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APR 30 2012

PPPO-02-1433854-12

Mr. Wm. Turpin Ballard
Remedial Project Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Mr. Todd Mullins, FFA Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Dear Mr. Ballard and Mr. Mullins:

FEASIBILITY STUDY FOR SOLID WASTE MANAGEMENT UNITS 2, 3, 7, AND 30 OF THE BURIAL GROUNDS OPERABLE UNIT AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-1274&D1)

References:

1. Letter from W. Murphie to G. Fleming and B. Scott, "Paducah Federal Facility Agreement—Transmittal of Resolution Agreement of the Formal Dispute for the D2 Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky," (PPPO-02-1399777-12), dated February 10, 2012
2. Letter from A. Webb to R. Knerr, "Non-Concurrence with the Feasibility Study for the Burial Grounds Operable Unit (DOE/LX/07-0130&D2)," dated January 31, 2011
3. Letter from T. Ballard to R. Knerr, "EPA Non-Concurrence with the Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant (PGDP) (DOE-LX/07-0130&D2)," dated January 14, 2011

In December 2010, the U.S. Department of Energy (DOE) issued the *Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0130&D2, for your review. In September 2011, the Federal Facility Agreement (FFA) parties agreed that the document, which addressed Solid Waste Management Units (SWMUs) 2, 3, 4, 5, 6, 7, and 30, should be revised so there would be three separate feasibility studies (FSs): one for SWMUs 5 and 6; a second for SWMUs 2, 3, 7, and 30; and a third FS for SWMU 4.

Enclosed is the certified FS for SWMUs 2, 3, 7, and 30. In addition to removing SWMUs 5 and 6 from the original FS, as described, DOE has incorporated resolution of the D2 FS comments provided by the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection. To properly address comments such as EPA Comment 158 (Section 1.4.2, Screening of Metals and Naturally Occurring Radionuclides, page 1-67), extensive document modifications were required beyond those specific to the section about which the comment was made, including a reexamination of the data presented in Remedial Investigation report. Significant changes also have been made to Section 2, Identification and Screening of Technologies, to accommodate the broader range of treatment alternatives.

As part of the FS for the Waste Disposal Options, DOE currently is evaluating the potential application of the corrective action management unit (CAMU) provisions. Consequently, the enclosed FS for the Burial Grounds Operable Unit may require revision during development of the D2 version to include CAMU provisions. It is recommended the FFA Parties further discuss the role and application of CAMUs in the near future during the FFA Project Managers Meeting.

If you have any questions or require additional information, please contact Lisa Santoro at (270) 441-6804.

Sincerely,

Reinhard Knerr
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. Feasibility Study

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CERTIFICATION

Document Identification: ***Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1274&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 ensure 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.

LATA Environmental Services of Kentucky, LLC

Mark J. Duff, Paducah Project Manager — 4-30-12 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 ensure 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)

Reinhard Knerr, Paducah Site Lead
Portsmouth/Paducah Project Office — 4/30/12 Date Signed

DOE/LX/07-1274&D1
Primary Document

Feasibility Study
for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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DOE/LX/07-1274&D1
Primary Document

Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—April 2012

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-10CC40020

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PREFACE

This *Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1274&D1, was prepared to evaluate remedial alternatives to support remedy selection under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the U.S. Department of Energy's Paducah Gaseous Diffusion Plant. This document follows *Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0130&D2 (DOE 2010a). As a result of review and discussion by the Federal Facility Agreement (FFA) parties, the D2 version of the feasibility study was separated into smaller documents focused on fewer solid waste management units (SWMUs). This document presents only information about SWMUs 2, 3, 7, and 30. Also as a result of discussions, it was decided that this FS for SWMUs 2, 3, 7, and 30 would be submitted as a D1 document. Information for the rest of the Burial Grounds Operable Unit (BGOU) landfills and burial grounds is presented in separate documents. This work was prepared in accordance with the requirements of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (EPA 1998). In accordance with Section IV of the FFA, this integrated technical document was developed to satisfy applicable requirements of CERCLA (42 USC § 9601 *et seq.* 1980) and the Resource Conservation and Recovery Act (42 USC § 6901 *et seq.* 1976). As such, the phases of the investigation process are referenced by CERCLA terminology within this document to reduce the potential for confusion.

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TABLES

FIGURES

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
AT123D	Analytical Transient 1-,2-,3-Dimensional
BHHRA	baseline human health risk assessment
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
COPC	chemical of potential concern
CR	contingent remedy
CSM	Conceptual Site Model
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPE	dual-phase extraction
ELCR	excess lifetime cancer risk
E/PP	excavation/penetration permit
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ERH	electrical resistance heating
FFA	Federal Facility Agreement
FS	feasibility study
FR	Federal Register
GAC	granular-activated carbon
GRA	general response action
HASP	health and safety plan
HDPE	high-density polyethylene
HEPA	high-efficiency particulate air
HI	hazard index
HQ	hazard quotient
HU	hydrogeologic unit
ISCO	*in situ* chemical oxidation
KAR	Kentucky Administrative Regulations
KEEC	Kentucky Energy and Environment Cabinet
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
KY	Commonwealth of Kentucky
LCD	Lower Continental Deposits
LDA	large diameter auger
LLTW	low-level threat waste
LLW	low-level waste
LTTD	low temperature thermal desorption
LUC	Land Use Control
LUCIP	land use control implementation plan
MCL	maximum contaminant level
MLLW	medium low-level waste
MNA	monitoring natural attenuation

MW	monitoring well
N/A	not applicable
NAL	no action level
NAPL	nonaqueous-phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
NRDA	Natural Resource Damage Assessment
NSDD	North-South Diversion Ditch
O&M	Operation & Maintenance
ORP	oxidation reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
POE	point of exposure
PPE	personal protective equipment
PRB	permeable reactive barrier
PRG	preliminary remediation goal
PTW	principal threat waste
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RDSI	Remedial Design Site Investigation
RDWP	Remedial Design Work Plan
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision
RPO	representative process option
SADA	Spatial Analysis and Decision Assistance
SERA	screening ecological risk assessment
SESOIL	Seasonal Soil Compartment Model
SMP	Site Management Plan
SPH	six-phase heating
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
Tc-99	technetium-99
T&E	threatened and endangered
TBC	to be considered
TCE	trichloroethene
TCH	thermal conduction heating
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
UCD	Upper Continental Deposits

UCRS	Upper Continental Recharge System
USC	United States Code
USFWS	U. S. Fish and Wildlife Service
VOC	volatile organic compound
WAC	waste acceptance criteria
WAG	waste area grouping
WDF	waste disposal facility
WKWMA	West Kentucky Wildlife Management Area
XRF	x-ray fluoroscopy
ZVI	zero-valent iron

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EXECUTIVE SUMMARY

This *Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1274&D1 (FS), was prepared to evaluate remedial alternatives to address risks associated with Solid Waste Management Units (SWMUs) 2, 3, 7, and 30 at the Burial Grounds Operable Unit (BGOU) in support of remedy selection under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at the Paducah Gaseous Diffusion Plant (PGDP). This document was prepared in accordance with the requirements of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998).

Under a work plan approved by U.S. Environmental Protection Agency (EPA) and the Commonwealth of Kentucky (KY) (DOE 2006), the U. S. Department of Energy (DOE) conducted a Remedial Investigation (RI), which was the continuation of earlier investigative activities, to evaluate source areas of contamination associated with PGDP's landfills and burial grounds. Results of the RI were reported in the *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0030&D2/R1 (DOE 2010b). A baseline human health risk assessment (BHHRA) also was conducted that evaluated the range of risks to human health under a range of exposure scenarios associated with current and future land use, some of which are unlikely or hypothetical. A screening ecological risk assessment (SERA) also evaluated impacts to the environment.

Following approval of the RI, an FS was prepared, with the latest version being *Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0130&D2, submitted in December 2010 (DOE 2010a). As a result of review, discussion, and agreement by the FFA parties, the D2 version of the FS has been subdivided into focused groupings. This document presents an FS for SWMUs 2, 3, 7, and 30 that develops and evaluates remedial alternatives to address risks from and uncertainties about these SWMUs. As a result of the discussions by the FFA parties, it was decided that this FS for SWMUs 2, 3, 7, and 30 would be submitted as a D1 document. Information for the rest of the BGOU landfills and burial grounds is presented in separate documents.

The RI identified risks to human health and the environment from potential exposure to contaminants of concern (COCs) remaining in wastes and surface and subsurface soils at SWMUs 2, 3, 7, and 30 under some current and future use scenarios. Thus, remedial alternatives have been developed to reduce the potential for exposure to surface soil, buried wastes and affected soils, using control, containment, treatment, and/or removal response actions. Alternatives developed to address buried waste will generally be effective at addressing associated affected soils. In addition, the RI identified the potential for impacts to groundwater from COCs. This FS addresses these constituents by developing and evaluating alternatives that include processes to contain, treat, or remove COCs. Finally, alternatives that allow wastes or affected media to be left in place incorporate Land Use Controls and monitoring to control exposure to COCs and support continued evaluation of the protectiveness of the remedy.

SCOPE OF THE BGOU

The BGOU at PGDP is one of five media-specific, sitewide operable units (OUs) associated with pre-shutdown efforts to evaluate and implement remedial actions. A final Comprehensive Site OU evaluation will be conducted following plant shutdown and completion of pre- and post-shutdown actions to ensure long-term protectiveness of human health and the environment. The five media-specific, strategic cleanup initiatives that have been agreed upon by the DOE, EPA, and KY, as documented in the current *Site Management Plan* (SMP) (DOE 2012a), are as follows:

- Groundwater OU Strategic Initiative
- Burial Grounds OU Strategic Initiative
- Surface Water OU Strategic Initiative
- Soils OU Strategic Initiative
- Decontamination and Decommissioning OU Strategic Initiative

The BGOU strategic initiative addresses under CERCLA the contamination associated with PGDP's landfills and burial grounds as listed in Table ES.1. The burial grounds contains low-level threat waste (LLTW), principal threat waste (PTW), and affected media.

Table ES.1 BGOU Source Areas and Solid Waste Management Units

SWMU No.	Description
2*	**C-749 Uranium Burial Grounds**
3*	**C-404 Low-Level Radioactive Waste Burial Grounds**
4	C-747 Contaminated Burial Yard and C-748-B Burial Area
5	C-746-F Burial Yard
6	C-747-B Burial Grounds
7 and 30*	**C-747-A Burial Grounds and Burn Area**
145 (9 and 10)	Area P and C-746-S and C-746-T Landfills

***Bold** indicates SWMU addressed in this FS.

PREVIOUS INVESTIGATIONS AND OTHER INFORMATION USED FOR THIS FS

Table ES.2 identifies the previously completed reports and/or investigations related to SWMUs 2, 3, 7, and 30 used in the development of this FS. Additionally, information obtained after completion of these previous investigations has been included where that information has been deemed relevant to the development of remedial alternatives. In particular, *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1: Human Health,* DOE/OR/07-1506&D2/R0/V1, dated December 2001, has been superseded by *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 1: Human Health,* DOE/LX-07-0107&D2/R1/V1 (DOE 2011a) and the latter document has been used in this FS.

SOURCE AREAS

The SWMUs comprising the BGOU consist of landfills and burial cells in which PGDP waste has been placed. The four SWMUs covered by this FS are SWMUs 2, 3, 7, and 30.

SWMUs 2 and 3 are located in the west-central section of the PGDP secured area. SWMU 2 (~32,000 ft^2) operated from 1951 to 1977. SWMU 2 is a below-ground burial area with individual disposal cells that were used primarily for the disposal of uranium and uranium-contaminated waste, including machine shop turnings, shavings, and sawdust. Because small pieces of uranium metal may be pyrophoric (spontaneously burn in air), operating practices of the time included placing the materials in drums along with associated cutting oils and sweepings. Additional petroleum-based or synthetic oil may have been added to minimize the contact of these materials with air. Other waste documented as being disposed of at SWMU 2 includes drummed TCE and uranyl fluoride. After disposal, drummed buried wastes were covered with soil.

BACK

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FORWARD

Table ES.2. Summary of Previous Investigations of BGOU

Dates	Title	SWMU 2	SWMU 3	SWMU 7	SWMU 30
1989	Post Closure Permit Application C-404 Low-Level Radioactive Waste Burial Ground		ü		
1990-1992	Phase II Site Investigation (CH2M HILL 1992)	ü	ü	ü	ü
1996	Closure Plan C-404 Low-Level Radioactive Waste Burial Ground		ü		
1996-1997	WAG 22 SWMUs 2 and 3 Remedial Investigation and Addendum (including SWMU 2 Data Summary Report)	ü	ü		
1996-1998	WAG 22 SWMUs 7 and 30 RI/FS			ü	ü
1999-2001	Data Gaps Investigation (DOE 2000)			ü	ü
2002-2003	Scrap Yards Site Characterization (Paducah OREIS)			ü	ü
2006	Burial Grounds RI/FS Work Plan (DOE 2006)	ü	ü	ü	ü
2007	Burial Grounds Remedial Investigation (DOE 2010b)	ü	ü	ü	ü

Table ES.2 is based on Table 1.4 of the *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0030&D2/R1, February (DOE 2010b).
Blank cells indicate document is not applicable to SWMU.

SWMU 3 (~1.2 acres) is an aboveground disposal cell that operated as a surface impoundment to manage uranium-contaminated effluent from C-400 from 1952 to 1957; then it was converted to a solid waste disposal facility with a tamped earth bottom that accepted solid uranium-contaminated waste (precipitates, slag, uranium tetrafluoride, uranium oxides, sludge, etc.) until 1976. Documentation indicates that before landfill closure in 1986, drums of various materials were placed on top of a buffer soil layer over the previously disposed of material. SWMU 3 was subsequently covered with a Subtitle C cap.

SWMUs 7 and 30 are located in the northwest corner of the PGDP secured area. SWMU 7 (~240,900 ft^2) includes six discrete burial cell areas used for disposal of wastes from 1957 to 1979. Wastes disposed of in SWMU 7 include noncombustible contaminated and uncontaminated trash, scrap metal (including empty used drums), material, and equipment. Previous investigations have documented volatile organic compound (VOC) (TCE and degradations products) concentrations attributed to an Upper Continental Recharge System (UCRS) dense nonaqueous-phase liquid (DNAPL) at SWMU 7. SWMU 30 (~117,600 ft^2) was used from 1957 to 1970 to burn combustible trash, which may have contained uranium contamination. Material disposed in this area included trash, ash and debris, as well as the remnants of the incinerator used to burn the trash.

The following PTW has been identified at SWMU 2:

· 270 tons of uranium (e.g., shavings and sawdust packed in oil);

· Buried drums of uranium-contaminated TCE and any high soil concentrations of TCE present under and adjacent to the drums;

· Buried drums of uranyl fluoride solution and high soil concentrations of uranyl fluoride solution present under and adjacent to the drums;

· High concentrations of TCE and *cis*-1,2-dichloroethene (DCE) in soil on the eastern side of SWMU 2; and

- Oil with PCB contamination at concentrations greater than 500 mg/kg.

There is the potential that up to 59,000 gal of oil that was co-disposed with the uranium contains polychlorinated biphenyls (PCBs) at concentrations greater than 500 mg/kg. Under EPA guidance, PCB concentrations greater than 500 mg/kg are considered PTW under certain exposure scenarios. Absent additional characterization (sampling and analysis) of the buried waste, it is uncertain whether PCBs are present at SWMU 2 at levels greater than 500 mg/kg. Notwithstanding the uncertainty, the 59,000 gal of oil could contain PCBs in excess of 500 mg/kg and has been identified as PTW.

Uranium-contaminated waste (approximately 3,200 tons) at SWMU 3 has been identified as PTW. (It is inconclusive whether some of the uranium may be pyrophoric).

TCE (including degradation products) present in UCRS at SWMU 7 as DNAPL and/or high concentration TCE residual soil contamination has been identified as PTW.

No PTW has been identified at SWMU 30.

All other waste at SWMUs 2, 3, 7, and 30 are considered LLTW.

NATURE AND EXTENT OF CONTAMINATION

The current understanding of the nature and extent of contamination in surface and subsurface soils was derived from historical investigations as shown on Table ES.2. In the BGOU RI, additional soil samples were collected from angled borings beneath the wastes to establish if releases had occurred from the waste and, if so, their magnitude in the secondary media. Each of the SWMUs has a surface cover. The amount of surface soil data collected for each SWMU varied, since the focus of the BGOU was to identify releases and these would primarily be identified from samples beneath the waste. In some cases, the BGOU data set includes soil and sediment samples collected from locations outside the SWMU boundary that are not affected by releases from the wastes and will be addressed by other strategic initiatives.

SWMU-specific sections provide details on the distribution of selected COCs. The sampling locations and distribution of the target chemicals in surface and subsurface soils evaluated in this FS are shown on figures in Appendix A for each of the SWMUs. Key general observations across all SWMUs include the following:

- Radionuclides were detected at each of the SWMUs. Those of greatest impact when evaluating releases include technetium-99 (Tc-99) and uranium-238. Tc-99 is one of the more mobile radionuclides and has been detected in RGA groundwater at PGDP. It was only detected above background in 1 of nearly 90 samples collected from depths below 20 ft. Tc-99 was detected in only 8 of over 100 samples collected from depths of 1–20 ft and was detected in surface samples (17/48). A similar pattern was observed for uranium-238, where detects exceeding background were observed most frequently in surface soils (0–1 ft bgs).

- Chlorinated volatile organic compounds were identified in soil samples at SWMUs 2 and 7. The highest concentration was noted in a sample collected from a SWMU 2 waste cell at a depth of 12 ft bgs with concentrations of TCE and *cis*-1,2-DCE (its anaerobic biodegradation product) each above 100 mg/kg. These concentrations are below the soil saturation concentration (C_{sat}); and this was the only location with concentrations that exceed 1 mg/kg. Other detected concentrations of TCE range from 0.0021 J to 0.428 mg/kg.

- Total PCBs were detected in soil samples from SWMUs 2, 7, and 30. The PCBs concentrations are higher and present at greater frequencies in surface soil, with no detections of total PCBs in the 68 soil samples collected at depths greater than 20 ft bgs. The maximum PCB concentration in burial ground soil was 14.8 mg/kg --the only soil sample with a concentration above 10 mg/kg.

- Polycyclic aromatic hydrocarbons (PAHs) were detected most frequently in surface samples at SWMUs 7 and 30. These were not detected in any samples below 20 ft.

- Naturally occurring metals sporadically exceeded both the no action level (NAL) and background concentrations. No clear patterns or gradients of concentrations were identified. For surface soils, these metals include antimony, arsenic, chromium, iron, nickel uranium and vanadium. Uranium was the metal that most frequently exceeded its NAL and background.

MIGRATION PATHWAYS AND RISK SUMMARY

The FS considers two mechanisms by which residual contamination at the BGOU may pose a risk:

- Through direct contact with wastes or affected media; and
- Through migration to Regional Gravel Aquifer (RGA) groundwater.

The potential for migration to groundwater is informed by a discussion of the Site Conceptual Model.

Conceptual Site Model. The potential for materials to migrate to groundwater was evaluated in the RI (DOE 2010b) and previous FS (DOE 2010a). If contaminants are mobilized, they have the potential to migrate downward through the UCRS soils and reach the RGA. Some lateral movement of contaminants could occur in the UCRS, but these pathways are known to be limited. Based on this conceptual model, any contamination resulting from buried waste found at these SWMUs would be expected to be found concentrated in the soils and groundwater of the UCRS immediately within and under the burial cells and landfills, with little lateral dispersion of contamination in the UCRS. Only the most mobile constituents are expected to be found at greater depths. The RI Report provides an assessment of data from the BGOU RI, along with data from historical investigations, to evaluate the nature and extent of contamination (vertical and lateral) associated with the BGOU SWMUs. Consistent with the BGOU FS scope, the source areas, contamination in secondary sources impacted by releases from the waste, and potential for future migration from the wastes were the basis for evaluation of remedial alternatives.[1]

The BHHRA for the BGOU RI characterized the baseline risks posed to human health from contact with contaminants in soil and water at the BGOU SWMUs and at locations to which contaminants may migrate. Several COCs were identified that could pose unacceptable threats to human health and the environment under some future use scenarios, particularly if there were any of the following:

- Direct contact with buried wastes;
- Direct contact with surface soils;

[1] Impacts identified in soil or sediment samples adjacent to the SWMUs that are not related to release from the BGOU are noted in this FS; however, these impacts are components of the larger integrated units of the Soils or Surface Water OUs.

- Direct contact with affected subsurface soils; and
- Migration of COCs to groundwater and/or surface water.

Human Health—Direct Contact

The impact to human health from direct contact with buried wastes was not quantitatively characterized in the BHHRA; nevertheless, direct contact with both PTW and LLTW wastes is assumed to be associated with unacceptable risks under some current or future use scenario and thus this pathway must be addressed in this FS for SWMUs 2, 3, 7, and 30.

The impact to human health from direct contact with surface and subsurface soils was quantitatively characterized.

The excess lifetime cancer risk (ELCR) and hazard index (HI) were found to be above EPA's acceptable risk range (ELCR > 1E-4 and HI > 1) for some residential and industrial worker land use scenarios at each of the SWMUs. In addition, there is some uncertainty in the evaluation of surface soils associated with the quantity and geographic distribution of samples.

Therefore, at a minimum, the FS must address for each SWMU:

- How the alternative will address the potential for direct contact with buried wastes and affected soils;

- How the alternative will address the risks or uncertainties associated with direct contact with surface soils; and

- How the alternative will address the potential for migration of source materials to RGA groundwater.

Table ES.3 is a summary of the target compounds for direct contact exposures that will address risks and hazards identified in the BHHRA for the worker scenarios.

Table ES.3 Summary of Target Compounds to be Addressed for Protection of Future Industrial and Outdoor Workers

	SWMU 2	**SWMU 3**	**SWMU 7**	**SWMU 30**
Carcinogenic COCs (ELCR > 1E-06)	Arsenic Uranium-235 Uranium-238	Uranium-235 Uranium-238	Arsenic Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*	Total PCBs Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*
Noncancer Hazard COCs (HQ > 0.1)	None	None	Uranium	Uranium

Note: Analytes in italics only identified as COCs for outdoor worker scenario.
Others are COCs for future industrial and outdoor worker scenarios.
At SWMUs 2 and 3, the industrial worker COCs were identified using both surface and subsurface soils.

Migration of COCs to Groundwater

The BGOU RI characterized potential releases from the wastes to groundwater. For RGA groundwater, the BHHRA evaluated the potential for unacceptable risks or hazards posed by residential use of RGA groundwater at the SWMU boundaries. Table ES.4 lists target compounds that were evaluated to address COCs identified based on assumptions that do not limit future use of RGA groundwater at the SWMU boundary (Appendix B) by considering the following:

- Use of the maximum contaminant level (MCL) as the appropriate groundwater target concentration
- Background
- Travel time
- Attenuation/biodegradation

For each of these constituents, a preliminary remediation goal (PRG) protective of groundwater at the SWMU boundary was developed to support decision making.

Table ES.4. Target COCs for Protection of RGA Groundwater

SWMU	COC for Migration to RGA Groundwater
2	Arsenic
	cis-1,2-DCE
	TCE
3	Technetium-99
7	Arsenic
	1,1-DCE
	TCE
	Technetium-99
	Vinyl chloride
30	Technetium-99

Screening Ecological Risk Assessment

The results of previous Ecological Risk Assessments (ERAs) conducted for SWMUs 2, 7, and 30 are summarized in the BGOU RI (DOE 2010b). SWMU 3 is covered with a Subtitle C cap, so no ecological evaluation was undertaken.

The SERA identified Constituents of Potential Concern (COPCs) in surface soils. Actions taken to address human health in this FS will reduce the potential for ecological exposures to these COPCs. Residual risks will be evaluated in a future sitewide ecological risk assessment.

IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES AND DEVELOPMENT OF PRGs

Once the risks associated with each SWMU are identified, the FS next considers the remedial action objectives (RAOs) that address these risks. The PGDP general site cleanup objectives have been used to guide the development of RAOs that are focused on specific OU problems.

SWMUs 2, 3, 7, and 30 are located within the secured area of the PGDP facility and reasonable future use of this area is expected to remain industrial with controlled access. Nevertheless, the FS will establish RAOs to address risks associated with all potential exposure scenarios.

Considering the risks identified in the RI, the following general RAOs were developed for the BGOU:

(1) Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination;

(2) Prevent exposure to waste and contaminated soils that present an unacceptable risk from direct contact; and

(3) Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

At SWMUs 2, 3, 7, and 30, buried waste includes a range of materials that are not fully characterized. To address this uncertainty, this FS evaluates alternatives designed to eliminate direct contact with both wastes and associated soils to ensure no unacceptable risk.

The general RAOs for protection of groundwater and direct contact to soils are refined to more specifically guide the alternative selection process in this FS. These SWMU-specific RAOs are as follows. These RAOs are further refined in the SWMU-specific sections of the document to include COCs identified at each SWMU.

SWMU-Specific RAO for protection of groundwater. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination that could result in an exceedance in RGA groundwater of the MCL (or risk-based concentration for residential use of groundwater in the absence of an MCL).

SWMU-Specific RAO for protection of direct contact with waste. Prevent exposure to waste that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Waste: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

SWMU-Specific RAO for protection of direct contact with contaminated soils. Prevent exposure to contaminated soils that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

Where the general RAO to address PTW applies (SWMUs 2, 3, and 7), it is restated as a SWMU-specific RAO.

- **SWMU-Specific RAO for PTW.** Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

To measure the successful implementation of remedial alternatives, PRGs are established. Soil PRGs are calculated for SWMUs 2, 3, 7, and 30 for both direct contact exposure to surface and subsurface soil and for protection of groundwater. The direct-contact PRGs for soil are based on NALs presented in the Risk

Methods Document (DOE 2011a). Groundwater PRGs are calculated based on MCLs as directed in the Safe Drinking Water Act (EPA 2006) or risk-based levels in the absence of an MCL. The PRGs are summarized in Table ES.5 and Table ES.6.

Table ES.5. PRGs for Direct Contact

Target Compound	Direct Contact PRGs		Basis	Applicable SWMU
	Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*		
Arsenic	12	7.9	Background**	2, 7
Uranium (metal)	535	290	NAL[a]	7, 30
Uranium-234+D	94.5	141.5	NAL[b]	7, 30
Uranium-235/236	1.975	22.75	NAL[b]	7, 30
Uranium-235+D	1.975	22.75	NAL[b]	2,3
Uranium-238+D	8.5	58.5	NAL[b]	2, 3, 7, 30
Neptunium-237+D	1.355	16.4	NAL[b]	7, 30
Plutonium-239+D	N/A	81	NAL[b]	7, 30
Total PAHs	0.296	2.425	NAL[b]	7, 30
Total PCBs	10	10	NAL[b]	30

*mg/kg for chemicals or pCi/g for radionuclides
**Background = 12 mg/kg surface soil; 7.9 mg/kg subsurface soils
N/A = not applicable
NAL values are given in Table A.4 of the 2011 Risk Methods Document (DOE 2011a).
[a] The PRG for surface soil is 5 x the NAL for the industrial worker, and for subsurface soils, 5 x the NAL for the outdoor worker. These correspond to a noncancer hazard quotient of 0.5.
[b] The PRG for surface soil is 5 times the NAL for the industrial worker corresponding to a cancer risk of 5E-6. For subsurface soils the PRG is 50 times the NAL for the outdoor worker corresponding to a cancer risk of 5E-5.

Table ES.6. PRGs for Protection of Groundwater

SWMU	Target Compound	MCL (mg/L) (pCi/L)*	Groundwater Protective PRG for Soil (mg/kg) (pCi/g)*
2	Arsenic	0.01	Background**
	cis-1,2-DCE	0.07	1.34
	TCE	0.005	0.311
3	Technetium-99	900	38.5
7	Arsenic	0.01	Background**
	1,1-DCE	0.007	0.773
	TCE	0.005	0.234
	Technetium-99	900	38.5
	Vinyl chloride	0.002	0.533
30	Technetium-99	900	38.5

*mg/kg for chemicals or pCi/g for radionuclides
**Background = 12 mg/kg surface soil; 7.9 mg/kg subsurface soils

The FS alternatives are designed to addressing contamination at sample locations exceeding the PRGs to reduce the cumulative ELCR and HI to levels that meet the RAOs. Upon completion of remedial actions at each SWMU, additional data will be collected to verify that the cumulative ELCR to the industrial worker from exposure to SWMU-specific COCs in surface soil will be below 1E-05 and the noncancer HI will be below 1 for all COCs at the SWMU and address the uncertainties associated with the coverage of the sampled locations. Verification of cleanup will be based on postremediation sampling conducted in accordance with the Risk Methods Document (DOE 2011a) and EPA (1991) guidance.

Once RAOs are established, the FS considers response actions. General response actions (GRAs) are broad categories of remedial measures that may be implemented individually or in combination to meet RAOs. The following are the GRAs evaluated for the BGOU FS.

- Land use controls (LUCs)
- Monitoring
- Monitored natural attenuation
- Removal
- Containment
- Treatment
- Disposal

A variety of technologies and process options for each GRA are presented and preliminarily evaluated in the FS. Those technologies and process options that are recognized to be most effective in addressing the types of issues associated with SWMUs 2, 3, 7, and 30 are considered to be representative process options (RPOs). RPOs are selected on the basis of effectiveness, technical and administrative implementability, and cost relative to other technologies in the same technology class.

For this FS, two GRAs, containment and treatment, had multiple RPOs considered and ultimately used in developing and evaluating remedial alternatives. The following are the GRAs with multiple RPOs in this FS.

GRA: Containment

- 1-ft local soil cover (a)
- 18-inch local clay/6-inch local topsoil (b)
- Subtitle C cap (c) [including the existing cap and leachate collection and treatment system on SWMU 3 (t5)]
- Subtitle D cap (d)

GRA: Treatment

- Electrical Resistance Heating (ERH) (t1)
- Dual Phase Extraction (DPE) (t2)
- Chemical Injection (ZVI) (t3)
- Biological Treatment (Bio) (t4)
- Northwest Plume Pump-and-Treat System (t6)

These treatment options were used as planned options in an alternative or as contingent options to address residual contamination present after an excavation.

For those alternatives with excavation, the potential for disposal of materials at an on-site waste disposal facility (WDF) was incorporated, as were contingent treatment remedies to address soils exceeding the PRGs in the base of the excavation.

The RPOs from GRAs including controls, monitoring, removal, containment, treatment, and disposal were used to develop alternatives to address risks at each SWMU. The alternatives include multiple elements that are reflected in the numbering scheme, as follows: general alternative designation, cover designation, and treatment designation. For example, Alternative 7 as applied to SWMU 2 is identified as 7.c.t2 (targeted excavation, Subtitle C cap, dual-phase extraction). A second Alternative for SWMU 2 might be 7.c.t3 (targeted excavation, Subtitle C cap, ZVI injection).

A second screening was conducted to limit the number of alternatives to be subjected to detailed analysis; however, the process includes a wide range of evaluated options and these options can be recombined to form an alternative even if that exact combination is not subjected to detailed analysis.

REMEDIAL ALTERNATIVES EVALUATION

This FS identifies a range of remedial alternatives that address the threats from SWMUs 2, 3, 7, and 30. EPA guidance (EPA/540/G-89/004 at pages 4-7) states that alternatives for source control actions should range from one that would eliminate, to the extent feasible, long-term management, to one that would use treatment as a primary component to address principal threats. The guidance also requires inclusion of one or more alternatives that involve containment of the waste with little or no treatment, as well as a No Action alternative. The selected final remedy must comply with applicable or relevant and appropriate requirements (ARARs), unless waived, and must protect human health and the environment.

A multistep screening process is performed in this FS using SWMU-specific conditions to screen containment and treatment options to give the broadest consideration of technologies while developing and screening alternatives on a SWMU-by-SWMU basis. First, the general alternatives developed in Section 3 are screened using the process described in EPA (1988) and the National Contingency Plan (NCP) to reduce the number of general alternatives and specific process options carried forward to detailed analysis. In the SWMU-specific sections, the retained alternatives and alternative elements are assembled into SWMU-specific alternatives to address conditions present at each SWMU.

Once assembled, SWMU-specific alternatives were subjected to detailed analysis against the five balancing criteria outlined in the NCP:

- Short term effectiveness;
- Long-term effectiveness and permanence;
- Implementability;
- Reduction of toxicity, mobility, and volume; and
- Cost* (* the Cost Rating used in this evaluation identifies a ***low*** cost as having a ***high*** cost rating).

The detailed analyses of alternatives follow the criteria outlined in EPA (1988) and the NCP. The evaluation of short-term effectiveness includes evaluating what steps are required to make the remedy effective, including an evaluation of risks posed by implementing the remedy. The long term effectiveness and permanence criterion evaluates how the remedy's effectiveness is maintained over time and considers how much maintenance it will require. The evaluation of implementability considers technical feasibility criteria, including the ability to construct, operate, and maintain the remedy, as well as administrative feasibility criteria, including the availability of treatment, storage, and disposal capacity. Reduction of toxicity, mobility, and volume of the remedy is evaluated with a preference given to those alternatives that achieve these reductions through treatment. The cost rating is developed based on the capital and operation and maintenance costs for the primary technologies utilized. These costs are combined to yield a net present worth cost. The cost rating used in this FS evaluation identifies an alternative having a low relative cost as having a high cost rating.

Alternatives retained for detailed analysis were evaluated against these criteria to determine the best balance. A summary of the alternatives retained for detailed and comparative analysis at each SWMU is presented in Table ES.7.

The summaries of the comparative analysis of alternatives are presented in Tables ES.8 through ES.11 for SWMUs 2, 3, 7, and 30, respectively. The evaluation includes a rating that averages the individual balancing criteria ratings.

Table ES.7. BGOU SWMU Remedial Action Alternative Summary

Alternative Number/Description		SWMU			
		2	3	7	30
1	<u>**No Action**</u>**:**	X	X	X	X
2	<u>**Limited Action (LUCs and Monitoring)**</u>**:** · Recognizes existing feature*** (where applicable)	X	X***	X***	X***
3	<u>**Surface Cover,* LUCs and Monitoring**</u>**:** · Recognizes existing feature*** (where applicable)		X***	X***	X***
4	<u>**Surface Cover,* *In Situ* Source Treatment,** LUCs, and Monitoring**</u>**:** · Recognizes existing feature*** (where applicable)	X		X***	
5	<u>**Excavation and Disposal**</u>**:** · Recognizes existing feature*** (where applicable) · Allows for CR beneath excavation**,[#] (where applicable) · Includes evaluation of disposal off-site and at a potential on-site WDF	X^{CR}	X***	$X^{***, CR}$	X***
6	<u>**Targeted Excavation and Disposal, Surface Cover,* LUCs, and Monitoring**</u>**:** · Recognizes existing feature*** (where applicable) · Allows for CR beneath excavation,**,[#] · Includes evaluation of off-site disposal, but acknowledges potential on-site WDF may be considered	X^{CR}		$X^{***, CR}$	
7	<u>**Targeted Excavation and Disposal, Surface Cover,* *In Situ* Source Treatment,** LUCs, and Monitoring**</u>**:** · Allows for CR beneath excavation,**,[#] and · Includes evaluation of off-site disposal but acknowledges potential on-site WDF may be considered	X^{CR}			

*<u>Surface Cover</u>
a. 1-ft soil cover, configured to drain
b. 18-inch local clay/6-inch soil cover
c. Subtitle C Cap equivalent
d. Subtitle D Cap equivalent

**<u>Treatment Options</u> [also contingent remedies (CRs) except t2]
t1. ERH
t2. DPE
t3. ZVI injection
t4. bio

***<u>Existing Features</u>
t5. Subtitle C cap and leachate collection and treatment system (SWMU 3)
t6. Northwest Plume Pump-and-Treat System (SWMUs 7 and 30)

#CR includes LUCs and monitoring (see SWMU specific application).

Table ES.8. Summary of the Comparative Analysis of Alternatives for SWMU 2

	Alternative 1	Alternative 2	Alternative 4.c.t1	Alternative 4.c.t2	Alternative 4.c.t3	Alternative 4.c.t4	Alternative 5.CR	Alternative 5.CR.WDF	Alternative 6.c.CR	Alternative 7.c.t2.CR
Evaluation Criteria	**No Action**	**Limited Action (LUCs, and Monitoring)**	**Subtitle C Cap, ERH, LUCs, and Monitoring**	**Subtitle C Cap, DPE, LUCs, and Monitoring**	**Subtitle C Cap, ZVI, LUCs, and Monitoring**	**Subtitle C Cap, Bio, LUCs, and Monitoring**	**Excavation and Disposal with CR**	**Excavation and Disposal, WDF with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Low to Moderate (3)	Moderate (4)	Moderate to High (6)	Moderate (5)	Moderate (4)	High (9)	High (9)	Moderate to High (6)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low (1)	Low (1)	Low to Moderate (3)	Moderate (5)	Moderate (4)	Low to Moderate (3)	High (9)	High (9)	Moderate to High (7)	Moderate to High (7)
Short-Term Effectiveness	Low (1)	Moderate (4)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (5)	Moderate to High (6)
Implementability	High (9)	High (9)	Moderate (4)	Moderate to High (6)	Moderate (5)	Moderate to High (6)	Moderate (4)	Moderate (4)	Moderate (5)	Moderate (5)
Cost * Present Worth Cost	High (9) $0	High (9) $3,301,000	Moderate (5) $22,195,000	Moderate (5) $ 17,009,000	Moderate (5) $29,885,000	Moderate (5) $9,282,000	Low (1) $179,233,000	Low (1) $172,609,000	Moderate (5) $39,107,000	Moderate (5) $49,966,000
Average Balancing Criteria Rating	4.0	5.2	4.2	5.4	4.8	4.6	5.4	5.4	5.6	6.2

* High overall cost rating corresponds to a low project cost relative to the site.
CR = contingent remedy should PRGs not be met by excavation. Components could include t1, t3, or t4. CR includes LUCs and monitoring. Costs do not include CR implementation.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

Table ES.9. Summary of the Comparative Analysis of Alternatives for SWMU 3

	Alternative 1	Alternative 2.t5	Alternative 3.a.t5	Alternative 5	Alternative 5.WDF
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal**	**Excavation and Disposal WDF**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness	Low (0)	Moderate to High (7)	Moderate to High (7)	High (9)	High (9)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low to Moderate (2)	Low to Moderate (2)	Low to Moderate (2)	Moderate (4)	Moderate (4)
Short-Term Effectiveness	Moderate (4)	Moderate to High (7)	Moderate to High (7)	Moderate (5)	Moderate to High (6)
Implementability	High (9)	High (9)	High (9)	Moderate to High (6)	Moderate to High (6)
Cost * Present Worth Cost	High (9) $0	High (9) $3,538,000	High (9) $4,212,000	Low (0) $138,694,000	Low (1) $43,018,000
Average Balancing Criteria Rating	4.8	6.8	6.8	4.8	5.2

*High overall cost rating corresponds to a low project cost relative to the site.
t5 = Alternatives 2 and 3 include impact of existing feature, Subtitle C cap and leachate collection and treatment system.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

Table ES.10. Summary of Comparative Analysis of Alternatives for SWMU 7

	Alternative 1	Alternative 2.t6	Alternative 3.b.t6	Alternative 3.d.t6	Alternative 4.b.t1.t6	Alternative 4.d.t1.t6
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**18/6 Cover, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, LUCs, and Monitoring with Existing Feature**	**18/6 Cover, ERH, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, ERH, LUCs, and Monitoring with Existing Feature**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Moderate to High (6)	Moderate to High (7)	Moderate to High (7)	High (8)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low to Moderate (0)	Low to Moderate (3)	Low to Moderate (3)	Low to Moderate (3)	Moderate (4)	Moderate (4)
Short-Term Effectiveness	Low (1)	Moderate to High (7)	Moderate to High (7)	Moderate to High (7)	Moderate (5)	Moderate (5)
Implementability	High (9)	High (9)	High (9)	High (8)	Moderate (5)	Moderate (5)
Cost* Present Worth Cost	High (9) $0	High (9) $3,700,000	High(9) $5,903,000	Moderate to High (7) $8,190,000	Low (1) $33,279,000	Low (1) $35,821,000
Average Balancing Criteria Rating	3.8	6.8	7.0	6.4	4.6	4.6

Table ES.10. Summary of Comparative Analysis of Alternatives for SWMU 7 (Continued)

Evaluation Criteria	Alternative 4.b.t3.t6 18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature	Alternative 4.d.t3.t6 Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature	Alternative 4.b.t4.t6 18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature	Alternative 4.d.t4.t6 Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature	Alternative 5.t6.CR Excavation and Disposal, LUCs, and Monitoring with Existing Feature and CR	Alternative 5.t6. Contingent Remedy.WDF Excavation and Disposal, LUCs, and Monitoring, WDF with Existing Feature and CR	Alternative 6.b.t6.CR Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR	Alternative 6.d.t6.CR Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR
Overall Protection of Human Health and the Environment	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	High (8)	High (8)	Moderate to High (7)	Moderate to High (7)	High (8)	High (8)	High (8)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Moderate (4)	Moderate(4)	Moderate(4)	Moderate(4)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (5)
Short-Term Effectiveness	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)
Implementability	Moderate to High (6)	Moderate to High (6)	Moderate to High (6)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)
Cost* Present Worth Cost	Moderate to High(7) $9,918,000	Moderate (5) $12,125,000	Moderate to High (7) $9,160,000	Moderate (5) $11,366,000	Low (0) $73,306,000	Low (0) $31,016,000	Low to Moderate (3) $19,243,000	Low to Moderate (3) $21,755,000
Average Balancing Criteria Rating	6.0	5.6	5.8	5.0	4.2	4.2	4.8	4.8

*High overall cost rating corresponds to a low project cost relative to the site.
CR = contingent remedy should PRGs not be met by excavation. Components could include t1, t3, or t4. CR includes LUCs and monitoring. Costs do not include CR implementation.
t6 = Alternatives 2 through 7 include impact of existing Northwest Plume Pump-and-Treat System.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

Table ES.11. Summary of the Comparative Analysis of Alternatives for SWMU 30

	Alternative 1	Alternative 2.t6	Alternative 3.a.t6	Alternative 3.d.t6	Alternative 5.t6	Alternative 5.t6.WDF
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal with Existing Feature**	**Excavation and Disposal, and WDF with Existing Feature**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Moderate to High (6)	Moderate to High (7)	Moderate to High (7)	High (8)	High (9)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low (0)	Low (1)	Low (1)	Low (1)	Low to Moderate (2)	Low to Moderate (2)
Short-Term Effectiveness	Low (1)	Moderate to High (7)	Moderate to High (7)	Moderate to High (7)	Moderate (4)	Moderate (5)
Implementability	High (9)	High (9)	High (9)	High (8)	Moderate to High (7)	Moderate to High (7)
Cost* Present Worth Cost	High (9) $0	High (9) $3,549,000	High (9) $5,000,000	High (7) $7,322,000	Low to Moderate (3) $38,164,000	Low to Moderate (3) $17,629,000
Average Balancing Criteria Rating	3.8	6.4	6.6	6.0	4.8	5.2

*High overall cost rating corresponds to a low project cost relative to the site.
t6 = Alternatives 2 through 7 include impact of existing Northwest Plume Pump-and-Treat System.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

1. INTRODUCTION

This *Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1274&D1 (FS), was prepared to evaluate remedial alternatives for Solid Waste Management Units (SWMUs) 2, 3, 7, and 30 at the Burial Grounds Operable Unit (BGOU) in support of remedy selection under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at the Paducah Gaseous Diffusion Plant (PGDP). This work was prepared in accordance with the requirements of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) (EPA 1998). Only SWMUs 2, 3, 7, and 30 are addressed in this D1 FS. Other SWMUs and source areas within the BGOU are addressed in separate documents.

This introduction explains the BGOU and the purpose and organization of the report. It provides background information and the regulatory framework for this FS. Site and area-specific descriptions are provided, including land use, demographics, climate, air quality, noise, ecological resources, and cultural resources. An overview also is provided of the topography, surface water hydrology, geology, and hydrogeology of the region and the study area. Previous investigations of the BGOU are discussed, as is a conceptual site model (CSM) summarizing the nature and extent of contamination and fate and transport modeling of selected contaminants of concern (COCs). Additional sections in this FS address the potential threat from direct contact with the waste buried within SWMUs 2, 3, 7, and 30, as well as a range of remedial alternatives that are protective of the public and future workers.

1.1 SCOPE OF THE BGOU

The BGOU at PGDP is one of five media-specific, sitewide operable units (OUs) associated with pre-shutdown efforts to evaluate and implement remedial actions. A final Comprehensive Site OU evaluation will be conducted following plant shutdown and completion of pre- and post-shutdown actions to ensure long-term protectiveness of human health and the environment. The five media-specific, strategic cleanup initiatives that have been agreed upon by the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky (KY), as documented in the current *Site Management Plan* (SMP) (DOE 2012a), are as follows:

- Groundwater OU Strategic Initiative
- Burial Grounds OU Strategic Initiative
- Surface Water OU Strategic Initiative
- Soils OU Strategic Initiative
- Decontamination and Decommissioning OU Strategic Initiative

The BGOU consists of contamination associated with PGDP's landfills and burial grounds as listed in Table 1.1. The CERCLA remedial process is employed at the BGOU. In general, the contents of the burial grounds may include low-level threat waste (LLTW) and principal threat waste (PTW) (See Section 1.3.3).

The scope of the BGOU FS includes evaluating actions as necessary to protect human health and the environment from the waste units and addressing potential releases from these source areas that may impact Regional Gravel Aquifer (RGA) groundwater or adjacent drainageways. Remedial decisions for sediments within the BGOU SWMUs fall primarily within the scope of the Surface Water OU. The Groundwater OU will address dissolved-phase groundwater contamination in the RGA.

Table 1.1 BGOU Source Areas and Solid Waste Management Units

SWMU No.	Description
2	C-749 Uranium Burial Grounds
3	C-404 Low-Level Radioactive Waste Burial Grounds
4	C-747 Contaminated Burial Yard and C-748-B Burial Area
5	C-746-F Burial Yard
6	C-747-B Burial Grounds
7 and 30	C-747-A Burial Grounds and Burn Area
145 (9 and 10)	Area P and C-746-S and C-746-T Landfills

1.2 PURPOSE AND ORGANIZATION OF FS REPORT

Under a work plan (DOE 2006) approved by EPA and KY, DOE conducted a Remedial Investigation (RI), which was the continuation of earlier investigative activities, to evaluate source areas of contamination associated with PGDP's landfills and burial grounds. Results of the RI were reported in the *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0030&D2/R1 (DOE 2010b). This report included a baseline human health risk assessment (BHHRA) that evaluated the full range of BGOU-related risks to human health, and a screening ecological risk assessment (SERA) evaluated impacts to the environment under a range of potential exposure scenarios associated with current and future land use.

Following approval of the RI, an FS was prepared with the latest version being *Feasibility Study for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0130&D2, submitted in December 2010 (DOE 2010a). Following review and discussion of that document by the FFA parties, it was agreed that this D1 FS will follow that D2 version and presents only information about SWMUs 2, 3, 7, and 30. The other SWMUs and source areas in the BGOU are addressed in separate documents.

This FS was prepared in accordance with the requirements of the FFA (EPA 1998). In accordance with Section IV of the FFA, this integrated technical document was developed to satisfy applicable requirements of CERCLA (42 USC § 9601 *et seq.*) and Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 *et seq.*). In addition to the EPA requirements, National Environmental Policy Act of 1969 (NEPA) values, consistent with the DOE's Secretarial Policy Statement on NEPA in June 1994 (DOE 1994a), are evaluated and documented in this FS. In consideration of the U.S. Department of the Interior's Natural Resource Damage Assessment (NRDA) and Restoration Program, the BGOU FS will be provided to trustee agencies for their review. It is DOE's policy to integrate natural resource concerns early into the investigation and remedy selection process to minimize unnecessary resource injury.

This FS also has been prepared in accordance with the Integrated FS/Corrective Measures Study Report outline prescribed in Appendix D of the FFA for PGDP, except for a few format changes. As such, this FS is considered a primary document. All subsections contained in the referenced outline have been included for completeness. Additional subsections have been added to the outline, as appropriate, to provide clarity and enhance the organization of the document.

1.3 BACKGROUND INFORMATION

The following subsections present background information concerning the site and regulatory setting at PGDP. They also provide a description of the PGDP region and source areas, as well as highlight key factors of the process history, nature and extent of contamination, migration potential, and risks associated with the source areas that provide the basis for screening technologies and remedial alternatives for SWMUs 2, 3, 7, and 30.

Additional details about SWMUs 2, 3, 7, and 30 are included in Sections 5, 6, 7, and 8 respectively.

1.3.1 Site Description

PGDP is located approximately 10 miles west of Paducah, KY, and 3.5 miles south of the Ohio River in the western part of McCracken County (Figure 1.1). The PGDP industrial area occupies approximately 650 acres of the DOE site and is surrounded by an additional 800-acre buffer zone. DOE licenses most of the remaining acreage to KY as part of the West Kentucky Wildlife Management Area (WKWMA). Tennessee Valley Authority's (TVA's) Shawnee Fossil Plant borders the DOE site to the northeast, between the plant and the Ohio River (Figure 1.2).

