermal	86.8 13.0
Future child rural resident at current concentrations (Surface Soil)	NA	NA	NA	NA	NA	3.16E+01	Aluminum Antimony Nickel Thallium Uranium	0.8 0.5 1.2 1.0 96.0	Ingestion Dermal	97.8 2.2
Future adult rural resident at current concentrations (Surface Soil)	3.93E-03	Total PAH Total PCB ^{237}Np ^{99}Tc ^{230}Th ^{234}U ^{235}U ^{238}U	44.7 6.8 0.8 0.1 0.0 0.6 5.4 41.6	Ingestion Dermal Inhalation External exposure	9.5 46.1 0.6 43.9	3.61E+00	Uranium	94.4	Ingestion Dermal	91.6 8.3
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	3.34E+02	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	1.7 0.2 0.1 0.4 0.2 97.4	Ingestion Dermal contact Inhalation while showering Inhalation household use	70.6 21.3 0.9 7.2
Future adult rural resident at current concentrations (RGA groundwater only)	2.40E-02	Arsenic 1,1-DCE TCE ^{99}Tc ^{234}U ^{238}U	2.0 5.8 92.1 0.1 0.0 0.0	Ingestion Dermal contact Inhalation while showering Inhalation household use	21.6 10.5 7.7 60.2	1.17E+02	Arsenic Manganese Uranium 1,1-DCE TCE	1.4 0.2 0.3 1.3 96.7	Ingestion Dermal contact Inhalation while showering Inhalation household use	57.9 36.5 0.9 4.7
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	NA	NA	NA	NA	NA	3.16E+02	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	1.2 0.2 0.1 0.2 0.2 98.2	Ingestion of groundwater Dermal contact Inhalation while showering Inhalation household use	70.4 21.4 0.9 7.3
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.28E-02	Arsenic 1,1-DCE TCE ^{99}Tc ^{234}U ^{238}U	1.4 6.0 92.5 0.1 0.0 0.0	Ingestion Dermal contact Inhalation while showering Inhalation household use	21.1 10.6 7.8 60.6	1.10E+02	Arsenic Manganese Uranium 1,1-DCE TCE	1.0 0.1 0.2 0.1 98.5	Ingestion Dermal contact Inhalation while showering Inhalation household use	58.0 37.0 0.6 4.5

Table F.271. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	2.76E+01	Arsenic TCE	2.7 97.1	Ingestion Dermal contact Inhalation while showering Inhalation household use	70.7 21.2 0.9 7.2
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	1.99E-03	Arsenic 1,1-DCE TCE Technetium-99	3.1 5.1 91.6 0.2	Ingestion Dermal contact Inhalation while showering Inhalation household use	22.3 10.4 7.6 59.7	9.56E+00	Arsenic TCE	2.2 97.6	Ingestion Dermal contact Inhalation household use	58.4 36.6 4.4
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	NA	NA	NA	NA	NA	8.97E+00	TCE	99.8	Ingestion Dermal contact Inhalation household use	69.9 21.8 7.4
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou Seeps)	6.41E-04	1,1-DCE TCE ^{99}Tc	4.8 95.0 0.2	Ingestion Dermal contact Inhalation while showering Inhalation household use	19.8 10.8 7.9 61.6	3.12E+00	TCE	99.9	Ingestion Dermal contact Inhalation household use	57.4 37.5 4.5
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU								
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	1.64E+01	Uranium	98.4	Ingestion of soil Ingestion of game (quail) Dermal	15.7 82.5 1.7
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	1.24E+01	Uranium	98.6	Ingestion of soil Ingestion of game (quail) Dermal	3.6 94.2 2.1

Table F.271. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future adult recreational user at current concentrations	7.15E-03	Cadmium Total PAH Total PCB ^{237}Np ^{234}U ^{235}U ^{238}U	<0.1 90.8 2.1 <0.1 0.7 0.3 6.0	Ingestion of soil Game ingestion –deer Game ingestion-quail Game ingestion-rabbit Dermal Inhalation External exposure	0.4 <0.1 84.5 0.2 13.0 0.1 1.8	1.43E+01	Uranium	99.1	Ingestion of soil Ingestion of game (quail)	1.4 97.9
Future excavation worker at current concentrations (Subsurface Soil)	9.40E-04	Arsenic Total PAH Total PCB ^{237}Np ^{99}Tc ^{228}Th ^{230}Th ^{234}U ^{235}U ^{238}U	1.8 61.5 11.0 0.1 0.5 1.4 0.1 2.6 2.7 18.3	Ingestion Dermal Inhalation External exposure	30.8 56.4 0.9 11.9	8.85E+00	Arsenic Iron Uranium	1.2 2.7 92.7	Ingestion Dermal	97.7 2.2

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

Table F.272. Summary of Risk Characterization for SWMU 145

Receptor	Total ELCRa	COCs	% Total ELCR	POCs	% Total ELCR	Total HIa	COCs	% Total HI	POCs	% Total HI
Future industrial worker at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child rural resident at current concentrations (Surface Soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future adult rural resident at current concentrations (Surface Soils)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future child rural resident at current concentrations (RGA groundwater only)	NA	NA	NA	NA	NA	3.99E+01	Antimony Arsenic	50.1 49.9	Ingestion Dermal contact	97.8 2.2
Future adult rural resident at current concentrations (RGA groundwater only)	2.20E-03	Arsenic ^{99}Tc	74.8 25.2	Ingestion Dermal contact	99.8 0.2	1.17E+01	Antimony Arsenic	51.2 48.8	Ingestion Dermal contact	95.5 4.5
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	NA	NA	NA	NA	NA	5.16E-01	Arsenic	99.9	Ingestion	99.8
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	1.44E-04	Arsenic ^{99}Tc	29.7 70.3	Ingestion	99.9	1.48E-01	Arsenic	99.9	Ingestion	99.6
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	NA	NA	NA	NA	NA	NE	NE	NE	NE	NE
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	5.29E-05	^{99}Tc	100.0	Ingestion	100	NE	NE	NE	NE	NE
Future child recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table F.272. Summary of Risk Characterization for SWMU 145 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	POCs	% Total ELCR	Total HI[a]	COCs	% Total HI	POCs	% Total HI
Future teen recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future adult recreational user at current concentrations (soil)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Future excavation worker at current concentrations	2.18E-04	Arsenic Total PAH Total PCB ^{137}Cs ^{90}Sr ^{99}Tc ^{235}U ^{238}U	10.2 10.2 44.7 1.0 0.7 0.7 0.7 31.5	Ingestion Dermal Inhalation External exposure	43.3 37.4 3.4 15.9	8.28E-01	Antimony Arsenic Uranium	28.3 16.7 47.8	Ingestion Dermal	82.0 17.8

ELCR = excess lifetime cancer risk; HI = hazard index; POC = point of contact; COC = contaminant of concern
Note: NA = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
NE = Land use scenario not of concern because exposure pathway ELCR was less than 1E-06 or HI was less than 0.1.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.

F.6. UNCERTAINTY IN THE RISK ASSESSMENT

Uncertainties are associated with each step of the risk assessment process. The potential effect of the uncertainties on the final risk characterization must be considered when interpreting the results of the risk characterization because a number of assumptions are made during the risk assessment. Types of uncertainties to consider are divided into four broad categories: those associated with data, exposure assessment, toxicity assessment, and risk characterization.

Specific uncertainties in each of these categories are discussed in the following sections. Magnitude of the effect of the uncertainty on the risk characterization is categorized as small, moderate, or large. Uncertainties categorized as small are assumed to not affect the risk estimates by more than one order of magnitude; those categorized as moderate are assumed to affect the risk estimates by between one and two orders of magnitude, and uncertainties categorized as large are assumed to affect the risk estimate by more than two orders of magnitude.

In evaluating these uncertainties and their estimated effect on the risk estimates, it should be remembered that the following uncertainties are neither independent nor mutually exclusive; therefore, the total effect of all uncertainties on the risk estimates (i.e., total ELCRs and HIs) is not necessarily the sum of the estimated effects.

F.6.1 UNCERTAINTIES ASSOCIATED WITH DATA AND DATA EVALUATION

Several uncertainties are associated with the data set and the selection of COPCs. Specific uncertainties that will be discussed in the following subsections are selection of COPCs, determination of EPCs under current and future conditions, and use of concentrations from total versus filtered samples for inorganic compounds in groundwater.

F.6.1.1 Selection of COPCs

Some uncertainty is involved with the selection of COPCs. This uncertainty is derived from several sources. The first uncertainty related to the selection of COPCs is whether or not to retain infrequently detected chemicals in the list of COPCs. During the initial COPC selection process, analytes detected at a frequency less than 5% that were unlikely to be related to processes were eliminated as COPCs. Most COPCs detected at less than 5% frequency also were below their NAL; therefore, the exclusion of analytes detected at less than 5% frequency had very little impact on the results of the screening. In the screening of subsurface soil at SWMU 4, TCE was dropped based on less than a 5% detection frequency but was higher than its NAL. As the tables in Section 2 detail, several of the chemicals retained in the list of COPCs were detected at greater than 5% frequency but in less than 10% of the samples taken. At SWMU 6, uranium in surface soil, as well as benzo(a)pyrene and benzo(b)fluoranthene, were retained for this reason. Of greatest concern is that some of these COPCs are retained as COCs. Fortunately, these COCs contribute far less to total ELCR and HI than the "priority COCs"[24]listed in Section 5; therefore, the estimated effect of the uncertainty on the risk estimates is small.

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[2] "Priority COCs" are identified as an aid to risk managers during decision making; however, all COCs will be addressed through remediation, removal, management, or other enforceable control.

An additional uncertainty related to selection of COPCs in the BHHRA is that temporal patterns in detection of analytes were not considered when selecting soil COPCs. If temporal patterns were considered, the final risk results in this BHHRA may be quite different depending on the times in the future at which risks were estimated. However, in the time frame for soil exposure considered in this BHHRA (i.e., 40 years), the assumed effect of this uncertainty on the risk estimates is small. Changes in concentration were considered in the selection of groundwater COPCs; there the peak concentration over the 1,000 model time frame was used for each COPC.

The selection of COPCs for the BGOU was based on screening using the current set of NALs from the 2001 Risk Methods Document, which has been approved by the regulatory agencies. New NALs are under development, but have not yet been approved. Differences between the old and new values are due to development of newer toxicity factors for some chemicals, reduction in the values for dermal absorption of chemicals, and a change in the exposure duration of the adult residential receptor from 30 years to 24 years. Changes in toxicity factors could increase or decrease the NAL for a chemical; however, the changes to dermal exposure and the residential exposure duration both would be likely to increase the NAL. The probability is small that potential COPCs that were screened out would have been retained otherwise.

Another uncertainty related to selection of COPCs in the BHHRA concerns the quantitation limits used for some analytes. As shown in the comparisons performed in Section 2, many organic compound analytes have a quantitation limit that exceeds their respective no action screening values for residential use scenarios. Because the quantitation limits exceed the screening levels, it is possible that these chemicals are present at concentrations that pose a risk, but may not be retained as COPCs and be quantitatively evaluated. Because these organic compounds tend to be unrelated to processes at PGDP (DOE 2001) and because risk from "priority COCs"[2] is significantly higher than the ELCR and HI targets used to develop the no action screening, the estimated effect of this uncertainty on the risk estimates is small.

The exclusion of common laboratory contaminants from the COPC list also represents an uncertainty. In this assessment, neither acetone and methylene chloride was retained as COPCs because both are common laboratory contaminants.

Another uncertainty related to the selection of the COPCs is using a background screen to determine the final COPC lists. As shown in Section 2, few inorganic chemical and radionuclide COPCs were removed from the COPC lists based on this screen. Additionally, because most "priority COCs"[2] are organic compounds that have no background value for comparison,, removal of inorganic chemicals using a background screen would have reduced total ELCR and HI little; therefore, the estimated effect of not using a background screen to develop the final list of COPCs is small.

F.6.1.2 Determination of EPCs—Current Conditions

The uncertainty in the calculated EPCs for environmental media under current conditions is estimated to have had little effect on the final ELCR and HI estimates. Sampling data came from sources of known quality, and the data set was generated from samples collected and analyzed using EPA-approved protocols. Additionally, because the ELCR and HI estimates are driven by contaminants known to be present at the BGOU sources, the effect of this uncertainty on the final risk estimates is believed to be small.

The BGOU cells also contain waste materials that may have different concentrations of contaminants than the surrounding soil. Too little analytical data is available to quantitatively assess risks due to direct exposure to the waste material. Risks from exposure to waste would be expected to exceed risks estimated from exposure to soil. The potential risks from exposure to waste also would depend greatly on whether the wastes buried in drums still are containerized or if the containers already have released their material to the surrounding soil.

F.6.1.3 Determination of EPCs—Future Conditions

Uncertainty is involved in characterizing EPCs for environmental media under future conditions in this BHHRA. In calculating the EPCs at the BGOU sources, the concentrations of COPCs are kept constant throughout the exposure period. That is, the risk assessment does not consider that concentrations of some COCs may be lower or higher in the future because of processes such as degradation and attenuation. However, because the COCs driving risk at the SWMUs are not expected to degrade significantly throughout a lifetime, the effect of this uncertainty is estimated to be small. Use of the RESRAD code for radionuclide COPCs incorporates changes in radionuclide concentrations, however.

A second uncertainty is the potential risk that may develop as COPCs in media at the BGOU sources migrate to groundwater below the SWMU and are transported off-site. To address this uncertainty, results from a fate and transport model were used to estimate potential contributions from each SWMU to POEs for groundwater exposure away from the source area. (See Appendix E.) While the modeling estimated contaminant transport though groundwater based on contaminant concentrations in the surrounding soil, uncertainty still exists in the POE at which exposure may occur in the future and the contaminant mass that is present in the source areas contributing to the future groundwater concentrations of contaminants. This is particularly true for wastes that originally were containerized. For these wastes, the impact on estimation of future contaminant concentrations in soil depends on whether the wastes already have been released from the containers (in which case, the surrounding soil concentrations may reflect the future contaminant mass) or whether the material may escape the containers in the future (which could result in an increase in the source term/contaminant mass). These uncertainties are discussed in Appendix E. Generally, the estimated effect for most of the modeling uncertainties is moderate to small, indicating that the ELCR and HI estimates generated using the modeled concentrations can be expected to vary by less than an order of magnitude. The potential effect of the status of the containerized wastes could have a significant effect on the risk estimates if drum failure has not yet occurred.

F.6.2 UNCERTAINTIES ASSOCIATED WITH EXPOSURE ASSESSMENT

Uncertainties associated with the exposure assessment are from three sources. These are uncertainties in biota fate and transport modeling, in use of the RME scenario, and in the development of the CSM and selection of pathways. Each of these uncertainties is discussed in the following material.

F.6.2.1 Uncertainties in Biota Fate and Transport Modeling

In the BHHRA, the CDI from soil includes a component for game ingestion for the recreational user. These components are based on modeled uptake of COPCs into the animals and modeled consumption by the recreational user. The uptake into both the game animal and the recreational user is based on default values that are likely to overestimate the contribution of this pathway. The risk and hazard for ingestion of quail includes the use of default bioaccumulation factors (BAFs), including a BAF of 1 for uranium. Use of conservative BAF factor results in risk and hazard estimates for quail ingestion that constitute the majority of risk and hazard and producing much higher risk and hazard values than ingestion of deer or rabbit. The values for consumption of deer or rabbit, which are POCs at only a few SWMUs, are probably better estimates of the potential for future risks through game consumption that the quail values. Other potential biota pathways (such as produce ingestion or consumption of domestic animals raised on site) were not included in the BHHRA, which could underestimate future exposures under this scenario.

The potential intake from produce ingestion was included in the WAG 3 RI Report BHHRA contains results for SWMU 4, SWMU 5, and SWMU 6 (DOE 2000) and are provided in that document. Other potential biota ingestion pathways (such as consumption of domestic animals) have not been included in any of the BHHRAs; however, the risks and hazard associated with game animals were included in this BHHRA and are expected to be similar in magnitude.

F.6.2.2 Uncertainties in Use of RME Scenarios

For each exposure pathway modeled, assumptions were made about the number of times a year an activity could occur, routes of exposure, and rate of intake of contaminated media. Because site-specific data were not available for many parameters, defaults from the Risk Methods Document were used. Because most of these defaults are conservative to prevent the underestimation of risk estimates, the risk estimates tend to be conservative and may overestimate risk. The default exposure values of 5 hours per day for 104 or 140 days per year for 6 to 12 years used for the recreational user, in particular, are likely to overestimate risk for the type of sites within the BGOU. These sites are small and maintained as mown grass with little other vegetation, and therefore recreational users are likely to remain on the sites for much shorter periods of time. The risk from direct exposure to soil on these types of sites is therefore much smaller than that estimated using the default factors. For recreational exposures, the risks and COCs estimated for game consumption, not soil exposure, should be the drivers for any future actions.

The exposure frequency set for the future industrial worker is 250 days per year, which exceeds the number of days workers currently are exposed to these sites. Presently, the only worker activities at these sites are maintenance (mowing the vegetation on the cover) and periodic sampling of monitoring wells. The highest frequency of current exposure is 8 days per year for mowing; this value is based on review of management records for this activity. The risk and hazard for this current maintenance worker was calculated using all the same parameters as the future industrial worker, except that the exposure frequency was set to 16 days per year (double the expected exposure) for 8 hours a day for 25 years. The total risk and hazard under this scenario are provided below for each SWMU, along with the COCs for this scenario. No HIs exceeded 0.1 for any of the SWMUs, so all the COCs listed are based on ELCRs greater than 1E-06.

- SWMU 2 ELCR is 5.62E-05 and HI is 0.09. The COCs are arsenic, ^{137}Cs, ^{235}U, and ^{238}U.
- SWMU 3 ELCR is 2.25E-07 and the HI is 0.009; therefore, there are no COCs for this SWMU for this scenario
- SWMU 4 ELCR is 6.1E-06 and the HI is 0.017. The COCs are arsenic, Total PAHs, and ^{238}U.
- SWMU 5 ELCR is 3.68E-04 and the HI is 0.057. The COCs are arsenic and PAHs.
- SWMU 6 ELCR is 1.93E-06 and the HI is 0.007. The COC is Total PAHs.
- SWMU 7 ELCR is 5.57E-05 and the HI is 0.034. The COCs are Total PAHs, Total PCBs, ^{228}Th and ^{238}U.
- SWMU 30 ELCR is 7.21E-05 and the HI is 0.087. The COCs are Total PAHs, Total PCBs, ^{235}U, and ^{238}U.

F.6.2.3 Uncertainties Related to Development of the Conceptual Site Model

Generally, the level of uncertainty in the development of the CSM is small. Data used to develop this model were from several previous investigations and from local experts; however, some of the uncertainties related to specific land use scenarios deserve additional explanation.

Uncertainties associated with elimination of exposure pathways for some land use scenarios is expected to be small. All pathways that could contribute significantly to exposures to workers, residents, and recreational users at these SWMUs were carried through the quantitative analysis. This included all direct exposure pathways for all receptors, and the pathway of game ingestion for the recreational receptor.

F.6.2.4 Uncertainties Related to Use of Values when Estimating Dermal Absorbed Dose

In this assessment, ABS values from the proposed PGDP Risk Methods Document were used. These values are 0.1% for inorganic COPCs and 1% for organic COPCs with a few exceptions to this were arsenic, benzo(a)pyrene, cadmium, fluoranthene, and Total PCBs with respective chemical-specific ABS values of 0.03, 0.13, 0.001, 0.13, and 0.14. These dermal values match those in the proposed PGDP Risk Methods Document, which matches EPA Region 4 (EPA 1995) default values. The values for chemicals without specific values are lower than the values used in previous risk assessments. The PGDP Risk Methods Document values are expected to provide a reasonable yet protective estimate of dermal exposures, but the dermal component will be lower than previous assessments due to the lower default values.

F.6.2.5 Uncertainties Related to Combining Soil and Sediment Surface Samples

All surface samples at the sites were evaluated together as soil whether the sample came from the SWMU surface (soil) or the surface of the surrounding ditches (sediment).This was done because the spatial extent of the SWMUs is small and some future uses may not maintain the distinction between grassy areas and ditches that currently exists. There may be differences in area between the SWMU surface and ditch so that sample results from the two areas may represent equivalent areas. Due to the uncertainty in potential future exposure at the two types of areas in each SWMU, it is appropriate to consider these two media as one for assessing the exposure of receptors.

F.6.3 UNCERTAINTIES ASSOCIATED WITH TOXICITY ASSESSMENT

Uncertainties related to the toxicity assessment are from the following three sources: uncertainty because of lack of toxicity values for some COPCs, uncertainty in the calculation of toxicity values by EPA, and uncertainty in the calculation of absorbed dose toxicity values from administered dose toxicity values. Each of these is discussed in the following paragraphs.

F.6.3.1 Uncertainties Because of Lack of Toxicity Values for Some Chemicals

Because virtually all COPCs had a toxicity value for either HI or ELCR, the only uncertainty to consider here is the use of provisional or withdrawn values in the BHHRA. The uncertainty from the use of provisional or withdrawn values is important to the results of the BHHRA. Some COPCs did not have approved toxicity values, so a provisional or withdrawn value was used. The most notable of these COPCs was TCE, which was evaluated using the current KDEP oral slope factor of 0.322 $(mg/kg \times day)^{-1}$. This factor is similar to the EPA provisional oral slope factor of 0.4 $(mg/kg \times day)^{-1}$, but both these values are very different from the values for TCE from the 2001 Risk Methods Document that were used in previous assessments. If the residential ELCR for TCE in groundwater at SWMU 2 is calculated with the previously used toxicity values, the ELCR would be 1.03E-03 instead of the 4.6E-02 ELCR derived with the KDEP value. The risk estimated using the new toxicity values is 45 times the risk calculated using the old toxicity factors and indicates the magnitude of the uncertainty associated with the choice of slope factor for this chemical.

Some COPCs either had no toxicity data or withdrawn toxicity data and could not be included in the quantitative assessment. The COPCs with no toxicity data were 3-methylcholanthrene, benzo(g,h,i)perylene, 3-nitrobenzenamine, and phenanthrene; 4-methylphenol was the COPC with withdrawn toxicity data. These COPCs generally were infrequently detected at the SWMUs and are unlikely to contribute significantly to the overall estimates of risk and hazard for the SWMUs considered in this BHHRA.

F.6.3.2 Uncertainties in Deriving Toxicity Values

Standard EPA RfDs and slope factors were used to estimate potential noncarcinogenic and carcinogenic health effects from exposure to chemicals. Considerable uncertainty is associated with the method applied to derive slope factors and RfDs. The EPA has working groups that review all relevant human and animal studies for each compound and select the studies pertinent to the derivation of the specific RfD and slope factor. These studies often involve data from experimental studies in animals, high exposure levels, and exposures under acute or occupational conditions. Extrapolation of these data to humans under low-dose, chronic conditions introduces uncertainties. The magnitude of these uncertainties is addressed by applying uncertainty factors to the dose response data for each applicable uncertainty. These factors are incorporated to provide a margin of safety for use in human health risk assessments. The effect of uncertainties in calculation of chemical toxicity values is moderate.

Unlike the uncertainty associated with chemical toxicity values, the uncertainty associated with radionuclide toxicity values is small. The dose-response relationship between cancer and ionizing radiation has been evaluated in many reports, some describing exposed human populations, and is well established.

F.6.3.3 Uncertainties Because of Calculation of Absorbed Dose Toxicity Values from Administered Dose Toxicity Values

Uncertainty exists in the validity of the calculations used to convert an administered dose toxicity value to an absorbed dose. Of greatest importance is the lack of consideration of point-of-contact effects in this calculation. For example, some organic analytes can cause a toxic or cancer response in skin. This effect is not considered in the calculation of absorbed dose toxicity values from administered dose toxicity values using EPA protocols. Similarly, the administered dose response for many chemicals relies on the delivery of a high concentration of contaminants to the liver via the portal system after ingestion; this effect is not seen if a contaminant is absorbed through the skin because of the larger distribution space for the contaminant absorbed through the skin. However, even with these uncertainties, the effect of the uncertainty in calculation of absorbed dose toxicity values from administered dose toxicity values upon the risk estimates is estimated to be small because the overall contribution of dermal exposure to total risk and hazard is much smaller due to the use of the new, lower dermal absorption factors.

F.6.4 UNCERTAINTIES ASSOCIATED WITH RISK CHARACTERIZATION

Three uncertainties are related to risk characterization. The first is the method used to combine HQs over pathways and combine pathway HIs to calculate total HI. This method also is used to combine chemical-and pathway-specific ELCRs to derive total ELCRs. The second is the uncertainty added to the assessment by combining risks from chemicals and radionuclides. These uncertainties are discussed in the following subsections.

F.6.4.1 Combining chemical-specific Risk Values and Pathway Risk Values

The primary uncertainty in risk characterization is the method used to combine HQs and chemical-specific ELCRs over pathways and combine pathway HIs and ELCRs to calculate total HI and ELCR. The uncertainties in this method are discussed in the following text.

The method used to calculate pathway HIs and ELCRs in the BHHRA followed EPA protocols (Risk Methods Document). This guidance calls for the simple summation of HQs and chemical-specific ELCRs to calculate pathway HIs and ELCRs, respectively. This method assumes that all effects between chemicals are additive. EPA makes this assumption because information concerning the effect of chemical mixtures is lacking. Specific limitations of this approach for systemic toxicity effects (HI) have been reported by EPA.

Little is known about the effects of chemical mixtures; although additivity is assumed, the interaction of multiple chemicals possibly could be synergistic or antagonistic.

The RfDs and reference concentrations do not have equal accuracy or precision and are not based on the same severity of effects.

Dose additivity is most properly applied to compounds that induce the same effect by the same mechanism of action. While the approach recommended by EPA is a useful screening-level approach, the potential for at least noncarcinogenic effects to occur can be overestimated for chemicals that act by different mechanisms and on different target organs.

The effect of this uncertainty on the estimate of HI depends on how many contaminants drive HI and if the contaminants have different endpoints. In this BHHRA, several contaminants do affect HI, and these contaminants do have differing endpoints and target organs (see Tables F.263 through F.270). Because only a few "priority COCs"[2] drive HI, as shown in Section 5, and because the HI from each of these "priority COCs"[2] alone is great enough that a systemic toxic effect may be reasonably expected, the effect of this uncertainty on HIs is small.

Specific limitations for this approach in regard to chemical carcinogenesis also have been reported by EPA in RAGS:

Cancer risks (i.e., ELCRs) are based on slope factors that represent an upper 95th percentile estimate of potency; the upper 95th percentiles of probability distributions are not strictly additive. Summing these risks can result in an overly conservative estimate of lifetime ELCR (EPA 1991).

Combined cancer risks for chemical carcinogens and radionuclides are presented, but may not be additive because the slope factors used to characterize the risk from chemicals are derived differently from the slope factors used to characterize risk from radionuclides.

Not all slope factors contain the same weight-of-evidence for human carcinogenicity. As explained in Section 4, EPA recognizes this by placing weight-of-evidence classifications on all slope factors. Those contaminants with an A weight-of-evidence should probably receive more attention in the selection of a remedial design than contaminants with a B or C classification. Similarly, a contaminant with a B classification should probably receive greater attention than one with a C classification. The simple combination of ELCRs does not take this hierarchy into account.

The uncertainties involved in combining chemical-specific ELCRs and pathway ELCRs are considerable. The effect of these uncertainties on the total ELCRs presented in the BHHRA is small because as noted above, only a few "priority COCs"[2] dominate the pathway ELCR for most pathways; therefore, the potential effect of mixtures is reduced.

F.6.5 SUMMARY OF UNCERTAINTIES

As is shown in the previous subsections, the risk estimates could vary if different assumptions were used in deriving the risk estimates or if better information was available for some parameters. The following text summarizes the estimated effects of each uncertainty mentioned previously.

No uncertainties were estimated to have a large effect on the risk characterization, and only three were estimated to have a moderate effect.

Following is a list of uncertainties with effects estimated to be moderate:

- Exclusion of some potential biota pathways (produce and fish) for future receptors,
- Migration of groundwater to off-site receptors, and
- Calculation of toxicity values for chemicals (particularly TCE).

Following is a list of uncertainties with effects estimated to be small:

- Inclusion of infrequently detected COPCs,
- Inclusion of infrequently analyzed for COPCs,
- Determination of temporal patterns in data,
- Use of quantitation limits that exceed residential use no action screening values,
- Contribution of analytes removed based on comparison to residential use no action screening values from the 2001 version of the Risk Methods Document,
- Including a background screen,
- Combining all surface data for both soil and sediment for determining an EPC,
- Determination of exposure points for current concentrations,
- Determination of exposure points for future concentrations,
- Not including biota exposure pathways,
- Use of RME default exposure values instead of central tendency exposure values,
- Use of provisional and withdrawn toxicity values,
- Determination of radionuclide toxicity values, and
- Use of absorbed toxicity values calculated from administered toxicity values.

F.7. CONCLUSIONS

This section summarizes the results of the BHHRA and draws conclusions from the results. The primary purpose of this section is to provide a concise summary of each of the BHHRA steps without the use of tables, extensive explanations, or justifications. This section also includes a series of observations in which the results of the BHHRA are combined with the uncertainties in the risk assessment.

F.7.1 CHEMICALS OF POTENTIAL CONCERN

COPCs were selected from soil data collected in the recently completed BGOU RI and historical data from the OREIS data base. This data set was screened to produce final COPCs lists aggregated by location.

Through a series of screening steps, which follow the Risk Methods Document (DOE 2001) and other regulatory agency approved procedures, the data sets were reduced to lists of COPCs for the entire BGOU. Conclusions are compiled from Tables F.4 through F.26.

F.7.2 EXPOSURE ASSESSMENT

Historical information and newly collected data were used to develop a CSM. After consideration of the available data and scope of the SI, the potential receptor population under current conditions at the source units is industrial workers, and the potential receptor populations under future conditions are industrial workers, excavation workers, recreational users, and on-site rural residents. The potential receptor populations under future conditions in BGOU areas are recreational and residential. Within these broad categories, the recreational users and rural residents contain age cohorts. For the recreational users, the cohorts include the child (aged 1 to 7), teen (aged 8 to 20), and the adult (older than 21). For rural residents, the cohorts include children (aged 1 to 7) and older individuals (termed adults in this and previous BHHRAs). The recreational user and the rural resident population may also contain sensitive subpopulations such as pregnant women, young children (aged 0 to 1), the elderly, and the infirm. In this and earlier BHHRAs, exposure by these subpopulations is not quantified because much of the information that is needed is not available; however, these subpopulations are considered qualitatively in the uncertainty discussions. Finally, this and earlier assessments assume that the recreational user is a rural resident who has repeated access to the study area. Recreational users not residing in the study area are not considered separately because nearby residents were determined to be the individuals most likely to take part in recreational activities at PGDP on a continual basis. In addition, the exposure assessment determined that little information useful in remedy selection would be obtained by including a separate visiting recreational user in the assessment. This also is a hypothetical scenario at all POEs considered (i.e., at the plant boundary, property boundary, and near the Ohio River) because the areas containing the POEs currently are used for recreational and industrial purposes and do not contain residences. Table F.47 in the CSM section shows the scenarios and media evaluated in this risk assessment. The exposure routes considered are listed below.

Industrial Worker

Ingestion of surface soil
Dermal contact with surface soil
Inhalation of vapors emitted by surface soil
External exposure to ionizing radiation

Excavation Worker

Ingestion of surface and subsurface soil
Dermal contact with surface and subsurface soil
Inhalation of vapors emitted by surface and subsurface soil
External exposure to ionizing radiation

Future recreational user

Ingestion of surface soil
Dermal contact with surface soil
Inhalation of vapors emitted by surface soil
Ingestion of game
External exposure to ionizing radiation

Future on-site rural resident

Ingestion of surface soil
Dermal contact with surface soil
Inhalation of vapors emitted by surface soil
External exposure to ionizing radiation
Ingestion of groundwater
Dermal contact with groundwater while showering
Inhalation of vapors emitted by groundwater during household use and
Inhalation of vapors emitted by groundwater while showering

Future off-site rural resident

Ingestion of surface soil
Dermal contact with surface soil
Inhalation of vapors emitted by surface soil
External exposure to ionizing radiation
Ingestion of groundwater
Dermal contact with groundwater while showering
Inhalation of vapors emitted by groundwater during household use and
Inhalation of vapors emitted by groundwater while showering

After selection of the exposure routes, CDIs were calculated using standard exposure models. Most parameters used in models were default values.

F.7.3 TOXICITY ASSESSMENT

The toxicity values used in the risk assessment were taken from the RAIS. After compiling toxicity information, the determination was made that the majority of the COPCs had a toxicity value available for one or more routes of exposure (see Section F.4.6).

F.7.4 RISK CHARACTERIZATION

Quantitative risks were computed by integrating the CDIs tabulated from the exposure assessment and toxicity values calculated from the toxicity assessment. The quantitative risks indicate elevated risks associated with exposure to subsurface soil, surface soil, and groundwater exposure. Significant findings are summarized below.

F.7.4.1 Land Use Scenarios of Concern

The following are land uses of concern for BGOU:

Industrial: SWMUs 2, 3, 4, 5, 6, 7, and 30
Excavation: SWMUs 2, 3, 4, 5, 6, 7, 30, and 145
Recreational: SWMUs 2, 3, 4, 5, 6, 7, and 30
On-Site Residential: SWMUs 2, 3, 4, 5, 6, 7, 30, and 145
Off-Site Residential: SWMUs 2, 3, 4, 5, 7, 30, and 145

F.7.4.2 Contaminants of Concern for Soil

To make a determination about whether contaminants are of concern, quantitative risk and hazard results over all pathways were compared to risk and hazard benchmarks for land use scenarios of concern. The benchmarks used for this comparison were a) 0.1 for HI and b) 1×10^{-6} for ELCR.

Contaminants with chemical-specific HIs or ELCRs exceeding these benchmarks were deemed COCs. Priority COCs are contaminants whose chemical-specific HI is greater than 1 or whose ELCR is greater than 1×10^{-4} for one or more scenarios. The following are priority COCs found in soil at individual SWMUs.

SWMU 2 – arsenic, iron, uranium, ^{137}Cs and ^{238}U
SWMU 3 – none
SWMU 4 – arsenic, iron, Total PAHs, Total PCBs, ^{137}Cs and ^{238}U
SWMU 5 – arsenic, uranium, Total PAHs and fluoranthene
SWMU 6 – uranium, Total PAHs
SWMU 7 – uranium, Total PAHs, Total PCBs, ^{228}Th and ^{238}U
SWMU 30 – uranium, Total PAHs, Total PCBs, ^{235}U and ^{238}U
SWMU 145 – none

Table F.273. Scenarios for Which Human Health Risk Exceeds *De Minimis* Levels[a]

Scenario	Location							
	SWMU 2	**SWMU 3**	**SWMU 4**	**SWMU 5**	**SWMU 6**	**SWMU 7**	**SWMU 30**	**SWMU 145**
Results for excess lifetime cancer risk:								
Future On-site Industrial Worker								
Exposure to Surface Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/ Subsurface Soil	X	X	X	X	X	X	X	X
Future On-site Recreational User								
Exposure to Game (Soil)	X	X	X	X	X	X	X	NA
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	X	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	---	X	---	---	---	X	---
Result for Systematic Toxicity [d]								
Future On-site Industrial Worker								
Exposure to Soil	X	---	---	---	---	---	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Excavation Worker								
Exposure to Surface/Subsurface Soil	X	---	---	X	---	X	X	---
Future On-site Recreational User								
Exposure to Game	X	---	---	X	X	X	X	NA
Exposure to Soil	X	---	---	---	---	X	X	NA
Exposure to Surface Water	NA	NA	NA	NA	NA	NA	NA	NA
Future On-site Rural Resident								
Exposure to Soil	X	X	X	X	X	X	X	NA
Exposure to Groundwater [b]	X	X	X	X	---	X	X	X
Vapor Intrusion [c]	X	X	X	---	---	X	X	X
Future Off-site Rural Resident								
Exposure to Groundwater [b]	X	---	X	X	NA	X	X	---
Vapor Intrusion [c]	---	---	---	---	---	---	---	---

Notes: Scenarios where risk exceeds *de minimis* levels are marked with an X. Scenarios where risk did not exceed *de minimis* levels are marked with a ---. NA indicates that the scenario/land use combination was not assessed because the scenario is not applicable, or the medium is not present.

[a] Consistent with the PGDP Risk Methods Document (DOE 2001), the *de minimis* levels used are a cumulative ELCR of 1×10^{-6} and a cumulative HI of 1.

[b]Systemic toxicity results summarized here for the resident and recreational user are for the child. The off-site POE considered is the property boundary.

F.7.4.3 Contaminants of Concern for Groundwater

Similarly for groundwater, to determine whether modeled concentrations of contaminants are of concern, quantitative risk and hazard results over all pathways were compared to risk and hazard benchmarks for land use scenarios of concern. The benchmarks used for this comparison were a) 0.1 for HI and b) 1 × 10 for ELCR.

Contaminants with chemical-specific HIs or ELCRs exceeding these benchmarks were deemed COCs. Priority COCs are contaminants whose chemical-specific HI is greater than 1 or whose ELCR is greater than 1×10^{-4} for one or more scenarios. The following presents priority COCs found in groundwater at individual SWMUs.

SWMU 2 – arsenic; manganese; uranium; *cis*-1,2-DCE; and TCE
SWMU 3 – arsenic, manganese, uranium, and ^{99}Tc
SWMU 4 – arsenic, manganese; *cis*-1,2-DCE; TCE; vinyl chloride; and ^{99}Tc
SWMU 5 – arsenic; manganese, and naphthalene
SWMU 6 – none
SWMU 7 – arsenic, 1,1-DCE; *cis*-1,2-DCE; Total PCBs, TCE, vinyl chloride.
SWMU 30 – arsenic; 1,1-DCE; TCE
SWMU 145 – antimony, arsenic, and ^{99}Tc

"Priority COCs" are identified in this section as an aid to risk managers during decision making.

The priority COCs identified above in this risk assessment are based on the modeled groundwater concentrations at all POEs. A screening of measured concentrations in the groundwater against NALs and action levels is presented in Appendix E of the BGOU Work Plan. The priority COCs identified in that screening for each of these SWMUs are listed below:

- SWMU 2 – arsenic; barium; beryllium; cadmium; iron; manganese; nickel; uranium; vanadium; 1,1-DCE; *cis*-1,2-DCE; TCE; and vinyl chloride
- SWMU 3 – arsenic, uranium, TCE, and ^{234}U
- SWMU 4 – aluminum; ammonia; antimony; arsenic; barium; beryllium; boron; cadmium; cobalt; copper; iron; manganese; mercury; nickel; nitrate; vanadium; zinc; acetone; PCB-1254; carbon tetrachloride; chloroform; 1,1-DCE; *cis*-1,2-DCE; *trans*-1,2-DCE; naphthalene; 1,1,2-TCA; TCE; vinyl chloride; and ^{99}Tc
- SWMU 5 – aluminum, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, manganese, nickel, vanadium, zinc, TCE, and ^{226}Ra+D
- SWMU 6 – aluminum, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, manganese, nickel, uranium, vanadium, PCB-1016, TCE, ^{237}Np+D, ^{99}Tc, and ^{234}U
- SWMUs 7 and 30 – aluminum; arsenic; barium; beryllium; cadmium; cobalt; copper; iron; manganese; molybdenum; nickel; uranium; acetone; PCB-1016; PCB-1248; PCB-1254; benzene; carbon tetrachloride; chlorobenzene; chloroform; 1,3-dichlorobenzene; 1,4-dichlorobenzene; *cis*-1,2-DCE; 2,4-dimethylphenol; tetrachloroethene; TCE; vinyl chloride; ^{222}Rn+D; ^{99}Tc; and ^{234}U
- SWMU 145 – aluminum, antimony, arsenic, barium, boron, iron, manganese, molybdenum, nickel, uranium, vanadium, white phosphorus, acetone, PCB-1016, benzene, chloroform, m-cresol, TCE, ^{222}Rn+D, and ^{234}U

F.7.4.4 Pathways of Concern

Each of the pathways included in the BHHRA is a POC.

