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PPPO-02-384-10

Mr. Edward Winner, FFA Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
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Dear Mr. Ballard and Mr. Winner:

TRANSMITTAL OF THE D1 ENGINEERING EVALUATION/COST ANALYSIS FOR A REMOVAL ACTION AT C-747 CONTAMINATED BURIAL YARD AND C-748-B BURIAL AREA (SWMU 4) AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-0335&D1)

Please find enclosed the certified D1 *Engineering Evaluation/Cost Analysis for a Removal Action at C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/LX/07-0335&D1) for your review.

The enclosed SWMU 4 Engineering Evaluation/Cost Analysis (EE/CA) includes the currently agreed upon Applicable or Relevant and Appropriate Requirements (ARARs) from the Southwest Plume Sources Feasibility Study and the EE/CA for the C-340 Complex and C-746-A East End Smelter; however, as has been discussed among the Federal Facility Agreement (FFA) parties certain ARARs are still under discussion. Submitting the EE/CA with the current ARARs allows the parties to move forward while finalizing the ARARs.

Additionally, as is indicated within the EE/CA and has been discussed among the parties, it is important to emphasize that the Portsmouth/Paducah Project Office is moving forward to accelerate implementation of SWMU 4 as an early action, but this accelerated implementation is limited to the availability of appropriated funds for this purpose.

If you have any questions or require additional information, please contact Jennifer Woodard at (270) 441-6820.

Sincerely,

Reinhard Knerr
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:

1. Certification Page
2. D1 EE/CA for SWMU 4 Removal Action

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CERTIFICATION

Document Identification: *Engineering Evaluation/Cost Analysis for a Removal Action at the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* **DOE/LX/07-0335&D1**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Paducah Remediation Services, LLC
Operator

Paul Woltite, for
Dennis Ferrigno, PM, Site Manager

3/2/10
Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy (DOE)
Owner

Reinhard Knerr, Paducah Site Lead
Portsmouth/Paducah Project Office

3/2/10
Date Signed

DOE/LX/07-0335&D1
Primary Document

Engineering Evaluation/Cost Analysis for a Removal Action at the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Engineering Evaluation/Cost Analysis for a Removal Action at the C-747 Contaminated Burial Yard and C-748-B Burial Area (SWMU 4) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—March 2010

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-AC30-06EW05001

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FIGURES

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ACRONYMS

AOC	area of contamination
ARAR	applicable or relevant and appropriate requirement
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
EE/CA	engineering evaluation/cost analysis
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
GAC	granular activated carbon
HI	Hazard Index
HQ	hazard quotient
KPDES	Kentucky Pollutant Discharge Elimination System
LDR	land disposal restrictions
LLW	low-level waste
MCL	maximum contaminant level
MLLW	mixed low-level waste
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NTCRA	non-time-critical removal action
NTS	Nevada Test Site
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PPE	personal protection equipment
PTW	principal threat waste
RAO	removal action objective
RAWP	removal action work plan
RCRA	Resource Conservation and Recovery Act
RG	remediation goal
RGA	Regional Gravel Aquifer
RI	remedial investigation
SAR	SWMU assessment report
SI	site investigation
SVOC	semivolatile
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TBC	to be considered
TCE	trichloroethene
T&E	threatened and endangered

UCRS	Upper Continental Recharge System
UF_6	uranium hexafluoride
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound
WAC	waste area criteria
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) has prepared this Engineering Evaluation/Cost Analysis (EE/CA) to evaluate alternatives that will address the potential threat to human health and the environment resulting from the release or potential release of contaminants of concern (COCs) from buried waste materials at Solid Waste Management Unit (SWMU) 4 within the Burial Grounds Operable Unit (BGOU) at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky.

SWMU 4 consists of the C-747 Contaminated Burial Yard and C-748-B Burial Area, which were historically utilized for disposal of radiologically contaminated and uncontaminated debris originating from the C-410 uranium hexafluoride (UF_6) feed plant. It also may have received sludges designated for disposal in the C-404 Burial Ground, which may have included uranium-contaminated solid waste and technetium-99-contaminated magnesium fluoride and waste associated with the work for others program. Four subsurface buried waste cells are expected to exist within SWMU 4 based on site geophysical investigations conducted as part of the Waste Area Group (WAG) 3 Remedial Investigation (RI) (DOE 2001a).

The BGOU RI documented the release of hazardous substances in surface soils, subsurface soils, and groundwater at SWMU 4 (DOE 2010). The BGOU RI also indentified SWMU 4 as a significant source to the Southwest Plume at PGDP. The contaminants in SWMU 4 include trichloroethene (TCE) and its degradation products (vinyl chloride and *cis* 1,2-dichloroethene); polychlorinated biphenyls (PCBs); radionuclides (cesium-137, plutonium-239, technetium-99, thorium-230, isotopic uranium); and metals (arsenic, manganese, beryllium, vanadium, lead and iron). Based on the conclusions of the BGOU RI, SWMU 4 presents current and potential future threats to human health and the environment. Risks to human health from SWMU 4 for some receptors exceed the upper limit of the U.S. Environmental Protection Agency's (EPA's) acceptable risk range [i.e., excess lifetime cancer risk (ELCR) 1E-06 to 1E-04], and contaminants of potential ecological concern were identified. Conditions at SWMU 4 make a removal action consistent with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 *CFR* § 300.415 (b)(2).

DOE has determined that a non-time-critical removal action (NTCRA), under the Comprehensive Environmental Response, Compensation and Liability Act and the Federal Facility Agreement, is warranted to address the risks associated with SWMU 4. Any remaining threats following the NTCRA, including dense nonaqueous-phase liquid (DNAPL) sources and contaminants in groundwater, will be addressed as part of the final remedial action for SWMU 4 under the BGOU. An NTCRA will provide the most appropriate level of analysis, oversight, public participation, and flexibility to conduct cleanup in a cost-effective manner that achieves risk reduction and protects human health and the environment in a timely manner.

This EE/CA evaluated two alternatives: (1) No Action and (2) Excavation and Disposal of Buried Waste Material and Contaminated Soils. The recommended removal action alternative based on the analysis in this EE/CA is Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils. The Remedial Action Objectives for this action include the following:

- Prevent future contaminant migration from buried waste to the environment such that it does not present unacceptable direct exposure risks to future receptors or migration to groundwater above acceptable levels.

- Prevent exposure from surface soil metals and radionuclides that would cause an unacceptable cumulative risk to future industrial workers.

- Prevent exposure to subsurface soil metals, radionuclides, and semivolatile organic compounds within the SWMU administrative boundary (as illustrated in Figure 4 of this EE/CA) to 16 ft bgs that would cause an unacceptable cumulative risk to future outdoor worker/gardeners.[1]

- Prevent migration of metals, radionuclides, and volatile organic compounds (VOCs) in the top 16 ft of soil such that they will not contribute contamination to the Regional Gravel Aquifer (RGA) groundwater exceeding maximum contaminant levels (MCLs), or in the absence of an MCL, a risk-based concentration.

The scope of Alternative 2 includes the following:

- Removal of all visible metals, disposed materials, and incidental soils (i.e., soils removed as a by-product of exhuming buried waste materials) from the area of SWMU 4 burial cells;

- Ensure that at completion of excavation, residual risk within the administrative boundary of SWMU 4 to a depth of 16 ft bgs would achieve removal action objectives;

- Disposal of excavated materials and contaminated soils in an appropriate disposal facility; and

- Backfill of excavation areas with clean soil and site restoration.

Alternative 2 would remove buried waste materials and contaminated soil in SWMU 4. The soil remediation goals (RGs) used to direct the removal would reduce cumulative direct contact risks and hazards to future industrial and excavation workers to within EPA's acceptable cancer risk range (i.e., ELCR = 1E-06 to 1E-04) and below EPA's hazard limit (i.e., hazard index = 1), respectively. Additionally, the soil RGs would reduce contaminant migration at SWMU 4 to the underlying RGA to a level that is protective of safe drinking water standards (i.e., MCLs or suitable risk-based concentrations for contaminants without MCLs.). The estimated maximum volume of waste generated for disposal upon implementation of this alternative is approximately 116,000 yd^3. Applicable or relevant and appropriate requirements defined for Alternative 2 are expected to be met.

Early removal of the metallic debris in the burial cells also would leave SWMU 4 in a state more conducive to effective implementation of a groundwater remedy because the subsurface physical interferences to groundwater treatment technologies no longer would be present.

This removal action will be implemented in parallel with the ongoing BGOU RI/Feasibility Study process. The proposed NTCRA would not address all problems warranting action identified in the BGOU RI associated with SWMU 4. Following the removal action, the scope of the final action pertaining to SWMU 4 would include the following residual threats to human health and the environment:

- Potential risks to ecological receptors associated with remaining constituents in surface and subsurface soil not excavated as part of the removal action;

- Residual contamination in the Upper Continental Recharge System (UCRS) with the potential for unacceptable impact to the RGA; and

[1] This exposure scenario correlates to the "excavation worker" scenario in the BGOU RI (DOE 2010).

- VOC DNAPL in the UCRS and RGA.

The BGOU final remedial action would address remaining risks to human health and the environment associated with SWMU 4.

The public is encouraged to comment on the alternatives presented in this EE/CA. Following the public comment period, an Action Memorandum will be prepared by DOE and added to the PGDP Administrative Record, which is accessible to the public. All responses to the public comments will be included in the Responsiveness Summary of the Action Memorandum.

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1. INTRODUCTION

Pursuant to Section X of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998) and the Removal Notification approved by U.S. Environmental Protection Agency (EPA) and Kentucky Department for Environmental Protection, the U.S. Department of Energy (DOE) is performing a non-time-critical removal action (NTCRA) to address the potential threat to human health and the environment resulting from the release or potential release of buried waste materials and contaminants of concern (COCs) at Solid Waste Management Unit (SWMU) 4 within the Burial Grounds Operable Unit (BGOU) at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky.

This Engineering Evaluation/Cost Analysis (EE/CA) defines conditions warranting a removal action, identifies the objectives of the removal action, evaluates alternatives that address the current and potential threats from release of contaminants to the environment, and provides a vehicle for public comment per the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 *CFR* § 300.415.

1.1 SITE DESCRIPTION

SWMU 4 consists of two former waste burial grounds located in the western section of the PGDP plant within the plant security controlled area (Figure 1). SWMU 4 covers an area of approximately 286,700 ft^2. The SWMU is an open field, bounded on the north, east, and west by plant roads and on the south by an active railroad spur, with a short, narrow gravel road that enters from the west, and is nearly completely grass covered (Figure 2). A 2 to 3 ft cover of soil material and a 6-inch clay cap cover the entire SWMU 4 area (DOE 2010), though it is uncertain whether the grasses on-site grow through the cap or if additional soil exists over the clay cap.

Shallow drainage swales on three sides (north, east, and west) of SWMU 4 direct surface runoff to the northwest corner of the site and beneath Virginia Avenue through a drainage culvert where it discharges into the main drainage ditch to Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 015 (Figure 1). The Surface Water Operable Unit (SWOU) Site Investigation (SI) will assess the nature and extent of any contamination, and remediation of these swales will occur as part of the SWOU. There is an elevation difference of approximately 10 ft from the highest point within the SWMU boundary to the adjacent drainage swales.

Four subsurface buried waste cells are expected to exist within SWMU 4 based on site geophysical investigations conducted as part of the Waste Area Group (WAG) 3 Remedial Investigation (RI) (DOE 2001a) (Figure 3). Figure 4 presents the estimated areas of the burial cells based on these geophysical interpretations and delineates the administrative boundary of SWMU 4 in red. The burial cells are expected to exist to a depth of 15-18 ft bgs. Additionally, an active raw water pipe cuts across the southeastern portion of the SWMU, approximately 30 ft from the nearest delineated burial cell with its base at a depth of approximately 367 ft above mean sea level (amsl), which is approximately 8-10 ft below the current grade in this area (DOE 2010). This pipe serves as one of two main conveyances of untreated Ohio River water into the PGDP, which is necessary for current operations.

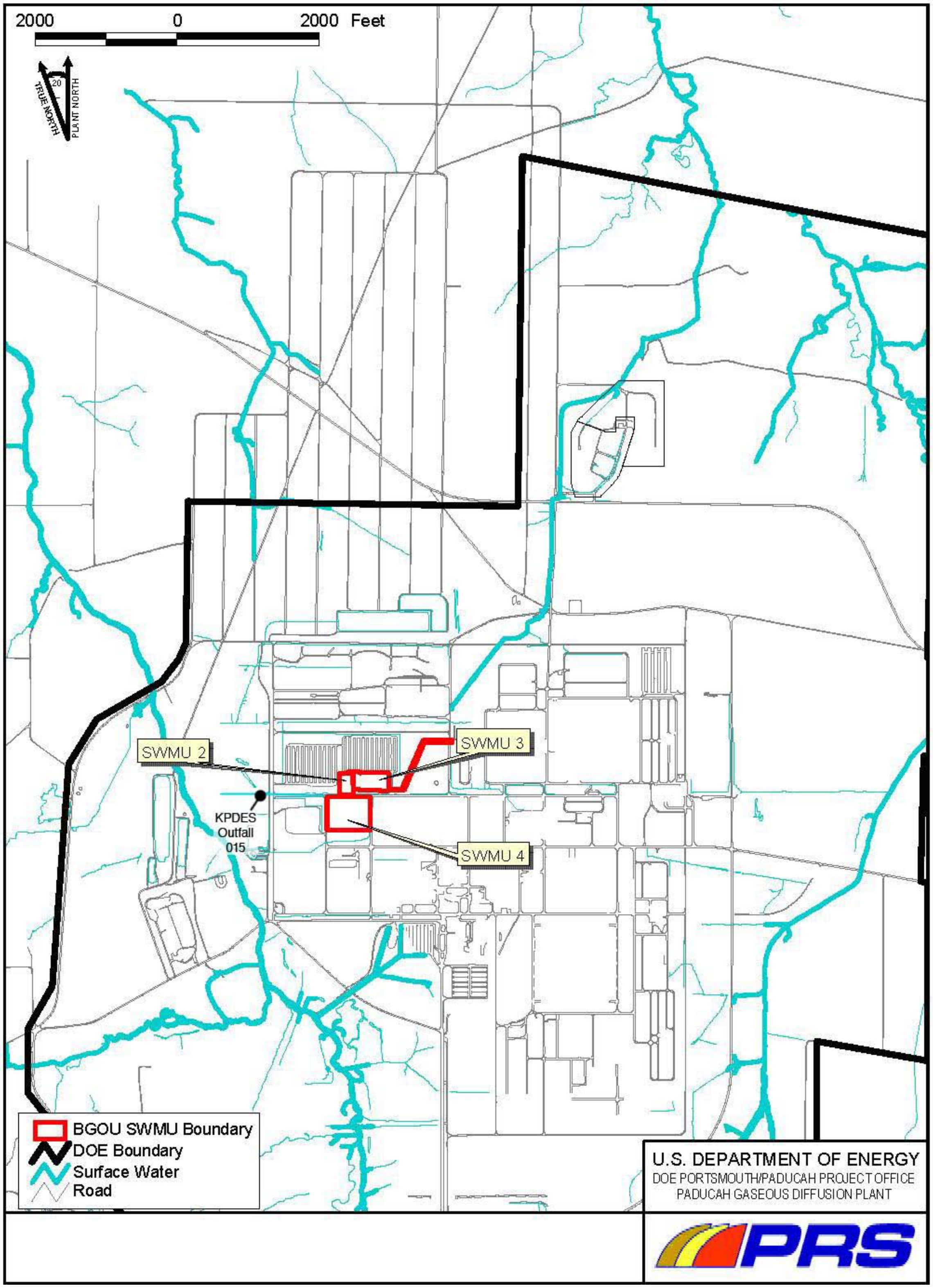

Figure 1. SWMU 4 Location at PGDP

Figure 2. SWMU 4 Aerial Photograph (SWMU Administrative Boundary Shown in Red)

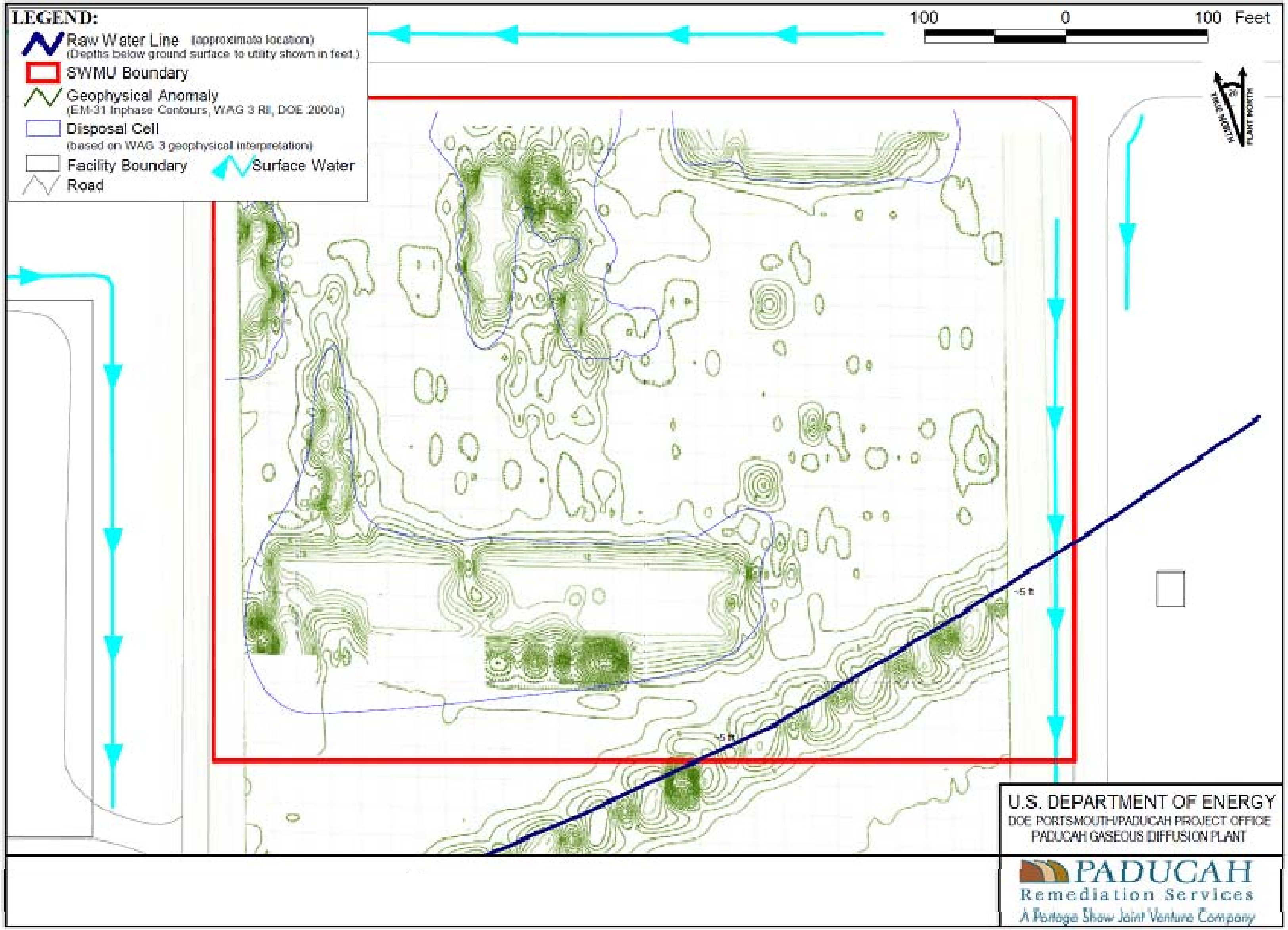

Figure 3. Geophysical Survey Results for SWMU 4

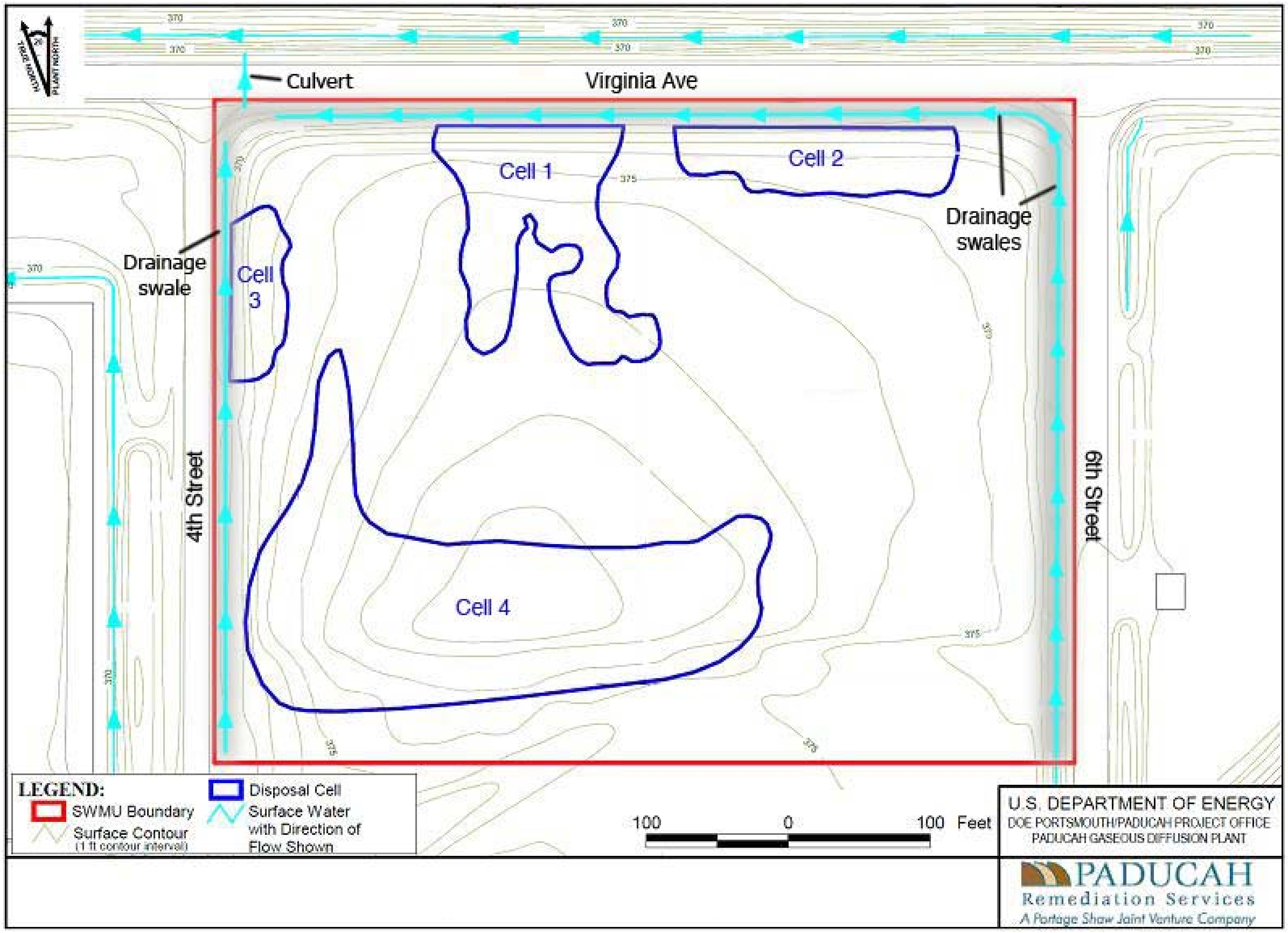

Figure 4. Expected Layout of SWMU 4 Burial Cells Based on Geophysical Results

1.2 SITE HISTORY

SWMU 4 consists of the C-747 Contaminated Burial Yard and C-748-B Burial Area. The C-747 Contaminated 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).

According to employee interviews, a majority of the contaminated metal was buried in the northern part of the yard. Some of the trash was burned before burial. Scrapped equipment with surface contamination from the enrichment process also was buried. When the yard was closed, a smaller pit was reported to have been created for the disposal of radiologically contaminated scrap metal that could not be sold (Union Carbide 1973).

The original SWMU Assessment Report (SAR) for SWMU 4, dated August 24, 1987, included only the C-747 Contaminated Burial Yard; however, 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 (Union Carbide 1973). The C-748-B Burial Area was incorporated into various descriptions of SWMU 4 starting in the mid-1990s based on geophysical surveys. As a result of this addition, the area of the SWMU was changed from 8,300 ft^2 to 286,700 ft^2 and documented in the revised SAR (DOE 2007a).

In the fall of 1999, employee interviews led to the designation the C-747 Contaminated Burial Yard as a classified area, and appropriate access restrictions were implemented.

SWMU 4 also may have received sludges designated for disposal at the C-404 Burial Ground (BGOU SWMU 3). The source of these sludges is unknown, but the WAG 3 RI Work Plan (DOE 1998) indicated that the sludges potentially included uranium-contaminated solid waste and technetium-99 (^{99}Tc)-contaminated magnesium fluoride. The total volume of waste material disposed at SWMU 4 is unknown.

1.3 ENVIRONMENTAL SETTING

1.3.1 Land Use

The PGDP limited area (i.e., inside the security fence) is heavily industrialized; however, the area surrounding the plant is mostly agricultural and open land, with some forested areas. The reasonably anticipated future land use of the PGDP Limited Area (where SWMU 4 is located) is industrial; however, final decisions associated with future land use at SWMU 4 will be made in conjunction with the BGOU remedial action process under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The PGDP is posted government property and trespassing is prohibited. Access to the PGDP Limited Area is controlled by guarded checkpoints, a perimeter fence, and vehicle barriers and is subject to routine patrol and visual inspection by plant protective forces. The DOE Reservation surrounding the PGDP limited area includes 1,986 acres licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources. This area is part of the Western Kentucky Wildlife Management Area (WKWMA) and borders PGDP to the north, west, and south. The WKWMA is an important recreational resource for western Kentucky and is used by more than 10,000 people each year. Major recreational activities include hunting, field trials for dogs and horses, trail riding, fishing, and skeet shooting. The Tennessee Valley Authority Shawnee Steam Plant, adjacent to the northeast border of the DOE Reservation, is the only other major industrial facility in the immediate area.

1.3.2 Climate

Current and historical meteorological information regarding temperature, precipitation, and wind speed/direction was obtained from the National Oceanic and Atmospheric Administration's National Climatic Data Center. Additional data were obtained from the National Weather Service office at Barkley Regional Airport.

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,[2] 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).

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.

1.3.3 Geology

PGDP is located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock.

Within the Jackson Purchase Region, strata deposited above the Precambrian basement rock attain a maximum thickness of 3,659 m to 4,573 m (12,000 ft to 15,000 ft). Exposed strata in the region range in age from Devonian to Holocene. The Devonian stratum crops out along the western shore of Kentucky Lake.

Mississippian carbonates form the nearest outcrop of bedrock and underlie the entire PGDP area at an approximate depth of 300 to 340 ft. The Coastal Plain deposits unconformably overlie Mississippian carbonate bedrock and consist of the following: the Tuscaloosa Formation; the sand and clays of the Clayton/McNairy Formations; the Porters Creek Clay; and the Eocene sand and clay deposits (undivided Jackson, Claiborne, and Wilcox Formations). Continental deposits unconformably overlie the Coastal Plain deposits, which are, in turn, covered by loess and/or alluvium.

Relative to the shallow groundwater flow system in the vicinity of the PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river channel. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP, marks the southern extent of the buried river channel. Fine sand and clay of the McNairy Formation directly underlie the continental deposits. These continental deposits are continuous from beneath the PGDP to beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the

[2] 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).

vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained to poorly drained, medium-textured soils on upland positions. Several other soil groups also occur in limited areas of the region, including the Grenada, Falaya-Collins, Waverly, Vicksburg, and Loring.

Although the soil over most of PGDP may be Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 45 years. Activities that have disrupted the original soil stratification include excavation, filling, mixing, and grading.

1.3.4 Hydrogeology

There are no direct measurements of the depth of the water table beneath SWMU 4; however, the stratigraphy is expected to be comparable to that of SWMUs 2 and 3, and groundwater is expected to be approximately 10 to 15 ft bgs, likely extending up into the burial cells. The Upper Continental Recharge System (UCRS) is saturated from the water table down. Groundwater flow through the UCRS is primarily downward to the top of the Regional Gravel Aquifer (RGA), which is approximately 60 ft bgs. Limited lateral dispersion results as groundwater and contaminants migrate vertically through the UCRS.

Once groundwater reaches the RGA, the predominant flow is horizontal. The RGA serves as the primary exit pathway for groundwater from within the PGDP property boundary (DOE 2001a). The dominant flow paths in the RGA beneath SWMU 4 are expected to be north to northwest, based on the northwest flow direction observed in the immediate area south of SWMU 3 and the general west-northwest trend of the Southwest Plume. 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. Average RGA groundwater flow velocity in the areas of the contaminant plumes is commonly 1 to 3 ft/day.

1.3.5 Threatened and Endangered Species

Potential habitat for federally listed threatened and endangered (T&E) species was evaluated for the area surrounding PGDP during the 1994 U.S. Army Corps of Engineers environmental investigation of the PGDP (COE 1994) and inside the fence of PGDP during the 1994 investigation of sensitive resources at PGDP (CDM 1994). Investigation inside PGDP security fence did not detect any T&E species or their preferred habitats, and the U.S. Fish and Wildlife Service (USFWS) has not designated critical habitat for any species within DOE property; however, a 2007 USFWS investigation determined that most of PGDP is within a maternity circle for Indiana Bat (listed endangered). Subsequently, the USFWS has conducted a biological assessment of Indiana bat in support of the draft Indiana Bat Recovery Plan (USFWS 2007). The assessment indicates that PGDP is within 5 miles of a maternity capture for Indiana bat; therefore, PGDP is designated within the Mississippi River Recovery and Mitigation Focus Area where Indiana bat minimization and mitigation efforts will be undertaken or attempted.

1.3.6 Cultural, Archaeological, and Historic Resources

In accordance with the National Historic Preservation Act (NHPA), a Programmatic Agreement among the DOE Paducah Site Office, the Kentucky State Historic Preservation Officer, and the Advisory Council on Historic Preservation Concerning Management of Historical Properties, was signed in January 2004. DOE developed the *Cultural Resources Management Plan for the Paducah Gaseous Diffusion Plant, Paducah Gaseous Diffusion Plant, McCracken County, Kentucky* (BJC 2006) to define the preservation strategy for PGDP and direct efficient compliance with the NHPA and federal archaeological protection legislation at PGDP. PGDP facilities are documented with survey forms and photographs in the *Cultural Resources Survey for the Paducah Gaseous Diffusion Plant, Paducah, Kentuck*y, BJC/PAD–688/R1. No cultural, archaeological, and historical resources have been identified within the vicinity of SWMU 4.

1.4 PREVIOUS REMEDIAL ACTIONS AND INVESTIGATIONS

There have been no previous CERCLA response actions for SWMU 4; however, in 1982 the entire SWMU was covered with 2 to 3 ft of soil material and a 6-inch clay cap (DOE 1998). During the summer of 1999, 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.

Previous source investigation work in and near SWMU 4 included sampling of soils and groundwater, a geophysical survey, document research, and personnel interviews. These investigations include the Phase II SI (CH2M HILL 1992), the WAG 3 RI (DOE 2001a), the Data Gaps Investigation (DOE 2001b), and the Southwest Plume SI (DOE 2007b). During the most recent RI, the BGOU RI (DOE 2010), results from the previous investigations were summarized, and sampling results were used to complete additional modeling of contaminant migration to the RGA.

In addition to the reports of previous investigations, the following documents provide historical context to plant operations and practices as they relate to on-site disposal of waste:

- *The Discard of Scrap Materials by Burial at the PGDP* (Union Carbide 1973);
- *The Disposal of Solid Waste at the PGDP* (Union Carbide 1978); and
- *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2010).