Before the PGDP was built, a munitions-production facility, the Kentucky Ordnance Works (KOW), was operated at the current PGDP location and in adjoining areas southwest of the site. Munitions, including trinitrotoluene, were manufactured in an area southwest of PGDP and stored at the KOW between 1942 and 1945. The KOW was shut down immediately after World War II. Construction of PGDP was initiated in 1951 and the plant began operations in 1952. Construction was completed in 1955, and PGDP became fully operational in 1955, supplying enriched uranium for commercial reactors and military defense reactors.

PGDP was operated by Union Carbide Corporation until 1984, when Martin Marietta Energy Systems, Inc., (which later became Lockheed Martin Energy Systems, Inc.) was contracted to operate the plant for DOE. On July 1, 1993, DOE leased the plant production/operations facilities to the United States Enrichment Corporation; however, DOE maintains ownership of the plant and is responsible for environmental restoration. On April 1, 1998, Bechtel Jacobs Company LLC, replaced Lockheed Martin Energy Systems, Inc., in implementing the Environmental Management Program at PGDP. On April 23, 2006, Paducah Remediation Services, LLC, replaced Bechtel Jacobs Company LLC, in implementing the Environmental Management Program at PGDP. On July 26, 2010, LATA Environmental Services of Kentucky, LLC, replaced Paducah Remediation Services, LLC, in implementing the Environmental Management Program at PGDP.

Contamination as a result of PGDP operations has resulted in three dissolved-phase trichloroethene (TCE) plumes that are migrating from PGDP toward the Ohio River. These groundwater plumes are the Northwest Groundwater Plume (SWMU 201), the Northeast Groundwater Plume (SWMU 202), and the Southwest Plume (SWMU 210) (Figure 1.3). There also is a technetium-99 (Tc-99) plume that is consistent with the footprint of the TCE Northwest Groundwater Plume, but the high concentration Tc-99 plume is contained within the fenced area of the site. SWMUs 2, 3, 7, and 30 are not a source for these plumes.

1.3.1.1 Regulatory setting

This section summarizes the regulatory framework for environmental restoration at PGDP, including the major statutes and accompanying regulations driving response actions, such as the CERCLA, RCRA, and NEPA. It also describes environmental programs and the documents controlling response actions, such as the FFA and the SMP (DOE 2012a). The scope of this action within the overall response strategy for PGDP is described.

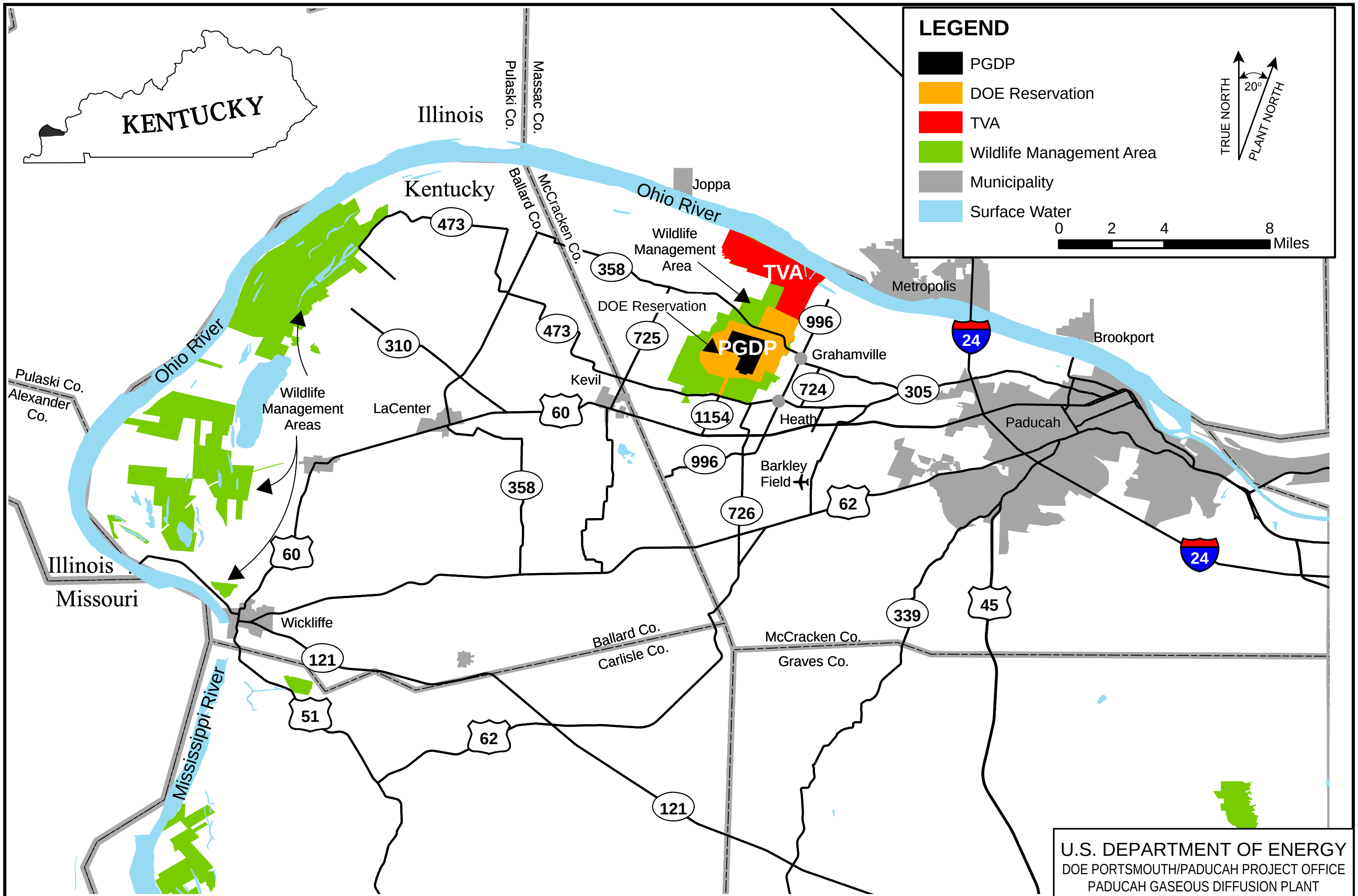

Figure 1.1. PGDP Site Location

LATA Environmental Services of Kentucky, LLC

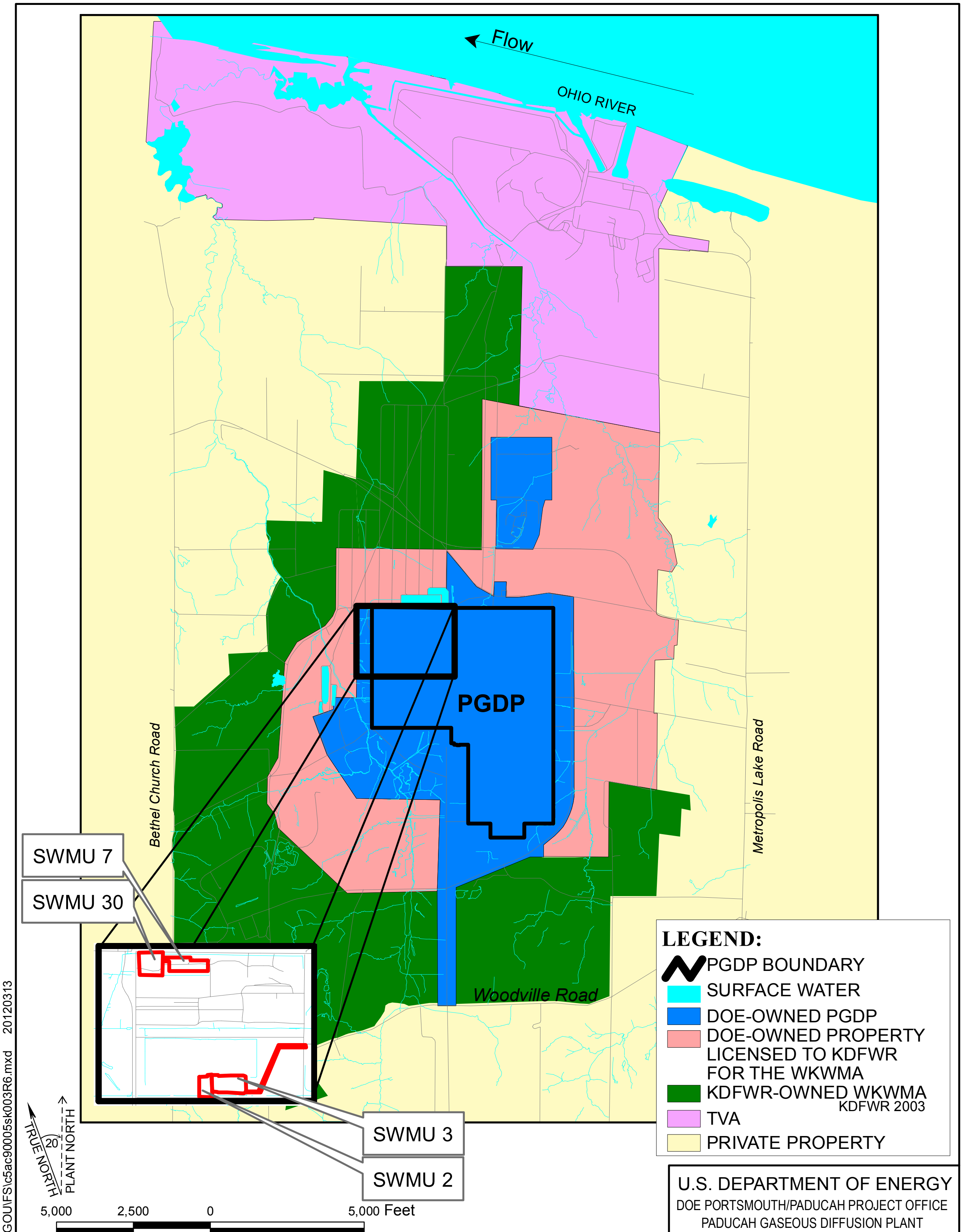

Figure 1.2. PGDP Land Ownership Map

Figure No. C5AC90005sk003r6.mxd
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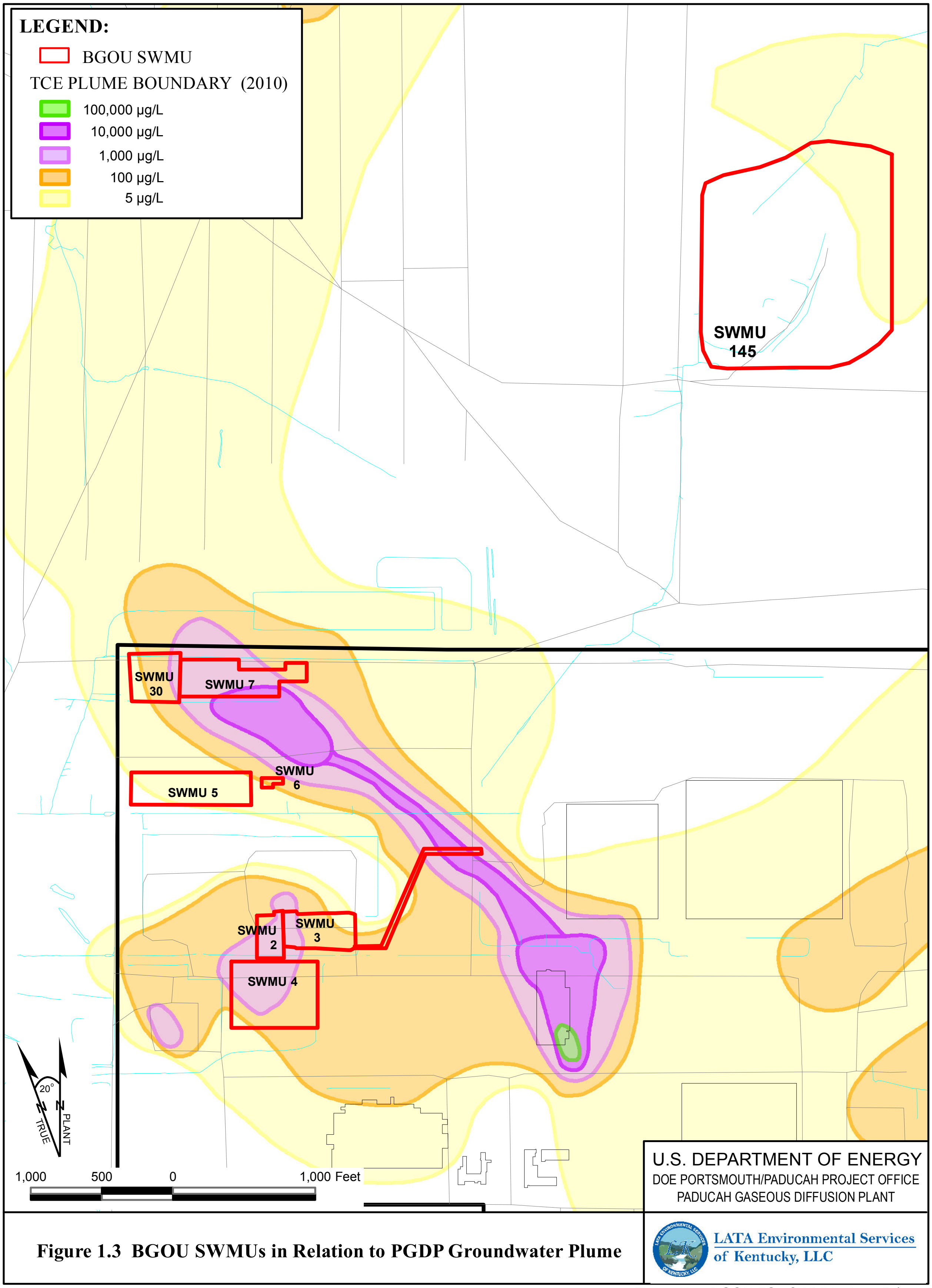

Figure 1.3 BGOU SWMUs in Relation to PGDP Groundwater Plume

Figure No. BGOU FS...SWMU_plumeR4.mxd
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1.3.1.1.1 Major statutes, regulations, and controlling documents

On June 30, 1994, EPA placed PGDP on the National Priorities List (NPL) [59 *Federal Register* (*FR*) 27989 (May 31, 1994)]. The NPL lists sites that are designated by EPA as high priority sites for remediation under CERCLA in accordance with CERCLA's National Contingency Plan (NCP). As the lead agency under CERCLA, DOE is responsible for conducting cleanup activities at PGDP in compliance with NCP. CERCLA is not the only driver for cleanup at PGDP. RCRA requires corrective action for releases of hazardous constituents from SWMUs.

Section 120 of CERCLA requires federal facilities listed on the NPL to enter into an FFA. The FFA coordinates the CERCLA remedial action and RCRA corrective action process into a set of comprehensive requirements for site remediation. Section XII of the PGDP FFA addresses FSs and includes the following requirement:

At a minimum, an evaluation of alternative remedies (i.e., an FS) to address any Release shall be conducted when the circumstances listed below are present.

- The Baseline Risk Assessment shows that the cumulative carcinogenic risk for an individual exposed to a given Release, based on a reasonable maximum exposure for both current and future land use, is greater than 10^{-6};

- The Baseline Risk Assessment shows that the noncarcinogenic hazard quotient for an individual exposed to a given Release, based on a reasonable maximum exposure for both current and future land use, is greater than 1;

- The release has caused adverse environmental impacts;

- Maximum contaminant levels (MCLs), non-zero MCL goals, or other chemical-specific applicable or relevant and appropriate requirements (ARARs) are exceeded; or

- Other site-specific or release-specific circumstances warranting an evaluation of alternatives.

The FFA requires that DOE develop and submit an annual SMP to EPA and Kentucky Energy and Environment Cabinet (KEEC). The SMP outlines the programmatic framework for implementing the FFA.

1.3.1.1.2 Environmental programs

Environmental sampling at PGDP is a multimedia (air, water, soil, sediment, direct radiation, and biota) program of chemical, radiological, and ecological monitoring. Environmental monitoring consists of two activities: effluent monitoring and environmental surveillance. As part of the ongoing environmental activities, SWMUs and areas of concern have been identified under Section IX of the FFA. Characterization and/or remediation of these sites will continue pursuant to CERCLA and Hazardous and Solid Waste Amendments corrective action conditions of the RCRA Permit. RCRA corrective action requirements have been integrated through the FFA.

1.3.1.1.3 National Environmental Policy Act

The intent of NEPA is to promote a decision making process that results in minimization of adverse impacts to human health and the environment. On June 13, 1994, the Secretary of Energy issued a Secretarial Policy (Policy) on NEPA that addresses NEPA requirements for actions taken under

CERCLA. Section II.E of the Policy indicates that DOE CERCLA documents will incorporate NEPA values, to the extent practicable, such as analysis of cumulative, off-site, ecological, cultural, and socioeconomic impacts.

1.3.1.2 Land use, demographics, surface features, and environment

1.3.1.2.1 Land use

The area of PGDP that includes SWMUs 2, 3, 7, and 30, is heavily industrialized. The area immediately beyond the secured industrial area is mostly agricultural and open land, with some forested areas (see Figure 1.4). TVA's Shawnee Fossil Plant, adjacent to the northeast border of the DOE Reservation, is the only other major industrial facility in the immediate area. PGDP is a posted government property and trespassing is prohibited. Access to the PGDP site is controlled by guarded checkpoints, a perimeter/security fence, and vehicle barriers and is subject to routine armed patrol and visual inspection by plant protective forces. The PGDP site includes 1,986 acres licensed to the Kentucky Department of Fish and Wildlife Resources. PGDP is a controlled industrial facility and is expected to remain a controlled industrial facility. The current access controls for SWMUs 2, 3, 7, and 30 (as well as all the burial grounds) are expected to continue into the foreseeable future. Thus, the future use scenario considered reasonable for SWMUs 2, 3, 7, and 30 is that of controlled industrial, with direct contact to subsurface soils and wastes controlled.

This area is part of the 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.

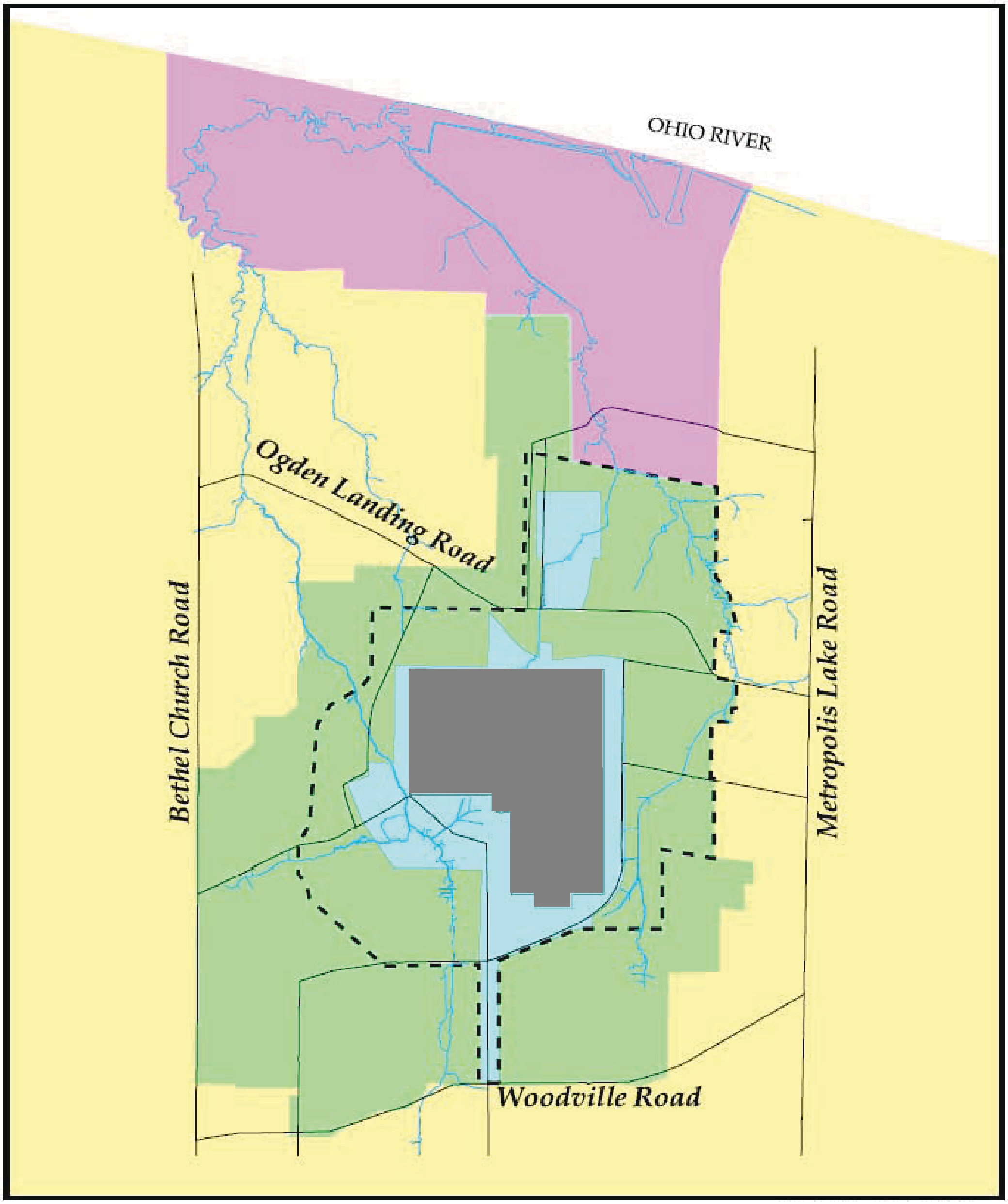
1.3.1.2.2 Demographics

Approximately 89,000 people live within the three counties that are included in the 10-mile radius of PGDP. The estimated population of Paducah, Kentucky, for 2009 was approximately 25,700. Metropolis, Illinois, had an estimated population in 2009 of approximately 6,500 (U.S. Census Bureau 2009). The closest communities to PGDP are the unincorporated towns of Grahamville [about 1.6 kilometers (1 mile) to the east] and Heath [about 1.6 kilometers (1 mile) southeast]. Current and anticipated future land use for PGDP and surrounding areas is depicted in Figure 1.5 and represents the future land use scenario from the PGDP SMP (DOE 2012a). SWMUs 2, 3, 7, and 30 are located inside the PGDP boundary. The future land use is anticipated to be controlled industrial.

Major employers in the area of PGDP include the United States Enrichment Corporation (approximately 1,200 employees); Babcock & Wilcox Conversion Services, LLC (approximately 140 employees); DOE Environmental Management contractors (approximately 500 employees); and TVA's Shawnee Fossil Plant (approximately 260 employees).

1.3.1.2.3 Surface features and topography

PGDP lies in the Jackson Purchase Region of western Kentucky between the Tennessee and Mississippi Rivers, bounded on the north by the Ohio River. The confluence of the Ohio and Mississippi Rivers is approximately 35 miles downstream (southwest) from the site. The confluence of the Ohio and Tennessee Rivers is approximately 15 miles upstream (east) from the site.

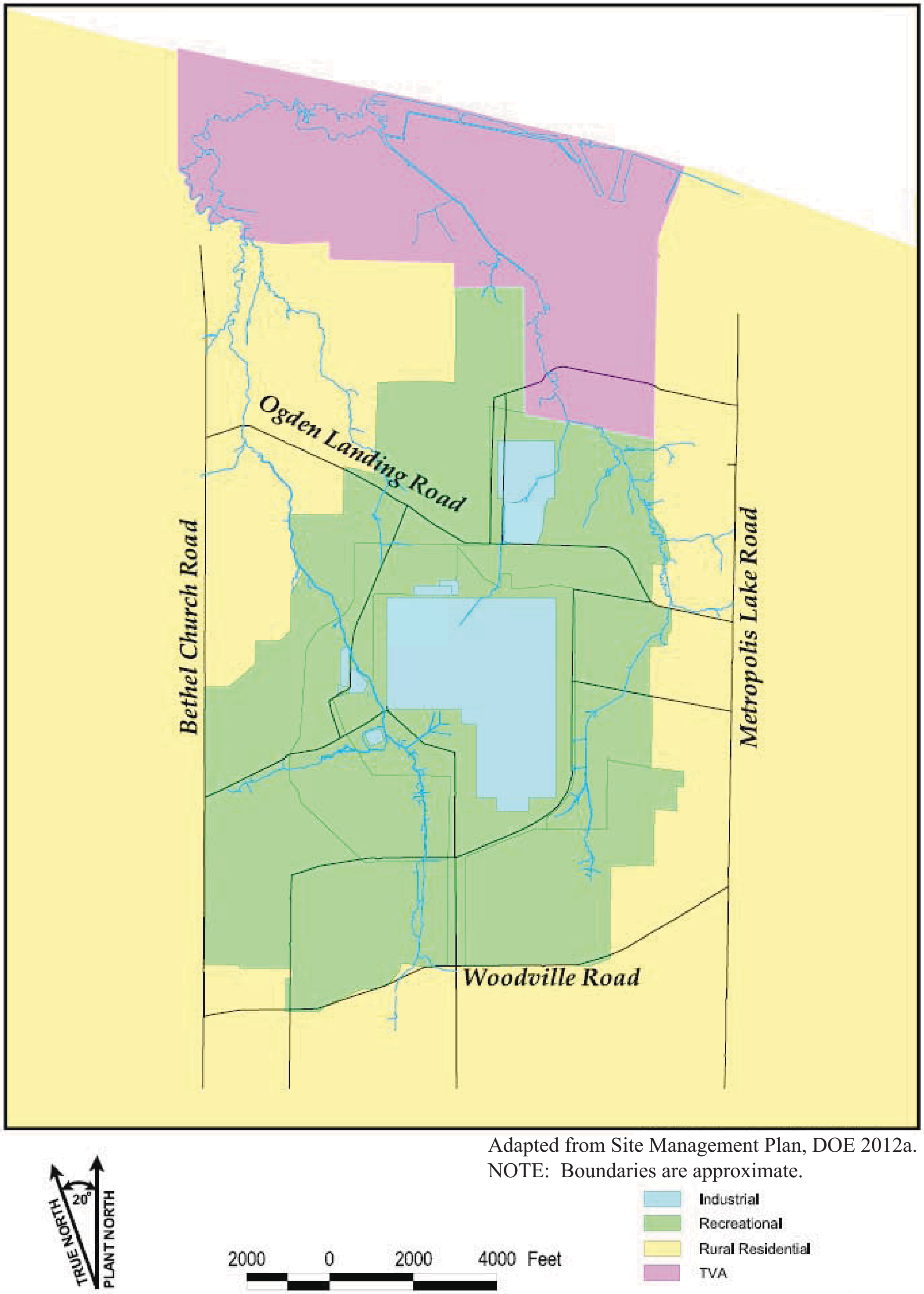


Adapted from Site Management Plan, DOE 2012a.
NOTE: Boundaries are approximate.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 1.4. Current Land Use in Proximity to PGDP

LATA Environmental Services of Kentucky, LLC



Adapted from Site Management Plan, DOE 2012a.
NOTE: Boundaries are approximate.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 1.5. Anticipated Future Land Use

LATA Environmental Services of Kentucky, LLC

Local elevations range from 290 ft above mean sea level (amsl) along the Ohio River to 450 ft amsl southwest of PGDP near Bethel Church Road. Generally, the topography in the PGDP area slopes toward the Ohio River at an approximate 27-ft/mile gradient (CH2M Hill 1992). Within the plant boundaries where most of the BGOU SWMUs are located, ground surface elevations vary from 360 to 390 ft amsl.

The terrain in the vicinity of the plant is slightly modified by the dendritic drainage systems associated with the two principal streams in the area, Bayou Creek and Little Bayou Creek. These streams have eroded small valleys, which are about 20 ft below the adjacent plain.

SWMU 2 is a uranium burial ground, C-749, located in the west-central portion of the plant (Figure 1.2). Graveled storage yards bound SWMU 2, to the north and west, respectively. The main drainage ditch to the Kentucky Pollutant Discharge Elimination System (KPDES) Outfall 015 passes between SWMU 2 and Virginia Avenue, to the south. SWMU 2 is grass covered. The land surface at SWMU 2 is relatively flat (with a slight mound on the east side); surface elevations range from 370 to 375 ft amsl. PGDP maintains SWMU 2 as a Radioactive Materials Area, with applicable boundary access controls.

SWMU 3 (Figure 1.2), located immediately east of SWMU 2, consists of an aboveground surface impoundment that was converted to a solid waste disposal facility (C-404) and a field to the east where a northeast-southwest ditch drained the C-404 surface impoundment to the North-South Diversion Ditch (NSDD). C-404 is a grass covered mound with steep, 10-ft high sides and a gently sloping cap (highest on the east side). Elevations at C-404 range from 375 to 392 ft amsl. An empty, graveled, cylinder storage yard borders C-404 to the north. The same main drainage ditch to KPDES Outfall 015 passes between C-404 and Virginia Avenue to the south. Gravel roads provide limited access to the east and south sides of C-404. PGDP maintains C-404 as a Radioactive Materials Area.

SWMU 7 is a burial cell area in the northwest corner of the plant (Figure 1.2). KPDES Outfall 001 drainage system ditches border SWMU 7 to the north and south. A scrap yard lies to the east. The earthen cover over the burial cells form slight hills (2 ft high) on the north and south sides of SWMU 7. A gravel pad covers the east end of SWMU 7. PGDP maintains grass cover over the west burial cells. Boundary chains limit access to the west burial cells, which are delimited Radioactive Materials Areas and High Radioactive Materials Areas.

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

1.3.1.2.4 Climate

The climate of the region may be broadly classified as humid-continental. The term “humid” refers to the surplus of precipitation versus evapotranspiration that normally is experienced throughout the year. 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).

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[2] For the 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).

The "continental" nature of the local climate refers to the dominating influence of the North American landmass. Continental climates typically experience large temperature changes between seasons. The 22-year average monthly temperature is 58.0°F, with the coldest month being January with an average temperature of 35°F and the warmest month being July with an average temperature of 79°F. The average mean prevailing wind speed is 10 miles per hour. Historically, stronger winds are recorded when the winds are from the southwest.

1.3.1.2.5 Air quality

PGDP is located in the Paducah-Cairo Interstate Air Quality Control Region of Kentucky, which includes McCracken County and 16 other counties in western Kentucky. Data from the state's air monitors are used to assess the region's ambient air quality for the criteria pollutants (ozone, nitrogen oxides, carbon monoxide, particulates, lead, and sulfur dioxide) and to designate nonattainment areas (i.e., those areas for which one or more of the National Ambient Air Quality Standards are not met). McCracken County is classified as an attainment area for all six criteria pollutants [*Fiscal Year 2008 Annual Report* (KDAQ 2008)]. Ten ambient air sampling stations are operated by the Kentucky Radiation Health Branch to monitor airborne radionuclides from PGDP.

1.3.1.2.6 Noise

Noises associated with plant activities generally are restricted to areas inside buildings located on-site. Currently, noise levels beyond the security fence are limited to wildlife, hunting, traffic moving through the area, and operation and maintenance (O&M) activities associated with outside waste storage areas located close to the security fence.

1.3.1.3 Ecological, cultural, archeological, and historical resources

The following sections give a brief overview of the soils, terrestrial and aquatic systems, wetlands, and cultural resources at PGDP. A more detailed description, including an identification and discussion of sensitive habitats and threatened and endangered (T&E) species, is contained in the *Investigation of Sensitive Ecological Resources Inside the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CDM 1994) and the *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky* (COE 1994).

1.3.1.3.1 Soils and prime farmland

Six soil types are associated with PGDP as mapped by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (USDA 1976). These are Calloway silt loam, Grenada silt loam, Loring silt loam, Falaya-Collins silt loam, Vicksburg silt loam, and Henry silt loam.

The dominant soil types, the Calloway and Henry silt loams, consist of nearly level, somewhat poorly drained to poorly drained soils that formed in deposits of loess and alluvium. These soils tend to have low organic content, low buffering capacity, and acidic hydrogen-ion concentration (pH) ranging from 4.5 to 5.5. The Henry and Calloway series have a fragipan horizon, a compact and brittle silty clay loam layer that extends from 26 inches below ground surface (bgs) to a depth of 50 inches or more. The fragipan reduces the vertical movement of water and causes a seasonally perched water table in some areas at PGDP. In areas within the PGDP where past construction activities have disturbed the fragipan layer, the soils are best classified as "urban."

The area of SWMUs 2, 3, 7, and 30 is mapped as Henry Silt Loam with fragipans common from 1.5–7 ft (USDA 1976). Grading operations during the construction of the plant largely disturbed the soils; nearby ditching dissected the fragipan. Moreover, subsequent diggings, fills, and cover in the burial areas of SWMUs 2, 3, 7, and 30 would have destroyed the fragipan. The cover for SWMUs 2, 3, 7, and 30 is likely a mixture of Henry silt loam and the underlying silt unit (loess).

Prime farmland, as defined by the NRCS, is land that is best suited for food, feed, forage, fiber, and oilseed productions, excluding "urban built-up land or water" (7 *CFR* § 657 and 658). The NRCS determines prime farmland based on soil types found to exhibit soil properties best suited for growing crops. These characteristics include suitable moisture and temperature regimes, pH, drainage class, permeability, erodibility factor, and other properties needed to produce sustained high yields of crops in an economical manner. Prime farmland is located north of the PGDP plant area. The prime farmland north of the plant is predominantly located in areas having soil types of Calloway, Grenada, and Waverly.

1.3.1.3.2 Terrestrial systems

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

Most of PGDP has been cleared of vegetation at some time, and much of the grassland habitat currently is mowed by PGDP personnel. The Kentucky Division of Fish and Wildlife Resources manages a large percentage of the adjacent WKWMA to promote native prairie vegetation by burning, mowing, and various other techniques. These areas have the greatest potential for restoration and for establishment of a sizeable prairie preserve in the Jackson Purchase area (KSNPC 1991).

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

Wildlife commonly found in the PGDP area consists of species indigenous to open grassland, thicket, and forest habitats. Small mammal surveys conducted on WKWMA documented the presence of southern short-tailed shrew, prairie vole, house mouse, rice rat, and deer mouse (KSNPC 1991). Large mammals commonly present in the area include coyote, eastern cottontail, opossum, groundhog, whitetail deer, raccoon, and gray squirrel.

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

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

Mist netting activities in the area have captured red bat, little brown bat, Indiana bat, northern long eared bat, evening bat, and eastern pipistrelle (KSNPC 1991).

1.3.1.3.3 Aquatic systems

The aquatic communities in and around PGDP area that could be contaminated by plant discharges include two perennial streams (Bayou Creek and Little Bayou Creek), the NSDD (a former ditch for the discharge of plant effluents to Little Bayou Creek), a marsh located at the confluence of Bayou Creek and

Little Bayou Creek, and other smaller drainage areas. The dominant taxa in all surface waters include several species of sunfish, especially bluegill and green sunfish, as well as bass and catfish. Shallow streams, characteristic of the two main area creeks, are dominated by bluegill, green and longear sunfish, and stonerollers.

1.3.1.3.4 Threatened and endangered species

Potential habitat for federally listed T&E species was evaluated for the area surrounding PGDP during the 1994 U.S. Army Corps of Engineers (COE) environmental investigation of PGDP (COE 1994) and inside the fence of the PGDP during the 1994 investigation of sensitive resources at PGDP (CDM 1994). Investigation inside the 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 the 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). No bat habitat exists at SWMUs 2, 3, 7, or 30.

1.3.1.3.5 Cultural, archaeological, and historic resources

No archaeological resources have been identified within the vicinity of the BGOU facilities.

1.3.1.4 Surface water hydrology, wetlands, and floodplains

1.3.1.4.1 Surface water hydrology

PGDP is located in the western portion of the Ohio River drainage basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

The plant is situated on the divide between the two creeks. Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River along a 9-mile course. The Little Bayou Creek's intermittent drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River along a 6.5-mile course.

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from PGDP. Plant discharges are monitored at the KPDES outfalls prior to discharge into the creeks.

1.3.1.4.2 Wetlands

The 1994 COE environmental investigations identified 1,083 separate wetland areas and grouped them into 16 vegetative cover types encompassing forested, scrub/shrub, and emergent wetlands (COE 1994). Wetland vegetation consists of species such as sedges, rushes, spikerushes, and various other grasses and forbs in the emergent portions; red maple, sweet gum, oaks, and hickories in the forested portions; and black willow and various other saplings of forested species in the thicket portions.

Five acres of potential wetlands were identified inside the fence at PGDP (COE 1995). The COE made the determination that these areas are jurisdictional wetlands. Wetlands inside the plant security fence are confined to portions of drainage ditches traversing the site. These areas provide some groundwater recharge, floodwater retention, and sediment retention. While the opportunity for these functions and values is high, the effectiveness is low due to water exiting the area quickly through the drainage system. Other functions and values (e.g., wildlife benefits, recreation, diversity, etc.) are very low.

1.3.1.4.3 Floodplains

Floodplains were evaluated during the 1994 COE environmental investigation of PGDP (COE 1994). This evaluation used the Hydrologic Engineering Center Computer Program-2 model to estimate 100- and 500-year flood elevations. Flood boundaries from the Hydrologic Engineering Center Computer Program-2 model were delineated on topographic maps of the PGDP area to determine areal extent of the flood waters associated with these events.

Flooding is associated with the Ohio River, Bayou Creek, and Little Bayou Creek. The majority of overland flooding at PGDP is associated with storm water runoff and flooding from Bayou and Little Bayou Creeks. A floodplain analysis performed by COE (COE 1994) found that much of the built-up portions of the plant lie outside the 100- and 500-year floodplains of these streams. Drainage ditches inside the PGDP security fence can contain nearly all of the expected 100- and 500-year flood discharges (COE 1994). It should be noted that precipitation frequency estimates for the 100- and 500-year events were updated in 2004 in the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 (NOAA 2004). In the updated report, the mean precipitation estimate for the 100-year, 24-hour event in Atlas 14 for the Paducah area is 10.1% to 15% greater than the mean estimate in previous publications. As stated in Atlas 14, in many cases, the mean precipitation estimate used previously still is within the confidence limits provided in Atlas 14; therefore, it is assumed the plant ditches still will contain the 100- and 500-year discharges. The BGOU SWMUs are not located within the floodplain.

1.3.1.5 Regional and study area geology and hydrogeology

1.3.1.5.1 Regional 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 Province. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Figure 1.6 summarizes the geologic and hydrogeologic systems of the PGDP region.

Within the Jackson Purchase Region, strata deposited above the Precambrian basement rock attain a maximum thickness of 12,000 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 are exposed approximately 9 miles northwest of PGDP in southern Illinois (MMES 1992). 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 PGDP, the Continental Deposits and the overlying loess and alluvium are of key importance. The Continental Deposits resemble a large low-gradient alluvial fan that covered much of the region and eventually buried the erosional topography. A principal geologic feature in the PGDP area is the Porters Creek Clay Terrace, a subsurface terrace that trends approximately east to west across the southern portion of the plant. The Porters Creek Clay Terrace represents the southern limit of erosion or scouring of the ancestral Tennessee River. Thicker sequences of Continental Deposits, as found underlying PGDP, represent valley fill deposits and can be informally

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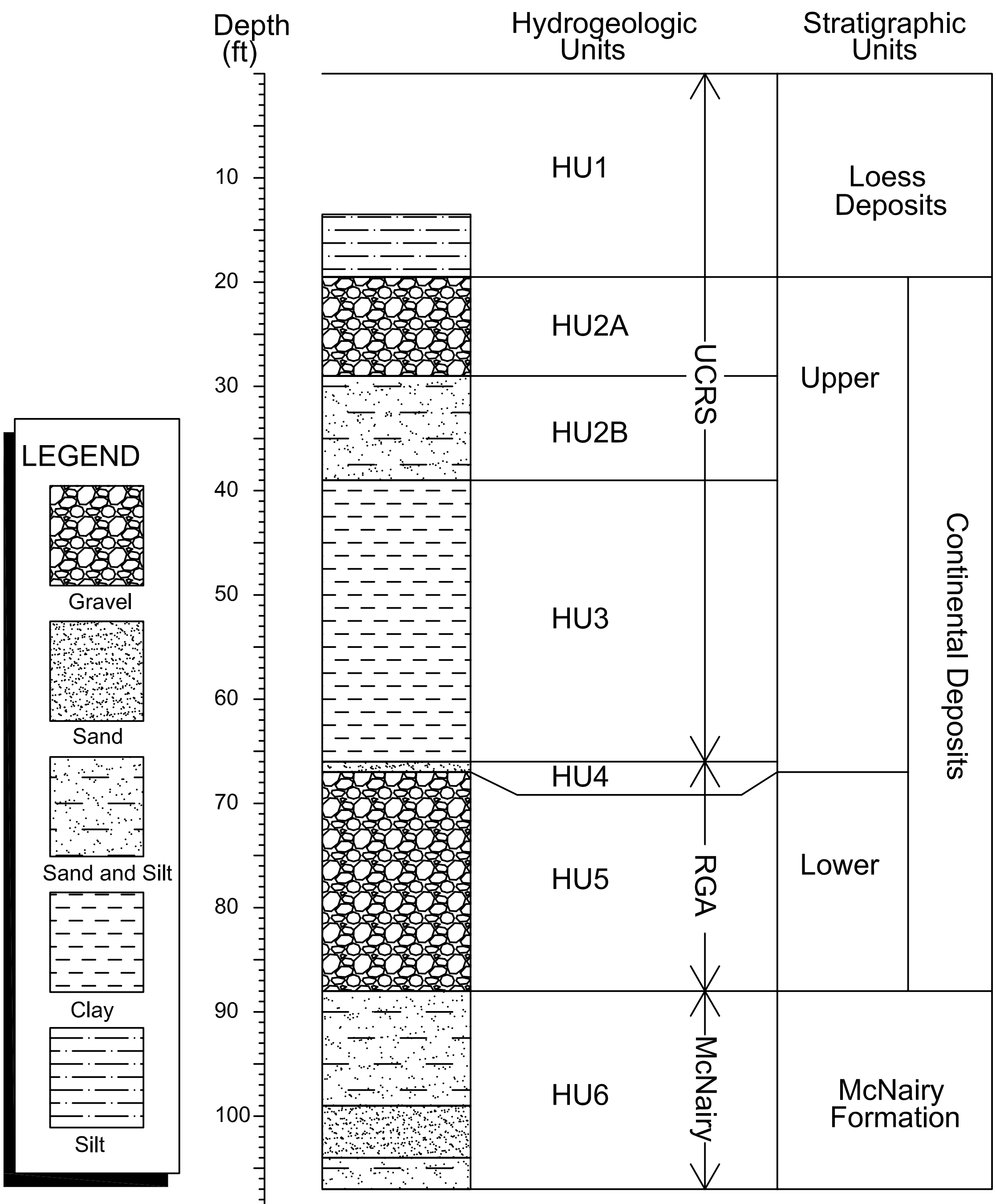

Geology based on SI Phase 1 Boring H007.
Actual depths of hydrogeologic units and stratigraphic units vary across the site.

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Figure 1.6. Example Stratigraphic and Hydrogeologic Units

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divided into a lower unit (gravel facies) and an upper unit (clay facies). The Lower Continental Deposits (LCD) is the gravel facies consisting of chert gravel in a matrix of poorly sorted sand and silt that rests on an erosional surface representing the beginning of the valley fill sequence. In total, the gravel units average an approximate 30-ft thickness, but some thicker deposits (as much as 50 ft) exist in deeper scour channels. The Upper Continental Deposits (UCD) is primarily a sequence of fine-grained, clastic facies varying in thickness from 15 to 60 ft that consist of clayey silts with lenses of sand and occasional gravel.

The BGOU area lies within the buried valley of the ancestral Tennessee River in which Pleistocene Continental Deposits (the fill deposits of the ancestral Tennessee River Basin) rest unconformably on Cretaceous marine sediments. Pliocene through Paleocene formations in the BGOU area have been removed by erosion from the ancestral Tennessee River Basin. In this area, the upper McNairy Formation consists of 60 to 70 ft of interbedded units of silt and fine sand and underlies the Continental Deposits. Total thickness of the McNairy Formation is approximately 225 ft.

The surface deposits found in the vicinity of PGDP consist of loess and alluvium. Both units are composed of clayey silt or silty clay and range in color from yellowish-brown to brownish-gray or tan, making field differentiation difficult.

1.3.1.5.2 Regional hydrogeology

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

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

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

Upper Continental Recharge System (UCRS). The upper stratum, where infiltration of water from the surface occurs and where the uppermost zone of saturation exists in the UCD (beneath PGDP and the contiguous land to the north) is called the UCRS. Groundwater flow is primarily downward in the Upper Continental Deposits. Vertical hydraulic gradients generally range from 0.5 to 1 ft/ft where measured by wells completed at different depths in the UCRS. Vertical gradients are 1 to 2 orders of magnitude greater than lateral hydraulic gradients. While groundwater flow is predominantly downward, there will be some lateral flow due to heterogeneities in the shallow soils.

Direct measurements of the UCRS water table elevation are available only for the south-central PGDP industrial area, where water levels commonly occur in the screened interval of the wells, and the location of two source unit investigations (the SWMU 2 Interim Remedial Design Investigation and the SWMUs 7 and 30 RI) in the west PGDP industrial area. All other well measurements, where water levels occur above the well screen interval, provide lower bounds to the elevation of the water table. Hydrographs of UCRS monitoring wells (MWs) on-site indicate fluctuations of only a few ft over the past 10 years. The main features of the water table are a broad trough in the northeast and central areas, a linear discharge area associated with a ditch in the northwest, and a lateral hydraulic gradient toward Bayou Creek on the west side. In general, the water table is less than 20 ft deep in the western half of PGDP and as much as 40 ft deep in the northeastern corner.

The infiltration rate for the PGDP area is approximately 6.6 inches/yr based on site-specific groundwater modeling. This 6.6 inches/yr applied over the area of the industrial area of the plant yields approximately 0.4 mgd of recharge to the shallow groundwater system. Leakage from plant water utilities, ditches, lagoons, and cooling tower basins is suspected to be another important source of infiltration at PGDP. Water use for PGDP for calendar year 2006 averaged 13 mgd. Municipal water systems lose as much as 24% of their daily conveyance (Jowitt and Xu 1990). A similar loss of the PGDP system would equal 3.1 mgd. Since the UCRS groundwater flow is predominantly downward, areas with higher anthropogenic recharge creates mounding of hydraulic head in the RGA that can affect contaminant transport. Because the hydraulic conductivity in the RGA on-site is relatively large, the mounding is only slight (often less than 1 ft) and difficult to measure.

Regional Gravel Aquifer. Vertically infiltrating water from the UCRS moves downward into a basal sand member of the UCD and the Pleistocene gravel member of the LCD and then laterally north toward the Ohio River. This lateral flow system is called the RGA. The RGA is the shallow aquifer beneath PGDP and contiguous lands to the north. The RGA is considered by EPA as Class IIA groundwater, current drinking water source, because it was an actual drinking water supply for nearby residents before it was contaminated by PGDP and continues to be a drinking water source outside the Water Policy protection area. It currently is not used on-site within the DOE property or off-site within the Water Policy Box for drinking water. DOE provides municipal water to certain nearby residences and businesses and this serves to limit off-site human exposure to contaminated groundwater. Nevertheless, the beneficial use for the RGA groundwater would be as a drinking water source.

Hydraulic potential in the RGA declines toward the Ohio River, which is the control of base level of the region's surface water and groundwater systems. The RGA potentiometric surface gradient beneath PGDP is commonly 10^{-4} ft/ft, but increases by an order of magnitude near the Ohio River. (Vertical gradients are not well documented, but small.) The hydraulic conductivity of the RGA varies spatially. Pumping tests have documented the hydraulic conductivity of the RGA ranges from 53 ft/day to 5,700 ft/day. East-to-west flow of the ancestral Tennessee River, which laid down the Pleistocene Continental Deposits gravel member, tended to orient permeable gravel and sand lenses east-west. Thus, with the hydraulic head in the RGA generally decreasing northward toward the Ohio River, groundwater flow trends to the northeast and northwest from PGDP in response to the anisotropy of the hydraulic conductivity as well as the anthropogenic recharge, which is greatest in the industrial portion of the plant. Anthropogenic recharge from waterline leaks, lagoons, cooling tower basins, and other sources provides the primary driving force in moving groundwater in northeastern and northwestern flow directions from the industrial plant area. Ambient groundwater flow rates in the more permeable pathways of the RGA commonly range from 1 to 3 ft/day.

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

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

1.3.1.5.3 Hydrogeologic units

Five hydrogeologic units (HUs) are commonly used to discuss the shallow groundwater flow system beneath the DOE site and the contiguous lands to the north (Figure 1.6). In descending order, the HUs are described below:

- Upper Continental Deposits
  - HU 1 (UCRS): Loess that covers the entire site.
  - HU 2 (UCRS): Discontinuous, sand and gravel lenses in a clayey silt matrix. In some areas of the plant, the HU2 interval consists of an upper sand and gravel member (HU2A) and a lower sand and gravel member (HU2B) separated by a thin silt unit.
  - HU 3 (UCRS): Relatively impermeable unit that acts as the upper semiconfining-to-confining layer for the RGA. The lithologic composition of HU 3 varies from clay to fine sand, but is predominantly silt and clay.
  - HU 4 (RGA): Near-continuous sand unit with a clayey silt matrix that forms the top of the RGA.
- Lower Continental Deposits
  - HU 5 (RGA): Gravel, sand, and silt.