F.7.4.5 Media of Concern

Media of concern are those media that appear in at least one POC. Because they contribute to at least one POC, soil and RGA groundwater are media of concern at all eight SWMUs.

F.7.5 OBSERVATIONS

Consistent with regulatory guidance and agreements contained in the PGDP Risk Methods Document, this BHHRA presents risks for land use scenarios representing current use, as well as several reasonable future uses. Risk evaluation of surface soil was conducted for all SWMUs as part of the evaluation of the scenarios specified in the work plan. The scenarios described in the BHHRA are as follows:

- Future on-site industrial use – direct contact with surface soil (soil found 0 to 1 ft bgs).

- Future on-site excavation worker – direct contact with surface and subsurface soil (soil 0 to 10 ft bgs).

- Future recreational user – direct contact with surface soils and consumption of game exposed to surface soils.

- Future on-site rural resident – direct contact with surface soil at and use of groundwater drawn from the RGA at source areas and vapor intrusion into basements.

- Future off-site rural resident – use in the home of groundwater drawn from the RGA at the DOE plant boundary, property boundary, and the Ohio River.

Specific observations for this BHHRA are presented below.

F.7.5.1 Observations -- Future Industrial Worker

Cumulative HIs for the industrial worker were greater than 1 at SWMUs 2 and 30 based on soil exposure. At SWMU 2, uranium and arsenic were the primary drivers contributing 60.9% and 27.5%, respectively. At SWMU 30, uranium was the primary driver contributing 93.1% to the HI.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at SWMU 2, SWMU 5, SWMU 7, and SWMU 30 for exposure to soil (SWMU 145 was not evaluated for this scenario). The following summarizes the cumulative risk estimates and major contributors to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 8.78E-04; drivers are ^{137}Cs at 67.7% and ^{238}U at 20.2%, and arsenic at 7.1%.

- SWMU 5 cumulative ELCR 5.75E-03; driver is Total PAHs at 99.1%.

- SWMU 7 cumulative ELCR 8.70E-04; drivers are Total PAHs at 37.7%, Total PCBs at 12.7%, ^{228}Th at 13.8%, and ^{238}U at 32.4%.

- SWMU 30 cumulative ELCR 1.13E-03; drivers are Total PAHs at 57.3%, Total PCBs at 8.3%, and ^{238}U at 29.5%.

The current industrial/maintenance worker (based on 16 days exposure per year) had ELCRs less than 1E-04 for all SWMUs except SWMU 5 (ELCR was 3.68E-04 at SWMU 5). Over 99% of the risk at SWMU 5 under this scenario was due to the risk from Total PAHs.

For both the current worker (16 days per year of exposure) and the default future worker, Total PAHs are the risk driver for the ELCR for all SWMUs with an ELCR exceeding 1E-04, with the exception of SWMU 2. Uranium and arsenic were the major contributors to HIs at SWMU 2 and 30; the maximum detected concentrations of these metals in surface soils at these sites are elevated above background. The industrial scenario is the most probable future use for the site, indicating that ^{137}Cs, PAHs, uranium, and arsenic may need to be addressed during the feasibility study (FS).

F.7.5.2 Observations -- Future Excavation Worker

Cumulative HIs for the future excavation worker were greater than 1 for SWMUs 2, 5, 7, and 30 based on soil exposure. The following summarizes the cumulative HIs and major contributors (> 5%) to elevated hazards at these SWMUs.

- SWMU 2 cumulative HI 2.97; drivers are arsenic at 20.1%, iron at 17.4%, thallium at 6.9%, and Total Uranium at 55.2%.

- SWMU 5 cumulative HI 1.91; drivers are arsenic at 12.7% and Total Uranium at 85.5%.

- SWMU 7 cumulative HI 1.31; drivers are iron at 14.0% and Total Uranium at 65.2%.

- SWMU 30 cumulative HI 8.85; driver is Total Uranium at 92.7%.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at SWMU 2, SWMU 4, SWMU 5, SWMU 7, SWMU 30, and SWMU 145 for exposure to soil. The following summarizes the cumulative risk estimates and major contributors (> 5%) to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 5.88E-04; drivers are arsenic at 16.3%, Total PCBs at 5.4%, ^{137}Cs at 22.4%, and ^{238}U at 48.5%.

- SWMU 4 cumulative ELCR 2.00E-03; drivers are Total PCBs at 10.6% and ^{137}Cs at 78.9%.

- SWMU 5 cumulative ELCR 5.23E-03; drivers are Total PAHs at 99.2%.

- SWMU 7 cumulative ELCR 7.71E-04; drivers are Total PAHs at 38.3%, Total PCBs at 15.9%, and ^{228}Th at 4.9%, ^{238}U at 34.8%.

- SWMU 30 cumulative ELCR 9.40E-04; drivers are Total PAHs at 61.5%, Total PCBs at 11.0%, and ^{238}U at 18.3%.

- SWMU 145 cumulative ELCR 2.18E-04; drivers are arsenic at 10.2%, Total PAHs at 10.2%, Total PCBs at 44.7%, and ^{238}U at 31.5%.

Risk and hazard for some COPCs that are listed as risk drivers are based on EPCs that may overestimate exposure. For SWMU 5, only one arsenic detection in the subsurface dataset exceeded background, therefore the risks from exposure across the site are similar to those that would be expected from background. The uranium hazard, though elevated over background is based on the maximum of 3 detected concentrations out of 31 samples. At SWMU 7 most of the detected concentrations of arsenic and iron in the subsurface also are at or near background. This is also true of arsenic at SWMU 145. This indicates that these metals are not the risk drivers of concern for the FS.

F.7.5.3 Observations -- Future Recreational Users

Cumulative HIs for the child, teen, and adult recreational users were greater than 1 for SWMUs 2, 5, 6, 7, and 30 based on soil exposure (SWMU 145 was not evaluated). The following summarizes the cumulative HIs and major contributors (>5%) to hazards for those SWMUs, receptors exceeding 1.

- SWMU 2 cumulative HI (child) 12.4; drivers are arsenic at 5%, iron at 6%, and Total Uranium at 88%.
- SWMU 2 cumulative HI (teen) 9.34; drivers are arsenic at 6%, iron at 6%, and Total Uranium at 88%.
- SWMU 2 cumulative HI (adult) 10.4; drivers are iron at 6% and total Uranium at 92%.
- SWMU 5 cumulative HI (child) 4.24; drivers are arsenic at 6%, Total Uranium at 76%, PAH compounds fluoranthene at 12%, and naphthalene at 5%.
- SWMU 5 cumulative HI (teen) 3.21; drivers are arsenic at 7%, Total Uranium at 76%, and PAH compound fluoranthene at 14%.
- SWMU 5 cumulative HI (adult) 3.17; drivers are Total Uranium at 89% and PAH compound fluoranthene at 7%.
- SWMU 6 cumulative HI (child) 1.33; driver is Total Uranium at 100%.
- SWMU 6 cumulative HI (teen) 1.00; driver is Total Uranium at 100%.
- SWMU 6 cumulative HI (adult) 1.16; driver is Total Uranium at 100%.
- SWMU 7 cumulative HI (child) 4.76; drivers are iron at 8% and Total Uranium at 87%.
- SWMU 7 cumulative HI (teen) 3.57; drivers are iron at 7% and Total Uranium at 88%.
- SWMU 7 cumulative HI (adult) 3.99; drivers are iron at 7% and Total Uranium at 91%.
- SWMU 30 cumulative HI (child) 16.4; driver is Total Uranium at 98%.
- SWMU 30 cumulative HI (teen) 12.4; driver is Total Uranium at 99%.
- SWMU 30 cumulative HI (adult) 14.3; driver is Total Uranium at 99%.

Cumulative ELCRs exceeded 1E-06 for all SWMUs and were greater than 1E-04 at: SWMUs 2, 4, 5, 6, 7, and 30 for soil exposure and consumption of game. The following summarizes the cumulative risk estimates and major contributors (> 5%) to the ELCR for these SWMUs.

- SWMU 2 cumulative ELCR 6.96E-04; drivers are arsenic at 11%, Total PAHs at 18%, ^{137}Cs at 32%, and ^{238}U at 33%.
- SWMU 4 cumulative ELCR 3.73E-04; drivers are arsenic at 10%, Total PAHs at 72% and ^{238}U at 11%.
- SWMU 5 cumulative ELCR 5.74E-02; driver is Total PAHs at 100%.
- SWMU 6 cumulative ELCR 3.01E-04; driver is Total PAHs at 96%.
- SWMU 7 cumulative ELCR 3.97E-03; drivers are Total PAHs at 84%, Total PCBs at 5%, and ^{238}U at 9%.
- SWMU 30 cumulative ELCR 7.15E-03; drivers are Total PAHs at 91% and ^{238}U at 6%.

At SWMU 7, most arsenic and iron values in the surface soils are at or near the background value, indicating that these metals are not risk drivers of concern for the FS for the recreational user exposure. A major pathway for risk to the recreational user is the modeled consumption of quail. As discussed in the uncertainty section, the default factors used to model contaminant transfer in game is extremely conservative. Iron and uranium both show very large contributions to HI from quail ingestion compared to ingestion of other game (deer and rabbits) and other pathways. The results of the quail ingestion risk and hazard calculations therefore are not the most appropriate pathway for consideration for decision-making in the FS.

F.7.5.4 Observations -- Future On-Site Rural Residents

Because of the nature of residential use, risk and hazard contributions were noted for both soil and groundwater exposure. The following summarizes the cumulative HIs and ELCRs observed for each resident.

Hazards - Future Child Residential Exposure to Soil. Cumulative HIs based on direct contact with soil for the child rural resident were greater than 1 for all of the SWMUs.[5] The largest contributors to elevated hazards are as follows:

- SWMU 2: arsenic at 10.0%, iron 7.6%, and Total Uranium at 79.0%
- SWMU 3: antimony at 47.8% and Total Uranium at 52.2%
- SWMU 4: arsenic at 49.5%, iron at 42.4%, and vanadium at 5.4%
- SWMU 5: arsenic at 11.3%, Total Uranium at 64.4%, fluoranthene at 12.7%, and naphthalene at 8.8%
- SWMU 6: Total Uranium at 99.0%
- SWMU 7: arsenic at 6.0%, iron at 9.0%, and Total Uranium at 77.8%
- SWMU 30: Total Uranium at 96.0%

At SWMUs 4 and 7 surface soils showed only slightly elevated concentrations of both arsenic and iron. Arsenic at SWMU 5 also was near background in surface soils. Total Uranium accounted for essentially

[5] SWMU 145 was evaluated for excavation worker scenario only.

all of the hazard at SWMU 6, but the EPC was based on a single detection out of 15 samples at the site and is unlikely to reflect realistic future exposure. These metals therefore are not of particular concern for decision-making in the FS.

Hazards - Future Adult Resident Exposure to Soil. Cumulative HIs for the future on-site adult resident were greater than 1 for SWMUs 2, 5, 7, and 30[6]. The largest contributors to elevated hazards are as follows:

- SWMU 2: uranium at 67.7%, arsenic at 20.9%, and iron at 7.8%
- SWMU 5: uranium at 40.7%, arsenic at 17.2%, fluoranthene at 27.3%, and naphthalene at 10.7%
- SWMU 7: uranium at 68.1%, arsenic at 12.7%, and iron at 9.4%
- SWMU 30: uranium at 94.4%

Risks – Future Residential Exposure to Soil. Cumulative ELCRs exceeding 1E-06 from direct contact with soil was observed for all of the SWMUs. Cumulative ELCRs greater than 1E-04 were identified for all of the SWMUs, except SWMU 3. The largest contributors to elevated risks are as follows:

- SWMU 2: ^{137}Cs at 70.5%, and ^{238}U at 20.5%
- SWMU 4: arsenic at 26.8%, Total PAHs at 18.0%, and ^{238}U at % 44.7%

- SWMU 5: Total PAHs at 99.4%
- SWMU 6: Total PAHs at 43.4%, ^{235}U at 53.5%
- SWMU 7: Total PAHs at 27.0%, Total PCBs at 9.6%, ^{228}Th at 18.2%, and ^{238}U at 41.8%
- SWMU 30: Total PAHs at 44.7%, Total PCBs at 6.8%, ^{235}U at 5.4%, and ^{238}U at 41.6%

The arsenic contributing to risk at SWMU 4 from surface soil exposure is due to arsenic concentrations near background.

Hazards - Future Resident Exposure to Groundwater. Cumulative HIs based on exposure to groundwater for the future on-site rural resident were greater than 1 for all of the SWMUs, except SWMU 6. The following lists those constituents that contributed to elevated HIs. The major contaminants driving the hazard were ingestion of uranium metal and iron and ingestion and inhalation of TCE and *cis*-1,2 DCE.

The following lists those constituents that contributed to elevated HIs by SWMU for the Child Resident:

- SWMU 2: TCE at 52.1% and *cis*-1,2-DCE at 46.8%
- SWMU 3: arsenic at 47.9%, uranium at 35.5%, and manganese at 16.6%
- SWMU 4: TCE at 92.5% and *cis*-1,2-DCE at 6.1%
- SWMU 5: arsenic at 37.5%, naphthalene at 35.4%, and manganese at 27.2%
- SWMU 7: arsenic at 30.2%, TCE at 26.4%, Total PCBs at 22.3%, and *cis*-1,2-DCE at 6.6%
- SWMU 30: TCE at 96.7%
- SWMU 145: antimony at 50.1% and arsenic at 49.9%

[6] SWMU 145 was evaluated for excavation worker scenario only.

Risks – Future Residential Exposure to Groundwater. Cumulative ELCRs exceeding 1E-06 from direct exposure to groundwater was observed for all of the SWMUs. Cumulative ELCRs greater than 1E-04 were identified for all of the SWMUs, except SWMU 6. The major contaminants driving risk were ingestion of arsenic and TCE.

The following lists those constituents that contributed to elevated risks by SWMU:

- SWMU 2: TCE at 98.0%
- SWMU 3: Arsenic at 72.3% and ^{99}Tc at 25.3%
- SWMU 4: TCE at 67.7% and vinyl chloride at 30.5%
- SWMU 5: Arsenic at 97.2%
- SWMU 7: 1,1-DCE at 66.4%, arsenic at 15.1%, and vinyl chloride at 11.9%
- SWMU 30: 1,1-DCE at 5.8% and TCE at 92.1%
- SWMU 145: Arsenic at 74.8% and ^{99}Tc at 25.2%

F.7.5.5 Observations -- Future Off-Site Rural Residents

Risk and hazard estimates for future off-site residential use are based on peak modeled groundwater concentrations. The following summarizes the results of the quantitative assessment at the plant boundary, property boundary, and at the Ohio River (or seeps).

Future Residential Exposure to Groundwater – Plant Boundary. SWMU 6 was not evaluated for groundwater exposure, and SWMU 145 lies outside the plant boundary. Cumulative HIs based on exposure to groundwater at the DOE plant boundary were greater than one for SWMU 2, SWMU 4, SWMU 5, SWMU 7, and SWMU 30. The major contaminants contributing to hazard were TCE, *cis*-1,2-DCE, arsenic, manganese, and Total PCBs. The cumulative ELCR was greater than 1E-06 for SWMU 2, SWMU 3, SWMU 4, SWMU 5, SWMU 7, and SWMU 30. The cumulative ELCR was greater than 1E-04 for SWMU 2, SWMU 3, SWMU 4, SWMU 7, and SWMU 30. The major contaminants contributing to risk were TCE, 1,1-DCE, vinyl chloride, ^{99}Tc, and arsenic.

Future Residential Exposure to Groundwater – Property Boundary. Cumulative HIs based on exposure to groundwater at the DOE property boundary were greater than 1 for SWMU 2, SWMU 4, SWMU 7, and SWMU 30. The major contaminants driving hazard were ingestion of arsenic, TCE, *cis*-1,2-DCE, and Total PCBs.

Cumulative ELCR exceeded 1E-06 for groundwater exposure for all of the SWMUs, except SWMU 6. Cumulative ELCRs greater than 1E-04 from groundwater use were identified for SWMUs 2, 4, 7, 30, and 145. The major contaminants driving risk were ingestion of arsenic, TCE, 1,1-DCE, vinyl chloride, and ^{99}Tc.

Future Residential Exposure to Groundwater – Ohio River or Seeps. Cumulative HIs based on exposure to groundwater for the future off-site rural resident at the Ohio River were greater than 1 for SWMUs 2, 4, and 30. The major contaminants driving hazard were ingestion of TCE and *cis*-1,2-DCE.

Cumulative ELCRs of 1E-06 from groundwater exposure were observed for SWMUs 2, 3, 4, 7, 30, and 145. Cumulative ELCRs greater than 1E-04 from groundwater use were identified for SWMUs 2, 4, 7, and 30. The contaminants driving risk were ingestion of TCE, 1,1-DCE, vinyl chloride, and ^{99}Tc.

F.7.5.6 Summary of Observations

The following summarize the observations noted for the BHHRA for BGOU. The discussion focuses on the individual exposure scenarios examined for the assessment.

F.7.5.6.1 Future Industrial Worker

SWMUs 2 and 30 hazard levels exceed 1 for industrial worker exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. SWMUs 2, 5, 7, and 30 exceed risk levels of 1E-04 for industrial worker exposure to soil, with ^{137}Cs, Total PAHs, and ^{238}U serving as the primary risk drivers. Other COCs contributing to elevated risks include Total PCBs and ^{228}Th.

F.7.5.6.2 Future Excavation Worker

SWMUs 2, 5, 7, and 30 exceed a hazard level of 1 for excavation worker exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. Other COCs contributing to hazards include arsenic, and iron. SWMUs 2, 4, 5, 7, 30, and 145 exceed the risk level of 1E-04 for excavation worker exposure to soil, with Total PCBs, Total PAHs, ^{238}U, and ^{137}Cs serving as the primary risk drivers. Other COCs contributing to elevated risks include arsenic, ^{226}Ra, and ^{228}Th.

F.7.5.6.3 Future Recreational Users

SWMUs 2, 5, 6, 7, and 30 exceed a hazard level of 1 for recreational user exposure to soil, with Total Uranium serving as the primary driver for elevated HIs. Other COCs contributing to hazards include arsenic, iron, and PAH compounds fluoranthene and naphthalene. SWMUs 2, 4, 5, 6, 7, and 30 exceed a risk level of 1E-04 for recreational user exposure to soil, with Total PAHs, ^{238}U, and ^{137}Cs serving as the primary risk drivers. Other COCs contributing to elevated risks include arsenic and Total PCBs.

F.7.5.6.4 Future On-Site Residents

SWMUs 2, 3, 4, 5, 6, 7, and 30 exceed a hazard level of 1 for on-site residential exposure to soil. Total Uranium, arsenic, and iron serve as the primary drivers for hazard for the child and adult resident. Other COCs contributing to elevated hazard include antimony, fluoranthene, iron, naphthalene, and vanadium. SWMUs 2, 3, 4, 5, 6, 7, and 30 exceed a risk level of 1E-04 for on-site residential exposure to soil, with ^{137}Cs, ^{238}U, and Total PAHs serving as the primary risk drivers. Other COCs contributing to elevated risks include Total PCBs, arsenic, ^{228}Th, and ^{235}U.

For residential groundwater use at the SWMU boundary, ELCR was greater than 1E-04 and HI was greater than 1 for all SWMUs except SWMU 6. The primary risk drivers are TCE, arsenic, vinyl chloride, 1,1-DCE, and ^{99}Tc.

F.7.5.6.5 Future Off-Site Residents

SWMUs 2, 4, 5, 7, and 30 exceed a hazard level of 1 for off-site residential exposure to groundwater at the PGDP plant boundary. SWMUs 2, 4, 7, and 30 exceed a hazard level of 1 at the property boundary. SWMUs 2, 4, and 30 exceed a hazard level of 1 at the Ohio River (or seeps). The primary drivers for hazard are arsenic, TCE, *cis*-1,2-DCE, and 1,1-DCE. SWMUs 2, 3, 4, 7, and 30 at the plant boundary, SWMUs 2, 4, 7, 30, and 145 at the property boundary, and SWMUs 2, 4, 7, and 30 at the Ohio River (or seeps) exceed a risk level of 1E-04 for off-site residential exposure to groundwater. The primary risk drivers are TCE, 1,1-DCE, and ^{99}Tc.

F.8. REMEDIAL GOAL OPTIONS

This section presents RGOs for the COCs identified in Section 5 and the methods used to calculate the RGOs. These RGOs should not be interpreted as being clean-up goals, but as risk-based values that may be used to guide the development of clean-up goals by risk managers. Clean-up goals will be determined in later decision documents.

RGOs were calculated for each COC from the modeled groundwater concentrations considering use of groundwater at each source and at the property boundary POE. When calculating the HI-based RGOs, the more conservative child-based values are reported. In addition, for comparison to the RGOs, the maximum contaminant level (MCL) for each COC is presented. Note, MCLs are not clean-up criteria. The National Contingency Plan notes that clean-up criteria different from MCLs may be required if multiple contaminants are present or if contaminants may reach a receptor through exposure routes different from those considered in the development of MCLs. Risks for use of contaminated groundwater must be presented in addition to a simple screen against MCLs so that risk managers can make appropriate decisions.

F.8.1 CALCULATION OF RGOS

EPA guidance (EPA 1991) directs that RGOs are to be calculated for all COCs identified in a BHHRA. The COCs identified in this risk assessment and their RGOs are presented in Table F.274. These COCs were calculated using the following equation.

$$\frac{\textbf{Concentration}}{\textbf{Risk}} = \frac{\textbf{RGO}}{\textbf{Target Risk}}$$

where:

Concentration is the exposure concentration for the medium.
Risk is the risk posed by exposure to the contaminated medium.
RGO is the remedial goal option.
Target Risk is one of the values listed in Table F.274.

F.8.2 PRESENTATION OF RGOS

The equation developed in the previous subsection was applied for each soil and groundwater COC. The RGOs developed for all COCs using this equation are presented in Table F.274. In addition, these tables present the EPCs used in the BHHRA.

Table F.274. RGOs for COCs of the BGOU SWMUs

COC[A]	EPC[B]	SWMU	ELCR at EPC	HI at EPC	RGO[C] at HI=0.1	RGO at HI=1	RGO at HI=3	RGO at ELCR= 1×10^{-6}	RGO at ELCR= 1×10^{-5}	RGO at ELCR= 1×10^{-4}	Units
Industrial Worker Soil Exposure											
Antimony	1.57E+01	3		1.09E-01	1.44E+01	1.44E+02	4.32E+02				mg/kg
Arsenic	3.00E+01	2	6.20E-05	3.85E-01	7.79E+00	7.79E+01	2.34E+02	4.84E-01	4.84E+00	4.84E+01	mg/kg
Iron	4.20E+04	2		1.11E-01	3.78E+04	3.78E+05	1.14E+06				mg/kg
Uranium	1.40E+03	30		1.27E+00	1.10E+02	1.10E+03	3.31E+03				mg/kg
Total PAHs	1.11E+02	5	5.73E-03					1.94E-02	1.94E-01	1.94E+00	mg/kg
Total PCBs	1.81E+01	7	1.11E-04					1.63E-01	1.63E+00	1.63E+01	mg/kg
Fluoranthene	5.33E+02	5		2.66E-01	2.00E+02	2.00E+03	6.01E+03				mg/kg
Naphthalene	1.60E+01	5		1.84E-01	8.70E+00	8.70E+01	2.61E+02				mg/kg
Cesium-137	5.10E+01	2	5.95E-04					8.57E-02	8.57E-01	8.57E+00	pCi/g
Neptunium-237	1.68E+00	30	6.21E-06					2.71E-01	2.71E+00	2.71E+01	pCi/g
Plutonium-239/240	2.71E+01	4	2.54E-06					1.07E+01	1.07E+02	1.07E+03	pCi/g
Thorium-228	3.36E+00	7	1.20E-04					2.80E-02	2.80E-01	2.80E+00	pCi/g
Thorium-230	1.59E+01	2	1.15E-06					1.38E+01	1.38E+02	1.38E+03	pCi/g
Uranium-234	1.15E+02	30	6.07E-06					1.89E+01	1.89E+02	1.89E+03	pCi/g
Uranium-235/236	1.66E+01	30	4.20E-05					3.95E-01	3.95E+00	3.95E+01	pCi/g
Uranium-238	5.65E+02	30	3.32E-04					1.70E+00	1.70E+01	1.70E+02	pCi/g
Residential User Groundwater Exposure											
Arsenic	6.21E-02	145	1.65E-03	1.99E+01	3.12E-04	3.12E-03	9.36E-03	3.76E-05	3.76E-04	3.76E-03	mg/L
Manganese	1.01E+00	5		2.15E+00	4.70E-02	4.70E-01	1.41E+00				mg/L
Selenium	1.51E-02	30		2.90E-01	5.21E-03	5.21E-02	1.56E-01				mg/L
Uranium	4.89E-02	3		7.82E+00	6.25E-04	6.25E-03	1.88E-02				mg/L
Total PCBs	5.23E-05	7	7.09E-06	4.20E+00	1.25E-06	1.25E-05	3.74E-05	7.38E-06	7.38E-05	7.38E-04	mg/L
1,1-DCE	8.98E-02	7	2.08E-03	8.51E-01	1.06E-02	1.06E-01	3.17E-01	4.32E-05	4.32E-04	4.32E-03	mg/L
cis-1,2-DCE	1.15E+01	2		6.07E+02	1.89E-03	1.89E-02	5.68E-02				mg/L

Table F.274. RGOs for COCs of the BGOU SWMUs (Continued)

COC[A]	EPC[B]	SWMU	ELCR at EPC	HI at EPC	RGO[C] at HI=0.1	RGO at HI=1	RGO at HI=3	RGO at ELCR= 1×10^{-6}	RGO at ELCR= 1×10^{-5}	RGO at ELCR= 1×10^{-4}	Units
Naphthalene	5.55E-03	5		2.80E+00	1.98E-04	1.98E-03	5.95E-03				mg/L
TCE	1.18E+00	4	3.67E-02	5.39E+02	2.19E-04	2.19E-03	6.57E-03	3.22E-05	3.22E-04	3.22E-03	mg/L
Vinyl Chloride	2.61E-02	4	1.65E-02	1.21E+00	2.16E-03	2.16E-02	6.47E-02	1.58E-06	1.58E-05	1.58E-04	mg/L
Technetium-99	1.01E+04	145	5.54E-04					1.82E+01	1.82E+02	1.82E+03	pCi/L
Uranium-234	7.94E+00	7	1.11E-05					7.12E-01	7.12E+00	7.12E+01	pCi/L
Uranium-238	1.59E+01	3	2.76E-05					5.76E-01	5.76E+00	5.76E+01	pCi/L

[A] COC = contaminant of concern
[B] EPC = exposure point concentration; represents maximum EPC value for all SWMUs where constituent was a COC for the applicable scenario
[C] RGO = remedial goal option

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ATTACHMENT F1

SUMMARY TABLES

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Table F1.1. Summary of Soil Data from SWMU 2

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Cyanide	mg/kg	0/3	-	0.13 - 0.18		1.4 - 1.8
Aluminum	mg/kg	5/5	5540 - 11000	14 - 19.5	8.06E+03	-
Antimony	mg/kg	1/5	0.5 - 0.5	0.46 - 9.99	5.00E-01	6 - 9.99
Arsenic	mg/kg	11/11	1.22 - 30	0.24 - 0.973	1.17E+01	-
Barium	mg/kg	11/11	54.7 - 350	0.12 - 2.43	1.33E+02	-
Beryllium	mg/kg	9/11	0.42 - 1.8	0.043 - 0.487	9.69E-01	0.427 - 0.487
Cadmium	mg/kg	6/11	0.091 - 0.45	0.033 - 1.95	2.60E-01	0.25 - 1.95
Calcium	mg/kg	5/5	858 - 5600	1.9 - 97.3	3.14E+03	-
Chromium	mg/kg	11/11	8.62 - 30	0.39 - 2.43	1.64E+01	-
Cobalt	mg/kg	4/5	2.8 - 11	0.53 - 2.43	6.15E+00	2.43 - 2.43
Copper	mg/kg	5/5	5.26 - 30	0.76 - 2.43	1.56E+01	-
Iron	mg/kg	5/5	5950 - 42000	2.6 - 19.5	2.16E+04	-
Lead	mg/kg	5/5	4.7 - 29	0.17 - 0.973	1.42E+01	-
Magnesium	mg/kg	5/5	750 - 1600	1.2 - 4.87	1.17E+03	-
Manganese	mg/kg	11/11	49.9 - 850	0.14 - 2.43	3.77E+02	-
Mercury	mg/kg	3/5	0.019 - 0.43	0.018 - 0.034	1.96E-01	0.018 - 0.14
Molybdenum	mg/kg	3/5	14 - 18	0.57 - 2.43	1.60E+01	2.13 - 2.43
Nickel	mg/kg	11/11	6.4 - 37	0.89 - 4.87	1.55E+01	-
Potassium	mg/kg	3/3	540 - 1000	4.3 - 5.7	8.27E+02	-
Selenium	mg/kg	3/5	0.77 - 1.7	0.39 - 0.973	1.14E+00	0.853 - 0.973
Silver	mg/kg	4/11	0.39 - 2.5	0.16 - 2.43	1.32E+00	1.3 - 2.6
Sodium	mg/kg	4/5	35 - 445	21 - 97.3	2.03E+02	85.3 - 85.3
Thallium	mg/kg	6/11	0.55 - 4.5	0.43 - 1.95	2.06E+00	1.2 - 1.95
Tin	mg/kg	3/3	2.6 - 15	2.2 - 3	9.03E+00	-
Uranium	mg/kg	5/13	15.3 - 1500	0.853 - 3	4.13E+02	0.973 - 26
Vanadium	mg/kg	11/11	2.8 - 37	0.16 - 2.43	2.08E+01	-
Zinc	mg/kg	4/5	22.1 - 140	1.4 - 19.5	7.68E+01	17.1 - 17.1
4,4'-DDD	mg/kg	0/6	-	0.00012 - 0.07		0.00012 - 0.07
4,4'-DDE	mg/kg	0/6	-	0.000042 - 0.06		0.000042 - 0.06
4,4'-DDT	mg/kg	0/6	-	0.000043 - 0.04		0.000043 - 0.04
Aldrin	mg/kg	0/6	-	0.00017 - 0.05		0.00017 - 0.05
alpha-BHC	mg/kg	0/6	-	0.000064 - 0.04		0.000064 - 0.04
alpha-Chlordane	mg/kg	1/3	0.00078 - 0.00078	0.000057 - 0.000057	7.80E-04	0.000057 - 0.000057
beta-BHC	mg/kg	0/6	-	0.000052 - 0.08		0.000052 - 0.08
delta-BHC	mg/kg	1/6	0.0065 - 0.0065	0.000083 - 0.09	6.50E-03	0.000083 - 0.09
Dieldrin	mg/kg	0/6	-	0.000042 - 0.085		0.000042 - 0.085
Endosulfan I	mg/kg	0/3	-	0.00011 - 0.00011		0.00011 - 0.00011
Endosulfan II	mg/kg	0/3	-	0.00016 - 0.00016		0.00016 - 0.00016

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Endosulfan sulfate	mg/kg	0/3	-	0.00022 - 0.00022		0.00022 - 0.00022
Endrin	mg/kg	0/3	-	0.000097 - 0.000097		0.000097 - 0.000097
Endrin aldehyde	mg/kg	0/3	-	0.00015 - 0.00015		0.00015 - 0.00015
Endrin ketone	mg/kg	1/3	0.0076 - 0.0076	0.000097 - 0.000097	7.60E-03	0.000097 - 0.000097
gamma-Chlordane	mg/kg	2/3	0.0011 - 0.003	0.000061 - 0.000061	2.05E-03	0.000061 - 0.000061
Heptachlor	mg/kg	0/6	-	0.000038 - 0.035		0.000038 - 0.035
Heptachlor epoxide	mg/kg	0/3	-	0.000054 - 0.000054		0.000054 - 0.000054
Lindane	mg/kg	0/6	-	0.000071 - 0.04		0.000071 - 0.04
Methoxychlor	mg/kg	0/6	-	0.00035 - 0.02		0.00035 - 0.02
PCB, Total	mg/kg	5/11	0.031 - 0.5	0.1 - 0.1	1.58E-01	0.009 - 0.1
PCB-1016	mg/kg	0/11	-	0.00092 - 0.1		0.00092 - 0.1
PCB-1221	mg/kg	0/11	-	0.009 - 0.1		0.009 - 0.1
PCB-1232	mg/kg	0/11	-	0.0037 - 0.1		0.0037 - 0.1
PCB-1242	mg/kg	0/11	-	0.0024 - 0.1		0.0024 - 0.1
PCB-1248	mg/kg	2/11	0.031 - 0.058	0.00074 - 0.1	4.45E-02	0.00074 - 0.1
PCB-1254	mg/kg	0/11	-	0.00071 - 0.1		0.00071 - 0.1
PCB-1260	mg/kg	3/11	0.05 - 0.5	0.00084 - 0.1	2.33E-01	0.00084 - 0.1
PCB-1268	mg/kg	0/2	-	0.1 - 0.1		0.1 - 0.1
Toxaphene	mg/kg	0/3	-	0.013 - 0.013		0.013 - 0.013
Alpha activity	pCi/g	18/18	2.28 - 98.68	1.43 - 1.66	3.10E+01	-
Americium-241	pCi/g	16/18	0.07 - 0.87	0.00001 - 0.0297	2.73E-01	-0.00696 - 0.00113
Beta activity	pCi/g	17/18	0 - 222.62	1.62 - 1.68	7.28E+01	-5 - -5
Cesium-137	pCi/g	10/18	0.05 - 51	0.00004 - 0.0496	9.50E+00	-0.0318 - 0.06
Cobalt-60	pCi/g	0/2	-	0.0427 - 0.0516		-0.0141 - 0.018
Neptunium-237	pCi/g	11/18	0.01 - 0.31	0.00002 - 0.0445	8.64E-02	-0.011 - 0.02
Plutonium-238	pCi/g	0/2	-	0.0175 - 0.0177		0.00162 - 0.00222
Plutonium-239	pCi/G	13/16	0.02 - 16.1	0.00001 - 0.00004	2.18E+00	0 - 0.01
Plutonium-239/240	pCi/g	0/2	-	0.0182 - 0.0194		-0.00492 - -0.000122
Protactinium-234	pCi/G	0/16	-	0.0003 - 0.00069		-0.13 - 1.4

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Technetium-99	pCi/g	15/18	0.05 - 14.6	0.00005 - 1.59	1.88E+00	-0.0361 - 1.22
Thorium-228	pCi/g	2/2	0.273 - 0.347	0.0843 - 0.0849	3.10E-01	-
Thorium-230	pCi/g	17/18	0.297 - 15.9	0.00002 - 0.242	2.75E+00	0.297 - 0.297
Thorium-232	pCi/g	2/2	0.327 - 0.335	0.167 - 0.168	3.31E-01	-
Thorium-234	pCi/g	1/2	11 - 11	0.851 - 0.891	1.10E+01	1.5 - 1.5
Uranium	pCi/g	1/2	6.77 - 6.77	0.302 - 0.327	6.77E+00	0.196 - 0.196
Uranium-234	pCi/g	17/18	0.824 - 155	0.00002 - 0.145	1.68E+01	0.0851 - 0.0851
Uranium-235	pCi/g	1/2	0.08 - 0.08	0.0374 - 0.0467	8.00E-02	0.0183 - 0.0183
Uranium-235/236	pCi/G	16/16	0.03 - 25.8	0.00001 - 0.0003	2.85E+00	-
Uranium-238	pCi/g	17/18	0.95 - 947	0.00002 - 0.136	9.73E+01	0.0922 - 0.0922
1,2,4,5-Tetrachlorobenzene	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
1,2,4-Trichlorobenzene	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
1,2-Dichlorobenzene	mg/kg	0/6	-	0.0002 - 0.045		0.0002 - 0.045
1,2-Diphenylhydrazine	mg/kg	0/3	-	0.035 - 0.035		0.035 - 0.035
1,3-Dichlorobenzene	mg/kg	0/6	-	0.000214 - 0.05		0.000214 - 0.05
1,4-Dichlorobenzene	mg/kg	0/6	-	0.00022 - 0.045		0.00022 - 0.045
1-Chloronaphtalene	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
1-Naphthalenamine	mg/kg	0/3	-	0.19 - 0.19		0.19 - 0.19
2,3,4,6-Tetrachlorophenol	mg/kg	0/3	-	0.06 - 0.06		0.06 - 0.06
2,4,5-Trichlorophenol	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
2,4,6-Trichlorophenol	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
2,4-Dichlorophenol	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
2,4-Dimethylphenol	mg/kg	0/3	-	0.12 - 0.12		0.12 - 0.12
2,4-Dinitrophenol	mg/kg	0/3	-	0.25 - 0.25		0.25 - 0.25
2,4-Dinitrotoluene	mg/kg	0/3	-	0.075 - 0.075		0.075 - 0.075
2,6-Dichlorophenol	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
2,6-Dinitrotoluene	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
2-Chloronaphthalene	mg/kg	0/3	-	0.02 - 0.02		0.02 - 0.02
2-Chlorophenol	mg/kg	0/3	-	0.055 - 0.055		0.055 - 0.055
2-Methyl-4,6-dinitrophenol	mg/kg	0/3	-	0.26 - 0.26		0.26 - 0.26
2-Methylnaphthalene	mg/kg	2/3	0.36 - 0.69	0.045 - 0.045	5.25E-01	0.045 - 0.045
2-Methylphenol	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
2-Methylpyridine	mg/kg	0/3	-	0.34 - 0.34		0.34 - 0.34
2-Naphthalenamine	mg/kg	0/3	-	0.33 - 0.33		0.33 - 0.33
2-Nitrobenzenamine	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
2-Nitrophenol	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
3,3'-Dichlorobenzidine	mg/kg	0/3	-	0.18 - 0.18		0.18 - 0.18
3-Methylcholanthrene	mg/kg	0/3	-	0.1 - 0.1		0.1 - 0.1
3-Nitrobenzenamine	mg/kg	0/3	-	0.13 - 0.13		0.13 - 0.13