The data and conclusions from these reports provide the basis for the site conditions and nature and extent of contamination used for the evaluation of removal action alternatives in this EE/CA. In addition, a Feasibility Study (FS) for the BGOU is currently in progress and provided information to support the description and evaluation of removal action alternatives and analysis in this EE/CA. These documents may be obtained from the Administrative Record for the BGOU.

1.5 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

Sampling information for SWMU 4 was collected from a number of locations at depths ranging from 3 to 60 ft bgs for the WAG 3 RI (DOE 2001a) and is further evaluated in the BGOU RI (DOE 2010). During scoping for the BGOU RI Work Plan, it was determined that sufficient data existed to move forward to the FS for SWMU 4; therefore, no additional data for SWMU 4 was collected. A map of sampling locations at SWMU 4 is presented in Figure 5.

The BGOU RI documented the release of hazardous substances to surface soils, subsurface soils, and groundwater at SWMU 4. The environmental media include surface soil, subsurface soil, the shallow groundwater of the UCRS, and samples of groundwater drawn from the RGA and McNairy Formation.

The BGOU RI Appendix F contains a baseline risk assessment that documents risks posed to human health and the environment. To determine COCs for direct contact to human receptors in soil, the BGOU RI compared quantitative risk and hazard results over all pathways relative to hazard benchmarks for land

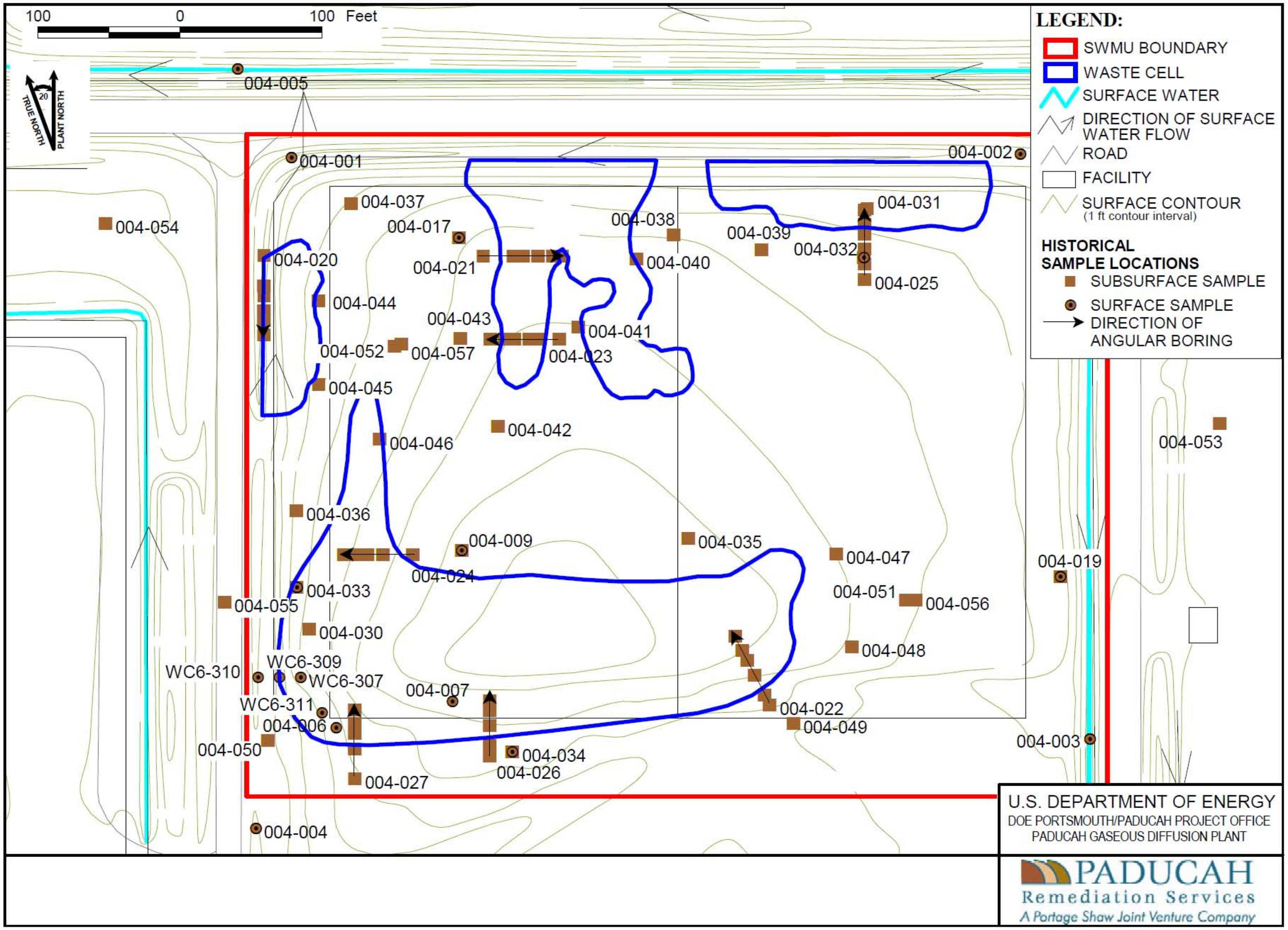

Figure 5. Sampling Locations for SWMU 4

use scenarios of concern.[3] The benchmarks used for this comparison were a) 0.1 for hazard index (HI); and b) 1×10^{-6} for excess lifetime cancer risk (ELCR). Contaminants with chemical-specific HIs or ELCRs within a land use scenario of concern exceeding these benchmarks are deemed COCs.

Additionally, fate and transport modeling was performed to determine whether constituents in surface and subsurface soil had the potential to migrate to RGA groundwater underlying SWMU 4. Contaminants predicted to impact RGA groundwater above protective levels are also deemed COCs.

Table 1 provides a summary of the COCs and conditions at SWMU 4 warranting further evaluation derived from the results of the BGOU RI report (DOE 2010). The baseline risk assessment summary that supports this table is presented in Appendix B of this EE/CA.

Figure 6 shows a representative cross-sectional illustration of SWMU 4 delineating COCs at varying depths within the SWMU boundary based on the sampling information from the locations illustrated in Figure 5. It should be noted that the Figure 6 representation does not account for uncertainty regarding the contents of the buried waste cells or the presence of many metals that may qualify as within a reasonable range of background. Figure 7 presents a conceptual model of SWMU 4 and all expected current or future pathways to potential receptors. Figure 8 presents trichloroethene (TCE) trends in groundwater in the vicinity of SWMU 4, which supports the determination of a dense nonaqueous-phase liquid (DNAPL) source beneath the SWMU.

1.5.1 Ecological Risk

The BGOU RI included a Screening Ecological Risk Assessment for SWMU 4. Comparison of site characterization data against No Further Action screening levels determined that SWMU 4 metals and organic compounds (in surface soil) are chemicals of potential ecological concern.

[3] Land use scenarios of concern evaluated in the BGOU RI included: current and future industrial workers; future outdoor worker/gardeners; future residents within the SWMU 4 boundary; and future residents using groundwater drawn from the PGDP or DOE property boundary.

Table 1. Summary of SWMU 4 Potential Threats to Human Health and Environment Derived from the BGOU RI

POTENTIAL THREATS TO HUMAN HEALTH AND THE ENVIRONMENT	PHYSICAL SCOPE
Buried waste materials present a risk to future outdoor worker/gardeners and a potential future contribution to RGA groundwater and subsurface soils.	Four burial cells extend to a depth of 15-18 ft; however, maximum depth of visible wastes is not known. Burial cells are expected to encompass an area of approximately 86,375 ft^2.
Radionuclides and metals in surface soil present a cumulative ELCR=5.4E-04 and HI=3.62E+00 to future industrial workers, exceeding an ELCR=1E-06 and HI=1 (without Be, cumulative ELCR is 1.62E-05). COCs are beryllium, ^{238}U, chromium, iron, vanadium, and barium.	Area of SWMU administrative boundary to a depth of 1 ft bgs.
Constituents in surface soil present a cumulative risk to hypothetical future on-site residents (ELCR=4.3E-03; HI=9.82E+01) if the land use conditions at PGDP were to change in the future, exceeding ELCR=1E-06 and HI=1 (without Be, cumulative ELCR is 1.24E-03). COCs are beryllium, uranium, PCBs, iron, chromium, vanadium, barium, cadmium, and nickel.	Area of SWMU administrative boundary to a depth of 1 ft bgs.
Constituents in subsurface soil present a cumulative ELCR=2.7E-03 and HI=2.61E+00 to future outdoor worker/gardeners, exceeding an ELCR=1E-06 and an HI=1. COCs are uranium, beryllium, dioxins/furans, PCBs, ^{226}Ra, arsenic, chromium, iron, vanadium, manganese, aluminum, barium, and cadmium.	Area of SWMU administrative boundary to a depth of 16 ft bgs.
VOCs in the subsurface constitute a DNAPL continuing source to groundwater, which represents a PTW.* COCs are TCE, VC, and *cis*-1,2-DCE.	TCE and degradation products underlie the southern burial area and the western boundary of the SWMU to a depth of 20 ft-~90 ft bgs.
Metals, radionuclides, and VOCs in subsurface soil exceed concentration criteria for cumulative risk (ELCR= 5.41E-02; HI=5.82E+02) to a potential future residential groundwater user. COCs are TCE, VC, arsenic, ^{99}Tc, manganese, *cis*-1,2-DCE, and VC. All of these COCs, with the exception of manganese, are also expected based on modeling to migrate to RGA groundwater at concentrations exceeding MCLs.	• Arsenic from 0-6 ft bgs. • Source of ^{99}Tc detected in soil from 3-6 ft bgs but may extend throughout the area of the waste cells. • TCE and degradation products in southern area of SWMU to a depth of 100 ft bgs.

* PTW is 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" (EPA 1991). EPA also recognizes that "although no threshold level of risk has been established to identify principal threat waste, a general rule of thumb is to consider as a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios" (EPA 1997).

COC = contaminant of concern
DCE = dichloroethene
DNAPL = dense nonaqueous-phase liquid
ELCR = excess lifetime cancer risk
HI = hazard index
MCL = maximum contaminant level
PCB = polychlorinated biphenyl
PGDP = Paducah Gaseous Diffusion Plant
PTW = principal threat waste
RGA = Regional Gravel Aquifer
SWMU = solid waste management unit
^{99}TC = technetium-99
TCE = trichloroethene
VC = vinyl chloride

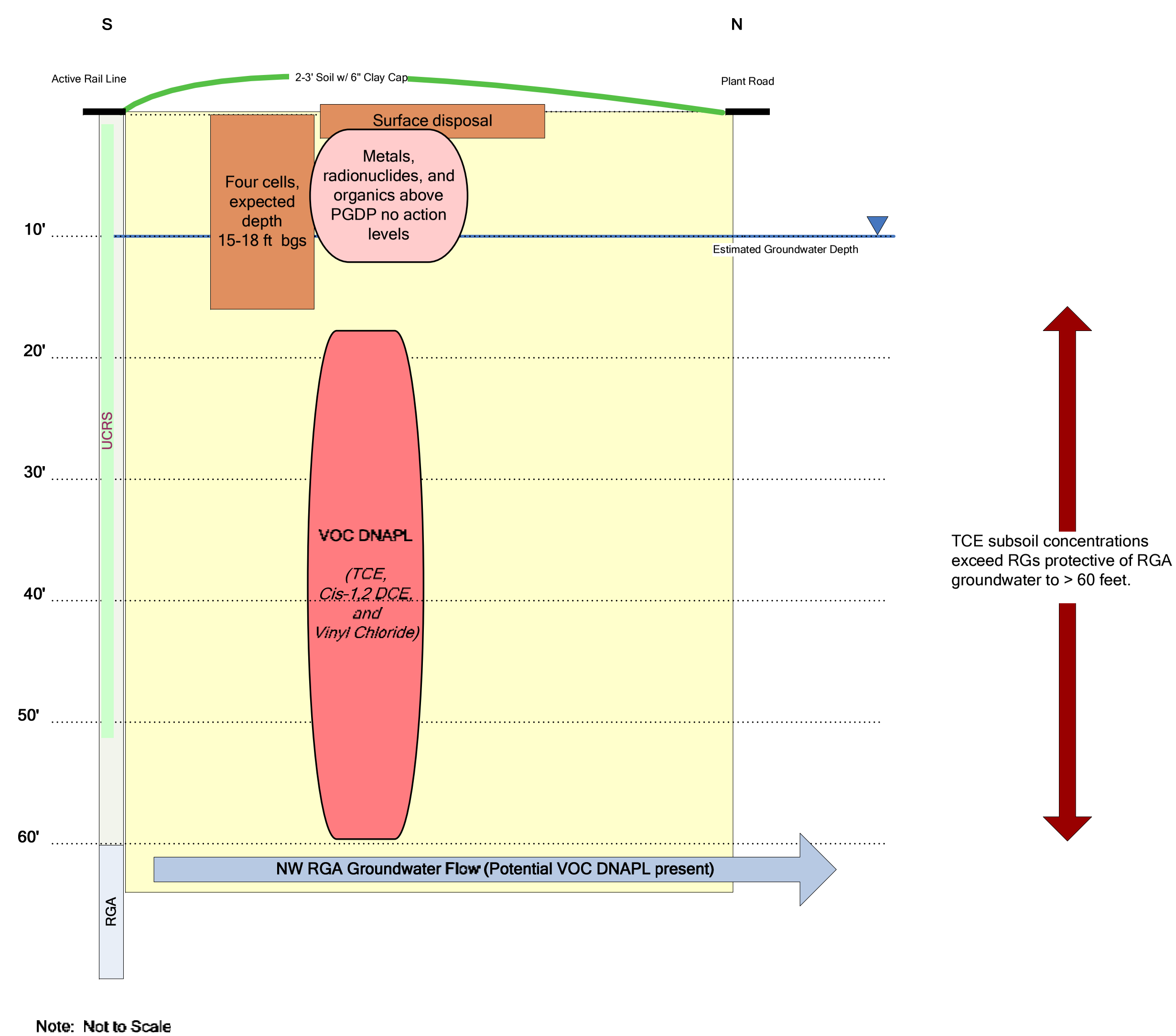

Figure 6. SWMU 4 Conceptual Physical Illustration

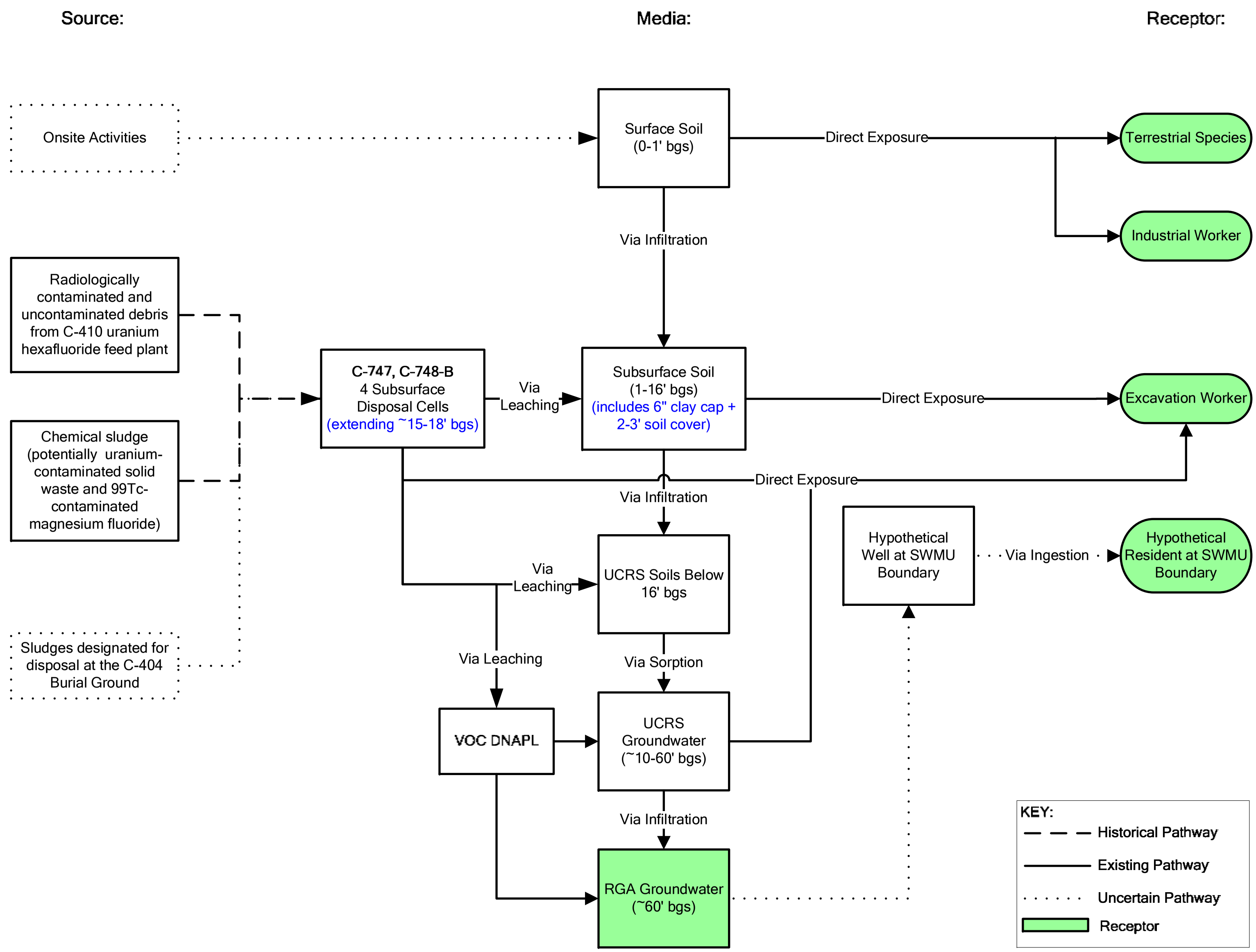

Figure 7. Conceptual Model of SWMU 4

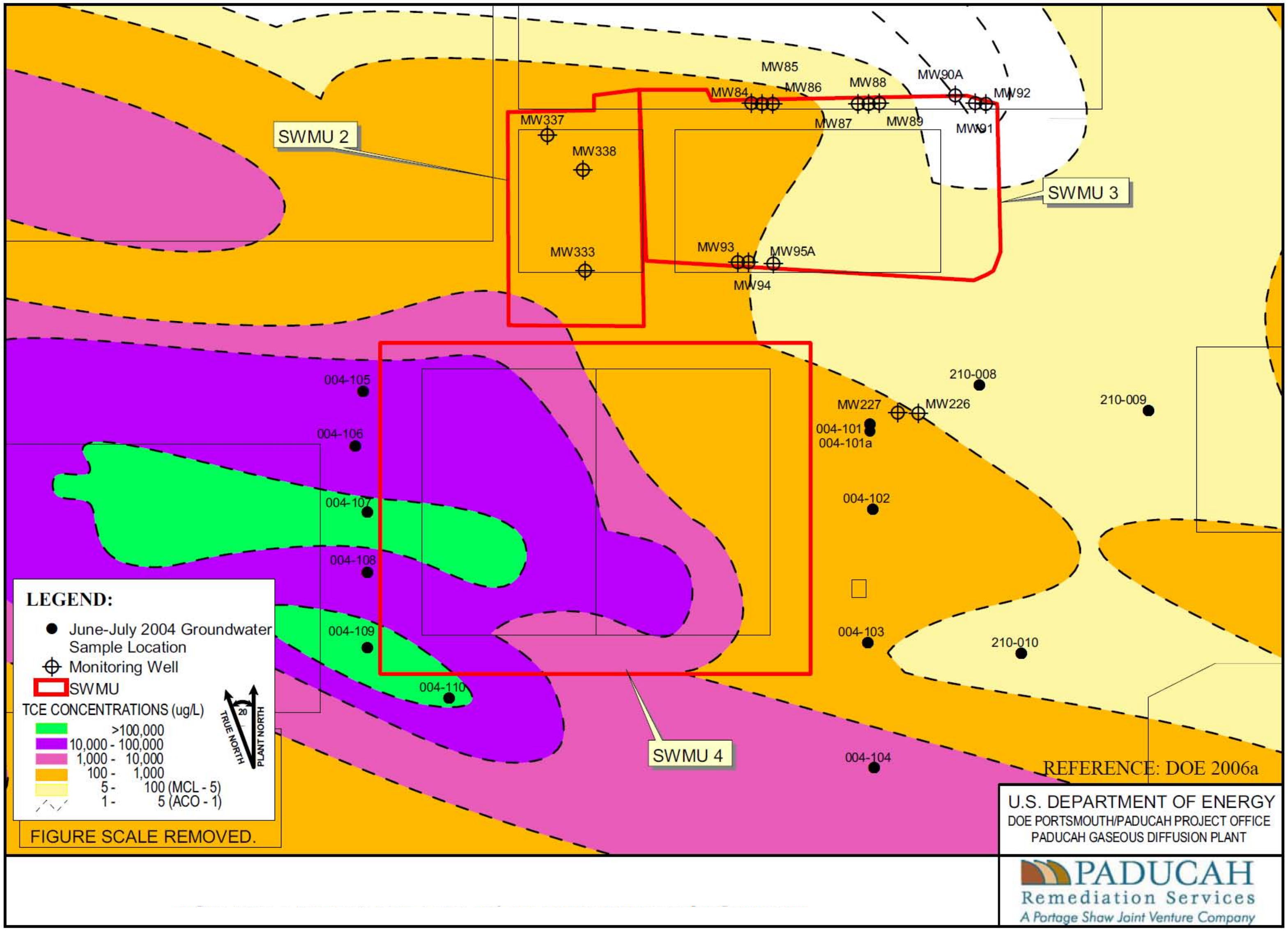

Figure 8. TCE Trends in Groundwater Surrounding SWMU 4 (June-July 2004)

1.6 JUSTIFICATION FOR ACTION

Under Executive Order 12580, *Superfund Implementation*, DOE, as lead agency, is authorized to take action to reduce the adverse effects of contamination at its facilities that pose a threat to human health and the environment. Section 300.415(b)(1) of the NCP states, "the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release." This determination should be based on the factors identified in 40 *CFR* § 300.415(b)(2).

Based on the conclusions of the BGOU RI, conditions at SWMU 4 meet the criteria for a removal action as stated in the NCP, 40 *CFR* § 300.415 (b)(2)(i), (iii), (v), and (viii) for the following reasons:

CERCLA hazardous substances (e.g., arsenic, TCE, polychlorinated biphenyls, and radionuclides) in surface soil, subsurface soil, and buried waste material pose a potential threat to industrial workers and excavation workers should they be exposed to these contaminants. The BGOU RI (DOE 2010) presents human health hazard and risk calculated for SWMU 4. For current and future on-site industrial workers, the cumulative ELCR is within the U.S. Environmental Protection Agency (EPA) risk range (i.e., 1E-06 to 1E-04); however, cumulative ELCR for the future on-site excavation worker is greater than 1E-04. The major contaminant driving the risk to the excavation worker is uranium. Additionally, TCE and its degradation products are found at high concentrations through the subsurface soil column and originate within the buried waste material. These contaminants continue to leach into the geologic layer underlying SWMU 4 and continue to pose a potential threat to RGA groundwater. The COCs driving the hazard associated with contaminant migration to groundwater are TCE, vinyl chloride, and *cis*-1,2 dichloroethene.

DOE has determined that a NTCRA under CERCLA and the FFA is warranted to address the potential risks associated with SWMU 4. A NTCRA will provide the most appropriate level of analysis, oversight, public participation, and flexibility to conduct cleanup that achieves risk reduction and protects human health and the environment in a cost-effective and timely manner.

1.7 COMMUNITY PARTICIPATION

Community involvement is a necessary aspect of the CERCLA process. DOE is conducting community relations activities for this project in compliance with 40 *CFR* § 300.415(n)(1), (n)(3), and (n)(4), and the *Community Relations Plan Under the Federal Facility Agreement at the U.S. Department of Energy, Paducah Gaseous Diffusion Plant* (DOE 2009).

The public is encouraged to comment on the alternatives presented in this EE/CA. Following the public comment period, an Action Memorandum will be prepared by DOE and added to the PGDP Administrative Record, which is accessible by the public. All responses to the public comments will be included in the Responsiveness Summary of the Action Memorandum.

2. REMOVAL SCOPE AND OBJECTIVES

This section addresses DOE's response authority under CERCLA for removal actions and identifies the scope and Removal Action Objectives (RAOs) for this removal action.

2.1 RESPONSE AUTHORITY

PGDP was placed on the NPL in 1994. Pursuant to Section 120 of CERCLA, the PGDP FFA was negotiated and implemented to provide the framework for CERCLA actions at PGDP. FFA Section X.B provides requirements applicable to the planning and implementation of removal actions.

Section 104 of CERCLA addresses the mitigation of releases or threatened releases of hazardous substances to the environment through response actions. Executive Order 12580, *Superfund Implementation*, delegates to DOE the authority for response actions at DOE facilities. As lead agency, DOE is authorized to conduct response measures (e.g., removal actions) under CERCLA.

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate and document the effect of their proposed actions on the quality of the human environment. DOE issued a *Secretarial Policy Statement on the National Environmental Policy Act* in June of 1994 (DOE 1994) stating that DOE hereafter will utilize the CERCLA process for review of actions to be taken under CERCLA and incorporate NEPA values in CERCLA documents to the extent practicable. Such values may include analysis of socioeconomic, cultural, ecological, and cumulative impacts, as well as environmental justice and land use issues and the impacts of off-site transportation of wastes. NEPA values have been incorporated into the EE/CA in accordance with the DOE Secretarial Policy Statement on NEPA.

2.2 REMOVAL ACTION OBJECTIVES

(1) Prevent future contaminant migration from buried waste to the environment such that it does not present unacceptable direct exposure risks to future receptors or migration to groundwater above acceptable levels.

(2) Prevent exposure from surface soil metals and radionuclides that would cause an unacceptable cumulative risk to future industrial workers.

(3) Prevent exposure to subsurface soil metals, radionuclides, and semivolatile organic compounds (SVOCs) within the SWMU administrative boundary to 16 ft bgs that would cause an unacceptable cumulative risk to future outdoor worker/gardeners.

(4) Prevent migration of metals, radionuclides, and volatile organic compounds (VOCs) in the top 16 ft of soil so that they will not contribute contamination to the RGA groundwater beneath the SWMU exceeding MCLs, or in the absence of an MCL, a risk-based concentration.

2.2.1 Remediation Goals for Soil

For any excavation activities conducted as part of the proposed removal action at SWMU 4, achievement of Remediation Goals (RGs) in soil would ensure that the RAOs have been met. Excavation activities would not remove COCs in soil below RG concentrations or background. The following standards provide the basis for RG development and represent the standards of protectiveness that the RGs would meet.[4]

(1) Removal of all visible buried waste material and incidental soils from burial cells at SWMU 4.

(2) Direct contact soil RGs in <u>surface soil</u> (less than 1 ft bgs) for the future *industrial worker* and *excavation worker* scenarios:
- Chemical-specific ELCR = 5E-06
- Chemical-specific Hazard Quotient (HQ) = 0.5

(3) Direct contact soil RGs in <u>subsurface soil</u> (1-16 ft bgs) for the future outdoor worker/gardener scenario:
- Chemical-specific ELCR = 5E-05
- Chemical-specific HQ = 1

(4) Groundwater-protective soil concentration to a depth of 16 ft bgs back-calculated from the top of the RGA.
- Groundwater-protective soil concentrations would not contribute contamination to RGA groundwater exceeding MCLs, or in the absence of an MCL, a risk-based concentration.

The risk targets utilized to develop RGs are based on default exposure parameters in the PGDP Risk Methods Document (DOE 2001c). Example RG concentrations are presented in Table 2. The risk targets described above apply to the complete list of COCs listed in Table 1 of this EE/CA; however, RGs for a subset of the complete COC list are presented in Table 2 to direct excavation activities because it is expected that addressing the subset during field implementation also will meet goals for the complete list of COCs. Following completion of the removal action, the cumulative residual risk/hazard will be calculated and presented in the removal completion letter. The FFA parties will consider these cumulative risk values relative to the final remedial decisions for the BGOU. Appendix B further discusses the process of developing RGs for the SWMU 4 Removal Action. Final RGs will be established in the Action Memorandum. Figure 9 shows an illustrated representation of how RGs would be applied to the SWMU 4 removal action.

After removing all visible buried waste materials, any additional excavation to achieve direct contact or groundwater-protective RGs in soils below 16 ft bgs as part of this removal action will be conducted at DOE's sole discretion considering health and safety, implementability, the relative efficiency achieved, and other relevant factors.

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[4] The cancer-risk targets and exposure scenarios were agreed upon during a June 2009 BGOU scoping meeting between DOE, EPA, and KY (i.e., the BGOU Project Team). This calculation uses upper-bound exposure assumptions (and may be overly health protective). When used as the upper-bound remedial goal for individual sample results, the project team believes that the average residual risk for the unit will be markedly lower than this cancer-risk targets and approach the lower end of the EPA acceptable risk range.

Table 2. Example Remediation Goals for the SWMU 4 Removal Action

COC[1]	Background[2] Surface/ Subsurface (mg/kg) (pCi/g)	Direct Contact RG for Soil[3] Surface/ Subsurface (mg/kg) (pCi/g)	Groundwater - Protective RG for Soil[4] (mg/kg) (pCi/g)	MCL[5] (mg/L) (pCi/L)	RG for Soil[6] (mg/kg) (pCi/g)
Technetium-99	2.5	X	6.30E+00[4,7]	9.00E+02[7]	2.5
	2.8	2.90E+03			2.8
Uranium (metal)[8]	4.9	X	No load	3.00E-02	1.01E+02
	4.6	1.13E+02			1.13E+02
Uranium-238+D	1.2	8.55E+00	No load	2.0E+01[9]	8.55E+00
	1.2	5.85E+01			5.85E+01
Trichloroethene	NE	X	4.00E-02	5.00E-03	4.00E-02
	NE	1.63E+02			
Vinyl chloride	NA	X	3.60E-02	2.0E-03	3.60E-02
		7.05E+00			
cis-1,2-DCE	NA	X	7.70E-01	7.00E-02	7.70E-01
		1.71E+02			
Total PCBs[10]	NE	1.0E+01	1.0E+01	5.00E-04	1.0E+01
	NE	1.0E+01	No load		

COC = contaminant of concern; MCL = maximum contaminant level; RG = remediation goal

Notes:

NE Not established in DOE (2001c) Risk Methods Document.

No load Modeling in the BGOU RI indicates no transport from source to groundwater at SWMU 4 within 1,000 years; therefore, a groundwater-protective RG does not apply.

X Chemical is not identified in the BGOU RI Baseline Human Health Risk Assessment (reproduced in Appendix B of this EE/CA) as a COC for direct contact exposure.