1.3.1.6 DOE plant controls

Current DOE plant controls for the PGDP are described below.

- The SWMUs are within areas protected from trespassing under the 1954 Atomic Energy Act as amended (referred to as the 229 Line). These areas are posted as "no trespassing" and trespassers are subject to arrest and prosecution. Physical access to the PGDP is prohibited by security fencing, and armed guards patrol the DOE property 24 hours per day to restrict workers entry and prevent uncontrolled access by the public/site visitors.
- Vehicle access to SWMUs 2, 3, 7, and 30 is restricted by passage through Security Post 57 and by the plant vehicle protection barrier.

· SWMUs 2, 3, 7, and 30 are in areas that are subject to routine patrol and visual inspection by plant protective forces, at a minimum once per shift.

· Protection of the current PGDP industrial workers is addressed under DOE's Integrated Safety Management System/Environmental Management System program and 29 *CFR* § 1910. Interim work area access controls that may be used under these programs during implementation of a remedy include warning and informational signage, temporary fencing and/or barricades, and visitor sign-in controls.

These existing access controls are maintained due to the nature and security needs of the facility or implemented for protection of worker safety and health and are being maintained outside of the requirements of CERCLA; nonetheless, the existing controls serve to protect against unacceptable/uncontrolled exposures.

Additionally, Section XLII of the FFA requires that the sale or transfer of the PGDP comply with Section 120(h) of CERCLA. In the event DOE determines to enter into any contract for the sale or transfer of any of PGDP, DOE will comply with the applicable requirements of Section 120(h) in effecting that sale or transfer, including all notice requirements. In addition, DOE will notify EPA and KY of any such sale or transfer at least 90 days prior to such sale or transfer.

1.3.2 SWMU 2, 3, 7, and 30 History

The disposal of solid waste began with construction of the plant in 1951. Scrap and wastes have been buried in a minimum of 22 different locations, and scrap has been stored in at least five storage yards. These known areas have been identified as SWMUs or areas of concern (Union Carbide 1978).

Table 1.2 identifies the previously completed reports and/or investigations primarily used as information for SWMUs 2, 3, 7, and 30. Reference information for these investigations can be found in Section 9. In addition to the reports of previous investigations, the following documents provide important information on the content and volume of SWMUs 2, 3, 7, and 30.

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

Table 1.2. Summary of Previous Relevant Investigations of BGOU

Dates	Title	SWMU 2	SWMU 3	SWMU 7	SWMU 30
1989	Post Closure Permit Application C-404 Low-Level Radioactive Waste Burial Ground		ü		
1990-1992	Phase II Site Investigation (CH2M HILL 1992)	ü	ü	ü	ü
1996	Closure Plan C-404 Low-Level Radioactive Waste Burial Ground		ü		
1996-1997	WAG 22 SWMUs 2 and 3 Remedial Investigation and Addendum (including SWMU 2 Data Summary Report)	ü	ü		
1996-1998	WAG 22 SWMUs 7 and 30 RI/FS			ü	ü
1999-2001	Data Gaps Investigation (DOE 2000)			ü	ü
2002-2003	Scrap Yards Site Characterization (Paducah OREIS)			ü	ü
2006	Burial Grounds RI/FS Work Plan (DOE 2006)	ü	ü	ü	ü

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Table 1.2 Summary of Previous Relevant Investigations of BGOU (Continued)

Dates	Title	SWMU 2	SWMU 3	SWMU 7	SWMU 30
2007	Burial Grounds Remedial Investigation (DOE 2010b)	ü	ü	ü	ü

Table 1.2 is based on Table 1.4 of the *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0030&D2/R1, February (DOE 2010b).
Blank cells indicate document is not applicable to SWMU.

Historical information that is known about the waste units for these SWMUs is summarized in Table 1.3. Additional details about the individual SWMUs are provided in the SWMU-specific sections of this document, Sections 5, 6, 7, and 8.

1.3.3 Nature and Extent of Contamination

The SWMUs comprising the BGOU consist primarily of landfills and below-ground burial cells in which various PGDP wastes have been placed. The BGOU CSM indicates infiltration of water (i.e., precipitation) descending through the buried waste has mobilized or could mobilize contaminants within the waste. Once mobilized, the most likely pathway of the contaminants would be downward through the UCRS soils, ultimately reaching the RGA. Some lateral movement of contaminants would occur in the UCRS, but these pathways are known to be limited.

1.3.3.1 Source Characteristics

The nature and dimensions of the source term is based on the information available on the wastes. The chemicals associated with the wastes are highlighted in Table 1.3 and may contain PTW. 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).

The following PTW are identified at SWMU 2:

- Approximately 270 tons of uranium (e.g., shavings and sawdust packed in oil);
- Buried drums of uranium-contaminated TCE and any high soil concentrations of TCE present under and adjacent to the drums;
- Buried drums (thirty-five 30-gal drums documented) of uranyl fluoride solution and high soil concentrations of uranyl fluoride solution present under and adjacent to the drums; and
- High concentrations of TCE and *cis*-1,2, dichloroethene (DCE) (a toxic degradation product of TCE) in soil on the eastern side of SWMU 2.

Additionally, there is the potential that the 59,000 gal of oil with which the uranium disposed of at SWMU 2 was packaged in drums contains PCBs at concentrations greater than 500 ppm. Under EPA guidance, PCBs greater than 500 ppm generally are considered PTW. Absent additional characterization (sampling and analysis) of the buried waste, it is uncertain whether PCBs are widely present at SWMU 2 at levels greater than 500 ppm. Notwithstanding the uncertainty, the 59,000 gal of oil could contain PCBs in excess of 500 ppm and thus be considered PTW.

Approximately 3,200 tons of uranium-contaminated waste at SWMU 3 has been identified as PTW. (It is inconclusive whether some of the uranium may be pyrophoric.)

Table 1.3. Summary of Historical Information for BGOU SWMUs 2, 3, 7, and 30

Sub Unit	Dates of Operation	Area of Waste	Cap[a]	Known or Expected Contents (Special Hazards)
SWMU 2 C-749 Uranium Burial Ground				
	1951–1977	32,000 ft^2 (7–17 ft deep)	6-inch clay 18-inch soil	Uranium (including uranium metal that may be pyrophoric), waste oil (potentially containing PCB), TCE
SWMU 3 C-404 Low-Level Radioactive Waste Burial Ground				
	1952–1986	53,000 ft^2 (8–12 ft deep)	RCRA multilayered cap	Uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, degreasing sludge, and radioactively contaminated trash
SWMU 7 C-747-A Burial Ground				
Cell B	?	10,320 ft^2 (6–7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment
Cell C	?	10,320 ft^2 (6–7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment,
Cell D	?	1,485 ft^2 (6–7 ft deep)	3 ft soil	Uranium-contaminated concrete pieces of reactor tray bases from fluorination process of uranium tetrafluoride to uranium hexafluoride
Cell E	?	2,145 ft^2 (6–7 ft deep)	3 ft soil	Uranium-contaminated concrete pieces of reactor tray bases
Cell F1–F5	?	1,600 ft^2 (6–7 ft deep)	3 ft soil	Uranium-contaminated scrap metal, equipment, empty uranium/magnesium powder drums
Cell G	?	3,294 ft^2 (6–7 ft deep)	3 ft soil	Noncombustible trash, contaminated material and equipment
SWMU 30 C-747-A Burn Area				
Cell A	1951–1970	128,000 ft^2 (12 ft deep)	4 ft soil	Ash and debris from combustible trash, possibly uranium-contaminated

Table 1.3 is based on Table 1.3 of the BGOU RI (DOE 2010b).
[a] The source material used for capping is unknown with the exception of the SWMU 3 Subtitle C cap that came from the Old Hickory Clay Company.
? indicates dates of operation are not known.

Any TCE (including degradation products) present in UCRS at SWMU 7 as dense nonaqueous-phase liquid (DNAPL) and/or high concentration TCE residual soil contamination constitutes PTW.

No PTW has been identified at SWMU 30.

1.3.3.2 Nature and Extent of Soil Impacts

The current understanding of the nature and extent of contamination in surface and subsurface soils was derived from historical investigations as shown on Table 1.2. In the BGOU RI, additional soil samples were collected from angled borings beneath the wastes to establish if releases had occurred from the waste and, if so, their magnitude in the secondary media. Each of the SWMUs has a surface cover. The amount of surface soil data collected for each SWMU varied, since the focus of the BGOU was to identify releases and these would primarily be identified from samples beneath the waste. In some cases, the BGOU data set includes soil and sediment samples collected from locations outside the SWMU boundary that are not affected by releases from the wastes and will be addressed by other strategic initiatives.

SWMU-specific sections provide details on the distribution of selected COCs. The sampling locations and distribution of the target chemicals in surface and subsurface soils evaluated in this FS are shown on figures in Appendix A for each of the SWMUs. Key general observations across all SWMUs include the following:

- Radionuclides were detected at each of the SWMUs. Those of greatest impact when evaluating releases include Tc-99 and uranium-238. Tc-99 is generally considered one of the more mobile radionuclides and has been detected in RGA groundwater. It was detected above background in only 1 of nearly 90 samples below 20 ft, 8 of over 100 samples from 1–20 ft, and the highest frequency of detection in the surface samples (17/48). A similar pattern was observed for uranium-238, with highest frequencies of exceeding background observed in surface soils (0–1 ft bgs).

- Selected chlorinated volatile organic compounds (VOCs) were identified in soil samples at SWMUs 2 and 7. There was one hot spot sample in SWMU 2 at a depth of 12 ft bgs with concentrations of TCE and *cis*-DCE (its anaerobic biodegradation product) each above 100 mg/kg. These concentrations are below the soil saturation concentration, a concentration above which you may expect to have a solvent phase, and are outliers in the data set. Other detected concentrations of TCE range from 0.0021 J to 0.428 mg/kg.

- Total PCBs were detected in soil samples from SWMUs 2, 7 and 30. These were typically at higher concentrations and greater frequencies in surface soil, with no detections of total PCBs in the 68 soil samples collected at depths greater than 20 ft bgs. The maximum concentration was 14.8 mg/kg, the only concentration above 10 mg/kg.

- Polycyclic aromatic hydrocarbons (PAHs) were detected most frequently in surface samples at SWMUs 7 and 30. These were not detected in any samples below 20 ft.

- Naturally occurring metals infrequently exceeded both the no action level (NAL) and background concentrations. No clear patterns or gradients of concentrations were identified. For surface soils, these metals include antimony, arsenic, chromium, iron, nickel uranium and vanadium. Uranium exceeded most frequently. For other metals that contribute to the noncancer hazards, only 1 or occasionally 2 were detected in a single sample, suggesting these detections were typically not collocated.

1.3.4 Conceptual Site Model

The waste materials and affected soils in SWMUs 2, 3, 7, and 30 include both potentially mobile and low mobility chemicals. To the extent these materials are mobile, the most likely pathway of the contaminants released from wastes would be downward migration through the UCRS soils, ultimately reaching the RGA (Figure 1.7). Some lateral movement of contaminants could occur in the UCRS, but these pathways are known to be limited. Based on this conceptual model, any contamination resulting from buried waste found at these SWMUs would be expected to be found concentrated in the soils and groundwater of the UCRS immediately within and under the burial cells, with little lateral dispersion of contamination in the UCRS from the cells and immediately adjacent soils. Consistent with the BGOU goals, the source areas, contamination in secondary sources impacted by releases from the waste, and potential for future migration from the wastes were the focus of the investigations and basis for evaluation of remedial alternatives. In general, there is a surface cover on these SWMUs; however, impacts identified in the surface soils within the SWMU boundary have the potential to migrate with runoff to adjacent drainageways.

1.3.5 Contaminant Fate and Transport

Release of chemicals from the wastes and subsequent migration to the RGA considers the potential for chemicals to degrade/transform (fate) and the rate at which these may migrate through the UCRS (transport). The following briefly highlights some of the factors that are considerations when evaluating releases from the waste for the key chemical groups: chlorinated VOCs, radionuclides, PAHs, and metals.

The assumptions used in modeling are shown and discussed in Appendix B.

1.3.5.1 Contaminant fate

Some contaminants may be transformed to new constituents in the environment; organic compounds may decompose or be transformed by various processes including hydrolysis, oxidation/reduction, photolysis, or biological processes, and radioisotopes may decay by nuclear reactions. All transformations produce new constituents or daughter products, some of which also may have hazardous or toxic effects. Transformations of organic compounds are governed by environmental conditions, pH or oxidation reduction potential levels, and the presence of bacteria and electron donors. Transformations of radionuclides are dependent on the decay constant of the isotope alone.

The distribution, mobility, and bioavailability of heavy metals and radionuclides in the environment depend not only on their total concentration but also on the association form in the solid phase to which they are bound. The potential rate of dissolution or release (leachability) of these compounds is not easily estimated by the bulk soil concentration. In some cases, minerals may be encapsulated in quartz or other chemically inert minerals; while in other cases, soils may contain reactive minerals in lower abundance. The release and subsequent mobility of metals and radionuclides released into infiltrating water may be dependent on oxidation state; therefore, considerations of potential changes to the form of these compounds in the UCRS are a factor in potential migration.

Chlorinated Volatile Organic Compounds. TCE is identified as a COC at SWMUs 2 and 7. TCE is the parent of an anaerobic degradation chain that produces *cis*-1,2-DCE and vinyl chloride as daughter products. Each step in the degradation has a lower rate than TCE and requires stronger reducing conditions than those required for reduction of TCE. Degradation products of TCE are identified as COCs at the SWMUs where TCE also is identified as a COC. In addition to the anaerobic pathway, aerobic biodegradation of TCE may occur under certain conditions where specialized microorganisms are present. The aerobic degradation pathway requires the presence of ammonia, methane, and toluene, and degrades TCE directly to epoxides, aldehydes, chlorinated oxides, and ethanols. TCE degradation is assumed to be occurring at the BGOU and is considered in the screening and evaluation of alternatives. Section 1.2.4.2 of the *Focused Feasibility Study for the Southwest Groundwater Plume Volatile Organic Compound Sources (Oil Landfarm and C-720 Northeast and Southeast Sites) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0186&D2/R1, discusses TCE degradation at PGDP (DOE 2011b).

Radionuclides. Although radionuclides behave chemically as metals, the radioactive nuclides undergo spontaneous transformations that involve the emission of particles (alpha and beta particles) and radiant energy (gamma energy). The resulting daughters (i.e., product nuclides) may be radioactive themselves or may be stable nuclides. Natural uranium consists of three primary isotopes: uranium-234, uranium-235, and uranium-238. Decay products of uranium isotopes also are radioactive, with unique decay chains.

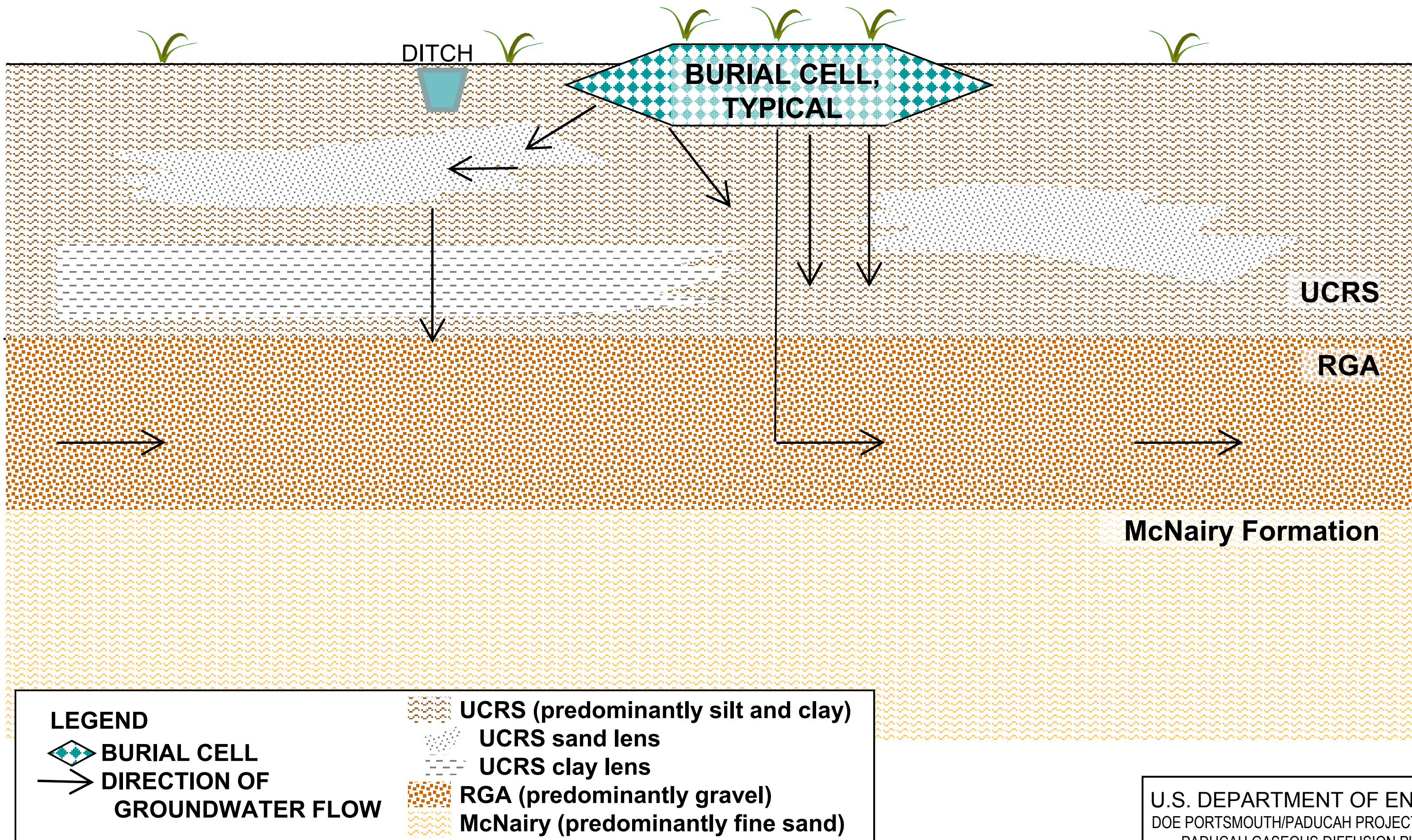

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Figure 1.7. Pictorial Conceptual Model of the BGOU

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Half-lives for radioisotope decay for the radioactive contaminants at PGDP are listed in the PGDP Risk Methods Documents (DOE 2011a).

Additional considerations include potential changes in oxidation state for technetium and uranium that may influence their release (dissolution) and transport. Dissolved technetium is present as pertechnetate (TcO4-), the most common form of technetium in oxidizing environments. Pertechnetate forms no sparingly soluble solids and, being anionic, sorbs sparingly at best. Under reducing conditions, however, dissolved technetium is present in the +4 valence state, which forms sparingly soluble solids such as TcO2.2H2O. Similarly, reduction of mobile uranium+6 to immobile uranium+4 occurs under reducing conditions; therefore, the reducing conditions present in the UCRS may essentially immobilize Tc-99 and uranium (See Appendix B).

Naphthalene and carcinogenic PAHs have been identified in a number of surface soil and sediment samples and detected in only one sample at depths greater than 1 ft at the BGOU SWMUs. These are present generally as a mixture and are likely highly weathered in surface soils, making the residuals higher molecular weight components that are less soluble and more persistent. Naphthalene has been identified at some locations, and using screening values were identified as potentially migrating to groundwater. However, biodegradation of naphthalene released into soils in the dissolved phase has been demonstrated to occur under both aerobic and anaerobic conditions, with rates that are more rapid under aerobic conditions. Howard et al. (1991) reports naphthalene half-lives in soil from 16.6 to 48 days based upon a soil-die away test, and in groundwater from 24 hours (aerobic) to 258 days (anaerobic). The attenuation of hydrocarbons that may dissolve into infiltrating water and migrate vertically to deeper soils or groundwater is supported by the fact that these are not detected in subsurface soils or RGA groundwater samples.

Metals. Although metals do not decrease in total concentrations through degradation, they may change oxidation states, which can impact the mobility of the metals. For example, hexavalent chromium is considered the more mobile and toxic form of this metal. Under reducing conditions expected in the UCRS, this metal would be in the less mobile and less toxic trivalent form.

1.3.5.2 Contaminant transport

The transport of contaminants from the BGOU SWMUs will occur primarily in the dissolved phase, due to partitioning from the solid or adsorbed phase to infiltration from rainfall or to groundwater where waste is saturated, which is a common condition in the BGOU. The dissolution of contaminants will be controlled by the rate of water infiltrating through soil and waste at the waste units, the solubility of the contaminants, and equilibrium partitioning between the liquid phase and the soil, described by a partitioning coefficient ($K_{d)}$. For volatile compounds, partitioning to the soil gas phase, described by a Henry's Law constant, also may be an important transport pathway. The K_d for organic compounds is a function of the organic carbon coefficient (K_{oc}) and fraction of organic carbon in the soil (f_{oc}). The range of K_{oc} for the volatile COCs and f_{oc} values for the BGOU soils indicates that chlorinated VOCs are relatively mobile through soils as dissolved constituents and tend not to partition significantly from water to soil (DOE 2010a).

The mobility of metals is dependent on a range of factors, including, but not limited to, soil pH, cation exchange capacity of the soils, redox of the disposal cell and soils below the cell, and the heterogeneity the HUs.

The K_d for metals and radionuclides is a measure of the interactions of the chemicals in the infiltrating water and the soil surfaces that control adsorption/retardation behavior of selected contaminants. As stated in the previous section, this is not a prediction of the equilibrium concentration based on the total concentration in the solids, in which much of the naturally occurring metals or radionuclides may be not be readily leachable or present at the exchangeable surface. The range of K_d for inorganic COCs is very large and some metals are expected to be relatively mobile and some are expected to be immobile. The high clay content and neutral pH of the UCRS is expected to limit migration of metals at these SWMUs.

Of the radionuclides, several (uranium, plutonium) have high K_d values and are typically considered immobile. Technetium has a low K_d, is soluble, and may be mobile in soils; therefore, this radionuclide in waste-impacted soils has a potential to reach the RGA. The data suggest that much of the Tc-99 detected in soils remains in surficial soils and as discussed previously, if it is reduced to the +4 valence state, its potential mobility in the UCRS would decrease.

Solvents may have been placed in some of the SWMUs as a liquid waste and may be DNAPL, which forms discreet masses that are immiscible with water. The transport mechanisms for a DNAPL include gravity-driven migration of this liquid as a mobile mass; however, some of the liquid may be retained in pore spaces as residual saturation. A DNAPL migrates principally under the influence of gravity and will migrate vertically, but can spread laterally by fingering out among available pore space, and may spread laterally along lower permeability zones, potentially pooling at a lower permeability zone. Capillary forces act to retain a portion of the DNAPL within the soil matrix (DNAPL at residual saturation) and remain unless there is a change in the matrix. The amount of DNAPL that will be trapped in pore space is a function of the soil texture and may range from approximately 4% to 10% of the pore space in the unsaturated soil zone to as high as 20% of the pore space in the saturated zone (Abriola et al. 1998). Thus, DNAPL may take a circuitous path downward and may be trapped at residual saturation within the vadose and saturated zone, or form pools at changes of lithology, making characterizing its presence difficult in the subsurface soils at the BGOU.

The identification of potential TCE DNAPL source areas in the BGOU RI (DOE 2010b) was based on process knowledge. None of the soil concentrations exceed saturation concentration and none of the data suggest levels above residual saturation. TCE trends in the RGA indicate that TCE DNAPL could be present in the vicinity of the shared border between SWMUs 7 and 30. TCE trends at SWMUs 7 and 30 indicate that this potential TCE DNAPL source likely is constrained to the UCRS soils. There is potential for a TCE DNAPL source at SWMU 2 based on historical disposal records; however, neither the subsurface soil nor shallow groundwater data at SWMU 2 support the presence of a DNAPL source.

1.3.5.3 Groundwater fate and transport modeling

Modeling for the BGOU RI used the Spatial Analysis and Decision Assistance (SADA), Seasonal Soil Compartment Model (SESOIL), and Analytical Transient 1-,2-,3-Dimensional (AT123D) models, consistent with Tier 3 of the modeling matrix in the PGDP Risk Methods Document (DOE 2011a). SADA was used for the definition of the source terms, SESOIL for fate and transport modeling through the UCRS, and AT123D for fate and transport modeling through the RGA to the points of exposure (POEs). In addition to the models used, the MODFLOW/MODPATH models were used along with the previously developed PGDP sitewide groundwater model to establish input parameters for AT123D (i.e., distances to the POEs along flow paths, hydraulic gradient, and hydraulic conductivity). These models, along with the fixed parameter values chosen for the analyses (i.e., deterministic analysis), and model implementation are discussed in detail in the BGOU RI (DOE 2010b).

Table 1.4 presents the results of the deterministic modeling effort for the BGOU RI for the SWMU boundary, plant boundary and off-site POEs. These data were used to update the risk assessment for residential use of RGA groundwater as discussed in the next section. The chemicals shown on Table 1.4 at the SWMU Boundary are the COCs identified for future residential use of RGA groundwater in the BHHRA at that location. As discussed in Appendix B, although these constituents were modeled in the

RI, these were not all constituents to be addressed in the FS based on factors including background, risk/maximum contaminant level (MCL) comparisons, and travel times. Among the modeled analytes, arsenic, Tc-99, TCE, and related VOCs commonly exceeded MCLs.

Table 1.4. Concentrations of the Analytes in Groundwater Predicted in SESOIL and AT123D Modeling of the BGOU SWMUs

Analyte	Predicted Maximum Groundwater Concentration[a]					
	SWMU Boundary (mg/L or pCi/L)[b]	Plant Boundary (mg/L or pCi/L)[b]	Property Boundary	Little Bayou seeps	Ohio River	MCL (mg/L or pCi/L)
SWMU 2						
Arsenic	***3.54E-02***	2.91E-03	8.35E-09	N/A	0.00E+00	0.01
cis-1,2-DCE	***1.15E+01***	***1.74E+00***	***8.58E-01***	N/A	***3.38E-01***	0.07
Manganese	7.16E-01	1.86E-05	0.00E+00	N/A	0.00E+00	[c]
Naphthalene	9.38E-04	1.57E-04	8.27E-05	N/A	3.42E-05	[c]
PCB-1248	1.54E-03	1.28E-09	0.00E+00	N/A	0.00E+00	[c]
PCB-1260	8.73E-05	0.00E+00	0.00E+00	N/A	0.00E+00	[c]
Technetium-99	1.02E+02	1.59E+01	8.06E+00	N/A	3.11E+00	900[d]
TCE	***1.48E+00***	***2.17E-01***	***1.10E-01***	N/A	***4.12E-02***	0.005
Uranium-234	1.58E+00	1.75E-05	0.00E+00	N/A	0.00E+00	20[e]
Uranium-238	1.81E+00	2.03E-05	0.00E+00	N/A	0.00E+00	20[e]
Uranium	9.86E-03	8.33E-08	0.00E+00	N/A	0.00E+00	0.03
SWMU 3						
Arsenic	***3.29E-02***	1.22E-03	0.00E+00	0.00E+00	N/A	0.01
Manganese	8.95E-01	4.08E-10	0.00E+00	0.00E+00	N/A	[c]
Technetium-99	***5.560E+03***	***1.81E+03***	***1.36E+03***	8.04E+02	N/A	900[d]
Uranium-238	1.59E+01	1.59E+01	7.32E-11	0.00E+00	N/A	20[e]
Uranium	***4.89E-02***	2.27E-13	0.00E+00	0.00E+00	N/A	0.03
SWMU 7						
1,1-DCE	***8.98E-02***	***8.24E-02***	1.10E-02	4.02E-03	N/A	0.07
Arsenic	***1.78E-02***	***1.26E-02***	2.35E-03	0.00E+00	N/A	0.01
cis-1,2-DCE	2.35E-02	2.15E-02	3.13E-03	1.17E-03	N/A	0.07
Manganese	3.32E-01	2.41E-01	1.05E-06	0.00E+00	N/A	[c]
PCB-1254	5.23E-05	3.09E-05	3.05E-06	1.32E-12	N/A	[c]
Technetium-99	***9.09E+02***	8.25E+02	2.70E+02	1.32E+02	N/A	900[d]
TCE	***1.09E-02***	***9.87E-03***	1.42E-03	5.06E-04	N/A	0.005
Uranium-234	7.94E+00	5.79E+00	5.84E-06	0.00E+00	N/A	20[e]
Uranium-238	7.59E+00	5.58E+00	5.85E-06	0.00E+00	N/A	20[e]
Uranium	3.46E-03	2.53E-03	2.68E-09	0.00E+00	N/A	0.03
Vinyl Chloride	***1.35E-02***	***1.24E-02***	1.21E-03	4.13E-04	N/A	0.002
SWMU 30						
1,1-DCE	8.18E-05	7.65E-05	6.14E-06	1.86E-06	N/A	0.07
Arsenic	***1.82E-02***	***1.21E-02***	2.50E-03	0.00E+00	N/A	0.01
Manganese	3.78E-01	2.51E-01	2.85E-04	0.00E+00	N/A	[c]
Selenium	1.51E-02	8.30E-03	9.21E-04	3.15E-04	N/A	0.05
Technetium-99	2.87E+02	2.64E+02	7.08E+01	2.92E+01	N/A	900[d]
TCE	9.11E-04	8.60E-04	7.70E-05	2.60E-05	N/A	0.005

Table 1.4. Concentrations of the Analytes in Groundwater Predicted in SESOIL and AT123D Modeling of the BGOU SWMUs (Continued)

Analyte	Predicted Maximum Groundwater Concentration[a,b]					
	SWMU Boundary (mg/L or pCi/L)[b]	Plant Boundary (mg/L or pCi/L)[b]	Property Boundary	Little Bayou seeps	Ohio River	MCL (mg/L or pCi/L)
SWMU 30						
Uranium-234	3.99E+00	2.75E+00	1.44E-03	0.00E+00	N/A	20[e]
Uranium-238	5.91E+00	4.07E+00	1.98E-03	0.00E+00	N/A	20[e]
Uranium	8.40E-03	4.81E-03	2.41E-06	0.00E+00	N/A	0.03

Table 1.4 is taken from Table 5.3 of the BGOU RI (DOE 2010b).
[a] Values in bold, italic font with highlight exceed the analyte's MCL.
[b] Radionuclide concentrations are in pCi/L.
[c] MCLs not available for these contaminants.
[d] Tc-99 MCL based on a critical organ dose at 4 mrem/yr from drinking water consumption.
[e] The MCLs for uranium-234 and uranium-238 are from Table A.20 of the Risk Methods Document (DOE 2011a).
N/A = The POE is not applicable. Groundwater flow pathways do not reach the specific discharge point from this SWMU as demonstrated in the RI Report (DOE 2010b).

1.3.6 Baseline Human Health Risk Summary

This section highlights the results of the BGOU BHHRA, then provides a summary of the target COCs to be addressed in this FS to meet the specific remedial action objectives (RAOs). These target chemicals are a refinement of the COC lists based on updated toxicity and exposure information. Details on this process are provided in Appendix B for migration to groundwater, and Appendix C for direct contact risks. Concentrations of target compounds are shown in figures in Appendix A.

1.3.6.1 BHHRA for the BGOU RI

The BHHRA for the BGOU RI characterized the baseline risks posed to human health from contact with contaminants in soil and water at the BGOU SWMUs and at locations to which contaminants may migrate. Several contaminants of concern (COCs) were identified that could pose unacceptable threats to human health and the environment under some future use scenarios, particularly if there were any of the following.

- Direct contact with buried wastes
- Direct contact with surface soils
- Direct contact with subsurface soils
- Migration of COCs to groundwater and/or surface water

The impact to human health from direct contact with buried wastes was not characterized quantitatively in the BHHRA. The source characteristics (Section 1.3.1) identify potential hazards, including pyrophoric uranium, solvents, and PCBs that may be present in one or more of these SWMUs.

A BHHRA was conducted as part of the RI. The BHHRA reported the hazards and risks for current and future uses, some of which are unlikely or hypothetical. The risk characterization summary for all scenarios evaluated in the RI for these SWMUs is included in Appendix C. The risk characterization for direct contact scenarios was reported in the Waste Area Group (WAG) 22 RI (DOE 1998a) for SWMUs 7 and 30 and the WAG 22 RI Addendum (DOE 1994b) for SWMUs 2 and 3. The emphasis in the BGOU RI was to better characterize potential releases from the wastes to subsurface soils and potential impacts to the RGA and to update the risk assessment for use of RGA groundwater at the SWMU boundary and downgradient POEs. Additional data collected in the 0–20 ft interval subsequent to the WAG 22 BHHRA were not used to revise the risks associated with direct contact exposures. These additional data were reviewed in the uncertainty section to determine potential impacts on the identification of COCs and magnitude of the risk estimates.

In the BGOU RI, the excess lifetime cancer risk (ELCR) and hazard index (HI) were above EPA's acceptable risk range (ELCR > 1E-4 and HI > 1) for residential and industrial worker land use scenarios at each of the SWMUs. The recreational scenario was evaluated for SWMUs 7 and 30, and was within the acceptable risk range. The excavation worker was evaluated at SWMUs 7 and 30, showing unacceptable risks. Although excavation worker scenario was not explicitly evaluated at SWMUs 2 and 3, the samples used to estimated risks to the industrial worker included samples collected to depths of approximately 8 ft so for this FS it is assumed that unacceptable risks for the industrial worker apply also to subsurface soils representing unacceptable risks to a future outdoor worker (note that future outdoor worker was defined as excavation worker in the RI).

For SWMU 3, some additional soil samples were collected along a ditch adjacent to the SWMU. These soil data were evaluated separately in this FS (Appendix D). Although risks were above 1E-6, they were within the acceptable risk range for both the future worker scenarios and residential land use scenarios. The HI was below 1 for industrial land use assumptions. The HI for residential land use scenarios would be below 1 using current guidance on dermal absorption of metals.

The land use is expected to remain industrial, and the emphasis of the review of the BHHRA for this FS was focused on the future industrial worker and the future outdoor worker. The COCs identified in the BHHRA for these receptors are summarized in Table 1.5.

Potential migration of contaminants from the waste that may pose an ongoing source to RGA groundwater was evaluated in the BHHRA and those chemicals listed on Table 1.4 represent the COCs identified in the risk assessment at the SWMU boundary following the modeling.

1.3.6.2 Identification of Target COCs to be Addressed in this FS

To meet the RAOs for these SWMUs, the COCs identified based on assumptions that do not limit residential use of RGA groundwater at the SWMU boundary (Appendix B) and direct contact with contaminants in soil (Appendix C) were reviewed to identify target compounds in soils to be addressed in this FS. Review of the COCs identified for direct contact scenarios was conducted (e.g., background comparisons, toxicity assumptions for beryllium) to better support management decisions based on current understanding of the risks/hazards. Data collected subsequent to the WAG 22 RIs were also reviewed to confirm COCs to be addressed in this FS are identified.

Target compounds to address COCs identified based on assumptions that do not limit future use of RGA groundwater at the SWMU boundary (Appendix B) consider the following:

- The use of the MCL as the appropriate groundwater target concentration
- Background
- Travel time
- Attenuation/biodegradation

Target compounds identified for impacts to RGA groundwater are listed in Table 1.6.

Target compounds to address the COCs for the future industrial and future outdoor worker scenarios (Appendix C) consider the following and are listed in Table 1.7.

Table 1.5. Summary of COCs Identified in the RI for Future Industrial Worker and Future Outdoor Worker at BGOU SWMUs 2, 3, 7, and 30

	SWMU 2	SWMU 3	SWMU 7	SWMU 30
Carcinogenic COCs (ELCR > 1E-06)	Arsenic Uranium-235 Uranium-238	Arsenic Uranium-235 Uranium-238	Arsenic Beryllium Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*	Arsenic Beryllium Total PCBs Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*
Noncancer Hazard COCs (HQ > 0.1)	None	None	Aluminum Antimony Arsenic Beryllium Chromium Iron Manganese Uranium Vanadium *Nickel*	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium *Copper*

Reference: Table 1.5 is taken from the BGOU RI (DOE 2010b).
Analytes in italics identified as COCs only for outdoor worker scenario.
Analytes not italicized are COCs for both future industrial and outdoor worker scenarios.
Total PAHs include individual carcinogenic PAHs were identified at SWMUs 7 and 30.

Table 1.6. Target Compounds Identified for Impacts to RGA Groundwater

SWMU	COC
2	Arsenic *cis*-1,2-DCE TCE
3	Technetium-99
7	Arsenic 1,1-DCE TCE Technetium-99 Vinyl chloride
30	Technetium-99

Table 1.7. Summary of COCs Identified for Future Industrial Worker and Outdoor Worker

	SWMU 2	**SWMU 3**	**SWMU 7**	**SWMU 30**
Carcinogenic COCs (ELCR > 1E-06)	Arsenic Uranium-235 Uranium-238	Uranium-235 Uranium-238	Arsenic Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*	Total PCBs Total PAHs Neptunium-237 Uranium-234 Uranium-235 Uranium-235/236 Uranium-238 *Plutonium-239*
Noncancer Hazard COCs (HQ > 0.1)	None	None	Uranium	Uranium

Note: Analytes in italics only identified as COCs for outdoor worker scenario.
Analytes not in italics are COCs for future industrial and outdoor worker scenarios.
At SWMUs 2 and 3, the industrial worker COCs were identified using both surface and subsurface soils.
There are no COCs identified for the SWMU 3 ditch (Appendix D).

- COCs that are at/below background concentrations are not target compounds.

- The direct contact COCs for the future industrial and outdoor workers were identified in the WAG 22 RI (DOE 1998a) for SWMUs 7 and 30 and the WAG 22 RI Addendum (DOE 1994b) for SWMUs 2 and 3. Where updated toxicity and dermal exposure information indicates the chemical would not be a COC using current assumptions, the chemical would not be retained as a target compound.

- Because additional data were collected following the completion of the WAG 22 BHHRA, the entire BGOU data set was reviewed to identify potential additional chemicals that may significantly contribute to the risk, but were not identified as COCs in the BHHRA. These are discussed on a SWMU-specific basis. In most cases, the concentrations of chemicals in the additional samples confirm the COC list. In a few cases, an additional chemical may be considered. For example, cesium-137, not identified as a COC for SWMU 2, was detected in two surface locations. These are included on Figure A.1 in Appendix A because of the identified contribution to the risks at these locations.

This SWMU-specific review also considered the locations of the COCs. There are samples in the BGOU data set that are located in drainageways adjacent to the SWMU. In some cases, decisions for these impacts are developed consistent with the conceptual model and pathways for the SWOU. It is important to determine whether these impacts are related to any releases from the SWMU. The cesium-137 at SWMU 2 is an example of an impact that is being addressed within the SWOU.

Although the future industrial and outdoor worker scenarios are used as the basis for addressing soil impacts in this FS, the exposure assumptions may be overly conservative. The risk assessment used default exposure durations and exposure frequencies for risk estimates for likely future industrial workers and future outdoor workers. Exposure parameters for general site maintenance (16 days/yr for 25 years) estimated for other locations at PGDP are more representative for future maintenance of the BGOU SWMUs than the assumptions of 250 days/year for 25 years assumed for a more unrestricted industrial land use assumptions (DOE 2011a). The future outdoor worker risk estimates assume 185 days/year for 25 years for the exposure frequency and exposure duration (DOE 2011a). This would exceed the exposures for an excavation land use scenario for a soil removal action associated with construction of a foundation or excavation of contaminated soil.

Other uncertainties for BGOU SWMUs 2, 3, 7, and 30 that may affect the assessment of risk are discussed in Section 1.4, and some may be addressed on a SWMU-specific basis.

1.3.7 Screening Ecological Risk Assessment

For the ecological risk characterization for soil, the results of previous Ecological Risk Assessments (ERAs) conducted for SWMUs 2, 7, and 30 are summarized in the BGOU RI (DOE 2010b). No new surface data have been collected for these SWMUs since the previous risk assessments were performed. SWMU 3 is covered with a Subtitle C cap, so no ecological evaluation was undertaken.

A summary of the results of the comparison in previous assessments of the site data to the ecological screening levels is provided in Table 1.8. This table lists the number of chemicals of potential concern (COPCs) in each suite retained for each site and the medium for further consideration. This table shows that a number of inorganic and organic analytes detected above background values were retained. Radionuclides were retained for SWMUs 7 and 30.

Table 1.8. Summary of Suite of Ecological COPCs Retained in Surface Soil

Area	Media	Metal	Rad	Pesticide/PCB	SVOC	VOC
SWMU 2	Soil	6	----	----	----	----
SWMU 3	Soil	NE	NE	NE	NE	NE
SWMU 7	Soil	19	Total*	1	----	----
SWMU 30	Soil	17	Total*	1	----	----

Table 1.8 is taken from Table 6.16 of the BGOU RI (DOE 2010b).
---- No ecological COPCs
NE SWMU did not undergo an ecological evaluation.
*Radionuclide risk was assessed based on a total dose benchmark for all radionuclides.

1.4 SUMMARY AND CONCLUSIONS

This section lists the major findings from the BGOU RI with regard to SWMUs 2, 3, 7, and 30.

1.4.1 Major Findings from the BGOU RI

- Environmental media, specifically subsurface soil and groundwater, have been impacted by releases of contaminants at SWMUs 2, 3, 7, and 30.

- Analytical data and review of disposal records indicate a potential exists for DNAPL in subsurface soils at SWMU 2 and in the vicinity of the shared border between SWMUs 7 and 30. TCE trends at SWMUs 7 and 30 indicate that the potential TCE DNAPL source likely is constrained to the UCRS soils.

- The BHHRA indicates that ELCRs greater than the upper end of EPA's acceptable risk range (i.e., 1E-04) and HIs greater than 1 exist at all SWMUs. The metals arsenic, beryllium, and uranium, the organic compounds Total PAHs and Total PCBs, and the radionuclides uranium-235 and uranium-238 are common contaminants that present the dominant risks from exposure to surface and subsurface soil. The major contaminants present in soil that pose potential threats to groundwater are arsenic, 1,1-DCE, TCE, Tc-99, and vinyl chloride.

- Migration of contaminants through groundwater from SWMUs 2, 3, 7, and 30 to locations at the SWMU boundary, the plant boundary, property boundary, and near the Ohio River also posed greater than *de minimis* risks to a hypothetical residential groundwater user, in some case exceeding MCLs. Arsenic, TCE, 1,1-DCE, Tc-99, and vinyl chloride are the primary risk drivers.

· The SERA retained a number of ecological COPCs, primarily metals, at each of the sites.

1.4.2 Uncertainties Identified in the RI Report

The BGOU Work Plan identified data gaps for individual SWMUs that were necessary to be filled in order to move forward with the FS. The Work Plan was implemented to reduce uncertainties from previous investigations regarding the nature of the source zone, extent of the source zone and secondary sources, surface and subsurface transport mechanisms, and to support evaluation of remedial technologies in this FS. These uncertainties are documented in the RI Report (DOE 2010b). The uncertainties associated with SWMUs 2, 3, 7, and 30, the approach taken to address the uncertainties, and the locations in the FS where the uncertainties are addressed are summarized in Table 1.9 and discussed in the following sections.

Table 1.9. Summary of RI Report Uncertainties

SWMU	Uncertainty Description	Response and Citation of Discussion in FS
Global	Whether process knowledge and existing data sufficiently characterize the contents of waste cells and allow for management of uncertainties.	In this FS, uncertainties related to data gaps are discussed in the context of remedial alternatives development for each SWMU. Remedial alternatives are designed to provide a degree of protection greater than that necessary to protect against the maximum observed concentrations of COCs, and to mitigate uncertainties in available data.
	Whether the expected industrial land use will continue in perpetuity.	This uncertainty is addressed throughout the FS document, which develops remedial alternatives according to CERCLA guidance, and will support remediation under CERCLA when executed. The remedial alternatives include the necessary postremediation sampling, monitoring, costs, and land use controls appropriate for each SWMU. Alternatives that include monitoring, or leave waste in place, will require five-year reviews under CERCLA. Consistent with guidance, five-year reviews would consider the effects of any changes in land-use on the protectiveness of the selected remedy.
Global	Whether the lateral extent of the burial cell is adequately delineated. Nature and extent of the source zone. Acidic leachate, oxidation/reduction conditions, and degree of waste saturation. Extent and volume of the source zone (burial cell) and secondary sources (TCE DNAPL). Limited groundwater monitoring around the BGOU SWMUs. Potential for leachate from burial areas to impact adjacent surface water ditches. Nature and extent of contaminants in	Remedial design includes the opportunity to collect engineering data to support technology sizing, design and optimization. These are the features or attributes of the alternatives evaluated for the BGOU. For excavation: · Criterion to remove visible waste. · Postremediation sampling. · Removal of contaminant source. For cover: · Geophysics to fully delineate burial cells. · A cover or cap will be engineered to reduce infiltration and manage runoff. · Reduced infiltration to further immobilize contaminants (see Appendix B). · Elimination of direct contact exposure pathway. · Surface water and groundwater monitoring. · Cover maintenance. For cap or containment:

Table 1.9. Summary of RI Report Uncertainties (Continued)

SWMU	Uncertainty Description	Response and Citation of Discussion in FS
	surface soil at selected SWMUs.	· Geophysics to fully delineate burial cells. · A cover or cap will be engineered to reduce infiltration and manage runoff. · Reduced infiltration to further immobilize contaminants (see Appendix B). · Elimination of direct contact exposure pathway. · Surface water and groundwater monitoring · Leachate collection and treatment. · Cap maintenance. For DNAPL source treatment: · Sampling and laboratory analysis for determining extent of DNAPL source sample collection may be augmented by membrane ion probe surveys. Remediation will not be considered complete until verified by postremediation sampling or long-term monitoring, or both. Appendix E contains area and volume assumptions for remediation and cost estimates, including postremediation sampling. An FS cost estimate assumes -30%/+50% accuracy to account for some degree of site uncertainty.
Global	Uranium mobility	Uranium modeling demonstrates that uranium is essentially immobile. In addition, alternatives evaluated for the FS either removes or further immobilizes uranium. See features of alternatives mentioned above.
	Whether waste has been completely or partially released from buried drums.	A discussion of drum integrity is cited earlier in this section. The features of the remedial alternatives described in this table also address this uncertainty. Appendix B analyses for infiltration reduction also are relevant.
	The uncertainty associated with the 1,000-year time horizon used in the groundwater modeling effort and the ingrowth of uranium-238 daughters after 1,000 years.	This uncertainty was discussed in the RI Report (Appendix E, DOE 2010b). The ingrowth of uranium-238 daughters is slow, such that the contributions of uranium-238 daughters and their related radiation doses to an exposed worker will occur over the next 100,000 to 1 million years. The mechanism, time frames, and activity concentrations for uranium-238 daughter ingrowth is discussed in more detail in Appendix B.
	Whether arsenic and other metals are COCs for future residential groundwater users and whether their concentrations might exceed regulatory limits in the RGA.	The BGOU is a source removal action, not a groundwater action. MCLs and risk-based concentrations in groundwater are used only to develop groundwater protective soil preliminary remediation goals (PRGs), as described in Section 2 and Appendix C.

Table 1.9. Summary of RI Report Uncertainties (Continued)

SWMU	Uncertainty Description	Response and Citation of Discussion in FS
2	Cesium-137 exceeds NALs and background at one location (sample 2-15) within the SWMU boundary, but the cesium-137 sample location is in the drainage ditch in the southern portion of the SWMU. As such, it will be considered by the Surface Water OU and is excluded from the BGOU scope.	See Appendix A, Figure A.1.
	Whether TCE and/or Tc-99 are present at the bottom or the waste cells at levels that will exceed MCLs in the RGA within 1,000 years.	Postremediation sampling is included in all excavation alternatives. Appendix B provides an evaluation of the groundwater protectiveness of a cover based on the degree of infiltration reduction the cover provides. In the cases of both TCE and Tc-99, concentrations in excess of the maximum observed concentrations at SWMU 2 could remain, and groundwater would be protected with appropriate infiltration reductions. The maximum observed concentrations in Table B.1 are associated with samples collected from under or near the source areas, but not directly from the buried waste materials and affected soils. As a result, the maximum TCE concentrations may not have been identified at this SWMU. Because the shallow groundwater has saturated the waste at SWMU 2, it is possible that the vertical infiltration reduction provided by a cover would require augmentation by lateral infiltration reduction via a vertical barrier and shallow groundwater extraction. Appendix B also shows the rates for TCE degradation.
	Whether COCs have migrated into a subgrade electrical conduit underlying SWMU 2 and/or outside the current SWMU boundary.	This conduit is described in Figures 5.1 and related text. Cost for engineering data collection prior to remediation and postremediation sampling to determine conduit status is in Appendix E.
2	Whether waste has been completely or partially released from drums into the environment and whether modeling has correctly predicted the extent of future TCE migration.	See response to global uncertainty regarding drum integrity.
	Because the RI Report risk assessment for SWMUs 2 and 3 did not evaluate an outdoor worker scenario, develop the PRGs for the outdoor worker scenario for these SWMUs using the full list of COCs for the residential soil direct contact receptor, which is expected to be the inclusive.	The RI Report risk assessment for SWMUs 2 and 3 did not evaluate an outdoor worker scenario for soil, but did evaluate hypothetical exposure to an adult or child resident to off-site groundwater. The COCs for SWMU 2 and SWMU 3 include COCs identified through the assessments of both the on-site industrial worker for soil and off-site groundwater user. Because the soils PRGs were developed to include protection of groundwater, these lists are the most comprehensive possible for each SWMU based on the RI Report risk assessment. This is addressed in Section 2.2.3 on Remediation Goals.