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
4-Aminobiphenyl	mg/kg	0/3	-	0.29 - 0.29		0.29 - 0.29
4-Bromophenyl phenyl ether	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
4-Chloro-3-methylphenol	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
4-Chlorobenzenamine	mg/kg	0/3	-	0.24 - 0.24		0.24 - 0.24
4-Chlorophenyl phenyl ether	mg/kg	0/3	-	0.035 - 0.035		0.035 - 0.035
4-Methylphenol	mg/kg	1/3	0.061 - 0.061	0.04 - 0.04	6.10E-02	0.04 - 0.04
4-Nitrobenzenamine	mg/kg	0/3	-	0.33 - 0.33		0.33 - 0.33
4-Nitrophenol	mg/kg	0/3	-	0.11 - 0.11		0.11 - 0.11
7,12-Dimethylbenz(a)anthracene	mg/kg	0/3	-	0.43 - 0.43		0.43 - 0.43
a,a-Dimethylphenethylamine	mg/kg	0/3	-	0.065 - 0.065		0.065 - 0.065
Acenaphthene	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
Acenaphthylene	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
Acetophenone	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
Aniline	mg/kg	0/3	-	0.26 - 0.26		0.26 - 0.26
Anthracene	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Benz(a)anthracene	mg/kg	1/3	0.13 - 0.13	0.04 - 0.04	1.30E-01	0.04 - 0.04
Benzenemethanol	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
Benzidine	mg/kg	0/3	-	1.6 - 1.6		1.6 - 1.6
Benzo(a)pyrene	mg/kg	1/3	0.14 - 0.14	0.045 - 0.045	1.40E-01	0.045 - 0.045
Benzo(b)fluoranthene	mg/kg	2/3	0.12 - 0.27	0.05 - 0.05	1.95E-01	0.05 - 0.05
Benzo(ghi)perylene	mg/kg	1/3	0.15 - 0.15	0.095 - 0.095	1.50E-01	0.095 - 0.095
Benzo(k)fluoranthene	mg/kg	0/3	-	0.05 - 0.05		0.05 - 0.05
Benzoic acid	mg/kg	0/3	-	0.13 - 0.13		0.13 - 0.13
Bis(2-chloroethoxy)methane	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Bis(2-chloroethyl) ether	mg/kg	0/3	-	0.055 - 0.055		0.055 - 0.055
Bis(2-chloroisopropyl) ether	mg/kg	0/3	-	0.28 - 0.28		0.28 - 0.28
Bis(2-ethylhexyl)phthalate	mg/kg	0/3	-	0.57 - 0.57		0.57 - 0.57
Butyl benzyl phthalate	mg/kg	0/3	-	0.64 - 0.64		0.64 - 0.64
Chrysene	mg/kg	2/3	0.094 - 0.17	0.05 - 0.05	1.32E-01	0.05 - 0.05
Dibenz(a,h)anthracene	mg/kg	0/3	-	0.06 - 0.06		0.06 - 0.06
Dibenzofuran	mg/kg	2/3	0.091 - 0.18	0.02 - 0.02	1.36E-01	0.02 - 0.02
Diethyl phthalate	mg/kg	0/3	-	0.055 - 0.055		0.055 - 0.055
Dimethyl phthalate	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Di-n-butyl phthalate	mg/kg	0/3	-	0.3 - 0.3		0.3 - 0.3
Di-n-octylphthalate	mg/kg	0/3	-	0.055 - 0.055		0.055 - 0.055
Ethyl methanesulfonate	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
Fluoranthene	mg/kg	2/3	0.17 - 0.34	0.05 - 0.05	2.55E-01	0.05 - 0.05
Fluorene	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Hexachlorobenzene	mg/kg	0/3	-	0.035 - 0.035		0.035 - 0.035
Hexachlorobutadiene	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
Hexachlorocyclopentadiene	mg/kg	0/3	-	0.03 - 0.03		0.03 - 0.03

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Hexachloroethane	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Indeno(1,2,3-cd)pyrene	mg/kg	0/3	-	0.065 - 0.065		0.065 - 0.065
Isophorone	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Methyl methanesulfonate	mg/kg	0/3	-	0.34 - 0.34		0.34 - 0.34
Naphthalene	mg/kg	2/3	0.18 - 0.36	0.05 - 0.05	2.70E-01	0.05 - 0.05
Nitrobenzene	mg/kg	0/3	-	0.17 - 0.17		0.17 - 0.17
N-Nitrosodimethylamine	mg/kg	0/3	-	0.085 - 0.085		0.085 - 0.085
N-Nitroso-di-n-propylamine	mg/kg	0/3	-	0.06 - 0.06		0.06 - 0.06
N-Nitrosodiphenylamine	mg/kg	0/3	-	0.02 - 0.02		0.02 - 0.02
N-Nitrosopiperidine	mg/kg	0/3	-	0.04 - 0.04		0.04 - 0.04
p-Dimethylaminoazobenzene	mg/kg	0/3	-	0.1 - 0.1		0.1 - 0.1
Pentachlorobenzene	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Pentachloronitrobenzene	mg/kg	0/3	-	0.065 - 0.065		0.065 - 0.065
Pentachlorophenol	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Phenacetin	mg/kg	0/3	-	0.07 - 0.07		0.07 - 0.07
Phenanthrene	mg/kg	2/3	0.3 - 0.57	0.04 - 0.04	4.35E-01	0.04 - 0.04
Phenol	mg/kg	0/3	-	0.045 - 0.045		0.045 - 0.045
Pronamide	mg/kg	0/3	-	0.06 - 0.06		0.06 - 0.06
Pyrene	mg/kg	2/3	0.2 - 0.29	0.08 - 0.08	2.45E-01	0.08 - 0.08
Pyridine	mg/kg	0/3	-	0.27 - 0.27		0.27 - 0.27
Total PAH	mg/kg	2/3	0.012094 - 0.18017	-	9.61E-02	0 - 0
1,1,1,2-Tetrachloroethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1,1-Trichloroethane	mg/kg	0/5	-	0.00022 - 0.00504		0.00022 - 0.00504
1,1,2,2-Tetrachloroethane	mg/kg	0/5	-	0.00013 - 0.00504		0.00013 - 0.00504
1,1,2-Trichloro-1,2,2-trifluoroethane	mg/kg	0/3	-	0.00087 - 0.00087		0.00087 - 0.00087
1,1,2-Trichloroethane	mg/kg	0/5	-	0.00013 - 0.00504		0.00013 - 0.00504
1,1-Dichloroethane	mg/kg	0/5	-	0.00038 - 0.00504		0.00038 - 0.00504
1,1-Dichloroethene	mg/kg	0/5	-	0.00078 - 0.00504		0.00078 - 0.00504
1,2,3-Trichloropropane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dibromoethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dichloroethane	mg/kg	0/5	-	0.00027 - 0.00504		0.00027 - 0.00504
1,2-Dichloropropane	mg/kg	0/5	-	0.000451 - 0.00504		0.000451 - 0.00504

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
1,2-Dimethylbenzene	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Butanone	mg/kg	0/5	-	0.0018 - 0.00504		0.0018 - 0.00504
2-Chloroethylvinyl ether	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Hexanone	mg/kg	0/5	-	0.00039 - 0.00504		0.00039 - 0.00504
4-Methyl-2-pentanone	mg/kg	0/5	-	0.00057 - 0.00504		0.00057 - 0.00504
Acetone	mg/kg	0/5	-	0.0041 - 0.00504		0.0041 - 0.00504
Acrolein	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Acrylonitrile	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Benzene	mg/kg	0/5	-	0.00039 - 0.00504		0.00039 - 0.00504
Bromodichloromethane	mg/kg	0/5	-	0.00027 - 0.00504		0.00027 - 0.00504
Bromoform	mg/kg	0/5	-	0.0002 - 0.00504		0.0002 - 0.00504
Bromomethane	mg/kg	0/5	-	0.00067 - 0.00504		0.00067 - 0.00504
Carbon disulfide	mg/kg	0/5	-	0.00068 - 0.00504		0.00068 - 0.00504
Carbon tetrachloride	mg/kg	0/5	-	0.00061 - 0.00504		0.00061 - 0.00504
Chlorobenzene	mg/kg	0/5	-	0.00036 - 0.00504		0.00036 - 0.00504
Chloroethane	mg/kg	0/5	-	0.00087 - 0.00504		0.00087 - 0.00504
Chloroform	mg/kg	0/5	-	0.00032 - 0.00504		0.00032 - 0.00504
Chloromethane	mg/kg	0/5	-	0.0013 - 0.00504		0.0013 - 0.00504
cis-1,2-Dichloroethene	mg/kg	3/11	0.00093 - 2.7	0.00045 - 0.056	9.01E-01	0.00045 - 0.056
cis-1,3-Dichloropropene	mg/kg	0/5	-	0.00023 - 0.00504		0.00023 - 0.00504
Dibromochloromethane	mg/kg	0/5	-	0.00024 - 0.00504		0.00024 - 0.00504
Dibromomethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Dichlorodifluoromethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504

Table F1.1. Summary of Soil Data from SWMU 2 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Ethyl methacrylate	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Ethylbenzene	mg/kg	0/5	-	0.00061 - 0.00504		0.00061 - 0.00504
Iodomethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
m,p-Xylene	mg/kg	0/2	-	0.00991 - 0.0101		0.00991 - 0.0101
Methylene chloride	mg/kg	3/5	0.0011 - 0.0013	0.00041 - 0.00504	1.20E-03	0.00496 - 0.00504
Styrene	mg/kg	0/5	-	0.00026 - 0.00504		0.00026 - 0.00504
Tetrachloroethene	mg/kg	0/5	-	0.00054 - 0.00504		0.00054 - 0.00504
Toluene	mg/kg	0/5	-	0.00075 - 0.00504		0.00075 - 0.00504
Total Xylene	mg/kg	0/3	-	0.0011 - 0.0011		0.0011 - 0.0011
trans-1,2-Dichloroethene	mg/kg	0/11	-	0.00055 - 0.069		0.00055 - 0.069
trans-1,3-Dichloropropene	mg/kg	0/5	-	0.00016 - 0.00504		0.00016 - 0.00504
Trans-1,4-Dichloro-2-butene	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Trichloroethene	mg/kg	2/13	0.01 - 0.28	0.00056 - 0.07	1.45E-01	0.00056 - 0.07
Trichlorofluoromethane	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl acetate	mg/kg	0/2	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl chloride	mg/kg	0/11	-	0.00072 - 0.09		0.00072 - 0.09

Table F1.2. Summary of Soil Data from SWMU 3

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Aluminum	mg/kg	23/23	4920 - 11800	17.6 - 19.8	7.61E+03	-
Antimony	mg/kg	7/23	9.89 - 15.7	7.31 - 9.96	1.14E+01	7.31 - 9.96
Arsenic	mg/kg	23/23	1.25 - 7.62	0.88 - 0.992	3.64E+00	-
Barium	mg/kg	23/23	33.6 - 122	2.2 - 2.48	7.43E+01	-
Beryllium	mg/kg	0/23	-	0.44 - 0.496		0.44 - 0.496
Cadmium	mg/kg	0/23	-	0.488 - 1.98		1.76 - 1.98
Calcium	mg/kg	22/23	557 - 35600	88 - 99.2	6.13E+03	94.8 - 94.8
Chromium	mg/kg	23/23	5.7 - 17.9	2.2 - 2.48	1.08E+01	-
Cobalt	mg/kg	22/23	2.54 - 9.2	2.2 - 2.48	4.49E+00	2.34 - 2.34
Copper	mg/kg	23/23	3.65 - 15.9	2.2 - 2.48	7.99E+00	-
Iron	mg/kg	23/23	6690 - 25700	17.6 - 19.8	1.17E+04	-
Lead	mg/kg	23/23	5.35 - 23.9	0.88 - 9.36	8.64E+00	-
Magnesium	mg/kg	23/23	534 - 2500	4.4 - 4.96	1.23E+03	-
Manganese	mg/kg	23/23	116 - 558	2.2 - 2.48	2.97E+02	-
Mercury	mg/kg	3/23	0.02 - 0.024	0.015 - 0.02	2.13E-02	0.015 - 0.02
Molybdenum	mg/kg	5/23	2.58 - 6.21	2.2 - 2.48	3.89E+00	2.2 - 2.47
Nickel	mg/kg	22/23	4.83 - 16.1	4.4 - 4.96	9.71E+00	4.68 - 4.68
Selenium	mg/kg	0/23	-	0.88 - 0.992		0.88 - 0.992
Silver	mg/kg	0/23	-	2.2 - 2.48		2.2 - 2.48
Sodium	mg/kg	13/23	94.7 - 249	88 - 99.2	1.61E+02	88.9 - 99.2
Thallium	mg/kg	0/23	-	1.76 - 1.98		1.76 - 1.98
Uranium	mg/kg	12/23	1.13 - 83.6	0.88 - 9.36	1.98E+01	0.88 - 0.992
Vanadium	mg/kg	23/23	11.1 - 33.7	2.2 - 2.48	2.08E+01	-
Zinc	mg/kg	19/23	19.7 - 41.5	17.6 - 19.8	2.76E+01	18.7 - 19.5
PCB, Total	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1016	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1221	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1232	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1242	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1248	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1254	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1260	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1
PCB-1268	mg/kg	0/23	-	0.09 - 0.1		0.09 - 0.1

Table F1.2. Summary of Soil Data from SWMU 3 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Alpha activity	pCi/g	23/23	2.5 - 147	1.33 - 5.57	1.49E+01	-
Americium-241	pCi/g	0/23	-	0.0213 - 0.0324		-0.0133 - 0.00587
Beta activity	pCi/g	21/23	1.86 - 268	1.41 - 4.18	2.53E+01	3.32 - 3.42
Cesium-137	pCi/g	2/23	0.344 - 0.456	0.0458 - 0.0873	4.00E-01	-0.0295 - 0.0646
Cobalt-60	pCi/g	0/23	-	0.0367 - 0.0928		-0.0377 - 0.0279
Neptunium-237	pCi/g	0/23	-	0.041 - 0.0704		-0.0116 - 0.0155
Plutonium-238	pCi/g	0/23	-	0.0175 - 0.0214		-0.00378 - 0.00349
Plutonium-239/240	pCi/g	2/23	0.0399 - 0.0562	0.0173 - 0.0223	4.81E-02	-0.00881 - 0.0162
Technetium-99	pCi/g	6/23	3.04 - 56.9	1.8 - 1.85	1.70E+01	-1.16 - 1.66
Thorium-228	pCi/g	23/23	0.177 - 0.484	0.0785 - 0.118	3.39E-01	-
Thorium-230	pCi/g	22/23	0.177 - 0.573	0.122 - 0.243	3.17E-01	0.147 - 0.147
Thorium-232	pCi/g	23/23	0.221 - 0.554	0.0639 - 0.172	3.62E-01	-
Thorium-234	pCi/g	10/23	1.59 - 14.1	0.652 - 1.36	8.01E+00	0.43 - 2.06
Uranium	pCi/g	10/23	0.48 - 25.8	0.28 - 0.333	6.50E+00	0.0293 - 0.401
Uranium-234	pCi/g	13/23	0.142 - 3.02	0.126 - 0.142	6.92E-01	0.00249 - 0.119
Uranium-235	pCi/g	6/23	0.0397 - 0.362	0.0356 - 0.0561	1.34E-01	-0.0146 - 0.0264
Uranium-238	pCi/g	16/23	0.127 - 22.4	0.118 - 0.136	3.54E+00	0.0193 - 0.0982
1,1,1,2-Tetrachloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1,1-Trichloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1,2,2-Tetrachloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1,2-Trichloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1-Dichloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1-Dichloroethene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504

Table F1.2. Summary of Soil Data from SWMU 3 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
1,2,3-Trichloropropane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dibromoethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dichloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dichloropropane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dimethylbenzene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Butanone	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Chloroethylvinyl ether	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Hexanone	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
4-Methyl-2-pentanone	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Acetone	mg/kg	3/22	0.00811 - 0.0369	0.00496 - 0.00504	2.06E-02	0.00496 - 0.00504
Acrolein	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Acrylonitrile	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Benzene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Bromodichloromethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Bromoform	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Bromomethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Carbon disulfide	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Carbon tetrachloride	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Chlorobenzene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Chloroethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Chloroform	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Chloromethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504

Table F1.2. Summary of Soil Data from SWMU 3 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
cis-1,2-Dichloroethene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
cis-1,3-Dichloropropene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Dibromochloromethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Dibromomethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Dichlorodifluoromethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Ethyl methacrylate	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Ethylbenzene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Iodomethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
m,p-Xylene	mg/kg	0/22	-	0.00992 - 0.0101		0.00992 - 0.0101
Methylene chloride	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Styrene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Tetrachloroethene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Toluene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
trans-1,2-Dichloroethene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
trans-1,3-Dichloropropene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Trans-1,4-Dichloro-2-butene	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Trichloroethene	mg/kg	1/22	0.00633 - 0.00633	0.00496 - 0.00504	6.33E-03	0.00496 - 0.00504
Trichlorofluoromethane	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl acetate	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl chloride	mg/kg	0/22	-	0.00496 - 0.00504		0.00496 - 0.00504

Table F1.3. Summary of Soil Data from SWMU 4

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Aluminum	mg/kg	39/39	3320 - 19000	20 - 20	1.06E+04	-
Antimony	mg/kg	0/39	-	20 - 20		20 - 20
Arsenic	mg/kg	10/39	5.97 - 17.1	5 - 5	1.01E+01	5 - 5
Barium	mg/kg	39/39	12.1 - 313	1 - 1	1.06E+02	-
Beryllium	mg/kg	31/39	0.51 - 1.11	0.5 - 0.5	6.91E-01	0.5 - 0.5
Cadmium	mg/kg	0/39	-	2 - 2		2 - 2
Calcium	mg/kg	39/39	83.9 - 131000	50 - 50	5.80E+03	-
Chromium	mg/kg	39/39	7.81 - 296	2 - 2	2.25E+01	-
Cobalt	mg/kg	39/39	2.06 - 13	1 - 1	5.47E+00	-
Copper	mg/kg	39/39	5.92 - 46.4	2 - 2	1.35E+01	-
Iron	mg/kg	39/39	4570 - 41900	5 - 50	1.52E+04	-
Lead	mg/kg	3/39	24.5 - 30.2	20 - 20	2.68E+01	20 - 20
Magnesium	mg/kg	39/39	270 - 2590	15 - 15	1.29E+03	-
Manganese	mg/kg	39/39	26.1 - 1520	1 - 1	3.85E+02	-
Mercury	mg/kg	1/39	0.45 - 0.45	0.2 - 0.2	4.50E-01	0.2 - 0.2
Nickel	mg/kg	35/39	5.03 - 153	5 - 5	1.97E+01	5 - 5
Potassium	mg/kg	39/39	189 - 2390	100 - 100	6.46E+02	-
Selenium	mg/kg	0/39	-	1 - 1		1 - 1
Silver	mg/kg	0/39	-	4 - 4		4 - 4
Sodium	mg/kg	31/39	203 - 1130	200 - 200	4.04E+02	200 - 200
Thallium	mg/kg	0/39	-	15 - 15		15 - 15
Vanadium	mg/kg	39/39	6.65 - 47.8	2 - 2	2.31E+01	-
Zinc	mg/kg	38/39	26.9 - 93.7	15 - 15	4.57E+01	15 - 15
PCB, Total	mg/kg	13/56	0.026 - 27	0.1 - 0.1	3.84E+00	0.091 - 121
PCB-1016	mg/kg	1/58	2.5 - 2.5	0.091 - 121	2.50E+00	0.091 - 121
PCB-1221	mg/kg	0/58	-	0.091 - 5.331		0.091 - 5.331
PCB-1232	mg/kg	0/58	-	0.091 - 5.331		0.091 - 5.331
PCB-1242	mg/kg	0/58	-	0.091 - 5.331		0.091 - 5.331
PCB-1248	mg/kg	1/58	0.8 - 0.8	0.091 - 5.331	8.00E-01	0.091 - 5.331
PCB-1254	mg/kg	7/58	0.026 - 27	0.091 - 5.331	6.37E+00	0.091 - 0.125
PCB-1260	mg/kg	7/58	0.041 - 0.898	0.091 - 5.331	3.04E-01	0.091 - 5.331
PCB-1268	mg/kg	0/10	-	0.1 - 0.1		0.1 - 0.1
Alpha activity	pCi/g	70/70	3.83 - 3076.71	0.57 - 16	9.22E+01	-
Americium-241	pCi/g	1/78	0.894 - 0.894	0.162 - 15	8.94E-01	-0.0843 - 15
Beta activity	pCi/g	70/70	3.77 - 3253.97	0.75 - 9	1.24E+02	-
Cesium-137	pCi/g	8/61	0.05 - 181	0.0677 - 10	2.30E+01	0.07 - 3.5
Cobalt-60	pCi/g	0/59	-	0.15 - 6.1		0.04 - 6.1

Table F1.3. Summary of Soil Data from SWMU 4 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Neptunium-237	pCi/g	13/25	0.07 - 5.78	0.0792 - 0.419	9.89E-01	0.0114 - 0.187
Plutonium-239	pCi/g	0/6	-	-		0.05 - 0.06
Plutonium-239/240	pCi/g	10/20	0.0644 - 27.1	0.05 - 0.086	3.28E+00	0.00923 - 0.0602
Protactinium-234m	pCi/g	2/53	134 - 380	23 - 820	2.57E+02	23 - 820
Radium-226	pCi/g	1/19	0.785 - 0.785	0.394 - 1.92	7.85E-01	1.25 - 2.53
Technetium-99	pCi/g	15/64	4.5 - 269	4.03 - 6.94	4.73E+01	0 - 4.4
Thorium-230	pCi/g	6/8	0.62 - 68.7	0.268 - 0.329	1.23E+01	0.29 - 0.38
Thorium-234	pCi/g	24/72	3.24 - 158	0.587 - 41	4.55E+01	5.1 - 72.6
Uranium	pCi/g	26/26	6.66 - 6260	2.13 - 35	3.03E+02	-
Uranium-234	pCi/g	19/19	2.68 - 69	0.593 - 2.99	2.27E+01	-
Uranium-235	pCi/g	0/53	-	1.5 - 13		1.5 - 13
Uranium-238	pCi/g	19/19	3.84 - 126	1.32 - 4.28	4.19E+01	-
1,2,4-Trichlorobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
1,2-Dichlorobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
1,3-Dichlorobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
1,4-Dichlorobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,4,5-Trichlorophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,4,6-Trichlorophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,4-Dichlorophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,4-Dimethylphenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,4-Dinitrophenol	mg/kg	0/16	-	0.41 - 0.5		0.41 - 0.5
2,4-Dinitrotoluene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2,6-Dinitrotoluene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2-Chloronaphthalene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2-Chlorophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2-Methyl-4,6-dinitrophenol	mg/kg	0/36	-	0.41 - 0.5		0.41 - 0.5
2-Methylnaphthalene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2-Methylphenol	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
2-Nitrobenzenamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
2-Nitrophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
3,3'-Dichlorobenzidine	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
3-Nitrobenzenamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
4-Bromophenyl phenyl ether	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
4-Chloro-3-methylphenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
4-Chlorobenzenamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
4-Chlorophenyl phenyl ether	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5

Table F1.3. Summary of Soil Data from SWMU 4 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
4-Methylphenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
4-Nitrobenzenamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
4-Nitrophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Acenaphthene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Acenaphthylene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Anthracene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Benz(a)anthracene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Benzo(a)pyrene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Benzo(b)fluoranthene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Benzo(ghi)perylene	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
Benzo(k)fluoranthene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Bis(2-chloroethoxy)methane	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Bis(2-chloroethyl) ether	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
Bis(2-chloroisopropyl) ether	mg/kg	0/37	-	0.41 - 0.5		0.41 - 0.5
Bis(2-ethylhexyl)phthalate	mg/kg	2/38	0.251 - 0.262	0.41 - 0.5	2.57E-01	0.41 - 0.5
Butyl benzyl phthalate	mg/kg	0/16	-	0.41 - 0.5		0.41 - 0.5
Carbazole	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Chrysene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Dibenz(a,h)anthracene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Dibenzofuran	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Diethyl phthalate	mg/kg	1/38	2.8 - 2.8	0.41 - 0.5	2.80E+00	0.41 - 0.5
Dimethyl phthalate	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Di-n-butyl phthalate	mg/kg	4/38	0.6 - 0.94	0.41 - 0.5	7.63E-01	0.47 - 1.2
Di-n-octylphthalate	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Fluoranthene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Fluorene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Hexachlorobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Hexachlorobutadiene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Hexachlorocyclopentadiene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Hexachloroethane	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Indeno(1,2,3-cd)pyrene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Isophorone	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Naphthalene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Nitrobenzene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
N-Nitroso-di-n-propylamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
N-Nitrosodiphenylamine	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Pentachlorophenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Phenanthrene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Phenol	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5

Table F1.3. Summary of Soil Data from SWMU 4 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Pyrene	mg/kg	0/38	-	0.41 - 0.5		0.41 - 0.5
Pyridine	mg/kg	0/6	-	0.41 - 0.48		0.41 - 0.48
Total PAH	mg/kg	0/38	-	-		0 - 0
1,1,1-Trichloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,1,2,2-Tetrachloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,1,2-Trichloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethene	mg/kg	0/88	-	0.01 - 0.519		0.01 - 0.519
1,2-Dichloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,2-Dichloropropane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
1,2-Dimethylbenzene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
2-Butanone	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
2-Hexanone	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
4-Methyl-2-pentanone	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Acetone	mg/kg	1/22	0.012 - 0.012	0.01 - 0.01	1.20E-02	0.01 - 0.01
Benzene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Bromodichloromethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Bromoform	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Bromomethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Carbon disulfide	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Carbon tetrachloride	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Chlorobenzene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Chloroethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Chloroform	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Chloromethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
cis-1,2-Dichloroethene	mg/kg	1/88	0.48 - 0.48	0.01 - 0.519	4.80E-01	0.01 - 0.519
cis-1,3-Dichloropropene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Dibromochloromethane	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Ethylbenzene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
m,p-Xylene	mg/kg	0/33	-	0.02 - 0.02		0.02 - 0.02
Methylene chloride	mg/kg	7/33	0.015 - 0.054	0.01 - 0.01	3.59E-02	0.01 - 0.01
Styrene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Tetrachloroethene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Toluene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
trans-1,2-Dichloroethene	mg/kg	0/88	-	0.01 - 0.519		0.01 - 0.519
trans-1,3-Dichloropropene	mg/kg	0/33	-	0.01 - 0.01		0.01 - 0.01
Trichloroethene	mg/kg	1/88	0.004 - 0.004	0.0012 - 0.519	4.00E-03	0.0012 - 0.519
Vinyl chloride	mg/kg	0/88	-	0.01 - 10		0.01 - 10
Cyanide	mg/kg	0/38	-	1 - 1		1 - 1

Table F1.3. Summary of Soil Data from SWMU 4 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Total Organic Carbon (TOC)	mg/kg	5/5	3400 - 13000	300 - 300	6.86E+03	-

Table F1.4. Summary of Soil Data from SWMU 5

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Aluminum	mg/kg	28/28	2430 - 13800	18 - 20	7.67E+03	-
Antimony	mg/kg	0/29	-	9.76 - 20		9.76 - 25
Arsenic	mg/kg	10/29	2.55 - 12.2	0.901 - 5	6.58E+00	5 - 5
Barium	mg/kg	29/29	33.3 - 141	1 - 5	8.53E+01	-
Beryllium	mg/kg	10/28	0.52 - 0.79	0.451 - 0.5	6.39E-01	0.451 - 0.5
Cadmium	mg/kg	0/29	-	1.8 - 2		1.8 - 10
Calcium	mg/kg	28/28	911 - 207000	50 - 2000	3.64E+04	-
Chromium	mg/kg	29/29	5.37 - 20.5	2 - 2.5	1.10E+01	-
Cobalt	mg/kg	27/28	2.5 - 14.3	1 - 2.5	5.01E+00	2.5 - 2.5
Copper	mg/kg	28/28	2.66 - 11.2	2 - 2.5	8.23E+00	-
Iron	mg/kg	28/28	4500 - 26900	5 - 50	1.21E+04	-
Lead	mg/kg	4/29	6.55 - 31.9	0.901 - 200	1.42E+01	20 - 200
Lithium	mg/kg	0/12	-	10 - 10		10 - 10
Magnesium	mg/kg	28/28	758 - 4780	4.51 - 15	1.68E+03	-
Manganese	mg/kg	28/28	135 - 690	1 - 10	3.72E+02	-
Mercury	mg/kg	0/29	-	0.017 - 0.2		0.017 - 0.2
Molybdenum	mg/kg	0/3	-	2.25 - 2.4		2.25 - 2.4
Nickel	mg/kg	28/29	6.9 - 135	4.51 - 5	1.92E+01	5 - 5
Potassium	mg/kg	13/13	292 - 942	100 - 100	5.47E+02	-
Selenium	mg/kg	2/29	1.06 - 1.23	0.901 - 1	1.15E+00	0.901 - 1
Silver	mg/kg	0/29	-	2.25 - 4		2.25 - 5
Sodium	mg/kg	14/16	150 - 325	90.1 - 200	2.49E+02	200 - 200
Thallium	mg/kg	0/29	-	1.8 - 20		1.8 - 60
Tin	mg/kg	0/12	-	100 - 1000		100 - 1000
Uranium	mg/kg	2/15	217 - 279	0.901 - 2000	2.48E+02	0.901 - 2000
Vanadium	mg/kg	28/28	6.8 - 35.4	2 - 2.5	1.95E+01	-
Zinc	mg/kg	22/28	19.4 - 163	15 - 200	5.78E+01	20 - 200
PCB, Total	mg/kg	6/29	0.035 - 0.306	0.09 - 0.1	1.14E-01	0.09 - 105
PCB-1016	mg/kg	0/30	-	0.06 - 105		0.06 - 105
PCB-1221	mg/kg	0/30	-	0.09 - 0.113		0.09 - 0.113
PCB-1232	mg/kg	0/30	-	0.09 - 0.113		0.09 - 0.113
PCB-1242	mg/kg	0/30	-	0.07 - 0.113		0.07 - 0.113
PCB-1248	mg/kg	0/30	-	0.08 - 0.113		0.08 - 0.113
PCB-1254	mg/kg	0/30	-	0.06 - 0.113		0.06 - 0.113
PCB-1260	mg/kg	6/30	0.035 - 0.306	0.09 - 0.113	1.14E-01	0.09 - 0.108
PCB-1268	mg/kg	0/17	-	0.09 - 0.1		0.09 - 0.1
Alpha activity	pCi/g	18/19	4.38 - 31.2	1.04 - 9.6	1.45E+01	6.3 - 6.3

Table F1.4. Summary of Soil Data from SWMU 5 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Americium-241	pCi/g	0/29	-	0.0213 - 8.4		-0.0107 - 8.4
Beta activity	pCi/g	19/19	1.75 - 41.4	0.94 - 7.7	1.96E+01	-
Cesium-134	pCi/g	0/12	-	0.00834 - 0.0201		-0.0139 - 0.00567
Cesium-137	pCi/g	13/29	0.0141 - 0.0741	0.01 - 1.7	4.56E-02	-0.0305 - 1.7
Cobalt-60	pCi/g	0/29	-	0.00891 - 4.6		-0.025 - 4.6
Neptunium-237	pCi/g	0/16	-	0.0166 - 0.0416		-0.0116 - 0.0555
Plutonium-238	pCi/g	0/15	-	0.0162 - 0.274		-0.079 - 0.00155
Plutonium-239	pCi/g	0/1	-	-		0.1 - 0.1
Plutonium-239/240	pCi/g	0/15	-	0.0164 - 0.045		-0.00666 - 0.00889
Protactinium-234m	pCi/g	0/13	-	86 - 440		86 - 440
Technetium-99	pCi/g	7/29	3.05 - 17.3	1.73 - 4.94	6.54E+00	-1.24 - 5.6
Thorium-228	pCi/g	15/15	0.228 - 0.422	0.033 - 0.0852	3.33E-01	-
Thorium-230	pCi/g	14/16	0.215 - 0.728	0.116 - 0.238	4.00E-01	0.196 - 2.8
Thorium-232	pCi/g	15/15	0.262 - 0.506	0.0414 - 0.171	3.53E-01	-
Thorium-234	pCi/g	1/16	8.9 - 8.9	0.846 - 19	8.90E+00	1.25 - 19
Tritium	pCi/g	0/2	-	-		1.64 - 1.82
Uranium	pCi/g	1/16	1.32 - 1.32	0.277 - 1.23	1.32E+00	0.0115 - 3.09
Uranium-234	pCi/g	1/15	0.641 - 0.641	0.126 - 0.587	6.41E-01	0.00143 - 1.47
Uranium-235	pCi/g	12/28	0.024 - 0.0733	0.0117 - 6.4	4.42E-02	0.00551 - 6.4
Uranium-238	pCi/g	12/15	0.647 - 1.68	0.113 - 0.644	1.20E+00	0.00453 - 0.0794
1,2,4-Trichlorobenzene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
1,2-Dichlorobenzene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
1,3-Dichlorobenzene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
1,4-Dichlorobenzene	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
2,4,5-Trichlorophenol	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
2,4,6-Trichlorophenol	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
2,4-Dichlorophenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
2,4-Dimethylphenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
2,4-Dinitrophenol	mg/kg	0/47	-	0.46 - 2.4		0.46 - 2.4
2,4-Dinitrotoluene	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
2,6-Dinitrotoluene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4

Table F1.4. Summary of Soil Data from SWMU 5 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
2-Chloronaphthalene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
2-Chlorophenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
2-Methyl-4,6-dinitrophenol	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
2-Methylnaphthalene	mg/kg	2/56	0.78 - 7.3	0.46 - 2.4	4.04E+00	0.46 - 2.4
2-Methylphenol	mg/kg	0/58	-	0.46 - 2.4		0.46 - 2.4
2-Nitrobenzenamine	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
2-Nitrophenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
3,3'-Dichlorobenzidine	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
3-Nitrobenzenamine	mg/kg	1/56	9.45 - 9.45	0.46 - 2.4	9.45E+00	0.46 - 2.4
4-Bromophenyl phenyl ether	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
4-Chloro-3-methylphenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
4-Chlorobenzenamine	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
4-Chlorophenyl phenyl ether	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
4-Methylphenol	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
4-Nitrobenzenamine	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
4-Nitrophenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Acenaphthene	mg/kg	18/56	0.08 - 32	0.46 - 2.4	5.46E+00	0.46 - 0.5
Acenaphthylene	mg/kg	2/56	1.2 - 9.45	0.46 - 2.4	5.33E+00	0.46 - 2.4
Anthracene	mg/kg	20/56	0.076 - 40	0.46 - 20	5.71E+00	0.46 - 0.5
Benz(a)anthracene	mg/kg	30/56	0.125 - 130	0.46 - 2.4	1.41E+01	0.46 - 0.5
Benzo(a)pyrene	mg/kg	30/56	0.213 - 80	0.46 - 2.4	1.11E+01	0.46 - 0.5
Benzo(b)fluoranthene	mg/kg	30/56	0.291 - 170	0.46 - 2.4	1.75E+01	0.46 - 0.5
Benzo(ghi)perylene	mg/kg	26/57	0.57 - 28	0.46 - 2.4	4.38E+00	0.46 - 0.5
Benzo(k)fluoranthene	mg/kg	6/15	0.277 - 11.7	0.46 - 0.5	3.65E+00	0.46 - 0.5
Bis(2-chloroethoxy)methane	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Bis(2-chloroethyl) ether	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
Bis(2-chloroisopropyl) ether	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
Bis(2-ethylhexyl)phthalate	mg/kg	18/56	4.4 - 5.7	0.46 - 2.4	4.91E+00	0.46 - 0.98
Butyl benzyl phthalate	mg/kg	0/48	-	0.46 - 2.4		0.46 - 2.4
Carbazole	mg/kg	11/56	0.55 - 71	0.46 - 2.4	1.30E+01	0.46 - 0.5
Chrysene	mg/kg	30/56	0.225 - 95	0.46 - 2.4	1.02E+01	0.46 - 0.5
Dibenz(a,h)anthracene	mg/kg	2/15	0.294 - 0.749	0.46 - 0.5	5.22E-01	0.46 - 0.5
Dibenzofuran	mg/kg	3/15	0.086 - 3.52	0.46 - 0.5	1.75E+00	0.46 - 0.5
Diethyl phthalate	mg/kg	0/15	-	0.46 - 0.5		0.46 - 0.5
Dimethyl phthalate	mg/kg	0/15	-	0.46 - 0.5		0.46 - 0.5
Di-n-butyl phthalate	mg/kg	3/15	0.9 - 1.7	0.46 - 0.5	1.18E+00	0.5 - 0.5
Di-n-octylphthalate	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Fluoranthene	mg/kg	7/15	0.325 - 53.3	0.46 - 0.5	1.00E+01	0.46 - 0.5

Table F1.4. Summary of Soil Data from SWMU 5 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Fluorene	mg/kg	16/56	0.056 - 28	0.46 - 2.4	5.91E+00	0.46 - 0.5
Hexachlorobenzene	mg/kg	0/16	-	0.46 - 0.5		0.46 - 2.4
Hexachlorobutadiene	mg/kg	0/16	-	0.46 - 0.5		0.46 - 2.4
Hexachlorocyclopentadiene	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Hexachloroethane	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
Indeno(1,2,3-cd)pyrene	mg/kg	25/56	0.62 - 37	0.46 - 2.4	5.45E+00	0.46 - 0.5
Isophorone	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
m,p-Cresol	mg/kg	0/1	-	-		2.4 - 2.4
Naphthalene	mg/kg	3/56	0.68 - 16	0.46 - 2.4	5.81E+00	0.46 - 2.4
Nitrobenzene	mg/kg	0/57	-	0.46 - 2.4		0.46 - 2.4
N-Nitroso-di-n-propylamine	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
N-Nitrosodiphenylamine	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Pentachlorophenol	mg/kg	2/57	0.237 - 0.357	0.46 - 2.4	2.97E-01	0.46 - 2.4
Phenanthrene	mg/kg	31/56	0.224 - 64	0.46 - 20	1.15E+01	0.46 - 0.5
Phenol	mg/kg	0/56	-	0.46 - 2.4		0.46 - 2.4
Pyrene	mg/kg	35/56	0.283 - 150	0.46 - 2.4	1.52E+01	0.46 - 0.5
Pyridine	mg/kg	0/44	-	0.46 - 2.4		0.46 - 2.4
Total Cresols	mg/kg	0/1	-	-		4.8 - 4.8
Total PAH	mg/kg	6/56	0.257595 - 33.1078	-	8.82E+00	0 - 0
1,1,1-Trichloroethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
1,1,2,2-Tetrachloroethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
1,1,2-Trichloroethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethene	mg/kg	1/17	2.8 - 2.8	0.01 - 0.42	2.80E+00	0.01 - 0.42
1,2-Dichloroethane	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
1,2-Dichloropropane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
1,2-Dimethylbenzene	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
2-Butanone	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
2-Hexanone	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
4-Methyl-2-pentanone	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Acetone	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Benzene	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
Bromodichloromethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Bromoform	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Bromomethane	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Carbon disulfide	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Carbon tetrachloride	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
Chlorobenzene	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
Chloroethane	mg/kg	0/1	-	0.01 - 0.01		0.01 - 0.01
Chloroform	mg/kg	0/2	-	0.01 - 0.01		0.01 - 2.8

Table F1.4. Summary of Soil Data from SWMU 5 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Chloromethane	mg/kg	0/1	-	0.01 - 0.01		0.01 - 0.01
cis-1,2-Dichloroethene	mg/kg	0/4	-	0.01 - 0.42		0.01 - 0.42
cis-1,3-Dichloropropene	mg/kg	0/1	-	0.01 - 0.01		0.01 - 0.01
Dibromochloromethane	mg/kg	0/1	-	0.01 - 0.01		0.01 - 0.01
Ethylbenzene	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
m,p-Xylene	mg/kg	0/13	-	0.02 - 0.02		0.02 - 0.02
Methylene chloride	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.035
Styrene	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Tetrachloroethene	mg/kg	0/14	-	0.01 - 0.01		0.01 - 2.8
Toluene	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
trans-1,2-Dichloroethene	mg/kg	0/16	-	0.01 - 0.42		0.01 - 0.42
trans-1,3-Dichloropropene	mg/kg	0/13	-	0.01 - 0.01		0.01 - 0.01
Trichloroethene	mg/kg	0/17	-	0.01 - 0.42		0.01 - 2.8
Vinyl chloride	mg/kg	0/5	-	0.01 - 0.42		0.01 - 2.8
Cyanide	mg/kg	0/13	-	1 - 1		1 - 1
Total Organic Carbon (TOC)	mg/kg	7/7	2800 - 9000	300 - 300	5.40E+03	-