1. COC identified according to the Risk Methods Document: *To determine COCs, risk characterization results for chemical hazard (HQi) and risk (ELCRi) over all pathways within a use scenario of concern will be compared to benchmarks of 0.1 and 1 × 10^{-6}, respectively. Chemicals of potential concern within a use scenario of concern exceeding either of these benchmarks will be deemed COCs for the use scenario of concern* (DOE 2001, Risk Methods Document, Volume 1, pp. 3-37).
2. Provisional background concentrations for surface and subsurface soil at PGDP given in Table A.12 (DOE 2001). Organic and inorganic chemicals are given in mg/kg units; radionuclides given in pCi/g units.
3. Direct Contact RG for surface soil is calculated as 5 x the Industrial Worker no action level (NAL) for carcinogenic COCs. The Industrial Worker NAL for carcinogenic COCs corresponds to a cancer risk of 1 x 10^{-6}; the resulting RG corresponds to a cancer risk of 5 x 10^{-6}. For noncarcinogenic COCs, the RG is calculated as 5 x the Industrial Worker NAL for noncarcinogenic COCs. The NAL for noncarcinogenic COCs corresponds to a noncancer hazard quotient of 0.1; the resulting RG corresponds to a noncancer hazard quotient of 0.5. The lower of the two values is shown for COCs having both cancer and noncancer health effects. NAL values are presented in Table A.4 of the DOE (2001c) document.
4. RG for soil developed to protect groundwater from COC migration from soil to groundwater and is applied to both surface and subsurface soil. The RG is calculated as dilution attenuation factor (DAF) x the MCL. DAF values are given in Table B.1.
5. Radionuclide concentrations are given in pCi/L units.
6. The RG for Soil is the lower of the Direct Contact RG and Groundwater-Protective RG for Soil. If the background concentration is greater than the lower of the Direct Contact RG and Groundwater-Protective RG, the RG for Soil equals the background concentration.
7. The MCL concentration for beta and photon emitters corresponding to specified annual radiation dose limit of 4 mrem/yr equals 900 pCi/L for ^{99}Tc. *EPA Facts About Technetium-99*, July 2002.
8. Uranium metal was not identified as a COC in the risk assessment for SWMU 4; however, isotopic uranium was identified as a COC, so an RG for uranium metal is presented here to facilitate field implementation of the action.
9. The Risk Methods Document gives a groundwater MCL concentration of 20 pCi/L for all uranium isotopes without regard to relative radiotoxicity (Table A.20, DOE 2001).
10. The Direct Contact RG for total PCBs is consistent with the Toxic Substances Control Act concentration as 10 ppm for high occupancy areas when covered by a cap as defined in 40 *CFR* §761.61. This concentration was agreed upon as part of risk management discussions during a June 2009 BGOU scoping meeting among DOE, EPA, and KY. At that meeting, the group recognized that, when used as the upper-bound goal for individual detections, the average concentration of PCBs for the unit is expected to be significantly lower.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) include the substantive requirements of federal or more stringent state environmental or facility siting laws/regulations. In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 *CFR* § 300.415(j), on-site removal actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) are required to attain applicable or relevant and appropriate requirements (ARARs) to the extent practicable or provide grounds for invoking a CERCLA waiver. Additionally, per 40 *CFR* § 300.400(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to be considered (TBC) category]. In determining whether compliance with ARARs is practicable, the lead agency may consider factors including (1) the urgency of the situation, and (2) the scope of the removal action. DOE expects that the proposed removal action will attain or exceed all ARARs within the scope of this removal action, as set forth in Appendix A. See Appendix A for a preliminary list of ARARs for the proposed SWMU 4 removal action.

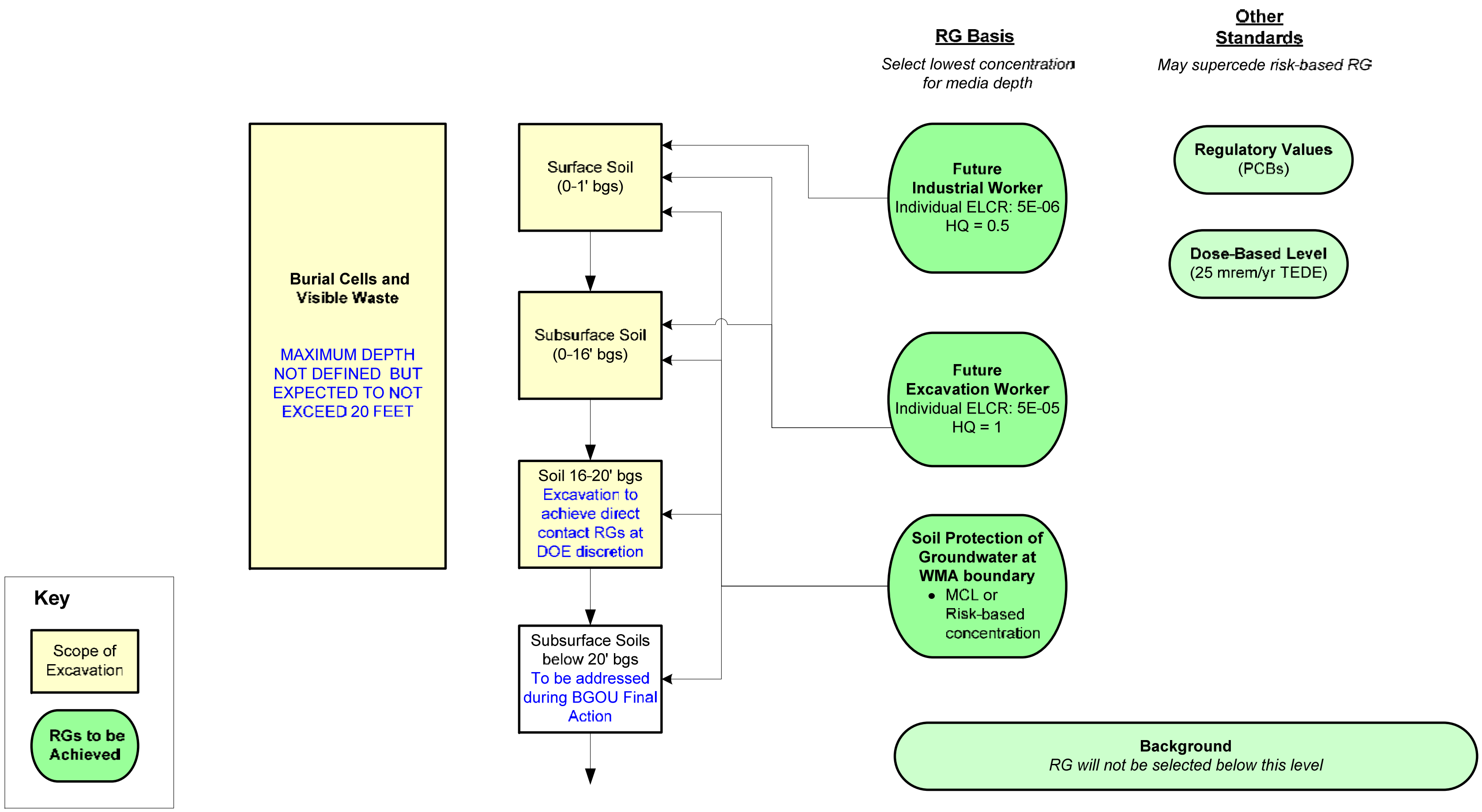


Figure 9. SWMU 4 Excavation Physical Extent and Applicable RAOs

2.4 SCOPE OF THE REMOVAL ACTION

The scope of the removal action for SWMU 4 includes the following:

- All buried waste materials and incidental soils from the area of burial cells identified within the SWMU 4 administrative boundary.

- Potential buried waste material and COCs in soil (surface and subsurface) outside of the identified burial cells, but inside the SWMU 4 administrative boundary.

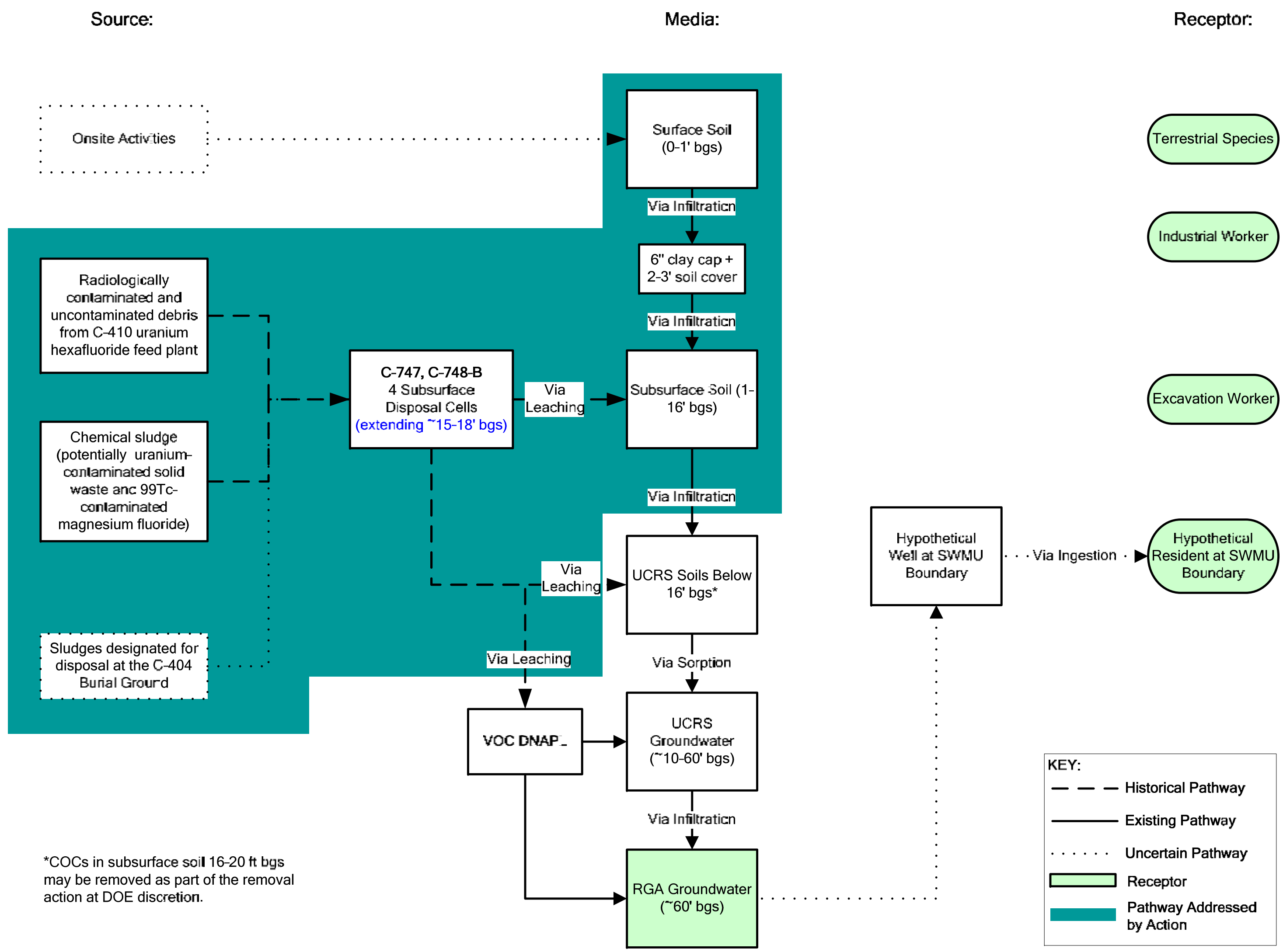
All visible buried waste materials and incidental soils would be removed from burial cells at SWMU 4. The areas currently identified as burial cells are based on the geophysical surveys of SWMU 4 (Figure 3) and may be modified based on additional site investigation (e.g., limited excavations, soil coring, geophysical survey) that would be conducted prior to implementation of the preferred removal action. The burial cells are approximately 15 to 18 ft deep, and for evaluation purposes it is assumed that buried waste material would not extend beyond 20 ft.

Table 3 provides an estimate of the size of each of the four identified burial cells based on the expected layout of SWMU 4 presented in Figure 4, plus a volume estimate for other contaminated soils within the SWMU 4 administrative boundary. Figure 10 illustrates the scope of this removal action relative to the conceptual site model for SWMU 4.

Table 3. Size and Volume Estimates for the Four SWMU 4 Burial Cells and Potential Waste within SWMU 4

Cell	Perimeter (ft)	Surface Area (ft^2)	Volume[1] (ft^3)	Volume[1] bcy	Volume[1] lcy
1	950	18,650	373,000	13,814	16,577
2	555	10,575	211,500	7,833	9,400
3	390	6,125	122,500	4,537	5,444
4	1,325	51,025	1,020,500	37,796	45,355
Total for Burial Cells	**3,220**	**86,375**	**1,727,500**	**63,980**	**76,776**
Other Potential Contaminated Soils in SWMU 4		**42,625**	**852,500**	**31,576**	**37,891**
Estimated Total for all of SWMU 4		**129,000**	**2,580,000**	**95,556**	**114,667**

[1] Volume estimates assume that the burial cells are excavated to a depth of 20 ft.
bcy = banked cubic yard
lcy = loose cubic yard



*COCs in subsurface soil 16-20 ft bgs may be removed as part of the removal action at DOE discretion.

Figure 10. Scope of SWMU 4 Removal Action Relative to Conceptual Site Model

2.5 INTEGRATION WITH RI/FS PROCESS FOR SWMU 4

The proposed NTCRA would not address all potential threats identified in the BGOU RI associated with SWMU 4. Following the removal action, the scope of the final action pertaining to SWMU 4 would include the following residual threats to human health and the environment:

- Potential risks to ecological receptors associated with remaining constituents in surface and subsurface soil not excavated as part of the removal action;
- Residual contamination in the UCRS with the potential for unacceptable impact the RGA; and
- VOC DNAPL in the UCRS and RGA.

A removal completion letter would document the residual conditions at SWMU 4 for reference in subsequent BGOU analyses and remedial decisions. The final remedy selected for the SWMU 4 would focus on addressing the residual threats to human health and the environment once the removal action is complete.

3. IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Consistent with the requirements of 40 *CFR* § 300.415 (d), this EE/CA evaluates the effectiveness, implementability, and cost of two alternatives: *No Action* and *Excavation and Disposal of Buried Waste Material and Contaminated Soils*. An additional alternative involving waste containment via a soil cover or Resource Conservation and Recovery Act (RCRA)-compliant cap was screened from further evaluation at SWMU 4 for the following reasons:

- Data in the BGOU RI Report indicate that buried wastes at SWMU 4 are in contact with the water table and construction of a soil cover likely would not prevent the continued leaching of contaminants to groundwater. The BGOU RI Report indicates that the water table within the BGOU ranges from 5 to 10 ft bgs and intrudes into buried wastes at the SWMU.

- SWMU 4 was identified as a significant contributor to the Southwest Plume at PGDP, and isolation of the buried wastes in-place would not adequately address the source of contamination.

This section describes the two alternatives evaluated in this EE/CA.

3.1 ALTERNATIVE 1: NO ACTION

The No Action Alternative is defined in accordance with CERCLA and provides a baseline to which other alternatives can be compared. Under this alternative, no action would be taken to respond to potential threats to human health and the environment at SWMU 4. As defined in CERCLA guidance (EPA 1988), a No Action Alternative may include environmental monitoring; however, actions taken to reduce exposure, such as site fencing, are not included as a component of the No Action Alternative. Alternative 1 includes no actions and no costs.

3.2 ALTERNATIVE 2: EXCAVATION AND DISPOSAL OF BURIED WASTE MATERIAL AND CONTAMINATED SOILS

This alternative is comprised of excavation of the burial cells within SWMU 4 to remove buried waste material and contaminated soil to satisfy all RAOs within the scope of this NTCRA (i.e., all visible buried waste materials and incidental soils, plus removal of contaminated soils within the SWMU that do not meet RAOs for soil described in Section 2).

Alternative 2 includes the following actions:

(1) Install engineering controls (e.g., sheet piling) to shore the excavation walls and minimize groundwater intrusion into the excavation area. The location of the engineering controls will be based on geophysical surveys conducted in support of the BGOU RI, plus any additional pre-excavation investigations conducted.

(2) Install temporary localized engineering controls such as small stormwater retention areas, silt fencing, or rock check dams during excavation activities, as needed. Installation will control sediment migration from the action and will be dependent upon the site conditions at the time of excavation.

(3) Erect a temporary enclosure over the area being excavated for removal. The excavation enclosure will be relocated as necessary. An additional temporary enclosure will be erected for use in waste management activities.

(4) Dewater excavation area and treat or dispose of intruding ground and surface water, if necessary, as indicated by sampling results.

(5) Excavate all visible buried materials, plus any COCs in soil in accordance with RAOs to a depth of 16 ft bgs.

(6) Postexcavation, sample the bottom of excavation areas to characterize the remaining conditions for reference in the BGOU remedial decision-making process.

(7) Sample excavated materials to confirm compliance with waste acceptance criteria (WAC) and determine any required treatment prior to disposal.

(8) Treat, segregate, and/or consolidate the waste and soil, if necessary, for transportation and/or disposal.

(9) Transport and dispose of waste to the appropriate disposal facility.

(10) Backfill with clean soil, segregated and confirmed via sampling during excavation, or import clean backfill soil from another location on-site. The method for characterization and verification of backfill soils would be further defined in the Removal Action Work Plan (RAWP) for the removal action.

(11) Removal of engineer controls and restore site except as necessary to support BGOU Record of Decision actions.

3.2.1 Waste Generation and Management

Waste generated during the SWMU 4 removal action would be characterized, packaged, and temporarily stored as necessary. On-site waste storage areas would be considered within the area of contamination (AOC) for the SWMU 4 removal action and would be operated in compliance with ARARs. Temporary on-site physical enclosures would be utilized as appropriate to contain and protect waste characterization and packaging activities. During characterization, and until shipment to the appropriate disposal facility can be implemented, waste (i.e., excavated soils, personal protective equipment, etc.) containers may be managed within alternative PGDP locations, which would be considered part of the AOC for SWMU 4. Examples of identified locations are as follows:

- C-746-P-1
- C-745 C-Yard and
- C-752

Excavated material would be segregated based on physical, chemical, and radioactive characteristics, as determined by field observation, testing, and monitoring. Alternatively, soils and materials may be directly packaged and prepared for disposal based on the disposal facility WAC. The existing cap and cover soils (expected to extend 2-3 ft bgs) would be scraped to a separate location within the SWMU administrative boundary (i.e., within the AOC for SWMU 4) potentially to be used as backfill upon the completion of excavation activities or to be used as fill material for waste containers.

Waste generated by this removal action alternative is expected to consist of low-level radioactive waste (LLW), mixed low-level waste (MLLW), and potential Toxic Substances Control Act-regulated waste based on the limited information available regarding the contents of the burial cells. Based on the radiological and chemical information available, it appears that there is a population of waste that may be disposed of at the Energy*Solutions* Clive disposal facility in Utah or other permitted facilities. There is an additional population of waste that may require disposal at the Nevada Test Site (NTS).

The wastes may require treatment to reduce toxicity, mobility or volume to meet the WAC of the appropriate disposal facility. Any necessary treatment would be conducted either on-site or off-site prior to transportation to the accepting off-site disposal facility and would be further defined in the RAWP. Sampling and analysis would be required to determine waste classifications for treatment and/or disposal in compliance with ARARs. Soil identified as suitable for reuse may be used as backfill at SWMU 4.

MLLW must meet RCRA Land Disposal Restrictions (LDRs) prior to disposal. Waste meeting the Energy*Solutions* WAC may be delivered to the Energy*Solutions* mixed waste treatment facility for RCRA treatment prior to disposal. Waste that would require disposal at NTS must be treated to meet LDRs prior to delivery. The waste may be treated on-site within the AOC, at a permitted treatment facility at PGDP, or at an off-site permitted treatment facility capable of accepting and treating the waste.

If the project encounters scrap materials subject to control for security purposes, the options for disposition are further limited. The Energy*Solutions* disposal facility at Clive, Utah, is not capable of disposal of materials requiring control higher than the Export Controlled Information or Unclassified Controlled Nuclear Information level. Materials required to be controlled beyond Unclassified Controlled Nuclear Information would limit disposal options to the NTS disposal facility for both LLW and MLLW. MLLW requiring treatment may be managed at one of several facilities assuming the waste treatment activities are authorized in the facility permit. The treatment options include on-site treatment via macroencapsulation for hazardous debris, on-site stabilization to meet Universal Treatment Standards, or off-site vendors with the appropriate RCRA permits and security programs (e.g., the Energy*Solutions* Oak Ridge Operations facility).

Dewatering likely would be required to conduct excavation activities. A water treatment unit located on-site would be constructed and utilized to treat wastewater generated from pit dewatering, solid/liquid separation in the roll-offs and bins, and waste water associated with waste treatment processes. Water would be treated to meet the Kentucky Water Quality standards prior to discharge into an on-site ditch, which leads to PGDP Outfall K001. The total estimated volume of water to be managed is 2,354,000 gal, and the rate of water extraction is expected to vary between 7.8 and 30 gal per minute. The water treatment system may include a large temporary storage tank; filtration for solids removal; air stripping for VOC removal (e.g., TCE) with granular activated carbon (GAC) for treatment of off-gas; ion exchange for technetium-99 removal; and GAC for PCB removal. Performance specifications for this unit would be issued for design-build procurement, but the system is expected to have the capacity to treat the following constituents in water:

- Organics
- Metals
- PCBs
- Solids and
- Radionuclides

3.2.2 Disposal

Consistent with the current *Waste Management Plan for the Paducah Environmental Remediation Project* (PRS 2006), waste generated by this action will be disposed of to the extent possible at the C-746-U Landfill, and the remaining waste will be disposed at an appropriate off-site disposal facility in accordance with the WAC of the receiving facility (Section 3.2.1). DOE may deem some materials to have recycle value and segregate from waste to reclaim. Table 4 displays the waste volume estimate with regard to the amount of waste expected to be disposed of on-site at the C-746-U Landfill or at an appropriate off-site disposal facility consistent with site-specific WAC. Before shipping hazardous remediation waste to an off-site facility, DOE will verify its acceptability in accordance with the requirements of the Off-Site Rule in 40 *CFR* § 300.440(a)(4).

Table 4. Estimated Approximate Waste Disposal Quantities, On-Site vs. Off-Site

Excavated Soil Volume Calculation								
Area (ft^2)	**Beginning Depth (ft bgs)**	**End Depth (ft bgs)**	**Quantity (bcy)**	**Quantity (lcy)**	**Quantity (lcy) w/sorbent**	**Percentage for Off-Site Disposal**	**Off-Site (yd^3)**	**DOE Site (yd^3)**
129,000	0	3	14,333	17,200	17,293	0	0	17,293
129,000	3	15	57,333	68,800	69,172	70	48,420	20,751
129,000	15	20	23,889	28,667	28,821	25	7,205	21,616
						Estimated Total	**56,000 (48%)**	**60,000 (52%)**

bcy = banked cubic yard
lcy = loose cubic yard

3.2.3 Sequence of Excavation Activities

Implementation of this alternative would occur in multiple segments of excavation activities based on available funding, the size and contents of individual burial cells, potential waste volume impacts on the Safety Authorization Basis of SWMU 4, the design capacity of a temporary enclosure over excavation pits, and the capacity of associated temporary enclosures to manage wastes generated during the action (i.e., segregation, treatment, packaging, etc.). The sequence of excavation and waste disposal activities will be further described in the RAWP.

It is currently expected that removal of burial cells would encompass a number of separate excavations. Figure 11 displays the expected area of excavation for each identified burial cell, though it should be noted that excavation of the cells may be further segmented in consideration of the sequencing criteria that will be described in the RAWP.

Depending on the results of additional sampling in the previously unsampled areas of the SWMU 4 administrative boundary (the non-delineated areas in Figure 4), an additional excavation may be necessary to remove other surface or subsurface contamination exceeding the risk-based RGs for protection of future industrial and excavation workers. The additional sampling would be conducted as part of the SWMU 4 removal action, with clear decision rules established in the RAWP to determine the scope of additional excavation activities.

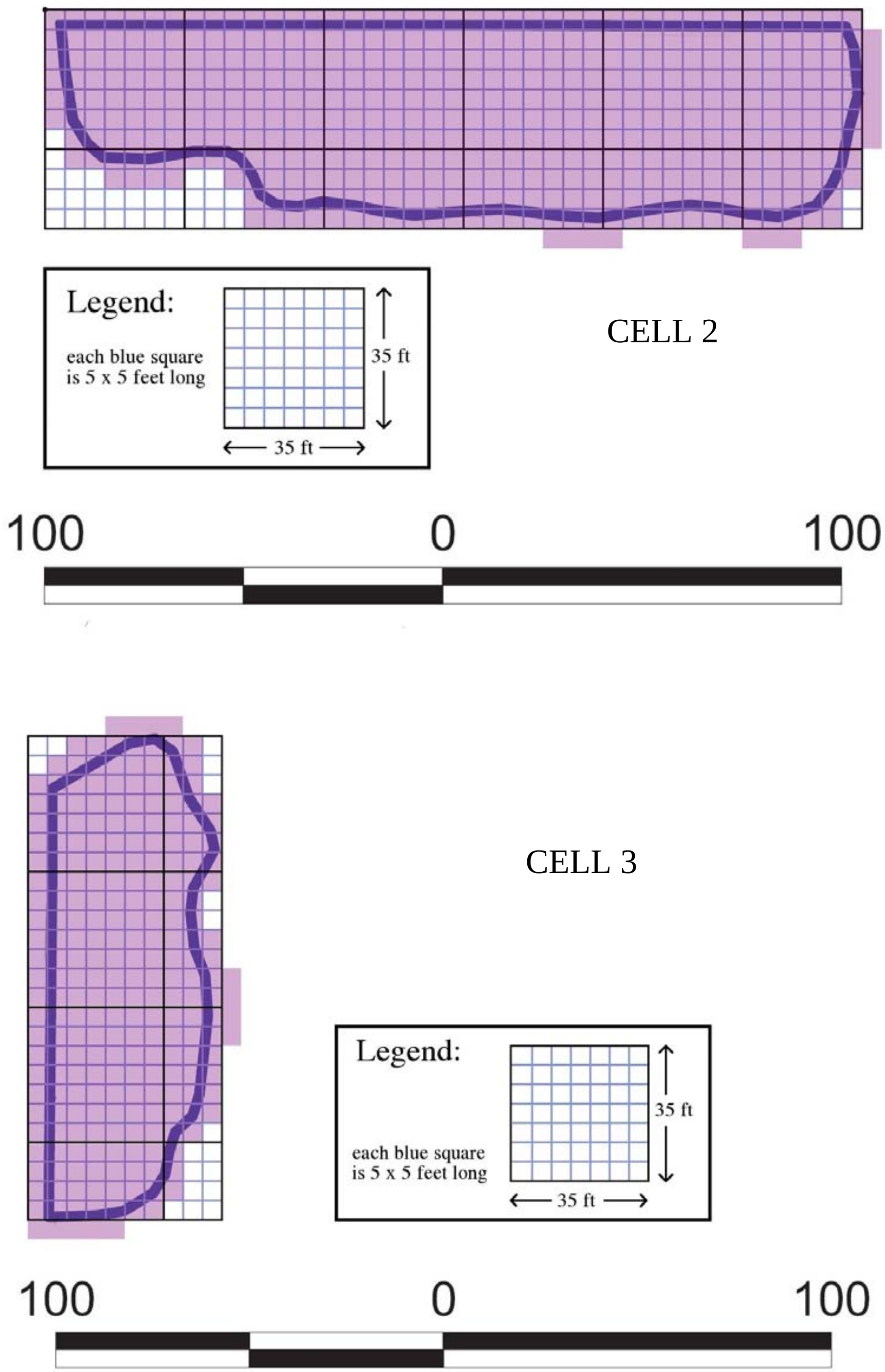
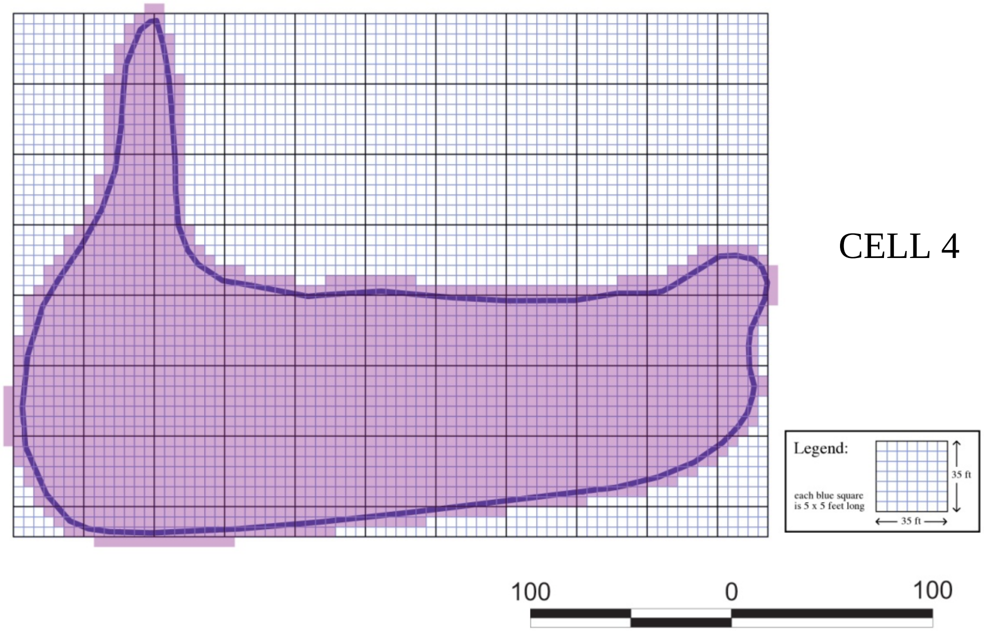


Figure 11. Anticipated Extent of Excavation for SWMU 4 Burial Cells



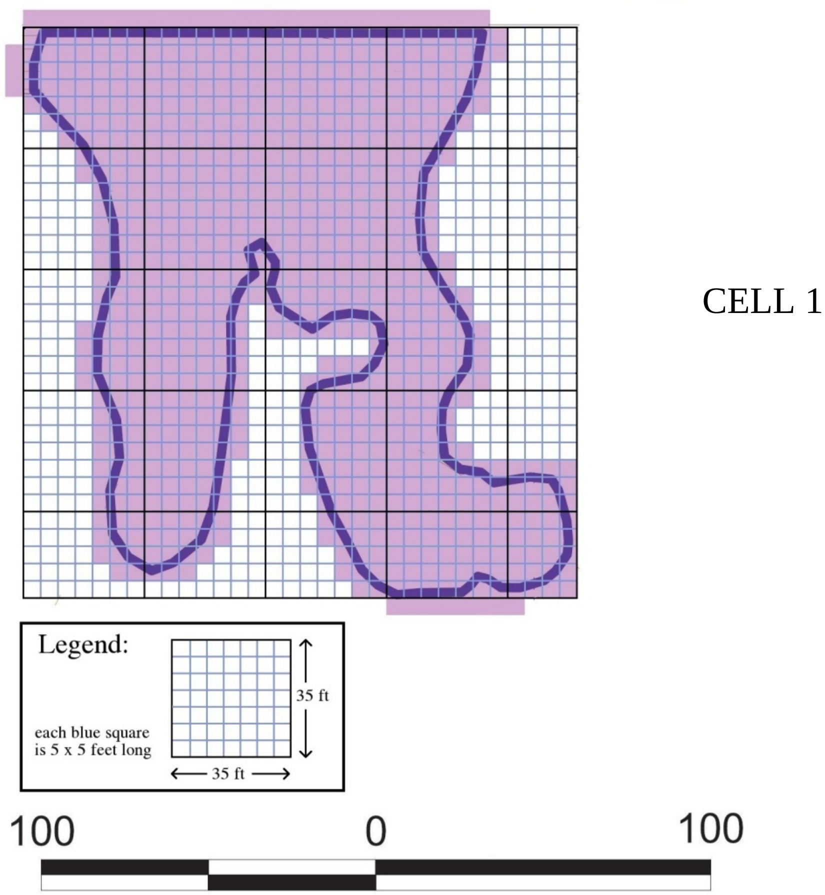


Figure 11. Anticipated Extent of Excavation for SWMU 4 Burial Cells (Continued)

4. ANALYSIS OF ALTERNATIVES

This section evaluates the alternatives for the SWMU 4 removal action based on their effectiveness, implementability, and cost. The NCP, EPA, and DOE guidance documents identify these three criteria for the evaluation of removal action alternatives as a basis for decision-makers to compare removal action alternatives.