Table 1.9. Summary of RI Report Uncertainties (Continued)

SWMU	Uncertainty Description	Response and Citation of Discussion in FS
	Whether PCBs exist within the waste at levels that would present a direct contact risk to a future outdoor worker, given that PCBs were detected at 4.2 mg/kg in a sample in waste located at 10 ft bgs.	This uncertainty was addressed in the June/July 2009 scoping meetings and throughout this document, which incorporates a 10 mg/kg target for Total PCBs in soil. Excavation alternatives include postremediation sampling. Cover alternatives provide containment for PCBs should they be present in concentrations above 10 mg/kg.
2	Some discharge has been observed to the ditch south of SWMU 2.	If waste remains in place, shallow groundwater monitoring would be conducted to determine if any contaminants leach from the SWMU to the ditch.
	Whether DNAPL is present after soil/waste excavation is complete.	Alternative 7 in Section 5.4.3 addresses this uncertainty.
3	Whether subsurface arsenic exists above background concentrations, although the likelihood is considered low.	A comparison of the observed concentrations for arsenic and other naturally occurring metals to PGDP background was performed. Based on the results of this comparison, arsenic was not determined to be an important COC for alternative screening and evaluation. This will be further examined as part of postremediation activities for some alternatives (i.e., excavation).
	Whether the existing Subtitle C cap presents a radiological surface risk to industrial workers or presents hotspot risks, although the likelihood is considered low.	The excavation/penetration permit (E/PP) will prevent site workers from conducting work that would penetrate the cap. Include additional soil cover if the cap is left in place to prevent unacceptable exposure risk. Cap materials will be properly characterized and disposed of as necessary if an excavation alternative is implemented.
	Whether waste in drums has been released into environment.	A general review of drum integrity is presented earlier in this section.
	Whether the operating water pipe cutting through the southeast portion of the SWMU is a conduit for lateral contaminant migration and will significantly impact the implementation of a response action.	This is addressed in Section 6.4 and included in the excavation alternative cost estimates (Appendix E).
7	Whether DNAPL is present.	A contingency for remediating DNAPL, should its presence be confirmed, has been included in the alternatives evaluated for SWMU 7. Recognizing that buried construction debris may interfere with identification and remediation also has been considered in the alternatives. This uncertainty is addressed in Section 7.
	Whether buried materials will interfere with potential TCE characterization and treatment options, although the likelihood of this occurrence is considered to be low.	See previous response.
30	SWMU 30 uncertainties.	Addressed previously under global uncertainties.

1.4.2.1 Uranium mobility

Uranium Data. The analytical results for uranium-235 are reported in the WAG 3 risk assessment either as uranium-235 or uranium-235/236 in some soil and groundwater samples from SWMUs 7 and 30 (DOE 2000). The identification of combined uranium-235/236 isotopes for some samples is due to the difficulty of differentiating between uranium-235 activity and uranium-236 activity. This uncertainty is expected to be minor because the same PRG value is calculated for uranium-235 and uranium-235/236 in the risk assessment (DOE 2000), and the same applicable PRG for soil was developed for both in Section 2. The trace amounts of uranium-236 at PGDP originated from reactor recycled uranium. Less than 10% of the material handled at PGDP was reactor recycled uranium; 0.002% of the reactor recycled uranium would be uranium-236. The important isotopes in assessing risk at PGDP are uranium-234, uranium-235, and uranium-238; therefore, these are the critical uranium isotopes that must be analyzed for in material at PGDP.

The preliminary surface and subsurface soil PRGs developed for uranium-235 are applied to uranium-235/236 for the development of remediation alternatives at SWMUs 7 and 30. If the same PRG concentration were to be carried through the cumulative risk assessments and radiological dose assessments for both uranium-235 and uranium-236 at SWMUs 7 and 30, the cumulative risk and total radiological doses estimated are expected to be overestimated by the contribution of the uncertain uranium-236 concentration. Section 2 shows that the radiotoxicities of uranium-235 and uranium-236 are sufficiently similar that the uncertainty introduced by uranium-236 is small so that remediation alternatives for these SWMUs can be based on the uranium-235 PRG alone. This uncertainty will be mitigated by analysis of future postremediation samples by analytical methods that can speciate both uranium isotopes, allowing more accurate cancer risk and radiological dose estimates.

Uranium Mass Estimate. BGOU RI soil sample analytical data from each SWMU were evaluated to develop assumptions for the remedial alternatives. The available data indicate that uranium concentrations below the waste layer decrease to background levels, consistent with the known mobility of uranium in soils. These concentrations do not exceed the PRGs established in the FS; however, postremediation sampling will be required to verify that these assumptions are correct and that uranium contamination above target concentrations can be remediated by excavation.

Uranium Transport Modeling. There was uncertainty associated with the 1,000 year time horizon used in the groundwater modeling effort and the ingrowth of Uranium-238 daughters after 1,000 years. The fate and transport modeling for the RI, as documented in Appendix E of the RI Report (DOE 2010b), uses a K_d of 66.8 mL/g to minimize the potential of eliminating uranium as a COC so that it could be properly addressed in the BGOU FS. The ingrowth of uranium-238 daughters is slow, such that the contributions of uranium-238 daughters and their related radiation doses to an exposed worker will occur over the next 100,000 years. The mechanism, time frames, and activity concentrations for uranium-238 daughter ingrowth are discussed in more detail in Appendix B.

1.4.2.2 Nature of the source zone

The BGOU RI did not conduct intrusive sampling in the existing burial cells. As a result, specific waste characterization data are limited. Historical records and data, past observations, and waste disposal documentation referenced in the BGOU RI Report were used to supplement the RI data to establish the basis for selecting remedial alternatives and preparing cost estimates for those alternatives (DOE 2010b). A key project assumption for the FS is that the available historical documentation and soil and groundwater characterization data are sufficient relative to waste characteristics, to chemical and physical properties, and to waste volume estimates to evaluate general response actions, to screen technology types, to develop effective alternatives, and to conduct a detailed alternative analysis. While the RI field investigation sampled directly beneath the waste units using angled borings, it remains possible that the buried waste contains hazards or constituents that current sample results do not characterize (historical disposal records and waste manifests are incomplete).

Many of the SWMUs have been investigated previously. The BGOU RI used a combination of historical and current sample results of soil and groundwater from the area of each SWMU. The results of previous investigations, as well as the recent RI sampling, documents the presence or absence of metals, organic compounds, and radionuclides in the Burial Grounds. The associated samples were collected and analyzed over several previous and continuing investigations, as well as in the BGOU RI, using several methods. Changes to analytical methods and variations in detection limits restrict a rigorous comparison of data (e.g., laboratory reporting limits have varied over time). During development of the BGOU RI Work Plan, it was decided to limit the historical sample analyses used in the RI to groundwater samples collected in January 1995 and later and soil samples collected in June 1996 and later to minimize the potential for “age” to bias the analysis of the data. This approach maximized the number of historical sample analyses available to the RI, while providing a reasonable assurance of the comparability of the data. There are limited MWs in close proximity to many of the SWMUs that would allow analyses of seasonal variations and analyte trending, but temporary borings provide a snapshot of the conditions where groundwater samples could be obtained.

Maximum COC Concentrations May Not be Known. Because only limited source-term data are available, it is possible that the maximum concentration of the COCs present at the SWMUs have not been established; however, sufficient data exist to determine if an action is needed at each unit. Although these uncertainties exist, postremediation sampling and groundwater monitoring performed in conjunction with implementation of individual remedies will satisfy the RAOs. Screening of technologies and development of alternatives considered this uncertainty. In consideration of this uncertainty, the screening of technologies and development of alternatives included best engineering judgment to ensure that alternatives were developed to provide protection of human health and the environment. In addition, the uncertainty concerning the maximum concentration has been considered in the selection of the alternatives by recognizing the general transport and fate mechanisms and their potential impact on maximum concentrations.

Approach for Addressing the Limited Source Term Data in the FS. The PRGs for the BGOU were developed based on exposure pathways and either direct contact risk levels or soil concentrations protective of groundwater. The SWMUs were evaluated for the FS by comparing actual soils data adjacent to or beneath each SWMU to the PRGs to determine if an action is needed. The comparison of soils data to PRGs complemented the modeling data performed in the RI and helped to better identify the specific locations and depths of contamination that warranted remedial action.

1.4.2.3 Acid leachate, oxidation/reduction conditions, and degree of waste saturation

Historically, DOE finds no evidence of acidic leaching from the BGOU SWMUs; however, the potential for acidic leachate at each SWMU is uncertain due to the lack of disposal records and the amount of time elapsed since disposal. It is unlikely that any acid moieties remain. Any change from this baseline condition would be detected by monitoring and addressed as part of the Five-Year Review.

Uncertainty exists with regard to the dissolved oxygen in the UCRS. Data from all BGOU SWMUs combined demonstrate the trends of dissolved oxygen (517 measurements) and oxidation/reduction potential (136 measurements) in the UCRS. The relative abundance of measurements demonstrates a trend that appears to be representative of conditions across the BGOU.

Although there is some potential for some wastes to be intermittently present in saturated conditions, this condition does not materially affect the alternative evaluation. The selected alternatives will need to include technologies that take into account any groundwater that is encountered by removing, isolating, or containing the waste or providing a mechanism to dewater the waste.

For SWMU 2, where the last disposal occurred more than 30 years ago, it is reasonable to assume most, if not all, drums have failed (an Oak Ridge National Library researcher estimated that drum failure would be expected to occur within 18 to 36 years). For SWMUs 7 and 30, it can be assumed that drums likely are breached, since they were dumped rather than being carefully stacked. Because all drummed waste was assumed to have been released to the environment during disposal or through degradation, samples from soils surrounding the buried wastes were used to evaluate potential contaminant migration and risks associated with the SWMUs. The risk assessment concluded that these uncertainties related to the source zone were not estimated to have a large effect on the risk characterization.

1.4.2.4 Extent and volume of source zone and secondary sources (TCE DNAPL)

There remains some uncertainty with regard to the boundaries of the burial cells. Geophysical surveys have not been completed across the entire area of all SWMUs. Engineering drawings and currently assumed burial cell extent were used as the basis for FS assumptions; however, to manage this uncertainty, a geophysical survey potentially will be needed and specified in the Remedial Design Work Plan (RDWP) to optimize planning/implementing the selected alternative, as appropriate.

Secondary sources of groundwater contamination that are derived from the BGOU SWMUs, such as the potential DNAPL source zone beneath SWMU 2, and in the vicinity of the shared border between SWMUs 7 and 30, are within the scope of the BGOU for evaluation and remedial action. The evidence for UCRS DNAPL presence is documented in previous investigations (DOE 2007; DOE 1998a) and discussed in the RI. Sample data suggest a potential DNAPL in the UCRS at SWMUs 7 and 30. There also is potential for a TCE DNAPL at SWMU 2 based on historical disposal records; however, sample data provide little evidence of a DNAPL source. The volumetric extent of secondary source contamination has been approximated and constitutes a project assumption for evaluation of the alternatives.

Assumptions Used for Area, Depth, and Volume of Contaminant Source Areas are Based on Available RI Data. Assumptions are made regarding the area, depth, and volumes of contaminated source areas throughout the different SWMUs. To address these issues, engineering data collection to support technology sizing, design, and optimization will be included as a component for remedial alternatives where additional information regarding the source term is needed to support the detailed design of the alternative. These assumptions are discussed below.

A VOC source, possibly DNAPL, is suspected at SWMUs 2 and in the vicinity of the shared border between SWMUs 7 and 30 (UCRS). As part of the remedial design (RD) of a potential source action at SWMUs 2 and 7, engineering data collection will be performed to support technology sizing, design, and optimization to determine the placement of the source action wells or system components.

The vertical extent of TCE contamination in soil attributable to SWMU 2 is uncertain. Additional evaluation will be required to determine if TCE from SWMU 2 actually is impacting groundwater. Based on the RI data, it is likely that most, if not all, TCE contamination would be remediated if an alternative involving excavation is implemented.

Groundwater monitoring at SWMU 2 (primarily as facility monitoring for adjacent SWMU 3) continues to demonstrate the presence of upgradient TCE contamination of the RGA, which masks the potential impact of TCE contamination from SWMU 2. This contamination previously has been associated with the Southwest Plume (derived in part from the south end of the C-400 Cleaning Building), located to the east of SWMU 2, but also may originate from SWMU 4, located to the immediate south of SWMU 2. Another potential source area to the Southwest Plume is the C-720 Building area. DOE currently is planning or implementing response actions to address these sources of TCE. As these response actions reduce the upgradient TCE contamination level, the contribution of SWMU 2, if any, to dissolved TCE in the RGA will be better defined.

Removal of COCs from Soil and Waste Layers. For alternatives that involve excavation, it is assumed that excavation will remove all COCs present in soils from the surface to approximately 20 ft below grade. Based on evaluation of RI data, the COC concentrations present in Layers 4-7 (20 to 64 ft bgs) are representative of residual values that are below PRGs, and RAOs should be met for radioactive and inorganic COCs. Residual DNAPL contamination should be remediated by implementing an appropriate alternative for these contaminants.

Previous work has shown that the primary pathway for groundwater flow and the site-related contaminants is vertical migration through the UCRS, followed by lateral migration in the RGA. Contaminated groundwater could migrate to the POEs identified in the RI Report for the BGOU SWMUs at the plant boundary, property boundary, surface seeps at Little Bayou Creek, and near the Ohio River. While there is some uncertainty related to modeling in predicting whether a SWMU would contribute to the Little Bayou seeps or the Ohio River, this uncertainty has almost no effect on the modeled contaminant concentrations used to develop PRGs and should not affect remedial decisions.

Use of Postremediation Sampling to Reduce Uncertainties. During the FS, PRGs are established that are protective of the groundwater exposure pathway or direct contact, if more restrictive. The soils at the SWMUs have been adequately characterized during the BGOU RI to identify that there are current exposure risks, and the data are sufficient for selection of appropriate remedies to mitigate those risks to acceptable levels. Without understanding the full nature and extent of contaminant sources or concentrations, uncertainty is managed by specifying postremediation sampling and groundwater monitoring, as appropriate, during implementation of the selected remedy to verify that target concentrations are met. No additional analyses for characterization are required, except to support waste management if needed.

Estimation of Waste Volumes for Remediation. This section presents the approaches applied to estimating the volumes of waste to be remediated at the BGOU SWMUs.

As part of the excavation alternative, it was assumed that selected SWMUs will require excavation. In general, the volume of waste to be excavated was estimated based on the areal footprint of the SWMU and an assumed excavation depth not to exceed 20 ft bgs. This depth is several ft deeper than the greatest disposal depth reported for any of the SWMUs and corresponds to the bottom of SADA modeling Layer 3. If documentation was available indicating that only a portion of the SWMU was used for waste disposal, the volume of waste material was reduced by an estimated percentage corresponding to the volume of soil that is not likely to have been impacted by contact with wastes. This was accomplished by evaluating the historical layout figures for each SWMU and estimating the volume of the SWMU likely to be in contact with waste, based on the size and position of disposal cells within the SWMU.

If an alternative that includes application of a cover to the SWMU was considered, the reported surface area of the SWMU, plus an additional buffer, was assumed for development of an estimate for installing a cover.

The RI Report concludes that DNAPL may be present in soil beneath SWMU 7. This DNAPL is assumed to be confined to the UCRS. In addition, DNAPL potentially is present in the soils beneath SWMU 2. The estimated volumes of soils potentially affected by DNAPL were developed for the affected SWMUs.

The DNAPL contamination potentially present at SWMU 2 and SWMU 7 is assumed, based on available data, to be confined to the UCRS; therefore, the volumes of soil to be remediated at these locations were calculated as follows:

(1) Begin at the top of SADA Layer 4 because Layer 3 is the estimated lower extent of waste excavation. (DNAPL/high VOC concentration contamination in Layers 1 to 3 were not included in these determinations because it is assumed that contamination in the upper layers either will be removed by excavation or contained by some combination of physical barriers.)

(2) Identify the specific samples for which the VOC concentrations exceed the PRG protective of groundwater and, based on the mapped waste cells around the samples exhibiting VOC concentrations above the PRG, establish the area requiring remediation. The treatment areas for both SWMUs 2 and 7 are estimated to be approximately 75 ft by 75 ft.

(3) Assume the contamination extends to a total depth of approximately 65 ft bgs to the top of the RGA for SWMU 2 and for SWMU 7 (corresponding to a contaminated soil thickness of approximately 40 ft, ranging from the top of Layer 4 to the bottom of Layer 7). This approach yields an approximate volume of 8,000 yd^3 of soil for treatment/remediation of DNAPL in the UCRS at SWMU 2 and SWMU 7. To provide for an estimate of the mass of VOC-contaminated soils, the masses reported from the SADA geostatistical model of the SWMU subsurface have been used in this estimate; however, the actual sampling data were used to establish the expected location and limits of the treatment cells.

It is anticipated that the extent of DNAPL contamination at these SWMUs will be more fully delineated during the RD. None of the other BGOU SWMUs is believed to contain a DNAPL source based on the BGOU RI Report (DOE 2010b).

1.4.2.5 Limited groundwater monitoring around SWMUs

The assumption carried forward from the BGOU RI is that all of the materials disposed of in the SWMUs potentially contained hazardous and/or radioactive materials. The conceptual model applicable to all of the BGOU SWMUs is that releases from the SWMUs have impacted soils below or immediately adjacent to the source zones and, through vertical infiltration in the soil, have the potential to contaminate the groundwater underlying these sources.

While the transport modeling conducted for the RI necessarily made simplifying assumptions, the data were adequate to identify the COCs, determine their contribution to risks to human health, and develop PRGs for evaluating alternatives. To the extent practicable, the modeling approach simulated actual PGDP site conditions using, as an example, K_ds for metals in soils based on acidic soils with a low cation exchange capacity, consistent with known site conditions. Uncertainty still exists with respect to source material because of limited source data.

1.4.2.6 Potential for leachate from burial areas to impact adjacent surface water ditches

Another potential pathway that exists at SWMUs 7 and 30 is lateral seepage from the burial cells into nearby ditches. The SWMUs 7 and 30 RI Report reported that water was observed emanating from the slope of the ditch following a heavy rainfall (DOE 1998a). It is uncertain whether the seepage was derived from the burial cells. The RI report concluded that uranium isotope activity ratios argued against waste burial cell waters as contributors to surface water contamination. Likewise, some discharge of shallow groundwater in the ditch south of SWMU 2 has been observed, but the report was unclear as to the contribution of contamination to the ditch (the report concluded that contaminant migration to Outfall 015 and Bayou Creek is unlikely to exceed PRGs) (DOE 1997). This FS will consider the pathway for leachate flow from the BGOU SWMUs to adjacent surface water features. Waste excavation will eliminate this pathway. A cover or cap will be engineered to reduce infiltration and manage runoff. This or any other remedial alternatives that leaves waste in place will be augmented by shallow groundwater monitoring to understand the extent, if any, to which contaminants leach from the SWMU to the ditch.

1.4.2.7 Nature and extent of contaminants in surface soil

Delineation Uncertainties. PRGs established in the FS are protective of both the direct contact and groundwater exposure pathways. Alternatives include address containment, removal or treatment of soils to meet the PRGs, as applicable. In a removal alternative, uncertainties regarding the extent of contamination above the PRGs will be managed by excavation guided by postremediation sampling until the effectiveness of excavation is demonstrated or by groundwater monitoring where target concentrations cannot be met in the subsurface soils or media.

Animals that burrow to 5 ft bgs would be expected to encounter ecological COPCs located in Layers 1 and 2, which extend to 10 ft bgs. Because these soils are the only media that would affect ecological receptors and are addressed in the FS by removing Layers 1 through 3 at the SWMUs during waste excavation or, if waste is left in place, selecting an alternative that places an appropriate surface barrier over the soils of interest to prevent contact with residuals also would prevent exposure by ecological receptors.

1.4.2.8 Cost estimate between -30% and +50%

The unknowns associated with source, volume, and characterization information related to waste types and volumes for treatment and/or disposal add uncertainty to the development of remedial cost estimates. Assumptions for these parameters were used to develop costs. Cost estimates are provided in Appendix E. SWMU-specific removal alternatives associated with SWMUs 2 and 7 include the potential for implementing contingent treatment remedies should removal to 20 ft bgs not be sufficient to meet PRGs; however, the cost to implement contingent treatment remedies is not considered during cost evaluation.

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2. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

RAOs and PRGs for potential remedial actions are introduced and developed in this section. In addition, technology types and process options that may be applicable for remediation of BGOU sources are identified, screened, and evaluated in this section. A primary objective of this FS is to identify remedial technologies and process options that potentially meet the RAOs for this action and then combine them into a range of remedial alternatives. The potential remedial technologies are evaluated for implementability, effectiveness, and relative cost in eliminating, reducing, or controlling risks to human health and the environment. The criteria for identifying, screening, and evaluating potentially applicable technologies are provided in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) and the NCP.

CERCLA requires development and evaluation of a range of responses, including a No Action alternative, to ensure that an appropriate remedy is selected. The selected final remedy must comply with ARARs, unless waived, and must protect human health and the environment. The technology screening process consists of a series of steps that include the following:

- Identifying general response actions (GRAs) that will meet RAOs, either individually or in combination with other GRAs;
- Identifying a volume or area of media to which the GRA will be applied;
- Identifying, screening, and evaluating remedial technology types for each GRA; and
- Selecting one or more representative process options (RPOs) for each technology type.

Following the technology screening, the RPOs are assembled into remedial alternatives that are evaluated further in the detailed and comparative analyses of alternatives.

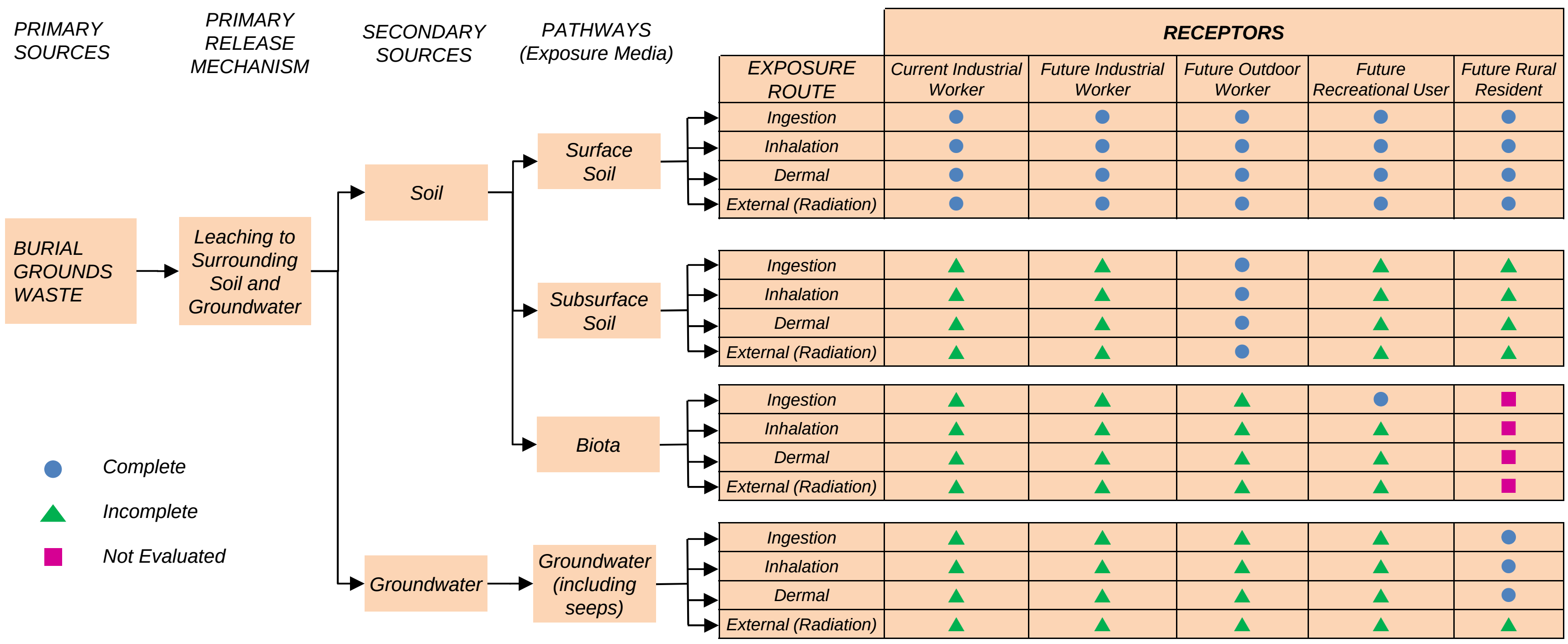
2.1 INTRODUCTION

Previous PGDP investigations and reports used to develop the CSM and to identify and screen remedial technologies are listed in Section 1. Other sources used in technology identification and screening, including EPA, DOE, and peer-reviewed databases, reports, and journal publications, are cited and the references are provided in Section 9.

Technologies are identified and evaluated in this FS based on their effectiveness in reducing or eliminating the primary sources.[3] Primary sources fall into two broad categories based on their physical and chemical properties: (1) VOCs to include TCE, TCE degradation products, and other chlorinated solvents; and (2) radioactive materials and inorganic chemicals. Technologies also are identified and evaluated for their effectiveness in reducing or eliminating secondary sources[4] such as DNAPL originating from primary VOC sources, eliminating or mitigating the secondary release mechanisms, or eliminating the exposure pathways, as shown in the CSM of the BGOU source areas (Figure 2.1).

[3] A primary source is contamination present in the waste material disposed of in a waste management unit.

[4] A secondary source is contamination caused by the presence of contaminants that have migrated outside of the waste management unit.



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 2.1 Conceptual Site Model for BGOU

LATA Environmental Services of Kentucky, LLC

Figure 2.1 is based on Figure F.1 of the *Remedial Investigation Report for the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0030&D2/R1, February (DOE 2010).

Other COCs that occur infrequently at the BGOU are nonvolatile organic chemicals such as PCBs and PAHs. These COCs could drive specific response actions, but are amenable to some of the same physical treatment remedial technologies identified for radioactive/inorganic COCs, but technologies also were evaluated for remediation of these classes of contaminants.

RPOs were developed from the appropriate technology types necessary to address the physical and chemical nature of the contamination at each SWMU. Alternatives were developed by combining the appropriate RPOs to remediate the full scope of contamination at each SWMU, including, in some cases, both radioactive/inorganic and DNAPL contamination-source RPOs.

2.2 DEVELOPMENT OF RAOs

The RAOs for the BGOU FS, developed in accordance with NCP requirements, consist of site-specific goals for protecting human health and the environment (EPA 1988) and meeting ARARs (in the absence of a CERCLA waiver). The RAOs were developed from the CSM and the BHHRA results by identifying the COCs and their sources, as well as the contaminant migration pathways and exposure scenarios that the action will address.

2.2.1 Allowable Exposure Based Upon Risk Assessment (Including ARARs)

ARARs include federal or more stringent state environmental or facility laws/regulations that are applicable or relevant and appropriate to the hazardous substances or circumstances at a site unless a CERCLA waiver is granted. ARARs do not include occupational safety or worker protection requirements. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site (40 *CFR* § 300.5). Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site (40 *CFR* § 300.5). In addition to ARARs, there are advisories, criteria, or guidance to be considered (TBC) for a particular release that were developed by other federal agencies or states that may be useful in developing CERCLA remedies. These are not potential ARARs, but are TBC guidance [40 *CFR* § 300.400(g)(3)]. CERCLA § 121(d)(4) provides several ARAR waiver options that may be invoked, provided that human health and the environment are protected. Additional ARAR discussion is presented in Appendix F.

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

There are no chemical-specific ARARs for remediation of the contaminated soils at the source areas with identified COCs; however, soil PRGs, including PRGs for radionuclides, were developed based on both direct exposure and migration from soil to groundwater. The Kentucky drinking water standard MCLs were used to back calculate soil PRGs (see 401 *KAR* 8:250 for inorganic compounds, 8:420 for VOCs, and 8:550 for radionuclides), but are not ARARs for this source action.

2.2.2 RAOs

RAOs are goals for protection of human health and the environment. RAOs provide a general description of what a CERCLA cleanup is designed to accomplish. The BGOU FS evaluates taking actions as necessary to protect human health and the environment from the BGOU waste units and addressing potential releases from these source areas that may impact RGA groundwater or adjacent drainageways. The following general RAOs were developed:

(1) Contribute to protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination;

(2) Prevent exposure to waste and contaminated soils that present an unacceptable risk from direct contact; and

(3) Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

The BGOU waste areas are located within the secured area of the PGDP facility, and reasonable future use of this area is expected to remain industrial with controlled access. This FS evaluates alternatives designed to eliminate direct contact with wastes to ensure no risk to future outdoor workers.

The general RAOs for protection of groundwater and direct contact to soils are refined to more specifically guide the alternative selection process in this FS. These SWMU-specific RAOs are as follows. These RAOs are further refined in the SWMU-specific sections of the document to include COCs identified at each SWMU.

SWMU-specific RAO for protection of groundwater. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination that could result in an exceedance in RGA groundwater of the MCL (or risk-based concentration for residential use of groundwater in the absence of an MCL).

SWMU-specific RAO for protection of direct contact with waste. Prevent exposure to waste that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Waste: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for a future outdoor worker

SWMU-specific RAO for protection of direct contact with contaminated soils. Prevent exposure to contaminated soils that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

Where the general RAO to address PTW applies (SWMUs 2, 3, and 7), it is restated as a SWMU-specific RAO.

SWMU-Specific RAO for PTW. Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

The SWMU-specific RAO may not fully address the general RAO for those direct contact risks that are more appropriately addressed in other programs and are not within the scope of the BGOU. Specifically, no PRGs will be identified in this FS to address potential ecological impacts.

The sitewide baseline ecological risk assessment is where cumulative effects to ecological receptors will be evaluated. COPCs identified in the SERA will be incorporated into that evaluation. Most of the impacts identified in the SERAs for these SWMUs were for drainageway or surface soil samples adjacent to the burial ground areas that did not result from migration from the waste. No significant ecological risks were identified that required short-term actions at these SWMUs. In addition, addressing human health risks within the SWMU boundaries would be expected to also reduce exposures to these receptors.

Additionally, DOE has included land use controls (LUCs) that will be implemented where waste is left in place or source area-related contamination remains after active remediation that precludes unrestricted use.

2.2.3 Preliminary Remediation Goals

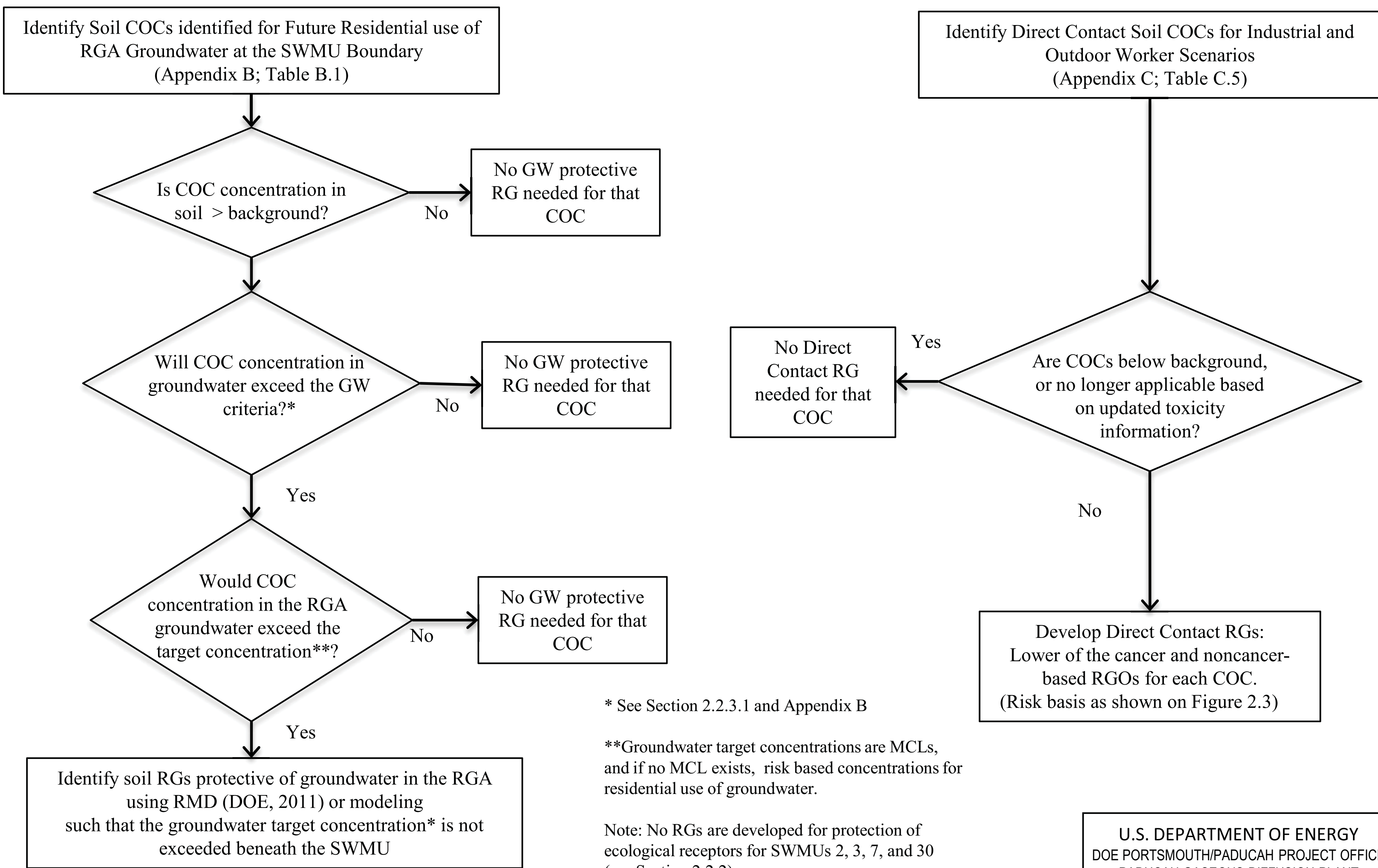
Consistent with Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-04, *Land Use in the CERCLA Remedy Selection Process,* DOE, EPA, and Kentucky have determined that the reasonably anticipated future use for the area of the PGDP that includes the burial grounds is industrial. This future use is consistent with continued use of these SWMUs as burial grounds. Nevertheless, the BHHRA for these SWMUs evaluated a full range of potential future uses including residential to ensure that the FS would evaluate methods to control threats that exceed risk levels acceptable for unrestricted future residential use. To address threats associated with future uses more restrictive than industrial, LUCs will be instituted as part of that alternative that leaves waste in place or where source area-related contamination remains after active remediation at levels that preclude unrestricted use. The purpose of the LUCs will be to prevent exposure to future receptors that could result in unacceptable risk to them. The LUC program for the BGOU is discussed in Section 2.4.1.1.

The PRGs are media-specific goals that serve as the basis for identifying and screening the treatment processes or mass removal and containment efficiencies required for the alternatives developed in Section 3. PRGs for chemicals that have the potential to impact RGA groundwater are derived differently than those to protect workers from exposure to contaminants in soil. An overview of the PRG development process is shown in Figure 2.2.

The COCs identified in the BHHRA are the constituents for which PRGs potentially are to be developed. This list was refined in Section 1.3.6 to identify the target compounds for which PRGs are to be developed for this FS. This included eliminating COCs that are at or below background and modifying the list based on updated toxicity and exposure assumptions. Evaluation of potential alternatives to meet the RAOs and corresponding development of soil PRGs protective for future workers or groundwater has the following additional considerations.

- The BHHRA identified risks to the outdoor worker based on contact with contaminants in surface and subsurface soils (0–16 ft). PRGs for surface soil are to be based on the future industrial worker. To

Alternatives must meet the RAOs for Direct Contact and Protection of Groundwater



* See Section 2.2.3.1 and Appendix B

**Groundwater target concentrations are MCLs, and if no MCL exists, risk based concentrations for residential use of groundwater.

Note: No RGs are developed for protection of ecological receptors for SWMUs 2, 3, 7, and 30 (see Section 2.2.2).

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Figure 2.2. PRG Development

meet the RAO, PRGs for the outdoor worker would be derived only for those COCs present in the subsurface soil (1–16 ft bgs).

· Chemicals identified as COCs for the future workers that are present only in the drainageways, are not a result of releases from the waste units, and addressed in the SWOU may be more appropriately managed within the decision process for the Surface Water OU. This is considered on a SWMU-specific basis.

The PRG derivation, as well as the technologies/alternatives to address the potential risks from exposure pathways, is considered independently in this FS; however, the final remedy will address both pathways to meet the RAOs. Figure 2.3 highlights the potentially applicable PRGs and the implications for evaluating the depth to which these apply.

Section 2.2.3.1 provides a summary of the derivation of PRGs for protection of groundwater, which is presented in greater detail in Appendix B. Section 2.2.3.2 summarizes the PRGs for protection of workers from direct contact exposures, which are discussed in detail in Appendix C. The primary risk associated with direct contact remains associated with direct contact with buried wastes.

2.2.3.1 Soil PRGs for groundwater protection

The BHHRA identified COCs for use of RGA groundwater based on risks for modeled concentrations in the RGA at the SWMU boundary. 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 POEs. In the FS, the objective of a remedial action is to reduce the impact to human health and the environment to acceptable levels. Modeling was conducted to establish the acceptable levels of COCs in soil that may not result in contributions to the RGA groundwater that would exceed MCLs or appropriate risk-based concentrations beneath the waste disposal area within the SWMU. These PRGs, as developed in Appendix B, are summarized in Table 2.1 for the target compounds. Figures showing the distribution of these COCs are presented in Appendix A.

Table 2.1. Soil PRGs for COCs Identified for Potential Impacts to RGA Groundwater

SWMU	COC	MCL* (mg/L)	Groundwater Protective PRG for Soil (mg/kg) (pCi/g)**
2	Arsenic	0.01	Background
	cis-1,2-DCE	0.07	1.34
	TCE	0.005	0.311
3	Tc-99	4 mrem/yr[a]	38.5
7	Arsenic	0.01	Background
	1,1-DCE	0.007	0.773
	TCE	0.005	0.234
	Tc-99	4 mrem/yr[a]	38.5
	Vinyl chloride	0.002	0.533
30	Tc-99	4 mrem/yr[a]	38.5

mg/L except Tc-99, which has units of mrem/yr.
**mg/kg for chemicals, pCi/g for Tc-99.
[a] MCL for beta and photon emitters.
MCLs from Table A.14 of the Risk Methods Document (DOE 2011a).
Tc-99 PRG, Table A.11 of the RMD (DOE 2011a) (adult, 4 mrem/yr).
Arsenic background—Surface soil 12 mg/kg; Subsurface 7.9 mg/kg.

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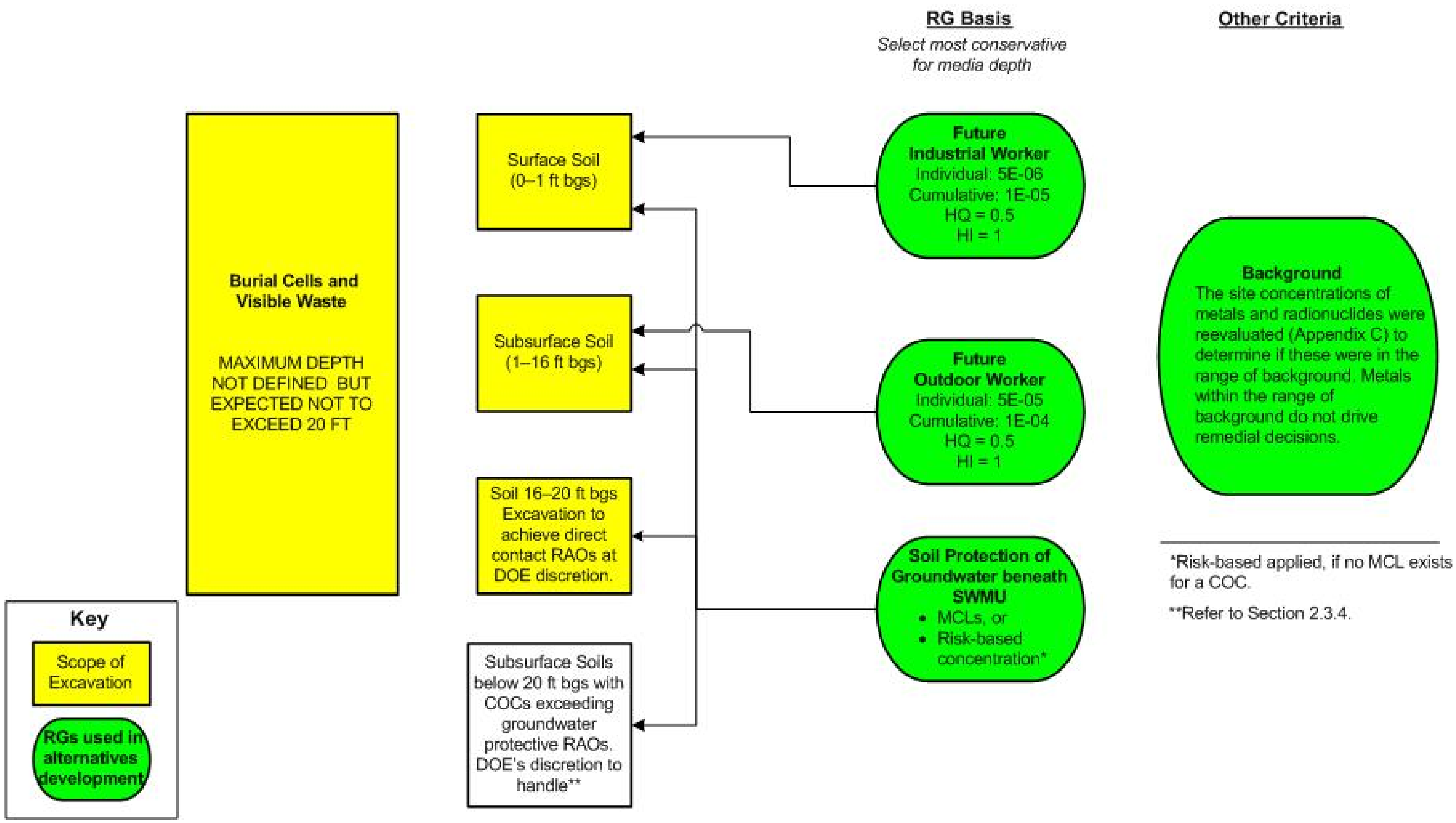

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Figure 2.3. BGOU Excavation Extent and Applicable PRGs

The PRGs in soil 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 MCL or a suitable risk-based concentration for those COCs that do not have an MCL. They 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-calculating the groundwater protective PRG in soil is consistent with the modeling approach used in the RI. It uses the same model parameters developed for the RI (as shown in Table 2.2) to determine if impacts to groundwater would result in unacceptable exposures at the PGDP boundary for each COC indicated as a threat to groundwater in Table 5.2 of the BGOU RI Report (DOE 2010b). The groundwater protective PRGs are protective of the RGA such that contributions from the SWMU would not impact groundwater at levels exceeding the MCL at the SWMU, and all downgradient concentrations should be lower.

Table 2.2. Site-Specific Soil and Aquifer Parameters for the BGOU SWMUs Used in Fate and Transport Modeling

Model	Parameter		Units	BGOU	Source
SESOIL	Soil Type		-	Silty Clay	BGOU RI Report, Table E.3.1, page E-22[1]
	Vadose Zone Dry Bulk Density		g/cm^3	1.46	
	Fraction of Organic Matter		-	0.0008	
	Intrinsic Permeability		cm^2	1.60E-10	
	Depth to water table		m	18.3 to 19.2	
	Percolation (Recharge Rate)		cm/yr	11	
AT123D	Hydraulic Gradient	SWMU 2, 3	m/m	2.00E-04	BGOU RI Report, Table E.3.2, page E-23[1]
		SWMU 7		3.00E-04	
		SWMU 30		3.60E-04	
	Hydraulic Conductivity		m/hr	19.05	
	Aquifer Bulk Density		kg/cm^3	1,670	
	RGA Thickness		m	9.14	
	Fraction of Organic Matter		-	0.0002	

[1] BGOU RI Report (DOE 2010b).

These COCs were reviewed consistent with the process identified on Figure 2.2 to determine which of these COCs requires development of an PRG to be protective of groundwater. The evaluation of these data is detailed in Appendix B. Those COCs that had concentrations below the MCL at the SWMU boundary, and modeling indicated the concentration beneath the SWMU would not exceed the MCL (based on a comparison of soil concentrations with the PRG) where not retained as target compounds for this FS.

The approach to developing groundwater protective PRGs for soil at each BGOU SWMU was based on data obtained from transport modeling used previously during the BGOU RI and is represented by Figures 2.2 and 2.3. The soil PRGs developed in this way are protective of groundwater in the RGA found below the respective SWMU. The period of model performance was 1,000 years.

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

- **Geostatistical Modeling of the Distribution of COCs in Soils at Each SWMU Using SADA.** 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 Appendix B Figure B.2) 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. The soil concentrations of COCs used for the modeling were based on data from the RI that represents the current concentrations in from soil below the SWMUs within the constraints of the type of sampling performed (e.g., diagonal borings). Uncertainties with the characterization of the source zone are discussed in Section 1.4.1 and Section 1.4.1.2.

- **Vertical Transport Modeling Using 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 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, 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.

- **Groundwater Transport Modeling Using AT123D.** This was used to estimate the groundwater concentrations at selected POEs downgradient of the SWMU to establish if and when groundwater concentrations will exceed the MCLs or risk-based criteria. 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 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 POEs. In the FS, the objective of a remedial action is to reduce the impact to human health and the environment to acceptable levels. Modeling was conducted to establish the acceptable levels of COCs in soil that may not result in contributions to the RGA groundwater that would exceed MCLs or appropriate risk-based concentrations beneath the waste disposal area within the SWMU.

The method for establishing the PRG followed the modeling methods used in the RI:

(1) SESOIL was used to model the transport from the source layer to the RGA, and

(2) AT123D was used to model dispersion in groundwater. A unit concentration was used in the source layer (L3) to establish the attenuation and dispersion of the COC during transport.

Then the groundwater target concentration (MCL or risk-based concentration) 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. For metals and radionuclides, this maximum soil concentration was compared to the established background concentration, and the higher of the two was chosen as the soil PRG protective of the groundwater exposure pathway. The modeling results for COCs at each SWMU are provided in Appendix B.

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 2010b). The following information is available for each SWMU model run in Appendix B of this FS:

- 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 2010b). 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 resulting groundwater protective PRGs for soil are shown in column 5 of Tables 2.1 and 2.2.

Simulating near-saturated or saturated conditions in SESOIL is difficult, due to the limitations of available input parameters. Moisture content in SESOIL is not an input parameter, but rather is calculated based on the values of other model inputs. Other parameters such as recharge rate and intrinsic permeability parameters directly affect moisture content values in SESOIL. While recharge rate cannot be modified directly in SESOIL, intrinsic permeability of the soil may be modified. Another method of increasing moisture content is to reduce the soil pore disconnectedness index in SESOIL; however, significant increases in saturation require soil pore disconnectedness index values that are unrealistic for the BGOU sites.

Conceptually, assuming an instantaneous source release with an increase in recharge and corresponding increase in the water table elevation, this would result in a shorter travel time to the water table with higher leachate concentrations. This is, in part, due to the shorter travel distance from the source, but also due to the additional recharge driving water through the unsaturated zone. There is less opportunity for chemical and physical processes such as biodegradation, adsorption, and volatilization to attenuate concentrations prior to reaching the water table; however, time to reach MCLs at the boundary should be lower since the majority of the mass would be flushed through the system faster. Based on this conceptualization, the SESOIL modeling is conservative with regard to time to reach the MCL, with more persistent concentrations at the boundary, but may under-predict concentrations at the water table.

2.2.3.2 PRGs for direct exposure to COCs in soil

The BGOU BHHRA identified several COCs for protection of future industrial or outdoor workers as summarized in Section 1.3.6, and refined to the target compounds to be addressed in this FS. To meet the SWMU-specific RAO for direct contact, the cumulative risk and hazard target criteria for future industrial worker direct contact to surface soil is to be below E-05 (ELCR) and 1 (HI) and for subsurface soil (1−16 ft bgs) below E-04 (ELCR) and 1 (HI) for the outdoor worker. These targets are within EPA's generally accepted risk range. The PRGs for the target chemicals are summarized on Table 2.3.