Table F1.5. Summary of Soil Data from SWMU 6

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Aluminum	mg/kg	23/23	5290 - 11200	18.4 - 20	8.22E+03	-
Antimony	mg/kg	0/23	-	8.85 - 20		8.85 - 20
Arsenic	mg/kg	7/23	1.92 - 6.38	0.921 - 5	4.32E+00	5 - 5
Barium	mg/kg	23/23	48.3 - 99.2	1 - 5	8.20E+01	-
Beryllium	mg/kg	12/23	0.505 - 2.62	0.461 - 0.5	7.59E-01	0.461 - 0.5
Cadmium	mg/kg	0/23	-	1.84 - 2		1.84 - 2
Calcium	mg/kg	23/23	463 - 146000	50 - 2000	2.93E+04	-
Chromium	mg/kg	23/23	4.46 - 19	2 - 2.5	1.09E+01	-
Cobalt	mg/kg	22/23	2.27 - 6.85	1 - 2.5	4.39E+00	2.5 - 2.5
Copper	mg/kg	23/23	5.63 - 21.3	2 - 2.5	9.34E+00	-
Iron	mg/kg	23/23	6080 - 54200	5 - 50	1.33E+04	-
Lead	mg/kg	5/23	5.81 - 35.4	0.921 - 20	1.32E+01	20 - 20
Lithium	mg/kg	6/7	5.53 - 8.08	5 - 10	6.59E+00	10 - 10
Magnesium	mg/kg	23/23	644 - 4410	2.5 - 15	1.78E+03	-
Manganese	mg/kg	23/23	79.3 - 664	1 - 10	3.23E+02	-
Mercury	mg/kg	0/23	-	0.018 - 0.2		0.018 - 0.2
Molybdenum	mg/kg	0/4	-	2.3 - 2.4		2.3 - 2.4
Nickel	mg/kg	18/23	6.07 - 43.2	4.61 - 5	1.12E+01	5 - 5
Potassium	mg/kg	12/12	164 - 821	100 - 100	5.31E+02	-
Selenium	mg/kg	1/23	1.37 - 1.37	0.921 - 1	1.37E+00	0.921 - 1
Silver	mg/kg	0/23	-	2.3 - 4		2.3 - 4
Sodium	mg/kg	13/16	142 - 410	92.1 - 200	2.39E+02	95.8 - 200
Thallium	mg/kg	0/23	-	1.84 - 20		1.84 - 20
Tin	mg/kg	0/7	-	100 - 1000		100 - 1000
Uranium	mg/kg	2/11	1.02 - 114	0.921 - 1000	5.75E+01	0.921 - 1000
Vanadium	mg/kg	23/23	5.1 - 65.6	2 - 2.5	2.19E+01	-
Zinc	mg/kg	22/23	17.8 - 128	10 - 20	3.95E+01	20 - 20
PCB, Total	mg/kg	0/23	-	0.09 - 0.1		0.09 - 106
PCB-1016	mg/kg	0/26	-	0.06 - 106		0.06 - 106
PCB-1221	mg/kg	0/26	-	0.09 - 0.11		0.09 - 0.11
PCB-1232	mg/kg	0/26	-	0.09 - 0.11		0.09 - 0.11
PCB-1242	mg/kg	0/26	-	0.07 - 0.11		0.07 - 0.11
PCB-1248	mg/kg	0/26	-	0.08 - 0.11		0.08 - 0.11
PCB-1254	mg/kg	0/26	-	0.06 - 0.11		0.06 - 0.11
PCB-1260	mg/kg	0/26	-	0.09 - 0.11		0.09 - 0.11
PCB-1268	mg/kg	0/14	-	0.09 - 0.1		0.09 - 0.1
Alpha activity	pCi/g	17/17	3.45 - 20.7	0.675 - 12	1.42E+01	-
Americium-241	pCi/g	0/23	-	0.0296 - 8.5		-0.0211 - 8.5
Beta activity	pCi/g	17/17	2.24 - 37.8	0.752 - 8.2	1.80E+01	-
Cesium-134	pCi/g	0/7	-	0.0139 - 0.0193		-0.00535 - 0.00302
Cesium-137	pCi/g	6/23	0.0176 - 0.0523	0.0166 - 3.2	2.70E-02	-0.024 - 3.2

Table F1.5. Summary of Soil Data from SWMU 6 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Cobalt-60	pCi/g	0/23	-	0.0141 - 1.4		-0.00908 - 1.4
Neptunium-237	pCi/g	0/11	-	0.0322 - 0.135		-0.0124 - 0.025
Plutonium-238	pCi/g	0/11	-	0.0184 - 0.275		-0.0459 - 0.00758
Plutonium-239/240	pCi/g	0/11	-	0.0179 - 0.0724		-0.0102 - 0.00771
Protactinium-234m	pCi/g	0/12	-	120 - 660		120 - 660
Technetium-99	pCi/g	3/23	6.47 - 18.8	1.83 - 5.77	1.31E+01	-1.74 - 5.76
Thorium-228	pCi/g	11/11	0.223 - 0.506	0.0644 - 0.228	3.42E-01	-
Thorium-230	pCi/g	10/11	0.145 - 0.541	0.108 - 0.301	3.45E-01	0.155 - 0.155
Thorium-232	pCi/g	11/11	0.21 - 0.457	0.0444 - 0.198	3.42E-01	-
Thorium-234	pCi/g	0/16	-	1.05 - 21		0.165 - 21
Uranium	pCi/g	0/11	-	0.289 - 1.59		-0.0234 - 2.35
Uranium-234	pCi/g	0/11	-	0.121 - 0.92		-0.0149 - 1.35
Uranium-235	pCi/g	7/23	0.029 - 0.075	0.0267 - 7.9	4.29E-02	-0.0204 - 7.9
Uranium-238	pCi/g	6/11	0.835 - 1.38	0.124 - 0.634	1.03E+00	0.00441 - 0.748
1,2,4-Trichlorobenzene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
1,2-Dichlorobenzene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
1,3-Dichlorobenzene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
1,4-Dichlorobenzene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,4,5-Trichlorophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,4,6-Trichlorophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,4-Dichlorophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,4-Dimethylphenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,4-Dinitrophenol	mg/kg	0/16	-	0.46 - 0.5		0.46 - 0.5
2,4-Dinitrotoluene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2,6-Dinitrotoluene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Chloronaphthalene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Chlorophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Methyl-4,6-dinitrophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Methylnaphthalene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Methylphenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Nitrobenzenamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
2-Nitrophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
3,3'-Dichlorobenzidine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
3-Nitrobenzenamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5

Table F1.5. Summary of Soil Data from SWMU 6 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
4-Bromophenyl phenyl ether	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Chloro-3-methylphenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Chlorobenzenamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Chlorophenyl phenyl ether	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Methylphenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Nitrobenzenamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
4-Nitrophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Acenaphthene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Acenaphthylene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Anthracene	mg/kg	1/19	0.156 - 0.156	0.46 - 0.5	1.56E-01	0.46 - 0.5
Benz(a)anthracene	mg/kg	2/19	0.118 - 0.255	0.46 - 0.5	1.87E-01	0.46 - 0.5
Benzo(a)pyrene	mg/kg	2/19	0.277 - 0.402	0.46 - 0.5	3.40E-01	0.46 - 0.5
Benzo(b)fluoranthene	mg/kg	2/19	0.284 - 0.5	0.46 - 0.5	3.92E-01	0.46 - 0.5
Benzo(ghi)perylene	mg/kg	2/19	0.117 - 0.124	0.46 - 0.5	1.21E-01	0.46 - 0.5
Benzo(k)fluoranthene	mg/kg	2/12	0.45 - 0.5	0.46 - 0.5	4.75E-01	0.46 - 0.5
Bis(2-chloroethoxy)methane	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Bis(2-chloroethyl) ether	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Bis(2-chloroisopropyl) ether	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Bis(2-ethylhexyl)phthalate	mg/kg	1/19	0.42 - 0.42	0.46 - 0.5	4.20E-01	0.46 - 0.5
Butyl benzyl phthalate	mg/kg	0/16	-	0.46 - 0.5		0.46 - 0.5
Carbazole	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Chrysene	mg/kg	2/19	0.217 - 0.417	0.46 - 0.5	3.17E-01	0.46 - 0.5
Dibenz(a,h)anthracene	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Dibenzofuran	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Diethyl phthalate	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Dimethyl phthalate	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Di-n-butyl phthalate	mg/kg	3/12	0.76 - 1.7	0.46 - 0.5	1.15E+00	0.5 - 0.5
Di-n-octylphthalate	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Fluoranthene	mg/kg	2/12	0.249 - 0.636	0.46 - 0.5	4.43E-01	0.46 - 0.5
Fluorene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Hexachlorobenzene	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Hexachlorobutadiene	mg/kg	0/12	-	0.46 - 0.5		0.46 - 0.5
Hexachlorocyclopentadiene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Hexachloroethane	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Indeno(1,2,3-cd)pyrene	mg/kg	2/19	0.138 - 0.159	0.46 - 0.5	1.49E-01	0.46 - 0.5
Isophorone	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Naphthalene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5

Table F1.5. Summary of Soil Data from SWMU 6 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Nitrobenzene	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
N-Nitroso-di-n-propylamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
N-Nitrosodiphenylamine	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Pentachlorophenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Phenanthrene	mg/kg	1/19	0.461 - 0.461	0.46 - 0.5	4.61E-01	0.46 - 0.5
Phenol	mg/kg	0/19	-	0.46 - 0.5		0.46 - 0.5
Pyrene	mg/kg	2/19	0.269 - 0.663	0.46 - 0.5	4.66E-01	0.46 - 0.5
Pyridine	mg/kg	0/10	-	0.46 - 0.49		0.46 - 0.49
Total PAH	mg/kg	2/20	0.337817 - 0.496717	-	4.17E-01	0 - 0
1,1,1-Trichloroethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,1,2,2-Tetrachloroethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,1,2-Trichloroethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,1-Dichloroethene	mg/kg	0/17	-	0.01 - 0.447		0.01 - 0.447
1,2-Dichloroethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,2-Dichloropropane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
1,2-Dimethylbenzene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
2-Butanone	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
2-Hexanone	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
4-Methyl-2-pentanone	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Acetone	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Benzene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Bromodichloromethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Bromoform	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Bromomethane	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Carbon disulfide	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Carbon tetrachloride	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Chlorobenzene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Chloroethane	mg/kg	0/3	-	0.01 - 0.01		0.01 - 0.01
Chloroform	mg/kg	0/3	-	0.01 - 0.01		0.01 - 0.01
Chloromethane	mg/kg	0/3	-	0.01 - 0.01		0.01 - 0.01
cis-1,2-Dichloroethene	mg/kg	0/10	-	0.01 - 0.447		0.01 - 0.447
cis-1,3-Dichloropropene	mg/kg	0/3	-	0.01 - 0.01		0.01 - 0.01
Dibromochloromethane	mg/kg	0/3	-	0.01 - 0.01		0.01 - 0.01
Ethylbenzene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
m,p-Xylene	mg/kg	0/10	-	0.02 - 0.02		0.02 - 0.02
Methylene chloride	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Styrene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Tetrachloroethene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Toluene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01

Table F1.5. Summary of Soil Data from SWMU 6 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
trans-1,2-Dichloroethene	mg/kg	0/17	-	0.01 - 0.447		0.01 - 0.447
trans-1,3-Dichloropropene	mg/kg	0/10	-	0.01 - 0.01		0.01 - 0.01
Trichloroethene	mg/kg	0/17	-	0.01 - 0.447		0.01 - 0.447
Vinyl chloride	mg/kg	0/10	-	0.01 - 0.447		0.01 - 0.447
Cyanide	mg/kg	0/11	-	1 - 1		1 - 1
Total Organic Carbon (TOC)	mg/kg	3/3	6100 - 11000	300 - 300	9.37E+03	-

Table F1.6. Summary of Soil Data from SWMU 7

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Chloride	mg/kg	14/14	1.2 - 23	-	6.78E+00	-
Cyanide	mg/kg	4/6	0.13 - 0.22	-	1.88E-01	0.099 - 0.14
Fluoride	mg/kg	14/14	2.2 - 32	-	1.26E+01	-
Nitrate/Nitrite	mg/kg	5/5	1.5 - 8.7	-	5.44E+00	-
Sulfate	mg/kg	14/14	3.4 - 61	-	1.65E+01	-
Total Organic Carbon (TOC)	mg/kg	13/14	880 - 50000	-	1.20E+04	1300 - 1300
Aluminum	mg/kg	37/37	2900 - 16000	18 - 19.9	8.32E+03	-
Antimony	mg/kg	11/37	0.47 - 1.7	8.42 - 9.98	8.35E-01	0.46 - 9.98
Arsenic	mg/kg	28/37	1.32 - 16	0.9 - 0.993	4.22E+00	0.929 - 5.7
Barium	mg/kg	37/37	21 - 180	2.25 - 2.48	8.58E+01	-
Beryllium	mg/kg	10/39	0.2 - 1.3	0.45 - 0.5	5.57E-01	0.39 - 1.3
Cadmium	mg/kg	10/37	0.11 - 1.3	1.8 - 1.99	6.01E-01	0.065 - 1.99
Calcium	mg/kg	37/37	362 - 210000	90 - 99.3	8.40E+03	-
Chromium	mg/kg	39/39	7.71 - 55.8	2 - 2.48	1.80E+01	-
Cobalt	mg/kg	34/37	2 - 11	2.25 - 2.48	5.29E+00	2.32 - 2.47
Copper	mg/kg	37/37	5.43 - 99	2.25 - 23.7	1.87E+01	-
Iron	mg/kg	37/37	6100 - 30000	18 - 19.9	1.33E+04	-
Lead	mg/kg	36/37	4.7 - 120	0.9 - 0.993	1.44E+01	10 - 10
Magnesium	mg/kg	37/37	380 - 3300	4.5 - 4.97	1.12E+03	-
Manganese	mg/kg	37/37	104 - 1200	2.25 - 2.48	3.30E+02	-
Mercury	mg/kg	16/39	0.018 - 0.092	0.015 - 0.2	5.09E-02	0.012 - 0.2
Molybdenum	mg/kg	0/37	-	2.25 - 2.48		0.41 - 14
Nickel	mg/kg	37/37	5.3 - 140	4.5 - 4.97	1.94E+01	-
Potassium	mg/kg	3/20	200 - 530	-	3.67E+02	230 - 870
Selenium	mg/kg	8/37	0.41 - 0.88	0.9 - 0.993	6.29E-01	0.39 - 0.993
Silver	mg/kg	3/37	0.18 - 1.9	2.25 - 2.48	8.40E-01	0.16 - 2.48
Sodium	mg/kg	16/37	21 - 330	90 - 99.3	1.70E+02	53 - 400
Thallium	mg/kg	9/37	0.52 - 2	1.8 - 1.99	1.32E+00	0.43 - 1.99
Tin	mg/kg	17/20	1.8 - 8.7	-	4.61E+00	5.9 - 15
Uranium	mg/kg	22/39	0.962 - 1270	0.11 - 948	2.14E+02	0.911 - 18

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Vanadium	mg/kg	36/37	4.5 - 52	2.25 - 2.48	1.98E+01	2.34 - 2.34
Zinc	mg/kg	34/37	17 - 240	18 - 19.9	5.54E+01	18 - 19
4,4'-DDD	mg/kg	0/17	-	-		0.014 - 0.037
4,4'-DDE	mg/kg	0/17	-	-		0.012 - 0.032
4,4'-DDT	mg/kg	0/17	-	-		0.008 - 0.021
Aldrin	mg/kg	0/17	-	-		0.01 - 0.026
alpha-BHC	mg/kg	0/17	-	-		0.008 - 0.021
beta-BHC	mg/kg	0/15	-	-		0.016 - 0.042
delta-BHC	mg/kg	0/17	-	-		0.018 - 0.047
Dieldrin	mg/kg	0/17	-	-		0.017 - 0.045
Heptachlor	mg/kg	0/17	-	-		0.007 - 0.018
Lindane	mg/kg	0/17	-	-		0.008 - 0.021
Methoxychlor	mg/kg	0/17	-	-		0.004 - 0.011
PCB, Total	mg/kg	19/40	0.0091 - 14.8	0.09 - 0.95	1.37E+00	0.009 - 0.1
PCB-1016	mg/kg	1/40	0.051 - 0.051	0.09 - 0.95	5.10E-02	0.00092 - 0.95
PCB-1221	mg/kg	0/40	-	0.09 - 0.95		0.009 - 0.95
PCB-1232	mg/kg	0/40	-	0.09 - 0.95		0.0037 - 0.95
PCB-1242	mg/kg	0/40	-	0.09 - 0.95		0.0024 - 0.95
PCB-1248	mg/kg	2/40	0.41 - 14.8	0.09 - 0.95	7.61E+00	0.00074 - 0.1
PCB-1254	mg/kg	4/40	0.0091 - 0.13	0.09 - 0.95	5.63E-02	0.00071 - 0.95
PCB-1260	mg/kg	13/40	0.027 - 3.1	0.09 - 0.95	8.06E-01	0.00084 - 0.95
PCB-1268	mg/kg	0/20	-	0.09 - 0.95		0.09 - 0.95
Actinium-228	pCi/g	2/2	0.8188 - 0.9663	0.1323 - 0.1596	8.93E-01	-
Alpha activity	pCi/g	54/60	3.22 - 742.07	0.865 - 14.5	8.91E+01	30.35 - 95
Americium-241	pCi/g	0/20	-	0.0196 - 0.821		-0.0128 - 2
Antimony-124	pCi/g	0/2	-	0.03643 - 0.05668		0.009344 - 0.01448
Antimony-125	pCi/g	0/2	-	0.09667 - 0.1753		0.04281 - 0.08223
Barium-133	pCi/g	0/2	-	0.03764 - 0.07783		0.00575 - 0.02418

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Barium-140	pCi/g	0/2	-	0.1468 - 0.248		0.001142 - 0.03928
Beta activity	pCi/g	54/60	2.68 - 1027.53	0.83 - 10.83	1.32E+02	25.33 – 210
Bismuth-211	pCi/g	0/2	-	0.4338 - 0.5006		1.886 - 2.38
Bismuth-212	pCi/g	2/2	0.7243 - 0.8214	0.3006 - 0.5012	7.73E-01	-
Bismuth-214	pCi/g	2/2	0.6941 - 0.8725	0.06596 - 0.1184	7.83E-01	-
Cerium-139	pCi/g	0/2	-	0.02607 - 0.0804		0.003988 - 0.06083
Cerium-141	pCi/g	0/2	-	0.04934 - 0.1863		0.03345 - 1.642
Cerium-144	pCi/g	0/2	-	0.1987 - 0.6453		0.0002939 - 0.467
Cesium-134	pCi/g	0/2	-	0.0345 - 0.0565		-0.00108 - 0.0154
Cesium-136	pCi/g	0/2	-	0.05483 - 0.05633		-0.0237 - - 0.01162
Cesium-137	pCi/g	3/20	0.0906 - 0.183	0.0415 - 0.249	1.24E-01	-0.0347 - 0.0612
Chromium-51	pCi/g	0/2	-	0.27 - 0.514		-0.01978 - 0.05218
Cobalt-56	pCi/g	0/2	-	0.03606 - 0.05577		0.01041 - 0.03123
Cobalt-57	pCi/g	0/2	-	0.02481 - 0.08619		0.001962 - 0.0676
Cobalt-58	pCi/g	0/2	-	0.03718 - 0.05518		-0.02246 - - 0.004549
Cobalt-60	pCi/g	0/19	-	0.0367 - 0.107		-0.0423 - 0.0467
Europium-152	pCi/g	0/2	-	0.0912 - 0.1758		-0.1269 - 0.02569
Europium-154	pCi/g	0/2	-	0.05254 - 0.1781		0.003085 - 0.04461
Europium-155	pCi/g	0/2	-	0.1124 - 0.4161		0.03243 - 0.345
Iridium-192	pCi/g	0/2	-	0.03 - 0.05936		0.002029 - 0.01196
Iron-59	pCi/g	0/2	-	0.07214 - 0.08401		0.005989 - 0.009486

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Lead-210	pCi/g	0/2	-	2.259 - 12.75		-10.07 - 0.5533
Lead-211	pCi/g	0/2	-	0.4338 - 0.5006		1.886 - 2.38
Lead-212	pCi/g	2/2	0.6114 - 0.774	0.04985 - 0.1221	6.93E-01	-
Lead-214	pCi/g	1/2	0.8365 - 0.8365	0.06624 - 0.1275	8.37E-01	0.791 - 0.791
Manganese-54	pCi/g	0/2	-	0.03949 - 0.0558		-0.04947 - 0.007914
Mercury-203	pCi/g	0/2	-	0.03161 - 0.06667		0.001696 - 0.01102
Neodymium-147	pCi/g	0/2	-	0.1968 - 1.223		1.058 - 57.59
Neptunium-237	pCi/g	17/42	0.0316 - 0.72	0.0275 - 0.247	2.53E-01	-0.147 - 0.273
Neptunium-239	pCi/g	0/2	-	0.3193 - 0.5986		-0.1427 - 0.5492
Niobium-94	pCi/g	0/2	-	0.03883 - 0.04877		-0.03231 - 0.01532
Niobium-95	pCi/g	0/2	-	0.05368 - 0.1852		0.07756 - 2.143
Plutonium-238	pCi/g	0/21	-	0.006 - 0.212		-0.0355 - 0.136
Plutonium-239	pCi/G	13/20	0.02 - 0.68	-	2.22E-01	-0.024 - 0.02
Plutonium-239/240	pCi/g	6/22	0.044 - 0.283	0.006 - 0.13	1.30E-01	-0.0041 - 0.0368
Potassium-40	pCi/g	2/2	10.6 - 10.6	0.352 - 0.357	1.06E+01	-
Promethium-146	pCi/g	0/2	-	0.04182 - 0.08257		-0.01623 - - 0.00306
Protactinium-231	pCi/g	1/2	0.6862 - 0.6862	0.2741 - 2.617	6.86E-01	94.16 - 94.16
Protactinium-233	pCi/g	0/2	-	0.08327 - 0.1348		0.1315 - 0.1606
Protactinium-234m	pCi/g	2/2	15.4 - 596	0.512 - 2.69	3.06E+02	-
Radium-223	pCi/g	1/2	0.1903 - 0.1903	0.1708 - 0.3857	1.90E-01	0.3615 - 0.3615
Radium-226	pCi/g	0/2	-	0.151 - 0.177		0.789 - 0.83
Radium-228	pCi/g	0/2	-	0.2772 - 0.3037		0.8587 - 0.8739

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Radon-219	pCi/g	0/2	-	0.2558 - 0.5009		0.26 - 0.5225
Ruthenium-106	pCi/g	0/2	-	0.2996 - 0.5764		-0.08525 - 0.1413
Silver-110m	pCi/g	0/2	-	0.03521 - 0.05895		-0.04118 - 0.0009897
Sodium-22	pCi/g	0/2	-	0.04173 - 0.04784		0.01399 - 0.01975
Strontium-90	pCi/g	0/2	-	1 - 1.2		-0.24 - 0.038
Technetium-99	pCi/g	26/40	0.205 - 406	0.233 - 4.25	3.23E+01	-0.154 - 1.68
Thallium-208	pCi/g	1/2	0.19 - 0.19	0.03709 - 0.06408	1.90E-01	0.2787 - 0.2787
Thorium-227	pCi/g	0/2	-	0.2077 - 0.4643		0.03398 - 0.1162
Thorium-228	pCi/g	19/21	0.326 - 3.36	0.0484 - 0.832	6.96E-01	0.6087 - 0.99
Thorium-229	pCi/g	0/2	-	0.1117 - 0.3252		0.06906 - 0.3592
Thorium-230	pCi/g	38/40	0.211 - 3.94	0.0264 - 0.91	1.32E+00	0.227 - 0.23
Thorium-232	pCi/g	19/21	0.203 - 0.54	0.03709 - 0.396	4.01E-01	0.235 - 0.2652
Thorium-234	pCi/g	8/19	2.01 - 2650	0.812 - 8.27	3.43E+02	0.851 - 518
Tin-113	pCi/g	0/2	-	0.03821 - 0.07385		-0.02087 - - 0.01732
Uranium	pCi/g	17/28	2.21 - 2750	0.283 - 5.93	2.87E+02	0.143 - 1.04
Uranium-234	pCi/g	45/49	0.142 - 318	0.053 - 1.1	2.66E+01	0.0519 - 0.134
Uranium-235	pCi/g	8/19	0.0509 - 42.1	0.0368 - 0.93	6.43E+00	-0.00141 - 0.0197
Uranium-235/236	pCi/G	20/20	0.07 - 6.03	-	2.02E+00	-
Uranium-238	pCi/g	44/49	0.147 - 2390	0.038 - 4.88	1.14E+02	0.0777 - 0.123
Yttrium-88	pCi/g	0/2	-	0.03016 - 0.03478		-0.009606 - 0.01105
Zinc-65	pCi/g	0/2	-	0.08259 - 0.08645		-0.03198 - 0.01447
Zirconium-95	pCi/g	0/2	-	0.05171 - 0.1824		0.07472 - 2.111

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
1,2,4,5-Tetrachlorobenzene	mg/kg	0/17	-	-		0.008 - 0.021
1,2,4-Trichlorobenzene	mg/kg	2/34	0.037 - 0.077	0.46 - 0.5	5.70E-02	0.01 - 0.5
1,2-Dichlorobenzene	mg/kg	0/42	-	0.46 - 0.5		0.0002 - 0.5
1,2-Diphenylhydrazine	mg/kg	0/17	-	-		0.007 - 0.018
1,3-Dichlorobenzene	mg/kg	0/42	-	0.46 - 0.5		0.000214 - 0.5
1,4-Dichlorobenzene	mg/kg	2/42	0.052 - 0.07	0.46 - 0.5	6.10E-02	0.00022 - 0.5
1-Chloronaphtalene	mg/kg	0/17	-	-		0.01 - 0.026
1-Naphthalenamine	mg/kg	0/17	-	-		0.038 - 0.1
2,3,4,6-Tetrachlorophenol	mg/kg	0/17	-	-		0.012 - 0.032
2,4,5-Trichlorophenol	mg/kg	1/34	0.035 - 0.035	0.46 - 0.5	3.50E-02	0.009 - 0.5
2,4,6-Trichlorophenol	mg/kg	1/34	0.041 - 0.041	0.46 - 0.5	4.10E-02	0.01 - 0.5
2,4-Dichlorophenol	mg/kg	0/34	-	0.46 - 0.5		0.009 - 0.5
2,4-Dimethylphenol	mg/kg	0/34	-	0.46 - 0.5		0.023 - 0.5
2,4-Dinitrophenol	mg/kg	0/34	-	0.46 - 0.5		0.049 - 0.5
2,4-Dinitrotoluene	mg/kg	0/34	-	0.46 - 0.5		0.015 - 0.5
2,6-Dichlorophenol	mg/kg	0/17	-	-		0.01 - 0.026
2,6-Dinitrotoluene	mg/kg	0/34	-	0.46 - 0.5		0.008 - 0.5
2-Chloronaphthalene	mg/kg	0/34	-	0.46 - 0.5		0.004 - 0.5
2-Chlorophenol	mg/kg	1/34	0.039 - 0.039	0.46 - 0.5	3.90E-02	0.011 - 0.5
2-Methyl-4,6-dinitrophenol	mg/kg	0/34	-	0.46 - 0.5		0.052 - 0.5
2-Methylnaphthalene	mg/kg	1/34	0.15 - 0.15	0.46 - 0.5	1.50E-01	0.009 - 0.5
2-Methylphenol	mg/kg	1/17	0.02 - 0.02	-	2.00E-02	0.008 - 0.021
2-Methylpyridine	mg/kg	0/17	-	-		0.067 - 0.18
2-Naphthalenamine	mg/kg	0/17	-	-		0.066 - 0.17
2-Nitroaniline	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
2-Nitrobenzenamine	mg/kg	0/17	-	-		0.01 - 0.026
2-Nitrophenol	mg/kg	0/34	-	0.46 - 0.5		0.009 - 0.5
3,3'-Dichlorobenzidine	mg/kg	0/34	-	0.46 - 0.5		0.036 - 0.5
3-Methylcholanthrene	mg/kg	1/17	0.11 - 0.11	-	1.10E-01	0.02 - 0.053

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
3-Nitroaniline	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
3-Nitrobenzenamine	mg/kg	0/17	-	-		0.025 - 0.066
4-Aminobiphenyl	mg/kg	0/17	-	-		0.057 - 0.15
4-Bromophenyl phenyl ether	mg/kg	0/34	-	0.46 - 0.5		0.008 - 0.5
4-Chloro-3-methylphenol	mg/kg	0/34	-	0.46 - 0.5		0.01 - 0.5
4-Chloroaniline	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
4-Chlorobenzenamine	mg/kg	0/17	-	-		0.047 - 0.12
4-Chlorophenyl phenyl ether	mg/kg	0/19	-	0.47 - 0.49		0.007 - 0.49
4-Chlorophenylphenyl ether	mg/kg	0/15	-	0.46 - 0.5		0.46 - 0.5
4-Methylphenol	mg/kg	1/17	0.016 - 0.016	-	1.60E-02	0.008 - 0.021
4-Nitroaniline	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
4-Nitrobenzenamine	mg/kg	0/17	-	-		0.066 - 0.17
4-Nitrophenol	mg/kg	0/34	-	0.46 - 0.5		0.022 - 0.5
7,12-Dimethylbenz(a)anthracene	mg/kg	0/17	-	-		0.085 - 0.22
a,a-Dimethylphenethylamine	mg/kg	0/17	-	-		0.013 - 0.034
Acenaphthene	mg/kg	2/34	0.031 - 0.44	0.46 - 0.5	2.36E-01	0.008 - 0.5
Acenaphthylene	mg/kg	1/34	0.019 - 0.019	0.46 - 0.5	1.90E-02	0.008 - 0.5
Acetophenone	mg/kg	0/17	-	-		0.008 - 0.021
Aniline	mg/kg	0/17	-	-		0.051 - 0.13
Anthracene	mg/kg	3/34	0.015 - 0.69	0.46 - 0.5	2.42E-01	0.009 - 0.5
Benz(a)anthracene	mg/kg	7/34	0.026 - 4.3	0.46 - 0.5	6.76E-01	0.008 - 0.5
Benzenemethanol	mg/kg	0/17	-	-		0.01 - 0.026
Benzidine	mg/kg	0/17	-	-		0.327 - 0.86
Benzo(a)pyrene	mg/kg	7/34	0.02 - 4.1	0.46 - 0.5	6.60E-01	0.009 - 0.5
Benzo(b)fluoranthene	mg/kg	7/34	0.034 - 5.2	0.46 - 0.5	8.46E-01	0.01 - 0.5
Benzo(ghi)perylene	mg/kg	3/34	0.076 - 3.8	0.46 - 0.5	1.36E+00	0.019 - 0.5
Benzo(k)fluoranthene	mg/kg	6/34	0.021 - 1.7	0.46 - 0.5	3.29E-01	0.01 - 0.5
Benzoic acid	mg/kg	2/34	0.044 - 0.15	0.46 -	9.70E-02	0.025 - 0.62

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				0.5		
Benzyl Alcohol	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
Bis(2-chloroethoxy)methane	mg/kg	0/34	-	0.46 - 0.5		0.009 - 0.5
Bis(2-chloroethyl) ether	mg/kg	0/34	-	0.46 - 0.5		0.011 - 0.5
Bis(2-chloroisopropyl) ether	mg/kg	0/34	-	0.46 - 0.5		0.056 - 0.5
Bis(2-ethylhexyl)phthalate	mg/kg	2/34	0.23 - 0.39	0.46 - 0.5	3.10E-01	0.113 - 0.5
Butyl benzyl phthalate	mg/kg	0/34	-	0.46 - 0.5		0.128 - 0.5
Chrysene	mg/kg	7/34	0.018 - 4.2	0.46 - 0.5	6.52E-01	0.01 - 0.5
Dibenz(a,h)anthracene	mg/kg	1/34	0.92 - 0.92	0.46 - 0.5	9.20E-01	0.012 - 0.5
Dibenzofuran	mg/kg	1/34	0.24 - 0.24	0.46 - 0.5	2.40E-01	0.004 - 0.5
Diethyl phthalate	mg/kg	0/33	-	0.46 - 0.5		0.011 - 0.5
Diethylphthalate	mg/kg	0/1	-	0.48 - 0.48		0.48 - 0.48
Dimethyl phthalate	mg/kg	0/33	-	0.46 - 0.5		0.009 - 0.5
Dimethylphthalate	mg/kg	0/1	-	0.48 - 0.48		0.48 - 0.48
Di-n-butyl phthalate	mg/kg	1/17	0.091 - 0.091	-	9.10E-02	0.059 - 0.16
Di-n-butylphthalate	mg/kg	0/17	-	0.46 - 0.5		0.48 - 4.4
Di-n-octylphthalate	mg/kg	1/34	0.072 - 0.072	0.46 - 0.5	7.20E-02	0.011 - 0.5
Ethyl methanesulfonate	mg/kg	0/17	-	-		0.008 - 0.021
Fluoranthene	mg/kg	8/34	0.02 - 7.9	0.46 - 0.5	1.05E+00	0.01 - 0.5
Fluorene	mg/kg	1/34	0.41 - 0.41	0.46 - 0.5	4.10E-01	0.009 - 0.5
Hexachlorobenzene	mg/kg	0/34	-	0.46 - 0.5		0.007 - 0.5
Hexachlorobutadiene	mg/kg	1/34	0.058 - 0.058	0.46 - 0.5	5.80E-02	0.008 - 0.5
Hexachlorocyclopentadiene	mg/kg	0/34	-	0.46 - 0.5		0.006 - 0.5
Hexachloroethane	mg/kg	1/34	0.034 - 0.034	0.46 - 0.5	3.40E-02	0.009 - 0.5
Indeno(1,2,3-cd)pyrene	mg/kg	3/34	0.071 - 3.8	0.46 - 0.5	1.36E+00	0.013 - 0.5
Isophorone	mg/kg	0/34	-	0.46 -		0.009 - 0.5

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				0.5		
m,p-cresol	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
Methyl methanesulfonate	mg/kg	0/17	-	-		0.068 - 0.18
Naphthalene	mg/kg	1/34	0.056 - 0.056	0.46 - 0.5	5.60E-02	0.01 - 0.5
Nitrobenzene	mg/kg	0/34	-	0.46 - 0.5		0.034 - 0.5
N-Nitrosodimethylamine	mg/kg	0/17	-	-		0.017 - 0.045
N-Nitroso-di-n-propylamine	mg/kg	0/34	-	0.46 - 0.5		0.012 - 0.5
N-Nitrosodiphenylamine	mg/kg	0/34	-	0.46 - 0.5		0.004 - 0.5
N-Nitrosopiperidine	mg/kg	0/17	-	-		0.008 - 0.021
o-Cresol	mg/kg	0/17	-	0.46 - 0.5		0.46 - 0.5
p-Dimethylaminoazobenzene	mg/kg	0/17	-	-		0.02 - 0.053
Pentachlorobenzene	mg/kg	0/17	-	-		0.009 - 0.024
Pentachloronitrobenzene	mg/kg	0/17	-	-		0.013 - 0.034
Pentachlorophenol	mg/kg	1/34	0.069 - 0.069	0.46 - 0.5	6.90E-02	0.009 - 0.5
Phenacetin	mg/kg	0/17	-	-		0.014 - 0.037
Phenanthrene	mg/kg	6/34	0.015 - 5.1	0.46 - 0.5	8.93E-01	0.008 - 0.5
Phenol	mg/kg	0/34	-	0.46 - 0.5		0.009 - 0.5
Pronamide	mg/kg	0/17	-	-		0.012 - 0.032
Pyrene	mg/kg	9/34	0.033 - 9	0.46 - 0.5	1.09E+00	0.016 - 0.5
Pyridine	mg/kg	0/34	-	0.46 - 0.5		0.053 - 0.5
Total PAH	mg/kg	7/34	0.026024 - 6.3712	-	1.01E+00	0 - 0
1,1,1,2-Tetrachloroethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
1,1,1-Trichloroethane	mg/kg	1/25	0.0677 - 0.0677	0.00496 - 0.00504	6.77E-02	0.00022 - 0.00504
1,1,2,2-Tetrachloroethane	mg/kg	0/25	-	0.00496 - 0.00504		0.00013 - 0.00504
1,1,2-Trichloro-1,2,2-trifluoroethane	mg/kg	0/8	-	-		0.00087 - 0.00087

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
1,1,2-Trichloroethane	mg/kg	1/25	0.149 - 0.149	0.00496 - 0.00504	1.49E-01	0.00013 - 0.00504
1,1-Dichloroethane	mg/kg	1/25	0.378 - 0.378	0.00496 - 0.00504	3.78E-01	0.00038 - 0.00504
1,1-Dichloroethene	mg/kg	1/25	1.11 - 1.11	0.00496 - 0.00504	1.11E+00	0.00078 - 0.00504
1,2,3-Trichloropropane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dibromoethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
1,2-Dichloroethane	mg/kg	1/25	0.0163 - 0.0163	0.00496 - 0.00504	1.63E-02	0.00027 - 0.00504
1,2-Dichloropropane	mg/kg	0/25	-	0.00496 - 0.00504		0.000451 - 0.00504
1,2-Dimethylbenzene	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
2-Butanone	mg/kg	0/25	-	0.00496 - 0.00504		0.0018 - 0.00504
2-Chloroethylvinyl ether	mg/kg	0/17	-	0.00496 - 0.0101		0.00496 - 0.0101
2-Hexanone	mg/kg	0/25	-	0.00496 - 0.00504		0.00039 - 0.00504
4-Methyl-2-pentanone	mg/kg	0/25	-	0.00496 - 0.00504		0.00057 - 0.00504
Acetone	mg/kg	9/25	0.0063 - 0.0837	0.00496 - 0.00504	1.86E-02	0.0041 - 0.022
Acrolein	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Acrylonitrile	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Benzene	mg/kg	0/25	-	0.00496 - 0.00504		0.00039 - 0.00504
Bromodichloromethane	mg/kg	0/25	-	0.00496 - 0.00504		0.00027 - 0.00504

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Bromoform	mg/kg	0/25	-	0.00496 - 0.00504		0.0002 - 0.00504
Bromomethane	mg/kg	0/25	-	0.00496 - 0.00504		0.00067 - 0.00504
Carbon disulfide	mg/kg	0/25	-	0.00496 - 0.00504		0.00068 - 0.00504
Carbon tetrachloride	mg/kg	0/25	-	0.00496 - 0.00504		0.00061 - 0.00504
Chlorobenzene	mg/kg	0/25	-	0.00496 - 0.00504		0.00036 - 0.00504
Chloroethane	mg/kg	0/25	-	0.00496 - 0.00504		0.00087 - 0.00504
Chloroform	mg/kg	0/25	-	0.00496 - 0.00504		0.00032 - 0.00504
Chloromethane	mg/kg	0/25	-	0.00496 - 0.00504		0.0013 - 0.00504
cis-1,2-Dichloroethene	mg/kg	4/25	0.00897 - 0.0325	0.00496 - 0.00504	1.68E-02	0.00045 - 0.00504
cis-1,3-Dichloropropene	mg/kg	0/25	-	0.00496 - 0.00504		0.00023 - 0.00504
Dibromochloromethane	mg/kg	0/25	-	0.00496 - 0.00504		0.00024 - 0.00504
Dibromomethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Dichlorodifluoromethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Ethyl methacrylate	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Ethylbenzene	mg/kg	0/25	-	0.00496 - 0.00504		0.00061 - 0.00504
Iodomethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
m,p-Xylene	mg/kg	0/17	-	0.00991 - 0.0101		0.00991 - 0.0101

Table F1.6. Summary of Soil Data from SWMU 7 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Methylene chloride	mg/kg	1/25	0.0057 - 0.0057	0.00496 - 0.00504	5.70E-03	0.00041 - 0.0059
Styrene	mg/kg	0/25	-	0.00496 - 0.00504		0.00026 - 0.00504
Tetrachloroethene	mg/kg	0/25	-	0.00496 - 0.00504		0.00054 - 0.00504
Toluene	mg/kg	1/25	0.0926 - 0.0926	0.00496 - 0.00504	9.26E-02	0.00075 - 0.00504
Total Xylene	mg/kg	0/8	-	-		0.0011 - 0.0011
trans-1,2-Dichloroethene	mg/kg	0/25	-	0.00496 - 0.00504		0.00055 - 0.00504
trans-1,3-Dichloropropene	mg/kg	0/25	-	0.00496 - 0.00504		0.00016 - 0.00504
Trans-1,4-Dichloro-2-butene	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Trichloroethene	mg/kg	2/25	0.00687 - 0.0108	0.00496 - 0.00504	8.84E-03	0.00056 - 0.00504
Trichlorofluoromethane	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl acetate	mg/kg	0/17	-	0.00496 - 0.00504		0.00496 - 0.00504
Vinyl chloride	mg/kg	2/25	0.00546 - 0.0075	0.00496 - 0.00504	6.48E-03	0.00072 - 0.00504