4.1 EFFECTIVENESS

Alternatives were evaluated relative to their effectiveness in meeting the RAOs presented in Section 2. For this evaluation, the following NCP threshold and balancing criteria were considered:

- Overall protection of human health and environment
- Compliance with ARARs
- Ability to achieve removal action objectives
- Long-term effectiveness and permanence
- Short-term effectiveness
- Reduction of toxicity, mobility, or volume of contamination through treatment

4.1.1 Alternative 1: No Action

The No Action Alternative would leave buried waste material and associated contaminants in the burial cells at SWMU 4. No Action would be protective of workers in the short-term since workers would not be exposed to excavated waste material and associated contamination. In the long-term, the risk associated with on-site worker exposure to contamination in buried waste material would persist. No Action would be protective of the public in the short-term since waste would not be transported off-site.

The No Action Alternative would not reduce the toxicity, mobility, or volume of contamination at SWMU 4. This alternative would not prevent further migration of contaminants from the buried waste material in the burial cells to subsurface soils, UCRS saturated soils, and RGA groundwater. This alternative would result in continued releases or the potential for releases to the environment; therefore, this alternative is not protective of the human health and the environment and would not comply with ARARs. This alternative does not achieve the RAOs and would not result in an effective or permanent solution over the long-term.

Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. There is a disproportionately high percentage of minority and low-income populations within 50 miles of the PGDP site (DOE 2004). Low-income families are those whose annual incomes are below the poverty levels, based on the family size and number of minor children. For example, in 1999, the poverty level for a family of three with one child under 18 was $13,410, while the poverty threshold for a family of five with one child under 18 was $21,024. If a family’s income fell below the poverty level, all members of the household are considered to be below the poverty level. Information from the U.S. Bureau of Census was used to determine the percentage of households where income was less than the poverty level in the area within a 50-mile radius of the PGDP. Figure 12 shows that approximately half of

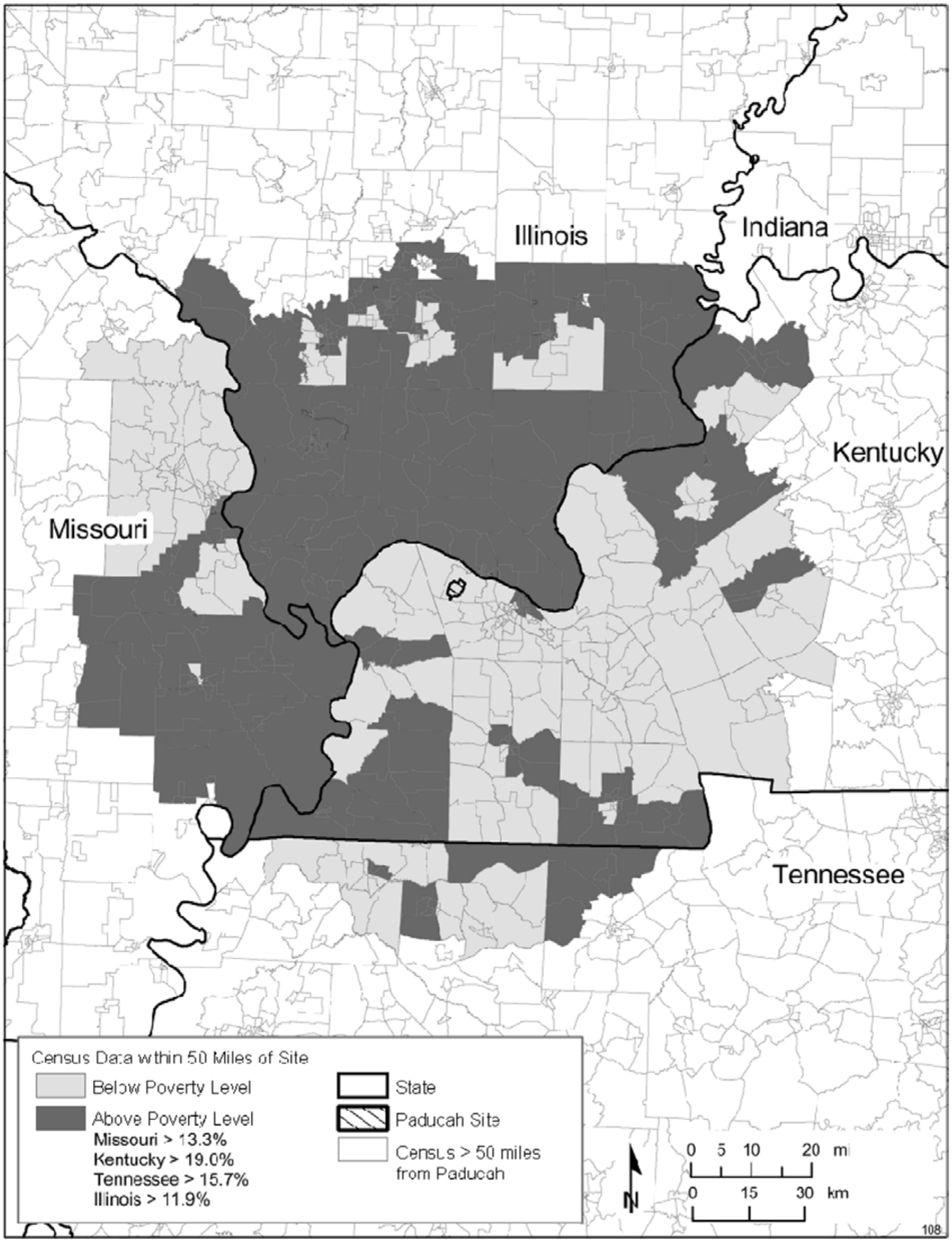


Figure 12. Regional Poverty Level Surrounding PGDP (Source DOE 2004)

the area within a 50-mile radius of PGDP has a higher percentage of low-income persons than other areas in Kentucky, Missouri, Illinois, or Tennessee (DOE 2004). Under this alternative, the continued mobilization of contaminants from SWMU 4 to groundwater due to water infiltration has the potential to adversely impact off-site minority or low income populations.

NEPA Values. Under the No Action Alternative, short- and long-term impacts may occur to the following NEPA values.

- Water resources
- Ecological resources

Water resources may be impacted as contaminants are mobilized due to continued water infiltration through buried waste materials and subsurface soils. Ecological resources, while not commonly present at SWMU 4, may be impacted as terrestrial biota is exposed to contaminated media in surface and subsurface soils.

4.1.2 Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils

Short-Term Effectiveness. Short-term exposures of workers to COCs during implementation of Alternative 2 could occur. Potential exposure pathways include direct contact with soil (ingestion, inhalation) and exposure to external penetrating radiation. An additional low-likelihood risk is that workers could encounter direct exposure to wastes or contaminated soils despite the use of personal protection equipment (PPE). Worker risks are not expected to exceed acceptable limits because exposure frequency and duration are anticipated to be less than those evaluated in the baseline risk assessment. Risks from handling waste/contaminated soils would be minimized through adherence to health and safety protocols. To protect workers, PPE, ambient conditions monitoring, and decontamination protocols would be used in accordance with an approved, a site-specific health and safety plan (HASP).

Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures including review of the as low as reasonably achievable principles, Documented Safety Analyses, health and safety plans, and safe work practices to maintain a work environment that minimizes injury or exposure to risks to human health or the environment. The temporary enclosure over the open excavations would protect against further exposure of any exposed DNAPL to rainfall and subsequent direct percolation of PTW to the groundwater. SWMU 4 is located on a secured site and effects on outlying communities would be negligible because the continued groundwater use and access restrictions would manage the residual exposure risks at SWMU 4 until a final remedial action as part of the BGOU.

Short-term risks to the community resulting from excavation activities at the site would not be expected. Potential risks resulting from migration of contaminants to off-site locations would be controlled by the localized ventilation, a high efficiency particulate air filtration system, and an on-site wastewater treatment system. Other potential short-term risks to the public may occur from transportation of the LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities, in the event of a transportation accident.

An additional benefit of implementing this alternative as a NTCRA prior to a BGOU remedial action is that an early action mitigates potential implementation concerns associated with a BGOU remedy to address VOC contamination in groundwater. Early removal of the metallic debris in the burial cells also would leave SWMU 4 in a state more conducive to effective implementation of a groundwater remedy because the subsurface physical interferences to groundwater treatment technologies no longer would be present.

Long-Term Effectiveness. Alternative 2 would remove buried waste material and associated contaminants in the burial cells at SWMU 4 and achieve the RAOs for radioactive, organic, and inorganic contaminants following completion of excavation.

This alternative would reduce the toxicity, mobility, or volume of contamination at SWMU 4 by removing the primary source of contamination to the groundwater. This alternative would prevent further migration of COCs from burial cells and subsurface soil to a depth of 16 ft bgs into UCRS and RGA groundwater; therefore, Alternative 2 allows for a maximum reduction of risks associated with continued contributions to the hydrogeologic system. Risks associated with direct contact from human receptors would be mitigated since RAOs would be achieved to 16 ft bgs, which is the maximum depth that a future outdoor worker/gardener may be anticipated to come into contact with subsurface contaminants.

This alternative is expected to be compliant with ARARs, achieves the RAOs, and would result in an effective and permanent solution over the long-term.

NEPA Values. No long-term and minor short-term impacts to land use would occur under Alternative 2. Land surrounding SWMU 4 is designated as industrial within the PGDP limited area.

Land use of the immediate area surrounding SWMU 4 is governed by controls that restrict access to these areas. It is assumed that these controls would remain in place into the anticipated future; thus, land use would remain unchanged.

Short-term impacts may occur to the following NEPA values by implementation of Alternative 2:

- Air quality and noise
- Soils
- Water resources
- Ecological resources

Excavation activities would require heavy construction. There would be minor short-term impacts to air quality and noise resulting from Alternative 2 during construction activities. Air quality impacts would include emissions from vehicle and equipment exhaust and fugitive dust from vehicle traffic and disturbance of soils. Site preparation and construction activities would be short-term, sporadic, and localized (except for emissions from vehicles of construction workers and transport of construction materials and equipment). Fugitive dust from excavation and earthwork activities would be noticeable on-site and in the immediate vicinity. Dispersion would decrease concentrations of pollutants in the ambient air as distance from the construction site increased. The use of control measures (i.e., covers and water or chemical dust suppressants) would minimize fugitive dust emissions. No exceedances of primary or secondary National Ambient Air Quality Standards would be expected. Additionally, there may be a minor impact to off-site receptors associated with air emissions of TCE during implementation of Alternative 2, but such emissions would be below concentrations that would pose a health risk to off-site populations.

Increased noise levels from the transport and use of construction equipment in the immediate vicinity of construction also would be short-term, sporadic, and localized. Noise levels already are slightly elevated in the industrialized PGDP limited area. No sensitive noise receptors (e.g., residences) are located near SWMU 4; thus, no noise impacts would occur. Construction or operational activities such as excavation may impact wetlands or regulatory floodways due to soil runoff. If, during the design phase of the removal action, it is determined that wetlands and/or floodplains would be impacted, ARARs/to be considered (TBC) requirements for floodplain/wetlands would be met the extent practicable, and actions would be taken to mitigate short- or long-term impacts.

Alternative 2 would have short-term impacts on soils. Construction would disturb existing topsoils in order to access subsurface buried waste materials and other contaminants. Soil erosion impacts during construction would be mitigated through the use of control measures (e.g., covers and silt fences). No conversion of prime farmland soils is expected to occur. Site restoration would be performed at the conclusion of this alternative to minimize the impacts to the areas disturbed during implementation.

Short-term impacts to water resources may result from localized construction activity. These impacts typically would occur in the form of stormwater runoff from the construction site resulting in elevated levels of suspended solids. Silt fencing and other construction best management practices would be used to minimize short-term impacts to water quality.

Short-term negative impacts to ecological resources may occur during construction activities associated with Alternative 2, if site preparation activities and excavation cause the direct loss of any less mobile wildlife located at the construction site. The degree of these potential impacts would increase with the surface area removed.

No archaeological or historical resources have been identified within SWMU 4; therefore, no impacts as a result of this alternative are expected. Under this alternative, there will be no disproportionately high and adverse off-site impacts to minority and low-income populations. Small short-term off-site impacts to these populations may occur associated with the implementation of Alternative 2; however, the long-term impacts would be reduced compared to the long-term impacts associated with Alternative 1.

4.2 IMPLEMENTABILITY

When evaluating the implementability of the retained alternatives, the following questions were considered:

- Is the alternative technically feasible with currently available technology?
- Is the alternative technically complex or difficult to implement?
- Is the alternative administratively feasible in terms of administrative or procedural requirements?
- Are there services and materials readily available for performing the alternative?

4.2.1 Alternative 1: No Action

The No Action Alternative can be implemented readily. If future remedial action is necessary, this alternative would not impede implementation of such action in the future.

The ongoing public awareness program would require regular coordination among DOE, Kentucky, and possibly with other governmental agencies.

4.2.2 Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils

Alternative 2 is considered to be technically and administratively feasible and implementable. The equipment and technologies associated with implementation of this alternative have been proven to be technically feasible and are available from contractors or vendors. Treatability testing may be required for waste treatment processes, including *ex situ* thermal desorption for excavated soils. The implementability of construction-related activities during excavation and backfilling at SWMU 4 subject to Alternative 2 is very similar to that carried out routinely at other sites. Likewise, sampling, analysis, transportation, and disposal at an approved location are routinely performed and, if properly implemented, are proven to be safe.

Some excavated waste materials may be radioactive, RCRA hazardous, PCB-contaminated, or a combination. Treatment of wastes with multiple regulatory classifications is more complex and may require more than one treatment process to make the waste suitable for transportation and/or land disposal. On-site treatment processes will comply with the substantive requirements of state and federal environmental laws.

Potential excavation interferences, such as the raw water pipe in the southeast corner of SWMU 4, adjacent roads, drainage ditches, security fences, and utility lines, would be managed through coordination with the appropriate on-site personnel during remedy design and mobilization activities prior to the start of the removal action.

Equipment, personnel, and services required to implement this alternative and manage the range of potentially applicable health, safety, and security requirements are readily available. No additional development of these technologies would be required. Contractors possessing the required skills and experience are available.

Uncertainties associated with waste types and forms to be encountered during the removal action would result in the following potential implementation risks that would need to be managed:

Potential High Radiological Activity Wastes. The potential exists to encounter high activity radiological wastes (i.e., wastes that would cause SWMU 4 to be classified as a Hazard Category 2 or 3 facility under a radiological safety basis), which would be managed by the following actions:

- Removal activities at SWMU 4 would stop.
- The DOE Lead Contractor would perform an Unreviewed Safety Question Determination.
- If the discovered material(s) exceeds a hazard category threshold, corrective action would be implemented to place the high activity materials in an existing PGDP facility with appropriate safety/security requirements.
- The activity would be reported to responsible parties and a Price-Anderson Amendments Act review would be completed as necessary.
- Removal activities at SWMU 4 would continue following completion of Corrective Actions as necessary.
- High activity materials placed in an existing PGDP facility with appropriate safety/security requirements would be characterized, packaged, and shipped to an appropriate off-site disposal facility.

4.3 COST

In this section, costs of alternatives are presented for comparison purposes only. In general, cost estimates include capital costs, labor costs, transportation and disposal costs, and surveillance and maintenance costs.

The estimation standards from EPA guidance (-30% to +50%) will be applied in this EE/CA for the purposes of comparative evaluation of alternatives.

4.3.1 Alternative 1: No Action

There are no capital or operation and maintenance costs associated with Alternative 1.

4.3.2 Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils

The estimated cost associated with this alternative is approximately $143.5 million, and supporting information for the cost estimate is provided in Appendix C.

4.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

Table 5 provides a comparative analysis of the removal action alternatives for SWMU 4 considering effectiveness, implementability, and cost based on the previous evaluation in Section 4 of this EE/CA.

Table 5. Comparative Analysis of Removal Action Alternatives

Alternative	Effectiveness	Implementability	Cost
Alternative 1: *No Action*	- Does not present short-term risks to excavation workers or the public; long-term risks would remain related to potential future direct exposure to contaminants. - Poses a long-term potential threat of contaminant release to subsurface soils, UCRS, and RGA groundwater. - Is not effective or permanent in the long-term. - Does not reduce toxicity, mobility, and volume of contamination in the buried waste material and incidental soils. - Does not achieve the removal action objective and is not protective of human health and the environment. - Does not comply with ARARs.	- Technically feasible with current technology - Not technically complex or difficult to implement - Administratively feasible - Services and materials readily available or easy to acquire	- Estimated cost: **$0**
Alternative 2: *Excavation and Disposal of Buried Waste Material and Contaminated Soils*	- Eliminates the potential threat of contaminant releases from buried waste material to subsurface soil and UCRS groundwater. - Is effective and permanent in the long-term. - Permanently eliminates toxicity, mobility, and volume of contamination in the buried waste material. - Protects future industrial and excavation workers from direct exposure risks to buried waste materials and constituents in surface and subsurface soils. - Presents a short-term risk to excavation workers and the public (due to excavation and off-site transportation of contaminated waste). - Achieves the RAOs and is protective of human health and the environment. - Complies with ARARs.	- Technically feasible with current technology - Potential technical complexity due to uncertainties associated with uncharacterized wastes and the potential to encounter high-activity waste or materials of value - Administratively feasible - Services and materials readily available or easy to acquire - Time-phased based on funding limitations	- Estimated cost: **$200,000,000**[1]

[1] Due to funding uncertainty, the estimate is based on completion in 2017. If funding allowed for completion in 2013, the estimated cost would be reduced to 150M.

5. RECOMMENDED REMOVAL ACTION ALTERNATIVE

The recommended removal action is Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils. The recommended alternative represents the most effective and permanent action that achieves the RAOs. This action will be implemented in accordance with all CERCLA requirements.

Alternative 2 meets RAOs by removing waste and contaminated soil from PGDP; eliminating direct contact risks to current and future human receptors; and reducing contaminant migration at SWMU 4 to the underlying RGA. ARARs defined for Alternative 2 are expected to be met. Additionally, this alternative facilitates the implementation of a final remedy for the remaining VOC DNAPL source in SWMU 4 as part of the BGOU remedial process. While some risk to current industrial workers and surrounding communities would be present as a result of implementing this alternative, these risks would be managed via worker protection programs and site controls, and overall the long-term benefits outweigh these short-term risks.

Alternative 2 is a higher cost alternative than Alternative 1, but Alternative 2 provides the greatest overall long-term effectiveness and permanence.

The RAWP for SWMU 4 will be developed in two phases—a first phase describes the excavation and disposal of the contents of the burial cells; and a second phase describes the activities necessary to achieve remedial goals in soil across the remainder of the SWMU boundary. The time gap between these two document phases would be as small as possible (i.e., within months) and would allow DOE to begin field work sooner, plus allow sufficient time to develop a detailed approach to remediating the remainder of the SWMU soils. After regulatory review and approval of the RAWP, DOE will initiate fieldwork activities as required by the FFA, contingent upon available funding. Upon completion of the activities, the postexcavation conditions would be provided to EPA and the Kentucky Department for Environmental Protection and incorporated into the final decision making and/or remedy for the BGOU.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED GUIDANCE

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INTRODUCTION

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 *CFR* § 300.415(j), on-site removal actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) are required to attain applicable or relevant and appropriate requirements (ARARs) to the extent practicable or provide grounds for invoking a CERCLA waiver. ARARs include only federal and state environmental or facility siting laws/regulations; they do not include occupational safety or worker radiation protection requirements. Additionally, per 40 *CFR* § 300.400(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to be considered (TBC) category].

When the U.S. Department of Energy (DOE) proposes a response action, Section XXI of the Federal Facility Agreement requires that DOE identify each state and federal permit that otherwise would have been required in the absence of CERCLA § 121(e)(1) and the National Contingency Plan. DOE also must identify the standards, requirements, criteria, or limitations necessary to obtain such permits and provide an explanation of how the proposed action will meet the standards, requirements, criteria, or limitations identified. This evaluation determined that the otherwise required permits may include a Kentucky Pollutant Discharge Elimination System (KPDES); Resource Conservation and Recovery Act of 1976 (RCRA) treatment, storage, and disposal facility; and solid waste landfill permits.

Response actions conducted on-site must comply with the substantive but not administrative requirements of ARARs. Administrative requirements include applying for permits, recordkeeping, consultation, and reporting. Response actions conducted off-site must comply with both the substantive and administrative requirements of applicable laws.

ARARs typically are divided into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific. “Chemical-specific ARARs usually are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values” [(53 *FR* 51394, 51437 (December 21, 1988)]. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. In the absence of chemical-specific ARARs, cleanup criteria are based upon risk calculations.

Location-specific ARARs generally are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations [53 *FR* 51394, 51437 (December 21, 1988)]. The boundary of SWMU 4 corresponds with the area where materials are found in the burial grounds and does not impact any area that would trigger a location specific ARAR.

Action-specific ARARs usually are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes or requirements to conduct certain actions to address particular circumstances at a site [53 *FR* 51394, 51437 (December 21, 1988)]. General site activities to prepare for the SWMU 4 removal action are described in Section 3 of the EE/CA and include conducting the excavation, managing waste (including water from the excavation as well as dewatering of the excavated materials), controlling air emission, controlling radiation exposure, decontamination, transportation, and waste disposal. The waste management activities associated with the SWMU 4 removal action would be conducted within the AOC consistent with the guidelines defined in *Management of Contaminated Media*, EPA Region 4, September 7, 1999.

The ARARs for SWMU 4 removal action were developed for the preferred alternative to remove all buried materials and remove incidental soils from the SWMU 4 disposal cells. The removal action also includes remediating the entire administrative boundary of SWMU to 16 ft bgs to achieve Removal

Action Objectives in soil (described in Section 2 of the EE/CA). All excavated materials and soils that do not meet the Waste Acceptance Criteria of the C-746-U Landfill will be disposed off-site at DOE approved facilities as identified in the Engineering Evaluation/Cost Analysis (EE/CA). The ARARs for the SWMU 4 removal action do not apply to groundwater since the removal action does not address groundwater contamination.

Table 1. Chemical-Specific ARARs

Action	Requirement	Prerequisite	Citation
On-site cleanup of bulk PCB remediation waste (self-implementing)	The cleanup level for bulk PCB remediation waste in high occupancy areas is ≤1 ppm without further conditions. High occupancy areas where bulk PCB remediation waste remains at concentrations >1 ppm and ≤10 ppm shall be covered with a cap meeting the requirements of paragraphs (a)(7) and (a)(8) of this section.	Cleanup and disposal of PCB remediation waste as defined in 40 *CFR* § 761.3—**relevant and appropriate**.	40 *CFR* § 761.61(a)(4)(i)(A)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Site preparation, construction, and excavation activities			
Activities causing fugitive dust emissions	No person shall cause, suffer, or allow any material to be handled, processed, transported, or stored, a building or its appurtenances to be constructed, altered, repaired, or demolished, or a road to be used without taking reasonable precaution to prevent particulate matter from becoming airborne. Such reasonable precautions shall include, when applicable, but not be limited to, the following: • Use, where possible, of water or chemicals for control of dust in the demolition of existing buildings or structures, construction operations, the grading of roads or the clearing of land; • Application and maintenance of asphalt, oil, water, or suitable chemicals on roads, materials stockpiles, and other surfaces which can create airborne dusts; • Covering, at all times when in motion, open bodied trucks transporting materials likely to become airborne; • The maintenance of paved roadways in a clean condition; and • The prompt removal of earth or other material from a paved street which earth or other material has been transported thereto by trucking or earth moving equipment or erosion by water.	Fugitive emissions from land-disturbing activities (e.g., handling, processing, transporting or storing of any material, demolition of structures, construction operations, grading of roads, or the clearing of land, etc.)—**applicable**.	401 *KAR* 63:010 § 3(1) and (1) (a), (b), (d), (e) and (f)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	No person shall cause or permit the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate.		401 *KAR* 63:010 § 3(2)
Activities causing radionuclide emissions	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem/yr.	Radionuclide emissions from point sources at a DOE facility—**applicable**.	40 *CFR* § 61.92 401 *KAR* 57:002
Activities causing toxic substances or potentially hazardous matter emissions	Persons responsible for a source from which hazardous matter or toxic substances may be emitted shall provide the utmost care and consideration in the handling of these materials to the potentially harmful effects of the emissions resulting from such activities. No owner or operator shall allow any affected facility to emit potentially hazardous matter or toxic substances in such quantities or duration as to be harmful to the health and welfare of humans, animals and plants.	Emissions of potentially hazardous matter or toxic substances as defined in 401 *KAR* 63:020 § 2 (2)—**applicable**.	401 *KAR* 63:020 § 3
Radiation dose limits for individual members of the public	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Dose received from operations —**relevant and appropriate**.	10 *CFR* § 20.1301(a)(1) 902 *KAR* 100:019 § 10 (1)
	Shall use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve doses to members of the public that are ALARA.		10 *CFR* § 20.1101(b) 902 *KAR* 100:019 § 2(2)
Radiation protection of the public and the environment	Except as provided in 5400.1(II)(1)(a)(4), the exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an EDE greater than 100 mrem per year. The ALARA process shall be implemented for all DOE activities and facilities that cause public doses.	Dose received from all exposure modes from all DOE activities (including removal actions) at a DOE facility—**TBC**.	DOE O 5400.5(II)(1)(a) and (2)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction techniques to control pollutants in storm water discharges during and after construction in accordance with substantive requirements provided by permits issued pursuant to 40 *CFR* § 122.26(c).	Storm water discharges associated with small construction activities as defined in 40 *CFR* 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157)—**applicable**.	40 *CFR* § 122.26(c)(1)(ii)(C) and (D) 401 *KAR* 5:060 § 8
	Storm water runoff associated with construction activities taking place at a facility with an existing Best Management Practices (BMP) Plan shall be addressed under the facility BMP and not under a storm water general permit.	Storm water discharges associated with small construction activities as defined in 40 *CFR* § 122.26(b)(15) and 401 *KAR* 5:002 § 1 (157)—**TBC**.	Fact Sheet for the KPDES General Permit For Storm water Discharges Associated with Construction Activities, June 2009
	Best management storm water controls will be implemented and may include, as appropriate, erosion and sedimentation control measures, structural practices (e.g., silt fences, straw bale barriers) and vegetative practices (e.g., seeding); storm water management (e.g., diversion); and maintenance of control measures in order to ensure compliance with the standards in Section C.5. Storm Water Discharge Quality.	Storm water runoff associated with construction activities taking place at a facility [PGDP] with an existing BMP Plan—**TBC**.	Appendix C of the PGDP Best Management Practices Plan (2007) —Examples of Storm water Controls
Monitoring Well Installation and Abandonment			
Monitoring well installation	Permanent monitoring wells shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for removal action—**applicable**.	401 *KAR* 6:350 §1(2)
	All permanent (including boreholes) shall be constructed to comply with the substantive requirements provided in the following Sections of 401 *KAR* 6:350: • Section 2. Design Factors; • Section 3. Monitoring Well Construction; • Section 7. Materials for Monitoring Wells; and • Section 8. Surface Completion.		401 *KAR* 6:350 § 2, 3, 7, and 8
	If conditions exist or are believed to exist that preclude compliance with the requirements of 401 *KAR* 6:350, may request a variance prior to well construction or well abandonment. *NOTE: Variance shall be made as part of the FFA CERCLA document review and approval process and shall include:* • A justification for the variance; and • Proposed construction, modification, or abandonment		401 *KAR* 6:350 § 6 (a)(6) and (7)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	procedures to be used in lieu of compliance with 401 *KAR* 6:350 and an explanation as to how the alternate well construction procedures ensure the protection of the quality of the groundwater and the protection of public health and safety.		
Development of monitoring well	Newly installed wells shall be developed until the column of water in the well is free of visible sediment. This well-development protocol shall not be used as a method for purging prior to water quality sampling.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for removal action—**applicable**.	401 *KAR* 6:350 §9
Direct Push monitoring well installation	Wells installed using direct push technology shall be constructed, modified, and abandoned in such a manner as to prevent the introduction or migration of contamination to a water-bearing zone or aquifer through the casing, drill hole, or annular materials.	Construction of direct push monitoring well as defined in 401 *KAR* 6:001 §1(18) for removal action—**applicable**.	401 *KAR* 6:350 §5 (1)
	Shall also comply with the following additional standards: (a) The outside diameter of the borehole shall be a minimum of 1 inch greater than the outside diameter of the well casing; (b) Premixed bentonite slurry or bentonite chips with a minimum of one-eighth (1/8) diameter shall be used in the sealed interval below the static water level; and (c) 1. Direct push wells shall not be constructed through more than one water-bearing formation unless the upper water bearing zone is isolated by temporary or permanent casing. 2. The direct push tool string may serve as the temporary casing.		401 *KAR* 6:350 §5 (3)
Monitoring well abandonment	A monitoring well that has been damaged or is otherwise unsuitable for use as a monitoring well, shall be abandoned within 30 days from the last sampling date or 30 days from the date it is determined that the well is no longer suitable for its intended use.	Construction of monitoring well as defined in 401 *KAR* 6:001 §1(18) for removal action—**applicable**.	401 *KAR* 6:350 §11 (1)
	Wells shall be abandoned in such a manner as to prevent the migration of surface water or contaminants to the subsurface and to prevent migration of contaminants among water bearing zones.		401 *KAR* 6:350 §11 (1)(a)
	Abandonment methods and sealing materials for all types of monitoring wells provided in subparagraphs (a)-(b) and (d)-(e) shall be followed.		401 *KAR* 6:350 §11 (2)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
General Waste Management			
Management of PCB waste	Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* 761, Subpart D.	Storage or disposal of waste containing PCBs at concentrations ≥ 50 ppm—**applicable**.	40 *CFR* § 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found.	Cleanup and disposal of PCB remediation waste as defined in 40 *CFR* § 761.3—**applicable**.	40 *CFR* § 761.61
Management of PCB/Radioactive waste	Any person storing such waste ≥ 50 ppm PCBs must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* § 761.65(a)(1), (b)(1)(ii) and (c)(6)(i).	Storage of PCB/Radioactive waste for a disposal—**applicable**.	40 *CFR* § 761.50(b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties. If, taking into account only the properties of the PCBs in the waste, the waste meets the requirements for disposal in a nonhazardous waste landfill, then the PCB/radioactive waste may be disposed without regard to the PCB component of the waste.		40 *CFR* §761.50(b)(7)(ii)
Waste Characterization			
Characterization of solid waste	Must determine if solid waste is excluded from regulation under 40 *CFR* § 261.4.	Generation of solid waste as defined in 40 *CFR* § 261.2—**applicable**.	40 *CFR* § 262.11(a) 401 *KAR* 32:010 §2
	Must determine if waste is listed as a hazardous waste in subpart D of 40 *CFR* Part 261.	Generation of solid waste which is not excluded under 40 *CFR* § 261.4—**applicable**.	40 *CFR* §262.11(b) 401 *KAR* 32:010 §2
	Must determine whether the waste is characteristic waste (identified in subpart C of 40 *CFR* Part 261) by using prescribed testing methods <u>or</u> applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 *CFR* Part 261 and not excluded under 40 *CFR* § 261.4—**applicable**.	40 *CFR* § 262.11(c) 401 *KAR* 32:010 §2
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous waste—**applicable**.	40 *CFR* § 262.11(d) 401 *KAR* 32:010 §2
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40	Generation of RCRA-hazardous waste for storage, treatment or disposal—**applicable**.	40 *CFR* § 264.13(a)(1) 401 *KAR* 34:020 § 4