The industrial and outdoor worker NALs from the 2011 Risk Management Document were derived using default assumptions for exposures to workers from three routes of exposure: incidental ingestion, inhalation, and dermal absorption. These numeric criteria are based on a target risk for carcinogens of 1E-06 and a HI of 0.1.

As shown on Table 2.2, the PRGs for each COC [with the exception of arsenic and polychlorinated biphenyls (PCBs)] is set at one half the target cumulative ELCR and HI as follows:

- **Surface soils.** PRG concentration is set at 5 times the Industrial Worker NAL. This corresponds to an ELCR of 5E-6 and a hazard quotient (HQ) of 0.5.

· **Subsurface soils.** PRG concentration is set at 50 times the Outdoor Worker NAL for carcinogens and 5 times the Outdoor Worker NAL for noncarcinogenic COCs (uranium). This corresponds to an ELCR of 5E-5 and a HQ of 0.5.

Arsenic at SWMUs 2 and 7 was retained as a COC because background concentrations were more frequently exceeded at these locations. The PRG for arsenic was set at background.

The WAG 22 RI for SWMUs 2 and 3 showed unacceptable risks to the future industrial worker; however, it included samples to depths of 8 ft. No outdoor or excavation worker scenario was evaluated; therefore, PRGs were defined for these COCs for both the surface and subsurface soils.

Table 2.3. PRGs for Direct Contact Exposures—Protection of Industrial and Outdoor Workers

SWMU	COC	Background		Direct Contact PRG	
		Surface Soil (mg/kg) (pCi/g)**	Subsurface Soil (mg/kg) (pCi/g)**	Surface Soil (mg/kg) (pCi/g)**	Subsurface Soil (mg/kg) (pCi/g)**
2	Arsenic	12	7.9	12[d]	20.8[b]
	Uranium-235+D	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
3	Uranium-235+D	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
7	Arsenic	12	7.9	12[d]	20.8[b]
	Total PAHs	NE	NE	0.296[b]	2.42[b]
	Neptunium-237+D	0.1	NE	1.36[b]	16.4[b]
	Plutonium-239+D	0.025	NE	N/A	81[b]
	Uranium-234+D	1.2	1.2	94.5[b]	141.5[b]
	Uranium-235/236	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
	Uranium (Soluble Salts)	4.9	4.6	535[a]	290[a]
30	Total PAHs	NE	NE	0.296[b]	2.42[b]
	Total PCBs	NE	NE	10[c]	10[c]
	Neptunium-237+D	0.1	NE	1.36[b]	16.4[b]
	Plutonium-239+D	0.025	NE	N/A	81[b]
	Uranium-234+D	1.2	1.2	94.5[b]	142[b]
	Uranium-235/236	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
	Uranium (Soluble Salts)	4.9	4.6	535[a]	290[a]

*mg/kg for chemicals; pCi/g for radionuclides.
NAL values are given in Table A.4 of the 2011 Risk Methods Document (DOE 2011).
Background concentrations from the Risk Methods Document, Table A.12 (DOE 2011).
[a] The PRG for surface soil is 5 times the NAL for the industrial worker and for subsurface soils, 5 times the NAL for the outdoor worker. These correspond to a noncancer HQ of 0.5.
[b] The PRG for surface soil is 5 times the NAL for the industrial worker, corresponding to a cancer risk of 5E-6. For subsurface soils, the PRG is 50 times the NAL for the outdoor worker corresponding to a cancer risk of 5E-5.
[c] Risk management level for PCBs.
[d] The surface soil PRG for arsenic is the background concentration.
NE = no background concentration for the analyte.
N/A = not applicable, not a COC at this depth.

PCBs were identified as COCs for industrial and outdoor workers at SWMU 30. The 10 ppm value for PCBs in soil is the value jointly agreed upon by representatives of EPA Region 4, the Kentucky Department for Environmental Protection, and DOE. This value was considered to be sufficiently protective of potential direct contact risk that could occur at the BGOU, when used to identify potential hot spots of PCBs. This is considered protective for cumulative risks for these exposure scenarios.

Uranium, a COC at SWMUs 7 and 30, is the only COC retained as a target compound in this FS that was identified for noncancer hazards. Using the PRG established at one half the target HQ of 1 would be conservative for individual sample locations, would allow for potential uncertainties associated with contributions from other metals, and would clearly result in meeting the overall target HI for the SWMU.

In some cases, multiple carcinogenic COCs were identified. Any sample where even one of the COCs is present at concentrations above the PRGs would require further evaluation. Using the approach for setting the PRG at half the target risk has been used at PGDP and demonstrated to achieve RAOs.

There were potential uncertainties raised regarding the identification/refinement of COCs list and the derivation of PRGs at half the target risk/HI as a guide to evaluate remedial actions. Because additional data were collected subsequent to the BHHRA for direct contact exposures, it was necessary to verify that additional chemicals that contributed to the risks/hazards are being addressed. An additional uncertainty regarded the case where multiple COCs are each present below the PRGs, but the cumulative ELCR could still exceed 1E-5 or 1E-4 (or HI > 1). The figures shown in Appendix A include chemicals that exceed their PRGs and also identify primary contributors to the risk or hazard on a sample specific basis. In this process, the following was confirmed.

- Locations where additional chemicals identified in samples collected after the BHHRA contributed significantly to the risk (e.g., cesium-137 at SWMU 2) are shown on the figures in Appendix A. This confirmed that these were locations where the PRGs are exceeded for one or more of the target compounds, indicating that area would be addressed in the FS.

- No instances were identified where the target cumulative risk was exceeded, yet no PRG was exceeded; however, there were instances where the PRGs were exceeded but the cumulative risk at that location did not exceed the target ELCR. This suggests that the process for identifying locations requiring actions based on the PRGs is a conservative approach that will lead to a SWMU-wide cumulative ELCR that meets the RAO.

- The refinement process for the COCs eliminated a number of metals that contribute to the noncancer hazard, and additional data subsequently were obtained. It was confirmed that the HI of 1 was very rarely exceeded in any sample in any SWMU and typically HI < 3. Using current toxicity and dermal absorption factors, the potential for isolated locations exceeding an HI of 1 would be infrequent, and clearly a SWMU-wide cumulative HI (which is the RAO) would not be a factor in the decision process.

2.2.3.3 Use of PRGs for soil direct contact and the protection of groundwater

The PRGs for soil (Tables 2.1 and 2.2) are used in Sections 5 through 8 to develop remediation alternatives for potential use at individual SWMUs. Upon completion of remedial actions at each SWMU, it will be necessary to attain the RAOs. This eventual evaluation of soil concentrations to verify attainment of RAOs will be based on the results of postremediation sampling.

The FFA parties have agreed that an excavation alternative would be conducted to 16 ft bgs, deeper if visible contamination continued to be observed. The maximum depth of an excavation was not defined, but is not expected to exceed 20 ft bgs based on available disposal records as represented in Figure 2.3. At SWMUs 2 and 7, where mobile COCs are identified, contingent treatment options are included.

To the extent that decisions may be affected by available resources, some of the proposed action may need to be completed in a sequential process instead of a single action. Also, additional excavation may be performed in pursuit of source contaminants exposed directly to area soils and/or groundwater based on the added environmental benefits of the continued action. In this instance, additional discussion of such discretionary expansion of proposed remedial action boundaries would be undertaken with the regulators. The cost estimate assumes excavation nominally to 20 ft bgs.

Although postremediation sampling results cannot be predicted, it is possible that soil concentrations of COCs at a SWMU would represent cumulative ELCR or HI levels above target criteria (Figure 2.3) if all were detected at their PRG concentrations. This will need to be managed when the Remedial Action Work Plan (RAWP) is prepared. Additional discussion concerning specific SWMUs and attainment of PRGs is best postponed until the RAWP.

Approximate lower bounds to the PRG concentrations for surface and subsurface soil that will meet the target criteria at SWMUs 7 and 30 were estimated under the assumption that all COCs will be detected in soil at their PRG concentrations. These approximate concentrations are presented in Appendix C to provide information on possible soil concentrations that might be encountered in postremediation sampling, but are not intended for remediation alternatives development.

2.2.4 Basis for BGOU Technology Identification and Screening

The BGOU RI did not conduct intrusive sampling in the existing waste management units. As a result, specific waste characterization data are limited. Historical records and data, past observations, and waste disposal documentation referenced in the BGOU RI Report were used to supplement the RI data to establish the basis for selecting remedial alternatives and preparing cost estimates for those alternatives (DOE 2010b). It also was necessary to make some assumptions regarding the nature, extent, and quantities of waste and waste-related contamination within the BGOU SWMUs that would require remediation. The assumptions and rationale applied in developing estimates of the extent of contamination and the corresponding waste volumes are presented in Section 1.4.

2.2.4.1 PTW

The PTW acknowledged for the SWMUs included in this FS is identified in Section 1. RAO 3 recognizes that it is EPA's expectation that PTW be treated, where practicable. The RAO will be utilized consistent with the NCP and EPA PTW guidance (DOE 2012b).

2.2.4.2 Contamination above remediation goals

The data from the BGOU RI Report were evaluated to determine which BGOU SWMUs are contaminated with COCs at concentrations above their respective PRGs (DOE 2010b).

2.3 GENERAL RESPONSE ACTIONS

GRAs describe those actions that will satisfy the RAOs. This section develops GRAs that may be implemented individually or in combination to meet the SWMUs 2, 3, 7, and 30 RAOs. The GRAs developed for SWMUs 2, 3, 7, and 30 FS include LUCs, monitoring, monitored natural attenuation (MNA), removal, containment, treatment, and disposal.

2.3.1 Land Use Controls

LUCs for the CERCLA sites at the PGDP BGOU as described in Section 2.4.1.1 are needed only for those alternatives that leave waste in place at concentrations that would not allow for unrestricted use.

2.3.2 Monitoring

Monitoring for SWMUs 2, 3, 7, and 30 include both monitoring the progress of cleanup by determining the extent of contamination remaining and long-term monitoring for potential migration of wastes left in place. Monitoring alone does not meet the RAOs, but can be used in combination with other GRAs to form a remedial action.

Any alternatives that leave waste in place will incorporate monitoring to confirm that there is no unacceptable threat to groundwater or surface water from migration from SWMUs 2, 3, 7, or 30.

2.3.3 Monitored Natural Attenuation

MNA relies on natural processes to achieve site-specific remedial objectives. Processes may include physical, chemical, or biological processes that reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. Monitoring of contaminant concentrations and process-specific parameters to ensure protection of human health and the environment during implementation is a critical element of MNA.

EPA technical brief, "Depleted Uranium" states that, "...the use of monitored natural attenuation (MNA) may be applied as an optional process, which should be evaluated with other applicable remedies (including innovative technologies) for restoring contaminated groundwater, preventing migration of contaminant plumes, and protecting groundwater and other environmental resources" (EPA 2006a).

As the waste disposal records show that SWMUs 2, 3, 7, and 30 contain uranium contaminated scrap, MNA may contribute to meeting RAOs at these SWMUs.

2.3.4 Removal

The removal GRA involves removal of all or some buried waste and soils in close proximity to the waste. Removal would generate secondary wastes potentially requiring *ex situ* treatment and disposal or discharge. Removal can meet RAOs. An excavation alternative would be conducted to the visible limits of buried wastes (assumed to be 16 ft bgs). Additional soil may be removed if the confirmation sampling at the margins of the excavation indicates residual contamination present above PRG, or deeper, if visible contamination continues to be observed. For cost estimating purposes, the excavation depth was assumed to be 20 ft bgs. If COCs still are present above their target concentrations below 20 ft bgs, DOE will evaluate whether additional excavation is warranted and will consult the regulatory agencies; however, the decision about whether to conduct additional excavation below 20 ft will remain at DOE's discretion, as presented in Figure 2.3. Lateral excavation will be bounded by sheet pile shoring placed prior to excavation. Placement of shoring will be determined during the RAWP.

Additional excavation may be performed in pursuit of source contaminants exposed directly to area soils and/or groundwater based on the added environmental benefits of the continued action. In this instance, additional discussion of such discretionary expansion of proposed remedial action boundaries would be undertaken with the regulators.

2.3.5 Containment

Containment isolates contaminated media from release mechanisms, transport pathways, and exposure routes using surface and/or subsurface barriers, thereby reducing contaminant flux and reducing or eliminating exposures to receptors. Containment can meet RAOs 1 and 2 and can help mitigate the uncertainties identified in Section 1.4.1.

2.3.6 Treatment

Treatment reduces the toxicity, mobility, or volume of contaminants or contaminated media. Contaminant sources may be reduced or eliminated, and contaminant migration pathways and exposure routes may be eliminated. *In situ* methods treat contaminants and media in place without removal. *Ex situ* methods treat contaminants or media after removal. Treatment may contribute to meeting RAOs 1, 2, and 3.

2.3.7 Disposal

Disposal may include land disposal of solid wastes or discharge of liquid or vapor phase effluents generated during waste treatment processes. Waste disposal for solids may include use of permitted commercial off-site disposal facilities, off-site DOE disposal facilities, or on-site facilities as available. These facilities may have regulated waste acceptance criteria (WAC).

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Table 2.4 lists the GRAs, as well as the technology types and process options contained within each GRA. Identification was based on demonstrated process efficiencies, engineering judgment, and existing policies or procedures.

The technologies and associated process options are described in Section 2.4.1, as are their potential technical implementability. Evaluated technologies and process options that cannot be technically implemented are screened and eliminated from further consideration. In Section 2.4.2, the retained process option's effectiveness, implementability and cost are evaluated. Finally, RPOs that will be used to develop the remedial alternatives are identified in Section 2.4.3.

2.4.1 Identification and Screening of Technologies and RPOs

The technology types and process options for each GRA are discussed in the following subsections 2.4.1.1 through 2.4.1.7. Table 2.5 summarizes the narrative discussion that follows.

In this FS, technologies and process options are evaluated for effectiveness, implementability, and cost as to how they may address the identified risk/hazards and uncertainties at the SWMUs.

Additionally, certain technologies or process options are retained as temporary or complementary actions subordinate to another retained action. For example, freezing is not effectively implementable as a long-term action, but it is further evaluation as a means to stabilize an excavation sidewall.

Table 2.4. BGOU SWMUs 2, 3, 7, 30 GRA Technology and Process Option Screening

Technology Type	Process Options	Description	Technology Status	Screening Comments
General Response Action—LAND USE CONTROLS				
Physical Controls	Warning signs	Warning signs notify workers of potential hazards and restrict access.	Available	Technically implementable. Retained for possible alternative development.
Institutional Controls	Property Record Notice/ CERCLA Section 120(h)	Property notice that waste left in place and survey plat of its location filed at McCracken County Clerk's office. CERCLA Section 120(h) requires certain notices and covenants for transfer of federally owned property.	Available	Technically implementable. Retained for possible alternative development.
	Deed and/or Lease Restrictions	Deed and/or lease restrictions prohibiting residential development or agricultural development within the BGOU source area will be put in place contingent upon the property transfer.	Available	Technically implementable. Retained for possible alternative development.
	EPP Program	EP/P program requires review and approval of any proposed intrusive activities to protect workers and remedy integrity.		
General Response Action—MONITORING				
Soil Monitoring	Conventional Sample Collection and Analysis	Conventional collection and analysis of soil samples for physical/chemical parameters yields data that verify effectiveness of remedial action. Samples usually collected with spade, trowel, scoop, hand auger, flight auger, trier, or split-spoon (shallow sample depths assumed so that no mechanized equipment is needed).	Commercially available	Technically implementable. This technology is screened from further evaluation as a primary technology, but its use may be incidental to other GRAs such as removal.
	Soil Cores	Cores may be obtained using direct push technology, hollow-stem auger, or other drilling methods. Laboratory analysis may be used on core samples to detect VOCs or other constituents.	Commercially available	Technically implementable. This technology is screened from further evaluation as a primary technology, but its use may be incidental to other GRAs such as removal.
	Membrane Interface Probe (MIP)	MIP is used for real-time VOC profiling and sampling using a heating element and gas permeable membrane. The element heats the material surrounding the probe, causing the VOCs contained in the material to vaporize. Vapors enter the probe through a gas permeable membrane and are transported through tubing to the surface by an inert carrier gas. The sample then is analyzed.	Commercially available	Technically implementable. Retained for possible alternative development.
	Soil Gas Monitoring (e.g., Gore-sorbers)	Multiple methods available to either directly collect soil gas or indirectly measure soil gas concentrations such as use of Gore-sorbers.	Commercially available	Technically implementable. Retained for possible alternative development. May also be used as a secondary technology to other GRAs.

Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Groundwater Monitoring	Conventional groundwater well installation, sample collection, and analysis	Groundwater samples can be obtained from wells completed in saturated zone using pumps, bailers, or passive samplers. Analysis can be performed on-site using field instrumentation or off-site at fixed-base laboratories.	Commercially available	Technically implementable. Retained for possible alternative development. May also be used as a secondary technology to other GRAs such as containment or treatment.
	Diffusion Bags	Semipermeable diffusion bags containing deionized water can be hung in wells to collect VOCs or other soluble contaminants. They are allowed to equilibrate with surrounding groundwater and eventually reach the same concentrations of soluble constituents. Useful in vertical profiling of contaminant distributions.	Commercially available	Technically implementable. Retained for possible alternative development.
	Borehole Fluxmeter	The passive fluxmeter (PFM) can be deployed in a well to directly measure subsurface water and contaminant flux. The interior is a matrix of hydrophobic and hydrophilic permeable sorbents that retain dissolved organic and/or inorganic contaminants present in fluid intercepted by the unit.	Commercially available	Technically implementable. Retained for possible alternative development.
	Ribbon NAPL Sampler	Direct sampling device that provides detailed depth-discrete mapping of DNAPLs in a borehole. This qualitative method is used to complement other techniques. Uses the Flexible Liner Underground Technologies, Ltd. (FLUTe), membrane system (patent pending) to deploy a hydrophobic absorbent ribbon in the subsurface. The system is pressurized against the wall of the borehole and the ribbon absorbs any NAPL that it contacts.	Commercially available	Technically implementable. Retained for possible alternative development.
	DNAPL Interface Probe	Incorporates an infrared sensor and a conductivity sensor attached to a coaxial cable. The cable is mounted on a spool, allowing the probe to be lowered into a well. The probe emits an audible signal upon detection of differences in electrical conductivity and infrared response that occurs when the probe passes through the interface between water and an organic liquid.	Commercially available	Technically implementable. Retained for possible alternative development.
General Response Action—MONITORED NATURAL ATTENUATION				
Monitoring and Natural Processes	Soil and Groundwater Monitoring with Abiotic and Biological Processes	Natural processes including dilution, diffusion, dispersion, sorption, biodegradation, combined with monitoring.	Commercially available	Technically implementable for some COCs. Retained for possible alternative development.
General Response Action—REMOVAL				
Excavators	Backhoes and/or Trackhoes	Tracked excavators with 45-ft arms limited to approximately 30 ft bgs.	Commercially available	Technically implementable. Retained for possible alternative development.
	Vacuum Excavation, Remote Excavator	Commercial vacuum excavators used for digging small exploratory holes to assess conditions, radioactive waste cleanup.	Commercially available	Technically implementable. Retained for possible alternative development.
	Crane and Clamshell	Excavation at depths greater than 100 ft bgs possible.	Commercially available	Technically implementable. Retained for possible alternative development.

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Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR … l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Excavators (Continued)	Large-diameter Auger	Large diameter augers (~2–4) are used to remove soils from a vertical column. Borings can be cased to avoid sidewall collapse. Augers are capable of drilling to depths of 100 ft bgs.	Commercially available	Process option is technically implementable. Retained for possible alternative development as a delivery method of chemical reagent or biological nutrients.
General Response Action—CONTAINMENT				
Hydraulic Containment	Recharge Controls	Recharge controls can reduce facility discharges to the UCRS, promote surface water runoff, and reduce recharge of the UCRS in the BGOU TCE source areas, thereby limiting leaching of TCE from NAPL source areas and migration to the RGA.	Commercially available	Not technically implementable. No sources of run-on.
	Groundwater Extraction	Groundwater pumping wells create a cone of depression in the piezometric surface, causing flow to the well resulting in a capture zone.	Commercially available	Yields of wells in the UCRS are expected to be low and thus, more wells may be needed to be effective in lower permeability zones. Technically implementable. Groundwater extraction is implementable in the RGA, although hydraulic control may require pumping large volumes of water. Retained for possible alternative development as a secondary technology for other treatments.
Surface Barriers	Subtitle C Cap	Multilayered cover incorporating compacted clay and geosynthetics used for RCRA hazardous waste landfill closures.	Commercially available	Technically implementable. Retained for possible alternative development.
	Subtitle D Cap	Multilayered cover used for RCRA nonhazardous waste landfill closures.	Commercially available	Technically implementable. Retained for possible alternative development.
	Evapotranspiration Cover	Soil cover system using one or more vegetated soil layers to retain water until it is either transpired through vegetation or evaporated from the soil surface.	Commercially available	Not technically implementable as a stand-alone installation due to local climate conditions and existing features. This form of cover is best suited to arid climates. It is eliminated from further consideration.
	Soil Cover	Monolayered cover used for waste landfill closures.	Commercially available	Technically implementable. Retained for possible alternative development.
	Concrete-based Cover	Concrete cover systems may consist of a single layer of concrete pavement over a prepared subgrade to isolate contaminated soils, reduce infiltration, and provide a trafficable surface.	Commercially available	Technically implementable. Retained for possible alternative development.

Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Surface Barriers (Continued)	Conventional Asphalt Cover	Asphalt cover systems may consist of a single layer of bituminous pavement over a prepared subgrade to isolate contaminated soils, reduce infiltration, and provide a trafficable surface. Must be sealed and/or combined with a low-permeability membrane to reduce permeability effectively.	Commercially available	Technically implementable. Retained for possible alternative development.
	MatCon™ Asphalt	MatCon™ asphalt has been used for Subtitle C-equivalent closures of landfills and soil contamination sites. MatCon™ is produced using a mixture of a proprietary binder and a specified aggregate in a conventional hot-mix asphalt plant.	Commercially available	Technically implementable. Retained for possible alternative development.
	Flexible Membrane	Consists of single layers of relatively impermeable polymeric plastic (HDPE and others) laid out in rolls or panels and welded together. The resulting membrane cover essentially is impermeable to transmission of water unless breached. Flexible membranes can be sealed around surface infrastructure using waterproof sealants. Must be combined with protective soil layers.	Commercially available	Technically implementable. Retained for possible alternative development.
Subsurface Horizontal Barriers	Freeze Walls	Constructed by artificially freezing the soil pore water, resulting in decreased permeability and formation of a low-permeability barrier. The frozen soil remains relatively impermeable and migration of contaminants is thereby reduced. A horizontal barrier would be constructed by installing freeze pipes through wells drilled at a 45 degree angle along the sides of an area to be contained.	Commercially available	Technically implementable, but less practical as a permanent barrier. Eliminated from alternative development.
	Jet Grouting	Grouts are injected through drill rods to reduce infiltration of water. The jetted grout mixes with the soil to form a column or panel.	Commercially available	The effectiveness of jet grouting as a vertical barrier remains uncertain with no means to verify *in situ* results. Eliminated from possible alternative development.
	Permeation Grouting	Low-viscosity grout is injected vertically or directionally into soil at multiple locations. Establishing and verifying a continuous, effective subsurface barrier is difficult or impossible in heterogeneous and/or low-permeability soils or in the presence of subsurface infrastructure.	Commercially available	Uncertain effectiveness. Retained for possible alternative development.
Subsurface Vertical Barriers	Freeze Walls	Constructed by artificially freezing the soil pore water, resulting in decreased permeability and formation of a low-permeability barrier. The frozen soil remains relatively impermeable and migration of contaminants is thereby reduced.	Commercially available	Technically implementable, but typically used to construct a temporary vertical hydraulic barrier during construction projects. Technology less practical as a permanent barrier. Retained for possible alternative development.

Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Subsurface Vertical Barriers (Continued)	Slurry Walls	Vertically excavated trenches that are kept open are backfilled with a slurry, generally bentonite and water. Soil (often excavated material) then is mixed with bentonite and water to create a low-permeability soil-bentonite backfill.	Commercially available	Technically implementable. Retained for possible alternative development.
	Sheet Piling	Long (e.g., 60 ft) structural steel sections with a vertical interlocking system that are driven into the ground to create a continuous subsurface wall. After the sheet piles have been driven to the required depth, they are cut off at the surface. The subsurface soils must be relatively homogenous (i.e., no boulders) to allow for a uniform installation.	Commercially available	Technically implementable. Retained for possible alternative development.
	Jet Grouting	This system breaks up the soil structure completely and performs deep soil mixing to create a homogeneous soil, which, in turn, solidifies. The jet grouting technique can be used regardless of soil, permeability, or grain size distribution. It is possible to apply jet grouting to most soils, from soft clays and silts to sands and gravels. Although it is possible to inject any binder, water-cement-bentonite mixtures typically are used when an impermeable vertical barrier is to be created.	Commercially available	Technically implementable. Retained for possible alternative development.
General Response Action—TREATMENT				
Biological	*In situ* Process Options—Enhanced biodegradation and phytoremediation	Bioremediation techniques are destruction techniques directed toward stimulating the microorganisms to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. A wide range of delivery methods can be used depending upon specific site conditions and include methods such as surface flooding, well injection, high pressure injection and soil mixing.	Commercially available	Technically implementable. Retained for possible alternative development.
	Ex Situ Process Options—Bioreactors and constructed wetlands	Bioremediation techniques are destruction techniques directed toward stimulating the microorganisms to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms.	Commercially available	Although theoretically implementable, eliminated from possible alternative development because of its reliance on extraction.
Physical/Chemical	Soil Vapor Extraction (SVE)—*in situ*	Removal of unsaturated zone air and vapor by applying vacuum.	Commercially available	Technically implementable. Retained for possible alternative development.
	Dual-Phase Extraction—*in situ*	Enhancement of SVE that includes extraction of groundwater and soil vapor.	Commercially available	Technically implementable. Retained for possible alternative development.
	Air Sparging—*in situ*	Promotes volatilization of VOCs in saturated zone by injecting air. Can be combined with SVE. Can be used in conjunction with actions that lower water table such as ERH.	Commercially available	Technically implementable. Retained for possible alternative development.

Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Physical/Chemical (Continued)	Soil Flushing—*in situ*	Promotes dissolution or desorption of VOCs in soil, may mobilize NAPLs by reducing interfacial tension. Can be applied *in situ* or *ex situ.*	Commercially available	Technically implementable. Retained for possible alternative development.
	Electrokinetics—*in situ*	Applied *in situ* as Lasagna™ process.	Commercially available	Not technically implementable due to large volume of waste. Eliminated from alternative development.
	Permeable Reactive Barrier—*in situ*	PRBs are designed and constructed to permit the passage of water while immobilizing or destroying contaminants through the use of various reactive agents. PRBs may be constructed to depths of 60 ft bgs, but complexity and cost increase with depth.	Commercially available	This process option does not mitigate risk from contact with buried waste. Also, it is not technically implementable because hydraulic gradients in the UCRS are primarily downward and the construction orientation exceeds the commonly applied practical limit of the technology. This process option is screened from further consideration.
	Air Stripping—*ex situ*	Applied *ex situ* for secondary waste treatment.	Commercially available	Technically implementable. Retained for possible alternative development as a component of an *ex situ* treatment process train.
	Ion Exchange—*ex situ*	Ion exchange removes ions from the aqueous phase by exchanging cations or anions between contaminants and the exchange media. Media are typically resins made from synthetic organic materials, inorganic materials, or natural polymeric materials.	Commercially available	Technically implementable. Retained for possible alternative development as a component of an *ex situ* treatment process train.
	Granular Activated Carbon (GAC) (vapor or liquid phase) —*ex situ*	GAC is used for VOC removal from aqueous streams. Dissolved contaminants are removed by adsorption onto activated carbon grains.	Commercially available	Technically implementable. Retained for possible alternative development as a component of an *ex situ* treatment process train.
	Vapor Condensation	Applied *ex situ* for secondary waste off-gas treatment.	Commercially available	Technically implementable. Retained for possible alternative development as a component of an *ex situ* treatment process train.
	Deep Soil Mixing—*in situ*	Potential adjunct technology for some *in situ* treatment, containment, or removal technologies.	Commercially available	Technically implementable. Retained for possible alternative development.
	Cement and Grouting—*in situ*	Stabilization/solidification agents are injected at high pressure through conventional boreholes to form a grouted mass.	Commercially available	Technically implementable. Retained for possible alternative development.

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Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Physical/Chemical (Continued)	Jet Injection/Grouting—*in situ*	Reactants are injected at high pressure through a rotating stylus as the stylus is moved vertically through the soil. The high pressure injectant will react *in situ*. If stabilization/solidification agents are injected, they will mix with the surrounding soil matrix to form a solid vertical column.	Commercially available	Technically implementable. Retained for possible alternative development.
Thermal	Electrical Resistance Heating (ERH) —*in situ*	Saturated or unsaturated soils are heated by applying current in subsurface, resulting in *in situ* steam stripping. VOCs and steam are recovered by dual phase extraction wells and treated. Can be implemented as three-phase or six-phase heating.	Commercially available	Technically implementable. Retained for possible alternative development. Most effective following removal of debris.
	Thermal Conduction Heating—*in situ*	Saturated or unsaturated soils are heated via thermal conduction by placing heating elements in wells. VOCs and steam are recovered by dual phase extraction wells and treated.	Commercially available	Technically implementable. Retained for possible alternative development.
	Steam Stripping	Hot air or steam is injected below the contaminated zone to heat contaminated soil and thereby enhance the release of VOCs and some VOCs from the soil matrix.	Commercially available	Technically implementable. Retained for possible alternative development.
	Catalytic Oxidation—*ex situ*	Oxidation equipment (thermal or catalytic) can be used for destroying contaminants in the exhaust gas from air strippers and SVE systems. Applied *ex situ* for secondary vapor treatment.	Commercially available	Technically implementable. Retained for possible alternative development.
	Thermal Desorption—*ex situ*	Soils are heated to volatilize VOCs, which then are treated. Applied *ex situ* for excavated waste treatment.	Commercially available	Technically implementable. Retained for possible alternative development.
	Vitrification	Extremely high heat is used either *in situ* or *ex situ* to melt and glassify the contaminated media.	Limited Commercially availability	Vitrification would reduce the uncertainties associated with SWMUs 2, 3, 7, and 30 as it would reduce potential contaminant mobility and direct contact with waste.
	Chip roaster	Burns uranium chips to an oxide which is a more stable form for disposal.	Available	Technically implementable. Retained for possible alternative development.
Chemical	*In situ* chemical oxidation using reagents such as • Permanganate • Fenton's Reagent • Ozonation • Persulfate • Redox manipulation • Surfactant-enhanced *in situ* chemical oxidation (ISCO)	*In situ* chemical oxidation processes involve injection of chemical compounds to oxidize organic contaminants in the subsurface.	Commercially available	Technically implementable. Retained for possible alternative development for *in situ* treatment of VOCs. This process option requires pairing with a site-appropriate delivery method.

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Table 2.4. BGOU SWMUs 2, 3, 7, 30 GR l Process Option Screening (Continued)

Technology Type	Process Options	Description	Technology Status	Screening Comments
Chemical (continued)	*In situ* reductive reagent (zero-valent iron)	*In situ* chemical reductive processes involve injection of chemical compounds that will create a reducing environment.	Commercially available	Technically implementable. Retained for possible alternative development for *in situ* treatment of VOCs, uranyl fluoride, and PCBs.
General Response Action—DISPOSAL				
Land Disposal	Off-site Permitted Disposal Facility	Shallow land burial site for LLW, MLLW, and HW disposal option.	Commercially available	Technically implementable. Retained for possible alternative development.
	Potential On-Site Disposal Unit	Planned radioactive and mixed waste on-site disposal unit.	Under consideration	Technically implementable. Retained for possible alternative development.
	PGDP C-746-U Landfill	Existing on-site nonhazardous nonradioactive waste landfill.	Available	Technically implementable. Retained for possible alternative development.
Discharge of Wastewater	Wastewater treatment demonstrating compliance with ARARs	Allowed under CERCLA after treatment.	Available	Technically implementable. Retained for possible alternative development.

Dark gray shading indicates the process option was screened out as not applicable or not technically implementable.

Table 2.5. Evaluation of SWMUs 2, 3, 7, and 30 Technologies and Process Options

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—LAND USE CONTROLS								
Institutional Controls	E/PP Program	Moderate—only effective for duration of plant operations	High—effective at preventing worker exposure	High—already implemented	High—already implemented	High—already implemented	Low	Low
	Property Record Notice	Moderate—relies on continued future implementation	High—effective for preventing groundwater and property use	High to moderate	High	High	Low	Low
	CERCLA Section 120(h)	Moderate—relies on continued future implementation	High—effective for preventing groundwater and property use	High to moderate	High	High	Low	Low
	Deed and/or Lease Restrictions	Moderate—relies on continued future implementation	High—effective for preventing groundwater and property use	High to moderate	High	High	Low	Low
Physical Controls	Warning Signs	Moderate—prevents and controls access; does not reduce contaminant levels	High—effective at preventing worker exposure	High—already implemented; requires inspections and maintenance	High—already implemented	High—already implemented	Low	Low
General Response Action—MONITORING								
Soil Monitoring	Conventional Sample Collection and Analysis	N/A—only considered as subordinate technology during remediation	High—effective at defining contamination and guiding excavation	High	High	High	Moderate	N/A
	Soil Cores	N/A—only considered as subordinate technology during remediation	High—effective at defining contamination and guiding excavation	High	High	High	Moderate	N/A

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Table 2.5. Evaluation of SWMUs 2, 3, 7 [illegible] gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—MONITORING (Continued)								
Soil Monitoring (Continued)	Membrane Interface Probe	N/A—only considered as subordinate technology during remediation	High—effective at defining contamination and guiding excavation	Moderate—can be difficult to calibrate MIP readings to analytical data	High	Moderate	Low	N/A
	Soil Gas Monitoring (e.g., Gore-sorbers)	N/A—only considered as subordinate technology during investigation	High—effective for qualitatively detecting VOCs	High for qualitative data only	High	High	Low	N/A
Groundwater Monitoring	Conventional Groundwater Well Installation, Sample Collection, Analysis	High—sampling can continue for many years	High—can be installed quickly	High	High	High	Moderate	Low
	Diffusion Bags	High—sampling can continue for many years	High—can be installed quickly	High	High	High	Moderate	Low
	Borehole Fluxmeter	High	High	Moderate	Moderate	Moderate	Moderate	Low
	Ribbon NAPL Sampler	N/A—only considered as subordinate technology during investigation	High	High for qualitative data only	High	High	Moderate	Low
	DNAPL Interface Probe	N/A—only considered as subordinate technology during investigation	High	High	High	High	Low	Low

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Table 2.5. Evaluation of SWMUs 2, 3, 7 ... gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—MONITORED NATURAL ATTENUATION								
Monitoring and Natural Processes	Soil and Groundwater Monitoring with Abiotic and Biological Processes	Low for uranium	High	Low for uranium	High	Low	Low	Moderate
General Response Action—REMOVAL								
Excavators	Backhoes/ Trackhoes	High—remove source to 15–20 ft bgs with conventional equipment. Deeper excavations possible, but with added complexity	Moderate—risks to workers in excavation	High	High	High	Low	Low
	Vacuum Excavation, Remote Excavator	High—remove source to 9.14 to 12.2 m (30–40 ft) bgs	Low—work may be hampered by metal debris or other large pieces	Low—because of the scrap and metal debris found at these SWMUs	Low—because of the scrap and metal debris found at these SWMUs	High	Moderate	Moderate
	Crane and Clamshell	High—remove source to > 30 m (100 ft) bgs	Moderate—more technically complex; hoisting and rigging concerns	High	Moderate	Moderate	High	High
	Large-diameter Auger	High—Remove sources to > 30 m (100 ft) bgs	Low—generates significant quantities of cuttings in order to achieve auger overlap	High	Low when debris is present or subsurface conditions are not well defined	Moderate	Moderate	Moderate
General Response Action—CONTAINMENT								
Hydraulic Containment	Groundwater Extraction	Moderate	High	High	Moderate	High	High	Moderate

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Table 2.5. Evaluation of SWMUs 2, 3, 7 ... gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—CONTAINMENT (Continued)								
Surface Barriers	Subtitle C Cap	Moderate	High	High	Moderate	High	High—complex construction	Moderate—ongoing maintenance &monitoring required
	Subtitle D Cap	Moderate	High	High	Moderate	High	High	Moderate
	Soil Cover	Moderate	High	Moderate	High	High	Moderate	Moderate
	Concrete-based Cover	Low—prone to cracking	High	Low—prone to cracking	Moderate	High	High	High
	Conventional Asphalt Cover	Low—relatively permeable	High	Low—relatively permeable	High	High	Low	Moderate
	MatCon™ Asphalt	Moderate	High	Moderate	Moderate—proprietary vendor technology	High	Moderate	Moderate
	Flexible Membrane	Moderate	High	Moderate–must be protected from damage	Moderate	High	Moderate	Moderate—ongoing maintenance and monitoring required
Subsurface Horizontal Barriers	Permeation Grouting	Low to moderate	Low to moderate	Low	Low—poor performance in heterogeneous and low conductivity soils	Low	High	Low
Subsurface Vertical Barriers	Freeze Walls	Low for permanent installation	High	Low—few long-term applications, but effectively used as a temporary measure in construction industry to stabilize excavation sidewalls	Low	High	High	High—energy and refrigerant costs

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Table 2.5. Evaluation of SWMUs 2, 3, 7 … gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—CONTAINMENT (Continued)								
Subsurface Vertical Barriers (Continued)	Slurry Walls	Potentially high	Low—intrusive and requires adequate space to implement	Moderate	Low	High	High	Moderate
	Sheet Piling	High	Moderate to high—installation may contact waste depending upon placement	High	High	High	High	None
	Jet Injection Grouting	Potentially high	Moderate—installation may contact waste and generate some residuals for management	Moderate—difficult to verify results	Moderate	Low	High	Low
General Response Action—TREATMENT								
Biological	*In Situ* Process Options—Enhanced Biodegradation	High for VOCs, but not other COCs	High	Moderate	Moderate	High	Moderate	Low
Physical/ Chemical	Soil Vapor Extraction—*In Situ*	High	High	Moderate	Moderate	Low	High	Low
	Dual-Phase Extraction—*In Situ*	High	High	Moderate	Moderate	Low	High	Low
	Air Sparging—*In Situ*	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation of soils; uncertain in RGA due to depth of injection in saturation zone	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Low to moderate—may not be effective on DNAPL	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Moderate—may require drilling into contaminated area resulting in contact with buried waste	Moderate	Low

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Table 2.5. Evaluation of SWMUs 2, 3, 7 … gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—TREATMENT (Continued)								
Physical/ Chemical (Continued)	Soil Flushing—*In Situ*	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation of soils; may be effective in RGA	Moderate—may require drilling into contaminated areas resulting in contact with buried waste; uncontrolled mobilization of DNAPL may occur if not carefully implemented	Low	Moderate—complex technology that requires significant lab and modeling work to select surfactant/ cosolvent and design a surfactant flood; location of DNAPL must be defined; requires good knowledge of site hydrogeology and geochemistry	Moderate—regulatory requirements may prevent chemical injection at some sites; may require drilling into contaminated areas resulting in contact with buried waste	High	High—injected surfactant/ cosolvent and mobilized DNAPL must be recovered and treated *ex situ*
	Air Stripping—*Ex Situ*	High	High	High	High	Moderate	Moderate	Moderate—ongoing energy costs
	Ion Exchange—*Ex Situ*	High	High	High	High	High	Low	Moderate—ongoing secondary waste treatment and disposal costs
	Granular Activated Carbon (Vapor or Liquid Phase) —*Ex Situ*	High	High	High	High	High	Low	High—ongoing carbon replacement cost

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Table 2.5. Evaluation of SWMUs 2, 3, 7 [...]ogies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—TREATMENT (Continued)								
Physical/ Chemical (Continued)	Vapor Condensation	High	High	High	Moderate	Moderate	High	High
	Deep Soil Mixing—*In Situ*	Potentially high—can treat all VOC phases and other contaminants	Moderate	High—if soil conditions and COCs well understood; Low—if large debris is present	Moderate—buried materials must be cleared from treatment area	Moderate	High	Varies depending on application
	Cement and Grouting—*In Situ*	Low to moderate	Low to moderate	Low	Low—poor performance in heterogeneous and low conductivity soils	Low	High	Low
	Jet Grouting—*In Situ*	Moderate—to high when used as a reagent delivery method	Moderate	Moderate	Moderate—injection may be hampered by debris and repositioning may be necessary	Moderate	Moderate	Moderate
Thermal	Electrical Resistance Heating—*In Situ*	High	High	Moderate	Moderate	Low	High	None
	Thermal Conduction Heating—*In Situ*	High	High	Moderate	Moderate	Low	High	None
	Steam Stripping	High	High	Moderate	Moderate	Low	High	None
	Catalytic Oxidation—*Ex Situ*	High	High	Moderate	Moderate	Low	High	None

Table 2.5. Evaluation of SWMUs 2, 3, 7 … gies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—TREATMENT (Continued)								
Thermal (Continued)	Thermal Desorption—*Ex Situ*	High	Moderate—soil must be excavated	High	High	Moderate—air emissions	High	High energy costs during implementa-tion; none after completion
	Vitrification	High	High	Moderate	Moderate	Low	High	Very High energy costs during implementa-tion; none after completion
Chemical	*In Situ* Oxidative Reagents	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate—may require continued injection
	In Situ Reductive Reagents	Moderate	Moderate	Moderate	Moderate	Low	Moderate	None
General Response Action—Disposal								
Land Disposal	Off-Site Permitted Disposal Facility	High	Moderate—long-distance transportation required	High	High	High	High	None
	Potential On-Site Disposal Unit	High	High	High	Moderate	Moderate	Low	None
	PGDP C-746-U Landfill	High	High	High	High	High	Low	None—long-term monitoring and maintenance not paid by program

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Table 2.5. Evaluation of SWMUs 2, 3, 7 [obscured by button] ogies and Process Options (Continued)

Technology Type	Process Option	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—DISPOSAL (Continued)								
Discharge of Wastewater	Wastewater Treatment Demonstrating Compliance with ARARs	High	Moderate	High	High	Moderate	Moderate	Moderate—monitoring required

LUCs will be implemented at BGOU SWMUs where waste is left in place or source area-related contamination remains after active remediation that precludes unrestricted use. In such cases, DOE will implement and maintain a LUC program that is protective based on current or reasonably anticipated future land use as described in the following subsections. LUCs will include institutional controls such as property record notices, the excavation/penetration permit (E/PP) Program, and physical controls (warning signs). Upon transfer of the property, DOE will comply with Section 120(h) of CERCLA and will implement deed restrictions as described in Section 2.4.1.1.

The LUC implementation actions, including inspections, monitoring, and continued maintenance, will be provided in a Land Use Control Implementation Plan (LUCIP) that will be prepared by DOE and submitted as a component of the RD.

In addition to LUCs selected and implemented as part of the BGOU remedy selection process, other existing DOE plant controls maintained outside of CERCLA, and that will not be a part of this remedy, currently are on-going and are discussed further in Section 1.3.1.6. Accordingly, PGDP is a federal facility with restricted access by the general public. Physical access to PGDP is prohibited by security fencing, and armed guards patrol the DOE property 24 hours per day to restrict worker entry and prevent uncontrolled access by the public/site visitors. These existing access controls are being maintained outside of the requirements of CERCLA due to the nature and security needs of the facility; nonetheless, the existing controls serve to protect against unacceptable/uncontrolled exposures.

2.4.1.1 LUC technologies/Process Options

Warning Signs. Warning signs are a physical control that will be placed at the source areas at the beginning of the remedial action to provide warning of potential contaminant exposure, will continue to be posted pending a final decision under the Comprehensive Site OU, or until such time as contaminant levels have been reduced that would allow for unrestricted use.

Property Record Notice. In the event contamination and/or waste is left in place that will preclude unrestricted use, a Property Record Notice (Notice) will be filed at the McCracken County Clerk's Office, in accordance with state and federal law, within 120 days of regulatory approval of the LUCIP and will remain in effect until DOE, KEEC, and EPA approve a request to modify or delete it. The Notice will include the purpose of the Notice, a brief summary of the main COCs and location of any waste remaining in-place, along with a description of the CERCLA remedial action and a DOE program contact. The Notice also will include a survey plat, accomplished by a registered land surveyor (under the direction and approval of a DOE official and consistent with applicable security requirements), that depicts the contamination and the area subject to LUCs. DOE will file both the Notice and survey plat in the register of deeds (e.g., Real Estate Office) of the McCracken County Clerk.

Deed and/or Lease Restriction. For alternatives with waste remaining in place, DOE will implement and maintain a LUC program that includes the use of deed and/or lease restrictions that prohibit residential development or agricultural development with the BGOU source area and will be put in place contingent upon the property transfer.

CERCLA Section 120(h). In the event that DOE should enter into any contract for the sale or transfer of any of the site property, DOE will comply with the provisions found in CERCLA 120(h) and Section XLII of the PGDP FFA.

E/PP Program. The E/PP program is a LUC administered by DOE's contractors at PGDP. It currently includes a specific permitting procedure (PAD-ENG-0026 or equivalent) designed to provide a common sitewide system to identify and control potential personnel hazards related to trenching, excavation, and penetration greater than 6 inches into the surface of the earth, concrete, pavement or walls, floors, and ceilings of buildings. The E/PP permits are issued by the Paducah Site's DOE Prime Contractor. The primary objective of the E/PP procedure is to provide notice of existing underground utility lines and/or other structures to the organization requesting a permit and to ensure that any E/PP activity is conducted safely and in accordance with all environmental requirements pertinent to the area (DOE 2008).

The E/PP procedure does the following:

· Requires formal authorization (i.e., internal permits/approvals) before beginning any intrusive activities at PGDP;

· Is reviewed annually; and

· Is implemented by trained personnel knowledgeable in its requirements.

An initial draft of an E/PP is reviewed by project support groups to ensure that the latest updates in engineering drawings and utility drawings are considered prior to the issuance of an E/PP.

2.4.1.2 Monitoring technologies

Monitoring may be used in combination with other technologies to meet RAOs. Monitoring for the BGOU could include determination of soil and groundwater contaminant concentrations during remedial action as well as long-term groundwater monitoring. This technology is retained for further evaluation of process options.

2.4.1.2.1 Soil monitoring

Soil monitoring may be used before, during, and after remediation to determine extent and concentration of COCs. Collection of samples for laboratory analysis for physical/chemical parameters yields data that may be used to support RD and verify effectiveness of remedial action.

This technology is screened from further evaluation as a primary technology; however, it is acknowledged that its use is incidental to removal responses.

Multiple process options are available and can be implemented during investigation or remediation on a site-specific and COC-specific basis. Specifically, conventional surface soil sample collection and analysis, soil core collection and analysis, membrane interface probe, and soil gas monitoring will be considered on a SWMU-specific basis during RAWP preparation.

2.4.1.2.2 Groundwater monitoring

Groundwater monitoring may be used in the UCRS and/or RGA saturated zones before, during, and after remediation to determine extent and concentrations of COCs. Conventional groundwater sampling consists of withdrawing a representative sample of groundwater from a well or drive point, using a variety of pump types or bailers, and analyzing the contents in a laboratory. Overall, groundwater monitoring is widely used for compliance monitoring and is effective, technically implementable, and commercially available. Monitoring of groundwater downgradient of the BGOU SWMUs is not a significant challenge; however, monitoring contribution of contaminants from individual SWMUs (which are adjacent to or contiguous) can be a challenge. Any monitoring systems selected would need to take into account comingled releases from adjacent units and upgradient sources. The design of any such unit would be addressed during RD.

This technology is retained for further evaluation. In addition to conventional well monitoring, multiple techniques are available for consideration during the RAWP. These include the use of diffusion bags, borehole fluxmeters, ribbon nonaqueous-phase liquid (NAPL) samplers and DNAPL interface probes.

Note that the ability to implement a successful groundwater monitoring program may depend on the design and installation of additional MWs at PGDP. MW needs would be addressed during the RD process for the selected remedial alternative. The need for additional MWs is accounted for in the remedial alternative cost estimates.

2.4.1.3 MNA/enhanced attenuation

Natural attenuation encompasses the naturally occurring soil and groundwater processes such as sorption, abiotic or biological degradation, and dilution, which immobilize, transform, or reduce concentrations of pollutants. Each natural attenuation process occurs under a range of conditions that must be extensively characterized and monitored over time to determine the effectiveness of the remedy. Although some natural attenuation processes may contribute to the protectiveness of the remedy, there are no additional steps that would be effective to enhance these natural processes. The sorption processes already have been estimated as part of the modeling of the impacts to groundwater. Thus, the viability of this option in a source area is uncertain

2.4.1.4 Removal technologies

Removal, in the context of this FS, means the excavation of source materials disposed in the BGOU, as well as UCRS soils containing COCs above PRGs. The technical complexity of conventional excavation increases greatly with depths greater than about 20 ft (6m) (Terzaghi et al. 1996), and several factors to be considered include slope stability, control of seepage, worker safety, management of excavated soil, shoring requirements, and potential for mobilization of COCs. Other removal methods could be considered in light of the potential impact of these factors.