Table F1.7. Summary of Soil Data from SWMU 30

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Chloride	mg/kg	9/9	1.8 - 4.7	-	2.66E+00	-
Cyanide	mg/kg	1/3	0.14 - 0.14	-	1.40E-01	0.14 - 0.2
Fluoride	mg/kg	9/9	3.1 - 26	-	1.12E+01	-
Nitrate/Nitrite	mg/kg	5/5	1.4 - 6.3	-	3.90E+00	-
Sulfate	mg/kg	9/9	6.3 - 150	-	3.94E+01	-
Total Organic Carbon (TOC)	mg/kg	10/10	1800 - 34000	-	1.12E+04	-
Aluminum	mg/kg	16/16	7430 - 19000	17.7 - 19.3	1.13E+04	-
Antimony	mg/kg	8/18	0.48 - 3	9.36 - 9.76	1.15E+00	7 - 25
Arsenic	mg/kg	11/18	1.69 - 8.9	0.885 - 0.965	4.86E+00	0.905 - 12
Barium	mg/kg	18/18	51.3 - 170	2.21 - 2.41	9.68E+01	-
Beryllium	mg/kg	8/16	0.44 - 0.85	0.442 - 0.483	6.36E-01	0.442 - 1.4
Cadmium	mg/kg	6/18	0.048 - 2.8	1.77 - 1.93	9.82E-01	0.13 - 10
Calcium	mg/kg	16/16	674 - 24000	88.5 - 96.5	6.39E+03	-
Chromium	mg/kg	18/18	10.7 - 49	2.21 - 2.41	2.67E+01	-
Cobalt	mg/kg	15/16	2.27 - 14	2.21 - 2.41	6.92E+00	2.26 - 2.26
Copper	mg/kg	16/16	6.27 - 170	2.21 - 2.41	3.64E+01	-
Iron	mg/kg	16/16	5940 - 29000	17.7 - 19.3	1.67E+04	-
Lead	mg/kg	16/18	3.15 - 71	0.885 - 0.965	2.23E+01	25 - 25
Magnesium	mg/kg	16/16	990 - 2200	4.42 - 4.83	1.42E+03	-
Manganese	mg/kg	16/16	66 - 1200	2.21 - 2.41	3.67E+02	-
Mercury	mg/kg	10/18	0.02 - 0.17	0.018 - 0.02	9.84E-02	0.019 - 0.2
Molybdenum	mg/kg	0/16	-	2.21 - 2.41		0.41 - 14
Nickel	mg/kg	18/18	9.35 - 570	4.42 - 4.83	7.13E+01	-
Potassium	mg/kg	0/12	-	-		420 - 1500
Selenium	mg/kg	7/18	0.43 - 1	0.885 - 0.965	6.47E-01	0.39 - 1
Silver	mg/kg	0/18	-	2.21 - 2.41		0.16 - 5
Sodium	mg/kg	5/16	85 - 178	88.5 - 96.5	1.53E+02	57 - 180

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Thallium	mg/kg	5/18	0.62 - 1.8	1.77 - 1.93	1.24E+00	1.2 - 60
Tin	mg/kg	9/12	1.9 - 9.3	-	5.29E+00	11 - 19
Uranium	mg/kg	7/16	1.07 - 1400	0.885 - 0.965	4.23E+02	0.905 - 23
Vanadium	mg/kg	15/16	3.69 - 40	2.21 - 2.41	2.29E+01	2.27 - 2.27
Zinc	mg/kg	15/16	25.1 - 750	17.7 - 19.3	1.35E+02	18.1 - 18.1
4,4'-DDD	mg/kg	0/13	-	-		0.014 - 0.018
4,4'-DDE	mg/kg	0/13	-	-		0.012 - 0.015
4,4'-DDT	mg/kg	0/13	-	-		0.008 - 0.01
Aldrin	mg/kg	0/13	-	-		0.01 - 0.013
alpha-BHC	mg/kg	0/13	-	-		0.008 - 0.01
beta-BHC	mg/kg	0/13	-	-		0.016 - 0.021
delta-BHC	mg/kg	0/13	-	-		0.018 - 0.023
Dieldrin	mg/kg	0/13	-	-		0.017 - 0.022
Heptachlor	mg/kg	0/13	-	-		0.007 - 0.009
Lindane	mg/kg	0/13	-	-		0.008 - 0.01
Methoxychlor	mg/kg	0/13	-	-		0.004 - 0.0051
PCB, Total	mg/kg	15/19	0.02 - 15	0.09 - 0.1	1.50E+00	0.09 - 0.1
PCB-1016	mg/kg	0/17	-	0.09 - 0.1		0.00092 - 0.1
PCB-1221	mg/kg	0/17	-	0.09 - 0.1		0.009 - 0.1
PCB-1232	mg/kg	0/17	-	0.09 - 0.1		0.0037 - 0.1
PCB-1242	mg/kg	0/17	-	0.09 - 0.1		0.0024 - 0.1
PCB-1248	mg/kg	0/17	-	0.09 - 0.1		0.00074 - 0.1
PCB-1254	mg/kg	3/19	0.028 - 0.2	0.09 - 0.1	1.43E-01	0.00071 - 0.1
PCB-1260	mg/kg	12/17	0.02 - 15	0.09 - 0.1	1.83E+00	0.00084 - 0.1
PCB-1268	mg/kg	0/4	-	0.09 - 0.1		0.09 - 0.1
Alpha activity	pCi/g	27/32	2.93 - 570	0.942 - 2.45	8.71E+01	21 - 190
Americium-241	pCi/g	0/4	-	0.0295 - 0.0301		-0.0025 - 0.00263
Beta activity	pCi/g	27/32	1.68 - 1200	1.08 - 1.72	1.28E+02	34 - 460
Cesium-137	pCi/g	0/4	-	0.041 - 0.0582		-0.0224 - 0.0327

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Cobalt-60	pCi/g	0/4	-	0.0456 - 0.0493		-0.0134 - 0.00261
Neptunium-237	pCi/g	10/17	0.05 - 1.68	0.0407 - 0.043	3.95E-01	-0.00666 - 0.04
Plutonium-238	pCi/g	0/4	-	0.0166 - 0.019		-0.00429 - 0.000995
Plutonium-239	pCi/G	11/13	0.05 - 0.62	-	1.68E-01	0 - 0.05
Plutonium-239/240	pCi/g	0/4	-	0.0163 - 0.0187		0.000266 - 0.00469
Technetium-99	pCi/g	13/17	0.101 - 360	1.71 - 1.92	3.77E+01	-1.22 - 0.456
Thorium-228	pCi/g	4/4	0.334 - 0.465	0.0952 - 0.0997	4.11E-01	-
Thorium-230	pCi/g	17/17	0.311 - 4.88	0.114 - 0.235	1.44E+00	-
Thorium-232	pCi/g	4/4	0.299 - 0.445	0.0558 - 0.172	3.86E-01	-
Thorium-234	pCi/g	2/4	2.22 - 2.88	0.649 - 0.922	2.55E+00	1.22 - 1.37
Uranium	pCi/g	6/8	0.35 - 59	0.292 - 0.297	1.79E+01	0.161 - 0.23
Uranium-234	pCi/g	17/19	0.15 - 115	0.131 - 0.131	3.01E+01	0.0707 - 0.102
Uranium-235	pCi/g	0/4	-	0.0371 - 0.0386		0.00306 - 0.0322
Uranium-235/236	pCi/G	13/13	0.02 - 16.6	-	4.03E+00	-
Uranium-238	pCi/g	17/19	0.181 - 565	0.124 - 0.128	7.36E+01	0.0868 - 0.118
1,2,4,5-Tetrachlorobenzene	mg/kg	0/13	-	-		0.008 - 0.01
1,2,4-Trichlorobenzene	mg/kg	1/17	0.033 - 0.033	0.47 - 0.49	3.30E-02	0.01 - 0.49
1,2-Dichlorobenzene	mg/kg	0/22	-	0.47 - 0.49		0.0002 - 0.49
1,2-Diphenylhydrazine	mg/kg	0/13	-	-		0.007 - 0.009
1,3-Dichlorobenzene	mg/kg	0/22	-	0.47 - 0.49		0.000214 - 0.49
1,4-Dichlorobenzene	mg/kg	1/22	0.025 - 0.025	0.47 - 0.49	2.50E-02	0.00022 - 0.49
1-Chloronaphtalene	mg/kg	0/13	-	-		0.01 - 0.013
1-Naphthalenamine	mg/kg	0/13	-	-		0.038 - 0.049
2,3,4,6-Tetrachlorophenol	mg/kg	0/13	-	-		0.012 - 0.015
2,4,5-Trichlorophenol	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
2,4,6-Trichlorophenol	mg/kg	0/17	-	0.47 - 0.49		0.01 - 0.49
2,4-Dichlorophenol	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
2,4-Dimethylphenol	mg/kg	0/17	-	0.47 - 0.49		0.023 - 0.49
2,4-Dinitrophenol	mg/kg	0/17	-	0.47 - 0.49		0.049 - 0.49
2,4-Dinitrotoluene	mg/kg	0/17	-	0.47 - 0.49		0.015 - 0.49
2,6-Dichlorophenol	mg/kg	0/13	-	-		0.01 - 0.013
2,6-Dinitrotoluene	mg/kg	0/17	-	0.47 - 0.49		0.008 - 0.49
2-Chloronaphthalene	mg/kg	0/17	-	0.47 - 0.49		0.004 - 0.49
2-Chlorophenol	mg/kg	1/17	0.023 - 0.023	0.47 - 0.49	2.30E-02	0.011 - 0.49
2-Methyl-4,6-dinitrophenol	mg/kg	0/17	-	0.47 - 0.49		0.052 - 0.49
2-Methylnaphthalene	mg/kg	2/17	0.011 - 0.27	0.47 - 0.49	1.41E-01	0.009 - 0.49
2-Methylphenol	mg/kg	0/13	-	-		0.008 - 0.01
2-Methylpyridine	mg/kg	0/13	-	-		0.067 - 0.086
2-Naphthalenamine	mg/kg	0/13	-	-		0.066 - 0.085
2-Nitroaniline	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
2-Nitrobenzenamine	mg/kg	0/13	-	-		0.01 - 0.013
2-Nitrophenol	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
3,3'-Dichlorobenzidine	mg/kg	0/13	-	-		0.036 - 0.046
3,3-Dichlorobenzidine	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
3-Methylcholanthrene	mg/kg	1/13	0.22 - 0.22	-	2.20E-01	0.02 - 0.026
3-Nitroaniline	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
3-Nitrobenzenamine	mg/kg	0/13	-	-		0.025 - 0.032
4-Aminobiphenyl	mg/kg	0/13	-	-		0.057 - 0.073
4-Bromophenyl phenyl ether	mg/kg	0/17	-	0.47 - 0.49		0.008 - 0.49
4-Chloro-3-methylphenol	mg/kg	0/17	-	0.47 - 0.49		0.01 - 0.49
4-Chloroaniline	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
4-Chlorobenzenamine	mg/kg	0/13	-	-		0.047 - 0.06
4-Chlorophenyl phenyl ether	mg/kg	0/13	-	-		0.007 - 0.009
4-Chlorophenylphenyl ether	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
4-Methylphenol	mg/kg	0/13	-	-		0.008 - 0.01
4-Nitroaniline	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
4-Nitrobenzenamine	mg/kg	0/13	-	-		0.066 - 0.085
4-Nitrophenol	mg/kg	0/17	-	0.47 - 0.49		0.022 - 0.49
7,12-Dimethylbenz(a)anthracene	mg/kg	0/13	-	-		0.085 - 0.11
a,a-Dimethylphenethylamine	mg/kg	0/13	-	-		0.013 - 0.017
Acenaphthene	mg/kg	5/17	0.01 - 1.7	0.47 - 0.49	3.56E-01	0.008 - 0.49
Acenaphthylene	mg/kg	3/17	0.03 - 0.091	0.47 - 0.49	5.37E-02	0.008 - 0.49
Acetophenone	mg/kg	1/13	0.013 - 0.013	-	1.30E-02	0.008 - 0.01
Aniline	mg/kg	0/13	-	-		0.051 - 0.066
Anthracene	mg/kg	5/17	0.035 - 3.2	0.47 - 0.49	6.79E-01	0.009 - 0.49
Benz(a)anthracene	mg/kg	10/17	0.017 - 9.1	0.47 - 0.49	1.25E+00	0.008 - 0.49
Benzenemethanol	mg/kg	0/13	-	-		0.01 - 0.013
Benzidine	mg/kg	0/13	-	-		0.327 - 0.42
Benzo(a)pyrene	mg/kg	7/17	0.049 - 8.4	0.47 - 0.49	1.71E+00	0.009 - 0.49
Benzo(b)fluoranthene	mg/kg	8/17	0.041 - 9.6	0.47 - 0.49	1.99E+00	0.01 - 0.49
Benzo(ghi)perylene	mg/kg	6/17	0.05 - 5.2	0.47 - 0.49	1.22E+00	0.019 - 0.49
Benzo(k)fluoranthene	mg/kg	7/17	0.026 - 4.3	0.47 - 0.49	9.07E-01	0.01 - 0.49
Benzoic acid	mg/kg	2/17	0.028 - 0.043	0.47 - 0.49	3.55E-02	0.025 - 0.49
Benzyl Alcohol	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
Bis(2-chloroethoxy)methane	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
Bis(2-chloroethyl) ether	mg/kg	0/17	-	0.47 - 0.49		0.011 - 0.49
Bis(2-chloroisopropyl) ether	mg/kg	0/17	-	0.47 - 0.49		0.056 - 0.49
Bis(2-ethylhexyl)phthalate	mg/kg	2/17	0.39 - 0.62	0.47 - 0.49	5.05E-01	0.113 - 0.49
Butyl benzyl phthalate	mg/kg	0/17	-	0.47 - 0.49		0.128 - 0.49
Chrysene	mg/kg	10/17	0.012 - 9.9	0.47 - 0.49	1.30E+00	0.01 - 0.49
Dibenz(a,h)anthracene	mg/kg	5/17	0.085 - 1.6	0.47 - 0.49	4.38E-01	0.012 - 0.49
Dibenzofuran	mg/kg	3/17	0.0097 - 0.83	0.47 - 0.49	2.87E-01	0.004 - 0.49

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Diethyl phthalate	mg/kg	0/17	-	0.47 - 0.49		0.011 - 0.49
Dimethyl phthalate	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
Di-n-butyl phthalate	mg/kg	2/13	0.087 - 0.1	-	9.35E-02	0.059 - 0.076
Di-n-butylphthalate	mg/kg	0/4	-	0.47 - 0.49		0.48 - 0.86
Di-n-octylphthalate	mg/kg	0/17	-	0.47 - 0.49		0.011 - 0.49
Ethyl methanesulfonate	mg/kg	0/13	-	-		0.008 - 0.01
Fluoranthene	mg/kg	12/17	0.012 - 20	0.47 - 0.49	1.92E+00	0.013 - 0.49
Fluorene	mg/kg	3/17	0.013 - 1.3	0.47 - 0.49	4.52E-01	0.009 - 0.49
Hexachlorobenzene	mg/kg	0/17	-	0.47 - 0.49		0.007 - 0.49
Hexachlorobutadiene	mg/kg	0/17	-	0.47 - 0.49		0.008 - 0.49
Hexachlorocyclopentadiene	mg/kg	0/17	-	0.47 - 0.49		0.006 - 0.49
Hexachloroethane	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
Indeno(1,2,3-cd)pyrene	mg/kg	6/17	0.044 - 5.4	0.47 - 0.49	1.29E+00	0.013 - 0.49
Isophorone	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
m,p-cresol	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
Methyl methanesulfonate	mg/kg	0/13	-	-		0.068 - 0.087
Naphthalene	mg/kg	1/17	0.31 - 0.31	0.47 - 0.49	3.10E-01	0.01 - 0.49
Nitrobenzene	mg/kg	0/17	-	0.47 - 0.49		0.034 - 0.49
N-Nitrosodimethylamine	mg/kg	0/13	-	-		0.017 - 0.022
N-Nitroso-di-n-propylamine	mg/kg	0/17	-	0.47 - 0.49		0.012 - 0.49
N-Nitrosodiphenylamine	mg/kg	0/17	-	0.47 - 0.49		0.004 - 0.49
N-Nitrosopiperidine	mg/kg	0/13	-	-		0.008 - 0.01
o-Cresol	mg/kg	0/4	-	0.47 - 0.49		0.47 - 0.49
p-Dimethylaminoazobenzene	mg/kg	0/13	-	-		0.02 - 0.026
Pentachlorobenzene	mg/kg	0/13	-	-		0.009 - 0.012
Pentachloronitrobenzene	mg/kg	0/13	-	-		0.013 - 0.017
Pentachlorophenol	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Phenacetin	mg/kg	0/13	-	-		0.014 - 0.018
Phenanthrene	mg/kg	9/17	0.012 - 17	0.47 - 0.49	1.99E+00	0.008 - 0.49
Phenol	mg/kg	0/17	-	0.47 - 0.49		0.009 - 0.49
Pronamide	mg/kg	0/13	-	-		0.012 - 0.015
Pyrene	mg/kg	11/17	0.018 - 23	0.47 - 0.49	2.59E+00	0.016 - 0.49
Pyridine	mg/kg	0/17	-	0.47 - 0.49		0.053 - 0.49
Total PAH	mg/kg	10/17	0.001712 - 12.4629	-	1.79E+00	0 - 0
1,1,1,2-Tetrachloroethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
1,1,1-Trichloroethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00022 - 0.00505
1,1,2,2-Tetrachloroethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00013 - 0.00505
1,1,2-Trichloro-1,2,2-trifluoroethane	mg/kg	0/5	-	-		0.00087 - 0.00087
1,1,2-Trichloroethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00013 - 0.00505
1,1-Dichloroethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00038 - 0.00505
1,1-Dichloroethene	mg/kg	0/11	-	0.00498 - 0.00505		0.00078 - 1.1
1,2,3-Trichloropropane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
1,2-Dibromoethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
1,2-Dichloroethane	mg/kg	0/11	-	0.00498 - 0.00505		0.00027 - 1.1
1,2-Dichloropropane	mg/kg	0/9	-	0.00498 - 0.00505		0.000451 - 0.00505
1,2-Dimethylbenzene	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
2-Butanone	mg/kg	0/11	-	0.00498 -		0.0018 - 1.1

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				0.00505		
2-Chloroethylvinyl ether	mg/kg	0/4	-	0.00996 - 0.0101		0.00996 - 0.0101
2-Hexanone	mg/kg	0/9	-	0.00498 - 0.00505		0.00039 - 0.00505
4-Methyl-2-pentanone	mg/kg	0/9	-	0.00498 - 0.00505		0.00057 - 0.00505
Acetone	mg/kg	3/9	0.00641 - 0.00973	0.00498 - 0.00505	7.55E-03	0.0041 - 0.018
Acrolein	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Acrylonitrile	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Benzene	mg/kg	0/11	-	0.00498 - 0.00505		0.00039 - 1.1
Bromodichloromethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00027 - 0.00505
Bromoform	mg/kg	0/9	-	0.00498 - 0.00505		0.0002 - 0.00505
Bromomethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00067 - 0.00505
Carbon disulfide	mg/kg	0/9	-	0.00498 - 0.00505		0.00068 - 0.00505
Carbon tetrachloride	mg/kg	0/11	-	0.00498 - 0.00505		0.00061 - 1.1
Chlorobenzene	mg/kg	0/11	-	0.00498 - 0.00505		0.00036 - 1.1
Chloroethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00087 - 0.00505
Chloroform	mg/kg	0/11	-	0.00498 - 0.00505		0.00032 - 1.1
Chloromethane	mg/kg	0/9	-	0.00498 - 0.00505		0.0013 - 0.00505

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
cis-1,2-Dichloroethene	mg/kg	0/9	-	0.00498 - 0.00505		0.00045 - 0.00505
cis-1,3-Dichloropropene	mg/kg	0/9	-	0.00498 - 0.00505		0.00023 - 0.00505
Dibromochloromethane	mg/kg	0/9	-	0.00498 - 0.00505		0.00024 - 0.00505
Dibromomethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Dichlorodifluoromethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Ethyl methacrylate	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Ethylbenzene	mg/kg	0/9	-	0.00498 - 0.00505		0.00061 - 0.00505
Iodomethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
m,p-Xylene	mg/kg	0/4	-	0.00996 - 0.0101		0.00996 - 0.0101
Methylene chloride	mg/kg	1/9	0.0018 - 0.0018	0.00498 - 0.00505	1.80E-03	0.0019 - 0.007
Styrene	mg/kg	0/9	-	0.00498 - 0.00505		0.00026 - 0.00505
Tetrachloroethene	mg/kg	0/11	-	0.00498 - 0.00505		0.00054 - 1.1
Toluene	mg/kg	2/9	0.0011 - 0.0011	0.00498 - 0.00505	1.10E-03	0.00075 - 0.00505
Total Xylene	mg/kg	0/5	-	-		0.0011 - 0.0011
trans-1,2-Dichloroethene	mg/kg	0/9	-	0.00498 - 0.00505		0.00055 - 0.00505
trans-1,3-Dichloropropene	mg/kg	0/9	-	0.00498 - 0.00505		0.00016 - 0.00505
Trans-1,4-Dichloro-2-butene	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505

Table F1.7. Summary of Soil Data from SWMU 30 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Trichloroethene	mg/kg	0/11	-	0.00498 - 0.00505		0.00056 - 1.1
Trichlorofluoromethane	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Vinyl acetate	mg/kg	0/4	-	0.00498 - 0.00505		0.00498 - 0.00505
Vinyl chloride	mg/kg	0/11	-	0.00498 - 0.00505		0.00072 - 1.1

Table F1.8. Summary of Soil Data from SWMU 145

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Aluminum	mg/kg	58/58	4880 - 13400	17.2 - 27.7	9.33E+03	-
Antimony	mg/kg	8/58	0.2 - 18.1	4.8 - 20	8.26E+00	4.8 - 20
Arsenic	mg/kg	58/67	3.1 - 14.7	0.859 - 5	6.38E+00	0.859 - 5
Barium	mg/kg	67/67	43.7 - 300	1 - 27.7	9.32E+01	-
Beryllium	mg/kg	53/68	0.39 - 1.86	0.429 - 0.69	8.03E-01	0.429 - 0.512
Boron	mg/kg	0/46	-	1.4 - 200		1.4 - 200
Cadmium	mg/kg	14/67	0.28 - 0.64	0.35 - 2	3.84E-01	0.35 - 2
Calcium	mg/kg	58/58	420 - 83000	85.9 - 5000	8.82E+03	-
Chromium	mg/kg	68/68	7.59 - 120	1 - 2.5	1.97E+01	-
Cobalt	mg/kg	53/58	2.18 - 14.7	2.15 - 6.9	6.88E+00	2.32 - 2.5
Copper	mg/kg	58/58	4.22 - 135	2.15 - 12.1	1.89E+01	-
Iron	mg/kg	58/58	3380 - 31400	10 - 20	1.51E+04	-
Lead	mg/kg	58/67	4.82 - 46.7	0.3 - 20	1.65E+01	20 - 20
Lithium	mg/kg	4/4	6.44 - 8.75	5 - 5	7.74E+00	-
Magnesium	mg/kg	58/58	523 - 2350	2.5 - 693	1.25E+03	-
Manganese	mg/kg	58/58	59 - 1900	1.5 - 10	4.00E+02	-
Mercury	mg/kg	42/68	0.017 - 0.47	0.016 - 0.2	6.56E-02	0.016 - 0.2
Molybdenum	mg/kg	41/54	0.23 - 3.39	0.15 - 5.5	5.38E-01	0.15 - 5
Nickel	mg/kg	58/58	4.85 - 101	4 - 5.5	1.67E+01	-
Potassium	mg/kg	44/46	224 - 807	200 - 693	5.39E+02	535 - 597
Selenium	mg/kg	2/67	0.86 - 1.1	0.3 - 1	9.80E-01	0.3 - 1
Silicon	mg/kg	44/44	212 - 845	50 - 69.3	6.15E+02	-
Silver	mg/kg	3/67	0.96 - 19.6	0.92 - 4	9.74E+00	0.92 - 4
Sodium	mg/kg	36/54	53.6 - 228	85.9 - 693	9.03E+01	85.9 - 693
Thallium	mg/kg	26/58	0.49 - 1.6	0.46 - 20	9.35E-01	0.46 - 20
Tin	mg/kg	0/4	-	100 - 100		100 - 100
Uranium	mg/kg	15/22	0.976 - 311	0.026 - 100	6.39E+01	0.859 - 100
Vanadium	mg/kg	54/58	5.22 - 65.2	2.15 - 6.9	2.94E+01	2.32 - 2.44
Zinc	mg/kg	59/62	16.8 - 138	2 - 20	4.55E+01	17.2 - 19
PCB, Total	mg/kg	7/94	0.33 - 12.5	0.07 - 1	2.76E+00	0.035 - 1
PCB-1016	mg/kg	0/71	-	0.035 - 1		0.035 - 1
PCB-1221	mg/kg	0/73	-	0.035 - 1		0.035 - 1
PCB-1232	mg/kg	0/73	-	0.035 - 1		0.035 - 1
PCB-1242	mg/kg	0/73	-	0.035 - 1		0.035 - 1

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
PCB-1248	mg/kg	0/73	-	0.035 - 1		0.035 - 1
PCB-1254	mg/kg	4/73	0.33 - 1.9	0.035 - 1	9.33E-01	0.035 - 1
PCB-1260	mg/kg	3/73	0.5 - 12.5	0.035 - 1	4.50E+00	0.035 - 1
PCB-1262	mg/kg	0/44	-	0.035 - 0.051		0.035 - 0.051
PCB-1268	mg/kg	0/71	-	0.035 - 1		0.035 - 1
Actinium-228	pCi/g	8/10	0.4131 - 1.934	0.071 - 0.2238	7.31E-01	0.032 - 0.3326
Alpha activity	pCi/g	27/27	2.3 - 62.23	0.441 - 7.91	1.27E+01	-
Americium-241	pCi/g	12/37	0.103 - 0.883	0.01 - 1.55	2.26E-01	-0.066 - 0.67
Americium-243	pCi/g	0/8	-	0.042 - 0.22		0.01 - 0.2462
Antimony-124	pCi/g	0/11	-	0.017 - 0.04243		-0.01012 - 0.007853
Antimony-125	pCi/g	0/11	-	0.053 - 0.1226		-0.01022 - 0.04219
Barium-133	pCi/g	0/11	-	0.024 - 0.056		-0.01161 - 0.01844
Barium-140	pCi/g	0/11	-	0.074 - 0.2621		-0.07749 - 0.03767
Beryllium-7	pCi/g	0/10	-	0.16 - 0.39		-0.1065 - 0.085
Beta activity	pCi/g	26/27	2.29 - 122.73	0.482 - 6.3	1.76E+01	5.88 - 5.88
Bismuth-211	pCi/g	0/7	-	0.3 - 0.702		0.28 - 7.585
Bismuth-212	pCi/g	9/11	0.16 - 1.655	0.11 - 0.39	5.35E-01	0.078 - 0.2567
Bismuth-214	pCi/g	10/10	0.39 - 2.712	0.031 - 0.07959	7.92E-01	-
Cerium-139	pCi/g	0/10	-	0.018 - 0.03556		-0.011 - 0.01061
Cerium-141	pCi/g	0/10	-	0.037 - 0.06604		-0.02711 - 0.08307
Cerium-144	pCi/g	0/11	-	0.14 - 0.55		-0.1129 - 0.26
Cesium-134	pCi/g	0/15	-	0.016 - 0.03986		-0.012 - 0.01367
Cesium-136	pCi/g	0/11	-	0.028 - 0.08981		-0.02168 - 0.01728
Cesium-137	pCi/g	12/24	0.045 - 1.04	0.02 - 0.543	2.96E-01	-0.0499 - 0.486
Chromium-51	pCi/g	0/11	-	0.16 -		-0.11 - 0.0356

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				0.39		
Cobalt-56	pCi/g	0/11	-	0.019 - 0.045		-0.0204 - 0.01
Cobalt-57	pCi/g	0/10	-	0.018 - 0.03087		-0.002411 - 0.01363
Cobalt-58	pCi/g	0/11	-	0.014 - 0.043		-0.03373 - 0.01235
Cobalt-60	pCi/g	0/24	-	0.014 - 0.366		-0.292 - 0.0402
Europium-152	pCi/g	0/11	-	0.051 - 0.12		-0.11 - 0.023
Europium-154	pCi/g	0/11	-	0.03868 - 0.15		-0.03907 - 0.067
Europium-155	pCi/g	0/10	-	0.081 - 0.1389		-0.0094 - 0.1545
Iridium-192	pCi/g	0/11	-	0.017 - 0.042		-0.017 - 0.005828
Iron-59	pCi/g	0/11	-	0.03 - 0.09528		-0.02556 - 0.02538
Lead-210	pCi/g	1/11	2.646 - 2.646	1.44 - 31	2.65E+00	-2.9 - 3.1
Lead-211	pCi/g	0/8	-	0.24 - 0.702		0.28 - 7.585
Lead-212	pCi/g	9/9	0.226 - 1.753	0.037 - 0.06753	5.47E-01	-
Lead-214	pCi/g	9/10	0.34 - 2.664	0.037 - 0.08593	8.08E-01	0.5536 - 0.5536
Manganese-54	pCi/g	0/11	-	0.018 - 0.04928		-0.01925 - 0.03733
Mercury-203	pCi/g	0/11	-	0.019 - 0.047		-0.01727 - 0.03046
Neodymium-147	pCi/g	0/7	-	0.1274 - 0.5728		0.2034 - 4.2
Neptunium-237	pCi/g	6/34	0.024 - 1.22	0.0087 - 0.734	3.04E-01	-0.008 - 0.069
Neptunium-237/Protactinium-233	pCi/g	10/13	0.083 - 0.362	0.06067 - 0.16	1.99E-01	-0.01056 - 0.127
Neptunium-239	pCi/g	0/11	-	0.19 - 4.49		-2.551 - 1.2
Niobium-94	pCi/g	0/11	-	0.014 - 0.04294		-0.01096 - 0.00606
Niobium-95	pCi/g	0/8	-	0.022 - 0.1052		-0.01573 - 0.357
Plutonium-238	pCi/g	0/41	-	0.01 - 10.28		-0.0865 - 0.7683
Plutonium-239/240	pCi/g	20/41	0.137 - 10.1	0.0044 - 7.34	9.64E-01	-1.535 - 0.0462
Potassium-40	pCi/g	11/12	1.1 - 12.17	0.14 -	6.66E+00	3.82 - 3.82

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				3.93		
Promethium-144	pCi/g	0/10	-	0.016 - 0.043		-0.01411 - 0.02012
Promethium-146	pCi/g	0/11	-	0.025 - 0.06		-0.008283 - 0.02504
Protactinium-231	pCi/g	6/9	0.32 - 0.9513	0.18 - 0.627	5.80E-01	0.13 - 2.645
Protactinium-233	pCi/g	0/11	-	0.042 - 0.1		0.006001 - 0.078
Protactinium-234m	pCi/g	8/11	1.1 - 260	0.34 - 4.239	5.05E+01	0.8373 - 4.747
Radium-223	pCi/g	0/9	-	0.11 - 0.271		-0.12 - 0.7861
Radium-226	pCi/g	1/8	0.16 - 0.16	0.073 - 0.326	1.60E-01	0.14 - 2.426
Radium-228	pCi/g	2/8	0.21 - 0.3315	0.057 - 0.4318	2.71E-01	0.032 - 2.419
Radon-219	pCi/g	0/9	-	0.14 - 0.3442		0.056 - 1.015
Ruthenium-106	pCi/g	0/11	-	0.15 - 0.43		-0.1056 - 0.13
Silver-110m	pCi/g	0/11	-	0.018 - 0.045		-0.02096 - 0.012
Sodium-22	pCi/g	0/11	-	0.014 - 0.05128		-0.01429 - 0.003
Strontium-90	pCi/g	2/10	1.4 - 4	0.03 - 4	2.70E+00	-1.5 - 7.1
Technetium-99	pCi/g	22/37	0.31 - 153	0.14 - 5.05	2.75E+01	-0.84 - 1.48
Thallium-208	pCi/g	5/11	0.1 - 0.346	0.02 - 0.06984	1.96E-01	0.049 - 0.3422
Thorium-227	pCi/g	0/11	-	0.12 - 0.31		-0.04721 - 0.1
Thorium-228	pCi/g	24/32	0.17 - 1.92	0.032 - 0.1823	4.24E-01	0.0931 - 2.357
Thorium-229	pCi/g	0/11	-	0.075 - 0.26		-0.0098 - 0.1826
Thorium-230	pCi/g	23/23	0.237 - 193	0.125 - 0.196	1.17E+01	-
Thorium-232	pCi/g	28/31	0.0651 - 2.16	0.021 - 0.136	4.09E-01	0.048 - 0.1788
Thorium-234	pCi/g	12/20	1.1 - 260	0.2947 - 5.66	3.50E+01	1.2 - 2.25
Tin-113	pCi/g	0/11	-	0.023 - 0.054		-0.021 - 0.008745
Uranium	pCi/g	9/20	5.4 - 593	0.28 - 8.29	9.39E+01	-0.00221 - 2.86
Uranium-233/234	pCi/g	4/4	0.6 - 4.7	0.024 - 0.072	1.69E+00	-
Uranium-234	pCi/g	33/44	0.128 - 254	0.0043 -	1.22E+01	0.00183 - 1.36

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				3.57		
Uranium-235	pCi/g	29/37	0.034 - 2.2	0.0054 - 0.4	2.29E-01	-0.00679 - 0.00312
Uranium-236	pCi/g	1/4	0.12 - 0.12	0.0095 - 0.027	1.20E-01	0 - 0.022
Uranium-238	pCi/g	39/48	0.123 - 326	0.0044 - 4.61	1.86E+01	0.00174 - 3.02
Yttrium-88	pCi/g	0/11	-	0.012 - 0.04267		-0.02174 - 0.014
Zinc-65	pCi/g	0/11	-	0.034 - 0.55		-0.054 - 0.002007
Zirconium-95	pCi/g	0/8	-	0.021 - 0.09409		-0.01464 - 0.3194
1,2,4,5-Tetrachlorobenzene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
1,2,4-Trichlorobenzene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
1,2-Dichlorobenzene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
1,3,5-Trinitrobenzene	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
1,3-Dichlorobenzene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
1,3-Dinitrobenzene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
1,4-Dichlorobenzene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
1,4-Naphthoquinone	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
1-Naphthalenamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
2,3,4,6-Tetrachlorophenol	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
2,4,5-Trichlorophenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2,4,6-Trichlorophenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2,4-Dichlorophenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2,4-Dimethylphenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2,4-Dinitrophenol	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
2,4-Dinitrotoluene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2,6-Dichlorophenol	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
2,6-Dinitrotoluene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2-Acetylaminofluorene	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
2-Chloronaphthalene	mg/kg	0/6	-	0.35 -		0.35 - 0.49

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
				0.49		
2-Chlorophenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2-Methyl-4,6-dinitrophenol	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
2-Methylnaphthalene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2-Methylphenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
2-Methylpyridine	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
2-Naphthalenamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
2-Nitrobenzenamine	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
2-Nitrophenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
3,3'-Dichlorobenzidine	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
3,3'-Dimethylbenzidine	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
3-Methylcholanthrene	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
3-Nitrobenzenamine	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
4-Aminobiphenyl	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
4-Bromophenyl phenyl ether	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
4-Chloro-3-methylphenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
4-Chlorobenzenamine	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
4-Chlorophenyl phenyl ether	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
4-Methylphenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
4-Nitrobenzenamine	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
4-Nitrophenol	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
4-Nitroquinoline-1-oxide	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
5-(2-Propenyl)-1,3-benzodioxole (Safrole)	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
5-Nitro-o-toluidine	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
7,12-Dimethylbenz(a)anthracene	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
a,a-Dimethylphenethylamine	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Acenaphthene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Acenaphthylene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Acetophenone	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Aniline	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Anthracene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Aramite	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Benz(a)anthracene	mg/kg	1/6	0.05 - 0.05	0.35 - 0.49	5.00E-02	0.35 - 0.49
Benzenemethanol	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Benzo(a)pyrene	mg/kg	1/6	0.044 - 0.044	0.35 - 0.49	4.40E-02	0.35 - 0.49
Benzo(b)fluoranthene	mg/kg	1/6	0.04 - 0.04	0.35 - 0.49	4.00E-02	0.35 - 0.49
Benzo(ghi)perylene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Benzo(k)fluoranthene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Benzoic acid	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Bis(2-chloroethoxy)methane	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Bis(2-chloroethyl) ether	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Bis(2-chloroisopropyl) ether	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Bis(2-ethylhexyl)phthalate	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Butyl benzyl phthalate	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Carbazole	mg/kg	0/4	-	0.48 - 0.49		0.48 - 0.49
Chlorobenzilate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Chrysene	mg/kg	1/6	0.067 - 0.067	0.35 - 0.49	6.70E-02	0.35 - 0.49
Diallate	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Dibenz(a,h)anthracene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Dibenzofuran	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Diethyl phthalate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Dimethoate	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Dimethyl phthalate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Di-n-butyl phthalate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Di-n-octylphthalate	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Dinoseb	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Disulfoton	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Ethyl methanesulfonate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Famphur	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
Fluoranthene	mg/kg	1/2	0.13 - 0.13	0.35 - 0.39	1.30E-01	0.35 - 0.35
Fluorene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Hexachloro-1-propene	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
Hexachlorobenzene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Hexachlorobutadiene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Hexachlorocyclopentadiene	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
Hexachloroethane	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Hexachlorophene	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
Indeno(1,2,3-cd)pyrene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Isodrin	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Isophorone	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Isosafrole	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Kepone	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
Methapyrilene	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Methyl methanesulfonate	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Methyl parathion	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Naphthalene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Nitrobenzene	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
N-Nitrosodiethylamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
N-Nitrosodimethylamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
N-Nitroso-di-n-butylamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
N-Nitroso-di-n-propylamine	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
N-Nitrosodiphenylamine	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
N-Nitrosomethylethylamine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
N-Nitrosomorpholine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
N-Nitrosopiperidine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
N-Nitrosopyrrolidine	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
O,O,O-Triethylphosphorothioate	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
o-Toluidine	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Parathion	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
p-Dimethylaminoazobenzene	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Pentachlorobenzene	mg/kg	0/2	-	0.35 - 0.39		0.35 - 0.39
Pentachloroethane	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Pentachloronitrobenzene	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Pentachlorophenol	mg/kg	0/6	-	0.48 - 1.9		0.48 - 1.9
Phenacetin	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Phenanthrene	mg/kg	1/6	0.11 - 0.11	0.35 - 0.49	1.10E-01	0.35 - 0.49
Phenol	mg/kg	0/6	-	0.35 - 0.49		0.35 - 0.49
Phorate	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
p-Phenylenediamine	mg/kg	0/2	-	3.5 - 3.9		3.5 - 3.9
Pronamide	mg/kg	0/2	-	0.71 - 0.79		0.71 - 0.79
Pyrene	mg/kg	1/6	0.084 - 0.084	0.35 - 0.49	8.40E-02	0.35 - 0.49
Pyridine	mg/kg	0/6	-	0.48 - 0.79		0.48 - 0.79
Sulfotepp	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9
Thionazin	mg/kg	0/2	-	1.7 - 1.9		1.7 - 1.9