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	CFR §§ 264 and 268.		
Characterization of industrial wastewater	Industrial wastewater discharges that are point source discharges subject to regulation under section 402 of the Clean Water Act, as amended, are not solid wastes for the purpose of hazardous waste management. [Comment: This exclusion applies only to the actual point source discharge. It does not exclude industrial wastewaters while they are being collected, stored or treated before discharge, nor does it exclude sludges that are generated by industrial wastewater treatment.] NOTE: For purpose of this exclusion, the CERCLA on-site treatment system for extracted VOCs and groundwater will be considered equivalent to a wastewater treatment unit and the point source discharges subject to regulation under CWA Section 402, provided the effluent meets all identified CWA ARARs.	Generation of industrial wastewater for treatment and discharge into surface water—**applicable**.	40 *CFR* 261.4(a)(2) 401 *KAR* 31:010 § 4
Determinations for management of hazardous waste	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* § 268.40 *et. seq.* *Note:* This determination may be made concurrently with the hazardous waste determination required in 40 *CFR* § 262.11.	Generation of hazardous waste—**applicable**.	40 *CFR* § 268.9(a) 401 *KAR* 37:010 §8
	Must determine the underlying hazardous constituents [as defined in 40 *CFR* § 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal—**applicable**.	40 *CFR* § 268.9(a) 401 *KAR* 37:010 §8
	Must determine if the hazardous waste meets the treatment standards in 40 *CFR* §§ 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *Note:* This determination can be made concurrently with the hazardous waste determination required in 40 *CFR* § 262.11.	Generation of hazardous waste—**applicable**.	40 *CFR* § 268.7(a) 401 *KAR* 37:010 §7
Characterization of LLW	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility.	Generation of LLW for storage and disposal at a DOE facility—**TBC**.	DOE M 435.1-1(IV)(I)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)
	• physical and chemical characteristics;		DOE M 435.1-1(IV)(I)(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(IV)(I)(2)(b)
	• weight of the container and contents;		DOE M 435.1-1(IV)(I)(2)(c)
	• identities, activities, and concentration of major radionuclides;		DOE M 435.1-1(IV)(I)(2)(d)
	• characterization date;		DOE M 435.1-1(IV)(I)(2)(e)
	• generating source; and		DOE M 435.1-1(IV)(I)(2)(f)
	• any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives.		DOE M 435.1-1(IV)(I)(2)(g)
Waste Accumulation and Storage			
Temporary on-site storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that	Accumulation of RCRA hazardous waste on-site as defined in 40 *CFR* § 260.10—**applicable**.	40 *CFR* § 262.34(a) 401 *KAR* 32:030 §5
	• waste is placed in containers that comply with 40 *CFR* § 265.171-173;		40 *CFR* § 262.34(a)(1)(i) 401 *KAR* 32:030 §5
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container;		40 *CFR* § 262.34(a)(2) 401 *KAR* 32:030 §5
	• container is marked with the words "hazardous waste."		40 *CFR* § 262.34(a)(3) 401 *KAR* 32:030 § 5
	Container may be marked with other words that identify the contents.	Accumulation of 55 gal or less of RCRA hazardous waste or one quart of acutely hazardous waste listed in 261.33(e) at or near any point of generation—**applicable**.	40 *CFR* § 262.34(c)(1) 401 *KAR* 32:030 §5
Use and management of containers holding hazardous waste	If container is not in good condition or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 265.171 401 *KAR* 35:180 §2

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 *CFR* § 265.172 401 *KAR* 35:180 §3
	Keep containers closed during storage, except to add/remove waste.		40 *CFR* § 265.173(a) 401 *KAR* 35:180 §4
	Open, handle and store containers in a manner that will not cause containers to rupture or leak.		40 *CFR* § 265.173(b) 401 *KAR* 35:180 §4
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 *CFR* § 264.175(b).	Storage of RCRA hazardous waste in containers with free liquids—**applicable**.	40 *CFR* § 264.175(a)
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA-hazardous waste in containers that do not contain free liquids (other than F020, F021, F022, F023, F026 and F027)—**applicable**.	40 *CFR* § 264.175(c)
Storage of PCB waste and/or PCB/radioactive waste in a RCRA-regulated container storage area	Does not have to meet storage unit requirements in 40 *CFR* 761.65(b)(1) provided unit	Storage of PCBs and PCB Items at concentrations ≥ 50ppm designated for disposal—**applicable**.	40 *CFR* 761.65(b)(2)
	• is permitted by EPA under RCRA § 3004 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761; or		40 *CFR* 761.65(b)(2)(i)
	• qualifies for interim status under RCRA § 3005 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761; or		40 *CFR* 761.65(b)(2)(ii)
	• is permitted by an authorized state under RCRA § 3006 to manage hazardous waste in containers and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761 NOTE: For purpose of this exclusion, CERCLA remediation waste, which is also considered PCB waste, can be stored on-site provided the area meets all of the identified RCRA container storage ARARs and spills of PCBs cleaned up in accordance with Subpart G of 40 *CFR* § 761		40 *CFR* 761.65(b)(2)(iii)
Storage of PCB waste and/or PCB/radioactive waste in non-	Except as provided in 40 *CFR* § 761.65 (b)(2), (c)(1), (c)(7), (c)(9), and (c)(10), after July 1, 1978, owners or operators of any	Storage of PCBs and PCB Items at concentrations ≥ 50ppm designated for	40 *CFR* § 761.65(b)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
RCRA regulated unit	facilities used for the storage of PCBs and PCB Items designated for disposal shall comply with the storage unit requirements in 40 *CFR* § 761.65(b)(1).	disposal—**applicable**.	
	Storage facility shall meet the following criteria: • Adequate roof and walls to prevent rainwater from reaching stored PCBs and PCB items;		40 *CFR* § 761.65(b)(1) 40 *CFR* § 761.65(b)(1)(i)
	• Adequate floor that has continuous curbing with a minimum 6-inch high curb. Floor and curb must provide a containment volume equal to at least two times the internal volume of the largest PCB article or container or 25% of the internal volume of all articles or containers stored there, whichever is greater. *Note*: 6 inch minimum curbing not required for area storing PCB/radioactive waste;		40 *CFR* § 761.65(b)(1)(ii)
	• No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from curbed area;		40 *CFR* § 761.65(b)(1)(iii)
	• Floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, non-porous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* § 761.65(b)(1)(iv)
	• Not located at a site that is below the 100-year flood water elevation.		40 *CFR* § 761.65(b)(1)(v)
	Storage area must be properly marked as required by 40 *CFR* § 761.40(a)(10).		40 *CFR* § 761.65(c)(3)
Risk-based storage of PCB remediation waste	May store PCB remediation waste in a manner other than prescribed in 40 *CFR* § 761.65(b) if approved in writing from EPA provided the method will not pose an unreasonable risk of injury to human health or the environment. *NOTE:* EPA approval of alternative storage method will be obtained by approval of the FFA CERCLA document.	Storage of waste containing PCBs in a manner other than prescribed in 40 *CFR* § 761.65(b) (see above)—**applicable**.	40 *CFR* § 761.61(c)
Temporary storage of PCB waste (e.g., PPE, rags) in a container(s)	Container(s) shall be marked as illustrated in 40 *CFR* 761.45(a).	Storage of PCBs and PCB items at concentrations ≥ 50 ppm in containers for disposal—**applicable**.	40 *CFR* 761.40(a)(1)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10).		40 *CFR* 761.65(c)(3)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	Any leaking PCB Items and their contents shall be transferred immediately to a properly marked nonleaking container(s).		40 *CFR* 761.65(c)(5)
	Container(s) shall be in accordance with requirements set forth in DOT HMR at 49 *CFR* §§ 171-180.		40 *CFR* 761.65(c)(6)
Staging of LLW	Shall be for the purpose of the accumulation of such quantities of wastes necessary to facilitate transportation, treatment, and disposal.	Staging of LLW at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(N)(7)
Temporary storage of LLW	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water.	Temporary storage of LLW at a DOE facility—**TBC**.	DOE M 435.1-1 (IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage.		DOE M 435.1-1 (IV)(N)(3)
	Shall be managed to identify and segregate LLW from mixed waste.		DOE M 435.1-1 (IV)(N)(6)
Packaging of LLW for storage	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container.	Storage of LLW in containers at a DOE facility—**TBC**.	DOE M 435.1-1(IV)(L)(1)(a)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.		DOE M 435.1-1(IV)(L)(1)(b)
	Containers shall be marked such that their contents can be identified.		DOE M 435.1-1(IV)(L)(1)(c)
Packaging of LLW for off-site disposal	Waste shall not be packaged for disposal in a cardboard or fiberboard box.	Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.56 902 *KAR* 100:021 § 7 (1)(b)
	Liquid waste shall be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid.	Preparation of liquid LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.56 902 *KAR* 100:021 § 7 (1)(c)
	Solid waste containing liquid shall contain as little freestanding	Preparation of solid LLW containing	10 *CFR* § 61.56

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	and noncorrosive liquid as is reasonably achievable. The liquid shall not exceed one (1) percent of the volume.	liquid for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	902 *KAR* 100:021 § 7 (1)(d)
	Waste shall not be readily capable of • Detonation; • Explosive decomposition or reaction at normal pressures and temperatures; or • Explosive reaction with water.	Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.56 902 *KAR* 100:021 § 7 (1)(e)
	Waste shall not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to a person transporting, handling, or disposing of the waste.	Packaging of LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.56 902 *KAR* 100:021 § 7 (1)(f)
	Waste shall not be pyrophoric.	Packaging of pyrophoric LLW for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.56 902 *KAR* 100:021 § 7 (1)(g)
Waste Treatment and Disposal/Discharge			
Treatment, storage, transportation, or conveyance of collected RCRA wastewater using a WWTU that receives and treats or stores hazardous waste located on the facility	Any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to an on-site KPDES-permitted wastewater treatment facility subject to regulation under the CWA are exempt from the requirements of RCRA Subtitle C standards. *NOTE:* For purposes of this exclusion, any dedicated tank systems, conveyance systems, and ancillary equipment used to treat, store or convey CERCLA remediation wastewater to a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a facility, are exempt from the requirements of RCRA Subtitle C standards.	On-site wastewater treatment units (as defined in 40 *CFR* § 260.10) subject to regulation under § 402 or § 307(b) of the CWA (i.e., KPDES-permitted) that manages hazardous wastewaters —**applicable**.	40 *CFR* 264.1(g)(6) 401 *KAR* 34:010 § 1
Discharge of contaminated groundwater or wastewater	Properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used to achieve compliance with the effluent standards. Proper operation and maintenance also includes	Discharge of pollutants to surface waters—**relevant and appropriate**.	401 *KAR* 5:065 § 2(1) and 40 *CFR* § 122.41(e)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed only when the operation is necessary to achieve compliance with the effluent standards.		
	Surface waters shall not be aesthetically or otherwise degraded by substances that: • Settle to form objectionable deposits; • Float as debris, scum, oil, or other matter to form a nuisance; • Produce objectionable color, odor, taste, or turbidity; • Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life; • Produce undesirable aquatic life or result in the dominance of nuisance species; 1. Cause fish flesh tainting. 2. The concentration of phenol shall not exceed 300 mg/l as an in stream value.	Discharge of pollutants to surface waters—**applicable**.	401 *KAR* 10:031 § 2(1)(a-f)
Kentucky Surface Water Standards	Warm water aquatic habitat. The following parameters and associated criteria shall apply: • Natural alkalinity as CaCO3 shall not be reduced by more than 25 percent; • pH shall not be less than 6.0 nor more than 9.0 and shall not fluctuate more than 1.0 pH units over a period of 24 hours; • Flow shall not be altered to a degree that will adversely affect the aquatic community; • Temperature shall not exceed 31.7 ^{o}C (89 ^{o}F); • Dissolved oxygen shall be maintained at a minimum concentration of 5.0 mg/l as a 24 hour average; instantaneous minimum shall not be less than 4.0 mg/l; • Total dissolved solids or specific conductance shall not be changed to the extent that the indigenous aquatic community is adversely affected; • Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected;	Discharge of pollutants to surface waters—**applicable**.	401 *KAR* 10:031 § 4(1) excluding § 4(1)(k)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	• Addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities shall be prohibited; • Concentration of the un-ionized ammonia shall not be greater than 0.05 mg/l at any time instream after mixing; • Allowable instream concentration of toxic substances, or whole effluents containing toxic substances, which are noncumulative or nonpersistent with a half-life of less than 96 hours, shall not exceed: 1. 0.1 of the 96 hour median LC50 of representative indigenous or indicator aquatic organisms; or 2. A chronic toxicity unit of 1.00 utilizing the 25 percent inhibition concentration, or LC25. Allowable instream concentration of toxic substances, or whole effluents containing toxic substances, which are bioaccumulative or persistent, including pesticides, if not otherwise regulated, shall not exceed: 1. 0.01 of the 96 hour median LC50 of representative indigenous or indicator aquatic organisms; or 2. A chronic toxicity unit of 1.00 utilizing the LC25. • In the absence of acute criteria for pollutants listed in 401 *KAR* 10:031 Section 6, for other substances known to be toxic but not listed in this administrative regulation, or for whole effluents that are acutely toxic, the allowable instream concentration shall not exceed the LC1 or 1/3 LC50 concentration derived from toxicity tests on representative indigenous or indicator aquatic organisms or exceed 0.3 acute toxicity units. • If specific application factors have been determined for a toxic substance or whole effluent such as an acute to chronic ratio or water effect ratio, they may be used instead of the 0.1 and 0.01 factors; • Allowable instream concentrations for specific pollutants for the protection of warm water aquatic habitat are listed in 401 *KAR* 10:031 Section 6 shall not be exceeded; and • Instream concentrations for total residual chlorine shall not exceed an acute criteria value of 19 µg/l or a chronic criteria value of 11 µg/l.		

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Kentucky Surface Water Standards	Provides chemical-specific numeric standards for pollutants discharged or found in surface waters.	Discharge of pollutants to surface waters—**applicable**.	401 *KAR* 10:031 § 6(1)
	Monitoring location and frequency will be conducted in accordance with the substantive provisions of the KPDES Permit	Discharge of pollutants to surface waters—**TBC**.	KPDES Permit KY0004049
	Absorbed dose to native animal aquatic organisms must not exceed 1 rad/day.	Discharge of radioactive materials in liquid waste to surface water at a DOE facility—**TBC**.	DOE O 5400.5(II)(3)(a)(1)(1)
Discharge of radionuclides into surface water	For liquid wastes containing radionuclides from DOE activities which are discharged to surface water, the best available technology (BAT) is the prescribed level of treatment if the surface waters otherwise would contain, at the point of discharge and prior to dilution, radioactive material at annual average concentrations greater than the DCG values in liquids given in Chapter III of DOE Order 5400.5. The BAT selection process shall be implemented in accordance with (II)(3)(a)(1)(a) and (b) of the Order 5400.5.	Discharge of radioactive materials in liquid waste to surface water at a DOE facility—**TBC**.	DOE O 5400.5 (II)(3)(a)(1)
	Selection of the best available technology for a specific application will be made from among candidate alternative treatment technologies which are identified by an evaluation process that includes factors related to technology, economics, and public policy considerations. Factors that are to be considered in selecting BAT, at a minimum, shall include: • the age of equipment and facilities involved; • the process employed; • the engineering aspects of the application of various types of control techniques; • process changes; • the cost of achieving such effluent reduction; • non-water quality environmental impact (including energy requirements); • safety considerations; and public policy considerations.		DOE O 5400.5 (II)(3)(a)(1)(a)
	Implementation of the BAT process for liquid radioactive wastes is not required where radionuclides are already at a low level, i.e., the annual average concentration is less than DCG level.		DOE O 5400.5 (II)(3)(a)(2)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	Additional treatment will not be required for waste streams that contain radionuclide concentrations of not more than the DCG values in Chapter III of DOE Order 5400.5 at the point of discharge to a surface waterway. However, the ALARA provisions are applicable.		
	To prevent the buildup of radionuclide concentrations in sediments, liquid process waste streams containing radioactive material in the form of settleable solids may be released to natural waterways if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (O.2 Bq) per gram above background level, of settleable solids for alpha-emitting radionuclides or 50 pCi (2 Bq) per gram above background level, of settleable solids for beta gamma- emitting radionuclides.	Discharge of radioactive concentrations in sediments to surface water from a DOE facility—**TBC**.	DOE O 5400.5 (II)(3)(a)(4)
	To protect native animal aquatic organisms, the absorbed dose to these organisms shall not exceed 1 rad per day from exposure to the radioactive material in liquid wastes discharged to natural waterways.		DOE O 5400.5 (II)(3)(a)(5)
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility.	Treatment of LLW for disposal at a LLW disposal facility—**TBC**.	DOE M 435.1-1(IV)(O)
Disposal of prohibited RCRA hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* § 268.40 before land disposal.	Land disposal, as defined in 40 *CFR* § 268.2, of prohibited RCRA waste—**applicable**.	40 *CFR* § 268.40(a) 401 *KAR* 37:040 §2
	All underlying hazardous constituents [as defined in 40 *CFR* § 268.2(i)] must meet the Universal Treatment Standards, found in 40 *CFR* § 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well—**applicable**.	40 *CFR* § 268.40(e) 401 *KAR* 37:040 § 2
	Must be treated according to the alternative treatment standards of 40 *CFR* § 268.49(c) or according to the UTSs specified in 40 *CFR* § 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 *CFR* § 268.2, of restricted hazardous soils—**applicable**.	40 *CFR* 268.49(b) 401 *KAR* 37:040 §10

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Disposal of RCRA hazardous debris in a land-based unit	Must be treated prior to land disposal as provided in 40 *CFR* § 268.45(a)(1)-(5) unless EPA determines under 40 *CFR* § 261.3(f)(2) that the debris no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standard provided in 40 *CFR* § 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 *CFR* § 268.2, of RCRA-hazardous debris—**applicable**.	40 *CFR* § 268.45(a) 401 *KAR* 37:040 §7
Disposal of RCRA characteristic wastewaters	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 of the CWA (i.e., NPDES permitted) unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40, or are D003 reactive cyanide. NOTE: For purposes of this exclusion, a CERCLA on-site wastewater treatment unit that meets all of the identified CWA ARARs for point source discharges from such a system, is considered a wastewater treatment system that is NPDES permitted.	Land disposal of hazardous wastewaters that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 *CFR* Part 268—**applicable**.	40 *CFR* 268.1(c)(4)(i) 401 *KAR* 37:010 §2
Disposal of bulk PCB remediation waste off-site (self-implementing)	May be sent off-site for decontamination or disposal provided the waste either is dewatered on-site or transported off-site in containers meeting the requirements of DOT HMR at 49 *CFR* Parts 171-180.	Generation of bulk PCB remediation waste (as defined in 40 *CFR* § 761.3) for off-site disposal—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(i)(B)
	Must provide written notice including the quantity to be shipped and highest concentration of PCBs [using extraction EPA Method 3500B/3540C or Method 3500B/3550B followed by chemical analysis using Method 8082 in SW-846 or methods validated under 40 *CFR* § 761.320-26 (Subpart Q)] before the first shipment of waste to each off-site facility where the waste is destined for an area not subject to a TSCA PCB Disposal Approval.	Bulk PCB remediation waste (as defined in 40 *CFR* § 761.3) destined for an off-site facility not subject to a TSCA PCB Disposal Approval—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(i)(B)(2)*(iv)*
	Shall be disposed of in accordance with the provisions for cleanup wastes at 40 *CFR* § 761.61(a)(5)(v)(A).	Off-site disposal of dewatered bulk PCB remediation waste with a PCB concentration < 50 ppm—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(i)(B)(2)*(ii)*
	Shall be disposed of • in a hazardous waste landfill permitted by EPA under §3004 of RCRA;	Off-site disposal of dewatered bulk PCB remediation waste with a PCB concentration ≥ 50 ppm—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(i)(B)(2)*(iii)*
	• in a hazardous waste landfill permitted by a State authorized		

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
	under §3006 of RCRA; or		
	• in a PCB disposal facility approved under 40 *CFR* § 761.60.		
Disposal of liquid PCB remediation waste (self-implementing)	Shall either • decontaminate the waste to the levels specified in 40 *CFR* § 761.79(b)(1) or (2); or	Liquid PCB remediation waste (as defined in 40 *CFR* § 761.3)—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(iv) 40 *CFR* § 761.61(a)(5)(iv)(A)
	• dispose of the waste in accordance with the performance-based requirements of 40 *CFR* § 761.61(b) or in accordance with a risk-based approval under 40 *CFR* § 761.61(c).		40 *CFR* § 761.61(a)(5)(iv)(B)
Performance-based disposal of PCB remediation waste	May dispose by one of the following methods • in a high-temperature incinerator under 40 *CFR* § 761.70(b);	Disposal of non-liquid PCB remediation waste (as defined in 40 *CFR* § 761.3)—**applicable**.	40 *CFR* § 761.61(b)(2) 40 *CFR* § 761.61(b)(2)(i)
	• by an alternate disposal method under 40 *CFR* § 761.60(e);		
	• in a chemical waste landfill under 40 *CFR* § 761.75;		
	• in a facility under 40 *CFR* § 761.77; or		
	• through decontamination in accordance with 40 *CFR* 761.79.		
	Shall be disposed according to 40 *CFR* § 761.60(a) or (e), or decontaminate in accordance with 40 *CFR* § 761.79.	Disposal of liquid PCB remediation waste—**applicable**.	40 *CFR* § 761.61(b)(1)
Risk-based disposal of PCB remediation waste	May dispose of in a manner other than prescribed in 40 *CFR* § 761.61(a) or (b) if approved in writing from EPA and method will not pose an unreasonable risk of injury to [sic] human health or the environment. *NOTE:* EPA approval of alternative disposal method will be obtained by approval of the FFA CERCLA document.	Disposal of PCB remediation waste—**applicable**.	40 *CFR* § 761.61(c)
Disposal of PCB cleanup wastes (e.g., PPE, rags, non-liquid cleaning materials) (self-implementing option)	Shall be disposed of • in a municipal solid waste facility under 40 *CFR* § 258 or non-municipal, nonhazardous waste subject to 40 *CFR* § 257.5 thru 257.30; or • in a RCRA Subtitle C landfill; or • in a PCB disposal facility; or • through decontamination under 40 *CFR* § 761.79(b) or (c).	Generation of non-liquid PCBs during and from the cleanup of PCB remediation waste—**relevant and appropriate**.	40 *CFR* § 761.61(a)(5)(v)(A)
Disposal of PCB cleaning	May be reused after decontamination in accordance with 40 *CFR*	Generation of PCB wastes from the	40 *CFR* § 761.61(a)(5)(v)(B)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
solvents, abrasives, and equipment (self- implementing option)	§ 761.79; or For liquids, disposed in accordance with 40 *CFR* § 761.60(a).	cleanup of PCB remediation waste—**relevant and appropriate**.	
Disposal of PCB decontamination waste and residues	Shall be disposed of at their existing PCB concentration unless otherwise specified in 40 *CFR* § 761.79(g)(1) through (6).	PCB decontamination waste and residues for disposal—**applicable**.	40 *CFR* § 761.79(g)
Disposal of LLW	LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility.	Disposal of LLW at a LLW disposal facility—**TBC**.	DOE M 435.1-1(IV)(J)(2)
Waste Treatment & Disposition			
Release of property with residual radioactive material	Property with residual radioactive material will be released from DOE control under survey methods and criteria of DOE Order 5400.5.	Release of soil, equipment and material with residual radioactive material from DOE control—TBC.	DOE O 5400.5
Decontamination/Cleanup			
Decontamination of movable equipment contaminated by PCBs (self-implementing option)	May decontaminate by • swabbing surfaces that have contacted PCBs with a solvent; • a double wash/rinse as defined in 40 *CFR* § 761.360-378; or • another applicable decontamination procedure under 40 *CFR* § 761.79.	Movable equipment contaminated by PCB and tools and sampling equipment—**applicable**.	40 *CFR* § 761.79(c)(2)
Decontamination of PCB containers (self-implementing option)	Must flush the internal surfaces of the container three times with a solvent containing < 50 ppm PCBs. Each rinse shall use a volume of the flushing solvent equal to approximately 10% of the PCB container capacity.	PCB Container as defined in 40 *CFR* § 761.3—**applicable**.	40 *CFR* § 761.79(c)(1)
Decontamination of PCB contaminated water	For discharge to a treatment works as defined in 40 *CFR* § 503.9 (aa), or discharge to navigable waters, meet standard of < 3 ppb PCBs; or	Water containing PCBs regulated for disposal—**applicable**.	40 *CFR* § 761.79(b)(1)(ii)
	The decontamination standard for water containing PCBs is less than or equal to 0.5 µg/L (i.e., approximately ≤0.5 ppb PCBs) for unrestricted use.		40 *CFR* § 761.79(b)(1)(iii)
Waste Transportation			

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Transportation of RCRA hazardous waste on-site	The generator manifesting requirements of 40 *CFR* §§ 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* § 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**.	40 *CFR* § 262.20(f) 401 *KAR* 32:020 § 1
Transportation of RCRA hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* § 262.20–23 for manifesting, § 262.30 for packaging, § 262.31 for labeling, § 262.32 for marking, § 262.33 for placarding, § 262.40, 262.41(a) for record keeping requirements, and § 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of hazardous waste off-site—**applicable**.	40 *CFR* § 262.10(h) 401 *KAR* 32:010 § 1
Transportation of PCB wastes off-site	Must comply with the manifesting provisions at 40 *CFR* § 761.207 through § 218.	Relinquishment of control over PCB wastes by transporting, or offering for transport—**applicable**.	40 *CFR* § 761.207(a)
Determination of radionuclide concentration	The concentration of a radionuclide may be determined by an indirect method, such as use of a scaling factor which relates the inferred concentration of one (1) radionuclide to another that is measured or radionuclide material accountability if there is reasonable assurance that an indirect method may be correlated with an actual measurement. The concentration of a radionuclide may be averaged over the volume or weight of the waste if the units are expressed as nanocuries per gram.	Preparation for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.55 (a)(8) 902 *KAR* 100:021 § 6(8)(a) and (b)
Labeling of LLW packages	Each package of waste shall be clearly labeled to identify if it is Class A, Class B, or Class C waste, in accordance with 10 *CFR* § 61.55 or Agreement State waste classification requirements.	Preparation for off-site shipment of LLW to a commercial NRC or Agreement State licensed disposal facility—**relevant and appropriate**.	10 *CFR* § 61.57 902 *KAR* 100:021 § 8
Transportation of radioactive waste	Shall be packaged and transported in accordance with DOE Order 460.1B and DOE Order 460.2.	Preparation of shipments of radioactive waste—**TBC**.	DOE M 435.1-(I)(1)(E)(11)
Transportation of LLW	To the extent practicable, the volume of the waste and the number of the shipments shall be minimized.	Preparation of shipments of LLW—**TBC**.	DOE M 435.1-1(IV)(L)(2)

Table 2. Action-Specific ARARs

Action	Requirement	Prerequisite	Citation
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMR at 49 *CFR* §§ 171–180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material—**applicable**.	49 *CFR* § 171.1(c)
Transportation of hazardous materials on-site	Shall comply with 49 *CFR* Parts 171-174, 177, and 178 or the site- or facility-specific Operations of Field Office approved Transportation Safety Document that describes the methodology and compliance process to meet equivalent safety for any deviation from the Hazardous material Regulations [i.e., *Transportation Safety Document for On-Site Transport within the Paducah Gaseous Diffusion Plant*, PRS-WSD-0661, (PRS 2007)].	Any person who, under contract with the DOE, transports a hazardous material on the DOE facility—**TBC**.	DOE O 460.1B(4)(b)
Transportation of hazardous materials off-site	Off-site hazardous materials packaging and transfers shall comply with 49 *CFR* Parts 171-174, 177, and 178 and applicable tribal, State, and local regulations not otherwise preempted by DOT and special requirements for Radioactive Material Packaging.	Preparation of off-site transfers of LLW—**TBC**.	DOE O 460.1B(4)(a)

ARAR = as low as reasonably achievable; AOC = area of contamination; *CFR* = *Code of Federal Regulations*; CWA = Clean Water Act; DOE = U.S. Department of Energy; EDE = effective dose equivalent; EPA = U.S. Environmental Protection Agency; HMR = hazardous material regulations; *KAR* = *Kentucky Administrative Rules*; LDR = land disposal restriction; LLW = low-level waste; NRC = Nuclear Regulatory Commission; NWP = Nationwide Permit; PCB = polychlorinated biphenyl; PPE = personal protective equipment; RAWP = Remedial Action Work Plan; RCRA = Resource Conservation and Recovery Act; ROD = Record of Decision; TBC = to be considered; T&E = threatened and endangered; *USC* = *United States Code*; UTS = Universal Treatment Standards; WAC = waste acceptance criteria

APPENDIX B

SUMMARY OF RISK CHARACTERIZATION FOR SWMU 4 AND REMEDIATION GOALS FOR THE SWMU 4 REMOVAL ACTION

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APPENDIX B. SUMMARY OF RISK CHARACTERIZATION FOR SWMU 4 AND REMEDIATION GOALS FOR THE SWMU 4 REMOVAL ACTION

BGOU RI Baseline Human Health Risk Assessment. The baseline human health risk assessment (BHHRA) for the Burial Grounds Operable Unit (BGOU) Remedial Investigation (RI) characterized the baseline risks posed to human health from contact with contaminants in soil and water at the BGOU solid waste management units (SWMUs) and at locations to which contaminants may migrate. The BHHRA utilized information collected during the RI of the BGOU SWMUs, in addition to information collected during previous investigations. Table B-1 provides a summary of the risk characterization for SWMU 4 presented in the RI BHHRA. The table present land use scenarios, contaminants of concern (COCs), and point of contacts (POCs). In addition, each table lists the following:

- Receptor risks for each use scenario of concern
- Percent contribution by pathway to the total risk
- Percent contribution each COC contributes to the total risk

Table B-1. 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
Current industrial worker at current concentrations (soil) (WAG 3 RI[b])	5.4E-04	Beryllium ^{238}U	97 2	Dermal External exposure	97 2	3.62E+00	Beryllium Chromium Iron Vanadium Barium	5 45 24 24 2	Dermal	99
Future industrial worker at current concentrations (soil) (WAG 3 RI[b])	5.4E-04	Beryllium ^{238}U	97 2	Dermal External exposure	97 2	3.62E+00	Beryllium Chromium Iron Vanadium Barium	5 45 24 24 2	Dermal	99
Future child rural resident at current concentrations (soil) (WAG 3 RI[b])	NA	NA	NA	NA	NA	9.82E+01	Barium Beryllium Cadmium Chromium Iron Nickel Vanadium	2 2 2 24 60 2 9	Ingestion Dermal Ingestion of vegetables	1 21 78
Future adult rural resident at current concentrations (soil) (WAG 3 RI[b])	4.3E-03	Beryllium Total PCB ^{234}U ^{238}U	72 5 6 17	Dermal External exposure Ingestion of vegetables	36 2 61	2.84E+01	Barium Beryllium Cadmium Chromium Iron Nickel Vanadium	2 2 2 22 63 2 8	Dermal Ingestion of vegetables	14 85
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

Table B-1. 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 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
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 (soil) (WAG 3 RI[b])	NA	NA	NA	NA	NA	< 1	*No COCs		*No COCs	
Future teen recreational user at current	NA	NA	NA	NA	NA	< 1	*No COCs		*No COCs	

Table B-1. 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
concentrations (soil) (WAG 3 RI[b])										
Future adult recreational user at current concentrations (soil) (WAG 3 RI[b])	< 1.0E-06	*No COCs		*No COCs		< 1	*No COCs		*No COCs	
Future outdoor worker/gardener at current concentrations (soil and waste) (WAG 3 RI[b])	2.7E-03	Arsenic Beryllium Total dioxins/furans Total PCB ^{226}Ra Total uranium[c] ^{238}U	1 7 4 2 2 83 1	Ingestion Dermal External exposure	37 10 54	2.61E+00	Aluminum Arsenic Barium Beryllium Cadmium Chromium Iron Manganese Vanadium	8 4 2 2 1 24 24 14 20	Ingestion Dermal	13 87

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.
*No COCs = There are no COCs or POCs.
[a] Total ELCR and total HI represent total risk or hazard summed across all POCs for all COCs.
[b] *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/07-1895&D1*, September 2000 (DOE 2001), Table 1.55. In this table, lead has been excluded as a COC.
[c] Uranium metal was not identified as a COC in the risk assessment for SWMU 4; however, isotopic uranium was identified as a COC so an RG for uranium metal is presented here to facilitate field implementation of the action.