This technology involves the use of commercially available heavy equipment to remove waste and contaminated soil. The selection of specific equipment is site specific and must consider items such as vertical and lateral extent of excavation, soil and groundwater conditions, specific hazards associated with the buried waste, site permit conditions, and potential interferences with existing utilities, infrastructure or buildings. When using conventional excavation equipment, deep excavations may require extensive terracing or elaborate shoring. Piping of groundwater and entry of heaving sands into the excavation can occur as excavation proceeds below the water table and also must be considered. Several types of excavation equipment that potentially could be used at the BGOU SWMUs are discussed later in this section.

Excavation can have a large capital cost, but low O&M cost, and may have the largest probability of achieving over 99% COC removal at smaller sites with contamination restricted to the upper 12.2 m (40 ft) of the soil (AFCEE 2000). Overall, experience has shown that excavation works best and is most cost-competitive at sites where confining layers are shallow, soil permeabilities are low, the volume of source materials is less than 5,000 m^3 (176,600 ft^3), and the contaminants do not require complex treatment or disposal (NRC 2004).

Removal technologies are combined with other GRAs such as treatment or disposal to meet RAOs. In some cases, RAOs may be met by combining selective, or hot spot, excavation with disposal, treatment, or containment GRAs.

This technology is technically implementable, is commercially available, and is retained for further evaluation.

2.4.1.4.1 Backhoes, trackhoes, and front-end loaders

Conventional excavation equipment such as backhoes, trackhoes, front-end loaders, and skid steer loaders can do an effective job of removing contaminated soil and overburden. Practical considerations regarding equipment limitations and sidewall stability can restrict the depth of excavation to a maximum of about 20 ft in a single lift. Where source zone contamination lies at greater depth, excavation can require a series of progressively deeper lifts or terraces accessed by ramps. This technique can extend the maximum depth of excavation in unconsolidated soil to over 40 ft; however, the unit cost of soil excavation increases rapidly with increasing depth of excavation. Additionally, implementation of methods to control or prevent the movement of groundwater into the excavation may be required if source removal extends below the water table. These methods are expensive and can require placement of caissons or driven sheet piling and dewatering (AFCEE 2000).

This process option is technically implementable, is commercially available, and is retained for further evaluation.

2.4.1.4.2 Vacuum excavation

Vacuum excavation can be used to remove contaminated soil to depths of about 30 ft in congested areas where access, obstructions, and buried utilities prevent safe operation of conventional excavators. A combination of high-pressure air (or water) is used to break up the soil, while a high flow vacuum removes the soil and deposits it in the vacuum truck collector body. Vacuum trucks are commercially available with capacities up to 15 yd^3. Additionally, contaminated soil and sludge can be placed directly in vacuum roll-off boxes (20 or 25 yd^3) or bags for disposal without having to decontaminate the vacuum truck.

Effective excavation can be performed as far as 300 ft from the vacuum truck, allowing work inside buildings and in highly congested areas. The high flow vacuum eliminates the need for additional dust control measures typically required during conventional excavation activities. This technology would not be effective at handling debris; thus, it would not be suitable for some of the wastes disposed of at SWMUs 2, 3, 7, and 30, but it could be used to remove soil from around the debris to expose the debris for further inspection or removal by other means.

This process option is technically implementable and is retained for further evaluation.

2.4.1.4.3 Cranes and clamshells

Cranes and clamshells are often are used in deep excavations (e.g., excavation of piers, dredging, and mining). Excavation to depths of over 100 ft is achievable. Deep excavations may require elaborate shoring to prevent sidewall collapse; otherwise a bentonite slurry or biopolymer is needed to fill the excavation.

This process option is technically implementable, is commercially available, and is retained for further evaluation.

2.4.1.4.4 Large diameter auger

Large diameter augers (LDAs) can be used to effectively remove contaminated soil using a drill rig equipped with a large diameter (3 ft–10 ft) solid stem auger. LDAs can be used either cased or uncased. Casing prevents water infiltration and prevents sidewalls from sloughing to the excavation. LDA borings can reach depths of 27.4 m (90 ft) depending on the lithology and drill rig. Following excavation, holes typically are filled with flowable fill material. Conventionally, LDAs are used for source removal where standard heavy equipment is not feasible (e.g., heavily industrialized sites and/or deep contamination). Densely located subsurface utilities potentially could impact the boring spacing, and, therefore, the removal efficiency of this technology. The effectiveness of this technology partially depends on the location and spacing of the borings. The boring overlap pattern can be designed to achieve 100% removal; however, due to the amount of fill material excavated by overlapping the borings, the cost of excavation increases with the percentage of boring overlap.

This process option is of questionable technical implementability. Large debris contained in SWMUs 2, 3, 7, and 30 could cause the auger flights to bind, could cause auger refusal, and could cause equipment damage; consequently, this process option is screened from further evaluation.

2.4.1.5 Containment technologies

Containment technologies can hydraulically isolate source areas, reduce infiltration, and minimize contaminant migration to the RGA. Containment technologies also can isolate contaminated media from release mechanisms, transport pathways, and exposure routes using surface and/or subsurface barriers, thereby reducing contaminant flux and reducing or eliminating exposures to receptors.

2.4.1.5.1 Hydraulic containment

Hydraulic containment involves implementing process options that either limit the potential for water to migrate through the waste or contaminated soil or limit the potential for contaminated water to enter the RGA. This technology is implementable and is retained for further evaluation.

Recharge Controls. Recharge controls can reduce facility process water discharges to the UCRS, promote surface water run-off, and reduce recharge of the source areas, thereby limiting leaching of COCs from source area and migration to the RGA. Recharge controls options are technically implementable at present using commercially available materials and equipment. Potential recharge control options include the following:

- Identifying saturated zones in the UCRS based on past investigations and determining sources. (artificial groundwater mounding influences for the C-616 Lagoons will be considered as necessary, during remedial design);
- Directing water away from source areas or to storm drains;
- Eliminating surface water drainage from adjacent areas onto source areas;
- Lining ditches and culverts in the vicinity of the BGOU source areas with concrete or membranes;
- Inspecting and repairing, as needed, asphalt areas to promote runoff and minimize infiltration;
- Inspecting, clearing and repairing, as needed, discharge pipes, culverts, and storm drains; and

- Inspecting, metering, and repairing water lines in the vicinity of the BGOU source areas as needed.

This technology is implementable and is retained for further evaluation.

Groundwater Extraction. Groundwater pumping may be used to contain dissolved-phase contaminant plumes or may be used as a secondary technology to circulate or contain treatment amendments. This process option is retained for further evaluation; however, its effectiveness is dependent upon site conditions such as location of well placement.

2.4.1.5.2 Surface barriers

Surface barriers eliminate direct contact with surface soils and reduce the potential for direct contact with subsurface soils and waste. Surface barriers can be designed to reduce recharge of precipitation and/or anthropogenic water to the subsurface, thereby reducing the driving force for infiltration and leaching of COCs from source areas. This technology is implementable and is retained for further evaluation.

EPA (2008) identifies the following advantages and limitations of surface barriers for containment of source areas.

- Advantages of containment
  - It is a simple and robust technology.
  - Containment typically is inexpensive compared to treatment, especially for large source areas.
  - A well-constructed containment system almost completely eliminates contaminant transport to other areas and thus prevents both direct and indirect exposures.
  - In unconsolidated soils, containment systems substantially reduce mass flux and source migration potential.
  - Containment systems can be combined with *in situ* treatment and, in some cases, might allow the use of treatments that would constitute too great a risk with respect to migration of either contaminants or reagents in an uncontrolled setting.
- Limitations of containment
  - Containment does not reduce source zone mass, concentration, or toxicity unless it is used in combination with treatment technologies.
  - Data are not yet available concerning the long-term integrity of the different types of physical containment systems.
  - Long-term monitoring of the containment system is essential for ensuring that contaminants are not migrating.
  - Covers and alternative soil cover systems that seek to control infiltration must address the potential for freeze/thaw damage, commonly by burying the low hydraulic conductivity layer or capillary barrier under an adequately thick (predicted by frost depth of the area) surface layer of soil.

This technology is retained for further evaluation. Specific process options are described below.

Subtitle C Cap. This type of cover is designed to meet performance objectives for Subtitle C landfill closures under 40 *CFR* § 264.310. EPA guidance recommends a cover consisting of (top to bottom) an upper vegetated soil layer, a sand drainage layer, and a flexible membrane liner overlying a compacted clay barrier (EPA 1987). A gas collection layer may be included if gas-generating wastes are capped. Nominal thickness of this type of cover is 4.9 ft, and addition of grading fill would increase the thickness at the crest. A biotic layer also can be added to prevent the intrusion of roots or burrowing animals and would also deter human intrusion.

This type of cover is designed to be less permeable than the bottom liner of a Subtitle C landfill and meets the requirements of 40 *CFR* § 264.310. Other types of covers may be used if equivalent performance can be demonstrated through numerical modeling and/or site-specific large scale lysimeter studies.

This type of cover is potentially effective, technically implementable, commercially available, and is retained for further consideration.

Subtitle D Cap. Subtitle D requirements are for nonhazardous waste landfills. The design of a landfill cover for a Subtitle D facility is generally a function of the bottom liner system or natural subsoils present. The cover will include the following components. Alternative specifications may be used if approved through the CERCLA document review process.

The components, listed from bottom to top, include the following:

- Filter fabric or other approved material;
- 12-inch sand gas venting system with a minimum hydraulic permeability of 1E-03;
- Filter fabric or other approved material;
- 18-inch clay layer with a maximum permeability of 1E-07 cm/sec;
- 12-inch drainage layer with a minimum permeability of 1E-03 cm/sec for areas of the final cap with a slope of less than 15%; and
- 36-inch vegetative soil layer.

This type of cover is potentially effective, technically implementable, commercially available, and is retained for further consideration.

Evapotranspiration Cover. Soil cover systems use one or more vegetated soil layers to retain water until it is either transpired through vegetation or evaporated from the soil surface. These cover systems rely on the water storage capacity of the soil layer, rather than low hydraulic conductivity materials, to minimize percolation. Alternative earthen cover system designs are based on using the hydrological processes (water balance components) at a site, which include the water storage capacity of the soil, precipitation, surface runoff, evapotranspiration, and infiltration. The greater the storage capacity and evapotranspirative properties, the lower the potential for percolation through the cover system.

This type of cover is best suited to arid climates. It is therefore eliminated from further consideration.

Soil Cover. A soil cover acts as a physical barrier to prevent direct contact with waste or contaminated materials. Both a 1-ft soil cover and a 2-ft soil cover (18 inches compacted local soil and 6 inches topsoil) were selected for inclusion as process options in this FS.

This type of cover is potentially effective, technically implementable, commercially available, and is retained for further consideration.

Concrete and Asphalt-based Covers. Concrete and asphalt covering systems may consist of a single layer of bituminous or concrete pavement over a prepared subgrade to isolate contaminated soils, reduce infiltration, and provide a trafficable surface. The asphalt surface can be sealed around infrastructure using adhesive sealants and flexible boots; however, constructability is improved by absence of surface infrastructure.

This process option is technically implementable and is retained for further evaluation.

MatCon™. MatCon™ asphalt has been used for Subtitle C-equivalent closures of landfills and soil contamination sites. MatCon™ is produced using a mixture of a proprietary binder and a specified aggregate in a conventional hot-mix asphalt plant. The EPA Superfund Innovative Technology Evaluation program evaluated MatCon™ in 2003 with respect to permeability, flexural strength, durability, and cost (EPA 2003). EPA determined that the as-built permeability of < 1E-07 cm/s was retained for at least 10 years with only minor maintenance, and MatCon™ had superior mechanical strength properties and durability.

This process option is effective, technically implementable, commercially available, and is retained for further evaluation.

Flexible Membranes. Flexible membranes are single layers of relatively impermeable polymeric plastic [high-density polyethylene (HDPE) and others]. Flexible membranes are a component of a Subtitle C cap, potentially other types of covers, and also may be used alone. Flexible membranes are laid out in rolls or panels and welded together. The resulting membrane cover essentially is impermeable to transmission of water unless breached. Flexible membranes can be sealed around infrastructure using adhesive sealants and flexible boots; however, constructability is improved by absence of surface infrastructure.

Flexible membranes must be protected from damage to remain impermeable. Flexible membranes are subject to damage and/or leakage due to puncturing or abrasion, exposure to excessive heat, freezing, temperature cycling, poor welds, tearing, shearing, ultraviolet or other radiation exposure, and chemical incompatibilities.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

2.4.1.5.3 Subsurface horizontal barriers

Subsurface horizontal barriers potentially may limit downward migration of contaminants in infiltrating water by formation of a physical barrier to flow. Surface barriers must be implemented with subsurface barriers to avoid "bathtubbing" (i.e., infiltrating water spilling over the sides). Several types of subsurface barriers are discussed below. This technology is implementable and is retained.

Freeze Walls. Frozen barrier walls, also called cryogenic barriers or freeze walls, are constructed by artificially freezing the soil pore water, resulting in decreased permeability and formation of a low permeability barrier. The frozen soil remains relatively impermeable and migration of contaminants thereby is reduced. This technology has been used for groundwater control and soil stabilization in the construction industry and for strengthening walls at excavation sites for many years. This technology also has been identified for contamination and dust control during excavation of buried wastes.

Implementation of this technology requires installing pipes called thermoprobes into the ground and circulating refrigerant through them. As the refrigerant moves through the system, it removes heat from the soil and freezes the pore water. Implementation in arid regions requires injecting water to provide the moisture necessary to form the barrier or to repair the frozen wall. Systems can be operated actively or passively depending on air temperatures (EPA 1999).

The thermoprobes can be placed at 45-degree angles along the sides of the area to be contained to form a V-shaped or conical barrier to provide subsurface containment. This technology is considered innovative and emerging for remediation, but is commercially available through the geotechnical construction industry.

Freeze wall containment potentially could eliminate vertical COC flux as long as the soil remains frozen and would be effective only as a temporary containment measure. The technology is not practical as a permanent hydraulic barrier system and therefore is screened from further consideration.

Jet Grouting. Grout mixtures injected at high pressures and velocities into the pore spaces of the soil or rock have been used in civil construction for many years to stabilize subgrades and reduce infiltration of water. More recently, jet grouting has been tested as a potential means of creating a subsurface horizontal barrier, without disturbing overlying soils. Grouts typically are injected through drill rods. The jetted grout mixes with the soil to form a column or panel. Jet grouting can be used in soil types ranging from gravel to clay, but the soil type can alter the diameter of the grout column. Soil properties also are related to the efficiency. For instance, jet grouting in clay is less efficient than in sand (EPA 1999).

V-shaped jet-grouted composite barriers were demonstrated at Brookhaven and the Hanford sites (Dwyer 1994) and at Fernald in 1992 (Pettit et al. 1996) in attempts to completely isolate contaminated soils in field trials. At Hanford and Brookhaven, V-shaped grouted barriers were created by injecting grout through the drill strings of rotary/percussion directional drilling rigs. Next, a waterproofing polymer (AC 400) was placed as a liner between the waste form and the cement v-trough, forming a composite barrier. Technologies to determine the continuity and impermeability of the completed barrier are unavailable; therefore, the effectiveness of the completed barriers is uncertain. This technology is screened from further consideration as a subsurface horizontal barrier.

Permeation Grout Barriers. Permeation grouting has been used extensively in construction and mining to stabilize soils and control movement of water. Low-viscosity grout is injected vertically or directionally at multiple locations into soil at sufficiently low pressure to avoid hydrofracturing while filling soil voids. Soil permeability may be reduced with minimal increase in soil volume using this method (EPA 1999).

The extent of grout permeation is a function of the grout viscosity, grout particle size, and soil particle size distribution. A variety of materials can be used in permeation grouting, and it is essential to select a grout that is compatible with the soil matrix. Particulate grouts are applicable when the soil permeability is greater than 1E-01 cm/s. Chemical grouts can be used with soil permeabilities greater than 1E-03 cm/s (EPA 1999). Permeation grouting has been tested at pilot scale, resulting in formation of subsurface layers of inconsistent coverage, thickness, and permeability.

Viscous liquid barriers are a variant of permeation grouting using low-viscosity liquids that gel after injection, forming an inert impermeable barrier. Field tests have resulted in formation of subsurface layers of inconsistent coverage, thickness, and permeability.

Permeation grouting is limited to soil formations with moderate to high permeabilities. Establishing and verifying a continuous, effective subsurface barrier is difficult or impossible in heterogeneous soils or in the presence of subsurface infrastructure. But because this process option is technically implementable, it is retained for further consideration.

2.4.1.5.4 Subsurface vertical barriers

Vertical barrier technologies can be used to isolate areas of soil contamination and to restrict groundwater flow into the contaminated area or underlying zones. Subsurface vertical barriers may be used to contain or divert contaminated groundwater flow. Subsurface vertical barrier technologies must be "keyed" into an underlying low permeability layer to avoid leakage around the barrier if complete containment is required (Deuren et al. 2002).

Given that flow is predominantly downward through the UCRS in the BGOU and that no continuous low permeability layer exists between the COC source areas and the RGA, vertical barriers are likely effective only as adjunct technologies for other primary technologies (e.g., removal). The following is a discussion of several different types of subsurface vertical barriers. This technology is retained for further consideration.

Freeze Walls. This technology previously was evaluated as a subsurface horizontal barrier. The same principles apply as a subsurface vertical barrier, only the thermoprobes are installed vertically instead of on a 45 degree angle to prevent/contain the lateral flow of groundwater. Freeze wall containment potentially could eliminate lateral COC flux as long as the soil remains frozen and, therefore, would be effective only as a temporary containment measure. The technology is used in the construction industry to prevent the influx of groundwater into and/or stabilize the sidewalls of deep excavations. Although impractical as a permanent hydraulic barrier and therefore screened, this process option is potentially effective as an adjunct process option during excavation, is technically implementable, commercially available, and is retained for further evaluation.

Slurry Walls. Slurry walls are an established and commercially available technology. Slurry walls consist of vertically excavated trenches that are kept open by filling the trench with a low permeability slurry, generally bentonite and water. The slurry forms a very thin layer of fully hydrated bentonite that is impermeable. Soil (often excavated material) then is mixed with bentonite and water to create a soil bentonite backfill with a hydraulic conductivity of approximately 1E-07 cm/s, which is used to backfill the trench, displacing the slurry. Trench excavation is commonly completed by a backhoe with a modified boom at depths of up to 60 ft. A drag line or clam shell may be used for excavations greater than 60 ft.

Alternatively, a cement, bentonite, and water slurry that is left in the trench to harden may be used. Concrete slurry walls may have a greater hydraulic conductivity than traditional slurry walls and the excavated soil that is not used as a backfill must be disposed of properly. This technology is technically implementable, commercially available, and is retained for further evaluation.

Sheet Pilings. Sheet pilings are an established and readily available technology. Sheet pilings are long structural steel sections with a vertical interlocking system that are driven into the ground to create a continuous subsurface wall. After the sheet piles have been driven to the required depth, they are cut off at the surface. Sheet pilings are commonly used in excavations for shoring and to reduce groundwater flow into the excavation and, therefore, are a potentially useful adjunct technology for soil removal. This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Jet Grouting. Although not considered an effective horizontal subsurface barrier, jet grouting is effective as a vertical subsurface barrier. Jet grouting can be used regardless of soil type, permeability, grain size distribution, etc. In theory, it is possible to stabilize most soils from soft clays and silts to sands and gravel. Although it is possible to inject any type of binder, in practice, water/cement mixtures normally are used. Where it is required that the soil be impermeable, water/cement/bentonite mixes are typically utilized.

A subsurface slurry wall can be formed by sequentially jet grouting adjoining columns of soil. An advantage of jet grouting over other slurry wall techniques is, it can be used to stabilize a wide range of soils ranging from gravel to heavy clays. A secondary advantage is that large diameter columns or panels can be created from relatively small diameter boreholes (http://www.recon-net.com/jet-grouting.html#jetgrouting). Waste soil and other material requiring management and disposal are less for jet grouting than for a conventional slurry wall and, therefore, jet grouting will be retained for consideration as a vertical subsurface barrier process option. This process option could be used as a secondary technology to removal to stabilize the sidewalls of an excavation.

2.4.1.6 Treatment technologies

Treatment technologies may destroy, immobilize, or render contaminants less toxic. Treatment technologies may be implemented *in situ, ex situ,* or both.

In situ treatments destroy, remove, or immobilize COCs without removing or extracting contaminated media. *In situ* treatment technologies may involve distributing fluids or gaseous amendments; applying thermal, pressure, or electrical potential gradients; manipulating subsurface conditions to promote biotic or abiotic contaminant degradation; or applying physical mixing in combination with other treatments. *Ex situ* treatments destroy, remove, or immobilize COCs after the contaminated media has been removed through excavation or extraction.

The following treatment technologies are evaluated for potential implementability at BGOU SWMUs 2, 3, 7, and 30: biological, physical/chemical, thermal, and chemical. Process options are described for each retained technology, with *in situ* process options being discussed prior to *ex situ* process options being discussed. Process options are not discussed for those technologies screened from further evaluation.

2.4.1.6.1 Biological technologies

Bioremediation techniques are destruction techniques directed toward stimulating the microorganisms to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. Generally, this means providing some combination of oxygen, nutrients, and moisture, and controlling the temperature and pH. Sometimes, microorganisms adapted for degradation of the specific contaminants are applied to enhance the process (FRTR 2008). Bioremediation techniques can be applied either *in situ* or *ex situ*.

Biological processes typically are implemented at low cost. Contaminants can be destroyed, and often little to no residual treatment is required. The process does require more time, and, in the case of *in situ* applications, it is difficult to determine whether contaminants have been destroyed. Biological treatment of PAHs leaves less degradable PAHs (cPAHs) behind. These higher molecular weight cPAHs are classified as carcinogens. Also, an increase in chlorine concentration leads to a decrease in biodegradability. Some compounds, however, may be broken down into more toxic by-products during the bioremediation process (e.g., TCE to vinyl chloride). For *in situ* applications, these by-products may be mobilized to groundwater or contacted directly if no control techniques are used. This type of treatment scheme requires soil, aquifer, and contaminant characterization, and may require extracted groundwater treatment. Groundwater with low-level contamination sometimes may be recirculated through the treatment area to supply water to the treatment area (FRTR 2008).

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

2.4.1.6.2 Physical/chemical technologies

Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert) or separate the contamination. For example, passive treatment walls separate and destroy the contaminant from *in situ* groundwater; air sparging, dual-phase extraction (DPE), fluid/vapor extraction and air stripping are separation techniques. Physical/chemical technologies also include stabilization/solidification process options.

Many physical/chemical process options primarily address groundwater either as a stand-alone remedy or as a component of a process train. This technology is retained for further evaluation because it contains cement and chemical grouting and jet grouting that could be implemented at SWMUs 2, 3, 7, and 30.

Soil Vapor Extraction—*In Situ.* Soil vapor extraction (SVE) applies a vacuum to unsaturated soils to induce the controlled flow of air through contaminated intervals, thereby removing volatile and some semivolatile contaminants from the soil. SVE can increase the rate of volatilization from DNAPL, aqueous, and sorbed VOC phases by maintaining a high concentration gradient between these phases and the air filled soil porosity.

The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and state air discharge regulations. Vertical extraction wells typically are used at depths of 5 ft or greater and have been successfully applied as deep as 300 ft. Horizontal extraction vents installed in trenches or horizontal borings can be used as warranted by contaminant zone geometry, drill rig access, or other site-specific factors. SVE is defined by EPA as a presumptive remedy for VOCs in soil (EPA 2007).

This process option is applicable for implementation at SWMUs 2, 3, 7, or 30. This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Dual-phase Extraction—*In Situ.* DPE, also known as multiphase extraction, uses a high-vacuum system to remove both contaminated groundwater and soil vapor. In DPE systems, a high-vacuum extraction well is installed with its screened section in the zone of contaminated soils and groundwater. Fluid/vapor extraction systems depress the water table and water flows faster to the extraction well. Impermeable covers often are placed over the soil surface during operations to prevent short circuiting of air flow and to increase the radius of influence of the wells. Groundwater depression pumps may be used to reduce groundwater upwelling induced by the vacuum or to increase the depth of the vadose zone. DPE was evaluated and recommended by Hightower et al. (2001) as potentially effective and implementable for remediation of DNAPL TCE in saturated conditions in the UCRS at PGDP. Potential adjunct technologies to improve performance, including fracturing, active or passive air injection, air sparging, and ozone injection, are discussed separately.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Air Sparging—*In Situ.* Air sparging injects air into a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps to volatilize the contaminants up into the unsaturated zone, where they typically are removed by an SVE system. This technology is designed to operate at high flow rates to maintain increased contact between groundwater and soil and strip more groundwater by sparging. Air sparging can act on aqueous DNAPL and sorbed phase VOCs by promoting volatilization of VOCs into an air phase, although air sparging may not effectively treat DNAPL when present in amounts significantly above residual saturation (COE 2008).

Oxygen added to contaminated groundwater and vadose zone soils also can enhance biodegradation of contaminants below and above the water table. Ozone may be generated on-site and added to air injection or sparging systems to oxidize contaminants *in situ*. This application of sparging was recommended for evaluation by Hightower et al. (2001) for remediation of TCE sources in the UCRS unsaturated zone at PGDP.

This process option is not applicable for implementation at SWMUs 2, 3, 7, and 30 because it would not effectively mitigate the risk associated with each SWMU's waste (see Section 1.3.6). It is therefore screened from further evaluation.

Soil Flushing—*In Situ.* Soil flushing is the extraction of contaminants from soil with water or other suitable aqueous solutions. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Extraction fluids are recovered from the underlying aquifer and, when possible, they are recycled. Many soil flushing techniques are adapted from enhanced oil recovery methods used by the petroleum industry for many years.

This process option is not applicable for implementation at SWMUs 2, 3, 7, and 30 because it would not effectively mitigate the risk associated with each SWMU's waste (see Section 1.3.6). It is therefore screened from further evaluation.

Electrokinetics—*In Situ.* The principle of electrokinetic remediation relies upon application of a low-intensity direct current through the soil between ceramic electrodes that are divided into a cathode array and an anode array. This mobilizes charged species, causing ions and water to move toward the electrodes. Metal ions, ammonium ions, and positively charged organic compounds move toward the cathode. Anions such as chloride, cyanide, fluoride, nitrate, and negatively charged organic compounds move toward the anode. The current creates an acid front at the anode and a base front at the cathode.

Two primary mechanisms, electromigration and electroosmosis, transport contaminants through the soil toward one or the other electrodes. In electromigration, charged particles are transported through the stationary soil moisture. In contrast, electroosmosis is the movement of the soil moisture containing ions relative to a stationary charged surface. The direction and rate of movement of an ionic species will depend on its charge, both in magnitude and polarity, as well as the magnitude of the electroosmosis-induced flow velocity. Non-ionic species, both inorganic and organic, also will be transported along with the electroosmosis-induced water flow. Electrokinetics can act on aqueous, DNAPL, and sorbed-phase VOCs. Electroosmosis has been used for years in the construction industry to dewater low-permeability soils.

While this process option has been demonstrated at PGDP to be effective, technically implementable, and commercially available for remediation of VOCs in soil, it is not suitable for implementation at SWMUs 2, 3, 7, and 30. It is therefore screened from further evaluation.

Permeable Reactive Barrier—*In Situ.* Permeable reactive barriers (PRBs) are designed and constructed to permit the passage of water while immobilizing or destroying contaminants through the use of various reactive agents. PRBs often are used in conjunction with subsurface vertical barriers such as sheet piling to form a funnel and gate system that directs the groundwater flow through the PRB.

This process option is not applicable for implementation at SWMUs 2, 3, 7, and 30 because it would not effectively mitigate the risk associated with each SWMU's waste (see Section 1.3.6). It is therefore screened from further evaluation.

Air Stripping—*Ex Situ.* Air stripping removes volatile organics from extracted groundwater by greatly increasing the surface area of the contaminated water exposed to air. Air stripping is a presumptive technology for treatment of VOCs in extracted groundwater (EPA 1996).

Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Packed tower air strippers typically include a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated water. Tray aerators stack a number of perforated trays vertically in an enclosure. Air is blown upward through the perforations as water cascades downward through the trays. Aeration tanks strip volatile compounds by bubbling air into a tank through which contaminated water flows. A forced air blower and a distribution manifold are designed to ensure air-water contact.

This process option is applicable as a component of an *ex situ* water treatment system and is retained for further evaluation.

Ion Exchange—*Ex Situ.* Ion exchange removes ions from the aqueous phase by exchanging cations or anions between the contaminants and the exchange medium. Ion exchange materials may consist of resins made from synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. Resins also may be inorganic and natural polymeric materials. After the resin capacity has been exhausted, resins can be regenerated (off-site by the vendor) for reuse.

This process option is applicable as a component of an *ex situ* water treatment system and is retained for further evaluation.

Granular-Activated Carbon (Vapor Phase and Liquid Phase)—*Ex Situ.* Vapor-phase carbon adsorption removes pollutants including VOCs removed from extracted air by physical adsorption onto activated carbon grains. Carbon is "activated" for this purpose by processing the carbon to create porous particles with a large internal surface area (300 to 2,500 m^2 or 3,200 to 27,000 ft^2 per gram of carbon) that attracts and adsorbs organic molecules as well as certain metal and inorganic molecules.

Commercial grades of activated carbon are available for specific use in vapor-phase applications. The granular form of activated carbon typically is used in packed beds through which the contaminated air flows until the concentration of contaminants in the effluent from the carbon bed exceeds an acceptable level. Granular-activated carbon (GAC) systems typically consist of one or more vessels filled with carbon connected in series and/or parallel operating under atmospheric, negative, or positive pressure. The carbon then can be regenerated in place, regenerated at an off-site regeneration facility, or disposed of depending upon economic considerations.

Liquid phase GAC also is widely used for removal of VOCs including VOCs from aqueous streams, including pump-and treat systems. Liquid-phase carbon adsorption removes dissolved pollutants by physical adsorption onto activated carbon grains, similar to gas-phase absorption as described previously.

Sizing of the GAC bed is based on effluent flow rate, face velocity, and residence time. Most GAC systems include a multiple bed configuration to optimize carbon utilization. GAC currently is used as a polishing step after air stripping at the PGDP Northwest Plume Pump-and-Treat Facility.

This process option is applicable as a component of an *ex situ* water treatment system and is retained for further evaluation.

Vapor Condensation. TCE and other VOCs in contaminated vapor streams can be cooled to condense the contaminants (EPA 2006b). The contaminant-laden vapor stream is cooled below the dew point of the contaminants, [e.g., below about 37.2°C (99°F) for TCE], and the condensate can be collected for recycling or disposal. Methods used to cool the vapor stream may include the use of liquid nitrogen, mechanical chilling, or a combination of the two.

Condensation systems are most often used when the vapor stream contains concentrations of contaminants greater than 5,000 ppm or when it is economically desirable to recover the organic contaminant contained in the vapor stream for reuse or recycling. Other configurations of vapor condensation include adsorbing or otherwise concentrating compounds from low-concentration vapors using another technology (e.g., GAC) and then performing condensation for recovery for disposal or recycling.

This process option is applicable as a component of an *ex situ* water treatment system and is retained for further evaluation.

Deep Soil Mixing. Deep soil mixing is a stabilization/solidification technique in which regents, generally cement, are injected into a soil matrix and mixed *in situ*. Several types of deep soil mixing systems are commercially available, including single- and dual-auger systems. Dual-auger soil mixing involves the controlled injection and blending of reagents into soil through dual overlapping auger mixing assemblies, consisting of alternate sections of auger flights and mixing blades that rotate in opposite directions to pulverize the soil and blend in the appropriate volumes of treatment reagents. Each auger mixing assembly is connected to a separate, hollow shaft (Kelly-bar) that conveys the treatment reagents to the mixing area, where the reagents are injected through nozzles located adjacent to the auger cutting edge. The mix proportions, volume, and injection pressures of the reagents are continuously controlled and monitored by an electronic instrumentation system.

Deep soil mixing is not implementable at SWMUs 2, 3, 7, and 30 without first removing debris known to exist at these SWMUs. This debris would interfere with the auger flights and could cause auger flights to bind, could cause auger refusal, or could cause equipment damage. However, this process option is retained for further evaluation.

Cement and Chemical Grouting—*In Situ.* Cement grouting, also known as slurry grouting or high mobility grouting, is a grouting technique that fills pores in granular soil or voids in rock or soil with flowable particulate grouts. Depending on the application, Portland cement or microfine cement grout is injected under pressure at strategic locations either through single port or multiple port pipes. The grout particle size and soil/rock void size must be properly matched to permit the grout to enter the pores or voids. The grouted mass has an increased strength and stiffness, and reduced permeability.

Chemical grouting is a grouting technique that transforms granular soils into sandstone-like masses, by permeation with a low viscosity grout. Typically, a sleeve port pipe first is grouted into a predrilled hole. The grout is injected under pressure through the ports on the pipe. The grout permeates the soil and solidifies it into a sandstone-like mass. The grouted soil has increased strength and stiffness and reduced permeability.

In situ grouting of the SWMUs 2, 3, 7, and 30 wastes would reduce the uncertainty associated with the wastes by reducing mobility. It is commercially available and technically implementable. This process option is retained for further evaluation.

Jet Grouting—*In Situ*. Jet grouting is a grouting technique that creates *in situ* geometries of soilcrete (grouted soil), using a grouting monitor attached to the end of a drill stem. The jet grout monitor is advanced to the maximum treatment depth, at which time high velocity grout jets (and sometimes water and air) are initiated from ports in the side of the monitor. The jets erode and mix the *in situ* soil as the drill stem and jet grout monitor are rotated and raised.

Jet grouting is effective across the widest range of soil types of any grouting system, including silts and most clays, although cohesionless soils typically are more erodible by jet grouting than cohesive soils.

Jet grouting the wastes at SWMUs 2, 3, 7, and 30 would reduce the uncertainty associated with the wastes by reducing mobility. This option is commercially available and is technically implementable. This process option is retained for further evaluation.

2.4.1.6.3 Thermal technologies

Thermal processes burn, decompose, or detonate contaminants (destruction); melt the contaminants (immobilization); or use heat to increase volatility of contaminants (separation). Destruction technologies include incineration, open burn/open detonation, and pyrolysis. Vitrification immobilizes inorganics and destroys some organics. Separation technologies include thermal desorption and hot gas decontamination.

Thermal treatments offer quick cleanup times, but typically are the most costly treatment group. This difference, however, is lower in *ex situ* applications than *in situ* applications. Cost is driven by energy and equipment costs and is both capital- and O&M-intensive.

This technology is technically implementable and is retained for further evaluation.

Electrical Resistance Heating—*In Situ*. Electrical resistance heating (ERH) uses electrical resistance heaters or electromagnetic/fiber optic/radio frequency heating to increase the volatilization rate of semivolatiles and facilitate vapor extraction. The vapor extraction component of ERH requires heat-resistant extraction wells, but is otherwise similar to SVE.

Contaminants in low-permeability soils such as clays and fine-grained sediments can be vaporized and recovered by vacuum extraction using this method. Electrodes are placed directly into the soil matrix and energized so that electrical current passes through the soil, creating a resistance that then heats the soil. The heat may dry out the soil causing it to fracture. These fractures make the soil more permeable, allowing the use of SVE to remove the contaminants.

The heat created by ERH also forces trapped liquids, including DNAPLs, to vaporize and move to the steam zone for removal by SVE. ERH applies low-frequency electrical energy in circular arrays of three (three-phase) or six (six-phase) electrodes to heat soils. The temperature of the soil and contaminant is increased, thereby increasing the contaminant's vapor pressure and its removal rate. ERH also creates an *in situ* source of steam to strip contaminants from soil. Heating via ERH also can improve air flow in high moisture soils by evaporating water, thereby improving SVE performance. ERH can act on aqueous, DNAPL, and sorbed phase VOCs.

Six-phase heating (SPH) was evaluated and recommended by Hightower et al. (2001) for TCE DNAPL contamination in the saturated and unsaturated zones of the UCRS. A pilot study using SPH subsequently was conducted at PGDP between February and September of 2003. The heating array was 30 ft in diameter and reached a depth of 99 ft bgs. Baseline sampling results showed an average reduction in soil contamination of 98% and groundwater contamination of 99% (DOE 2003).

ERH was implemented as the C-400 IRA remedy to remove VOC contamination, primarily TCE, from subsurface soils in the vicinity of the C-400 Cleaning Building. This decision was documented in a Record of Decision (ROD) signed in August 2005.

Phase I construction began in December 2008 and was substantially complete in December 2009; at that time, start up and shakedown testing began. Testing was complete and operations commenced at the end of March 2010. Heating operations ceased (soil vapor extraction continued) at the end of October 2010, and all system operations ended on December 4, 2010.

Phase I performance assessment results support the conclusion that RAOs, as documented in the ROD, were achieved for the UCRS and upper RGA in the Phase I treatment areas.

Postoperational soil sample results show average percent reductions in TCE concentrations of 95% and 99% in the Phase I east and southwest treatment areas. Groundwater analytical results from postoperational samples show average reductions of 76% and 99% in the east and southwest areas, respectively.

Target temperatures were attained in treatment areas and depths targeted for VOC removal, indicating that the ERH design was adequate for thermal treatment of UCRS soils.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Thermal Conduction Heating—*In Situ.* Thermal conduction heating (TCH) is similar to ERH in that the physical processes of contaminant removal and collection are similar, but the two processes use different methods to heat the subsurface. TCH uses an array of heating elements placed in heater wells to raise the temperature of the subsurface by thermal conduction. Unlike ERH, it does not pass a current through the subsurface or rely on the electrical resistance of the soil to facilitate the heating process. TCH can generate subsurface temperatures above 100°C and is therefore effective at removing semivolatile organic compounds (SVOCs) such as PAHs, PCBs, pesticides, and dioxins. The maximum soil temperature achievable with ERH is 100°C and its application typically is limited to treatment of VOCs. Unlike ERH, buried metal objects are not a significant limitation to the implementation of TCH, as long as the buried materials do not interfere with the construction of heater and heater/vacuum wells.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Steam Stripping—*In Situ.* Hot air or steam is injected below the contaminated zone to heat contaminated soil and thereby enhance the release of VOCs and some VOCs from the soil matrix. Desorbed or volatilized VOCs are removed through SVE (FRTR 2008). Steam injection has been used to enhance oil recovery for many years and was investigated for environmental remediation beginning in the 1980s. Approximately 10 applications of this technology for recovery of fuels, solvents, and creosote are reported in EPA 2005, detailing varied results.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Catalytic Oxidation—*Ex Situ*. Oxidation equipment (thermal or catalytic) can be used for destroying contaminants in the exhaust gas from air strippers and SVE systems. Thermal oxidation units typically are single chamber, refractory-lined oxidizers equipped with a propane or natural gas burner and a stack. Lightweight ceramic blanket refractory is used because many of these units are mounted on skids or trailers. Flame arrestors are installed between the vapor source and the thermal oxidizer. Burner capacities in the combustion chamber range from 0.5 to 2 million BTUs per hour. Operating temperatures range from 760° to 870°C (1,400°F to 1,600°F), and gas residence times typically are one second or less.

Catalytic oxidation units are widely used for the destruction of VOCs and numerous vendors are available. It is retained for further evaluation.

Thermal Desorption—*Ex Situ*. Thermal desorption heats wastes *ex situ* to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to a gas treatment system where they are collected or oxidized to CO_2 and water (FRTR 2008).

Two common thermal desorption designs are the rotary dryer and thermal screw. Rotary dryers are horizontal cylinders that can be indirect- or direct-fired. The dryer is normally inclined and rotated. Thermal screw units transport the medium through an enclosed trough using screw conveyors or hollow augers. Hot oil or steam circulates through the auger to indirectly heat the medium. Thermal desorption systems typically require treatment of the off-gas to remove particulates and destroy contaminants. Particulates are removed by conventional particulate removal equipment such as wet scrubbers or fabric filters. Contaminants may be removed through condensation followed by carbon adsorption or destroyed in a secondary combustion chamber or a catalytic oxidizer.

Most of the hardware components for thermal desorption systems are readily available off the shelf. Most *ex situ* soil thermal treatment systems employ similar feed systems consisting of a screening device to separate and remove materials greater than five centimeters (2 inches), a belt conveyor to move the screened soil from the screen to the first thermal treatment chamber, and a weight belt to measure soil mass. Occasionally, augers are used rather than belt conveyors, but either type of system requires daily maintenance and is subject to failures that can shut down the system.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Vitrification. Of all the common solidification methods, vitrification offers the greatest degree of containment. Most (but not all) of the resultant solids have an extremely low leach rate; however, the high energy demand and requirements for specialized equipment and trained personnel greatly limit the use of this method. Exposure to contaminants to the vitrification process results in several desirable results: (1) destruction of hazardous organics by pyrolytic decomposition and/or oxidation, and (2) removal (partial or fully) of low-solubility, high-volatility, and high-solubility inorganics in the residual glass product, through chemical incorporation and/or encapsulation.

In the *ex situ* method, the waste, together with other chemicals that produce the glassy product, are mixed and melted within a special furnace. Waste and glass- (or slag-) forming constituents are introduced into the heated zone of the furnace. These react to produce a molten mass while organic materials are decomposed or volatilized into a suitable scrubber system. The fused mass of insoluble materials can be cast into blocks or removed in a granular form depending on composition and intended disposal requirements.

In situ vitrification is another *in situ* process that uses an electric current to melt soil or other earthen materials at extremely high temperatures (1,600 to 2,000°C or 2,900 to 3,650°F) and thereby immobilize most inorganics and destroy organic pollutants by pyrolysis. Inorganic pollutants are incorporated within the vitrified glass and crystalline mass. Water vapor and organic pyrolysis combustion products are captured in a hood, which draws the contaminants into an off-gas treatment system that removes particulates and other pollutants from the gas. The vitrification product is a chemically stable, leach-resistant, glass and crystalline material similar to obsidian or basalt rock. The process destroys and/or removes organic materials. Radionuclides and heavy metals are retained within the molten soil (FRTR 2008).

In situ vitrification would mitigate the uncertainties associated with SWMUs 2, 3, 7, and 30 wastes by reducing mobility. It is therefore retained for further evaluation.

2.4.1.6.4 Chemical technologies

***In situ* chemical oxidation (ISCO).** ISCO processes are *in situ* treatments whereby chemical compounds are injected to oxidize organic contaminants in the subsurface. Commercially available chemical oxidation/reduction technologies include the following:

- Permanganate
- Fenton's reagent
- Ozonation
- Persulfate
- Redox manipulation
- Surfactant-enhanced ISCO

ISCO has been used at many sites, and oxidants are available from a variety of vendors. Water-based oxidants can react directly only with the dissolved-phase of NAPL contaminants because the two will not mix. This property limits their activity to the oxidant solution/DNAPL interface; however, significant mass reduction has been reported for application of ISCO at sites with dissolved-phase VOCs and DNAPL residual ganglia (EPA 2008). Off-gas control is often important during implementation of chemical oxidation technologies.

This technology is effective, technically implementable, commercially available, and is retained for further evaluation.

Reductant (Zero-Valent Iron). ZVI is conventionally used in conjunction with a permeable reactive barrier to dechlorinate chlorinated hydrocarbons in the subsurface. However, the technology also may be applied as direct injection of particulate iron, mixing of iron with clay slurries, or incorporating micro or nanoscale ZVI into an oil emulsion prior to injection. A form of ZVI may be injected into the subsurface downgradient of the contaminant source to create a zone of treatment. This is an innovative/emerging technology that would require field demonstration prior to implementation. This technology is potentially implementable and commercially available and is retained for further evaluation.

2.4.1.7 Disposal technologies

Disposal technologies for wastes and soil produced during excavation are discussed.

2.4.1.7.1 Land disposal

Land disposal of buried waste and soils generated from excavation at the SWMUs will require disposal facilities to accept the waste types generated during the action. It is acknowledged that once excavation begins, sampling of uncovered buried waste would be used to definitively determine waste types and to confirm the waste meets WAC of the receiving facility if one must be used. The following discussion presents potential on-site and off-site options for land disposal of waste materials generated during remediation of SWMUs 2, 3, 7, and 30.

On-Site Disposal. DOE has existing and available capacity for on-site disposal of nonhazardous solid wastes. The C-746-U Landfill at PGDP on DOE-owned property would be used to dispose of the nonhazardous solid wastes generated from SWMUs 2, 3, 7, and 30.

On-site disposal of waste also may be possible for additional waste types depending upon the remedy selected from a waste disposal alternatives evaluation DOE is conducting for CERCLA-derived wastes. One alternative being considered in that evaluation is the siting, design, construction, operation, closure, and postclosure of a new on-site waste disposal facility. This potential facility would be designed and operated to accept LLW, RCRA, Toxic Substances Control Act (TSCA), and mixed low-level waste (MLLW) and also may be designed to accept classified wastes. The CERCLA waste disposal alternative evaluation is currently in progress (an RI/FS is under development); therefore, a decision is not yet available. If a new on-site facility were selected in a ROD, then CERCLA waste that meets the facility's WAC could be disposed of on-site when the facility is open and ready for disposal operations. Cost for disposal of waste in a potential on-site disposal unit is included in the estimate in Appendix E. Additionally, operations at the potential on-site waste disposal facility anticipate the incorporation of concrete and metal recycling. Any applicable waste generated through excavation would be evaluated for recycle value and potential for waste minimization.

This process option is technically implementable and retained for possible alternative development.

Off-Site Disposal. Off-site disposal currently is used by DOE for land disposal of wastes that do not meet the WAC of the on-site PGDP C-746-U Landfill. DOE has existing contracts with off-site commercial disposal facilities (Energy*Solutions* in Clive, UT, is most frequently used) as well as access to disposal at the Nevada National Security Site (NNSS) in Mercury, NV. DOE also has established methods for packaging and transportation of waste off-site. Energy*Solutions* can be reached either by rail or truck; NNSS-bound waste can be shipped only by truck. Other off-site disposal facilities that become available in the future would be considered for off-site disposal as a method to validate and maintain cost efficiency. One such facility is Waste Control Specialists in Andrews County, TX.

Off-site disposal costs for the FS are based on current contract rates that DOE has in place with the primary disposal facilities discussed. The main cost elements associated with off-site disposal include the cost of the containers (either purchased or rentals), transportation costs, and disposal fees. The costs also are dependent on the waste type (regulatory classification) and form (i.e., soil, debris) of the waste.

This process option is technically implementable and retained for possible alternative development.

2.4.1.7.2 Discharge of wastewater

Water collected as incidental to the implementation of an excavation alternative will be sent to a temporary water treatment unit to be installed as part of the remedial action. Based on the COCs found at SWMUs 2, 3, 7, and 30, it is anticipated that the temporary wastewater treatment unit will consist of media appropriate to remove solids and radionuclides. The used filter media would be sent to a land disposal facility or regenerated, as appropriate.

Water would be discharged from the water treatment unit to existing ditches and would exit PGDP through an existing KPDES-permitted outfall.

It is reasonably expected that BGOU project effluent will meet all ambient water quality criteria in the receiving stream if the concentration of pollutants is at or below the Kentucky numeric water quality criteria for fish consumption specified in Table I of 401 *KAR* 10:031 Section 6(1). There are no waste load allocations approved by EPA pursuant to 40 *CFR* § 130.7 for the receiving stream (Bayou Creek) that would impact effluent limits based on the numeric water quality criteria for fish consumption specified in Table I of 401 *KAR* 10:031 Section 6(1).

2.4.2 Evaluation and Screening of Representative Technologies

Technologies retained following the initial screening in Section 2.4.1 are evaluated with respect to effectiveness, implementability, and cost in Table 2.6. The objective of this evaluation is to provide sufficient information for subsequent selection of RPOs in Section 2.4.3.

Effectiveness is the most important criterion at this evaluation stage. The evaluation of effectiveness was based primarily on the following:

- The potential effectiveness of process options in handling the estimated areas or volumes of contaminated media and meeting the RAO;
- The potential impacts to worker safety, human health, and the environment during construction and implementation; and
- The degree to which the processes are proven and reliable with respect to the contaminants and conditions at the site.

The evaluation of implementability includes consideration of the following:

- The availability of necessary resources, skilled workers, and equipment to implement the technology;
- Site accessibility and interfering infrastructure;
- Potential public concerns regarding implementation of the technology; and
- The time and cost-effectiveness of implementing the technology in the physical setting associated with the waste unit.
- A relative cost evaluation is provided in Table 2.5 for comparison among technologies. Relative capital and O&M costs are described as high, medium, or low. Capital costs for the technologies evaluated tend to increase with increasing complexity and number of process unit operations. O&M costs are estimated to be lower when an alternative may meet PRGs and reduce or eliminate the need for long-term monitoring.
- While it is understood that monitoring will be needed for as long as there is a potential for a completed exposure pathway between COPCs and receptors, a technology that leaves waste in place is assumed for estimating purposes to have a 30-year long-term monitoring program that is moderate in cost. A technology such as a surface barrier cap that incorporates a long-term monitoring program and cap maintenance is estimated to have higher O&M costs. These costs are based on references applicable to the particular process option, prior estimates, previous experience, and engineering judgment. The costs are not intended for budgeting purposes. Additionally, a LUC program will be implemented to assure that a containment remedy controls direct contact over the long-term protection of human health and the environment.