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Total PAH	mg/kg	1/6	0.053067 - 0.053067	-	5.31E-02	0 - 0
1,1,1,2-Tetrachloroethane	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
1,1,1-Trichloroethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,1,2,2-Tetrachloroethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,1,2-Trichloroethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,1-Dichloroethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,1-Dichloroethene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,2,3-Trichloropropane	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
1,2-Dibromo-3-chloropropane	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005
1,2-Dibromoethane	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
1,2-Dichloroethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,2-Dichloropropane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
1,2-Dimethylbenzene	mg/kg	2/20	0.015 - 0.036	0.00498 - 0.01	2.55E-02	0.00498 - 0.01
1,4-Dioxane	mg/kg	0/2	-	0.5 - 0.5		0.5 - 0.5
2-Butanone	mg/kg	1/22	0.0283 - 0.0283	0.00498 - 0.02	2.83E-02	0.00498 - 0.02
2-Chloro-1,3-butadiene	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005
2-Chloroethylvinyl ether	mg/kg	0/8	-	0.00498 - 0.00505		0.00498 - 0.00505
2-Hexanone	mg/kg	0/22	-	0.00498 - 0.02		0.00498 - 0.02
4-Methyl-2-pentanone	mg/kg	1/22	0.015 - 0.015	0.00498 - 0.02	1.50E-02	0.00498 - 0.02
Acetone	mg/kg	9/22	0.00664 - 0.116	0.00498 - 0.02	3.24E-02	0.00498 - 0.02
Acetonitrile	mg/kg	0/2	-	0.02 - 0.02		0.02 - 0.02
Acrolein	mg/kg	0/10	-	0.00496 - 0.1		0.00496 - 0.1
Acrylonitrile	mg/kg	0/10	-	0.00498 - 0.1		0.00498 - 0.1

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Allyl chloride	mg/kg	0/2	-	0.01 - 0.01		0.01 - 0.01
Benzene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Bromodichloromethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Bromoform	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Bromomethane	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Carbon disulfide	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Carbon tetrachloride	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Chlorobenzene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Chloroethane	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01
Chloroform	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01
Chloromethane	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01
cis-1,2-Dichloroethene	mg/kg	0/16	-	0.00498 - 0.01		0.00498 - 0.01
cis-1,3-Dichloropropene	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01
Dibromochloromethane	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01
Dibromomethane	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
Dichlorodifluoromethane	mg/kg	0/10	-	0.00498 - 0.01		0.00498 - 0.01
Ethyl cyanide	mg/kg	0/2	-	0.02 - 0.02		0.02 - 0.02
Ethyl methacrylate	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
Ethylbenzene	mg/kg	3/22	0.011 - 0.018	0.00498 - 0.01	1.33E-02	0.00498 - 0.01
Iodomethane	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
Isobutanol	mg/kg	0/2	-	0.2 - 0.2		0.2 - 0.2
m,p-Xylene	mg/kg	2/20	0.022 - 0.04	0.00996 - 0.02	3.10E-02	0.00996 - 0.02
Methacrylonitrile	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005
Methyl methacrylate	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005

Table F1.8. Summary of Soil Data from SWMU 145 (Continued)

Chemical Name	Units	Frequency of Detection	Range of Detected Concentrations	Range of Detection Limits	Mean of Detected Concentrations	Range of Nondetected Concentrations
Methylene chloride	mg/kg	2/22	0.002 - 0.003	0.00498 - 0.01	2.50E-03	0.00498 - 0.01
Pentachloroethane	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005
Styrene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Tetrachloroethene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Toluene	mg/kg	5/22	0.012 - 0.037	0.00498 - 0.01	2.14E-02	0.00498 - 0.01
Total Xylene	mg/kg	0/2	-	0.005 - 0.005		0.005 - 0.005
trans-1,2-Dichloroethene	mg/kg	0/22	-	0.002 - 0.01		0.002 - 0.01
trans-1,3-Dichloropropene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Trans-1,4-Dichloro-2-butene	mg/kg	0/10	-	0.00498 - 0.00505		0.00498 - 0.00505
Trichloroethene	mg/kg	0/22	-	0.00498 - 0.01		0.00498 - 0.01
Trichlorofluoromethane	mg/kg	0/10	-	0.00498 - 0.01		0.00498 - 0.01
Vinyl acetate	mg/kg	0/10	-	0.00498 - 0.01		0.00498 - 0.01
Vinyl chloride	mg/kg	0/18	-	0.00498 - 0.01		0.00498 - 0.01

ATTACHMENT F2

HISTORICAL RISK ASSESSMENT TABLES

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Table F2.1. Cancer Risk Estimates for Direct Contact to Soil

Future Industrial Exposure
Scenario: unrestricted worker (250 days/year)

Chemical	Slope Factor (mg/kg-day)-1	Soil Conc. mg/kg	Chronic Daily Intake mg/kg-day	Excess Lifetime Cancer Risk
INGESTION				
Pentachlorophenol	0.12	0.1000	1.7E-08	2.1E-09
OCDD (total)	150	0.0033	5.8E-10	8.6E-08
PCB-1248	7.7	0.2100	3.7E-08	2.8E-07
PCB-1260	7.7	0.1300	2.3E-08	1.7E-07
Arsenic	1.75	10.1700	1.8E-06	3.1E-06
Beryllium	4.3	0.7400	1.3E-07	5.6E-07
pathway sum=				4E-06
DERMAL ABSORPTION				
Pentachlorophenol				
OCDD (total)	0.12	0.1000	1.1E-08	1.3E-09
PCB-1248	150	0.0033	3.6E-10	5.4E-08
PCB-1260	7.7	0.2100	2.3E-08	1.BE-07
Arsenic	7.7	0.1300	1.4E-08	1.1E-07
Beryllium	1.75	10.1700	1.1E-07	1.9E-07
	4.3	0.7400	8.1E-09	3.5E-08
pathway sum=				6E-07
	Unit Risk (ug/m^3)-1			
INHALATION				
OCDD (total)	0.000000033	0.0033	5.0E-14	5.8E-18
Arsenic	0.0043	10.1700	1.5E-10	2.3E-09
Beryllium	0.0024	0.7400	1.1E-11	9.4E-11
Chromium VI	0.012	19.0000	2.9E-10	1.2E-08
Nickel (soluble salt)	0.00024	25.1000	3.8E-10	3.2E-10
pathway sum=				1E-08
sum of pathways=				5E-06

Ingestion:	Intake (mg/kg-d)=(conc. in soil-IngR*CF*FI*EF*ED)/(BW*AT)
Dermal Absorption:	Abs dose(mg/kg-d)=(soil conc.*CF*SA*AF*ABS*EF*ED)/(BW*AT)
Inhalation:	Inh dose (mg/kg-d)=(soil conc.*EF*ED*InhR*(1/PEF)/(BW*AT)
	SFI=Unit Risk*(BW/InhR)*1000

exposure parameters

IngR=Ingestion rate (mg soil/day)	50	
CF=Conversion factor (10E-6)	1E-06	
FI=Fraction ingested	1	
EF=Exposure frequency (days/year)	250	
ED=Exposure duration (year)	25	
BW=Body weight (kg)	70	
AT=Averaging time (days	25550	
SA=Skin surface area (cm^2)	3120	
AF=Soil to skin adherence (mg/cm^2)	1	
ABS=Absorption (0.1 % metals; 1 % organics)	0.001	0.01
PEF=Particulate emission (m^3/kg)	4.63E+09	
InhR=Inhalation rate (m^3/day)	20	

Table taken from Attachment 2-1 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.2. Chronic Hazard Index Estimates for Direct Contact to Soil

Future Industrial Exposure
Scenario: unrestricted worker (250 days/year)

Chemical	**Reference Dose mg/kg-day**	**Soil Conc. mg/kg**	**Chronic Daily Intake mg/kg-day**	**Chronic Hazard**
INGESTION				
Pentachlorophenol	0.03	0.10	4.9E-08	2E-06
Arsenic	0.0003	10.17	5.0506	2E-02
Barium	0.07	132.68	6.5E-05	9E-04
Beryllium	0.005	0.74	3.6E-07	7E-05
Chromium VI	0.005	19.00	9.3E-06	2E-03
Copper	0.037	24.71	1.2E-05	3E-04
Manganese	0.14	2541.05	1.2E-03	9E-03
Mercury	0.0003	0.15	7.3E-08	2E-04
Nickel (soluble salt)	0.02	25.10	1.2E-05	6E-04
Selenium	0.005	0.40	2.0E-07	4E-05
Silver	0.005	5.38	2.6E-06	5E-04
Vanadium	0.007	31.80	1.6E-05	2E-03
Zinc	0.3	67.05	3.3E-05	1 E-04
Uranium (soluble salt)	0.003	83.58	4.1 E-05	1 E-02
pathway sum=				0.05
DERMAL ABSORPTION				
Pentachlorophenol	0.03	0.10	3.1E-08	1E-06
Arsenic	0.0003	10.17	3.1E-07	1E-03
Barium	0.07	132.68	4.1E-06	6E-05
Beryllium	0.005	0.74	2.3E-08	5E-06
Chromium VI	0.005	19.00	5.8E-07	1E-04
Copper	0.037	24.71	7.5E-07	2E-05
Manganese	0.005	2541.05	7.8E-05	2E-02
Mercury	0.0003	0.15	4.6E-09	2E-05
Nickel (soluble salt)	0.02	25.10	7.7E-07	4E-05
Selenium	0.005	0.40	1.2E-08	2E-06
Silver	0.005	5.38	1.6E-07	3E-05
Vanadium	0.007	31.80	9.7E-07	1E-04
Zinc	0.3	67.05	2.0E-06	7E-06
Uranium (soluble salt)	0.003	83.58	2.6E-06	9E-04
pathway sum=				0.02
	Reference Conc. mg/m^3			
INHALATION				
Barium	0.0005	132.68	5.6E-09	4E-05
Chromium VI	0.000002	19.00	8.oE-10	1 E-03
Manganese	0.0004	2541.05	1.1 E-07	9E-04
Mercury	0.0003	0.15	6.3E-12	7E-08
pathway sum=				0.002
sum of pathways=				0.07

Ingestion:	Intake (mg/kg-d)=(conc. in soil-IngR*CF*FI*EF*ED)/(BW*AT)
Dermal Absorption:	Abs dose(mg/kg-d)=(soil conc.*CF*SA*AF*ABS*EF*ED)/(BW*AT)
Inhalation:	Inh dose (mg/kg-d)=(soil conc.*EF*ED*InhR*(1/PEF)/(BW*AT)
	SFI=Unit Risk*(BW/InhR)*1000

Table F2.2. Chronic Hazard Index Estimates for Direct Contact to Soil (Continued)

exposure parameters		
IngR=Ingestion rate (mg soil/day)	50	
CF=Conversion factor (10E-6)	1E-06	
FI=Fraction ingested	1	
EF=Exposure frequency (days/year)	250	
ED=Exposure duration (year)	25	
BW=Body weight (kg)	70	
AT=Averaging time (days	25550	
SA=Skin surface area (cm^2)	3120	
AF=Soil to skin adherence (mg/cm^2)	1	
ABS=Absorption (0.1 % metals; 1 % organics)	0.001	0.01
PEF=Particulate emission (m^3/kg)	4.63E+09	
InhR=Inhalation rate (m^3/day)	20	

Table taken from Attachment 2-2 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.3. Excess Lifetime Risk of Cancer Incidence for Direct Contact to Soil

Future Industrial Exposure
Scenario: unrestricted worker (250 days/year)

Radionuclide[a]	Soil Concentration (pCi/g) (SC)	Annual Intake (pCi)	Total Intake (pCi)	Dose Conversion Factor[b] (mrem/pCi) or (mrem*g/pCi/h)	Committed Effective Dose Equivalent 1 Yr Intake (mrem/yr)[c]	Total Committed Effective Dose Equivalent (mrem)	Cancer Incidence Risk Factor (pCi)-1[d] or (g/pCi-1)	Risk of Cancer Incidence
INGESTION								
Neptunium-237+D	0.32	4.00	100.0	4.4E-03	1.8E-02	4.4E-01	2.2E-10	2.2E-08
Plutonium-239	7.90	98.75	2468.8	3.7E-04	3.6E-02	9.1E-01	2.3E-10	5.7E-07
Thorium-230	14.00	175.00	4375.0	5.5E-04	9.6E-02	2.4E+00	1.3E-11	5.7E-08
Uranium-234	18.00	225.00	5625.0	2.8E-04	6.4E-02	1.6E+00	1.6E-11	9.0E-08
Ursnium-235+D	1.70	21.25	531.3	2.7E-04	5.7E-03	1.4E-01	1.6E-11	8.5E-09
Uranium-238+D	69.00	862.50	21562.5	2.6E-04	2.2E-01	5.5E+00	2.8E-11	6.0E-07
Technetium-99	58.00	725.00	18125.0	1.5E-06	1.1 E-03	2.6E-02	1.3E-l2	2.4E-08
Pathway sum=					4.4E-01	1.1E+0l		1 E-06
INHALATION								
Neptunium-237+D	0.32	3.5E-04	8.6E-03	5.4E-01	1.9E-04	4.7E-03	2.9E-08	2.5E-10
Plutonium-239	7.90	8.5E-03	2.1E-01	3.1E-01	2.6E-03	6.6E-02	3.8E-08	8.1E-09
Technetium-99	14.00	1.5E-02	3.8E-01	8.3E-06	1.3E-07	3.1 E-06	8.3E-12	3.1E-12
Thorium-230	18.00	1.9E-02	4.9E-01	2.6E-01	5.1E-03	1.3E-01	2.9E-08	1.4E-08
Uranium-234	1.70	1.8E-03	4.6E-02	1.3E-01	2.4E-04	6.1E-03	2.6E-08	1.2E-09
Ursnium-235+D	69.00	7.5E-02	1.9E+00	1.2E-01	9.2E-03	2.3E-01	2.5E-08	4.7E-08
Uranium-238+D	58.00	6.3E-02	1.6E+00	1.2E-01	7.4E-03	1.8E-01	5.2E-08	8.1E-08
Pathway sum=					2.5E-02	6.2E-0l		2 E-07
EXPOSURE TO EXTERNAL RADIATION								
Neptunium-237+D	0.32			1.0E-04	8.4E-02	1.6E+00	4.3E-07	8.2E-07
Plutonium-239	7.90			4.2E-08	6.6E-04	1.7E-02	1.7E-11	8.0E-10
Technetium-99	14.00			1.5E-08	4.2E-04	1.0E-02	6.0E-13	5.0E-11
Thorium-230	18.00			1.2E-07	4.3E-03	1.1E-01	5.4E-11	5.8E-09
Uranium-234	1.70			5.7E-08	1.9E-04	4.8E-03	3.0E-11	3.0E-10
Ursnium-235+D	69.00			3.8E-05	5.2E+00	1.3E+02	2.4E-07	9.9E-05
Uranium-238+D	58.00			7.5E-06	8.7E-01	2.2E+01	3.6E-08	1.2E-05
Pathway sum=					6.2E+00	1.5E+02		1E-04
Sum of the Pathways=					6.6E+00	1.7E+02		1E-04

exposure assumptions

Ingestion Rate IR (g/day)	0.05	Ingestion Risk= SCx IRxEFx EDx RF
Exposure Frequency (EF) (day/yr)	250	Inhalation Risk = SC + IR x EF x ED x CF x l/PEF x RF
Exposure Duration (ED) (years)	25	External Radiation Risk = SC x ED x Te x (1-SF) x RF
Particulate emission factor (m^3/kg):	4.63E+09	
Worker inhalation rate (m^3/day):	20	
Conversion factor(1000 g/kg):	1000	
Exposure Time (ET) (hr/day)	8	
Shielding factor (SF):	0	
Fraction of year exposed (Te):	0.24	Te = (ET x EF) / (8400 HR/YR)

NOTES:
(a) Radionuclides shown with +D include short lived daughter products in risk calculations.
(b) Ingestion and inhalation dose factors were taken from Federal Guidance Report 11. "Limiting Values of Radionuclide Intake and Air Concentration and Dose Factors for Inhalation, Submersion, and Ingestion"(EPA-520/1-88-020). Dose after intake of parent radionuclide. External Radiation dose factors were taken from NUREG/CR-5512 "Residual Radioactive Contamination from Decommissioning,
Technical Basis for Translating Contamination Levels to Annual Dose."
(c) Committed effective dose equivalent expressed as committed (50 yr) dose (mrem) due to one year of exposure(mrem/yr).
(d) Cancer risk factors taken from January1992 HEAST tables.

Table taken from Attachment 2-3 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.4. Cancer Risk Estimates for Direct Contact to Soil

Current Industrial Exposure
Scenario: worker/intruder (25 days/year)

Chemical	Slope Factor (mg/kg-day)-1	Soil Conc. (mg/kg)	Chronic Daily Intake (mg/kg-day)	Excess Lifetime Cancer Risk
INGESTION				
Pentachlorophenol	0.12	0.10	1.7E-09	2.1E-10
OCDD (total)	150	0.0033	5.8E-11	8.6E-09
PCB-1248	7.7	0.21	3.7E-09	2.8E-08
PCB-1260	7.7	0.130	2.3E-09	1.7E-08
Arsenic	1.75	10.17	1.8E-07	3.1E-07
Beryllium	4.3	0.74	1.3E-08	5.6E-08
Pathway sum=				4E-07
DERMAL ABSORPTION				
Pentachlorophenol	0.12	0.10	1.1 E-09	1.3E-10
OCDD (total)	150	0.0033	3.6E-11	5.4E-09
PCB-1248	7.7	0.21	2.3E-09	1.8E-08
PCB-1260	7.7	0.130	1.4E-09	1.1 E-08
Arsenic	1.75	10.17	1.lE-08	1.9E-08
Beryllium	4.3	0.74	8.1E-10	3.5E-09
Pathway sum=				6E-08
	Unit Risk (ug/m^3)-1			
INHALATION				
OCDD (total)	0.000000033	0.0033	5.OE-15	5.8E-19
Arsenic	0.0043	10.17	1.5E-11	2.3E-10
Beryllium	0.0024	0.74	1.lE-12	9.4E-12
Chromium VI	0.01 2	19.00	2.9E-11	1.2E-09
Nickel (soluable salts)	0.00024	25.10	3.8E-11	3.2E-11
Pathway sum=				1E-09
Sum of pathways=				5E-07

Ingestion: Intake (mg/kg-d)=(conc. in soil*IngR*CF*FI*ED)/(BW*AT)
Abs dose(mg/kg-d)=(soil conc. *CF*SA*AF*ABS*EF*ED)/(BW*AT)

Dermal Absorption:
Inhalation: Inh dose (mg/kg-d)=(soil conc. *EF*ED*InhR*(l/PEF)/(BW*AT)
SFi=Unit Risk*(BW/InhR)*1000

exposure parameters

IngR=Ingestion rate (mg soil/day)		
CF=Conversion factor (10E-6)	50	
FI=Fraction ingested	1E-06	
EF=Exposure frequency (days/year)	1	
ED=Exposure duration (year)	25	
BW=Body weight (kg)	25	
AT=Averaging time (days	70	
SA=Skin surface area (cm^2)	25550	
AF=Soil to skin adherence (mg/cm^2)	3120	
ABS=Absorption (0.l % metals; l % organics)	1	
PEF=Particulate emission (m^3/kg)	0.001	0.01
InhR=Inhalation rate (m^3/day)	4.63E+09	
	20	

Table taken from Attachment 2-4 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.5. Chronic Hazard Index Estimates for Direct Contact to Soil

Current Industrial Exposure
Scenario: worker/intruder (25 days/year)

Chemical	Reference Dose mg/kg-day	Soil Conc. mg/kg	Chronic Daily Intake mg/kg-day	Hazard Quotient
INGESTION				
Pentachlorophenol	0.03	0.10	4.9E-09	1.6E-07
Arsenic	0.0003	10.17	5.0E-07	1.7E-03
Barium	0.07	132.68	6.5E-06	9.3E-05
Beryllium	0.005	0.74	3.6E-08	7.2E-06
Chromium VI	0.005	19.00	9.3E-07	1.9E-04
Copper	0.037	24.71	1.2E-06	3.3E-05
Manganese	0.14	2541.05	1.2E-04	8.9E-04
Mercury	0.0003	0.15	7.3E-09	2.4E-05
Nickel (soluble salt)	0.02	25.10	1.2E-06	6.1E-05
Selenium	0.005	0.40	2.0E-08	3.9E-06
Silver	0.003	5.38	2.6E-07	8.8E-05
Vanadium	0.007	31.80	1.6E-06	2.2E-04
Zinc	0.30	67.05	3.3E-06	1.1E-05
Uranium (soluble salt)	0.003	83.58	4.1 E-06	1.4E-05
pathway sum=				0.005
DERMAL ABSORPTION				
Pentachlorophenol	0.03	0.10	3.1E-09	1.0E-07
Arsenic	0.0003	10.17	3.1E-08	1.0E-04
Barium	0.07	132.68	4.1E-07	5.8E-06
Beryllium	0.005	0.74	2.3E-09	4.5E-07
Chromium VI	0.005	19.00	5.8E-08	1.2E-05
Copper	0.037.	24.71	7.5E-08	2.0E-06
Manganese	0.005	2541.05	7.8E-06	1.6E-03
Mercury	0.0003	0.15	4.6E-10	1.5E-06
Nickel (soluble salt)	0.02	25.10	7.7E-08	3.8E-06
Selenium	0.005	0.40	1.2E-09	2.4E-07
Silver	0.003	5.38	1.6E-08	5.5E-06
Vanadium	0.007	31.80	9.7E-08	1.4E-05
Zinc	0.3	67.05	2.0E-07	6.8E-07
Uranium (soluble salt)	0.003	83.58	2.6E-07	8.5E-05
pathway sum=				0.002
	Reference Conc. mg/m^3			
INHALATION				
Barium	0.0005	132.68	5.6E-10	3.9E-06
Chromium VI	0.000002	19.00	8.0E-11	1.4E-04
Manganese	0.0004	2541.05	1.1E-08	9.4E-05
Mercury	0.0003	0.15	6.3E-13	7.4E-09
pathway sum=				0.0002
sum of pathways=				0.007

Ingestion: Intake (mg/kg-d)=(conc. in soil-IngR*CF*FI*EF*ED)/(BW*AT)
Dermal Absorption: Abs dose(mg/kg-d)=(soil conc.*CF*SA*AF*ABS*EF*ED)/(BW*AT)
Inhalation: Inh dose (mg/kg-d)=(soil conc.*EF*ED*InhR*(1/PEF)/(BW*AT)
SFI=Unit Risk*(BW/InhR)*1000

Table F2.5. Chronic Hazard Index Estimates for Direct Contact to Soil (Continued)

exposure parameters		
IngR=Ingestion rate (mg soil/day)	50	
CF=Conversion factor (10E-6)	1E-06	
FI=Fraction ingested	1	
EF=Exposure frequency (days/year)	25	
ED=Exposure duration (year)	25	
BW=Body weight (kg)	70	
AT=Averaging time (days	25550	
SA=Skin surface area (cm^2)	3120	
AF=Soil to skin adherence (mg/cm^2)	1	
ABS=Absorption (0.1 % metals; 1 % organics)	0.001	0.01
PEF=Particulate emission (m^3/kg)	4.63E+09	
InhR=Inhalation rate (m^3/day)	20	

Table taken from Attachment 2-5 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.6. Excess Lifetime Risk of Cancer Incidence for Direct Contact to Soil

Current Industrial Exposure
Scenario: worker/intruder (25 days/year)

Radionuclide[a]	Soil Concentration (pCi/g) (SC)	Annual Intake (pCi)	Total Intake (pCi)	Dose Conversion Factor[b] (mrem/pCi) or (mrem*g/pCi/h)	Committed Effective Dose Equivalent 1 Yr Intake (mrem/yr)[c]	Total Committed Effective Dose Equivalent (mrem)	Cancer Incidence Risk Factor (pCi)-1[d] or (g/pCi-1)	Risk of Cancer Incidence
INGESTION								
Neptunium-237+D	0.36	0.45	11.3	4.4E-03	2.0E-03	5.0E-02	2.2E-10	2.5E-09
Plutonium-239	7.90	9.88	246.9	3.7E-04	3.6E-03	9.1E-01	2.3E-10	5.7E-08
Thorium-230	14.00	17.50	437.5	5.5E-04	9.6E-03	2.4E-01	1.3E-11	5.7E-09
Uranium-234	18.00	22.50	562.5	2.8E-04	6.4E-03	1.6E-01	1.6E-11	9.0E-09
Ursnium-235+D	1.70	2.13	53.1	2.7E-04	5.7E-04	1.4E-02	1.6E-11	8.5E-10
Uranium-238+D	69.00	86.25	2156.3	2.6E-04	2.2E-02	5.5E-01	2.8E-11	6.0E-08
Technetium-99	58.00	72.50	1812.5	1.5E-06	1.1 E-04	2.6E-03	1.3E-l2	2.4E-09
Pathway sum=					4.4E-02	1.1E+00		1 E-07
INHALATION								
Neptunium-237+D	0.36	3.9E-05	9.7E-04	5.4E-01	2.1E-05	5.2E-04	2.9E-08	2.8E-11
Plutonium-239	7.90	8.5E-04	2.1E-02	3.1E-01	2.6E-04	6.6E-03	3.8E-08	8.1E-10
Technetium-99	14.00	1.5E-03	3.8E-02	8.3E-06	1.3E-08	3.1 E-07	8.3E-12	3.1E-13
Thorium-230	18.00	1.9E-03	4.9E-02	2.6E-01	5.1E-04	1.3E-02	2.9E-08	1.4E-09
Uranium-234	1.70	1.8E-04	4.6E-03	1.3E-01	2.4E-05	6.1E-04	2.6E-08	1.2E-10
Ursnium-235+D	69.00	7.5E-03	1.9E-01	1.2E-01	9.2E-04	2.3E-02	2.5E-08	4.7E-09
Uranium-238+D	58.00	6.3E-03	1.6E-01	1.2E-01	7.4E-04	1.8E-02	5.2E-08	8.1E-09
Pathway sum=	7.90				2.5E-03	6.2E-02		2 E-08
EXPOSURE TO EXTERNAL RADIATION								
Neptunium-237+D	0.36			1.0E-04	7.2E-03	1.8E-01	4.3E-07	9.2E-08
Plutonium-239	7.90			4.2E-08	6.6E-05	1.7E-03	1.7E-11	8.0E-11
Technetium-99	14.00			1.5E-08	4.2E-05	1.0E-03	6.0E-13	5.0E-12
Thorium-230	18.00			1.2E-07	4.3E-04	1.1E-02	5.4E-11	5.8E-10
Uranium-234	1.70			5.7E-08	1.9E-05	4.8E-04	3.0E-11	3.0E-11
Ursnium-235+D	69.00			3.8E-05	5.2E-01	1.3E+01	2.4E-07	9.9E-06
Uranium-238+D	58.00			7.5E-06	8.7E-02	2.2E+00	3.6E-08	1.2E-06
Pathway sum=	7.90				6.2E-01	1.5E+01		1E-05
Sum of the Pathways=					6.7E-01	1.7E+01		1E-05

exposure assumptions

Ingestion Rate IR (g/day)	0.05	Ingestion Risk= SCx IRxEFx EDx RF
Exposure Frequency (EF) (day/yr)	25	Inhalation Risk = SC + IR x EF x ED x CF x l/PEF x RF
Exposure Duration (ED) (years)	25	External Radiation Risk = SC x ED x Te x (1-SF) x RF
Particulate emission factor (m^3/kg):	4.63E+09	
Worker inhalation rate (m^3/day):	20	
Conversion factor(1000 g/kg):	1000	
Exposure Time (ET) (hr/day)	8	
Shielding factor (SF):	0	
Fraction of year exposed (Te):	0.2	Te = (ET x EF) / (8400 HR/YR)

NOTES:
(a) Radionuclides shown with +D include short lived daughter products in risk calculations.
(b) Ingestion and inhalation dose factors were taken from Federal Guidance Report 11. "Limiting Values of Radionuclide Intake and Air Concentration and Dose Factors for Inhalation, Submersion, and Ingestion"(EPA-520/1-88-020). Dose after intake of parent radionuclide. External Radiation dose factors were taken from NUREG/CR-5512 "Residual Radioactive Contamination from Decommissioning, Technical Basis for Translating Contamination Levels to Annual Dose."
(c) Committed effective dose equivalent expressed as committed (50 yr) dose (mrem) due to one year of exposure(mrem/yr).
(d) Cancer risk factors taken from January1992 HEAST tables.

Table taken from Attachment 2-6 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.7. Cancer Risks Estimated for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW093 (RGA)

Chemical	Oral Slope Factor (mg/kg-day)-1	Concentration MW093 ug/L	Chronic Daily Intake mg/kg-day	Excess Lifetime Cancer Risk	Total Pathway Risk
INGESTION OF GROUNDWATER					
2,4-Dinitrotoluene	0.68	18.50	2.2E-04	1.5E-04	
N-Nitroso-di-npropylamine	7.0	22.00	2.6E-04	1.8E-03	
Pentachlorophenol	0.12	57.00	6.7E-04	8.0E-05	
Arsenic	1.75	3.35	3.9E-05	6.9E-05	
Sum=					2E-03

Ingestion: Intake (mg/kg-d)=(conc. in gw*IngR*CF* EF*ED)/(BW*AT)

exposure parameters

IngR=Ingestion rate (L/day)	2
CF=Conversion factor (mg/ug)	0.001
EF=Exposure frequency (days/year)	350
ED=Exposure duration (year)	30
BW=Body weight (kg)	70
AT=Averaging time (days)	25550

Table taken from Attachment 2-7 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.8. Cancer Risks Estimated for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW074 (UCRS)

Chemical	Oral Slope Factor (mg/kg-day)-1	Concentration MW074 ug/L	Chronic Daily Intake mg/kg-day	Excess Lifetime Cancer Risk	Total Pathway Risk
INGESTION OF GROUNDWATER					
Beryllium	4.3	15.8	1.9E-04	8.0E-04	8.0E-04
INHALATION OF VOLATILE COMPOUNDS DURING DOMESTIC USE OF GROUNDWATER					0.0E+00
Sum of Pathways=					8E-04

Ingestion: Intake (mg/kg-d)=(conc. in gw*IngR*CF* EF*ED)/(BW*AT)
Inhalation: Inh dose (mg/kg-d)=(conc. in gw*VF*InhR*EF*ED)/(BW*AT)
SFi=Unit Risk*(BW/InhR)*1000

exposure parameters

IngR=Ingestion rate (L/day)	2
CF=Conversion factor (mg/ug)	0.001
EF=Exposure frequency (days/year)	350
ED=Exposure duration (year)	30
BW=Body weight (kg)	70
AT=Averaging time (days)	25550
InhR=Indoor Inhalation Rate (m^3/day)	15
VF=Volatilization Factor (L/m^3)	0.5

Table taken from Attachment 2-8 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.9. Hazard Index Estimates for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW074 (UCRS)

Chemical	Reference Dose (mg/kg-day)	Concentration MW074 ug/L	Chronic Daily Intake mg/kg-day	Hazard Quotient	Pathway Hazard Index
INGESTION OF GROUNDWATER					
Nickel	0.02	125.4	3.4E-03	0.172	
Barium	0.07	634	1.7E-02	0.248	
Zinc	0.3	343.3	9.4E-03	0.031	
Vanadium	0.007	410.1	1.1E-02	1.605	
Chromium	0.005	139.8	3.8E-03	0.766	
Cadmium	0.0005	4.6	1.3E-04	0.252	
Silver	0.003	42.1	1.2E-03	0.384	
Manganese	0.005	1535.3	4.2E-02	8.413	
Copper	0.037	95.9	2.6E-03	0.000	
Beryllium	0.005	15.8	4.3E-04	0.087	
Uranium (soluble salts)	0.003	10.68	2.9E-04	0.098	
					12

Equations:

Ingestion: Intake (mg/kg-d)=(conc. in gw*IngR*CF* EF*ED)/(BW*AT)

exposure parameters

IngR=Ingestion rate (L/day)	2
CF=Conversion factor (mg/ug)	0.001
EF=Exposure frequency (days/year)	350
ED=Exposure duration (year)	30
BW=Body weight (kg)	70
AT=Averaging time (days)	10950

Table taken from Attachment 2-9 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.10. Hazard Index Estimates for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW089 (RGA)

Chemical	Reference Dose (mg/kg-day)	Concentration MW074 ug/L	Chronic Daily Intake mg/kg-day	Hazard Quotient	Pathway Hazard Index
INGESTION OF GROUNDWATER					
Nickel	0.02	14.6	4.0E-04	0.020	
Barium	0.07	253	6.9E-03	0.099	
Zinc	0.3	34.3	9.4E-04	0.003	
Vanadium	0.007	7.6	2.1E-04	0.030	
Chromium	0.005	7.8	2.1E-04	0.043	
Cyanide	0.02	3	8.2E-05	0.004	
Thallium (Carbonate)	0.00008	0.9	2.5E-05	0.308	
Manganese	0.005	3630	9.9E-02	19.890	
Copper	0.037	9	2.5E-04	0.000	
Arsenic	0.0003	3.9	1.1E-04	0.356	
					20.75
INHALATION OF VOLATILE COMPOUNDS DURING DOMESTIC USE OF GROUNDWATER					0.0
Sum of Pathways=					20.75

Equations:

Ingestion:	Intake (mg/kg-d)=(conc. in gw*IngR*CF* EF*ED)/(BW*AT)
Inhalation:	Inh dose (mg/kg-d)=(conc. in gw*VF*InhR*EF*ED)/(BW*AT)

exposure parameters

IngR=Ingestion rate (L/day)	2
CF=Conversion factor (mg/ug)	0.001
EF=Exposure frequency (days/year)	350
ED=Exposure duration (year)	30
BW=Body weight (kg)	70
AT=Averaging time (days)	10950
InhR=Indoor Inhalation Rate (m^3/day)	15
VF=Volatilization Factor (L/m^3)	0.5

Table taken from Attachment 2-10 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.11. Risk of Cancer Incidence for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW154 (UCRS)

Radionuclide[a]	Groundwater Concentration (pCi/L)[b]	Annual Intake (pCi/yr)	Total Intake (pCi)	Ingestion Dose Conversion Factor[c] (mrem/pCi)	Committed Effective Dose Equivalent 1 Yr Intake (mrem/yr)[d]	Total Committed Effective Dose Equivalent (mrem)	Cancer Incidence Risk Factor (pCi)-1[e]	Risk of Cancer Incidence
Np-237	0.32	224.0	6720.0	4.4E-03	9.9E-01	3.0E+01	2.2E-10	1.5E-06
Pu-239	0.18	126.0	3780.0	3.7E-04	4.6E-02	1.4E+00	2.3E-10	6.7E-07
Tc-99	1000	7.0E+05	2.1E+07	1.5E-06	1.0E+00	3.1E+01	1.3E-12	2.7E-05
U-234	3.6	2520.0	75600.0	2.8E-04	7.1E-01	2.1E+01	1.6E-11	1.2E-06
U-235+D	0.14	98.0	2940.0	2.7E-04	2.6E-02	7.8E-01	1.6E-11	4.7E-08
U-238+D	27	18900.0	567000.0	2.6E-04	4.8E+00	1.4E+02	2.8E-11	1.6E-05
Pathway totals=					7.6E+00	2.3E+02		5E-05

exposure assumptions

Ingestion Rate IR (g/day)	2	Ingestion Risk= WC x IR x EF x ED x RF
Exposure Frequency (EF) (day/yr)	350	
Exposure Duration (ED) (years)	30	

NOTES:
[a]Radionuclides shown with +D include short lived daughter products in risk calculations.
[b] Sample concentrations are actual values. Results are shown as calculated by the lab, even if they are less than the detection limit for this analysis. ND is shown if the actual value was negative.
[c] Ingestion and inhalation dose factors were taken from Federal Guidance Report 11. “Limiting Values of Radionuclide Intake and Air Concentration and Dose Factors for Inhalation, Submersion, and Ingestion”(EPA-520/1-88-020). Dose factors include the contribution to dose from ingrowth of decay products after intake of parent radionuclide.
[d] Committed effective dose equivalent expressed as committed (50 yr) dose (mrem) due to one year of exposure (mrem/yr).

[e] Cancer risk factors taken from January1992 HEAST tables.

Table taken from Attachment 2-11 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.12. Risk of Cancer Incidence for Domestic Use of Groundwater

Scenario: Future Potable Use of Groundwater
MW84 (RGA)

Radionuclide[a]	Groundwater Concentration (pCi/L)[b]	Annual Intake (pCi/yr)	Total Intake (pCi)	Ingestion Dose Conversion Factor[c] (mrem/pCi)	Committed Effective Dose Equivalent 1 Yr Intake (mrem/yr)[d]	Total Committed Effective Dose Equivalent (mrem)	Cancer Incidence Risk Factor (pCi)-1[e]	Risk of Cancer Incidence
Np-237	ND	0.0	0.0	4.4E-03	0.0E+00	0.0E+00	2.2E-10	0.0E+00
Pu-239	0.03	21.0	630.0	3.7E-04	7.7E-03	2.3E-01	2.3E-10	1.4E-07
Tc-99	466	3.3E+05	9.8E+06	1.5E-06	4.8E-01	1.4E+01	1.3E-12	1.3E-05
U-234	0.14	98.0	2940.0	2.8E-04	2.8E-02	8.3E-01	1.6E-11	4.7E-08
U-235+D	0.01	7.0	210.0	2.7E-04	1.9E-03	5.6E-02	1.6E-11	3.4E-09
U-238+D	0.23	161.0	4830.0	2.6E-04	4.1E-02	1.2E+00	2.8E-11	1.4E-07
Totals					5.5E-01	1.7E+01		1E-05

exposure assumptions

Ingestion Rate IR (g/day)	2	Ingestion Risk= WC x IR x EF x ED x RF
Exposure Frequency (EF) (day/yr)	350	
Exposure Duration (ED) (years)	30	

NOTES:

[a]Radionuclides shown with +D include short lived daughter products in risk calculations.

[b] Sample concentrations are actual values. Results are shown as calculated by the lab, even if they are less than the detection limit for this analysis. ND is shown if the actual value was negative.

[c] Ingestion and inhalation dose factors were taken from Federal Guidance Report 11. "Limiting Values of Radionuclide Intake and Air Concentration and Dose Factors for Inhalation, Submersion, and Ingestion"(EPA-520/1-88-020). Dose factors include the contribution to dose from ingrowth of decay products after intake of parent radionuclide.

[d] Committed effective dose equivalent expressed as committed (50 yr) dose (mrem) due to one year of exposure (mrem/yr).

[e] Cancer risk factors taken from January1992 HEAST tables.

Table taken from Attachment 2-12 *Remedial Investigation Addendum for Waste Area Grouping 22, Burial Grounds, Solid Waste Management Units 2 and 3, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1141&D2 (KY/ER-32 & D2) September 1994 Revision 2.