Remediation Goals for Direct Exposure to COCs in Soil

Direct contact remediation goals (RGs) for COCs in soil that are protective of exposures of industrial workers to COCs in surface soil and future outdoor worker/gardeners to COCs in subsurface soil were based on no action levels (NALs). NAL values are given in Table A.4 of the Paducah Gaseous Diffusion Plant (PGDP) Risk Methods Document (DOE 2001). The direct contact RGs for surface soil and subsurface soil are shown in Table 2 of the Engineering Evaluation/Cost Analysis (EE/CA).

Surface Soil The direct contact RGs for COCs in surface soil that are protective of the industrial worker from exposure by soil ingestion, inhalation, and dermal contact pathways were calculated as 5 x the Industrial Worker NAL for carcinogenic COCs. The NAL for carcinogenic COCs corresponds to a cancer risk of 1 x 10^{-6}; the resulting RG corresponds to a cancer risk of 5 x 10^{-6}. For noncarcinogenic COCs, the RG is calculated as 5 x the Industrial Worker NAL for noncarcinogenic COCs. The NAL for noncarcinogenic COCs corresponds to a noncancer hazard quotient of 0.1; the resulting RG corresponds to a noncancer hazard quotient of 0.5. The lower of the two direct contact RGs is shown for COCs having either cancer or noncancer health effects.

Subsurface Soil The direct contact RGs for COCs in subsurface soil that are protective of excavation worker exposures were calculated as 50 x the Excavation Worker NAL for carcinogenic COCs. The NAL for carcinogenic COCs corresponds to a cancer risk of 1 x 10^{-6}; the resulting RG corresponds to a cancer risk of 5 x 10^{-5}. For noncarcinogenic COCs, the RG is calculated as 10 x the NAL for noncarcinogenic COCs. The NAL for noncarcinogenic COCs corresponds to a noncancer hazard quotient of 0.1; the resulting RG corresponds to a noncancer hazard quotient of 1. The lower of the two direct contact RGs is shown for COCs having either cancer or noncancer health effects. The direct contact RG for total polychlorinated biphenyls (PCBs) is consistent with the Toxic Substances Control Act concentration as 10 ppm for high occupancy areas when covered by a cap as defined in 40 *CFR* §761.61.

The direct contact RG risk targets were agreed upon as part of risk management discussions during a June 2009 Burial Grounds Operable Unit (BGOU) scoping meeting among U.S. Department of Energy (DOE), U. S. Environmental Protection (EPA), and KY. At that meeting, the group recognized that, when used as the upper-bound goal for individual detections at the conclusion of excavation activities, the average concentrations of individual COCs for the unit are expected to be lower or even not detected.

Following completion of the removal action, the cumulative cancer risk and noncancer hazard estimates will be calculated and provided. The Federal Facility Agreement (FFA) parties will consider these cumulative risk values relative to the final remedial decisions for the final BGOU. Final RGs will be established in the Action Memorandum.

The Preliminary RG for soil is the lower of the direct contact RG and groundwater-protective RG for soil. If the background concentration is greater than the lower of the direct contact RG and groundwater-protective RG, the RG equals the background concentration.

Remediation goals for COCS in Soil that are Protective of Groundwater

The approach to developing groundwater protective RGs for soil at SWMU 4 was based on data obtained from transport modeling used previously during the BGOU RI. The soil RGs developed in this way are protective of groundwater in the Regional Gravel Aquifer (RGA) below the SWMU, which is the point of attainment for BGOU remedial actions. The period of model performance was 1,000 years.

The RGs that would be protective of groundwater are those concentrations that, if left in place at that depth, would not result in a contribution to groundwater that would cause the groundwater concentration in the RGA at the SWMU to exceed the maximum contaminant level (MCL).

The objective of the modeling conducted for the RI was to determine if, under current conditions, existing soil contamination levels at the SWMUs within the BGOU may result in exceeding groundwater standards at particular points of exposure. The modeling presented in this EE/CA was conducted to establish the acceptable levels of COCs that may not result in contributions to the RGA groundwater that would exceed MCLs beneath the waste disposal area within the SWMU. The groundwater target concentration (MCL) was used to back-calculate the corresponding maximum allowable soil concentration that would not result in groundwater concentrations exceeding the groundwater target concentration for the COC.

Modeling for the RI at the PGDP BGOU consisted of the following:

- **Geostatistical modeling of the distribution of COCs in soils at each SWMU.** The distribution of COCs in soil was estimated by numeric interpolation or extrapolation of the known soil concentrations at each SWMU, and the resulting geostatistical model was subdivided into seven vertical layers (L1 to L7 as shown in Figure B-1) between the surface and the top of the RGA. An average concentration for each COC within the model layers was computed, based on the values derived from the geostatistical model.

- **Vertical transport modeling using Seasonal Soil Compartment Model (SESOIL)**. The mean layer concentrations derived from the geostatistical model were used as the initial concentration in the leaching model to determine the potential impact to the RGA groundwater. SESOIL allows for variable soil concentrations within in the soil column and for partitioning of the transported constituent between the soil water and the soils during transport. The leachate concentration derived from the SESOIL modeling was used as the contaminant loading input to the RGA groundwater for transport modeling. The soil leaching model provided the peak leachate impact to groundwater for contaminants that are mobile, and the time frame in which the peak concentration would reach the RGA. The modeling was limited to a 1,000 year period of performance. If a contaminant did not reach the RGA within the model period, it is considered "immobile."

- **Groundwater transport modeling using Analytical Transient 1-,2-,3- Dimensional (AT123D)**. This was used to estimate the groundwater concentrations at the Upper Continental Recharge System (UCRS)/RGA interface (i.e., the point where constituents would reach groundwater) beneath SWMU 4 to establish if and when groundwater concentrations will exceed the MCLs. The analytical model used assumes a uniform flow gradient and hydraulic properties within the aquifer. Contaminant loading is assumed to be uniform across the length of the source area.

The RG for each COC was calculated based the impact of a unit concentration in soils on the RGA groundwater underlying SWMU 4. Leaching and transport to the RGA was modeled using SESOIL, and the resulting concentration in the RGA was simulated using AT123D. The modeling provides an estimate of the dilution and attenuation factor (DAF) for each COC, and the RG is the product of the groundwater standard (e.g., the MCL) and the DAF. Based upon the modeling outputs presented in Attachment 1, the following calculations were performed for each COC at SWMU 4 to derive a groundwater-protective RG for soil:

<u>Chemical COCs:</u>
Groundwater-Protective Soil Concentration (mg/kg) = MCL (mg/L) x DAF x 1L/kg.

Radionuclides:
Groundwater-Protective Soil Concentration (pCi/g) = MCL (pCi/L) x DAF x 1E-03L/g.

For metals and radionuclides, the groundwater-protective RG concentration was compared to the established background concentration, and the higher of the two was chosen as the preliminary soil RG protective of the groundwater exposure pathway. The resulting groundwater-protective RGs for Soil are shown in Table B-2. The modeling results for COCs at each SWMU are provided in Attachment B-1 of this appendix.

Assumptions and Methods for Developing Soil RGs Protective of Groundwater beneath SWMU 4

The input values for the modeling runs for the vadose zone and saturated zone soils are the same as those used in the modeling conducted for the BGOU RI Report (DOE 2010). The following information is available for each SWMU model run in Attachment 1 of this appendix:

- A summary of the input data for both SESOIL and AT123D;
- The minimum initial concentrations for each model; and
- The maximum concentration at the endpoint (the RGA for the SESOIL and AT123D, respectively).

It is important that these model runs used input data that are identical (or as close as possible) to those used in the RI model runs so that the results reflect the same conditions that led to the identification and selection of COCs in the BGOU RI Report (DOE 2010). The calculated values represent the soil concentration of the COC that will not result in a groundwater concentration beneath the waste management unit that exceeds the groundwater target concentration for the COC.

The groundwater-protective RGs do not include any transport or residency below the SWMU because the analytical model being employed for lateral transport does not account for lateral heterogeneity in the source material or the underlying aquifer. This method of back-calculation is consistent with the modeling approach used in the RI and uses the same model parameters developed for the RI (as shown in Table B-3) (DOE 2010).

Groundwater-protective RG values for Total Dioxins and Furans are described as the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalent concentration (TEQ), which is the only dibenzodioxin or dibenzofuran species with an MCL.

Final Determination of Remediation Goals in Soil

The RGs for each COC in soil for this non-time-critical removal action (NTCRA) at SWMU 4 are the lower of the direct contact RG and groundwater-protective RG for soil. If the background concentration is greater than the lower of the direct contact RG and groundwater-protective RG for a particular COC, the RG equals the background concentration. Table 2 in the EE/CA presents example RGs for this NTCRA at SWMU 4. Final RGs will be established in the Action Memorandum.

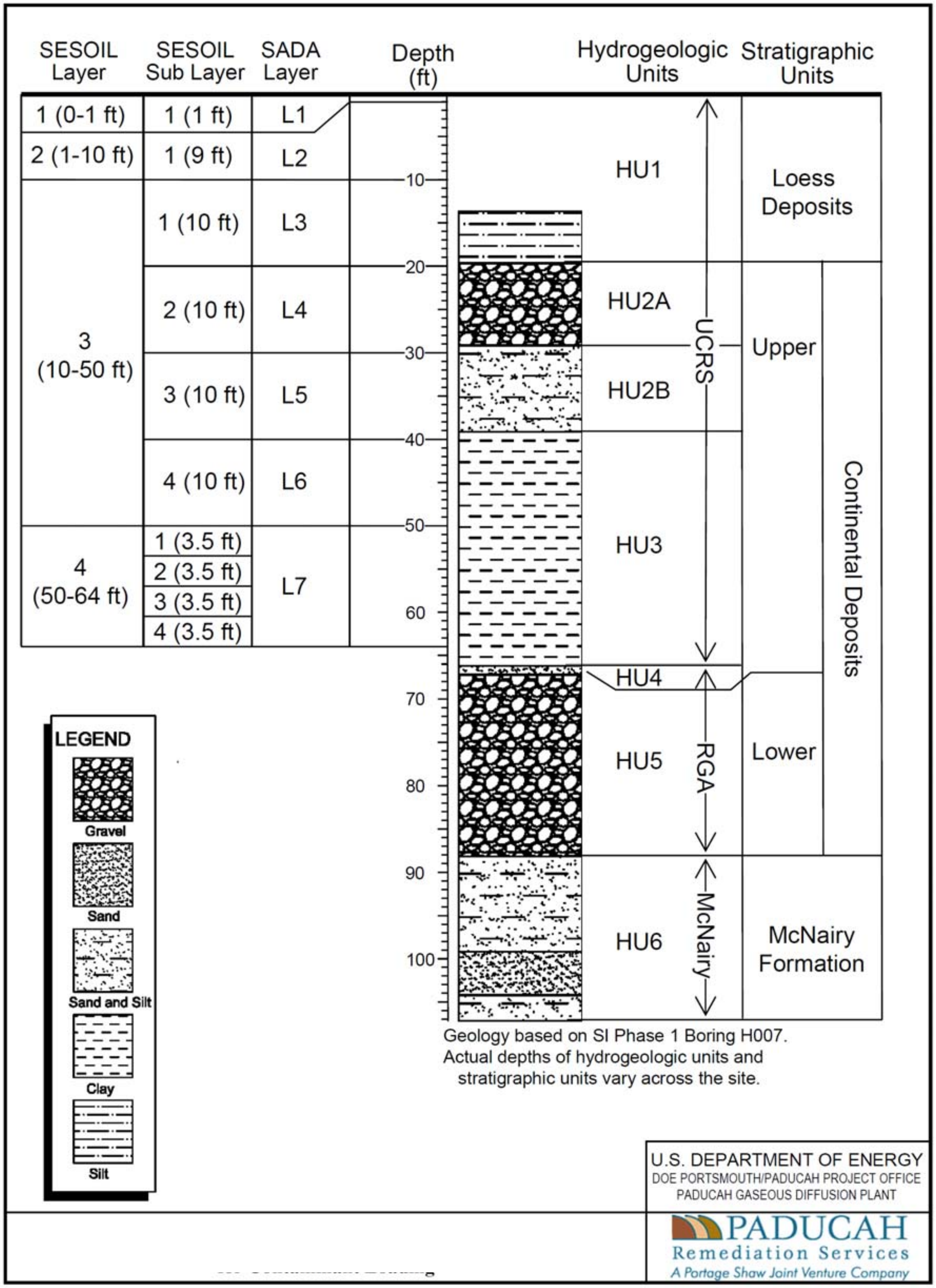

Figure B-1. Conceptualization of the SADA and SESOIL Layers for Contaminant Loading

Table B-2 Calculation of RGs in Soil at SWMU 4 that are Protective of Groundwater

Contaminant of Concern [a]	Groundwater Concentration		Maximum Leachate Concentration (SESOIL)	Maximum Concentration in the RGA Underlying SWMU 4 (AT123D)	Dilution Attenuation Factor (DAF) [d]	Groundwater-Protective Soil Concentration at the SWMU [e]
	MCL [b]	NAL [c]				
	(mg/L) (pCi/L)	(mg/L) (pCi/L)	mg/L	mg/L	(unitless)	(mg/kg) (pCi/g)
Technetium-99 [f]	9.00E+02	--			7.00E+00	6.30E+00
Uranium (metal)	3.00E-02	--	0	N/A	no load	NA
Uranium-238 [g]	2.00E+01	--	0	N/A	no load	NA
cis-1,2-Dichloroethene	7.00E-02	--	1.64E+00	1.44E-01	1.10E+01	7.70E-01
Trichloroethene	5.00E-03	--	4.04E-01	5.01E-02	8.00E+00	4.00E-02
Vinyl chloride	2.00E-03	--	1.46E-01	8.29E-03	1.80E+01	3.60E-02
Total Dioxins/Furans	3.00E-08	--	0	N/A	no load	NA
Total PCBs [h]	h	h	0	N/A	h	10 ppm

[a] COC identified according to criteria specified in the baseline human health risk assessment as having ELCR > 1E-06 or HQ >0.1 for the ingestion, inhalation, and dermal exposure pathways or for residential groundwater use.

[b] The MCL concentration for the COC as established in the Safe Drinking Water Act. Chemical concentrations are given in mg/L units; radionuclide concentrations are given in pCi/L units. The "--" entry indicates NAL value is used.

[c] No Action Level (NAL) taken from the 2001 Risk Methods Document (Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Vol.1, Human Health, DOE/OR/07-1506&D2, December, 2001). The value represents the concentration calculated for ELCR = 1E-06 for groundwater use by a rural resident. The lower of values calculated for the adult and child resident are taken from Table A.5 of Appendix A of the 2001 Risk Methods Document. Chemical concentrations are given in mg/L units; radionuclide concentrations are given in pCi/L units. The "--" entry indicates MCL value is used.

[d] DAF for contaminant leaching from soil to groundwater beneath the SWMU is calculated by dividing the maximum leachate concentration of a COC in SESOIL Layer 3 (directly beneath the burial cells) from the maximum concentration of the COC modeled to reach the RGA directly underlying SWMU 4 (modeling output of AT123D).

[e] Contaminant concentration in soil at the SWMU that will not exceed the MCL in groundwater beneath the SWMU. For chemical COCs, Groundwater-Protective Soil Concentration (mg/kg) = MCL (mg/L) x DAF x 1L/kg. For radionuclides, Groundwater-Protective Soil Concentration (pCi/g) = MCL (pCi/L) x DAF x 1E-03L/g.

[f] The MCL concentration for beta and photon emitters corresponding to specified annual radiation dose limit of 4 mrem/yr equals 900 pCi/L for ^{99}Tc. *EPA Facts About Technetium-99*, EPA, July 2002.

[g] The MCL concentration used for U-234, U-235, and U-238 is 20 pCi/L (DOE 2001).

[h] The direct contact RG for total PCBs is consistent with the Toxic Substances Control Act concentration as 10 ppm for high occupancy areas when covered by a cap as defined in 40 *CFR* §761.61.

NA Not applicable. There is no transport to groundwater (no load) and no groundwater-protective concentration is calculated.

no load Modeling indicates no transport to groundwater.

Table B-3. Site-Specific Soil and Aquifer Parameters for the BGOU SWMUs used on Modeling COC Transport

	Parameter	Symbol	Units	EPA, 1996	BGOU	BGOU Source
UCRS	Soil Type				Silty Clay	BGOU RI Report
	Vadose Zone Dry Bulk Density	ρ	g/cm3	1.5	1.46	
	Fraction of Organic Matter	x_{oc}		0.002	0.0008	
	Fraction of Fines	f		0.1		
	Effective Porosity	n		0.43	0.45	
	Intrinsic Permeability		cm2		1.60E-10	
	Water Filled Porosity	Θ_w		0.3	0.135	
	Air Filled Porosity	Θ_a		0.13	0.389	$n (1- \Theta_w)$
	pH	pH		6.8		
	Unsaturated Depth		m		19.2	
	UCRS Permeability	K_v	cm/sec		3.45E-04	Southwest Plume FS Report
Hydraulic Gradient	SWMU 2, 3, 4, and 5	I	m/m		2.00E-04	BGOU Report
	SWMU 6 and 145				8.00E-04	
	SWMU 7				3.00E-04	
	SWMU 30				3.60E-04	
Hydraulic Conductivity	Southwest Plume	K_s	cm/sec		3.78E-01	Southwest Plume FS Report
	SWMUs 2, 3, 4, 5, 6, 7, and 30	K_s	cm/sec		3.18E+01	BGOU RI Report
	SWMU 145	K_s	cm/sec		1.06E+01	
	Aquifer Bulk Density	ρ	g/cm3	NA	1.67	
	RGA Thickness	b	m		9.14E+00	
	Dispersivity	D	m		1.50E+01	
	Fraction of Organic Matter	x_{oc}		0.002	2.00E-04	
	Percolation (Recharge Rate)		cm/yr	150	11	
	CEC		cmol/kg	25		
		Path Length (m)	Mixing Zone Depth (m)	DAF		
	SWMU-2	100	19.72	1		
	SWMU-3	150	25.01	1		
	SWMU-4	200	30.31	1		
	SWMU-5	100	19.72	1		
	SWMU-7	150	25.01	1		
	SWMU-30	200	30.31	1		
	SWMU-145	500	62.06	1		

L - Length of groundwater flow path under the waste unit

DAF - dilution attenuation factor

APPENDIX B
ATTACHMENT 1

CONTAMINANT MIGRATION MODELING OUTPUTS FOR SWMU 4 COCs

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Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SCLIM.CLM

Month	Temperature		Precipitation		Evapotranspiration Rate		Storms		Cloud Cover	Albedo	Humidity
Units	°C	°F	cm	Inches	cm	Inches	# per Month	Length Days	Fraction	Fraction	Fraction
October	15.28	59.50	9.98	3.93	0.00	0.00	4.50	0.32	0.45	0.17	0.70
November	8.39	47.10	10.67	4.20	0.00	0.00	5.00	0.45	0.55	0.18	0.70
December	3.33	37.99	15.19	5.98	0.00	0.00	5.62	0.49	0.65	0.20	0.75
January	2.06	35.71	16.08	6.33	0.00	0.00	5.29	0.47	0.70	0.22	0.75
February	3.67	38.61	12.19	4.80	0.00	0.00	5.84	0.41	0.65	0.20	0.70
March	8.11	46.60	15.32	6.03	0.00	0.00	6.65	0.40	0.65	0.19	0.65
April	14.72	58.50	13.72	5.40	0.00	0.00	6.82	0.37	0.60	0.17	0.65
May	19.39	66.90	10.26	4.04	0.00	0.00	7.38	0.30	0.60	0.17	0.70
June	23.89	75.00	12.85	5.06	0.00	0.00	5.85	0.25	0.55	0.17	0.70
July	25.56	78.01	10.54	4.15	0.00	0.00	6.15	0.25	0.50	0.17	0.70
August	24.94	76.89	7.39	2.91	0.00	0.00	5.28	0.23	0.45	0.17	0.70
September	21.17	70.11	11.38	4.48	0.00	0.00	4.60	0.27	0.45	0.17	0.70
Total			145.57	57.31	0.00	0.00					

SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness		Intrinsic Permeability	Organic Carbon Content	Adsorption Coefficient	Cation Exchange Capacity	Freundlich Exponent	Solid Phase Degradation Rate	Liquid Phase Degradation Rate	Soil pH
		cm	feet	cm^2	percent	µg/g / µg/mL	mEq / 100 g soil	unitless	1/day	1/day	pH
1	1	30.5	1.00	1.60E-10	0.08	66.80	0.00	1.00	4.20E-13	4.20E-13	7.00
2	1	274.0	8.99	1.60E-10	0.08	66.80	0.00	1.00	4.20E-13	4.20E-13	7.00
3	4	1220.0	40.03	1.60E-10	0.08	66.80	0.00	1.00	4.20E-13	4.20E-13	7.00
4	4	396.0	12.99	1.60E-10	0.08	66.80	0.00	1.00	4.20E-13	4.20E-13	7.00

Soil Parameters

Bulk Density (g/cm^3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

Area	cm^2	1.59E+8
	ft^2	1.71E+5
Latitude	degrees	37.0
Spill Index		1

Chemical Parameters

Water Solubility	(µg/mL)	1.00E+7	**Moles Ligand / Moles Chemical**	0.00
Henry's Law	(M^3atm/mol)	.000	**Ligand Molecular Weight** (g/mol)	0.00
K_{oc}	(µg/g)/(µg/mL)	0.00	**Base Hydrolysis Rate** (L/mol/day)	0.00
Valance	(g/mole)	0.00	**Ligand Dissociation Constant**	0.00
Air Diffusion Coefficient	(cm^2/sec)	.000	**Neutral Hydrolysis Rate** (L/mol/day)	0.00
Water Diffusion Coefficient	(cm^2/sec)	1.00E-6	**Acid Hydrolysis Rate** (L/mol/day)	0.00
Molecular Weight	(g/mol)	238.00		

Output File:
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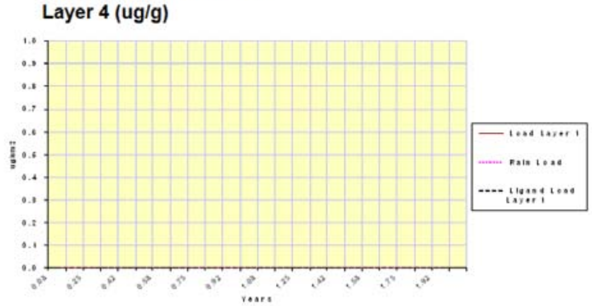
Chemical File: total uranium
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\URANIUM.CHM
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI
Application File: PGDP SWMU-4: total uranium (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\URANIUM.APL

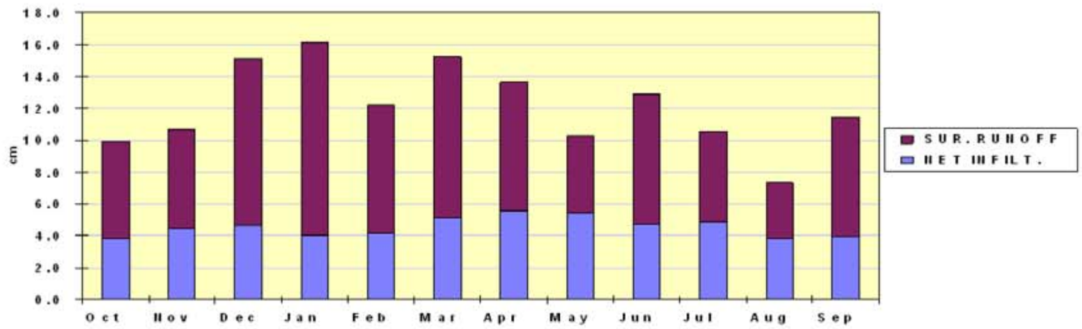
Sublayer Loads	1	2	3	4	5	6	7	8	9	10
Layer 1 (ug/g)										
Layer 2 (ug/g)										
Layer 3 (ug/g)	1.00E+04									
Layer 4 (ug/g)										

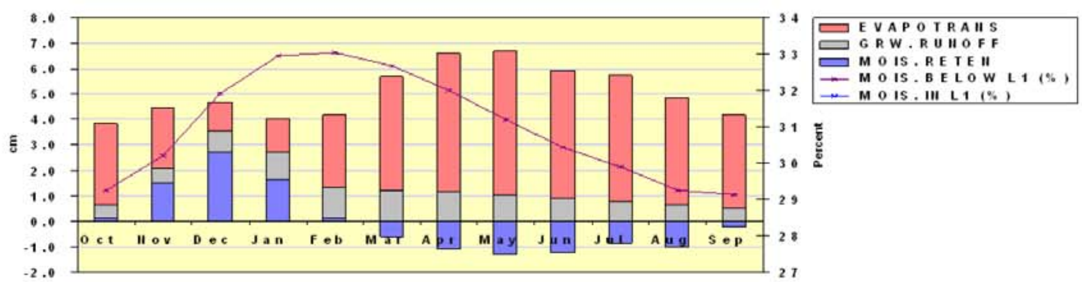


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.09	2.40	3.84	1.51	3.20	1.26	0.14	0.06	0.49	0.19	29.27	29.27
November	6.22	2.45	4.47	1.76	2.40	0.94	1.51	0.59	0.56	0.22	30.21	30.21
December	10.48	4.13	4.68	1.84	1.12	0.44	2.74	1.08	0.83	0.33	31.92	31.92
January	12.11	4.77	4.03	1.59	1.29	0.51	1.66	0.65	1.09	0.43	32.96	32.96
February	8.07	3.18	4.17	1.64	2.85	1.12	0.14	0.06	1.18	0.46	33.05	33.05
March	10.13	3.99	5.11	2.01	4.47	1.76	-0.58	-0.23	1.21	0.48	32.69	32.69
April	8.08	3.18	5.54	2.18	5.44	2.14	-1.08	-0.43	1.18	0.46	32.01	32.01
May	4.87	1.92	5.40	2.13	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.17	3.22	4.71	1.85	5.04	1.98	-1.22	-0.48	0.90	0.35	30.44	30.44
July	5.66	2.23	4.89	1.93	4.97	1.96	-0.86	-0.34	0.78	0.31	29.90	29.90
August	3.50	1.38	3.85	1.52	4.24	1.67	-1.01	-0.40	0.62	0.24	29.27	29.27
September	7.47	2.94	3.97	1.56	3.64	1.43	-0.22	-0.09	0.54	0.21	29.13	29.13
Total	90.84	35.76	54.65	21.51	44.32	17.45	-0.07	-0.03	10.40	4.09		

SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	0.000E+00	0.00
In Soil Air	0.000E+00	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	6.391E+14	90.32
Hydrol Soil	0.000E+00	0.00
Degrad Soil	1.001E+08	0.00
Pure Phase	0.000E+00	0.00
Complexed	0.000E+00	0.00
Immobile CEC	0.000E+00	0.00
Hydrol CEC	0.000E+00	0.00
In Soil Moi	1.909E+12	0.27
Hydrol Mois	0.000E+00	0.00
Degrad Mois	3.185E+05	0.00
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	0.000E+00	0.00
Total Output	6.410E+14	90.59
Total Input	7.076E+14	
Input - Output	6.659E+13	

Maximum leachate concentration: 0.000E+00 **mg/l**

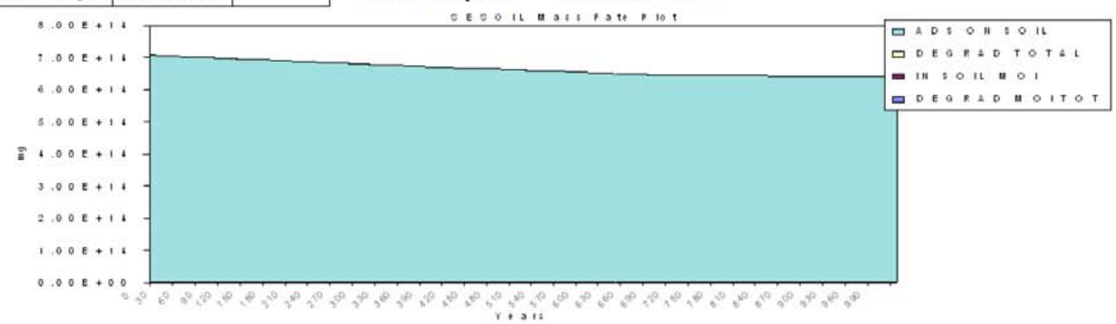
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SCLIM.CLM

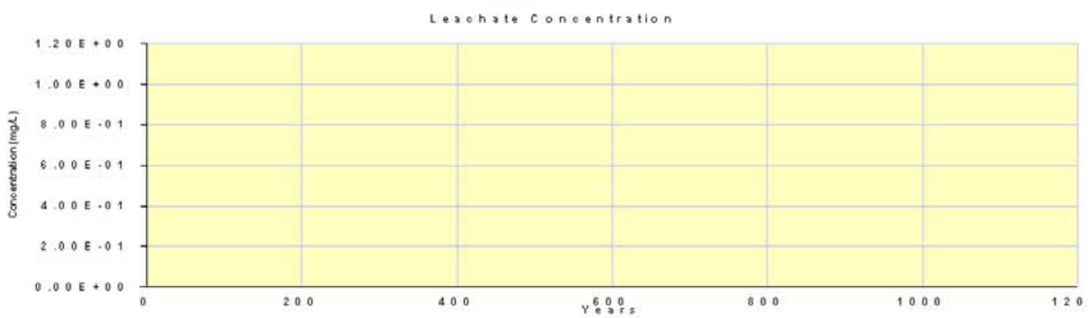
Chemical File: total uranium
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\URANIUM.CHM

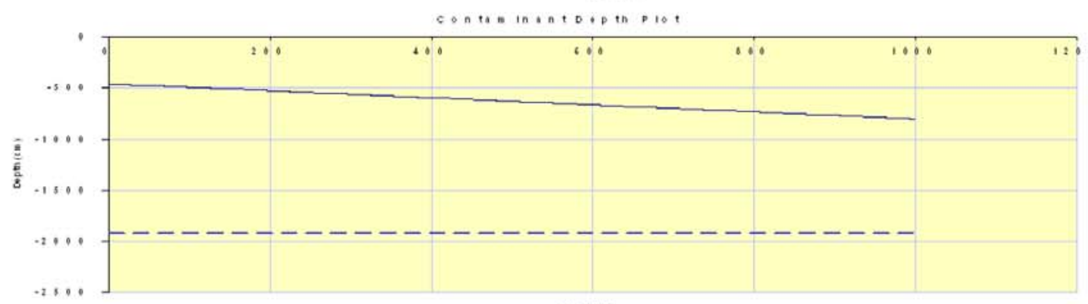
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI

Application File: PGDP SWMU-4: total uranium (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\URANIUM.APL

Starting Depth: 457.20 cm
Ending Depth: 800.90 cm
Total Depth: 1920.50 cm







SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness		Intrinsic Permeability	Organic Carbon Content	Adsorption Coefficient	Cation Exchange Capacity	Freundlich Exponent	Solid Phase Degradation Rate	Liquid Phase Degradation Rate	Soil pH
		cm	feet	cm^2	percent	μg/g / μg/mL	mEq / 100 g soil	unitless	1/day	1/day	pH
1	1	30.5	1.00	1.60E-10	0.08	66.80	0.00	1.00	7.77E-09	7.77E-09	7.00
2	1	274.0	8.99	1.60E-10	0.08	66.80	0.00	1.00	7.77E-09	7.77E-09	7.00
3	4	1220.0	40.03	1.60E-10	0.08	66.80	0.00	1.00	7.77E-09	7.77E-09	7.00
4	4	396.0	12.99	1.60E-10	0.08	66.80	0.00	1.00	7.77E-09	7.77E-09	7.00