Table 2.6. Selection of Representative Process Options

General Response Actions	Technology Type	Representative Process Options	Basis for Selection
Land Use Controls	Institutional Controls	Engineering, legal, or administrative controls intended to prevent or limit exposure to hazardous substances	Effective and implementable. Low cost.
Monitoring	Groundwater Monitoring	Conventional sampling and analysis from MWs. Potential exists for installation of additional MWs.	Effective and implementable for monitoring. Moderate cost.
Removal	Excavators	Backhoes, trackhoes	Demonstrated effectiveness to depths of 20 ft bgs; technically implementable at BGOU source areas. Moderate cost.
Containment	Surface Barriers	Soil cover (including covers of varying thicknesses)	Implementable and prevents direct contact and migration of residual contamination not effectively removed/destroyed by other means. Moderate cost.
		Landfill covers (including Subtitle C and D landfill caps)	Implementable and prevents direct contact and migration of residual contamination not effectively removed/destroyed by other means. Moderate cost.
Containment	Subsurface Horizontal Barriers	Permeation grouting	Implementable and will provide some protection to groundwater if paired with a surface barrier to prevent infiltration. Moderate cost.
Containment	Subsurface Vertical Barriers	Sheet pile	Sheet pile is selected as a complementary process option to excavation, not as a permanent installation. Moderate cost.
Treatment	Biological	*In Situ* Enhanced Biodegradation	Implementable and will provide some protection to groundwater if paired with a surface barrier to prevent infiltration. Low cost.
Treatment	Physical/Chemical	Dual-phase Extraction—*In Situ*; Cement and chemical grouting	Implementable and will provide some protection to groundwater if paired with a surface barrier to prevent infiltration. Moderate cost.
Treatment	Thermal	Electrical resistance heating—*In Situ*	Implementable and will provide some protection to groundwater if paired with a surface barrier to prevent infiltration. High cost.

Table 2.6. Selection of Representative Process Options (Continued)

General Response Actions	Technology Type	Representative Process Options	Basis for Selection
Treatment	Chemical	ZVI	Implementable and will provide some protection to groundwater if paired with a surface barrier to prevent infiltration. Moderate cost.
Disposal	Land Disposal	Off-site disposal	Effective and implementable as an adjunct technology for soil removal. High cost.
		Potential on-site disposal unit	Effective as an adjunct technology for soil removal. Not currently implementable. Low cost.
		C-746-U on-site landfill	Effective and implementable for nonhazardous nonradioactive wastes, currently available. Wastes must meet WAC, including for PCBs. Low cost.
Disposal	Discharge of Wastewater	Wastewater treatment demonstrating compliance with ARARS	Effective and implementable for treated groundwater. Moderate cost.

2.4.3 Representative Process Options

Table 2.6 shows the RPOs that were selected to be included in alternative development based on the implementability screening and effectiveness evaluation performed in Sections 2.4.1 and 2.4.2, respectively. The selected RPOs were determined to be the most potentially effective and implementable of the process options considered for each technology type. The RPOs were selected as needed to formulate the remedial alternatives that are appropriate for each SWMU, as presented in Section 3. Not all technologies or process options were developed into components of remedial alternatives.

In some cases, more than one representative process option was selected for a technology type; this was done, for example, when two or more process options were considered to be sufficiently different in their performance such that one would not adequately represent the other.

3. DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 INTRODUCTION

The alternatives presented in the following sections were developed by combining the RPOs identified in Section 2.4 into a range of treatment strategies to meet the goals of the FS. The alternatives were formulated to create responses that vary in the methods and degree of attainment of RAOs, the degree of reduction in toxicity, mobility, or volume; implementability; effectiveness; and cost in order to meet EPA's expectation that an FS for source control actions provides, "A range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants is a principal element" [40 *CFR* § 300.430(e)(3)].

The historically demonstrated effectiveness of combined technologies was used to identify candidate alternatives. Media interactions, including effects of source actions on RGA groundwater during implementation, also were considered.

Alternatives are developed and discussed with the assumption that each could be applied to the various BGOU SWMUs as presented; however, decision makers could select portions of different alternatives at individual SWMUs, depending on additional evaluation, including public response to the Proposed Plan. Sufficient information is provided to allow for this type of alternative selection in the Proposed Plan and ROD.

3.2 CRITERIA FOR THE DEVELOPMENT OF REMEDIAL ALTERNATIVES

The purpose of the FS and the overall remedy selection process is to identify remedial actions that, at a minimum, eliminate, reduce, or control risks to human health and the environment and also meet ARARs. The national program goal of the FS process, as defined in the NCP, is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. The NCP defines certain expectations for developing remedial action alternatives to achieve these goals.

3.3 DEVELOPMENT OF ALTERNATIVES

In this section and Section 3.4, seven alternatives that encompass a range of processes are introduced and developed to address the conditions found at the four SWMUs addressed in this FS. These general alternatives are assembled from RPOs and screened and evaluated within the SWMU-specific sections. For example, a surface cover is a component of Alternatives 3 and 4. Four types of covers (Section 3.3.1) are considered under these alternatives; however, not every cover type is evaluated for every SWMU. The SWMU-specific sections will screen the cover types to decide which will be retained for detailed evaluation. A similar approach is used, as applicable, for *in situ* treatments for COCs (Section 3.3.2), including residual treatments identified as parts of contingent remedies, and additional nontreatment remedies (Section 3.3.3). By using this general approach that is customized for each SWMU, the number of alternatives is limited to a manageable size, while cover and treatment approaches are tailored to address SWMU-specific conditions.

The alternatives were developed by combining process options to address the risks and uncertainties present at the individual SWMUs in the surface soils, waste and affected soils, and subsurface soils beneath the waste (migration pathway to the RGA) as depicted in Figure 3.1.

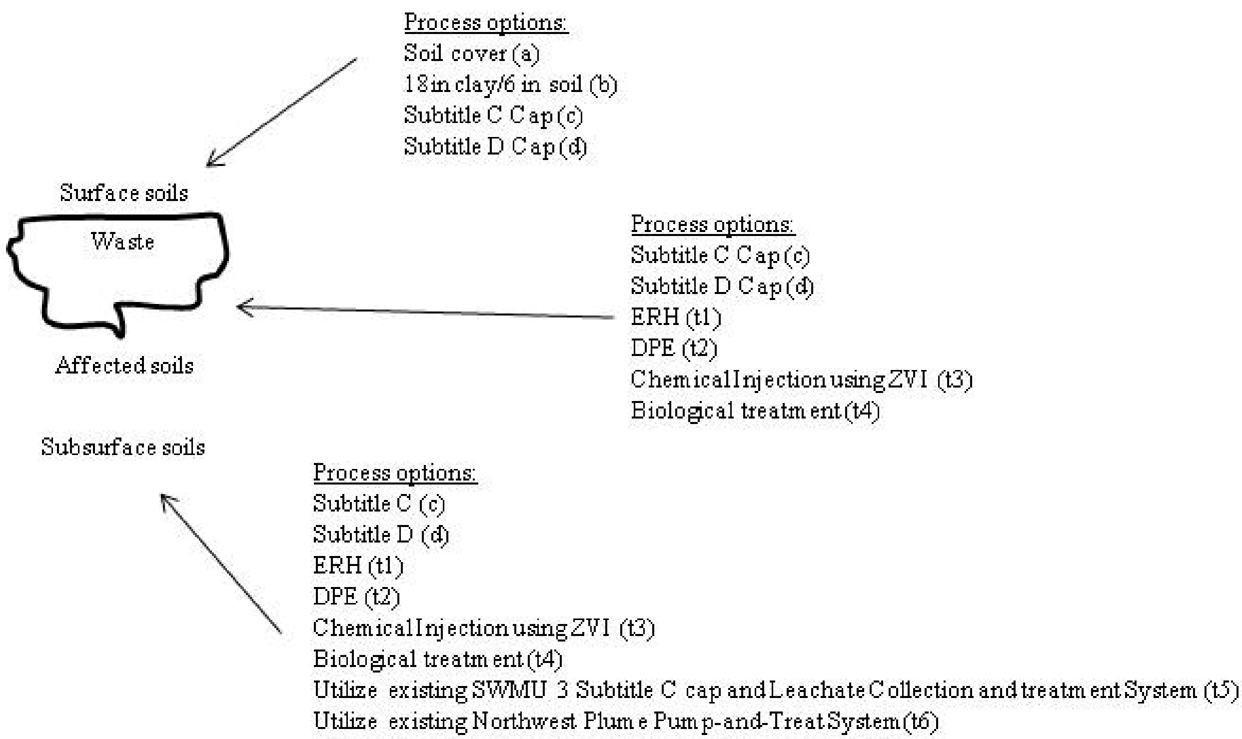

Figure 3.1. Process Options Used to Develop Alternatives

3.3.1 Surface Cover Types Considered in This FS

A range of surface cover options was considered. The design, construction, and implementation of these covers largely would include the same process, with some variation due to materials and SWMU-specific conditions and requirements. The surface covers considered in this FS include four general designs: soil cover, 18-inch clay/6-inch soil cover, Subtitle C cap, and Subtitle D cap. These surface covers are identified as a, b, c, and d, respectively, for use in designating alternative combinations (Section 3.6).

Soil cover (a). A soil cover is constructed to provide approximately 1 ft of soil that will support plant (grass) growth to limit erosion and act as a physical barrier to prevent direct contact with waste or contaminated materials. A soil cover will be designed to limit water accumulation and support runoff, but this design will not be considered appropriate for those SWMUs where control of infiltration is needed to meet PRGs.

18-inch clay/6-inch soil cover (b). An 18-inch clay/6-inch soil cover will use soils available locally and will act as a physical barrier to prevent direct contact with waste or contaminated materials. It will limit rainwater infiltration to a greater degree than will a soil cover; however, this type of cover generally will not be considered appropriate for those SWMUs where control of infiltration is needed to meet PRGs.

The 18-inch clay/6-inch soil cover will meet the following specifications:

- The cover is a two layer system;

- The infiltration lower (bottom) layer must contain at least 18 inches of locally-available earthen, preferentially lower permeability, materials;

- The erosion control (top) layer must be at least 6 inches of earthen material capable of sustaining native plant growth.

Subtitle C cap (c). This type of cover is designed to meet performance objectives for Subtitle C landfill closures under 40 *CFR* § 264.310. EPA guidance recommends a cover consisting of (top to bottom) an vegetated soil layer, a sand drainage layer, and a flexible membrane liner overlying a compacted clay barrier (EPA 1987). A gas collection layer may be included if gas-generating wastes are capped. Nominal thickness of this type of cover is 4.9 ft, and addition of grading fill would increase the thickness at the crest. A biotic layer also can be added to prevent the intrusion of roots or burrowing animals and also would deter human intrusion. This type of cover is designed to be less permeable than the bottom liner of a Subtitle C landfill and meets the requirements of 40 *CFR* § 264.310. Alternative types of covers may be used if equivalent performance can be demonstrated through modeling and/or site-specific lysimeter studies. SWMU 3 already is covered by a Subtitle C cap.

Subtitle D cap (d). A Subtitle D cap is designed to meet requirements for nonhazardous (solid) waste landfills. The design of a landfill cover for a Subtitle D facility generally is a function of the bottom liner system or natural subsoils present. The Subtitle D cap evaluated in this FS will include the following components. Alternative designs that meet the performance objectives ultimately may be used.

The components, listed from bottom to top, include the following:

- Filter fabric or other approved material;

- 12-inch sand gas venting system with a minimum hydraulic permeability of 1×10^{-3} cm/sec;

- Filter fabric or other approved material;

- 18-inch clay layer with a permeability not to exceed 1×10^{-7} cm/sec;

- 12-inch drainage layer with a minimum permeability of 1×10^{-3} cm/sec for areas of the final cap with a slope of less than 15%; and

- 36-inch vegetative soil layer.

3.3.2 Treatment Types Considered in This FS

The details for the *in situ* source treatment systems will be developed during the RD and are discussed in the individual SWMU sections later in this FS. *In situ* treatments include technologies developed in Section 2.4.1.5 that are considered feasible, effective, and fiscally sound to address the SWMU-specific conditions. RPO technologies carried forward from the screening process include *in situ* thermal treatment using ERH, DPE, chemical injection using ZVI, and *in situ* enhanced biological treatment. These treatment process options are identified as t1, t2, t3, and t4, respectively, for use in designating alternative combinations (Section 3.6).

***In Situ* Thermal Treatment Using ERH (t1).** The RPO of thermal treatment via ERH is described in Section 2. ERH has demonstrated effectiveness and implementability for all VOC phases in the UCRS at the PGDP [including in variably saturated soils (DOE 2003)]. ERH generally would be implemented in the following way (although potentially adjusted depending on location specific needs).

Electrodes would be placed on approximately 15–20 ft centers (similar to that applied to the C-400 Building remedy). Electrodes would be installed throughout the area identified as the TCE source area. Electrodes may be installed in drilled boreholes or by utilizing direct push technologies to deploy electrodes. ERH is not considered appropriate for those SWMUs that have metallic wastes in the treatment area; therefore, ERH will be included as an alternative only for those SWMUs without buried metallic wastes or as a CR implemented subsequent to an excavation.

ERH is expected to be effective at removing TCE and its daughter products. TCE removed by ERH will be treated *ex situ*. Limitations of ERH include the inability to treat semi- and nonvolatile organic and inorganic contaminants. The heterogeneous stratigraphy and the variable unsaturated zone at PGDP complicate the collection of volatilized VOCs. Costs associated with ERH are expected to be high.

DPE with subsequent *ex situ* groundwater and residual treatment (t2). The RPO of physical treatment via DPE is described in Section 2. DPE would require installation of extraction wells in the source area. DPE is appropriate for moderately permeable soils with a range of hydraulic conductivity from 1E-03 to 1E-05 cm/s (EPA 1996; Suthersan 1997; EPA 1999c; COE 1999). The use of high vacuum DPE can extend treatment to soil with hydraulic conductivities in the range 1E-06 to 1E-07 cm/s (Hightower et al. 2001). Application at the BGOU most likely would require a high vacuum pumping system based on hydraulic conductivity information data from the SWMUs (e.g., hydraulic conductivity ranges from 1E-05 to 8E-07 cm/s at SWMU 2). The stratified nature of the UCRS complicates the application of DPE because of the potential for preferential flow of fluids and air from more permeable layers (e.g., HU2) with little to no liquid and vapor recovery from less permeable layers. As a result, the application of DPE may vary from SWMU to SWMU, depending on the SWMU-specific goals, recognizing those applications that may straddle units of differing hydraulic conductivity. DPE also will serve to dewater the area, given sufficient wells. The number of wells required to dewater the system will vary based upon local conditions and the geometry of the treatment area. In unsaturated zones (or zones dewatered by DPE), the DPE will perform like SVE.

Extracted groundwater will require treatment to remove organic contaminants, such as VOCs, and inorganic contaminants (e.g., Tc-99). Treatment may be provided by the existing Northwest Plume Pump-and-Treat System, provided the WAC can be met, or with a SWMU- or BGOU-specific treatment system.

This technology does not effectively address nonmobile or sparingly mobile contaminants; thus, this technique is expected to be effective on TCE and its daughter products, Tc-99, and uranyl fluoride, but generally ineffective on all other constituents, except possibly mobile PCBs associated with liquids.

Costs associated with DPE are expected to be moderate.

Chemical injection of a reductant such as ZVI (t3). The RPO of chemical treatment via direct injection of ZVI or other reductants is described in Section 2. Use of ZVI as the reductant has undergone bench scale testing on samples collected from the vicinity of SWMU 7 (Clausen and Richards 1994). The reduction of chlorinated ethenes (i.e., TCE, DCE) with ZVI is well documented in the literature. ZVI may decrease the mobility or immobilize Tc-99 and some forms of uranium. ZVI also may be effective to some degree on PCBs. The effectiveness of ZVI will depend upon the delivery of ZVI to the vicinity of the contamination and the form and phase of both the delivered ZVI and the substrate. For estimating purposes, this alternative assumed delivery of ZVI as a water/guar (or equivalent) slurry using a range of methods from gravity to jet injection. In soil or waste cells, injection points likely will be spaced on 10–15 ft centers. The injection depth is variable, depending on SWMU, but is expected to extend to at least the bottom of the HU2 unit (more permeable UCRS zone) if there is contamination in that unit.

Consistent and uniform delivery is difficult to achieve in heterogeneous matrices to ensure that the mobile constituents are effectively treated in the more permeable zones.

The implementation of the remedy may require soil or water samples from the treated areas to demonstrate delivery and effectiveness. Treatment of chlorinated ethenes typically occurs rapidly as long as there is good contact between ZVI and chlorinated ethenes, which further emphasizes the importance of effective subsurface delivery. The rate of treatment of uranium, Tc-99, and PCBs in PGDP matrices is uncertain, depending on SWMU-specific conditions and the form, phase, and type of matrix associated with each constituent. Costs associated with ZVI injection are moderate.

***In Situ* Enhanced Biological Treatment (t4).** Biologically-enhanced biodegradation (reductive dechlorination or bio) is one of the most widely used and effective treatment technologies for addressing chlorinated ethenes (i.e., TCE, DCE). This technology increases the dissolution rate of chlorinated ethenes (including DNAPL in some processes) and reduces the dissolved VOC quickly. Treatability tests and an evaluation of subsurface geochemical conditions may be required as part of the design of *in -situ* enhanced biodegradation to determine the degree of augmentation of natural processes required based upon site-specific conditions.

The technology may be implemented by the direct injection or recirculating of electron donor substrates, microbes, water, and nutrients. A recirculating system has the advantage of fewer injection points, the ability to direct the movement of the electron donor using recovery wells, and more reliable remedial progress monitoring; while direct injection has the advantage of better coverage of affected areas.

In some cases, naturally occurring bacteria are able to completely dechlorinate chlorinated ethenes; however, the completeness of treatment and the rate of treatment are usually improved by the addition of commercially-available dechlorinating microbial cultures. Reductive dechlorination occurs under deeply anaerobic conditions, which also favors the biogeochemical reduction of Tc-99 and uranium, making them less soluble (perhaps even insoluble). Anticipated time for groundwater remediation is two to three years. Effectiveness and time to remediate is dependent upon effectiveness of delivery of all the required elements to the affected areas. Effectiveness will vary based upon the degree of saturation of the treated materials. Costs for *in situ* enhanced bioremediation typically are lower than costs for other *in situ* technologies.

Three of these *in situ* treatments, ERH (t1), ZVI (t3), and bio (t4), also will be evaluated as contingent remedies (CR) to address residual contamination (if remaining) in alternatives involving excavation scenarios. DPE (t2) is not further considered as a CR because it is deemed to be less effective below the HU2 layer.

The following are selected additional technologies that were eliminated from consideration for detailed evaluation and major reasons for their elimination.

- *In situ* chemical oxidation: Oxidation may be realized by treatment with ozone, Fenton's Reagent, activated persulfate, permanganate, or other oxidants. Permanganate is commonly used for TCE but its effectiveness in treating DNAPL is limited because it forms a low-permeability manganese rind around the ganglia and droplets of DNAPL.

  Another negative side effect of strong oxidants is that they can oxidize metals, often making them much more soluble than they would otherwise be. This includes Tc-99 and uranium. Oxidants never should be used in locations containing reduced or zero-valent metals (like some forms of uranium) or in areas with significant amounts of hydrocarbons (or other reduced carbon). Oxidants are not known to have demonstrated effectiveness in treating PCBs. Costs are considered moderate, and *in situ* oxidation usually requires multiple oxidant applications to achieve PRGs, especially at sites that contain DNAPL.

- Solidification/encapsulation: *In situ* solidification or encapsulation is a method of reducing the mobility of wastes or contaminated media. Although this technique has some applicability to address mobile constituents like TCE, uranyl fluoride, Tc-99, or pyrophoric uranium, the method is not expected to be effective for addressing the mobile constituents remaining in the BGOU SWMUs because these constituents already have had 50 years to migrate, thus, if mobile, already would have largely migrated from the source areas. The method could effectively address the pyrophoric uranium, should any uranium still be pyrophoric; however, the pyrophoric uranium is already well-controlled through burial and continued limiting of direct contact. Additional *in situ* treatment would not materially reduce the potential mobility, and the encapsulation does not affect the inherent toxicity of the treated element.

- Soil mixing: Soil mixing is a physical/chemical technique that utilizes large diameter soil augers or excavators to mix soils with injected treatment chemicals. This technology can be used in unsaturated or saturated soils. Technical implementability may be limited by the nature of the buried wastes (if sufficient debris is present), but in areas where mixing is feasible, the technique can reduce the mobility of constituents such as Tc-99, arsenic, and uranium if grout is used. This technique potentially is used to mix delivered reagents more effectively; however, for the burial ground SWMUs, soil mixing/injection is considered to be less implementable and more costly than jet injection of reagents. In addition, the soil mixing will destroy any preferential pathways that the contamination may have used to migrate thereby reducing the potential for injected treatment chemicals to be conveyed in the same preferential paths.

  Certain reagents react with the outer surface of metallic uranium and uranium solids to form an insoluble rind or coating that prevents further dissolution. These reagents include ZVI, activated carbon, fixative, and stabilizing agents for inorganic constituents, such as interchelating clays, precipitants (such as phosphate based stabilizers), or combinations of technologies to address SWMU specific needs. Although these treatments reduce the mobility of constituents, they will not affect the inherent toxicity of the treated constituents.

- Electrokinetics: Electrokinetic treatment of shallow unsaturated soil is an impracticable application of this technology. Buried drums and metal particles may interfere with effectiveness and implementation of electrokinetics even in saturated soil. The anticipated time required for investigation and subsequent removal of PTW would be longer than for other alternatives. Effective treatment relies on water solubility and mobility of wastes. Costs are considered high.

3.3.3 Existing Features Considered in This FS

The following existing features have been considered in this FS: the SWMU 3 existing Subtitle C cap and leachate collection and treatment system and the existing Northwest Plume Pump-and-Treat System. These existing features are identified as t5 and t6, respectively, for use in designating alternative combinations (Section 3.6).

SWMU 3 Subtitle C Cap and Leachate Collection and Treatment System (t5). The SWMU 3 leachate collection and treatment system collects leachate that is draining from the waste from beneath the existing Subtitle C cap. This system is an existing feature and limits the potential for migration of contaminants from SWMU 3. Although low levels of TCE historically have been detected in SWMU 3 leachate, there has been no TCE detected in SWMU 3 leachate at concentrations above MCLs for many years.

Northwest Plume Pump-and-Treat System (t6). The Northwest Plume Pump-and-Treat System is an existing feature of the site and is located immediately north of SWMU 7. This system is designed to capture the Northwest TCE and Tc-99 plumes. The Northwest Plume Pump-and-Treat System was optimized in 2010 and now has an established capture zone that includes the RGA groundwater from SWMUs 7 and 30.

3.3.4 Alternative Development

The primary elements that comprise each of the seven general remedial alternatives are summarized in Table 3.1. All alternatives that leave waste or contamination in place (above unrestricted use levels) include LUCs (described in Section 2.4.1.1) and monitoring to manage protection of human health and the environment. Effectiveness, implementability, degree of reduction of toxicity, mobility, or volume, and cost are the balancing criteria used to guide the development and screening of remedial alternatives. RD is included for each alternative in anticipation that additional information will be required to support technology sizing, design, and optimization for any remedy selected.

Soil PRGs were developed (Section 2) to be protective of groundwater (Table 2.1) and direct contact with soils (Table 2.3). Table 3.2 summarizes how alternatives address those COCs and how the alternatives address the PTW identified in SWMUs 2, 3, and 7.

The final determination of successful remediation will be based on a demonstration that the target concentrations for COCs have been met. Target concentrations are those concentrations that meet acceptable risk criteria for the specific COCs present incorporating all the risk/hazard control elements of the alternative. They differ from PRGs in that they consider the cumulative risk of actual COCs present in samples at time of sampling and the realistic exposure scenarios to be allowed at the site.

In order to develop remedial costs for each alternative, assumptions were made about the area, depth, and volume of the contaminant source areas. These assumptions are based on the available characterization data and site history. Assumptions regarding each SWMU's disposal history including area, depth, and volume are captured in Section 1.3.2. Assumptions regarding specific areas, depths, and volumes of treatment, removal, or containment are found in the SWMU-specific sections of this FS, as well as in the cost estimates found in Appendix E.

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Table 3.1. Development of Alternatives for PGDP BGOU Source Areas

	Alternative 1 No Action	Alternative 2 Limited Action (LUCs and Monitoring)	Alternative 3 Surface Cover, LUCs, and Monitoring	Alternative 4 Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring	Alternative 5 Excavation and Disposal	Alternative 6 Targeted Excavation and Disposal, Surface Cover, LUCs, and Monitoring	Alternative 7 Targeted Excavation and Disposal, Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring
Primary Elements	No action	LUCs (where waste and affected soils are left in place) Monitoring (where waste and affected soils are left in place) Recognizes existing features: · Utilize existing SWMU 3 leachate collection and treatment system (t5) · Utilize existing Northwest Plume Pump-and-Treat System (t6) (SWMUs 7 and 30)	SWMU-specific evaluation of Surface cover: · 1-ft cover (a) · 18-inch clay/ 6-inch soil (b) · Subtitle C Cap (c) · Subtitle D Cap (d) LUCs, monitoring, and existing features as under Alternative 2	Surface cover as under Alternative 3 *In situ* treatments: · ERH (t1) · Dual phase extraction (DPE) (t2) · Chemical injection (ZVI) (t3) · Biological treatment (t4) LUCs, monitoring, and existing features as under Alternative 2, including monitoring for process optimization and performance verification Analyze then treat or dispose of affected media including groundwater extracted from source treatment	Installation of vertical barriers (etc.) to support excavation Excavation of buried waste and affected soil to PRGs (max. 16–20 ft) Postremediation sampling and analysis at excavation margins Analyze then treat or dispose of groundwater removed from excavation Treatment of excavated wastes and soil as needed to meet WAC for on-site or off-site facilities Evaluation of disposal off-site and at a potential on-site WDF Transportation of excavated waste and soil to disposal facility Contingent remedies (same technologies as *in situ* treatments t1, t3, and t4 under Alternative 4 for affected soils deeper than 20 ft, including LUCs, monitoring, and existing features as under Alternative 2, including monitoring for process optimization and performance verification Backfill excavation with clean soil (includes potential alternative options)	Installation of vertical barriers, etc., to support excavation Targeted excavation in selected areas of buried wastes and affected soils to PRGs (max. 16–20 ft) Postremediation sampling and analysis at excavation margins Analyze then treat or dispose of groundwater removed from excavation Treatment of excavated wastes and soil as needed to meet WAC for on-site or off-site facilities Evaluation of disposal off-site (but acknowledges potential on-site WDF may be considered, if available) Transportation of excavated waste and soil to disposal facility Surface cover as under Alternative 3; LUCs, monitoring, and existing features as under Alternative 2 Contingent remedies (same technologies as *in situ* treatments t1, t3. and t4 under Alternative 4 for affected soils deeper than 20 ft, including LUCs, monitoring, and existing features as under Alternative 2, including monitoring for process optimization and performance verification Backfill excavation with clean soil (includes potential alternative options)	Scenario as in Alternative 6 with the addition of *in situ* treatments as under Alternative 4

Table 3.2. Estimated Effectiveness of Alternatives in Addressing COCs and PTW

		Alternative 1[a] No Action	Alternative 2[a] Limited Action (LUCs and Monitoring)	Alternative 3[a] Surface Cover,[b] LUCs, and Monitoring	Alternative 4[a] Surface Cover,[b] *In Situ* Source Treatments,[c] LUCs, and Monitoring	Alternative 5[a] Excavation and Disposal[d]	Alternative 6[a] Targeted Excavation and Disposal,[d] Surface Cover,[b] LUCs, and Monitoring	Alternative 7[a] Targeted Excavation and Disposal,[d] Surface Cover,[b] *In Situ* Source Treatments,[c] LUCs, and Monitoring
PTW								
Direct Contact	Uranium solids (including PTW)	No	Yes/No: Addresses direct contact but does not reduce toxicity, mobility, or volume.	Yes/No. Addresses direct contact with LUCs and cover, but no reduction of toxicity, mobility, or volume because uranium is already nonmobile.	Yes/No. Addresses direct contact through LUCs and cover, but no reduction of toxicity, mobility, or volume because uranium is already nonmobile.	Yes	Yes, depending on what is excavated.	Yes, depending on what is excavated. No: treatments will not be effective because uranium is already nonmobile.
Mobile Constituents	Mobile uranium (including pyrophoric uranium via air and uranyl fluoride PTW via water) and mobile Uranium 234, 235/236, 238 + daughters	No	No/Maybe. (Some effectiveness due to existing SWMU 3 leachate collection and treatment system and Northwest Plume Pump-and-Treat System).	Maybe/Yes. Some types of cover will reduce mobility. Some effectiveness due to existing SWMU 3 leachate collection and treatment system and Northwest Plume Pump-and-Treat System.	Maybe/Yes. Reduce mobility depending on cover. Reduces toxicity/mobility if treatment strategy addresses mobile uranium.	Yes	Yes, depending upon what is excavated and type of CR.	Yes, depending upon what is excavated, what treatment is employed, and type of CR.
	TCE, DCE (DNAPL/soil source, including PTW)	No	Yes. Some effectiveness due to existing Northwest Plume Pump-and-Treat System.	Maybe/Yes. Some types of cover will reduce mobility. Some effectiveness due to Northwest Plume Pump-and-Treat System.	Yes/Yes. Reduce mobility depending on cover/reduces toxicity/mobility if treatment strategy addresses VOCs.	Yes	Yes, depending upon what is excavated and type of CR.	Yes, depending upon what is excavated, what treatment is employed, and type of CR.
PCBs (including PTW)								
Direct Contact	PCB (> 10 but < 50 ppm)	No	Yes. LUCs are considered sufficient per 40 *CFR* § 761.61.	Yes	Yes	Yes	Yes	Yes
	PCB (> 50 but less than 100 ppm)	No	No	Yes, if cap meets criteria in 40 *CFR* § 761.61.	Yes if treatment effective or cap meets criteria in 40 *CFR* § 761.61.	Yes	Yes, if cap meets criteria in 40 *CFR* § 761.61 or if sufficient excavation.	Yes, if cap meets criteria in 40 *CFR* § 761.61 or if sufficient excavation of if treatment effective on PCBs.
	PCBs > 100 ppm incl. PTW PCBs 100 ppm [residential], > 500 ppm [industrial])	No	No	No	No (unless source treatments reduce concentrations to below PTW levels).	Yes	Yes, if PCBs removed to below PTW level and sufficient level to match type of cap.	Yes, if PCBs removed to below PTW level and sufficient to match type of cap.
Other COCs								
Direct Contact	Arsenic	No	Yes, depending on LUCs (but no significant potential for reduction in toxicity, mobility, or volume).	Yes, depending on LUCs and cover.	Yes, depending on LUCs and cover.	Yes	Yes, depending on soils removed LUCs and cover.	Yes, depending on soils removed, LUCs, and cover.
	Tc-99	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Plutonium-239 + daughters	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Neptunium-237 + daughters	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Uranium 234, 235/236, 238 + daughters	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Total PCBs (< 50 ppm)	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Total PAHs	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
	Uranium (metal)	No	Yes	Yes	Yes	Yes	Yes, depending on soils removed.	Yes, depending on soils removed.
Mobile Constituents	Arsenic	No	Yes, depending on LUCs and existing elements (but no significant potential for reduction in toxicity, mobility, or volume).	Yes, depending on LUCs and cover.	Yes, depending on LUCs and cover.	Yes	Yes, depending on soils removed, LUCs, and cover.	Yes, depending on soils removed, LUCs, and cover.
	Tc-99	No	Yes, depending on LUCs and existing elements (but no significant potential for reduction in toxicity, mobility, or volume).	Yes, depending on LUCs and cover.	Yes, depending on LUCs and cover.	Yes	Yes, depending on soils removed, LUCs, and cover.	Yes, depending on soils removed, LUCs, and cover.
	TCE, DCE (non-DNAPL)	No	Yes, depending on LUCs and existing elements. Variable effectiveness depending upon SWMU.	Yes, depending on LUCs, cover, and existing elements. Variable effectiveness depending upon SWMU.	Yes, depending on LUCs, cover, treatments, and existing elements. Variable effectiveness depending upon SWMU.	Yes	Yes, depending on LUCs, cover, removal, and existing elements. Variable effectiveness depending upon SWMU.	Yes, depending on LUCs, cover, treatments, and removal and existing elements. Variable effectiveness depending upon SWMU.

[a] Alternatives are presented in a general format and will be developed into SWMU-specific alternatives in subsequent sections.
[b] Soil cover is a general term that could include a soil cover (nominal 1 ft), 18-inch clay/6-inch soil cover, Subtitle C cap, or Subtitle D cap, and may include an intruder barrier (See Section 3.3.1).
[c] *In situ* treatment could include a number of technologies as discussed in Section 3.3.2.
[d] Disposal could include consolidation and/or segregation of contaminated materials with either no treatment or on-site treatment of excavated material and then disposal on-site or off-site in approved disposal facility designed to receive specific waste.

3.4 ALTERNATIVES FOR BGOU SOURCE AREAS

3.4.1 Alternative 1—No Action

Formulation of a No Action alternative is required by the NCP [40 *CFR* § 300.430(e)(6)]. The No Action alternative serves as a baseline for evaluation of other remedial action alternatives and is retained throughout the FS process. As defined in CERCLA guidance actions taken to reduce exposure, such as site fencing, are not included as a component of the No Action alternative (EPA 1988). Alternative 1 includes no actions and no costs.

3.4.2 Alternative 2—Limited Action (LUCs and Monitoring)

This alternative includes the following, as necessary:

- RD;
- Monitoring;
- LUCs; and
- Recognition of existing features.

This alternative eliminates direct contact risk via LUCs and recognizes the role played by the existing surface covers in preventing direct contact with the waste and contaminated materials. This alternative may also eliminate risk from exposure to groundwater through the use of LUCs and existing features. Monitoring mitigates the uncertainties associated with managing risks associated with exposure to groundwater and supports monitoring of progress in restoration of groundwater by monitoring any changes in SWMU status or condition that may warrant an additional response or action.

3.4.2.1 Remedial design

A SWMU-specific RD will be performed. This design will evaluate existing data to define the limits of waste placement or the SWMU boundary as necessary to develop LUCs. The need for and placement of additional MWs will be identified to document the continuing protectiveness of the remedy.

3.4.2.2 Groundwater and surface water monitoring

The groundwater monitoring program is expected to incorporate sampling of upgradient and downgradient wells, screened in the RGA, followed by analyses for SWMU-related analytes. For estimating purposes, it is assumed that any newly-installed wells will be sampled quarterly for at least two years, with additional annual monitoring through five years. As necessary, sampling and analysis may occur biannually for Years 6 through 30. Existing PGDP MWs will be used, if properly placed to meet the monitoring needs, with new wells added as needed. SWMU-specific monitoring details will be developed as part of the RD. For estimating purposes, it is assumed that the addition of at least one upgradient well and three downgradient wells will be required to monitor each SWMU as part of this alternative.

Surface water monitoring may be needed to assess surface water impacts (particularly from SWMUs 7 and 30) to adjacent surface water ditches. SWMU-specific monitoring details will be developed in the RD. As additional impacts to ditches adjacent to these SWMUs are identified, they will be evaluated.

3.4.2.3 LUCs

LUCs as described in Section 2.4.1.1 will be implemented for units where waste or contamination remains in place that precludes unrestricted use.

3.4.2.4 Recognition of existing features

Existing features at some SWMUs (e.g., SWMU 3 Subtitle C cap and leachate collection and treatment system (t5) and the effect of the Northwest Plume Pump-and-Treat System (t6) at SWMUs 7 and 30) may assist in eliminating risk from direct contact with soils and waste and exposure to groundwater.

3.4.3 Alternative 3—Surface Cover, LUCs, and Monitoring

This alternative includes the following as necessary:

- RD;
- Construction of a surface cover;
- Monitoring;
- LUCs; and
- Recognition of existing features.

Under this alternative, a surface cover will be designed to provide a protective barrier over surface soils containing residual contamination. Depending on the SWMU-specific application and cover design, the cover would do the following:

- Protect humans and wildlife from coming into direct contact with the wastes or contaminated soils;
- Prevent wind transport of surface soil contaminants; and
- Reduce rainwater infiltration and reduce migration of contaminants to groundwater.

3.4.3.1 Remedial design

A SWMU-specific RD will be performed. This design will evaluate existing information as necessary to design the cover. This design also will incorporate information necessary to develop LUCs. The need for and placement of additional MWs will be identified to document the continuing protectiveness of the remedy. Engineering data collection to support technology sizing, design, and optimization will be performed as necessary during the RD in accordance with the RAWP.

3.4.3.2 Surface cover construction

If selected, one of the four types of surface covers described in Section 3.3.1 will be constructed over the unit.

For estimating purposes, it is assumed that the final cover will be grassed. It will be armored where erosion may occur. The cover will be contoured to promote runoff and will support control of direct exposure to the surface and subsurface contamination. Any of these covers also may include the addition of a 2 ft lift, type H riprap as an intruder barrier.

Decay of in-place uranium eventually will generate radium and subsequently radon gas; however, the half life of the uranium decay is very long. All radon isotopes have a short half-life and low potential for vapor migration from affected areas. These conditions support a determination that specific radon mitigation measures are not required for these burial grounds. Further, the rapid dispersion of radon in the atmosphere and the absence of buildings located on or adjacent to the SWMU where radon could accumulate, the barrier provided by surface covers, and radon's rapid decay minimizes exposure hazards. Any subsequent modification to the cover (including the installation of buildings) should consider the potential for impacts from radon; however, no additional remediation or mitigation measures are recommended to address radon under these cover alternatives.

3.4.3.3 Groundwater monitoring and surface water monitoring

A groundwater monitoring program will be implemented to support performance monitoring of Alternative 3 (the cover remedy). This program is expected to be of a level comparable to that described under Alternative 2.

Depending upon the type of cover selected and the potential for SWMU-related impacts to surface water, a surface water monitoring program may be implemented for this alternative. This program is expected to be of a level comparable to that described under Alternative 2.

3.4.3.4 LUCs

LUCs as described in Section 2.4.1.1 would be implemented for units where waste or contamination remains in place that precludes unrestricted use.

3.4.3.5 Recognition of existing features

Existing features t5 and t6, as described in Sections 3.3.3 and Alternative 2, would be recognized as part of this alternative, where applicable.

3.4.4 Alternative 4—Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring

This alternative includes the following:

- RD;
- Installation of *in situ* source treatment;
- Treatment of extracted residuals, if necessary;
- Process monitoring (may require well installation and monitoring);
- Postremediation sampling as appropriate;
- Construction of a surface cover;
- Monitoring;
- LUCs; and
- Recognition of existing features.

Alternative 4 is the same as Alternative 3 with the addition of *in situ* source treatment to the installation of a surface cover. The *in situ* treatment will be used to address in-place wastes and/or contaminated media.

No excavation to remove buried construction rubble, debris, or metallic waste that could interfere with the installation or operation of the source treatment system is planned as part of this alternative. Any incidental removal needed to implement the treatment will be identified in the RD. Excavated material will be managed and/or disposed of properly in accordance with its composition and degree of contamination, if any. Upon completion of the source treatment phase, a surface cover would be installed over the SWMU. A surface cover would be designed to provide a protective barrier over waste and surface soils containing residual contamination.

3.4.4.1 Remedial Design

A SWMU-specific RD will be performed for this remedial alternative. This design will evaluate existing information as necessary to design the treatment system, cover, and LUCs. The need for and placement of additional MWs to support either performance monitoring or extended monitoring will be identified. Engineering data collection to support technology sizing, design, and optimization will be performed as necessary during the RD in accordance with the RAWP. The SWMU-specific alternative evaluation will consider the uncertainties and assumptions inherent in this alternative and how the implementation and performance of the alternative would be affected by changes to the assumptions.

3.4.4.2 *In situ* source treatment

One of the four *in situ* source treatment options described in Section 3.3.3, and as evaluated for each SWMU in later sections of this document, will be used to reduce toxicity, mobility, or volume of the COCs.

3.4.4.3 Treatment of extracted residuals

Where the source treatment remedy generates residual waste (e.g., liquid and vapor from DPE, or liquid from ERH) appropriate treatment and disposal of that residual waste will occur as necessary as part of the treatment option.

The process monitoring system and procedures will be developed and modified, as necessary, for application to the individual treatment, source areas, and SWMU-specific needs. Process monitoring will be defined in detail in the RAWP. Potential monitoring approaches include collecting groundwater samples from the RGA immediately downgradient of each SWMU and collecting water samples from extracted/recirculating water/nutrient streams. For some SWMUs, the use of angled borings for collecting soil, soil vapor, and water samples will be considered. Directional drilling (horizontal wells) may have application in process monitoring of some treatment options. Aboveground treatment systems will be monitored using extracted, recirculating, or discharge streams that could include vapor emissions or liquid discharges. Personnel monitoring for exposure potential during operations will be addressed in SWMU-specific Health and Safety Plans (HASPs). Process monitoring also may include monitoring of parameters like liquid injection rate and volume, water recovery rate and volume, reagent additions, pH, oxidation reduction potential (ORP), temperature (either *in situ* or in extracted media), and types and quantities of generated waste.

3.4.4.4 Postremediation sampling

Confirmatory sampling in the treatment area may be utilized to determine treatment effectiveness in achieving PRGs and documenting residual contaminant concentrations. A postremediation/confirmation sampling plan will be prepared during RAWP development. Postremediation sampling will vary with the applied technology and also with the process monitoring.

3.4.4.5 Surface cover construction

A surface cover will be constructed over the unit as summarized above for Alternative 3 and as specified in the SWMU-specific discussions later in this document.

3.4.4.6 Groundwater and surface water monitoring

A groundwater monitoring program will be implemented to support performance monitoring of Alternative 4 (the *in situ* treatment/cover remedy). The monitoring program is expected to be a level comparable to that described under Alternative 2.

Depending upon the treatment selected, the type of cover selected, and the potential for SWMU-related impacts to surface water, a surface water monitoring program may be implemented for this alternative. This program is expected to be of a level comparable to that described under Alternative 2.

3.4.4.7 LUCs

LUCs as described in Section 2.4.1.1 would be implemented (in a manner comparable to that described in the SWMU-specific description for Alternative 2) for units where waste or contamination remains in place at levels that preclude unrestricted use.

3.4.4.8 Recognition of existing features

Existing features t5 and t6, as described in Sections 3.3.3 and Alternative 2, would be recognized as part of this alternative, where applicable.

3.4.5 Alternative 5—Excavation and Disposal

This alternative includes the following:

- RD (including identification of disposal location and WACs of disposal facilities;
- Install sheet pilings to shore the excavation walls and minimize groundwater intrusion, as necessary;
- Excavate waste and source area soils contaminated with COCs above target concentrations;
- Treat or dispose of removed water, as necessary, as indicated by sampling results;
- Waste compliance with WAC verification plan;
- Postremediation sampling and analysis;
- Treat the waste and soil on- or off-site, if necessary, for transportation and/or disposal;
- Transport and dispose of waste;
- Backfill to meet final design requirements and contours (alternatives to conventional backfill will be considered where appropriate);
- Recognize existing features; and
- Implement contingent remedies, including LUCs and monitoring, to address residual COCs remaining at above PRG levels after alternative implementation, if necessary.

Alternative 5 includes excavating wastes and associated affected soils for disposal. This alternative could be differentially implemented depending upon the nature of the burial ground; however, generally, this alternative will provide bulk excavation of both wastes and soils in the same horizon without any attempts at segregation during excavation.

The excavation alternative includes the removal of waste from the individual SWMU. Based on disposal records, wastes are disposed of at depths less than 16 ft bgs. Excavation will progress until visible wastes have been removed and the appropriate target concentrations are met at the margins of the excavation. It is anticipated that target concentrations for nonmobile constituents would be met before reaching a depth of approximately 16 ft—a depth that also corresponds with typical maximum depths for utility installations at PGDP (and therefore protective of both future industrial and outdoor workers). There is some potential for mobile constituents to be present at levels at the bottom of the excavation at above-target levels. At DOE's discretion, excavations may be advanced to 20 ft to meet PRGs. For estimating purposes, excavation to 20 ft has been assumed for SWMUs where excavation of buried wastes is considered. (NOTE: SWMU 3 is an abovegrade unit and its excavation is anticipated not to advance beyond 4 ft below historical grade). Depending on the methods used in the excavation, the margins (i.e., bottom of the excavation) will be characterized to document the success of the remedy.

The SWMU-specific excavation alternatives at SWMUs 2 and 7 also include treatment contingencies to address residual VOC's RGs below 20 ft bgs, should they be found.

Contaminants in the excavated waste potentially could include VOCs, PCBs, metals, and radionuclides; therefore, *ex situ* treatments may be required to treat the contaminants prior to disposal. Waste containing pyrophoric uranium, but no PCBs will be stabilized on-site. Waste requiring treatment for PCBs, metals, and/or VOCs will be treated off-site.

The RD will include methods to address liquids generated during the excavation activities. Certain constituents pose other potential concerns that will be addressed in the RD (including excavation of wastes that may contain pyrophoric uranium).

3.4.5.1 Remedial design

A SWMU-specific RD will be performed for this remedial alternative. This design will evaluate existing information as necessary to design the excavation, LUCs, and performance monitoring. The need for and placement of additional MWs to support either performance monitoring or extended monitoring will be identified. Engineering data collection to the excavation sizing, design and optimization would be performed as necessary during the RD in accordance with the RAWP. This alternative does not anticipate the need for any large scale Remedial Design Site Investigation (RDSI). Rather, the SWMU-specific alternative evaluation will consider the uncertainties and assumptions and inherent in this alternative and how the alternative would be affected by changes to the assumptions.

As necessary, the RD may include updating the geophysical survey to ensure that the bounds of the waste area are well understood. The excavation process will include the installation of sheet pile around the waste perimeter at SWMUs 2, 7, and 30 to minimize the layback. This is not necessary at SWMU 3 due to the decreased depth. This approach would preclude the collection of confirmatory sidewall samples at SWMUs 2, 7, and 30. Depending upon the application, there may be additional measures to sample outside the sheet pile to ensure, as appropriate, a sufficient margin of soil free of waste is obtained.

3.4.5.2 Sheet piling

Because some of the SWMUs are located in areas of PGDP with limited accessibility, sheet piles may be required to excavate the waste cell material to the anticipated depth. If sheet pile is determined to be necessary in the RAWP, a comprehensive shoring system will be designed based on a maximum anticipated excavation depth of 20 ft bgs. This system, to be designed as part of the RDWP, is expected to include interlocking sheet pile and may include drilled tie-back anchors, which will extend through the sheet pile to the surrounding soil.

Installation of sheet piles around the perimeter of the waste trench will be performed prior to beginning excavation. A geophysical survey to determine the placement of the sheet piles may be included as needed to support the RAWP development and approval process. During excavation, dewatering would be required to remove groundwater trapped within the confines of the sheet piles. At the area of initial excavation, a sump pump will be placed at the base of the trench to pump out any collected water. Discharge of collected water is discussed in Section 2.4.1.7.2.

Where sheet pile is not used to implement an excavation, excavation will be performed in a safe manner to include sloping or benching of sidewalls to meet health and safety requirements.

3.4.5.3 Excavation

Soil containing COCs above their target concentrations will be removed from the identified SWMUs to a depth of up to 20 ft as shown in Figure 2.3. The method of waste excavation, staging, stabilization, and loading are complex and site specific; therefore, only a general approach is presented in this section. A number of factors and variables are considered part of the general excavation approach including, but not limited to, site controls and monitoring; dewatering; controls for fugitive emissions; weather protection; combustibles monitoring; and fire suppression. A detailed description of the excavation methodology will be presented in the SWMU-specific RAWP.

(1) The waste material will be excavated with conventional heavy equipment such as trackhoes and backhoes/loaders. The maximum planned depth of excavation using such equipment is approximately 20 ft bgs. This conventional equipment will be limited by its own design or by the design depth of the shoring.

(2) Depending on how the material is to be characterized to meet the disposal facility WAC, the waste and soil either will be temporarily staged at the PGDP, loaded into trucks or trailers, or loaded directly into waste containers. If the waste and soil meets the WAC of the C-746-U Landfill or the potential on-site disposal unit (if available), then it may be directly loaded into trucks for transportation and disposal.

(3) The material may be segregated based on physical, chemical, and radioactive characteristics, as determined by field observation, testing, and monitoring, to facilitate meeting the WAC of the disposal facilities.

(4) The waste and soil will be treated as necessary to meet disposal facility WAC requirements. Waste may be temporarily stored for the purpose of treatment in containers such as 208-liter (55-gal) drums; 1,325-liter (350-gal polyliners); 1,585-kg (3,500-lb) steel boxes; or 10-m^3 (25-yd^3) roll-off containers. The wastes will be stored in compliance with ARARs. Temporary storage would occur only as long as needed to facilitate the characterization and treatment processes required to allow disposal.