Table F2.13. Summary of Human Health Risk Characterization for SWMU 4 without Lead as a COPC

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Current industrial worker at current concentrations (soil)	5.4E-04	Beryllium Uranium-238	97 2	Dermal contact External exposure	97 2	3.62	Beryllium Chromium Iron Vanadium Barium	5 45 24 24 2	Dermal contact	99
Future industrial worker at current concentrations (soil)	5.4E-04	Beryllium Uranium-238	97 2	Dermal contact External exposure	97 2	3.62	Beryllium Chromium Iron Vanadium Barium	5 45 24 24 2	Dermal contact	99
Future industrial worker at current concentrations (RGA groundwater)	4.7E-04	Arsenic Beryllium 1,1-DCE Carbon tetrachloride Chloroform TCE Vinyl chloride	15 48 8 7 2 20 2	Incidental ingestion Dermal contact Inhalation while showering	72 18 10	32.6	Aluminum Arsenic Cadmium Chromium Iron Manganese Vanadium Carbon tetrachloride TCE	4 1 1 1 66 5 2 4 14	Ingestion Dermal contact Inhalation while showering	88 6 6
Future industrial worker at current concentrations (McNairy groundwater)	3.1E-03	Arsenic Beryllium	18 82	Ingestion Dermal contact	78 22	75.9	Aluminum Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Vanadium	4 5 1 1 1 3 63 8 14	Ingestion Dermal contact	93 7
Future child rural resident at current concentrations (soil)	NA	NA	NA	NA	NA	98.2	Barium Beryllium Cadmium Chromium Iron Nickel Vanadium	2 2 2 24 60 2 9	Ingestion Dermal contact Ingestion of vegetables	1 21 78

Table F2.13. Summary of Human Health Risk Characterization for SWMU 4 without Lead as a COPC (Continued)

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Future child rural resident at current concentrations (RGA groundwater)	NA	NA	NA	NA	NA	487	Aluminum Arsenic Boron Chromium Iron Manganese Vanadium Carbon tetrachloride Chloroform TCE *cis*-1,2-DCE	3 1 1 1 49 3 1 10 1 29 1	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	40 1 30 29
Future child rural resident at current concentrations (McNairy groundwater)	NA	NA	NA	NA	NA	798	Aluminum Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Mercury Vanadium Zinc	4 5 1 1 1 3 66 6 1 12 1	Ingestion Dermal contact Ingestion of vegetables	60 2 39
Future adult rural resident at current concentrations (soil)	4.3E-03	Beryllium Total PCBs Uranium-234 Uranium-238	72 5 6 17	Dermal contact External exposure Ingestion of vegetables	6 2 1	28.4	Barium Beryllium Cadmium Chromium Iron Nickel Vanadium	2 2 2 22 63 2 8	Dermal contact Ingestion of vegetables	14 85
Future adult rural resident at current concentrations (RGA groundwater)	7.0E-03	Arsenic Beryllium 1,1-DCE Carbon tetrachloride Chloroform TCE Vinyl chloride Technetium-99	8 22 15 7 5 20 2 21	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	26 3 30 41	158	Aluminum Arsenic Boron Chromium Iron Manganese Vanadium Carbon tetrachloride TCE	3 1 1 1 57 4 1 7 22	Ingestion Dermal contact Inhalation of vapors/particles Ingestion of vegetables	51 2 19 28

Table F2.13. Summary of Human Health Risk Characterization for SWMU 4 without Lead as a COPC (Continued)

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at current concentrations (McNairy groundwater)	> 1.0E-02*	Arsenic Beryllium Technetium-99	21 77 2	Ingestion Dermal contact Ingestion of vegetables	58 8 35	303	Aluminum Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Vanadium Zinc	4 5 1 1 1 3 66 6 12 1	Ingestion Dermal contact Ingestion of vegetables	65 2 32
Future child recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future teen recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future adult recreational user at current concentrations (soil)	< 1.0E-06	–	–	–	–	< 1	–	–	–	–
Future excavation worker at current concentrations (soil and waste)	2.7E-03	Arsenic Beryllium Total dioxins/furans Total PCBs Radium-226 Total uranium Uranium-238	1 7 4 2 2 83 1	Ingestion Dermal contact External exposure	37 10 54	2.61	Aluminum Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Vanadium	8 4 2 2 1 24 24 14 20	Ingestion Dermal contact	13 87

Table taken from *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1,July 2000.
NA = ECLR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
– = There are no COCs or POCs.
* = The ELCR is approximate because the linearized multistage model returns imprecise values at risks > 1.0E-02.

Table F2.14. Summary of Human Health Risk Characterization for SWMU 5 without Lead as a COPC

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Current industrial worker at current concentrations (soil)	4.1E-04	Arsenic Beryllium Total PAHs	6 49 45	Ingestion Dermal contact	2 98	< 1	–	–	–	–
Future industrial worker at current concentrations (soil)	4.1E-04	Arsenic Beryllium Total PAHs	6 49 45	Ingestion Dermal contact	2 98	< 1	–	–	–	–
Future industrial worker at current concentrations (RGA groundwater)	5.4E-04	Beryllium 1,1-DCE Radium-226	35 1 64	Ingestion Dermal contact	90 9	26.8	Aluminum Barium Cadmium Chromium Iron Manganese Vanadium	4 1 1 2 73 16 2	Ingestion Dermal contact	96 4
Future industrial worker at current concentrations (McNairy groundwater)	1.2E-03	Beryllium Radium-226	42 58	Ingestion Dermal contact	89 11	63	Aluminum Cadmium Chromium Iron Manganese Vanadium	4 1 7 79 3 5	Ingestion Dermal contact	95 5
Future child rural resident at current concentrations (soil)	NA	NA	NA	NA	NA	46.2	Aluminum Arsenic Beryllium Chromium Nickel Zinc	24 53 1 17 3 1	Ingestion Dermal contact Ingestion of vegetables	1 12 87
Future child rural resident at current concentrations (RGA groundwater)	NA	NA	NA	NA	NA	283	Aluminum Barium Cadmium Chromium Iron Manganese Vanadium	4 1 1 2 77 12 1	Ingestion Dermal contact Ingestion of vegetables	61 1 37
Future child rural resident at current concentrations (McNairy groundwater)	NA	NA	NA	NA	NA	680	Aluminum Cadmium Chromium Iron Manganese Vanadium	4 1 6 81 3 4	Ingestion Dermal contact Ingestion of vegetables	60 1 39
Future adult rural resident at current concentrations (soil)	> 1.0E-02*	Arsenic Beryllium Total PAHs Total PCBs	21 9 68 2	Dermal contact Ingestion of vegetables	9 90	13.9	Aluminum Arsenic Beryllium Chromium Nickel Zinc	24 55 1 15 3 1	Dermal contact Ingestion of vegetables	8 92

Table F2.14. Summary of Human Health Risk Characterization for SWMU 5 without Lead as a COPC (Continued)

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at current concentrations (RGA groundwater)	3.9E-03	Beryllium 1,1-DCE Radium-226 Technetium-99	33 4 57 5	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	56 3 4 37	107	Aluminum Barium Cadmium Chromium Iron Manganese Vanadium	4 1 1 2 76 13 1	Ingestion Dermal contact Ingestion of vegetables	67 2 31
Future adult rural resident at current concentrations (McNairy groundwater)	8.2E-03	Beryllium Radium-226	43 57	Ingestion Dermal contact Ingestion of vegetables	61 4 34	257	Aluminum Cadmium Chromium Iron Manganese Vanadium	4 1 6 81 3 4	Ingestion Dermal contact Ingestion of vegetables	65 2 33
Future child recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future teen recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future adult recreational user at current concentrations (soil)	1.0E-05	Arsenic Total PAHs Total PCBs	2 96 2	Ingestion of venison Ingestion of rabbit Ingestion of quail	16 63 21	< 1	–	–	–	–
Future excavation worker at current concentrations (soil and waste)	2.9E-04	Arsenic Beryllium Total PAHs Total PCBs	8 62 28 1	Ingestion Dermal contact	13 87	2.16	Aluminum Arsenic Barium Beryllium Chromium Iron Manganese	9 7 2 3 18 38 22	Ingestion Dermal contact	18 82

Table taken from *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1,July 2000.
NA = ECLR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
– = There are no COCs or POCs.
* = The ELCR is approximate because the linearized multistage model returns imprecise values at risks > 1.0E-02.

Table F2.15. Summary of Human Health Risk Characterization for SWMU 6 without Lead as a COPC

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Current industrial worker at current concentrations (soil)	2.4E-04	Beryllium Total PAHs	90 10	Dermal contact	99	< 1	–	–	–	–
Future industrial worker at current concentrations (soil)	2.4E-04	Beryllium Total PAHs	90 10	Dermal contact	99	< 1	–	–	–	–
Future industrial worker at current concentrations (RGA groundwater)	2.3E-04	Arsenic Beryllium TCE	15 74 11	Ingestion Dermal contact Inhalation while showering	76 22 2	19.1	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium TCE	3 1 1 2 2 61 20 3 6	Ingestion Dermal contact Inhalation while showering	92 6 2
Future industrial worker at current concentrations (McNairy groundwater)	7.8E-04	Arsenic Beryllium	24 76	Ingestion Dermal contact	79 21	41.7	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium	5 3 1 1 6 74 3 5	Ingestion Dermal contact	95 5
Future child rural resident at current concentrations (soil)	NA	NA	NA	NA	NA	9.38	Beryllium Chromium Nickel Zinc	8 72 15 5	Dermal contact Ingestion of vegetables	34 65
Future child rural resident at current concentrations (RGA groundwater)	NA	NA	NA	NA	NA	223	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium TCE	3 1 1 1 2 58 14 2 17	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	54 1 12 33
Future child rural resident at current concentrations (McNairy groundwater)	NA	NA	NA	NA	NA	451	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium	5 3 1 1 6 76 2 5	Ingestion Dermal contact Ingestion of vegetables	59 1 39

Table F2.15. Summary of Human Health Risk Characterization for SWMU 6 without Lead as a COPC (Continued)

Receptor	Total ELCR	COCs	% Total ELCR	POCs	% Total ELCR	Total HI	COCs	% Total HI	POCs	% Total HI
Future adult rural resident at current concentrations (soil)	2.4E-03	Beryllium Total PAHs	54 46	Dermal contact Ingestion of vegetables	30 69	2.57	Beryllium Chromium Nickel Zinc	7 70 17 6	Dermal contact Ingestion of vegetables	24 75
Future adult rural resident at current concentrations (RGA groundwater)	2.3E-03	Arsenic Beryllium TCE Technetium-99	12 51 16 21	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	41 6 8 46	79.9	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium TCE	3 1 1 1 2 61 15 2 12	Ingestion Dermal contact Inhalation while showering/household Ingestion of vegetables	62 2 7 29
Future adult rural resident at current concentrations (McNairy groundwater)	5.7E-03	Arsenic Beryllium	28 72	Ingestion Dermal contact Ingestion of vegetables	59 7 34	170	Aluminum Arsenic Barium Cadmium Chromium Iron Manganese Vanadium	5 3 1 1 6 76 2 5	Ingestion Dermal contact Ingestion of vegetables	65 2 33
Future child recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future teen recreational user at current concentrations (soil)	NA	NA	NA	NA	NA	< 1	–	–	–	–
Future adult recreational user at current concentrations (soil)	< 1.0E-06	–	–	–	–	< 1	–	–	–	–
Future excavation worker at current concentrations (soil and waste)	2.3E-04	Beryllium Total PAHs	90 9	Ingestion Dermal contact	5 95	2.44	Aluminum Barium Beryllium Chromium Iron Manganese Vanadium	8 2 3 15 32 15 26	Ingestion Dermal contact	12 88

Table taken from *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1,July 2000.
NA = ECLR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
– = There are no COCs or POCs.

Table F2.16. Summary of Human Health Risk Characterization for SWMU 7 without Lead as a COPC

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	4×10^{-3}	Arsenic Beryllium Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Indeno(1,2,3-cd)pyrene ^{237}Np ^{234}U ^{235}U $^{235/236}U$ ^{238}U	<1 97.4 <1 <1 <1 <1 <1 <1 <1 <1 <1	Ingestion of soil Dermal contact with soil External exposure to soil	<1 97.4 2.5	5	Aluminum Antimony Arsenic Beryllium Chromium Iron Manganese Uranium Vanadium	4.1 4.4 2.6 9.6 13.6 20.7 10.7 13.7 17.7	Ingestion of soil Dermal contact with soil	3.6 96.4
Future industrial worker at current concentrations	6×10^{-3}	Arsenic Beryllium 1,1-DCE PCB-1248 PCB-1254 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Carbon tetrachloride Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene TCE Vinyl chloride ^{237}Np ^{239}Pu ^{222}Rn ^{99}Tc ^{230}Th ^{234}U ^{235}U $^{235/236}U$ ^{238}U	12.0 70.9 <1 <1 1.3 <1 <1 <1 <1 <1 <1 2.4 4.9 1.7 <1 2.5 <1 <1 <1 <1 <1 2.4	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering Ingestion of soil Dermal contact with soil External exposure to soil	25.5 2.9 3.5 <1 67.3 1.7	62	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Nickel Uranium Vanadium 1,2-*cis*-DCE 1,2- DCE (total) 2,4-Dimethylphenol 4-Methylphenol PCB-1254 Carbon tetrachloride TCE	2.3 1.0 6.7 <1 <1 <1 2.9 8.4 8.8 <1 1.2 3.2 <1 13.8 <1 <1 40.0 <1 7.0	Ingestion of groundwater Dermal contact with groundwater Ingestion of soil Dermal contact with soil	63.7 27.2 <1 7.8
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	0.07	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	0.06	NE	NE	NE	NE
Future adult recreational user at current concentrations	1×10^{-5}	PCB-1260 Benzo(a)pyrene Dibenzo(a,h)anthracene ^{238}U	18.2 9.1 41.8 16.4	Ingestion of deer Ingestion of rabbit Ingestion of quail	10.0 70.9 21.8	0.07	NE	NE	NE	NE

Table F2.16. Summary of Human Health Risk Characterization for SWMU 7 without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	1320	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Fluoride Iron Manganese Mercury Molybdenum Nickel Nitrate-nitrite Selenium Silver Tin Uranium Vanadium Zinc 1,2-*cis*-DCE 1,2- DCE (total) 2,4-Dimethylphenol 2-Methylphenol 4-Methylphenol Acetone PCB-1254 Benzene Carbon tetrachloride TCE	1.8 <1 5.2 <1 <1 <1 1.6 <1 <1 <1 8.9 3.9 <1 <1 <1 <1 <1 <1 <1 16.4 1.4 <1 <1 40.8 <1 <1 <1 <1 12.4 <1 <1 4.0	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering Inhalation from household use Ingestion of vegetables from groundwater Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	20.7 3.5 <1 <1 47.6 <1 2.2 25.5

Table F2.16. Summary of Human Health Risk Characterization for SWMU 7 without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations	5 x 10^{-2}	Arsenic Beryllium 1,1,2-TCA 1,1-DCE 1,2-DCE PCB-1248 PCB-1254 PCB-1260 Benzene Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Bis(2ethylhexyl)phthalate Carbon tetrachloride Chloroform Chloromethane Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Tetrachloroethene TCE Vinyl chloride ^{241}Am ^{237}Np ^{239}Pu ^{222}Rn ^{99}Tc ^{230}Th ^{234}U ^{235}U $^{235/236}$U ^{238}U	14.6 42.6 <1 <1 <1 <1 1.5 <1 <1 <1 1.0 <1 <1 <1 <1 <1 1.2 <1 <1 3.3 10.2 <1 1.2 <1 <1 7.4 <1 2.2 <1 <1 11.5	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering Inhalation from household use Ingestion of vegetables from groundwater Ingestion of soil Dermal contact with soil External exposure to soil Ingestion of vegetables from soil	13.1 <1 <1 3.5 20.3 <1 20.3 1.2 38.9	446	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Fluoride Iron Manganese Mercury Molybdenum Nickel Nitrate-nitrite Uranium Vanadium Zinc 1,2-*cis*-DCE 1,2- DCE (total) 2,4-Dimethylphenol 2-Methylphenol 4-Methylphenol Acetone PCB-1254 Carbon tetrachloride TCE	1.8 <1 5.4 <1 <1 <1 1.6 <1 <1 <1 8.8 4.3 <1 <1 <1 <1 15.0 <1 <1 <1 39.0 <1 <1 <1 <1 14.8 <1 4.3	Ingestion of groundwater Dermal contact with groundwater Inhalation from household use Ingestion of vegetables from groundwater Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	25.1 5.3 <1 44.2 <1 1.2 23.8
Future excavation worker at current concentrations	2 x 10^{-3}	Arsenic Beryllium Benzo(a)pyrene Dibenzo(a,h)anthracene ^{237}Np ^{239}Pu ^{234}U ^{235}U $^{235/236}$U ^{238}U	1.8 42.5 <1 1.7 <1 <1 3.4 9.4 <1 41.3	Ingestion of soil Dermal contact with soil External exposure to soil	25.6 43.8 32.5	5	Aluminum Antimony Arsenic Chromium Copper Iron Manganese Nickel Uranium Vanadium	5.0 11.3 3.4 17.6 2.9 21.3 11.0 3.9 7.5 10.9	Ingestion of soil Dermal contact with soil	18.4 81.5

Table taken from Executive Summary *Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1604/V2&D1 July 1997
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario no evaluated or not of concern. Total ELCR and total HI columns reflect values from Tables 1.59 to 1.70 of DOE 1997 without lead included.
[a] %Total HI for COCs and PCBs values do not include lead as a COC. Tables 1.59 to 1.70 of DOE 1997 present the systemic toxicity with lead included.

Table F2.17. Summary of Human Health Risk Characterization for SWMU 30 without Lead as a COPC

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	4 x 10^{-3}	Arsenic Beryllium PCB-1260 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Indeno(1,2,3-cd)pyrene ^{237}Np ^{234}U ^{235}U $^{235/236}$U ^{238}U	<1 97.3 <1 <1 <1 <1 <1 <1 <1 <1 <1 1.4	Ingestion of soil Dermal contact with soil External exposure to soil	<1 97.3 1.7	4	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium	5.1 3.7 2.7 10.7 3.5 13.5 19.8 11.3 9.0 17.6	Ingestion of soil Dermal contact with soil	2.9 97.0
Future industrial worker at current concentrations	4 x 10^{-3}	Arsenic Beryllium 1,1-DCE PCB-1260 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Bis(2ethylhexyl)phthalate Carbon tetrachloride Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Tetrachloroethene TCE Vinyl chloride ^{241}Am ^{237}Np ^{239}Pu ^{222}Rn ^{99}Tc ^{234}U ^{235}U $^{235/236}$U ^{238}U	1.3 90.0 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 3.0 <1 <1 <1 <1 2.5 <1 <1 <1 <1 1.4	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering Ingestion of soil Dermal contact with soil External exposure to soil	4.0 <1 3.0 <1 90.0 1.6	12	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Nitrate Uranium Vanadium Carbon tetrachloride Di-n-octylphthalate TCE	2.0 1.4 2.7 4.0 1.3 6.5 7.7 4.3 1.9 3.7 7.1 1.3 19.0 34.2	Ingestion of groundwater Dermal contact with groundwater Ingestion of soil Dermal contact with soil	33.1 28.8 1.1 36.3
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	0.04	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	0.04	NE	NE	NE	NE

Table F2.17. Summary of Human Health Risk Characterization for SWMU 30 without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future adult recreational user at current concentrations	2 x 10^{-5}	PCB-1260 Benzo(a)pyrene Dibenzo(a,h)anthracene	48.0 12.7 20.7	Ingestion of deer Ingestion of rabbit Ingestion of quail	8.7 80.0 11.3	0.04	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	334	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Fluoride Chromium VI Iron Manganese Mercury Nickel Nitrate Nitrate as nitrogen Selenium Uranium Vanadium Zinc 1,2- DCE (total) PCB-1254 Bis(2ethylhexyl)phthalate Carbon tetrachloride Di-n-octylphthalate TCE	3.3 <1 6.6 <1 1.4 1.7 3.0 <1 <1 <1 18.0 2.0 <1 <1 <1 <1 <1 37.1 2.5 <1 <1 2.0 <1 1.7 1.8 14.4	Ingestion of groundwater Dermal contact with groundwater Inhalation while showering Inhalation from household use Ingestion of vegetables from groundwater Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	8.0 2.7 <1 1.3 8.7 1.0 7.4 70.7

Table F2.17. Summary of Human Health Risk Characterization for SWMU 30 without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future adult rural	4×10^{-2}	Arsenic	5.5	Ingestion of	1.8	105	Aluminum	3.1	Ingestion of	10.4
resident at current		Beryllium	47.7	groundwater	<1		Antimony	<1	groundwater	4.6
concentrations		1,1,2-TCA	<1	Dermal contact with			Arsenic	6.7	Dermal contact with	
		1,1-DCE	<1	groundwater	<1		Barium	<1	groundwater	<1
		PCB-1254	<1	Inhalation while			Beryllium	1.1	Inhalation from	
		PCB-1260	1.3	showering	2.1		Cadmium	1.7	household use	8.8
		Benz(a)anthracene	<1	Inhalation from			Chromium	2.8	Ingestion of	
		Benzo(a)pyrene	3.2	household use	22.7		Copper	<1	vegetables from	<1
		Benzo(b)fluoroanthene	<1	Ingestion of			Iron	17.3	groundwater	4.6
		Benzo(k)fluoroanthene	<1	vegetables from	<1		Manganese	1.6	Ingestion of soil	70.4
		Bis(2ethylhexyl)phthalate	<1	groundwater	25.0		Mercury	<1	Dermal contact with	
		Carbon tetrachloride	<1	Ingestion of soil	<1		Nickel	<1	soil	
		Chloroform	<1	Dermal contact with	45.5		Nitrate	<1	Ingestion of	
		Chrysene	<1	soil			Uranium	35.9	vegetables from	
		Dibenzo(a,h)anthracene	1.3	External exposure to			Vanadium	2.0	soil	
		Indeno(1,2,3-cd)pyrene	<1	soil			Zinc	<1		
		Tetrachloroethene	<1	Ingestion of			1,2- DCE (total)	<1		
		TCE	3.9	vegetables from			PCB-1254	2.0		
		^{241}Am	<1	soil			Carbon tetrachloride	1.3		
		^{237}Np	<1				Di-n-octylphthalate	3.0		
		^{239}Pu	<1				TCE	16.9		
		^{226}Ra	<1							
		^{222}Rn	<1							
		^{99}Tc	21.4							
		^{230}Th	3.2							
		^{234}U	<1							
		^{235}U	<1							
		$^{235/236}U$	8.4							
		^{238}U								

Table F2.17. Summary of Human Health Risk Characterization for SWMU 30 without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future excavation worker at current concentrations	1 x 10^{-3}	Arsenic Beryllium PCB-1248 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene ^{237}Np ^{239}Pu ^{234}U ^{235}U $^{235/236}$U ^{238}U	2.0 91.7 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 <1 4.1	Ingestion of soil Dermal contact with soil External exposure to soil	6.3 91.7 3.3	4	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium	5.0 6.8 3.6 3.4 3.2 11.1 21.5 15.6 13.3 13.8	Ingestion of soil Dermal contact with soil	20.0 80.0

Table taken from Executive Summary *Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1604/V2&D1 July 1997
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario no evaluated or not of concern. Total ELCR and total HI columns reflect values from Tables 1.59 to 1.70 of DOE 1997 without lead included.
[a] %Total HI for COCs and PCBs values do not include lead as a COC. Tables 1.59 to 1.70 of DOE 1997 present the systemic toxicity with lead included.

Table F2.18. Summary of Human Health Risk Characterization for the North Ditch without Lead as a COPC

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	4×10^{-4}	Arsenic Beryllium PCB-1260 $^{235/236}U$ ^{238}U	7.6 84.2 <1 4.5	Ingestion of soil Dermal contact with soil External exposure to soil	1.0 92.1 5.0	5	Aluminum Antimony Arsenic Chromium Iron Manganese Uranium Vanadium	6.6 5.7 3.7 14.4 24.9 15.3 3.2 22.5	Dermal contact with soil	98.8
Future industrial worker at current concentrations	4×10^{-4}	Arsenic Beryllium PCB-1260 $^{235/236}U$ ^{238}U	7.6 84.2 1.2 8.2 4.5	Ingestion of soil Dermal contact with soil External exposure to soil	1.0 92.1 5.0	5	Aluminum Antimony Arsenic Chromium Iron Manganese Uranium Vanadium	6.6 5.7 3.7 14.4 24.9 15.3 3.2 22.5	Dermal contact with soil	98.8
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	0.004	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	0.003	NE	NE	NE	NE
Future adult recreational user at current concentrations	1×10^{-6}	NE	NE	NE	NE	0.004	NE	NE	NE	NE
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	229	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Nickel Uranium Vanadium Zinc	7.0 1.9 14.1 1.1 <1 <1 4.4 <1 36.2 4.3 <1 23.4 4.7 <1	Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	1.3 12.3 86.4

Table F2.18. Summary of Human Health Risk Characterization for the North Ditch without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future adult rural resident at current concentrations	9×10^{-3}	Arsenic Beryllium PCB-1260 ^{237}Np ^{234}U $^{235/236}U$ ^{238}U	37.8 21.1 9.7 <1 5.0 1.1 24.4	Ingestion of soil Dermal contact with soil External exposure to soil Ingestion of vegetables from soil	<1 11.1 2.6 84.4	68	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Nickel Uranium Vanadium Zinc	7.0 1.6 14.6 1.1 <1 <1 4.0 <1 37.3 3.8 1.0 23.8 3.8 <1	Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	<1 7.9 91.6
Future excavation worker at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table taken from Executive Summary *Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1604/V2&D1 July 1997
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario no evaluated or not of concern. Total ELCR and total HI columns reflect values from Tables 1.59 to 1.70 of DOE 1997 without lead included.
[a] %Total HI for COCs and PCBs values do not include lead as a COC. Tables 1.59 to 1.70 of DOE 1997 present the systemic toxicity with lead included.

Table F2.19. Summary of Human Health Risk Characterization for the South Ditch without Lead as a COPC

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Current industrial worker at current concentrations	4 x 10^{-4}	Arsenic Beryllium PCB-1260 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Dibenzo(a,h)anthracen e Indeno(1,2,3- cd)pyrene ^{237}Np $^{235/236}$U ^{238}U	4.7 58.3 1.9 1.3 16.9 3.1 2.3 1.0 <1 2.2 6.9	Ingestion of soil Dermal contact with soil External exposure to soil	1.7 88.9 9.2	5	Aluminum Antimony Arsenic Cadmium Chromium Iron Manganese Nickel Uranium Vanadium	6.9 16.0 2.1 2.4 10.7 17.3 9.8 4.6 9.2 17.6	Dermal contact with soil	98.2
Future industrial worker at current concentrations	4 x 10^{-4}	Arsenic Beryllium PCB-1260 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Dibenzo(a,h)anthracen e Indeno(1,2,3- cd)pyrene ^{237}Np $^{235/236}$U ^{238}U	4.7 58.3 1.9 1.3 16.9 3.1 2.3 1.0 <1 2.2 6.9	Ingestion of soil Dermal contact with soil External exposure to soil	1.7 88.9 9.2	5	Aluminum Antimony Arsenic Cadmium Chromium Iron Manganese Nickel Uranium Vanadium	6.9 16.0 2.1 2.4 10.7 17.3 9.8 4.6 9.2 17.6	Dermal contact with soil	98.2
Future child recreational user at current concentrations	NA	NA	NA	NA	NA	0.005	NE	NE	NE	NE
Future teen recreational user at current concentrations	NA	NA	NA	NA	NA	0.005	NE	NE	NE	NE
Future adult recreational user at current concentrations	2 x 10^{-6}	PCB-1260	66.7	Ingestion of rabbit	83.3	0.006	NE	NE	NE	NE

Table F2.19. Summary of Human Health Risk Characterization for the South Ditch without Lead as a COPC (Continued)

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI[a]	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future child rural resident at current concentrations	NA	NA	NA	NA	NA	334	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Nickel Uranium Vanadium Zinc PCB-1260	4.9 3.5 5.6 <1 <1 1.4 2.3 1.6 17.9 1.9 <1 9.5 46.4 2.7 <1	Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	1.3 8.5 90.1
Future adult rural resident at current concentrations	1×10^{-2}	Arsenic Beryllium PCB-1016 PCB-1260 Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoroanthene Benzo(k)fluoroanthene Bis(2ethylhexyl)- phthalate Chrysene Dibenzo(a,h)anthra- cene Indeno(1,2,3- cd)pyrene ^{237}Np ^{234}U $^{235/236}$U ^{238}U	14.2 8.6 <1 10.0 1.6 20.7 3.8 <1 <1 <1 2.8 1.2 1.1 8.57 1.8 23.6	Ingestion of soil Dermal contact with soil External exposure to soil Ingestion of vegetables from soil	<1 6.7 2.9 85.7	101	Aluminum Antimony Arsenic Barium Cadmium Chromium Copper Iron Manganese Mercury Nickel Uranium Vanadium Zinc PCB-1016	5.0 3.1 5.8 <1 1.3 2.0 1.6 17.8 1.6 <1 9.8 47.2 2.2 1.4 <1	Ingestion of soil Dermal contact with soil Ingestion of vegetables from soil	<1 5.5 94.2
Future excavation worker at current concentrations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table taken from Executive Summary *Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1604/V2&D1 July 1997

NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.

NE = Land use scenario no evaluated or not of concern. Total ELCR and total HI columns reflect values from Tables 1.59 to 1.70 of DOE 1997 without lead included.

[a] %Total HI for COCs and PCBs values do not include lead as a COC. Tables 1.59 to 1.70 of DOE 1997 present the systemic toxicity with lead included.

Table F2.20. Summary Human Health Risk Characterization for Future Risk at Future Modeled Concentrations for SWMUs 7 and 30 and Associated Ditches

Receptor	Total ELCR	ELCR COCs	% Total ELCR	ELCR POCs	% Total ELCR	Total HI	Systematic Toxicity COCs	% Total HI	Systematic Toxicity POCs	% Total HI
Future child rural resident at future modeled concentrations – 30 years	NA	NA	NA	NA	NA	0.08	NE	NE	NE	NE
Future child rural resident at future modeled concentrations – 100 years	NA	NA	NA	NA	NA	0.3	NE	NE	NE	NE
Future adult rural resident at future modeled concentrations – 30 years	5×10^{-5}	Vinyl chloride ^{99}Tc	7.5 91.7	Ingestion of groundwater Inhalation from household use	95.8 3.75	0.03	NE	NE	NE	NE
Future adult rural resident at future modeled concentrations – 100 years	2×10^{-4}	Vinyl chloride ^{99}Tc	7.0 90.0	Ingestion of groundwater Inhalation from household use	95.0 2.75	0.1	NE	NE	NE	NE

Table taken from Executive Summary *Remedial Investigation Report for Solid Waste Management Units 7 and 30 of Waste Area Grouping 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/OR/07-1604/V2&D1 July 1997
NA = ELCR not applicable to child and teen cohorts. Values for adult include exposure as child and teen.
NE = Land use scenario no evaluated or not of concern. Total ELCR and total HI columns reflect values from Tables 1.59 to 1.70 of DOE 1997 without lead included.

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ATTACHMENT F3

PROUCL OUTPUT FILES

AND

ATTACHMENT F4

LOCATIONS OF SURFACE SOIL CONTAMINATION

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Attachments F3 and F4 are found on the CD.

Attachment F3 contains the PROUCL output files used to determine the exposure point concentration for all COPCs. The output files are only for those COPCs that had more than 9 detects (DOE 2008).

Attachment F4 contains the locations of surface soil detections for those chemicals detected above screening levels.

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APPENDIX F

ATTACHMENT F3
PROUCL OUTPUT FILES
AND
ATTACHMENT F4
LOCATIONS OF SURFACE SOIL CONTAMINATION

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APPENDIX G

SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

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ACRONYMS

ASV	NFA Screening Value
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
COPC	contaminant of potential concern
CSM	conceptual site model
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
KDEP	Kentucky Department for Environmental Protection
NFA	no further action
NV	no screening value
Paducah OREIS	Paducah Oak Ridge Environmental Information System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
SERA	Screening-Level Ecological Risk Assessment
SVOC	semivolatile organic compound
SWMU	solid waste management unit
^{99}Tc	technetium-99
TCE	trichloroethene
TEF	toxicity equivalence factor
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area

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G.1. INTRODUCTION

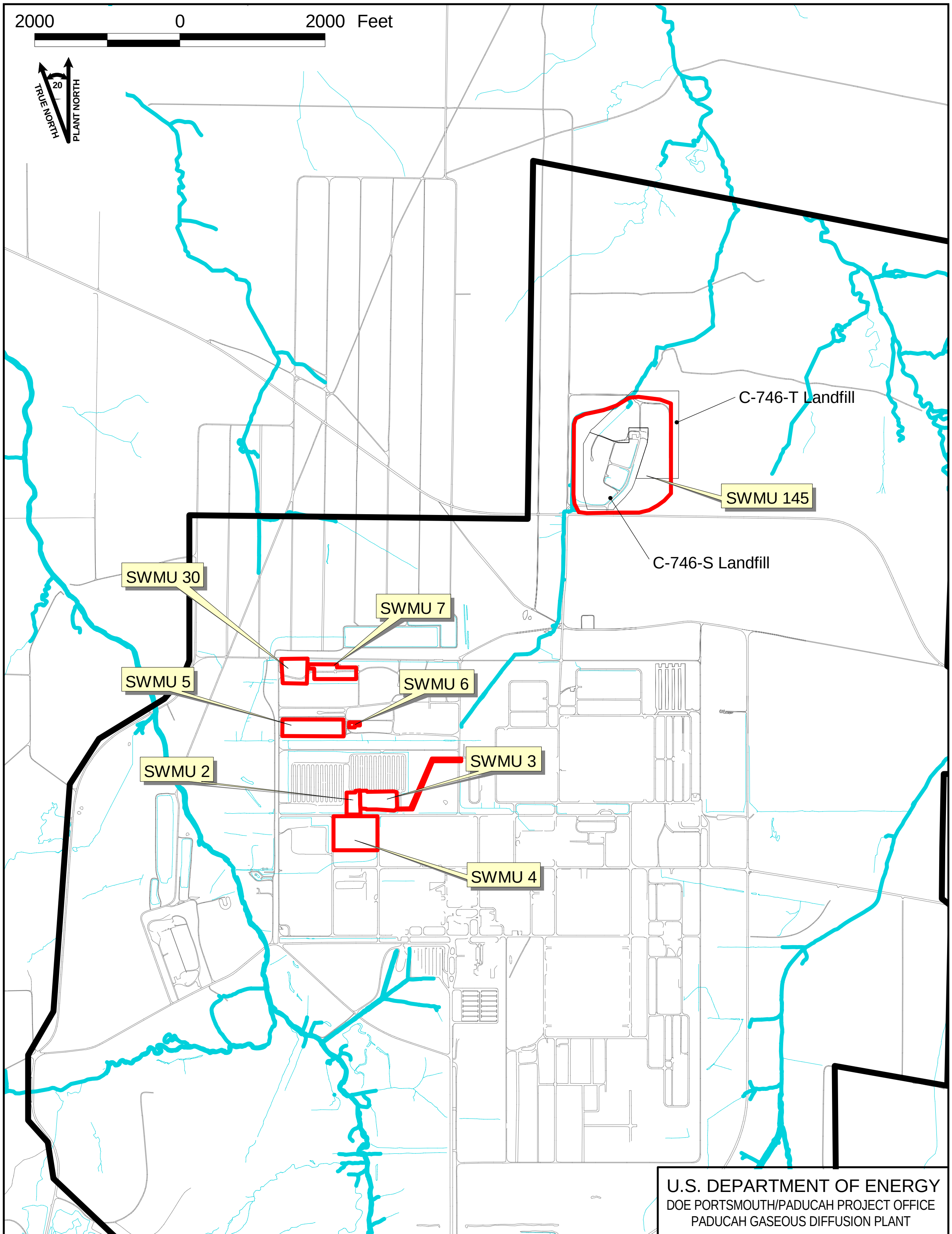
G.1.1 SITE LOCATION

The current Screening-Level Ecological Risk Assessment (SERA) includes Solid Waste Management Units (SWMUs) 2, 3, 4, 5, 6, 7, and 30 within the Burial Grounds Operable Unit (BGOU) of Paducah Gaseous Diffusion Plant (PGDP) (Figure G.1). SWMU 145, sited on 44 acres that now lie beneath the C-746-S&T Landfills, also is included in the SERA. A review of the data in Paducah Oak Ridge Environmental Information System (OREIS) determined that all surface samples from that SWMU represented the ditch areas outside SWMU 145 and were not representative of surface soil concentrations within SWMU 145. SWMU 145 therefore is addressed only qualitatively in the uncertainty section. SWMUs 2, 3, 4, 5, 6, 7, and 30 are located within the developed area of the PGDP facility. SWMUs 2, 3, and 4 are in the west-central area of the plant inside the security fence-lined area. SWMU 4 is bounded on all sides by plant roads and an active railroad spur (see Section 1.3 of the main text). SWMUs 5, 6, 7, and 30 are in the northwestern section of the PGDP secured area. Some of the area surrounding the PGDP facility is a recreational wildlife area, the West Kentucky Wildlife Management Area (WKWMA), with residential areas lying beyond the WKWMA. Private land under rural residential and agricultural areas also borders the PGDP facility.

G.1.2 SITE HISTORY

All the SWMUs considered in this SERA originally were burial pits or landfills for process wastes from PGDP. The individual waste streams, burial practices, and operating time frames for each SWMU are described in-depth in Section 1.3 of this Remedial Investigation Report, and that material is briefly summarized here.

SWMU 2 was used primarily for the disposal of uranium metal pieces, uranium oxides, oils [that may have contained polychlorinated biphenyls (PCBs)], trichloroethene (TCE), and uranyl fluoride. Some technetium-99 (^{99}Tc) also may be present at this SWMU associated with the uranium wastes. SWMU 3 was an aboveground earth and clay surface impoundment with an overflow weir that subsequently was converted for disposal of solid uranium-contaminated wastes (uranium metal, uranium oxides, smelter furnace liners, and radioactively contaminated trash). This SWMU also includes an adjacent ditch that carried leachate from the surface impoundment. The landfill ceased operation in 1986 and was covered with a Resource Conservation and Recovery Act (RCRA) multilayered cap. SWMU 4 is an open vegetated field that was used to bury wastes in designated burial cells. This SWMU may have received uranium- and ^{99}Tc-contaminated sludge as well as TCE. SWMU 4 was covered in 1982 with 2 to 3 ft of soil material and a 6-inch clay cap. SWMU 5 contained disposal cells laid out in a grid pattern. Slag from nickel and aluminum smelters was disposed of here along with radioisotopes. Waste cells in SWMU 5 were covered with 2 to 3 ft of soil after they were filled. SWMU 6 also was divided into discrete burial cells: two for magnesium scrap, one for exhaust fan hoods contaminated with perchloric acid (see Section 2.5.4 of the main text for further discussion of the instability of perchloric acid), one for contaminated aluminum scrap, and one area for a single contaminated modine trap. SWMU 7 contains burial pits that were used for disposal of noncombustible, uranium-contaminated and uncontaminated trash, material, and equipment. SWMU 30 contained an area used for burning combustible trash that may have contained uranium contamination. The ash and debris from the incineration were buried below ground in a pit at SWMU 30. SWMU 145 contains landfills used to discard scrap and waste materials, including construction debris.



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure G.1. Location of the BGOU SWMUs

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure No. \BGOU\RI.apr
DATE 08-02-07

Trends in TCE concentration in soil and groundwater suggest dense nonaqueous-phase liquid (DNAPL) is present at SWMUs 4 and 30. Some of the burial ground SWMUs ceased operation in the 1950s, but others were in use as late as 1977. After each unit ceased to be used for waste burial, it was covered with a soil cap. SWMU 3 was closed with the addition of a RCRA cap in 1987. Previous sampling identified a groundwater plume of dissolved phase TCE in the subsurface under most of these SWMUs.

G.2. SCREENING-LEVEL PROBLEM FORMULATION

The first step in a SERA includes the problem formulation. This step encompasses development of the preliminary conceptual site model (CSM), determination of potentially complete exposure pathways and potentially contaminated media, selection of exposure endpoints, and selection of screening levels protective of the endpoints and potentially exposed receptors at the site.

G.2.1 PRELIMINARY CONCEPTUAL SITE MODEL

The preliminary CSM includes a description of the environmental setting, known site contaminants, and a figure representing the potential exposure pathways. This preliminary CSM is used as the basis for selection of benchmark values used to screen the site for potential ecological risk.

G.2.1.1 Site Environmental Setting and Habitat Descriptions

The SWMUs included in this SERA are generally similar in topography and process history. All the SWMUs, except SWMU 3, originally served as burial grounds or landfills for process wastes from PGDP operations. Once the pits within the burial grounds no longer were being used, they were topped with soil covers and most sites were revegetated. SWMU 3, however, was covered with a RCRA cap. Although there is potential for contamination below the surface to migrate laterally toward surface water, the direction of shallow groundwater flow is primarily downward and represents limited risks to terrestrial receptors near these sites. Figures G.2 to G.9 show the surface conditions at the SWMUs considered in this report.