Soil Parameters

Bulk Density (g/cm^3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

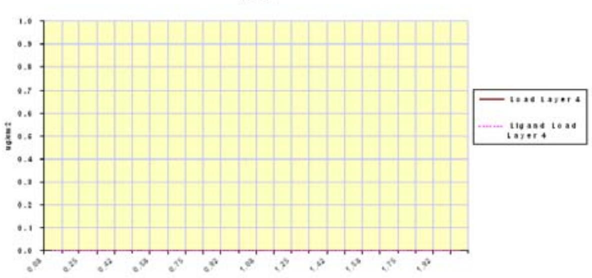
Area	cm^2	1.59E+8
	ft^2	1.71E+5
Latitude	degrees	37.0
Spill Index		1

Chemical Parameters

Water Solubility	(μg/mL)	1.00E+7	Moles Ligand / Moles Chemical	0.00
Henry's Law	(M^3atm/mol)	.000	Ligand Molecular Weight (g/mol)	0.00
K_{oc}	(μg/g)/(μg/mL)	0.00	Base Hydrolysis Rate (L/mol/day)	0.00
Valance	(g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient	(cm^2/sec)	.000	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient	(cm^2/sec)	1.00E-6	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight	(g/mol)	234.00		

Output File:
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.OUT
Chemical File: U-234
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.CHM
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI
Application File: PGDP SWMU-4: U-234 (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.APL

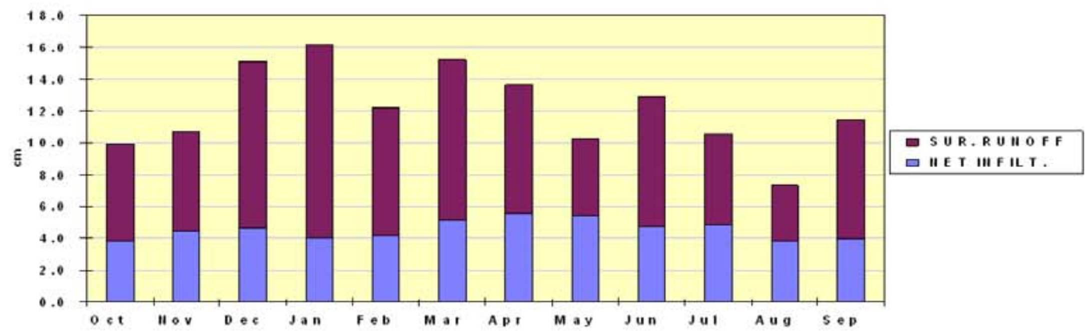
Sublayer Loads	1	2	3	4	5	6	7	8	9	10
Layer 1 (ug/g)										
Layer 2 (ug/g)										
Layer 3 (ug/g)	1.00E+04									
Layer 4 (ug/g)										

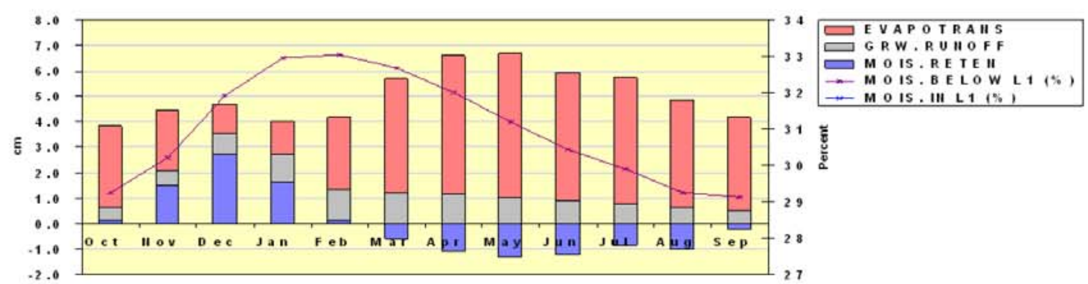


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.09	2.40	3.84	1.51	3.20	1.26	0.14	0.06	0.49	0.19	29.27	29.27
November	6.22	2.45	4.47	1.76	2.40	0.94	1.51	0.59	0.56	0.22	30.21	30.21
December	10.48	4.13	4.68	1.84	1.12	0.44	2.74	1.08	0.83	0.33	31.92	31.92
January	12.11	4.77	4.03	1.59	1.29	0.51	1.66	0.65	1.09	0.43	32.96	32.96
February	8.07	3.18	4.17	1.64	2.85	1.12	0.14	0.06	1.18	0.46	33.05	33.05
March	10.13	3.99	5.11	2.01	4.47	1.76	-0.58	-0.23	1.21	0.48	32.69	32.69
April	8.08	3.18	5.54	2.18	5.44	2.14	-1.08	-0.43	1.18	0.46	32.01	32.01
May	4.87	1.92	5.40	2.13	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.17	3.22	4.71	1.85	5.04	1.98	-1.22	-0.48	0.90	0.35	30.44	30.44
July	5.66	2.23	4.89	1.93	4.97	1.96	-0.86	-0.34	0.78	0.31	29.90	29.90
August	3.50	1.38	3.85	1.52	4.24	1.67	-1.01	-0.40	0.62	0.24	29.27	29.27
September	7.47	2.94	3.97	1.56	3.64	1.43	-0.22	-0.09	0.54	0.21	29.13	29.13
Total	90.84	35.76	54.65	21.51	44.32	17.45	-0.07	-0.03	10.40	4.09		

SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	0.000E+00	0.00
In Soil Air	0.000E+00	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	6.381E+14	90.18
Hydrol Soil	0.000E+00	0.00
Degrad Soil	1.852E+12	0.26
Pure Phase	0.000E+00	0.00
Complexed	0.000E+00	0.00
Immobile CEC	0.000E+00	0.00
Hydrol CEC	0.000E+00	0.00
In Soil Moi	1.905E+12	0.27
Hydrol Mois	0.000E+00	0.00
Degrad Mois	5.889E+09	0.00
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	0.000E+00	0.00
Total Output	6.418E+14	90.71
Total Input	7.076E+14	
Input - Output	6.573E+13	

Maximum leachate concentration: 0.000E+00 **mg/l**

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SCLIM.CLM

Chemical File: U-234
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.CHM

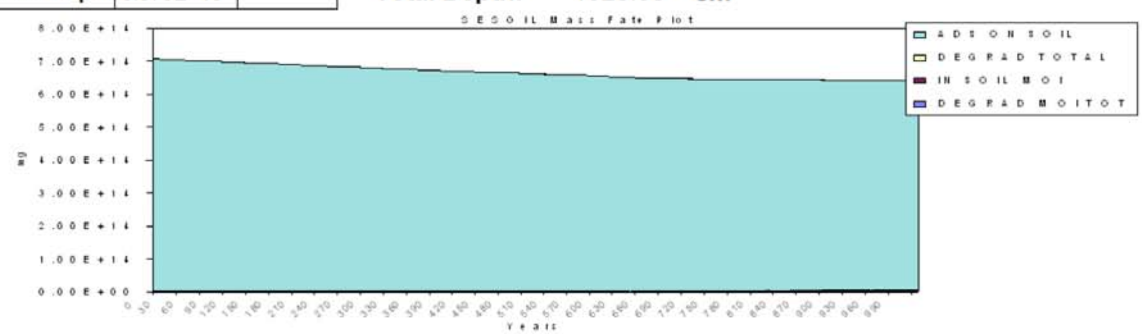
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI

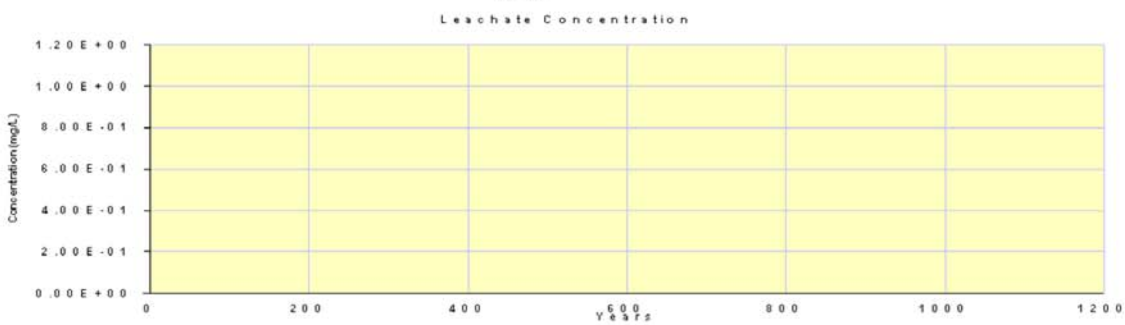
Application File: PGDP SWMU-4: U-234 (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\U234.APL

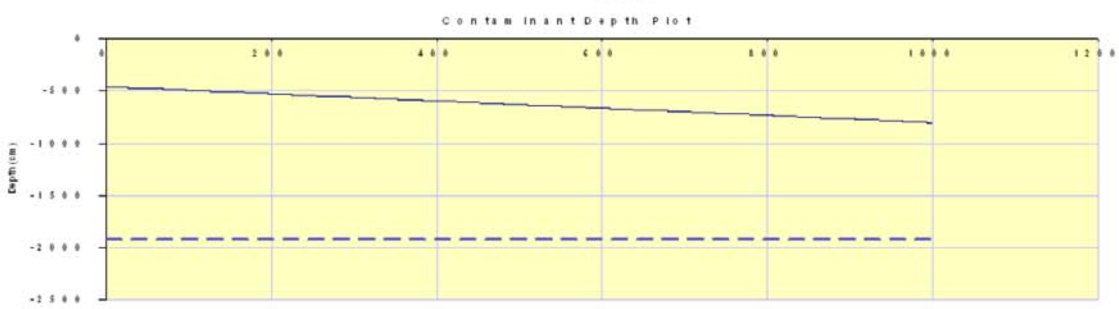
Starting Depth: 457.20 **cm**

Ending Depth: 800.90 **cm**

Total Depth: 1920.50 **cm**







SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness		Intrinsic Permeability	Organic Carbon Content	Adsorption Coefficient	Cation Exchange Capacity	Freundlich Exponent	Solid Phase Degradation Rate	Liquid Phase Degradation Rate	Soil pH
		cm	feet	cm^2	percent	µg/g / µg/mL	mEq / 100 g soil	unitless	1/day	1/day	pH
1	1	30.5	1.00	1.60E-10	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	7.00
2	1	274.0	8.99	1.60E-10	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	7.00
3	4	1220.0	40.03	1.60E-10	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	7.00
4	4	396.0	12.99	1.60E-10	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	7.00

Soil Parameters

Bulk Density (g/cm^3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

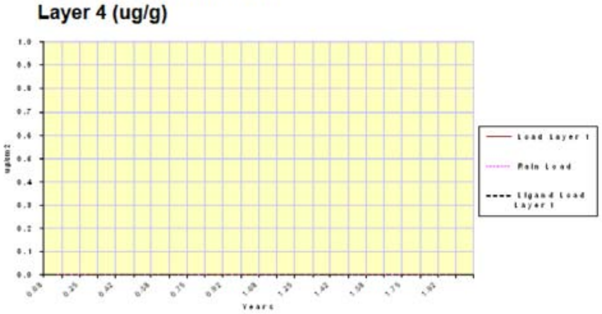
Area	cm^2	3.94E+7
	ft^2	4.24E+4
Latitude	degrees	37.0
Spill Index		1

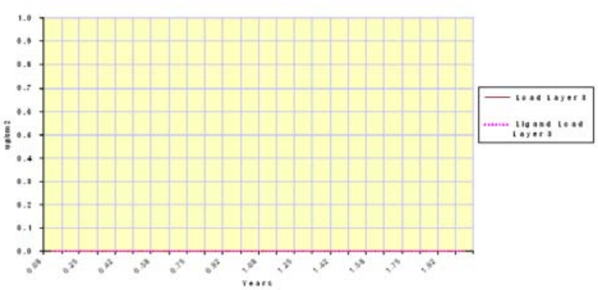
Chemical Parameters

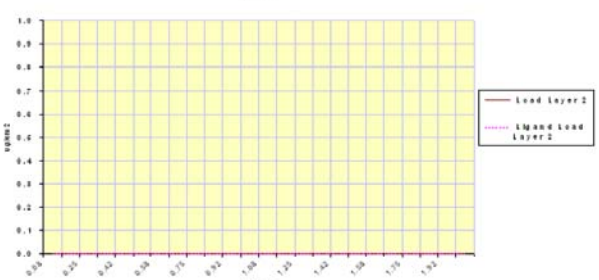
Water Solubility (µg/mL)	3.50E+3	Moles Ligand / Moles Chemical	0.00
Henry's Law (M^3atm/mol)	4.08E-3	Ligand Molecular Weight (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	35.50	Base Hydrolysis Rate (L/mol/day)	0.00
Valance (g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient (cm^2/sec)	7.36E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	1.13E-5	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	96.90		

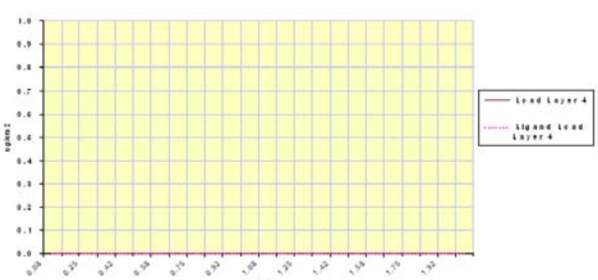
Output File:
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.OUT
Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.CHM
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI
Application File: PGDP SWMU-4: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.APL

Sublayer Loads	1	2	3	4	5	6	7	8	9	10
Layer 1 (ug/g)										
Layer 2 (ug/g)										
Layer 3 (ug/g)	1.00E+00									
Layer 4 (ug/g)										





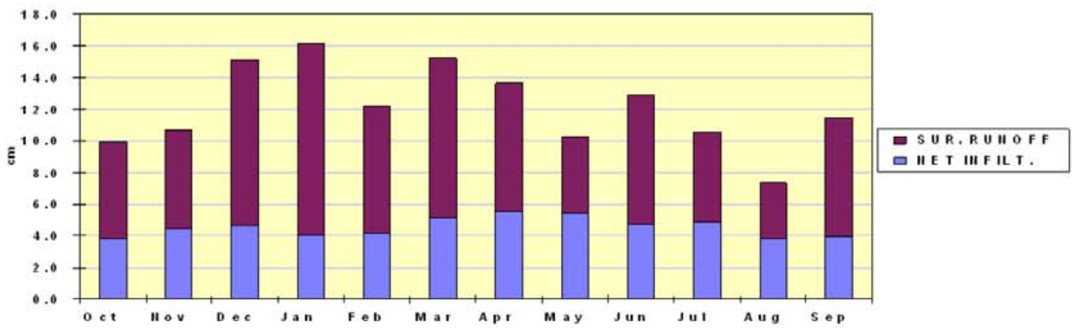


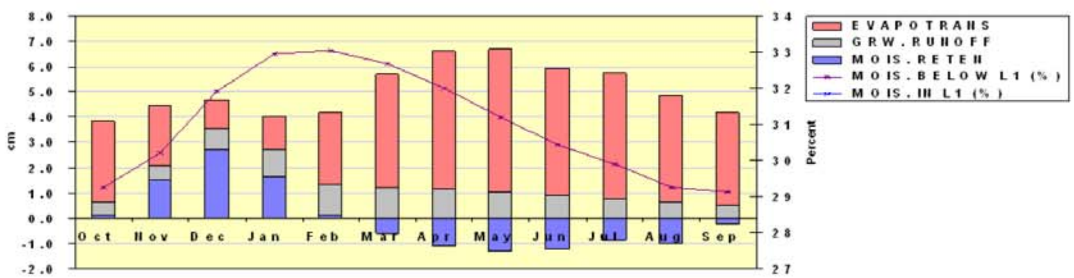


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.09	2.40	3.84	1.51	3.20	1.26	0.14	0.06	0.49	0.19	29.27	29.27
November	6.22	2.45	4.47	1.76	2.40	0.94	1.51	0.59	0.56	0.22	30.21	30.21
December	10.48	4.13	4.68	1.84	1.12	0.44	2.74	1.08	0.83	0.33	31.92	31.92
January	12.11	4.77	4.03	1.59	1.29	0.51	1.66	0.65	1.09	0.43	32.96	32.96
February	8.07	3.18	4.17	1.64	2.85	1.12	0.14	0.06	1.18	0.46	33.05	33.05
March	10.13	3.99	5.11	2.01	4.47	1.76	-0.58	-0.23	1.21	0.48	32.69	32.69
April	8.08	3.18	5.54	2.18	5.44	2.14	-1.08	-0.43	1.18	0.46	32.01	32.01
May	4.87	1.92	5.40	2.13	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.17	3.22	4.71	1.85	5.04	1.98	-1.22	-0.48	0.90	0.35	30.44	30.44
July	5.66	2.23	4.89	1.93	4.97	1.96	-0.86	-0.34	0.78	0.31	29.90	29.90
August	3.50	1.38	3.85	1.52	4.24	1.67	-1.01	-0.40	0.62	0.24	29.27	29.27
September	7.47	2.94	3.97	1.56	3.64	1.43	-0.22	-0.09	0.54	0.21	29.13	29.13
Total	90.84	35.76	54.65	21.51	44.32	17.45	-0.07	-0.03	10.40	4.09		

SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	7.121E+08	4.06
In Soil Air	2.039E+07	0.12
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	3.188E+07	0.18
Hydrol Soil	0.000E+00	0.00
Degrad Soil	0.000E+00	0.00
Pure Phase	0.000E+00	0.00
Complexed	0.000E+00	0.00
Immobile CEC	0.000E+00	0.00
Hydrol CEC	0.000E+00	0.00
In Soil Moi	2.239E+08	1.28
Hydrol Mois	0.000E+00	0.00
Degrad Mois	0.000E+00	0.00
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	1.648E+10	94.05
Total Output	1.747E+10	99.69
Total Input	1.753E+10	
Input - Output	5.521E+07	

Maximum leachate concentration: 1.636E+00 **mg/l**

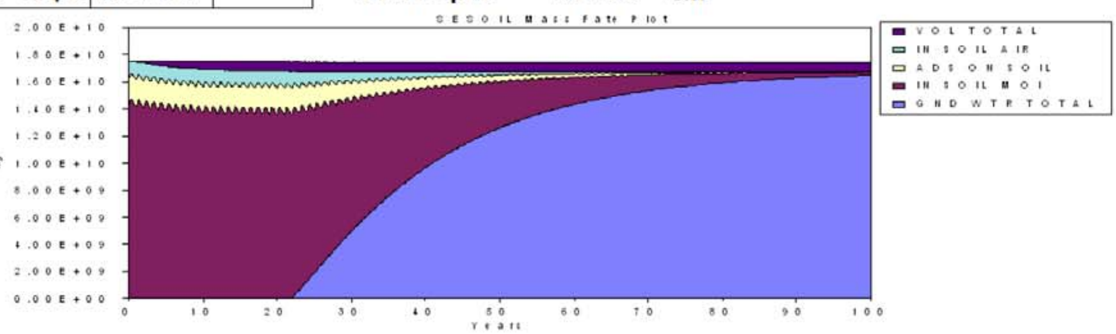
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SCLIM.CLM

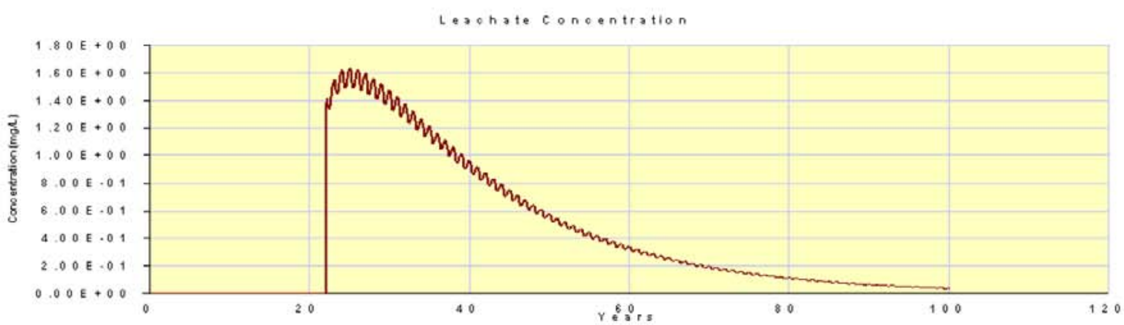
Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.CHM

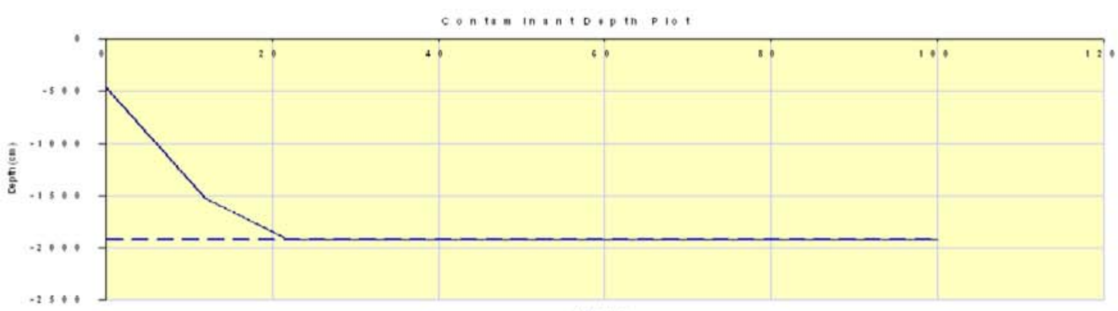
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI

Application File: PGDP SWMU-4: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.APL

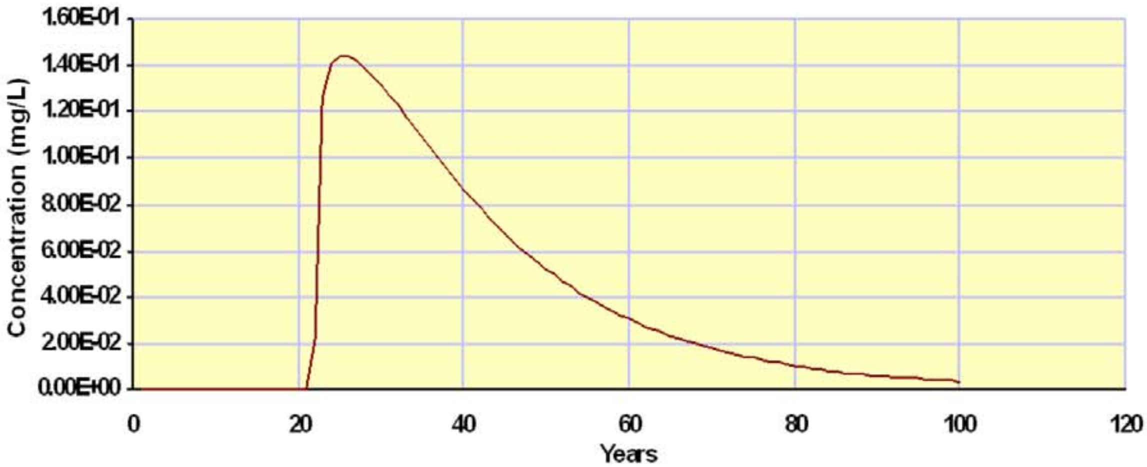
Starting Depth: 463.40 **cm**
Ending Depth: 1920.00 **cm**
Total Depth: 1920.50 **cm**







AT123D Point of Compliance Report



Maximum Concentration: 1.440E-01 mg/L
Year of Maximum Concentration: 25.00

Output Coordinates

X:	0.00000 m	0.0000 ft	**Output Time Step:**	0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	**Initial Load (mg/kg):**	0.0000E+00	
Z:	0.00000 m	0.0000 ft	**Initial Load (kg):**	0.7300E+03	

Input Parameters

Porosity:	0.30000	**Soil Organic Carbon Content (percent):**	0.02000
Hydraulic Gradient:	0.00020	**Carbon Adsorption Coeff. (ug/g)/(ug/ml):**	0.3550E+02

Hydraulic Conductivity:	1.905E+01 m/hr	5.291E-01 cm/sec
Soil Bulk Density:	1.670E+03 kg/m3	1.670E+00 g/cm3
Aquifer Width:	Infinite m	Infinite ft
Aquifer Depth:	9.140E+00 m	2.998E+01 ft
Kd:	1.000E-05 m3/kg	1.000E-02 (ug/g)(ug/ml)
Molecular Diffusion:	4.070E-06 m2/hr	1.130E-05 cm2/sec
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day

Retardation Factor:	1.040E+00	
Retarded Darcy Velocity:	1.222E-02 m2/hr	3.394E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	1.833E-01 m2/hr	5.091E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	1.834E-02 m2/hr	5.094E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	3.796E-04 m2/hr	1.054E-03 cm2/sec

Dispersivities	**Meters**	**Feet**
Longitudinal:	1.500E+01	4.921E+01
Lateral:	1.500E+00	4.921E+00
Vertical:	3.000E-02	9.842E-02

Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-6.277E+01	0.000E+00	-2.059E+02	0.000E+00
Y:	-3.138E+01	3.138E+01	-1.029E+02	1.029E+02
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.ATI
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\CIS12DIC.ATO

SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness		Intrinsic Permeability	Organic Carbon Content	Adsorption Coefficient	Cation Exchange Capacity	Freundlich Exponent	Solid Phase Degradation Rate	Liquid Phase Degradation Rate	Soil pH
		cm	feet	cm^2	percent	µg/g / µg/mL	mEq / 100 g soil	unitless	1/day	1/day	pH
1	1	30.5	1.00	1.60E-10	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	7.00
2	1	274.0	8.99	1.60E-10	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	7.00
3	4	1220.0	40.03	1.60E-10	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	7.00
4	4	396.0	12.99	1.60E-10	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	7.00

Soil Parameters

Bulk Density (g/cm^3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

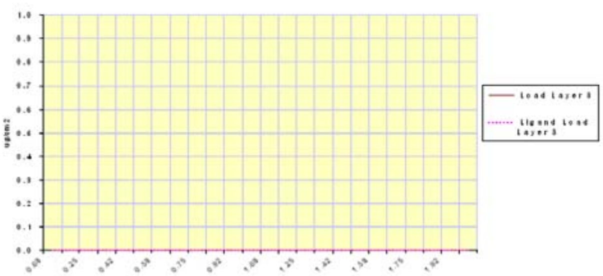
Area	cm^2	8.92E+7
	ft^2	9.60E+4
Latitude	degrees	37.0
Spill Index		1

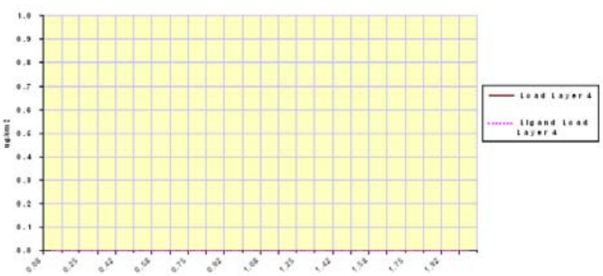
Chemical Parameters

Water Solubility (µg/mL)	1.10E+3		**Moles Ligand / Moles Chemical**	0.00
Henry's Law (M^3-atm/mol)	1.03E-2		**Ligand Molecular Weight** (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	94.00		**Base Hydrolysis Rate** (L/mol/day)	0.00
Valance (g/mole)	0.00		**Ligand Dissociation Constant**	0.00
Air Diffusion Coefficient (cm^2/sec)	7.90E-2		**Neutral Hydrolysis Rate** (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	9.10E-6		**Acid Hydrolysis Rate** (L/mol/day)	0.00
Molecular Weight (g/mol)	131.00			

Output File:
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.OUT
Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.CHM
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI
Application File: PGDP SWMU-4: TCE (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.APL

Sublayer Loads	1	2	3	4	5	6	7	8	9	10
Layer 1 (ug/g)										
Layer 2 (ug/g)										
Layer 3 (ug/g)	1.00E+00									
Layer 4 (ug/g)										

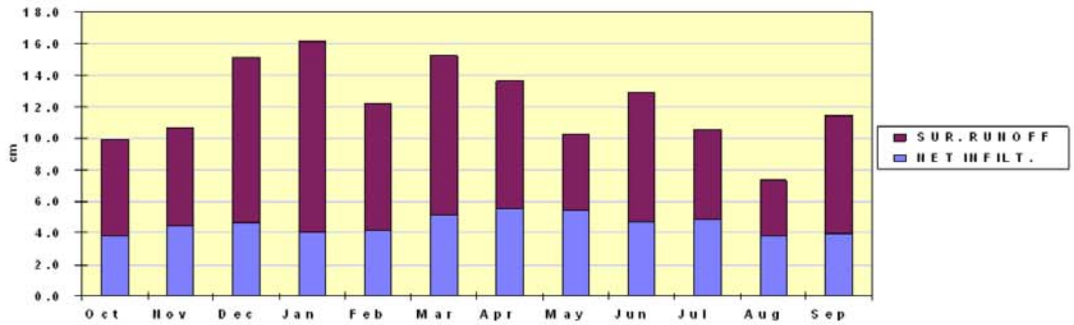


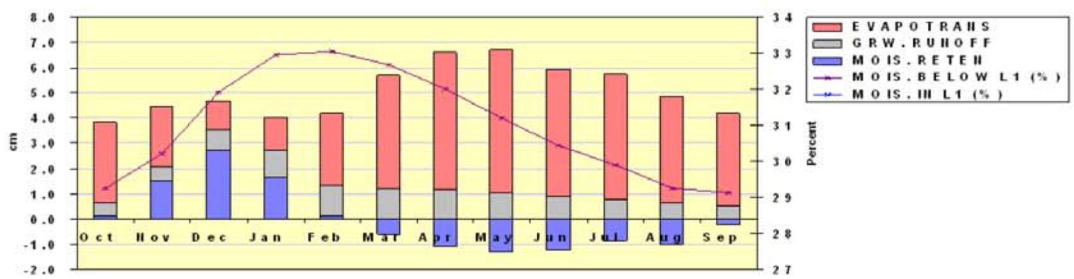


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.09	2.40	3.84	1.51	3.20	1.26	0.14	0.06	0.49	0.19	29.27	29.27
November	6.22	2.45	4.47	1.76	2.40	0.94	1.51	0.59	0.56	0.22	30.21	30.21
December	10.48	4.13	4.68	1.84	1.12	0.44	2.74	1.08	0.83	0.33	31.92	31.92
January	12.11	4.77	4.03	1.59	1.29	0.51	1.66	0.65	1.09	0.43	32.96	32.96
February	8.07	3.18	4.17	1.64	2.85	1.12	0.14	0.06	1.18	0.46	33.05	33.05
March	10.13	3.99	5.11	2.01	4.47	1.76	-0.58	-0.23	1.21	0.48	32.69	32.69
April	8.08	3.18	5.54	2.18	5.44	2.14	-1.08	-0.43	1.18	0.46	32.01	32.01
May	4.87	1.92	5.40	2.13	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.17	3.22	4.71	1.85	5.04	1.98	-1.22	-0.48	0.90	0.35	30.44	30.44
July	5.66	2.23	4.89	1.93	4.97	1.96	-0.86	-0.34	0.78	0.31	29.90	29.90
August	3.50	1.38	3.85	1.52	4.24	1.67	-1.01	-0.40	0.62	0.24	29.27	29.27
September	7.47	2.94	3.97	1.56	3.64	1.43	-0.22	-0.09	0.54	0.21	29.13	29.13
Total	90.84	35.76	54.65	21.51	44.32	17.45	-0.07	-0.03	10.40	4.09		

SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	8.206E+09	20.68
In Soil Air	5.809E+07	0.15
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	9.526E+07	0.24
Hydrol Soil	0.000E+00	0.00
Degrad Soil	5.922E+09	14.92
Pure Phase	0.000E+00	0.00
Complexed	0.000E+00	0.00
Immobile CEC	0.000E+00	0.00
Hydrol CEC	0.000E+00	0.00
In Soil Moi	2.527E+08	0.64
Hydrol Mois	0.000E+00	0.00
Degrad Mois	1.671E+10	42.12
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	8.379E+09	21.11
Total Output	3.962E+10	99.85
Total Input	3.969E+10	
Input - Output	6.017E+07	