The terrestrial ecosystems occurring in the area of these SWMUs are described more fully in the work plan for the BGOU (DOE 2006a). This section presents a brief summary of the ecosystem relevant to defining the CSM and exposure pathways. The primary ecosystem in the area outside the industrial area around the SWMUs is upland grassland interspersed with developed industrial areas. The vegetation over these SWMUs is maintained with routine mowing (see section 3.1) approximately eight times per year. Most of the SWMUs also are surrounded by fencing and/or roads. The buffer area and areas bordering the PGDP facility include forest, thickets, and agricultural land. Much of the PGDP facility is surrounded by the WKWMA, which includes managed native prairie and deciduous forest. Species documented to occur in the area include numerous small mammals, particularly shrews, mice, and voles. Numerous bird species, including doves, turkey, quail, bluebirds and other songbirds, as well as hawks and owls, are found in this area. There also are amphibians, reptiles (primarily lizards and turtles), and bats. Table G.1 lists species observed in the nonindustrial areas of the PGDP and at the adjacent WKWMA.

Figure G.2. Surface of SWMU 2

Figure G.3. Surface of SWMU 3

Figure G.4. Surface of SWMU 4 (Area behind Fence)

Figure G.5. Surface of SWMU 5 (behind Fence)

Figure G.6. Surface of SWMU 6

Figure G.7. Surface of SWMU 7 (Field with Tree Surrounded by Road)

Figure G.8. SWMU 30 (Foreground, SWMU 7 Is in Upper Left)

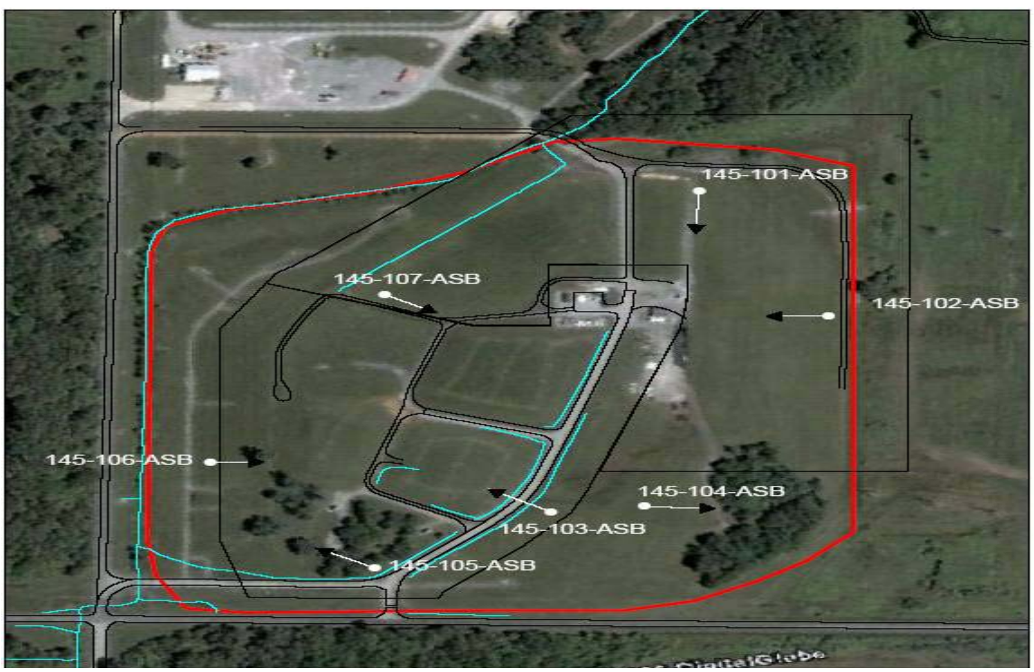


Figure G.9. Aerial View of Landfills at SWMU 145

Table G.1. Wildlife Species Present or Potentially Present at the PGDP Site[a]

Common Name	Scientific Name
Fish	
Black Buffalo	*Ictiobus niger*
Blackspotted Topminnow	*Fundulus olivaceus*
Creek Chub	*Semotilus atromaculatus*
Bluegill sunfish	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
Redspotted Sunfish	*Lepomis miniatus*
Largemouth bass	*Micropterus salmoides*
Longear sunfish	*Lepomis megalotis*
Stoneroller	*Campostoma sp.*
Reptiles and Amphibians	
American Toad	*Bufo americanus*
Bull frog	*Rana catesbeiana*
Eastern box turtle	*Terrapene carolina*
Leopard frog	*Rana sphenocephala*
Salamanders	Various species
Snakes	Various species
Green Treefrog	*Hyla cinerea*
Woodhouse toad	*Bufo woodhousei*
Northern crawfish frog	*Rana areolata circulosa*
Green frog	*Rana clamitans melanota*
Upland chorus frog	*Pseudacris triseriata feriiarum*
Birds	
American robin	*Turdus migratorius*
American woodcock	*Scolopax minor*
Bald eagle	*Haliaeetus leucocephalus*
Barred owl	*Strix varia*
Belted kingfisher	*Ceryle alcyon*
Blue jay	*Cyanocitta cristata*
Blue-winged teal	*Anas discors*
Canada goose	*Branta canadensis*
Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
Downy woodpecker	*Picoides pubescens*
Eastern bluebird	*Sialis sialus*
Eastern kingbird	*Tyrannus tyrannus*
Eastern meadowlark	*Sturnella magna*
Eastern phoebe	*Sayornis phoebe*

Table G.1. Wildlife Species Present or Potentially Present at the PGDP Site[a] (Continued)

Common Name	Scientific Name
Bird (Continued)	
Eastern wood pewee	*Contopus virens*
Gadwall duck	*Anas strepera*
Great Blue Heron	*Ardea herodias*
Great Crested Flycatcher	*Myiarchus crinitus*
Great-horned owl	*Bubo virginianus*
Hairy woodpecker	*Picoides villosus*
Hawks	Various species
Herons and egrets	Various species
Killdeer	*Charadrius vociferus*
Loggerhead shrike	*Lanius ludovicianus*
Mallard duck	*Anas platyrhynchus*
Mourning dove	*Zenaida macroura*
Northern bobwhite (aka bobwhite quail)	*Colinus virgianus*
Northern cardinal	*Cardinalis cardinalis*
Northern flicker	*Colaptes auratus*
Pileated woodpecker	*Dryocopus pileatus*
Red-bellied woodpecker	*Melanerpes erythrocephalus*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Ruby-throated hummingbird	*Archilochus colubris*
Screech owl	*Megascops asio*
Song sparrow	*Melospiza melodia*
Swallows	Various species
vireos	Various *vireo sp.*
Tufted titmouse	*Baeolophus bicolor*
Turkey Vulture	*Cathartes aura*
Warblers	*Various species*
Chuck-will's widow	*Caprimulgus carolinensis*
White-breasted nuthatch	*Sitta carolinensis*
Whip-poor-will	*Caprimulgis vocifierous*
Wild turkey	*Meleagris gallopavo*
Wood cock	*Scolopax minor*
Wood duck	*Aix sponsa*
Wrens	Various species
Yellow-billed cuckoo	*Coccyzus americanus*

Table G.1. Wildlife Species Present or Potentially Present at the PGDP Site (Continued)

Common Name	Scientific Name
Mammals	
American beaver	*Castor canadensis*
American mink (aka mink)	*Mustela vison*
Bobcat	*Lynx rufus*
Common muskrat	*Ondatra zibethicus*
Coyote	*Canis latrans*
Eastern cottontail	*Sylvilagus floridanus*
Eastern grey squirrel and fox squirrel	*Sciurus carolinensis*
Evening bat	*Nycticeceius humeralis*
Groundhog	*Marmota monax*
Indiana bat	*Myotis sodalist*
Mice	Various species
Moles	Various species
Opposum	*Didelphis virginiana*
Raccoon	*Procyon lotor*
Red fox	*Vuples vulpes*
Grey fox	*Urocyon cinereoargenteus*
Shrews	Various species
Skunk	Mephitis mephitis
Southeastern myotis bat	Myotis sodalis
Voles	Various species
White-tailed deer	*Odocoileus virginianus*

[a] The listed species are the Surface Water Operable Unit Report (DOE 2006b) and the WKWMA species information website (http://fw.ky.gov/kfwis/arcims/WmaSpecies.asp?strID=137)

A number of state and federal listed, threatened, and endangered species may be present on the buffer areas within PGDP and the surrounding WKWMA land, though they are unlikely to be found on the maintained surface within the SWMUs. These species are listed in Table G.2 of this document. As noted in the footnote to Table G.2, none of the species listed in the table have been reported as sighted on the U.S. Department of Energy (DOE) Reservation.

Table G.2. Federally Listed, Proposed, and Candidate Species Potentially Occurring within the Paducah Site Study Area[a]

Common Name	Scientific Name	Animal Type	Endangered Species Act Status
Indiana bat[b]	Myotis sodalist	Mammal	Listed endangered
Interior least tern	Sterna antillarum athalassos	Bird	Listed endangered
Pink mucket	Lampsilis abrupta	Mussel	Listed endangered
Ring pink	Obovaria retusa	Mussel	Listed endangered
Orangefoot pimpleback	Plethobasus cooperianus	Mussel	Listed endangered
Fat pocketbook	Potamilus capax	Mussel	Listed endangered

[a] All of the listed species are discussed in *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume III,* COE Nashville District, May 1994. Note that the area evaluated in the referenced report encompasses 11,719 acres and extends to include the Ohio River, which is over three miles north of the DOE Reservation. None of these species have been reported as sighted on the DOE Reservation, although potential summer habitat exists there for the Indiana bat. No critical habitat for any of these species has been designated anywhere in the area.
[b] Specimens of the Indiana bat were collected from WKWMA property in 1991 and 1999.

G.2.1.2 Existing Data

The dataset from OREIS developed for the human health risk assessment (Appendix F) for these SWMUs was used as the basis for the SERA. Both detected concentrations and detection limits for nondetected analytes were included in the SERA. No comparison to background concentrations was conducted prior to conducting the screen against the PGDP no further action (NFA) screening levels.

G.2.1.3 Site Contaminants

Surface soil contaminants at the SWMUs were considered in the SERA. Section 4 of this RI Report describes known site contaminants for surface soil at the SWMUs. Table G.3 shows the summary of surface soil contaminants for each SWMU. Site contaminants at all SWMUs included inorganic chemicals, organic chemicals, and radionuclides.

G.2.1.4 Fate and Transport Mechanisms

Potential migration pathways for contaminants from waste and soil at the BGOU include transport of contaminated surface soil off-site by surface water, migration of contaminants to the subsurface soil, migration to groundwater, and uptake of soil contaminants through the on-site food chain. The surface soils at most of the BGOU SWMUs considered in this SERA are held in place by vegetation or, for SWMU 3, by the presence of a RCRA cap with a vegetative cover. Transport of surface soil off-site is likely to be minimal. Migration of contaminants to subsurface soil and through subsurface soil to groundwater is likely to occur. Contaminants in groundwater may be discharged to surface water at areas away from the BGOU SWMUs. Contaminants in surface and subsurface soil are likely to be taken up into plants and soil invertebrates at these sites and would enter higher trophic level organisms through the food chain.

G.2.2 POTENTIALLY COMPLETE EXPOSURE PATHWAYS

Only surface samples (0–1 ft) were included in the screening. Subsurface contamination may be accessible to burrowing ecological receptors. The subsurface interval of interest for this type of exposure would be in the 1–5 ft bgs depth. Insufficient analytical data is available in this depth range at these SWMUs to conduct a quantitative screening of potential exposure to burrowing animals. Burrowing animals also could encounter buried waste, but insufficient characterization is available for the waste to conduct a screening for exposure to materials in waste. Potential ecological risk from exposure to subsurface soil and waste to burrowing animals therefore is addressed qualitatively in the uncertainty section of this SERA. Significant contaminant transport through runoff directly to surface water is unlikely because most of the sites have vegetated surfaces. The pathways through which receptors could contact contaminants in surface soil include direct ingestion of soil, ingestion of plant or animals from the site as food, external exposure to ionizing radiation, and dermal contact with soil or surface water. The CSM is shown in Figure G.10.

G.2.3 POTENTIALLY CONTAMINATED MEDIA

Potential sources within the pits in the burial grounds may have contaminated both surface and subsurface soil. Only surface samples (0-1 ft) were included in the screening. Subsurface contamination and buried waste are addressed qualitatively in the uncertainty section.

Table G.3. Surface Soil Contaminants at the BGOU SWMUs

SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30
			Inorganics (mg/kg)			
Antimony	Antimony	Arsenic	Aluminum	Copper	Aluminum	Aluminum
Arsenic	Uranium	Chromium	Arsenic	Nickel	Antimony	Antimony
Cadmium		Copper	Chromium	Selenium	Arsenic	Cadmium
Chromium		Iron	Nickel	Uranium	Cadmium	Chromium
Copper		Mercury	Selenium		Chromium	Copper
Iron		Nickel	Uranium		Copper	Nickel
Mercury					Iron	Thallium
Nickel					Nickel	Uranium
Selenium					Selenium	Zinc
Thallium					Thallium	
Uranium					Uranium	
			Organics (mg/kg)			
Benz(a)anthracene	TCE	Methylene chloride	Benz(a)anthracene	Benz(a)anthracene	Benz(a)anthracene	Benzo(a)pyrene
Benzo(b) fluoranthene			Benzo(a)pyrene	Benzo(a)pyrene	Benzo(a)pyrene	Benzo(b) fluoranthene
Methylene chloride			Benzo(b) fluoranthene	Benzo(b) fluoranthene	Benzo(b) fluoranthene	Benzo(k) fluoranthene
			Benzo(k) fluoranthene		Dibenz(a,h)anthracene	Chrysene
			Carbazole		Indeno(1,2,3-cd)pyrene	Dibenz(a,h) anthracene
			Chrysene		Pentachlorophenol	Indeno(1,2,3-cd)pyrene
			Dibenz(a,h) anthracene		Methylene chloride	PCB-1260
			Indeno(1,2,3-cd)pyrene		PCB, Total	
			Naphthalene		PCB-1248	
			Pentachlorophenol		PCB-1260	
			1,1-DCE			
			Radionuclides (pCi/g)			
^{137}Cs	$^{239/240}Pu$	^{137}Cs	^{99}Tc	^{99}Tc	^{237}Np	^{237}Np
^{237}Np	^{99}Tc	^{237}Np	^{238}U	^{238}U	^{239}Pu	^{239}Pu
^{239}Pu	^{238}U	$^{239/240}Pu$			$^{239/240}Pu$	^{99}Tc
^{99}Tc		^{99}Tc			^{99}Tc	^{230}Th
^{230}Th		^{234}U			^{228}Th	^{234}U
^{234}U		^{238}U			^{230}Th	$^{235/236}U$
$^{235/236}U$					^{234}U	^{238}U
^{238}U					^{235}U	
					$^{235/236}U$	
					^{238}U	

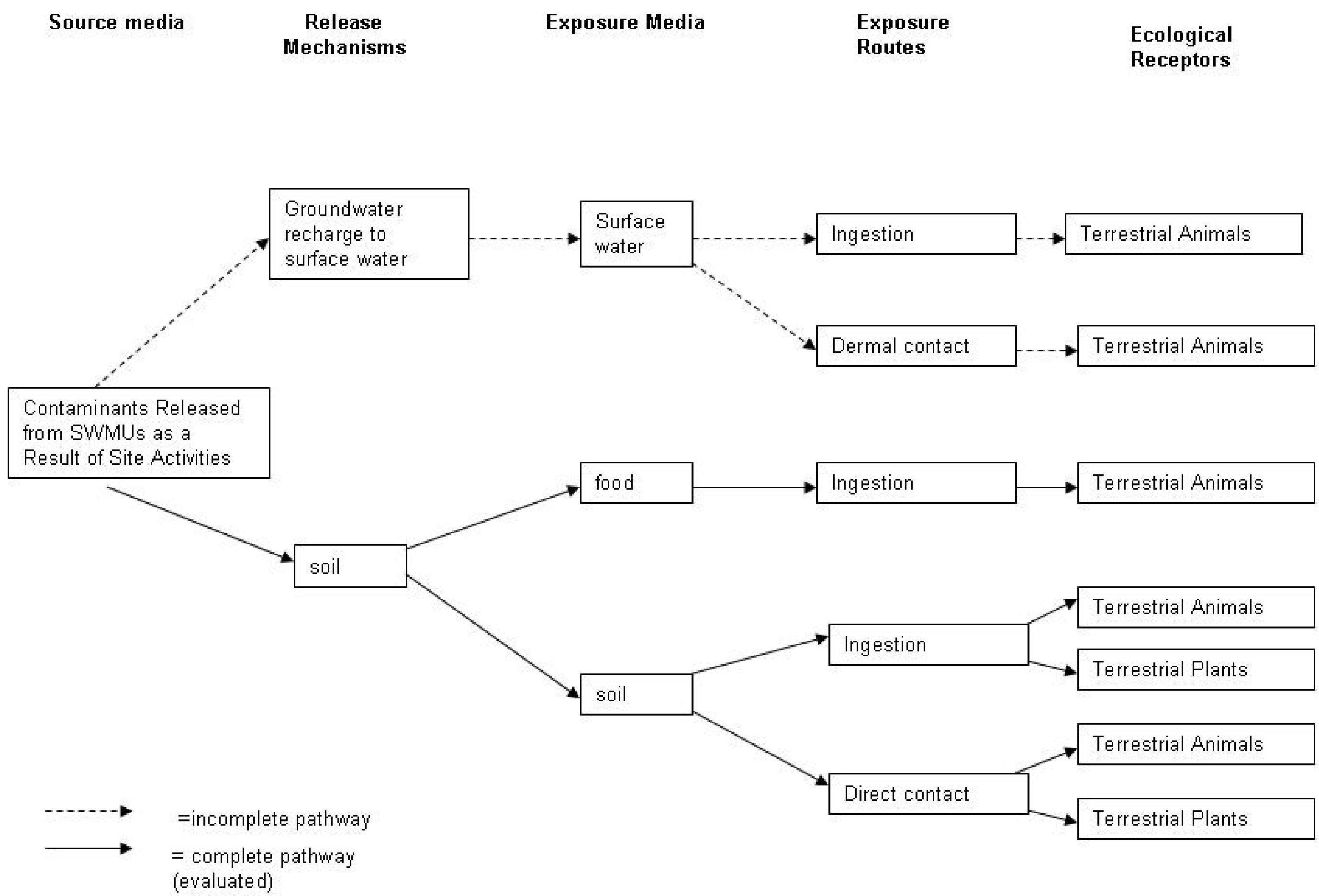


Figure G.10. Preliminary Conceptual Site Model for BGOU SWMUs

G.3. SCREENING-LEVEL EFFECTS EVALUATION

The screening was conducted using the NFA levels provided in Appendix A of the PGDP ecological risk assessment methods document (DOE 2001). These sets of screening levels were developed in 2001, but represent the established consensus compilation of available values from state and federal agencies. These values were considered the most appropriate screening levels for this SERA.

G.3.1 SOIL NFA LEVELS

Soil NFA screening levels are available for most metals and radionuclides, along with some pesticides, semivolatile organic compounds (SVOCs) [including some individual polyaromatic hydrocarbons (PAHs)], and volatile organic compound (VOCs). There are no soil screening levels for individual PCBs, but there is a screening level for total PCBs and also one for total PAHs. The NFA screening levels for soil do not take into account the background concentrations of those metals and radionuclides that are naturally occurring. Soil NFA levels for inorganic and organic constituents were based on the lower of the U.S. Environmental Protection Agency (EPA) Region 4 screening levels and the Kentucky Department for Environmental Protection (KDEP) soil screening values. The soil NFA levels for radionuclides are based on the Ecological Risk Assessment Working Group consensus dose, which is the National Council on Radiation Protection 0.1 rad/day threshold dose. The soil NFAs are based on the calculated dose to soil-dwelling invertebrates.

G.4. SCREENING-LEVEL EXPOSURE ESTIMATES

G.4.1 DATA SUMMARY

This SERA includes SWMUs 2, 3, 4, 5, 6, 7, and 30 at PGDP. SWMU 145 originally was included in the SERA, but a review of the data in OREIS determined that all surface samples from that SWMU represented the ditch areas outside SWMU 145 and were not representative of surface soil concentrations within SWMU 145. The dataset from OREIS developed for the human health risk assessment in this document was used as the dataset from which the maximum concentrations were developed. The dataset used to determine maximum concentrations for the SERA included some analytes that were not assessed in the Baseline Human Health Risk Assessment: those detected only below their background concentrations and analytes that may have been removed as essential nutrients in the human health risk assessment. For any analyte detected at a site, the maximum concentration was represented by the maximum detected concentration or the maximum detection limit, if that detection limit was higher than the concentration in the maximum detected sample.

Screening levels also are available for some classes of compounds (PCBs and PAHs). To calculate values for the total PAHs, the maximum detected concentration for each detected PAH was adjusted by its toxicity equivalence factor (TEF) (see Appendix F for a discussion of TEFs) and the weighted values were summed to determine the total concentration for the PAH class. The total concentration then was compared to the soil NFA level for total PAHs. The maximum detected concentration for each detected PCB was summed to develop a value for the PCB class. If no PCBs were detected at a SWMU, there was no evaluation in the SERA of the PCB class for that SWMU.

A summary of the results of the comparison of the site data to the NFA levels is provided in Table G.4. This table lists the number of chemicals of potential concern (COPCs) in each suite retained for each site and the medium for further consideration. This table shows that most inorganic analytes and detected organic analytes were retained. Radionuclides were eliminated as COPCs for all sites except for one that was retained for SWMU 7.

Table G.4. Summary of Suite of COPCs Retained in Surface Soil

Area	Media	Metal	Rad	Pesticides/PCB	SVOC	VOC
SWMU 2	Soil	22	----	7	12	----
SWMU 3	Soil	16	----	----	----	2
SWMU 4	Soil	19	----	1	----	----
SWMU 5	Soil	19	----	1	22	1
SWMU 6	Soil	18	----	----	12	----
SWMU 7	Soil	23	1	4	21	2
SWMU 30	Soil	22	----	2	21	----

----: no COPCs

In accordance with the PGDP ERA guidance, if a detection limit exceeded the maximum detected concentration, then the maximum concentration was set at the detection limit. A number of COPCs were retained using these detection-limit based concentrations. For these COPCs, the table for the site is footnoted to indicate whether this COPC also would be retained if the maximum detected concentration had been used for comparison to the screening value.

The next section presents the screening results for each of the individual SWMUs. Only site contaminants retained as COPCs are listed in the tables. All nonradionuclide analytes retained as COPCs are listed, along with their maximum concentration, NFA screening level (if a level is available), and the reason that the COPCs were retained for further ecological evaluation. All radionuclide COPCs (except for one at SWMU 7) were well below their screening levels; therefore, only the one retained radionuclide COPC is listed in the following tables. An analyte was retained as a COPC if the maximum concentration was above its NFA screening value (ASV) or if no NFA screening value was available (NV).

G.4.2 SWMU 2

Selected COPCs for SWMU 2 are listed in Table G.5.

Table G.5. SWMU 2 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
	Metals (mg/kg)		
Aluminum	11,000	5	ASV
Arsenic	30	1	ASV
Barium	160	20	ASV
Beryllium	1.8[a]	0.19	ASV
Cadmium	0.45	0.11	ASV
Calcium	5,600		NV
Chromium	30	0.04	ASV
Cobalt	11	2.5	ASV
Copper	30	0.45	ASV
Iron	42,000	110	ASV
Lead	29	20	ASV
Magnesium	1,600		NV
Manganese	540	25	ASV
Mercury	0.43	0.1	ASV

Table G.5. SWMU 2 Selected COPCs (Continued)

Analyte	Result	Soil NFA value	Rationale
Nickel	37	11	ASV
Potassium	1,000		NV
Selenium	1.7	0.21	ASV
Sodium	180		NV
Thallium	4.5	1	ASV
Uranium	943	5	ASV
Vanadium	34	2	ASV
Zinc	140	8.5	ASV
Pesticides/PCBs (mg/kg)			
alpha-Chlordane	0.00078		NV
delta-BHC	0.09		NV
Endrin ketone	0.0076		NV
PCB-1254	1.1		NV
PCB-1260	0.5		NV
PCB	1.1		NV
gamma-Chlordane	0.003		NV
SVOCs (mg/kg)			
2-Methylnaphthalene	0.69		NV
4-Methylphenol	0.061		NV
Benz(a)anthracene	0.13		NV
Benzo(a)pyrene	0.14	0.1	ASV
Benzo(b)fluoranthene	0.27		NV
Benzo(ghi)perylene	0.15		NV
Chrysene	0.17		NV
Dibenzofuran	0.18		NV
Fluoranthene	0.34	0.1	ASV
Naphthalene	0.36	0.1	ASV
Phenanthrene	0.57	0.1	ASV
Pyrene	0.29	0.1	ASV
Total Class Values (mg/kg)			
Total PCBs	1.6	0.02	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value
ASV = screening value
NV = no screening value

Aluminum, barium, calcium, cobalt, lead, magnesium, manganese, potassium, sodium, and vanadium have maximum concentrations below their background values at SWMU 2. These are shown highlighted in Table G.5.

G.4.3 SWMU 3

Selected COPCs for SWMU 3 are listed in Table G.6.

Aluminum, arsenic, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, sodium, vanadium, and zinc have maximum concentrations below their background values at SWMU 3. These are shown highlighted in Table G.6.

Table G.6. SWMU 3 Selected COPCs

Analyte	Result	Soil NFA Value	Rationale
Metals (mg/kg)			
Aluminum	8,570	5	ASV
Antimony	15.7	1.9	ASV
Arsenic	7.62	1	ASV
Barium	87.7	20	ASV
Calcium	35,200		NV
Chromium	12.5	0.04	ASV
Cobalt	6.41	2.5	ASV
Copper	10.6	0.45	ASV
Iron	15,700	110	ASV
Magnesium	2,500		NV
Manganese	558	25	ASV
Molybdenum	6.21	2	ASV
Sodium	112		NV
Uranium	43[a]	5	ASV
Vanadium	33.7	2	ASV
Zinc	31.8	8.5	ASV
VOAs (mg/kg)			
Acetone	0.00811		NV
TCE	0.00633	0.001	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value.
ASV = screening value
NV = no screening value

G.4.4 SWMU 4

Selected COPCs for SWMU 4 are listed in Table G.7.

Aluminum, barium, calcium, cobalt, lead, magnesium, manganese, potassium, and sodium have maximum concentrations below their background values at SWMU 4. These are shown highlighted in Table G.7.

Table G.7. SWMU 4 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg)			
Aluminum	12,900	5	ASV
Arsenic	13.8	1	ASV
Barium	200	20	ASV
Beryllium	1.11	0.19	ASV
Calcium	13,400		NV
Chromium	296	0.04	ASV
Cobalt	7.54	2.5	ASV
Copper	30.1	0.45	ASV
Iron	41,900	110	ASV
Lead	25.7	20	ASV
Magnesium	1,900		NV
Manganese	1,300	25	ASV

Table G.7. SWMU 4 Selected COPCs (Continued)

Analyte	Result	Soil NFA value	Rationale
Mercury	0.45	0.1	ASV
Nickel	153	11	ASV
Potassium	943		NV
Sodium	320		NV
Uranium	106		NV
Vanadium	47.8	2	ASV
Zinc	93.7	8.5	ASV
PCBs/Pesticides (mg/kg)			
PCB-1260	0.898		NV
Total Class Values (mg/kg)			
Total PCBs[a]	0.898	0.02	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value.
ASV = screening value
NV = no screening value

G.4.5 SWMU 5

Selected COPCs for SWMU 5 are listed in Table G.8.

Table G.8. SWMU 5 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg)			
Aluminum	13,800	5	ASV
Arsenic	12.2	1	ASV
Barium	125	20	ASV
Beryllium	0.79	0.19	ASV
Calcium	207,000		NV
Chromium	20.5	0.04	ASV
Cobalt	7.19	2.5	ASV
Copper	11.2	0.45	ASV
Iron	26,900	110	ASV
Lead	200[a]	20	ASV
Magnesium	4,780		NV
Manganese	599	25	ASV
Nickel	135	11	ASV
Potassium	942		NV
Selenium	1.23	0.21	ASV
Sodium	325		NV
Uranium	2,000[a]	5	ASV
Vanadium	35.4	2	ASV
Zinc	200[a]	8.5	ASV
PCBs/Pesticides (mg/kg)			
PCB-1260	0.306		NV

Table G.8. SWMU 5 Selected COPCs (Continued)

Analyte	Result	Soil NFA value	Rationale
SVOCs (mg/kg)			
2-Methylnaphthalene	7.3		NV
3-Nitrobenzenamine	9.45		NV
Acenaphthene	32	20	ASV
Acenaphthylene	9.45		NV
Anthracene	40	0.1	ASV
Benz(a)anthracene	130		NV
Benzo(a)pyrene	80	0.1	ASV
Benzo(b)fluoranthene	170		NV
Benzo(ghi)perylene	28		NV
Benzo(k)fluoranthene	11.7		NV
Bis(2-ethylhexyl)phthalate	5.7		NV
Carbazole	71		NV
Chrysene	95		NV
Dibenz(a,h)anthracene	0.749		NV
Dibenzofuran	3.52		NV
Fluoranthene	53.3	0.1	ASV
Fluorene	28		NV
Indeno(1,2,3-cd)pyrene	37		NV
Naphthalene	16	0.1	ASV
Pentachlorophenol	2.4[a]	0.002	ASV
Phenanthrene	64	0.1	ASV
Pyrene	150	0.1	ASV
VOCs (mg/kg)			
1,1-Dichloroethene	2.8		NV
Total Class Values (mg/kg)			
Total PCBs	0.306	0.02	ASV
Total PAHs	111	1	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value
ASV = screening value
NV = no screening value

Arsenic, barium, cobalt, copper, iron, magnesium, manganese, potassium, sodium, and vanadium have maximum concentrations below their background values at SWMU 5. These are shown highlighted in Table G.8.

G.4.6 SWMU 6

Selected COPCs for SWMU 6 are listed in Table G.9.

Table G.9. SWMU 6 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg)			
Aluminum	11,200	5	ASV
Barium	99.2	20	ASV
Beryllium	0.73	0.19	ASV
Calcium	146,000		NV
Chromium	14.4	0.04	ASV
Cobalt	6.85	2.5	ASV
Copper	21.3	0.45	ASV
Iron	19,600	110	ASV
Lithium	10[a]	2	ASV
Magnesium	4,410		NV
Manganese	664	25	ASV
Nickel	43.2	11	ASV
Potassium	821		NV
Selenium	1.37	0.21	ASV
Sodium	234		NV
Uranium	1,000[a]	5	ASV
Vanadium	24.8	2	ASV
Zinc	128	8.5	ASV
SVOCs (mg/kg)			
Anthracene	0.5[a]	0.1	ASV
Benz(a)anthracene	0.5[a]		NV
Benzo(a)pyrene	0.5[a]	0.1	ASV
Benzo(b)fluoranthene	0.5		NV
Benzo(ghi)perylene	0.5[a]		NV
Benzo(k)fluoranthene	0.5		NV
Bis(2-ethylhexyl)phthalate	0.5[a]		NV
Chrysene	0.5[a]		NV
Fluoranthene	0.636	0.1	ASV
Indeno(1,2,3-cd)pyrene	0.5[a]		NV
Phenanthrene	0.5[a]	0.1	ASV
Pyrene	0.663	0.1	ASV

[a]This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value
ASV = screening value
NV = no screening value

Aluminum, barium, calcium, chromium, cobalt, iron, magnesium, manganese, potassium, sodium, and vanadium have maximum concentrations below their background values at SWMU 6. These are shown highlighted in Table G.9.

G.4.7 SWMU 7

Selected COPCs for SWMU 7 are listed in Table G.10.

Table G.10. SWMU 7 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg)			
Aluminum	14,000	5	ASV
Antimony	9.89[a]	1.9	ASV
Arsenic	16	1	ASV
Barium	120	20	ASV
Beryllium	1.3	0.19	ASV
Cadmium	1.9[b]	0.11	ASV
Calcium	210,000		NV
Chromium	55.8	0.04	ASV
Cobalt	11	2.5	ASV
Copper	99	0.45	ASV
Iron	30,000	110	ASV
Lead	120	20	ASV
Magnesium	3,300		NV
Manganese	900	25	ASV
Mercury	0.2[a]	0.1	ASV
Nickel	140	11	ASV
Potassium	870		NV
Selenium	0.948[b]	0.21	ASV
Sodium	170		NV
Thallium	2	1	ASV
Uranium	1,270		NV
Vanadium	52	2	ASV
Zinc	240	8.5	ASV
Radionuclides (pCi/g)			
^{238}U	2,390	1060	ASV
PCBs/Pesticides (mg/kg)			
PCB-1016	0.95		NV
PCB-1248	14.8		NV
PCB-1254	0.13		NV
PCB-1260	3.1		NV
SVOCs (mg/kg)			
2-Methylnaphthalene	0.48		NV
3-Methylcholanthrene	0.11		NV
Acenaphthylene	0.48		NV
Anthracene	0.69	0.1	ASV
Benz(a)anthracene	4.3		NV
Benzo(a)pyrene	4.1	0.1	ASV
Benzo(b)fluoranthene	5.2		NV
Benzo(ghi)perylene	3.8		NV

Table G.10. SWMU 7 Selected COPCs (Continued)

Analyte	Result	Soil NFA value	Rationale
SVOCs (mg/kg) (Continued)			
Benzo(k)fluoranthene	1.7		NV
Benzoic acid	0.48		NV
Bis(2-ethylhexyl)phthalate	0.48		NV
Chrysene	4.2		NV
Dibenz(a,h)anthracene	0.92		NV
Dibenzofuran	0.48		NV
Fluoranthene	7.9	0.1	ASV
Fluorene	0.48		NV
Indeno(1,2,3-cd)pyrene	3.8		NV
Naphthalene	0.48[b]	0.1	ASV
Pentachlorophenol	0.48[a]	0.002	ASV
Phenanthrene	5.1	0.1	ASV
Pyrene	9.0	0.1	ASV
VOCs (mg/kg)			
Acetone	0.0837		NV
Methylene chloride	0.0057		NV
Total Class Values (mg/kg)			
Total PAHs	6.37	1	ASV
Total PCBs	18.1	0.02	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration **does not** exceed its screening value

[b] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value

ASV = screening value

NV = no screening value

Barium, cobalt, magnesium, manganese, mercury, and potassium have maximum concentrations below their background values at SWMU 7. These are shown highlighted in Table G.10. Calcium, iron, and aluminum are elevated less than 10% over their background values.

G.4.8 SWMU 30

Selected COPCs for SWMU 30 are listed in Table G.11.

Table G.11. SWMU 30 Selected COPCs

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg)			
Aluminum	16,000	5	ASV
Antimony	25[a]	1.9	ASV
Arsenic	8.9	1	ASV
Barium	170	20	ASV
Beryllium	0.85	0.19	ASV
Cadmium	10[a]	0.11	ASV
Calcium	24,000		NV
Chromium	45.7	0.04	ASV
Cobalt	8.9	2.5	ASV
Copper	170	0.45	ASV

Table G.11. SWMU 30 Selected COPCs (Continued)

Analyte	Result	Soil NFA value	Rationale
Metals (mg/kg) (Continued)			
Iron	24,000	110	ASV
Lead	71	20	ASV
Magnesium	2,200		NV
Manganese	490	25	ASV
Mercury	0.2[a]	0.1	ASV
Nickel	570	11	ASV
Selenium	1[a]	0.21	ASV
Sodium	88		NV
Thallium	60[a]	1	ASV
Uranium	1,400	5	ASV
Vanadium	34	2	ASV
Zinc	750	8.5	ASV
PCBs/Pesticides (mg/kg)			
PCB-1254	0.2		NV
PCB-1260	15		NV
SVOCs (mg/kg)			
2-Methylnaphthalene	0.27		NV
3-Methylcholanthrene	0.22		NV
Acenaphthylene	0.091		NV
Acetophenone	0.013		NV
Anthracene	3.2	0.1	ASV
Benz(a)anthracene	9.1		NV
Benzo(a)pyrene	8.4	0.1	ASV
Benzo(b)fluoranthene	9.6		NV
Benzo(ghi)perylene	5.2		NV
Benzo(k)fluoranthene	4.3		NV
Benzoic acid	0.19		NV
Bis(2-ethylhexyl)phthalate	0.62		NV
Chrysene	9.9		NV
Dibenz(a,h)anthracene	1.6		NV
Dibenzofuran	0.83		NV
Fluoranthene	20	0.1	ASV
Fluorene	1.3		NV
Indeno(1,2,3-cd)pyrene	5.4		NV
Naphthalene	0.31	0.1	ASV
Phenanthrene	17	0.1	ASV
Pyrene	23	0.1	ASV
Total Class Values (mg/kg)			
Total PCBs	15.2	0.02	ASV
Total PAHs	12.5	1	ASV

[a] This analyte is screened using a maximum detection limit, but the maximum detected concentration also exceeds its screening value
ASV = screening value
NV = no screening value

Arsenic, barium, calcium, cobalt, iron, magnesium, manganese, sodium, and vanadium have maximum concentrations below their background values at SWMU 30. Mercury has a maximum concentration equal to its background value at SWMU 30. These are shown highlighted in Table G.11.

G.5. UNCERTAINTIES

There are a number of uncertainties that impact the potential usefulness of the SERA results. Many COPCs were retained because no NFA value was available for comparison, not because they exceeded their NFA screening level. Further evaluation of these COPCs should include evaluation against additional benchmarks to determine if the presence of the COPCs at the concentrations at which they occur at these sites represents potential risk to ecological receptors.

The screening evaluation in this SERA included the surface soil interval. Sufficient sampling results were not available for subsurface soil in the depth range of interest (0-5 ft bgs) to which burrowing animals may be exposed to conduct a quantitative screen of the subsurface soil. In addition, characterization of the buried waste was not adequate to quantitatively assess potential exposure for burrowing animals. Because the screening for surface soil indicated that additional evaluation of all the BGOU SWMUs was necessary, the uncertainties relating to exposures of burrowing animals will be addressed as part of that future evaluation, which will resolve the uncertainties related to these potential exposure pathways.

Maximum detected concentrations used for screening analytes may not provide appropriate estimates of the concentrations to which ecological receptors are exposed at these sites. For areas with sufficient sampling, the maximum detected concentration is likely to overestimate the concentrations to which ecological receptors are exposed as they move around the site. At least some COPCs at each site were evaluated based on screening of a detection limit that substantially exceeded the maximum detected concentration. Excluding detection limits would alter the screening results only at SWMU 7, where two COPCs screened on detection limits would have been eliminated if the maximum detected concentration were used instead.

In addition, the NFA screening levels are protective of entire suites of receptors, some of which may not be present at these disturbed sites. The grassy areas of these sites would be attractive to ecological receptors, but the surrounding industrial area may limit the extent to which ecological receptors use these areas.

In accordance with the PGDP ERA guidance (DOE 2001), analytes detected only below background levels are not excluded from the ecological screening. Retention of COPCs present at background concentrations would overestimate the risks related to site-related contaminants. The selected COPCs table for each site lists below the table each inorganic analyte where the maximum concentration is below its respective background level. A number of COPCs could be eliminated from all sites if only analytes detected below background level were removed from the screening.

These uncertainties, combined with the results of the SERA, indicate the need for further evaluation of these sites. Risk managers may determine that sites do not need further evaluation (if exposure pathways are not complete or planned actions will eliminate the exposure pathway) or may recommend additional evaluation of the sites to better define the potential ecological risk.

G.6. SCIENTIFIC MANAGEMENT DECISION POINT 1

Each of the sites evaluated in this SERA retained a number of COPCs. Although some COPCs retained at each site were present only at concentrations at or below their background concentrations, excluding these, each site still would have COPCs retained for further ecological evaluation. Based on the guidance in the ecological Risk Methods Document (DOE 2001), SWMUs 2, 3, 4, 5, 6, 7, and 30 warrant additional evaluation for potential ecological risk. For SWMU 145, the potential ecological risk from exposure to surface soil could not be quantified in this SERA due to the lack of surface soil data. The potential risk from surface soil for that SWMU is therefore unknown.

G.7. REFERENCES

DOE (U.S. Department of Energy) 2001. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, KY, Volume 2, Ecological,* DOE/OR/07-1506/V2&D2, U.S. Department of Energy, Paducah, KY, July.

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