Maximum leachate concentration: 4.035E-01 **mg/l**

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SCLIM.CLM

Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.CHM

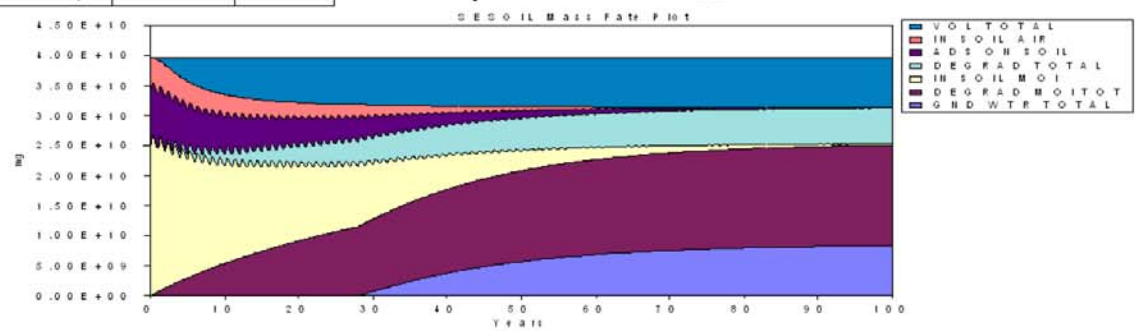
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\SSOIL.SOI

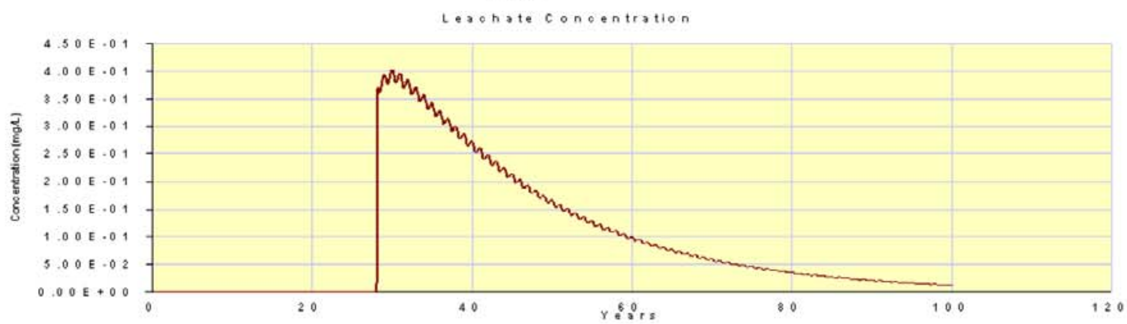
Application File: PGDP SWMU-4: TCE (infinite decay)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.APL

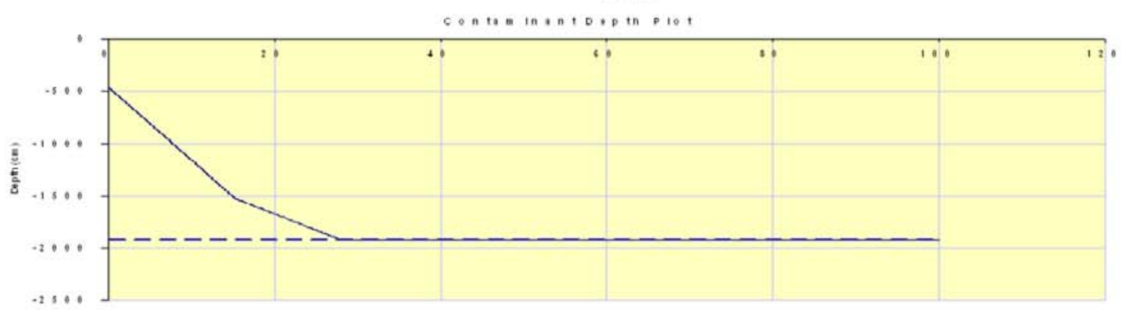
Starting Depth: 462.00 **cm**

Ending Depth: 1920.00 **cm**

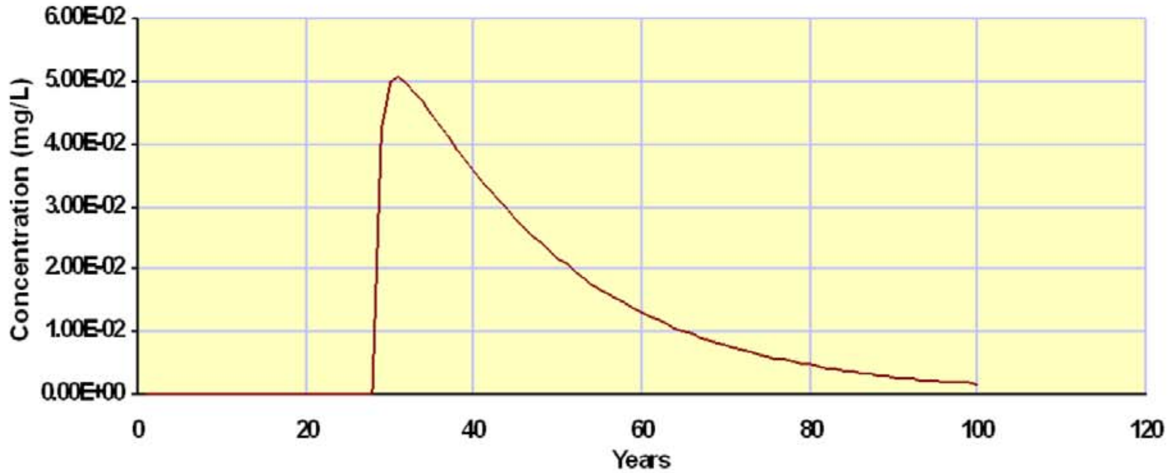
Total Depth: 1920.50 **cm**







AT123D Point of Compliance Report



Maximum Concentration: 5.080E-02 mg/L
Year of Maximum Concentration: 31.00

Output Coordinates

X:	0.00000 m	0.0000 ft	**Output Time Step:**	0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	**Initial Load (mg/kg):**	0.0000E+00	
Z:	0.00000 m	0.0000 ft	**Initial Load (kg):**	0.7300E+03	

Input Parameters

Porosity:	0.30000	**Soil Organic Carbon Content (percent):**	0.02000
Hydraulic Gradient:	0.00020	**Carbon Adsorption Coeff. (ug/g)/(ug/ml):**	0.9400E+02
Hydraulic Conductivity:	1.905E+01 m/hr	5.291E-01 cm/sec	
Soil Bulk Density:	1.670E+03 kg/m3	1.670E+00 g/cm3	
Aquifer Width:	Infinite m	Infinite ft	
Aquifer Depth:	9.140E+00 m	2.998E+01 ft	
Kd:	2.000E-05 m3/kg	2.000E-02 (ug/g)(ug/ml)	
Molecular Diffusion:	3.280E-06 m2/hr	9.111E-06 cm2/sec	
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day	

Retardation Factor:	1.105E+00	
Retarded Darcy Velocity:	1.150E-02 m2/hr	3.194E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	1.725E-01 m2/hr	4.791E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	1.726E-02 m2/hr	4.794E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	3.548E-04 m2/hr	9.855E-04 cm2/sec

Dispersivities	Meters	Feet
Longitudinal:	1.500E+01	4.921E+01
Lateral:	1.500E+00	4.921E+00
Vertical:	3.000E-02	9.842E-02

Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-9.446E+01	0.000E+00	-3.099E+02	0.000E+00
Y:	-4.722E+01	4.722E+01	-1.549E+02	1.549E+02
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.ATI
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU4\TCE.ATO

SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness		Intrinsic Permeability	Organic Carbon Content	Adsorption Coefficient	Cation Exchange Capacity	Freundlich Exponent	Solid Phase Degradation Rate	Liquid Phase Degradation Rate	Soil pH
		cm	feet	cm 2	percent	µg/g / µg/mL	mEq / 100 g soil	unitless	1/day	1/day	pH
1	1	30.5	1.00	1.60E-10	0.08	0.20	0.00	1.00	8.91E-09	8.91E-09	7.00
2	1	274.0	8.99	1.60E-10	0.08	0.20	0.00	1.00	8.91E-09	8.91E-09	7.00
3	4	1220.0	40.03	1.60E-10	0.08	0.20	0.00	1.00	8.91E-09	8.91E-09	7.00
4	4	305.0	10.01	1.60E-10	0.08	0.20	0.00	1.00	8.91E-09	8.91E-09	7.00

Soil Parameters

Bulk Density (g/cm^3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

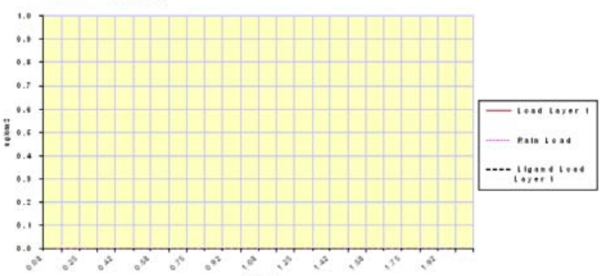
Area	cm ^{2}	2.46E+8
	ft ^{2}	2.64E+5
Latitude	degrees	37.0
Spill Index		1

Chemical Parameters

Water Solubility	(µg/mL)	1.00E+7	**Moles Ligand / Moles Chemical**	0.00
Henry's Law	(M^{3}atm/mol)	.000	**Ligand Molecular Weight**(g/mol)	0.00
K$_{oc}$	(µg/g)/(µg/mL)	0.00	**Base Hydrolysis Rate**(L/mol/day)	0.00
Valance	(g/mole)	0.00	**Ligand Dissociation Constant**	0.00
Air Diffusion Coefficient	(cm^2/sec)	.000	**Neutral Hydrolysis Rate** (L/mol/day)	0.00
Water Diffusion Coefficient	(cm^2/sec)	1.00E-6	**Acid Hydrolysis Rate** (L/mol/day)	0.00
Molecular Weight	(g/mol)	99.00		

Output File:
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.OUT
Chemical File: Tc-99
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.CHM
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\SSOIL.SOI
Application File: PGDP SWMU-7: Tc-99
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.APL

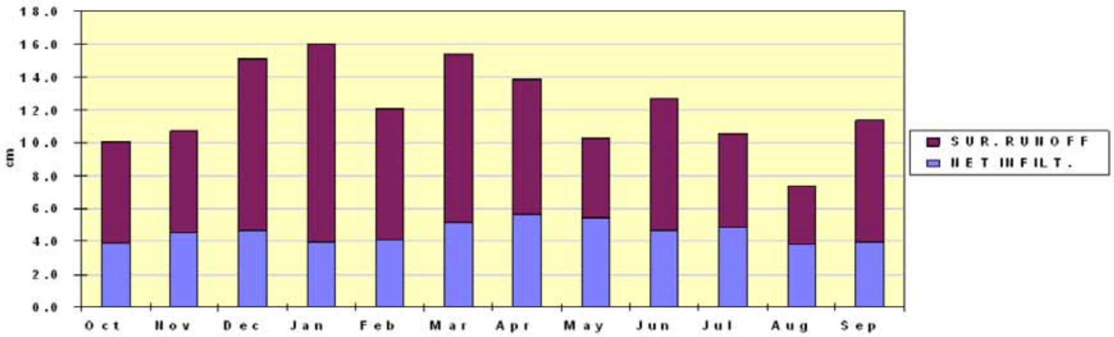
Sublayer Loads	1	2	3	4	5	6	7	8	9	10
Layer 1 (ug/g)										
Layer 2 (ug/g)										
Layer 3 (ug/g)	1.00E+00									
Layer 4 (ug/g)										

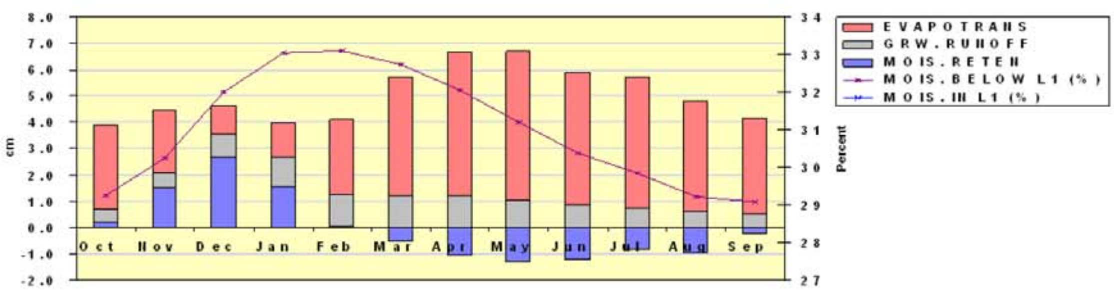


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.18	2.43	3.90	1.54	3.20	1.26	0.21	0.08	0.49	0.19	29.27	29.27
November	6.25	2.46	4.48	1.76	2.40	0.94	1.51	0.59	0.57	0.22	30.26	30.26
December	10.45	4.11	4.64	1.83	1.12	0.44	2.68	1.06	0.85	0.33	32.01	32.01
January	12.04	4.74	3.98	1.57	1.29	0.51	1.58	0.62	1.12	0.44	33.05	33.05
February	7.99	3.15	4.11	1.62	2.85	1.12	0.07	0.03	1.20	0.47	33.09	33.09
March	10.27	4.04	5.16	2.03	4.48	1.76	-0.55	-0.22	1.23	0.48	32.73	32.73
April	8.23	3.24	5.63	2.22	5.46	2.15	-1.03	-0.41	1.20	0.47	32.06	32.06
May	4.86	1.91	5.39	2.12	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.07	3.18	4.66	1.83	5.02	1.98	-1.23	-0.48	0.88	0.35	30.39	30.39
July	5.65	2.22	4.89	1.93	4.95	1.95	-0.82	-0.32	0.77	0.30	29.85	29.85
August	3.51	1.38	3.87	1.52	4.22	1.66	-0.96	-0.38	0.61	0.24	29.22	29.22
September	7.42	2.92	3.95	1.56	3.62	1.43	-0.21	-0.08	0.53	0.21	29.09	29.09
Total	90.91	35.79	54.67	21.52	44.27	17.43	-0.07	-0.03	10.47	4.12		

SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	0.000E+00	0.00
In Soil Air	0.000E+00	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	3.948E+08	0.36
Hydrol Soil	0.000E+00	0.00
Degrad Soil	8.659E+06	0.01
Pure Phase	0.000E+00	0.00
Complexed	0.000E+00	0.00
Immobile CEC	0.000E+00	0.00
Hydrol CEC	0.000E+00	0.00
In Soil Moi	3.931E+08	0.36
Hydrol Mois	0.000E+00	0.00
Degrad Mois	9.190E+06	0.01
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	1.082E+11	98.84
Total Output	1.090E+11	99.57
Total Input	1.095E+11	
Input - Output	4.685E+08	

Maximum leachate concentration: 1.551E+00 **mg/l**

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU30\SCLIM.CLM

Chemical File: Tc-99
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.CHM

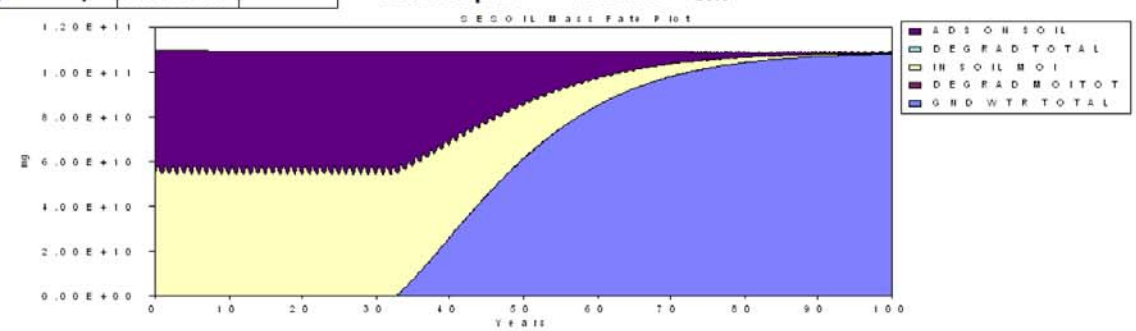
Soil File: Silty- Loam
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\SSOIL.SOI

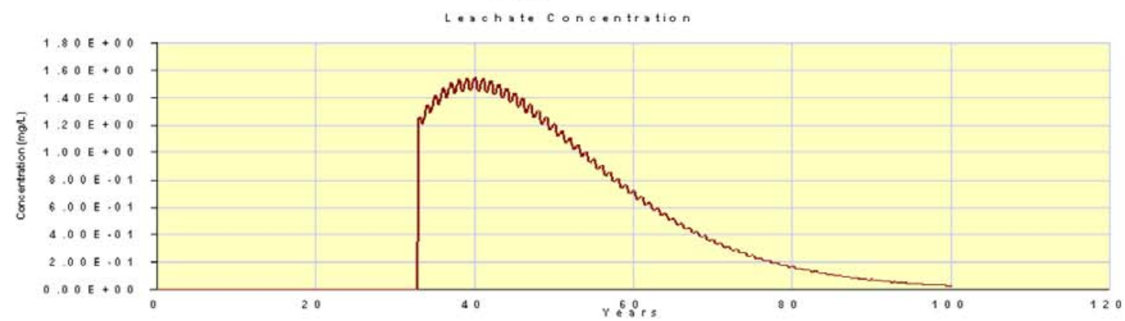
Application File: PGDP SWMU-7: Tc-99
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.APL

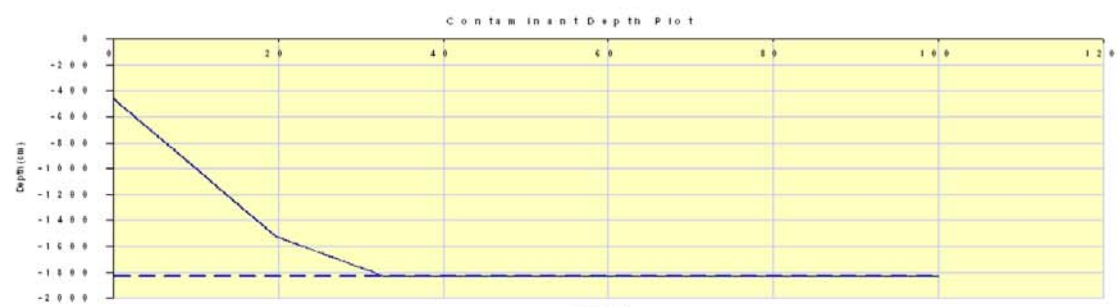
Starting Depth: 460.90 **cm**

Ending Depth: 1829.00 **cm**

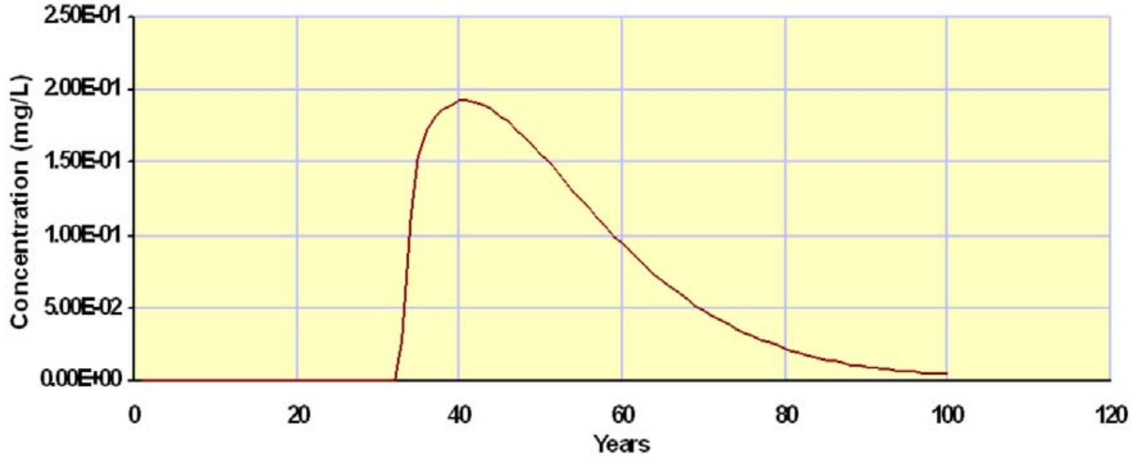
Total Depth: 1829.50 **cm**







AT123D Point of Compliance Report



Maximum Concentration: 1.920E-01 mg/L
Year of Maximum Concentration: 40.00

Output Coordinates

X:	0.00000 m	0.0000 ft	**Output Time Step:**	0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	**Initial Load (mg/kg):**	0.0000E+00	
Z:	0.00000 m	0.0000 ft	**Initial Load (kg):**	0.7300E+03	

Input Parameters

Porosity:	0.30000	**Soil Organic Carbon Content (percent):**	0.02000
Hydraulic Gradient:	0.00030	**Carbon Adsorption Coeff. (ug/g)/(ug/ml):**	0.0000E+00

Hydraulic Conductivity:	1.905E+01 m/hr	5.291E-01 cm/sec
Soil Bulk Density:	1.670E+03 kg/m3	1.670E+00 g/cm3
Aquifer Width:	Infinite m	Infinite ft
Aquifer Depth:	9.140E+00 m	2.998E+01 ft
Kd:	2.000E-04 m3/kg	2.000E-01 (ug/g)(ug/ml)
Molecular Diffusion:	3.600E-07 m2/hr	1.000E-06 cm2/sec
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day

Retardation Factor:	2.113E+00	
Retarded Darcy Velocity:	9.014E-03 m2/hr	2.503E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	1.352E-01 m2/hr	3.755E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	1.352E-02 m2/hr	3.755E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	2.710E-04 m2/hr	7.527E-04 cm2/sec

Dispersivities	Meters	Feet
Longitudinal:	1.500E+01	4.921E+01
Lateral:	1.500E+00	4.921E+00
Vertical:	3.000E-02	9.842E-02

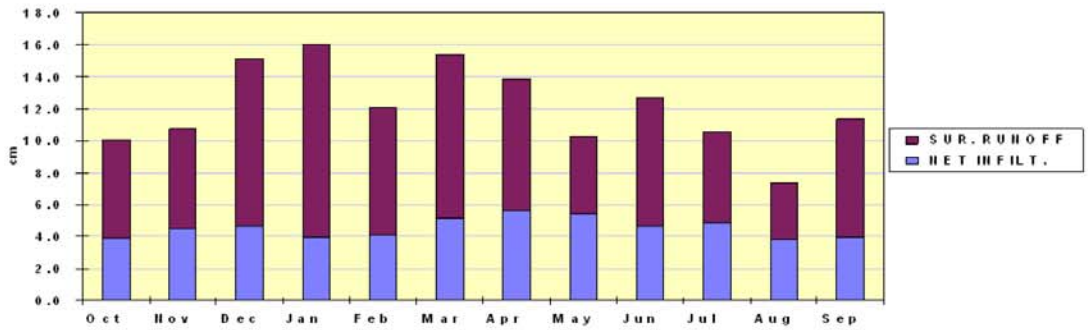
Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-1.568E+02	0.000E+00	-5.145E+02	0.000E+00
Y:	-7.842E+01	7.842E+01	-2.572E+02	2.572E+02
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

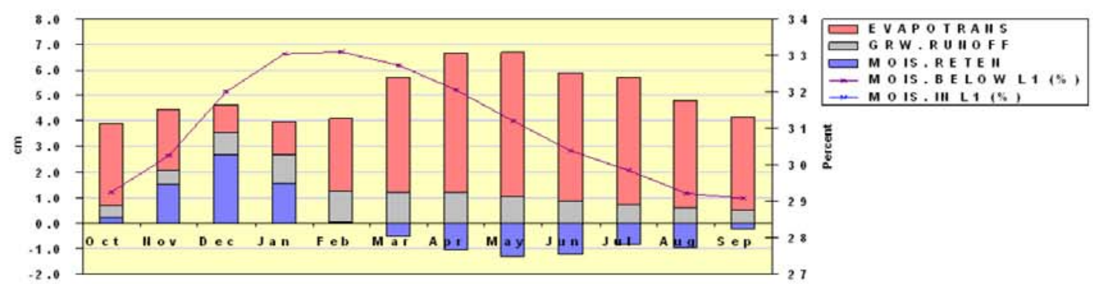
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.ATI
C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\TC99.ATO

SESOIL Hydrologic Cycle Report

Scenario Description:

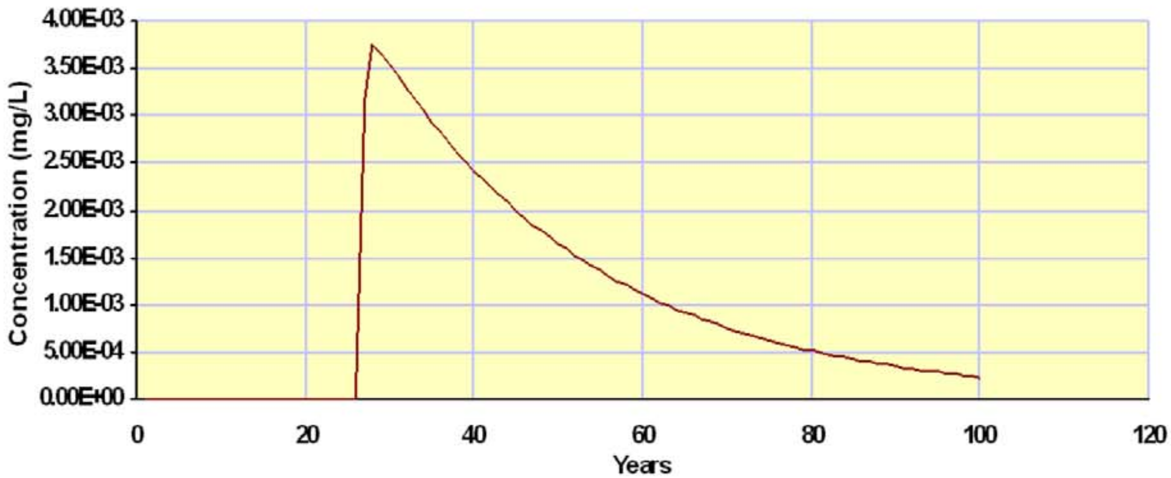
SESOIL Output File: C:\SEVIEW63\PADUCAH\BGOU_FS\SWMU7\VC.OUT





	Surface Water Runoff		Net Infiltration		Evapotranspiration		Soil Moisture Retention		Groundwater Runoff (Recharge)		Soil Moisture	
											Layer 1	Below Layer 1
Units	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	Percent	Percent
October	6.18	2.43	3.90	1.54	3.20	1.26	0.21	0.08	0.49	0.19	29.27	29.27
November	6.25	2.46	4.48	1.76	2.40	0.94	1.51	0.59	0.57	0.22	30.26	30.26
December	10.45	4.11	4.64	1.83	1.12	0.44	2.68	1.06	0.85	0.33	32.01	32.01
January	12.04	4.74	3.98	1.57	1.29	0.51	1.58	0.62	1.12	0.44	33.05	33.05
February	7.99	3.15	4.11	1.62	2.85	1.12	0.07	0.03	1.20	0.47	33.09	33.09
March	10.27	4.04	5.16	2.03	4.48	1.76	-0.55	-0.22	1.23	0.48	32.73	32.73
April	8.23	3.24	5.63	2.22	5.46	2.15	-1.03	-0.41	1.20	0.47	32.06	32.06
May	4.86	1.91	5.39	2.12	5.66	2.23	-1.30	-0.51	1.03	0.41	31.20	31.20
June	8.07	3.18	4.66	1.83	5.02	1.98	-1.23	-0.48	0.88	0.35	30.39	30.39
July	5.65	2.22	4.89	1.93	4.95	1.95	-0.82	-0.32	0.77	0.30	29.85	29.85
August	3.51	1.38	3.87	1.52	4.22	1.66	-0.96	-0.38	0.61	0.24	29.22	29.22
September	7.42	2.92	3.95	1.56	3.62	1.43	-0.21	-0.08	0.53	0.21	29.09	29.09
Total	90.91	35.79	54.67	21.52	44.27	17.43	-0.07	-0.03	10.47	4.12		

AT123D Point of Compliance Report



Maximum Concentration: 3.750E-03 mg/L
Year of Maximum Concentration: 28.00

Output Coordinates

X:	0.00000 m	0.0000 ft	**Output Time Step:** 0.0833 years	1.0005 months
Y:	0.00000 m	0.0000 ft	**Initial Load (mg/kg):** 0.0000E+00	
Z:	0.00000 m	0.0000 ft	**Initial Load (kg):** 0.7300E+03	

Input Parameters

Porosity:	0.30000	**Soil Organic Carbon Content (percent):**		0.02000
Hydraulic Gradient:	0.00030	**Carbon Adsorption Coeff. (ug/g)/(ug/ml):**		0.1880E+02
Hydraulic Conductivity:	1.905E+01 m/hr	5.291E-01 cm/sec		
Soil Bulk Density:	1.670E+03 kg/m3	1.670E+00 g/cm3		
Aquifer Width:	Infinite m	Infinite ft		
Aquifer Depth:	9.140E+00 m	2.998E+01 ft		
Kd:	0.000E+00 m3/kg	0.000E+00 (ug/g)(ug/ml)		
Molecular Diffusion:	4.428E-07 m2/hr	1.230E-06 cm2/sec		
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day		

Retardation Factor:	1.021E+00	
Retarded Darcy Velocity:	1.866E-02 m2/hr	5.183E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	2.799E-01 m2/hr	7.775E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	2.799E-02 m2/hr	7.775E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	5.612E-04 m2/hr	1.558E-03 cm2/sec

Dispersivities	Meters	Feet
Longitudinal:	1.500E+01	4.921E+01
Lateral:	1.500E+00	4.921E+00
Vertical:	3.000E-02	9.842E-02

Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-3.224E+01	0.000E+00	-1.057E+02	0.000E+00
Y:	-1.612E+01	1.612E+01	-5.288E+01	5.288E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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APPENDIX C

COST ESTIMATE SUPPORTING INFORMATION FOR ALTERNATIVE 2

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APPENDIX C. COST ESTIMATE SUPPORTING INFORMATION FOR ALTERNATIVE 2

The estimated cost associated with Alternative 2: Excavation and Disposal of Buried Waste Material and Contaminated Soils is approximately $143.5 million. Presented below is additional detail regarding the cost estimate for Alternative 2.

Task	**Estimated Cost**	**Notes**
Project Plans	$2,000,000	Estimates are for labor.
Engineering Design	$3,000,000	Engineering estimates for labor and 1% factor of construction costs for design.
Work Package Preparation/ Readiness Review	$1,000,000	
Training	$500,000	Estimates are for labor and vendor quotes for radiation techs, radiation supervisor, and health physicist.
Mobilization	$25,000,000	Estimates are for labor, vendor quotes, instrument costs, and equipment costs.
Site Preparation, Construction Laydown, and Staging Areas	$5,000,000	Includes stormwater measures, geophysical survey of the burial ground, a temporary weather enclosure, and a temporary waste management building. Estimates are for labor, vendor quotes, instrument costs, and equipment costs.
Excavation	$45,000,000	Includes approximately $7M for dewatering. Estimates are for labor, vendor quotes, instrument costs, PPE, equipment, and verification sampling costs.
Waste Treatment, Transportation, and Disposal	$107,400,000	Assumes that this task is performed concurrent with the excavation. Estimates are for labor, vendor quotes, PPE, equipment, disposal sampling, transportation, disposal costs, absorbent, rail car mover, and decontamination.
Backfill and Equipment Decontamination	$10,000,000	Estimates are for labor, vendor quotes, equipment costs, backfill delivery, and backfill sampling.
Site Restoration	$1,000,000	Estimates are for labor, equipment, and hydroseeding.
Removal Completion Letter	$100,000	Engineering estimate for labor.
Total for SWMU 4 Removal Action	**$200,000,000**	

PPE = personal protective equipment
FS = feasibility study

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