(5) If the material is determined by analytical testing to be nonhazardous, does not exceed the target concentrations, and meets PGDP guidance for clean backfill (PRS 2010), it will be set aside and considered for use as backfill for the BGOU project or for other projects. If the material meets criteria for fill at the on-site disposal cell (or the C-746-U Landfill), it may be set aside and used as fill for these units. These procedures will be documented in the RAWP.

(6) The waste and soil will be treated to meet WAC requirements. A uranium chip roaster[5] or other appropriate technology (Solidification/stabilization) would be required to treat any pyrophoric uranium encountered during excavation. Soils containing organic contaminants (e.g., VOCs or PCBs potentially present at SWMU 2) that exceed land disposal restrictions may be subjected to off-site treatment prior to disposal.

(7) The material will be loaded into the proper shipping container and transported for treatment or disposal.

(8) As required by the RAWP and associated site-specific HASP, air-borne emissions containment and monitoring may be implemented. This may include a temporary structure that maintains air containment by negative pressure during excavation. The HASP will also evaluate methods to control fugitive dust emissions and ensure waste transportation does not allow contaminants to leave the site.

The excavation alternative includes the removal of waste and associated affected soils. Excavation will progress until visible wastes have been removed and the appropriate target concentrations are met up to a depth of 20 ft bgs. If soils at the bottom of a 20 ft excavation exceed target concentrations established in the RAWP, DOE may decide to implement a CR either before or after backfill of the excavation.

Equipment and Preparation. Excavation of contaminated soil and the removal of buried waste (including waste present in drums and other types of packaged debris) can be accomplished using conventional excavation techniques and equipment. Excavation equipment will typically consist of a trackhoe, rubber-tired backhoe, and/or front-end loader. The excavator bucket will be equipped with teeth fabricated from material that minimizes spark-potential while handling drums or excavating soil from areas suspected to contain pyrophoric uranium.

A second backhoe, outfitted with a drum grappler, may be used to exhume intact drums of waste and place them directly into overpacks. The management of the excavation will be detailed in the RAWP. Drums that should not be placed into an overpack will be evaluated to determine whether the drum should be opened and its contents transferred to another container or treated with foam or other fixing agent. The track excavator will work with the drum removal operation to excavate loose waste and backfill material at and around the drums. As specified in the to-be-developed RAWP, other waste such as decayed drums, packaging, and soil will either be direct loaded into trucks, staged at the perimeter of the excavation, or be placed in dewatering roll-off containers to minimize retention of free liquids with the excavated material.

Water collected from the dewatering process and any water removed by dewatering of waste/soil will be characterized, classified and, if necessary, treated and then properly discharged. When the water has drained from the containers, the containers filled with solid waste material then will be transferred to the waste treatment areas, as necessary.

Drums that still are intact will be removed from the excavation individually in order to minimize exposure to workers and the environment. Site controls will be utilized for both intact and degraded drums, as specified in the HASP. Standard fire prevention and suppression techniques will be utilized. Additional extinguishing agents for the potentially pyrophoric uranium at SWMU 2 will be located immediately adjacent to the excavation site and ready for use as defined in the RAWP.

[5] Depleted uranium chips are burned to an oxide (a more stable form) under controlled conditions in a chip roaster. Chip roasters have been used previously at other DOE facilities including Rocky Flats.

Pyrophoric Uranium Waste (SWMU 2 Only). Excavation activities will be performed in accordance with a HASP designed for handling pyrophoric uranium. The excavation and handling of this uranium presents challenges for the remedial action contractor. Detailed information regarding handling of uranium waste will be provided in the RAWP.

During milling, grinding, and turning operations, uranium shavings were cooled and protected from oxidation by metalworking oil. The uranium shavings, associated oil, and floor sweeping including sawdust have been placed in drums underground, stored in the original metalworking coolant (potentially supplemented with waste oils), for a period of about 40 years. It is likely that drums have degraded enough to have lost any mobile liquids covering the shavings. Uranium shavings that have been exposed to air or water are expected to be oxidized. While unlikely, other drums still may be intact and may contain waste oils covering the shavings. Uranium shavings within intact drums still covered by coolant are expected to be at least partially oxidized from the presence of water in the coolant. It is unlikely that fresh surfaces of small particle-size material have remained intact for the period of burial; however, historical or current oxidation of uranium by water has the potential of producing hydrogen gas and build-up in the drums is possible if the drums still are intact and airtight. Hydrogen atoms are small and lighter than air and tend to diffuse out of the drums and soil. Thus, there are several potential hazards that are associated with intact drums that could result from piercing of these drums. The RAWP will describe how intact and degraded drums will be handled.

Uranium will undergo combustion if the oxide layer on the fines is disturbed in the presence of air and the rate of heat production by the self-sustaining chemical reaction (oxidation) exceeds the rate of the heat loss to the surroundings. Any type of handling has the potential to disturb the oxide layer. In the absence of a flammable or combustible material, the combustion of these types of materials resembles smoldering and produces a heavy smoke that likely would settle in the immediate vicinity. Typically, this type of event may be managed by covering the material with soil to allow the combustion to self-extinguish.

Dust emissions from excavation can be controlled by foam and or water-based spray solutions. Emissions can also be controlled by a mobile vacuum hood equipped with the capability to provide high-efficiency particulate air (HEPA) filtration, as needed, and supported by an all-terrain crane so that it can be placed to capture smoke or fumes from a fire.

Water generally is acceptable for use as an extinguishing or cooling agent for fires involving uranium. However, the preferred extinguishing agent is a sodium chloride-based powder such as MET-L-X. This dry powder is noncombustible and does not produce secondary fires as a result of its application to burning metal. Sodium chloride-based extinguishers and sodium chloride-based powder will be available at the site.

Staging/Segregation of Contaminated Materials. Excavation, sorting, sampling, and treatment procedures will be explained in detail in the RAWP.

Materials excavated from the unit will be placed in trucks, bins, drums, or roll-offs depending upon the nature of the materials being excavated as outlined in the RAWP. These materials will then be moved from the excavation to the staging/segregation area or the disposal unit. The bins will collect drums, drum fragments, debris, waste materials, and affected soils. Historical waste materials reports for the BGOU include uranium metal, uranium oxides, uranyl fluoride solution, uranium tetrafluoride solution, zirconium-bearing scrap, sandblast grit, crucible burnout materials, cleanup debris, TCE (including uranium contaminated TCE sludge), and radioactive sources. The RAWP and HASP will address measures to be taken to monitor for potentially explosive airborne particulate mixtures of combustible metals. Liquids and sludges, when encountered, will be segregated and managed appropriately.

Soils from the surface and at depth will be segregated in roll-off bins. This material will be segregated and managed appropriately based on levels of radioactivity and other forms of contamination, such as RCRA- or TSCA-mixed waste.

Soils and waste drums from below the surface will be segregated into bins and roll-off containers. Drums that are found intact may be placed in separate bins or overpacks as described in the RAWP. Once in the bins, the drums may be punctured to vent built-up hydrogen or other gasses and to drain liquids or waste oils from the drums. Decayed drums, soils, and other waste materials will be separated into containers. This material can then be immediately transported to an on-site treatment area or directly to the disposal area for appropriate waste management.

Miscellaneous debris is expected to include compatible materials such as waste personal protective equipment (PPE), concrete, roofing materials, cleanup debris, and radioactive sources. In addition to radiation and volatile organic screening, these items will be visually inspected for stains or discoloration to help identify hazardous materials. In general, these items are anticipated to be LLW material unless RCRA hazardous characteristics or the presence of PCBs or other TSCA regulated materials are indicated.

Materials that cannot be immediately identified will be containerized and sampled to identify the contents. Once the materials are characterized, they will be disposed of properly.

The excavated containers will be inspected for labels, markings, or other information that may indicate their contents. If the physical state of the drum contents cannot be determined, the material will be sampled to determine its characteristics. If the liquids/sludges cannot be identified, they will be screened for radiological and volatile organic contamination and will be repackaged, as required, to allow proper characterization, transport, and disposal. Based on known information, screening information, or if necessary, sampling data, the characteristics of the excavated materials will be evaluated to ensure that each material meets the WAC of the appropriate disposal site.

Handling and Treatment of Soils and Waste Debris. Soils excavated directly from the disposal plots may contain waste drums, pieces of drums, debris, etc., and may possess hazardous or radioactive characteristics. The nature of the disposed materials will be identified based on disposal records and visual indicators. Visual indicators may include miscellaneous debris and particulate mixed in with soils, staining and discoloration, odors, or other indications from field instruments that indicate the soils may be contaminated. Soils that appear stained or discolored or appear to possess chemical or radioactive contamination automatically will be segregated as suspect-contaminated to ensure waste minimization.

The excavation will be designed to decouple the excavation from the waste handling processes to the extent practical to minimize the impacts that each of these activities has on the other. The excavation rates may be adjusted based on the rate of residual treatment to keep a minimum amount [determined by HASP and sampling and analysis plan (SAP)] of material staged prior to treatment. During the excavation, soils will be handled appropriately considering the contaminants suspected to be disposed therein.

Waste material will be sized, scanned, and may be segregated to separate magnetic/metallic materials, depending upon the disposal facility WAC. These materials will then be scanned and segregated for radioactive contamination (Such a segregation step actually may reduce the volume of soils that would have to be sent off as LLW). Soils and debris that fail the radioactive segregation will be disposed as LLW.

Material determined to require treatment will be transported to the treatment facility where it will be handled properly, including but not limited to one of these ways:

- Reduced in size and blended;
- Treated in a low-temperature thermal desorption unit;
- Screened and separated by metal detection;
- Segregated according to its level of radioactivity;
- Dewatered as necessary; and
- Disposed of properly according to its final characterization.

Each of these elements is discussed in the following sections concerning example treatment methods.

Shredders and Waste Blenders. Shredders and waste blenders may be purchased separately or may come as part of the thermal desorption unit package, if needed. Shredding and waste blending may be implemented as pretreatment steps to manage wastes/soils before disposal or before the waste enters the thermal desorption unit or before the waste is treated for TCE using other means. Separate shredders may be used for soils and other solid debris.

Low-Temperature Thermal Desorption. Low-temperature thermal desorption (LTTD) systems are physical separation processes that are designed to treat organically contaminated soils, sludges, and solids, but not to destroy organics. Wastes are heated from 90°C to 320°C (194°F to 608°F) to volatilize water and organics while a carrier gas and vacuum system are used to transport the gasses to a gas treatment system. The LTTD bed temperatures and residence times are designed to volatilize selected contaminants, but not oxidize them. A proven full-scale technology, LTTD is currently used to remediate all types of soils contaminated with petroleum or chlorinated hydrocarbons. Many of these units are transportable.

Two common thermal desorption designs are the rotary dryer and the thermal screw. Often, wastes are reduced in size and blended to allow easier materials handling and more uniform drying. Rotary dryers are horizontal cylinders (typically inclined) that can be indirectly heated or direct-fired. Thermal screw units are screw conveyors that transport wastes through an enclosed trough where hot oil or steam circulating through a hollow auger indirectly heats the medium. Thermal desorption systems require off-gas treatment to remove particulates and capture or destroy the desorbed contaminants. Particulates are typically removed by conventional particulate removal equipment, such as wet scrubbers or fabric filters. Volatilized contaminants can be removed through condensation followed by carbon adsorption, vapor phase carbon adsorption, or destroyed in a secondary combustion or treatment chamber.

Chemical Oxidation. VOCs may also be treated to meet the WAC by chemical oxidation. Shredders and blenders may still be need to prepare the wastes for treatment but the oxidation could be implemented in field containers.

Metal Detection/Separation System. A metal detection/separation system is a proven technology that will screen out nonoxidized (and, therefore, pyrophoric) uranium as well as drums, pieces of drums, and metal components. Uranium chips separated by this process may be oxidized in a uranium chip roaster or otherwise rendered non-pyrophoric to support meeting the disposal site WAC.

Segmented Gate System. A segmented gate system was used to scan radioactive soils at the DOE Formerly Utilized Sites Remedial Action Program site in New Brunswick, New Jersey. This gate system separates radiologically contaminated soils from the below-action-level soils. This process reduces the total amount of contaminated soils that requires treatment. It provides 100 percent assay of all soils processed for radioactive contamination and produces no secondary waste.

Waste Disposition. Waste disposition will occur at appropriate facilities.

Additional Treatment of Waste and Soil. A stabilization process may be utilized as appropriate to encapsulate radioactively contaminated soils and other low-level radioactive debris recovered from the disposal plots. Stabilization involves mixing the wastes with a stabilization agent to form either a solid monolith or a granular encapsulation. Encapsulation within the monolith/granular materials isolates depleted uranium pieces from oxygen and moisture, rendering them non-reactive. Stabilization techniques can be sensitive to the presence of oils or solvents. If these materials are detected, the stabilization mixture may be modified, or the oils/solvents may be separated and containerized. Following stabilization, the stabilized material may be sampled to support meeting the site disposal WAC and may include analysis by the EPA Toxicity Characteristic Leaching Procedure for metals, VOCs, and reactivity, if necessary to meet the WAC.

Secondary Waste. Secondary waste, such as PPE and spent bag filters, generated as part of the proposed action, will be characterized based on process knowledge and radiological screening. High-efficiency particulate air filters (if any are used) may contain low-levels of radioactivity and will be managed on-site until they can be appropriately disposed of. Wastes or contaminated media identified as non-radiological and non-hazardous will be disposed of in the PGDP C-746-U Landfill if they meet the WAC. Wastes or contaminated media identified as hazardous or low-level/low-level-mixed will be stored on-site pending shipment to an appropriate disposal facility.

Wastes will be managed, recycled, treated, and/or disposed of in accordance with ARARs.

On-Site Storage. Waste may be temporarily stored in containers for the purpose of dewatering or treatment. The wastes will be stored on-site in compliance with ARARs. Temporary storage will occur only as long as needed to get the wastes/media through the treatment process(es), and then the treated materials would be sent for disposal.

3.4.5.4 Treatment or disposal of residual groundwater

Postremediation samples will be collected to determine the effectiveness of remediation. Interim samples may be collected to determine if excavation is complete. The target soil concentrations will be developed in the RAWP and will be based on a cumulative ELCR and cumulative HI calculation. There may be contaminated groundwater entering the excavation. If groundwater enters the excavation during or after removal of waste and contaminated soils, the groundwater will be treated and/or disposed of appropriately based on the nature of the contamination and the levels present in the groundwater.

An on-site wastewater treatment unit will be used as required to treat wastewater generated from pit dewatering as needed based on sample analysis results. Water will come from both precipitation contacting waste/media as well as groundwater seeping from sidewalls. A wastewater treatment unit will be designed as part of the remedial action to treat the COCs. BGOU wastewater treatment will be performed in compliance with ARARs. A temporary confinement structure or existing decontamination pad will provide a controlled environment for performing treatment operations, as necessary.

Alternatively, it is possible that there will be capacity available at the existing on-site water treatment facility at the Northwest Plume. This system has a total capacity of 220 gpm. Use of the existing on-site facility would be dependent on available capacity at the time. If available, it would reduce the cost for this alternative, as shown in the break out for the treatment system in the cost estimates in Appendix E. Potential treatment mechanisms available at the Northwest Plume Pump-and-Treat System include precipitation/coagulation, air stripping, ion exchange, and carbon adsorption. Treatability testing may be required to optimize treatment of wastes and/or extracted groundwater.

Appropriate precautions will be taken during the excavation phase to prevent adverse effects to workers and the surrounding environment. This alternative would address or eliminate long-term risks to the environment and will be conducted in compliance with ARARs.

3.4.5.5 Sampling and analysis

Several types of sampling and analysis efforts may be performed during the excavation phase. As required, samples will be collected to support identification of disposal options and verify that the excavated materials meet the disposal facility WAC requirements. Periodic sampling and analysis may occur throughout the course of excavating the SWMU to monitor progress. Excavation will continue to the desired depth or until materials above the target concentrations are no longer encountered. A final set of samples may be collected from the bottom of the excavation to confirm that the material above the target concentrations has been removed. Sidewall samples will be collected if sheet-pile walls are not installed. The RAWP will summarize whether/how the excavation will be backfilled.

3.4.5.6 Transportation and disposal

The exact mode of transportation will be chosen based on material characteristics and disposal facility requirements. The shipping container requirements and transportation method(s) will be described in detail in the RAWP. It is anticipated that the wastes will be transported either by rail cars in appropriate containers or by truck.

Shipment to an Off-Site Disposal Facility. This option assumes that the waste would be shipped off-site to an existing federal or commercial facility. Shipments would require manifesting and would occur in accordance with local, state, and federal regulations. The excavated waste would undergo treatment, if necessary, to meet the WAC of the facility.

Any radioactively or chemically-contaminated solid waste generated during remedial actions would be collected and placed in containers acceptable for transportation or combined with bulk contaminated soils for shipment off-site. The rail cars or trucks used to haul contaminated materials would undergo safety inspection before use. All containers would be checked for surface contamination and decontaminated, if necessary, before being loaded onto the rail cars or trucks. Containers would be manifested according to the applicable requirements for shipments of radioactive and chemically hazardous and non-hazardous waste materials. As required, pre-designated routes would be traveled and an emergency response program would be developed for responding to any accidents. Off-site transportation of radioactively and chemically contaminated materials would comply with all applicable state and federal regulations.

DOE Disposal Facilities. An evaluation of the feasibility of constructing an on-site disposal facility for CERCLA waste is underway. Should such a facility be constructed and available within a reasonable time frame for use, it would provide a more cost-effective disposal option for this alternative. The WAC for the U-landfill may allow some of the generated materials to be properly disposed there. The RAWP will identify which materials are candidates to be disposed at each of the disposal facilities.

3.4.5.7 Backfill

Upon completion of excavation and receipt of confirmatory postremediation sample results, fill material compatible with the final site use may be placed in the excavation. Drainage structures or long-term monitoring equipment and sampling points may need to be installed in the excavation prior to backfill. Alternatively, the SWMU may be re-graded to support future uses (i.e., as wetlands, as staging areas for soil borrow for the on-site cell, as staging areas for soils for the C-746-U Landfill, etc.).

If backfilled, the fill material will be placed in the excavation in lifts and compacted as described in the RAWP. The excavation will be backfilled and graded to return the location to its original condition. If confirmed clean, soil from the upper layer of each SWMU that has been set aside will be combined with soil from elsewhere on the facility. All clean backfill material used will be confirmed clean prior to placement, in accordance with DOE protocol (PRS 2010). The cost estimate for this alternative assumes clean soil is obtained from off-site sources to be used for backfill.

3.4.5.8 Recognition of existing features

Existing feature t6, as described in Sections 3.3.3 and Alternative 2, would be recognized as part of this alternative, where applicable.

3.4.5.9 Contingent remedies

If contamination above PRGs remains at the bottom of the excavation, a CR will be applied. These remedies typically will be used to address mobile constituents like chlorinated VOCs (TCE), uranyl fluoride, and Tc-99 because nonmobile constituents are expected to be effectively addressed by excavation. The *in situ* treatments discussed in Section 3.3.2 and the existing features discussed in Section 3.3.3 are the contingent remedies potentially applicable to Alternative 5. A CR may have LUCs and monitoring as a component.

The applicability of contingent remedies and the triggers for those remedies will be discussed in the SWMU-specific sections.

3.4.6 Alternative 6—Targeted Excavation and Disposal, Surface Cover, LUCs and Monitoring

The alternative includes the following:

- RD;
- Install sheet pilings to shore the excavation walls and minimize groundwater intrusion, as necessary;
- Excavate waste and source area soils contaminated with COCs above target concentrations;
- Treat or discharge residual groundwater, if necessary, as indicated by sampling results;
- Sample to develop and monitor WAC compliance;
- Conduct interim or postexcavation sampling and analysis;
- Treat the waste and soil, if necessary, for transportation and/or disposal;
- Transport and dispose of waste;
- Backfill with clean, uncontaminated, or affected soil;
- Construct a surface cover;
- Install wells and monitor;
- LUCs;

- Recognize existing features; and

- Implement contingent remedies to address residual COCs remaining above PRG levels after alternative implementation, if necessary.

Alternative 6 employs targeted excavation and disposal of waste to provide more active remediation than is available through containment. Targeted excavation will address relatively high risk portions of the SWMU. This targeted excavation will be conducted on buried waste to a maximum depth of 20 ft bgs. A surface cover will be needed to protect human health or the environment from contact with those areas not excavated.

Alternative 6 reduces risk to receptors by removing COCs that have the greatest potential for risk under certain contaminant exposure and migration pathways and controlling direct contact by both removal (excavation), containment (covering), and LUCs. The containment components include installing a surface cover, as appropriate, to limit direct contact and prevent infiltration of precipitation. Groundwater and surface water monitoring will be continued as necessary to monitor the effectiveness of the remedy.

Details for each element of the alternative are presented below. The cover system design also could include an intruder barrier.

3.4.6.1 Remedial design

A SWMU-specific RD will be performed for this alternative. This design will evaluate existing information as necessary to design the scope of the excavation, cover, LUCs, and performance monitoring. The need for and placement of additional MWs to support either performance monitoring or extended monitoring will be identified. Engineering data collection to the excavation sizing, design and optimization would be performed as necessary during the RD in accordance with the RAWP. This alternative does not anticipate the need for any large scale RDSI. Rather, the SWMU-specific alternative evaluation will consider the uncertainties and assumptions and inherent in this alternative and how the alternative would be affected by changes to the assumptions.

As necessary, the RD may include updating the geophysical survey to ensure that the bounds of the targeted waste area are well understood. The excavation process in this alternative will likely include the installation of sheet pile around the targeted waste perimeter. This approach will preclude the collection of confirmatory sidewall samples. In general, the excavation will be performed to the sheet pile. Any residual contamination outside the sheet pile will be managed by containment, LUCs, or contingent remedies.

3.4.6.2 Sheet pilings

Targeted excavation is expected to extend to the bottom of the waste or affected media to a depth of approximately 20 ft bgs, as described in Alternative 5.

3.4.6.3 Excavation and disposal

Excavation and disposal will be performed in a manner similar to that outlined in Alternative 5 but adjusted to target individual COCs present in smaller areas as described in the SWMU-specific RAWP.

3.4.6.4 Installation of surface cover

The surface cover will be designed as described in the SWMU-specific RAWP in a manner similar to that outlined in Alternative 4, above.

3.4.6.5 Groundwater and surface water monitoring

A groundwater monitoring program will be implemented to support performance monitoring of Alternative 6, the targeted excavation/cover remedy. This program is expected to be of a level comparable to that described under Alternative 2.

Depending upon the treatment selected, the type of cover selected, and the potential for SWMU-related impacts to surface water, a surface water monitoring program may be implemented for this alternative. This program is expected to be of a level comparable to that described under Alternative 2.

3.4.6.6 LUCs

LUCs as described in Section 2.4.1.1 would be implemented for units where waste or contamination remains in place that precludes unrestricted use.

3.4.6.7 Recognition of existing features

Existing feature t5 and t6, as described in Sections 3.3.3 and Alternative 2, would be recognized as part of this alternative, where applicable.

3.4.6.8 Contingent remedies

If contamination above PRGs remains at the bottom of the targeted excavation, a CR will be applied. These remedies typically will be used to address mobile constituents like chlorinated VOCs (TCE), uranyl fluoride, and Tc-99 because nonmobile constituents are expected to be effectively addressed by excavation. The *in situ* treatments discussed in Section 3.3.2 and the existing features discussed in Section 3.3.3 are the contingent remedies potentially applicable to Alternative 6. A CR may have LUCs and monitoring as a component.

The applicability of contingent remedies and the triggers for those remedies will be discussed in the SWMU-specific sections.

3.4.7 Alternative 7—Targeted Excavation and Disposal, Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring

This alternative includes the following:

- RD;
- Install sheet pilings to shore the excavation walls and minimize groundwater intrusion (if necessary);
- Excavate waste and source area soils contaminated with COCs above target concentrations;
- Treat or dispose of residual groundwater, if necessary, as indicated by sampling results;
- Sample to develop and monitor WAC compliance;

- Conduct interim or postremediation sampling and analysis;
- Treat the waste and soil, if necessary, for transportation and/or disposal;
- Transport and dispose of waste;
- Backfill with clean, uncontaminated, or affected soil (depending on cover and remedy);
- Excavate and dispose of targeted areas;
- *In situ* treatment of sources not excavated;
- Off-gas treatment, as necessary;
- Conduct performance and process monitoring;
- Conduct postremediation sampling;
- Construct a surface soil cover;
- Install wells and groundwater monitoring long-term ;
- LUCs;
- Recognize existing features; and
- Implement contingent remedies to address residual COCs remaining at above PRG levels after alternative implementation, if necessary.

Alternative 7 is identical to the excavation, disposal, and cover alternative described for Alternative 6, except this alternative is supplemented with *in situ* source treatment to remediate waste cell areas. This alternative would reduce the mass of source constituents in the UCRS through excavation and *in situ* treatment; control direct contact through containment and LUCs; and control groundwater threats through LUCs, removal, and treatment. Requirements and conceptual designs for each element of Alternative 7 are discussed in more detail in their appropriate SWMU specific sections.

3.4.7.1 Remedial design

A SWMU-specific RD will be performed for this remedial alternative. This design will evaluate existing information as necessary to design the excavation, *in situ* treatment, cover, LUCs, and performance monitoring. The need for and placement of additional MWs to support either performance monitoring or extended monitoring will be identified. Engineering data collection to support the excavation and treatment sizing, design and optimization would be performed as necessary during the RD in accordance with the RAWP. This alternative does not anticipate the need for any large scale RDSI. Rather, the SWMU-specific alternative evaluation will consider the uncertainties and assumptions and inherent in this alternative and how the alternative would be affected by changes to the assumptions.

As necessary, the RD may include updating the geophysical survey to ensure that the bounds of the targeted waste area are well understood. The excavation process in this alternative will likely include the installation of sheet pile around the targeted waste perimeter to ensure that the excavation may extend to limits of buried waste expected to be encountered within 20 ft bgs. This approach will preclude the collection of confirmatory sidewall samples. In general, the excavation will be performed to the sheet pile. Any residual contamination outside the sheet pile will be managed by *in situ* treatment, containment, LUCs, or contingent remedies.

3.4.7.2 Sheet pilings

Targeted excavation is expected to extend to the bottom of the waste and affected soils (typically within 20 ft bgs, as described in Alternative 5).

3.4.7.3 Excavation and disposal

Excavation and disposal will be performed in a manner similar to that outlined in Alternative 6 as described in the SWMU-specific RAWP.

3.4.7.4 Installation of surface cover

The surface cover will be designed as described in the SWMU-specific RAWP in a manner similar to that outlined in Alternative 4.

3.4.7.5 *In Situ* Treatment

The *in situ* treatment of subsurface contaminants will address COCs not addressed by excavation and will focus on those COCs that are mobile and have the potential to migrate to the RGA at unacceptable levels. Treatment technologies considered are summarized in Alternative 4. The specific application of Alternative 7 is outlined in the SWMU-specific section.

3.4.7.6 Process monitoring

The process monitoring system and procedures would be developed and modified, as necessary, for application to the individual BGOU SWMU source areas and SWMU specific needs. Process monitoring would be defined in detail in the RAWP. Potential monitoring approaches include collecting groundwater samples from the RGA beneath each SWMU, collecting water samples from recirculating water/nutrient streams. There may be some consideration of the use of angled borings for collecting soil, soil vapor, and water samples. Directional drilling (horizontal wells) is another possibility for groundwater sampling below the SWMUs. Above-ground treatment systems would be monitored based on extracted media or discharge streams that could include vapor emissions or liquid discharges. Personnel monitoring for exposure potential during operations will be addressed in SWMU-specific HASPs. Process monitoring may also include monitoring of parameters like liquid injection rate and volume, water recovery rates and volumes, reagent additions, pH, ORP, and temperature of *in situ* or extracted media, and types and quantities of generated wastes.

3.4.7.7 Postremediation sampling

Confirmatory sampling in the treatment area may be required to determine treatment effectiveness in achieving PRGs and to document residual contaminant concentrations. A postremediation sampling plan would be prepared during RAWP development. Postremediation sampling will vary with the applied technology and also with the process monitoring.

3.4.7.8 Surface cover construction

A surface cover will be constructed over the unit as summarized above for Alternative 3 and as specified in the SWMU-specific discussions below.

3.4.7.9 Groundwater and surface water monitoring

A groundwater monitoring program will be implemented to support performance monitoring of Alternative 7, the targeted excavation, *in situ* treatment/cover remedy. This program is expected to be of a level comparable to that described under Alternative 2.

Depending upon the treatment selected, the type of cover selected, and the potential for SWMU-related impacts to surface water, a surface water monitoring program may be implemented for this alternative. This program is expected to be of a level comparable to that described under Alternative 2.

3.4.7.10 LUCs

LUCs as described in Section 2.4.1.1 would be implemented for units where waste or contamination remains in place that precludes unrestricted use.

3.4.7.11 Recognition of existing features

Existing feature t5 and t6, as described in Sections 3.3.3 and Alternative 2, would be recognized as part of this alternative, where applicable.

3.4.7.12 Contingent remedies

If contamination above PRGs remains at the bottom of the targeted excavation, a CR will be applied. These remedies typically will be used to address mobile constituents like chlorinated VOCs (TCE), uranyl fluoride, and Tc-99 because nonmobile constituents are expected to be effectively addressed by excavation. The *in situ* treatments discussed in Section 3.3.2 and the existing features discussed in Section 3.3.3 are the contingent remedies potentially applicable to Alternative 7. A CR may have LUCs and monitoring as a component.

The applicability of contingent remedies and the triggers for those remedies will be discussed in the SWMU-specific sections.

3.5 ADDRESSING DATA GAPS

There are some remedy-specific and SWMU-specific uncertainties that have been identified during the FS process. Specific uncertainties, technologies affected, and the general approach for addressing the specific uncertainties are presented in Table 3.3.

3.6 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The general alternatives developed thus far in Section 3 are now screened using the process described by EPA (1988) and the NCP to reduce the number of general alternatives and specific elements carried forward to detailed analysis. In the SWMU-specific sections (Sections 5–8) of this FS, the retained alternatives and alternative process options are assembled into SWMU-specific alternatives subjected to detailed and comparative analysis based on conditions present at each SWMU.

Table 3.3. Summary of Uncertainties, Affected Technologies, and Approaches to Address the Uncertainties

Uncertainty	Affected Technology(ies)	Approach(es) to Address Uncertainty
Presence of DNAPL (speculated but not confirmed)	*In situ* treatments: ERH, ZVI, *in situ* bioremediation, and DPE	Flexible design to address DNAPL if present. Install MWs or other process monitoring points to monitor remedial progress. Uncertainty factored into excavation alternatives to address DNAPL.
Depth and Extent of DNAPL/High Concentration Source Areas	*In situ* treatments: ERH, ZVI application, *in situ* bioremediation, and DPE	Flexible design to address DNAPL if present. Install MWs or other process monitoring points to monitor remedial progress. Uncertainty factored into excavation alternatives to address DNAPL/source areas.
PCB Concentrations in SWMU 2 Waste	Excavation and disposal, and capping	The presence and prevalence of PCBs has not been established. There are no treatment technologies that will effectively address PCBs, if present at PTW levels in SWMU 2 wastes because the PCBs (if present) were co-disposed with uranium in drums.
Pyrophoric Uranium	Excavation and disposal	The presence and prevalence of pyrophoric uranium remaining in SWMU 2 has not been established. Although there are some treatment technologies that will effectively address the pyrophoricity, none will affect the continued presence of elemental uranium.
Groundwater Elevation	Excavation and shallow treatments	The depth to water and the thickness of unsaturated soil influences the evaluation of excavation and shallow soil treatments and the need for groundwater infiltration control. The groundwater elevation measurements from UCRS wells in the BGOU will be used to identify gaps that may be filled with additional monitoring points.
Treatability Tests	*In situ* treatments: ERH, ZVI application, *in situ* bioremediation, and DPE	No treatability tests are specifically planned as part of the alternatives presented in this FS. It is recognized that, depending upon selected technology, some limited bench or treatability tests may be performed to support the RD.

These alternatives may include multiple process options that are reflected in the numbering: general alternative designation, cover designation, and treatment designation. For example, Alternative 7 as applied to SWMU 2 may be identified as 7.c.t2—targeted excavation, Subtitle C cap, DPE. A second Alternative for SWMU 2 might be 7.c.t3—targeted excavation, Subtitle C cap, chemical injection (ZVI). In the SWMU-specific sections, a screening will be conducted to identify which of the representative process options will be used in the assembly of alternatives to be subjected to detailed analysis. The SWMU-specific sections also will discuss why certain process options were chosen over others for detailed and comparative analysis.

Once assembled, SWMU-specific alternatives will be subjected to detailed analysis against the five balancing criteria outlined in the NCP as outlined in Section 4 of this FS.

A summary of the alternatives carried forward for each SWMU is presented in Table 3.4.

Table 3.4. BGOU SWMU Remedial Action Alternative Summary

Alternative Number/Description		SWMU			
		2	3	7	30
1	**No Action**:	X	X	X	X
2	**Limited Action (LUCs and Monitoring)**: · Recognizes existing feature*** (where applicable)	X	X***	X***	X***
3	**Surface Cover,* LUCs and Monitoring**: · Recognizes existing feature*** (where applicable)		X***	X***	X***
4	**Surface Cover,* *In Situ* Source Treatment,** LUCs, and Monitoring**: · Recognizes existing feature*** (where applicable)	X		X***	
5	**Excavation and Disposal**: · Recognizes existing feature*** (where applicable) · Allows for CR beneath excavation**,[#] (where applicable) · Includes evaluation of disposal off-site and at a potential on-site WDF	X[CR]	X***	X***, [CR]	X***
6	**Targeted Excavation and Disposal, Surface Cover,* LUCs, and Monitoring**: · Recognizes existing feature*** (where applicable) · Allows for CR beneath excavation,**,[#] · Includes evaluation of off-site disposal, but acknowledges potential on-site WDF may be considered	X [CR]		X***, [CR]	
7	**Targeted Excavation and Disposal, Surface Cover,* *In Situ* Source Treatment,** LUCs, and Monitoring**: · Allows for CR beneath excavation,**,[#] and · Includes evaluation of off-site disposal, but acknowledges potential on-site WDF may be considered	X [CR]			

*Surface Cover
a. 1-ft soil cover, configured to drain
b. 18-inch local clay/6-inch soil cover
c. Subtitle C Cap equivalent
d. Subtitle D Cap equivalent

**Treatment Options [also contingent remedies (CRs) except t2]
t1. ERH
t2. DPE
t3. ZVI injection
t4. bio

***Existing Features
t5. Subtitle C cap and leachate collection and treatment system (SWMU 3)
t6. Northwest Plume Pump-and-Treat System (SWMUs 7 and 30)

#CR includes LUCs and monitoring (see SWMU specific application).
WDF = potential on-Site Waste Disposal Facility

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4. DETAILED AND COMPARATIVE ANALYSES OF ALTERNATIVES

Remedial alternatives were developed in Section 3. The alternatives carried forward for SWMU-specific analysis are shown in Table 3.4. A determination about whether to retain an alternative for detailed analysis at each individual SWMU occurs in the SWMU-specific Sections 5, 6, 7, and 8. The purpose and approach for performing the detailed analysis are discussed here in Section 4. Results of the detailed analysis form the basis for comparing alternatives. The general approach for performing the comparative analysis also is presented in Section 4. The SWMU-specific comparative analyses of each alternative retained for consideration are presented in SWMU-specific Sections 5, 6, 7, and 8. The results of the detailed and comparative analyses ultimately will be used for preparing the Proposed Plan for BGOU SWMUs 2, 3, 7, and 30.

4.1 DETAILED ANALYSIS

4.1.1 Approach to the Detailed Analysis

The remedial action alternatives developed in Section 3 and retained after screening are analyzed in detail against the nine CERCLA threshold, balancing, and modifying criteria outlined in 40 *CFR* § 300.430(e)(9)(iii). This analysis forms the basis for selecting a final remedial action. The intent of this analysis is to present sufficient information for selection of an appropriate remedy.

4.1.2 Overview of the CERCLA Evaluation Criteria

The CERCLA evaluation criteria include technical, administrative, and cost considerations; compliance with specific statutory requirements; and state and community acceptance. Overall protection of human health and the environment and compliance with ARARs (in the absence of a CERCLA waiver) are categorized as threshold criteria that any viable alternative must meet. The balancing criteria upon which the detailed analysis is primarily based include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Both state acceptance and community acceptance are considered modifying criteria and are evaluated following a public comment period on the Proposed Plan, as well as when a final decision is made and the ROD is prepared. Each criterion is described below.

4.1.2.1 Overall protection of human health and the environment (threshold criterion)

Alternatives will be assessed to determine whether they can adequately protect human health and the environment in both the short- and long-term. Alternatives must protect human health and the environment from unacceptable risks posed by contaminants present at the BGOU source areas by eliminating, reducing, or controlling exposures as established during the development of RAOs consistent with 40 *CFR* § 300.430(e)(2)(I). Overall protection of human health and the environment draws on the assessments of the other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs (in the absence of a CERCLA waiver).

4.1.2.2 Compliance with ARARs (threshold criterion)

ARARs include substantive federal or more stringent 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 (TBC category). CERCLA § 121(d)(4) provides several ARAR waiver options that may be invoked, provided that human health and the environment are protected. Activities conducted on-site must comply with the substantive, but not administrative, requirements. Administrative requirements include applying for permits, recordkeeping, consultation, and reporting. Activities conducted off-site must comply with both the substantive and administrative requirements of applicable laws. Measures required to meet ARARs will be incorporated into the design phase and implemented during the construction and operation phases of the remedial action.

ARARs typically are divided into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific. Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, or air) for specific hazardous substances, pollutants, or contaminants. Location-specific ARARs establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., floodplains or historic districts). Action-specific ARARs include operation, performance, and design of the preferred alternative based on waste types and/or media to be addressed and removal/remedial activities to be implemented.

Alternatives are assessed to determine whether they meet ARARs identified for each alternative. If ARARs will not be met at the end of an action, an evaluation will occur to determine when a basis exists for invoking one of the ARAR waivers cited in 40 *CFR* § 300.430(f)(l)(ii)(c) that are listed as follows:

The alternative is an interim measure and will become part of a total remedial action that will attain the federal or state ARARs.

(1) Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

(2) Compliance with the requirement is technically impracticable from an engineering perspective.

(3) The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach.

(4) With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.

An alternative must meet this threshold criterion (or obtain a CERCLA waiver) to be eligible for selection. The ARARs in this FS are tailored to the scope of the FS, which does not include groundwater or surface water remediation. ARARs for each of the remedial alternatives retained for detailed and comparative analysis at one or more of the SWMUs are listed in Appendix F.

4.1.2.3 Long-term effectiveness and permanence (balancing criterion)

Long-term effectiveness and permanence are an assessment of the risk remaining at the site after RAOs have been met and the effectiveness and reliability of controls required to manage the risk posed by untreated waste or treatment residuals. Alternatives will be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. These are factors that may be considered in this assessment:

- The magnitude of residual risk from untreated waste or treatment residuals remaining at the conclusion of the remedial activities, including their volume, toxicity, and mobility.

- The adequacy and reliability of controls such as containment systems necessary to manage treatment residuals and untreated waste. For example, this factor addresses uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cover or treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

- The ability of controls to prevent treatment residuals and untreated waste from serving as a continuing source of contamination to groundwater, such that groundwater quality cannot be restored throughout the plume.

4.1.2.4 Reduction of toxicity, mobility, or volume through treatment (balancing criterion)

The degree to which the alternatives employ treatment or recycling that reduces toxicity, mobility, or volume will be assessed, including how the treatment is used to address the principal threats posed by the release sites. Factors that will be considered, as appropriate, include these:

- Treatment or recycling processes that the alternatives employ and the materials that they will treat;

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed or recycled;

- The degree of expected reduction in toxicity, mobility, or volume of the waste because of the treatment or recycling and the specification of which reductions are occurring;

- The degree to which the treatment is irreversible;

- The type and quantity of residuals that will remain following treatment, taking into consideration the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents; and

- The degree to which treatment reduces the inherent hazards posed by the principal threats at the release sites.

4.1.2.5 Short-term effectiveness (balancing criterion)

Short-term effects during implementation of the remedial action will be assessed, including the following:

- The ability to achieve effectiveness in a short period of time;
- Short-term risks that might be posed to the community;
- Potential risks or hazards to workers and the effectiveness and reliability of protective measures;
- Potential environmental effects and the effectiveness and reliability of mitigative measures; and
- Time until protection is achieved.

4.1.2.6 Implementability (balancing criterion)

The ease or difficulty of implementing the alternatives will be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including the technical difficulties and unknowns associated with constructing and operating the technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy;

- Administrative feasibility, including the availability of treatment, storage, and disposal capacity; and

- Availability of required materials and services.

4.1.2.7 Cost (balancing criterion)

Supporting calculations for conceptual designs including cost estimates are provided in Appendix E. These are the types of costs assessed:

- RD and construction documentation costs, including RD, construction management and oversight, RD and remedial action document preparation, project/program management and oversight, and reporting costs;

- Construction costs, including capital equipment, general and administrative costs, and construction subcontract fees;

- Operating and maintenance costs;

- Equipment replacement costs; and

- Surveillance and monitoring costs.

EPA guidance distinguishes between scope contingency and bid contingency costs (EPA 2000). Scope contingency costs represent risks associated with incomplete design and include contributing factors such as limited experience with technologies, additional requirements because of regulatory or policy changes, and inaccuracies in defining quantities or characteristics. Bid contingency costs are unknown costs at the time of estimate preparation that become known as remedial action construction proceeds. They represent reserves for quantity overruns, modifications, change orders, and claims during construction. Although EPA guidance allows for contingency based on the complexity and size of the project and the inherent uncertainties related to the remedial technologies, scope contingency was applied to the excavation alternative cost estimates prepared for this FS.

Life-cycle costs are presented as Net Present Worth, and in escalated dollars, for capital, O&M, and periodic costs for each alternative. Escalation was applied as directed by DOE Order 430.1A, “Life Cycle Asset Management.” Guidance was provided by U.S. Department of Energy, Office of Project Assessment, “FY 2011 Field Budget Call: Escalation Rates.”

Detailed total costs for implementing each alternative at the appropriate BGOU source areas are presented in Appendix E. Summary costs for implementing each alternative at the individual source areas are presented in the sections for the individual SWMUs that follow.

The alternative cost estimates are for comparison purposes only and are not intended for budgetary, planning, or funding purposes. Estimates were prepared to meet the -30% to +50% range of accuracy recommended in CERCLA guidance EPA (1988).

4.1.2.8 State acceptance (modifying criterion)

This assessment evaluates the technical and administrative issues and concerns Kentucky Department for Environmental Protection (KDEP) may have regarding each of the alternatives. This criterion will be addressed in the Proposed Plan and ROD after KDEP comments on the FS are received.

4.1.2.9 Community acceptance (modifying criterion)

This assessment evaluates the issues and concerns the public may have regarding each of the alternatives. This criterion will be addressed in the ROD after public comments on the Proposed Plan are received.

4.1.3 Federal Facility Agreement and NEPA

Additional requirements considered in this FS include the specific requirements of the FFA and NEPA, consistent with the DOE's Secretarial Policy Statement on NEPA in June of 1994 (DOE 1994a).

4.1.3.1 Otherwise required permits under the FFA

When DOE proposes a response action, Section XXI of the FFA further requires that DOE identify each state and federal permit that otherwise would have been required in the absence of CERCLA Section 121(e)(1) and the NCP. DOE identifies the permits that otherwise would be required, 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.

An evaluation of alternatives presented in the FS determined that the otherwise required permits may include the KPDES permit; the RCRA Treatment, Storage, and Disposal Facility permit; and the Solid Waste Landfill permit. Jurisdictional wetlands have been identified on PGDP and will be delineated, as necessary, prior to a remedial action.

PGDP currently operates under KPDES Permit No. KY0004049, Hazardous Waste Facility Operating Permit No. KY8-890-008-982, and Solid Waste Permit No. 07300045. The substantive requirements of the otherwise required permits are identified in the ARARs provided for each alternative. A list of ARARs is provided in Appendix F.

4.1.3.2 NEPA values

The following NEPA values also are considered in this FS to the extent practicable, consistent with DOE policy.

- Land use
- Air quality and noise
- Geologic resources and soils
- Water resources
- Wetlands and floodplains
- Ecological resources
- T&E species
- Migratory birds
- Cultural and archeological resources
- Socioeconomics, including environmental justice and transportation

Alternatives selected for detailed analysis would have no identified short-term or long-term impacts on geological resources, migratory birds, cultural resources, or socioeconomics. Upon final selection of the alternative, the absence of any short- and long-term impacts to these values will be verified.

No long-term impacts to air quality or noise would result from implementation of the remedial action alternatives evaluated. Remedial actions should not result in generation of air pollutants above regulatory limits, and noise levels should be similar to current background levels.

None of the remedial alternatives would have any impacts on geologic resources, and construction activities would have only short-term impacts on soils. Site clearing, excavation, grading, and contouring would alter the topography of the construction area, but the geologic formations underlying those sites should not be affected. Construction would disturb existing soils, and some topsoil might be removed in the process. Soil erosion impacts during construction would be mitigated through the use of best management practices control measures (e.g., covers and silt fences). No conversion of prime farmland soils is expected to occur. Surface soil quality may improve for all alternatives except for No Action and Limited Action. Any alternative that would create disturbances also would include restoration to these areas.

None of the activities associated with the remedial alternatives would be conducted within a floodplain. Wetlands were identified during the 1994 COE environmental investigation for the area surrounding PGDP. This investigation identified five acres of potential wetlands inside the fence at PGDP (COE 1994). The COE made the determination that these areas are jurisdictional wetlands (COE 1995).

As stated in the ARARs, construction activities must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. These applicable requirements include avoiding construction in wetlands, avoiding (to the extent practicable) long- and short-term adverse impacts to floodplains and wetlands, avoiding degradation or destruction of wetlands, and avoiding discharge of dredge and fill material into wetlands. In addition, the protection of wetlands shall be incorporated into all planning documents and decision making as required by 10 *CFR* § 1022.3.

No long- or short-term impacts have been identified to archeological or cultural resources. 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 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), but because there are no potential impacts from these alternatives, there would be no disproportionate or adverse environmental justice impacts to these populations associated with these alternatives.

No long- or short-term adverse transportation impacts are expected to result from implementation of remedial alternatives. During construction activities there would be a slight increase in the volume of truck traffic in the vicinity of the BGOU SWMUs, but the affected roads are capable of handling the additional truck traffic. Any wastes transferred off-site or transported in commerce along public rights-of-way will meet the packaging, labeling, marking, manifesting, and applicable placarding requirements for hazardous materials at 49 *CFR* Parts 107, 171-174, and 178; however, transport of wastes along roads within the PGDP site that are not accessible to the public would not be considered "in commerce."

In addition, CERCLA § 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be sent to a treatment, storage, or disposal facility that complies with applicable federal and state laws and has been approved by the EPA for acceptance of CERCLA waste. Accordingly, DOE will verify with the appropriate EPA regional contact that any needed off-site facility is acceptable for receipt of CERCLA wastes before transfer.

4.1.3.3 Natural Resources Damage Assessment

The alternatives evaluated are acceptable because they are anticipated to have beneficial impact, and they are not expected to cause any further injury to a natural resource through their implementation than already might exist. Future integration of NRDA may occur for the alternatives selected in the Proposed Plan.

4.2 COMPARATIVE ANALYSIS

The SWMUs 2, 3, 7, and 30 remedial action alternatives are subjected to comparative analysis to identify the relative advantages and disadvantages of each so that the key tradeoffs that risk managers must balance can be identified. The comparative analysis provides a measure of the relative performance of the alternatives against each evaluation criterion.

Alternatives are compared based on two of the three CERCLA categories including threshold criteria and primary balancing criteria. The third category, modifying criteria, including state and community acceptance, will not be addressed until the Proposed Plan has been issued for public review. These modifying criteria will be addressed in the responsiveness summary and the ROD, which will be prepared following the public comment period.

Threshold criteria are of greatest importance in the comparative analysis because they reflect the key statutory mandates of CERCLA, as amended. The threshold criteria that any viable alternative must meet are as follows:

- Overall protection of human health and the environment, and
- Compliance with ARARs (in the absence of a CERCLA waiver).

The primary balancing criteria to which relative advantages and disadvantages of the alternatives are compared include the following:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The first and second balancing criteria address the statutory preference for treatment as a principal element of the remedy and the bias against off-site land disposal of untreated material. Together with the third and fourth criteria, they form the basis for determining the general feasibility of each potential remedy. The final criterion addresses whether the costs associated with a potential remedy are proportional to its overall effectiveness, considering both the cleanup period and O&M requirements during and following cleanup, relative to other alternatives. Key tradeoffs among alternatives most frequently will relate to one or more of the balancing criteria.

The comparative analyses for remedial alternatives are presented in the SWMU-specific sections that follow.

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5. SWMU 2

5.1 SWMU 2 HISTORY AND BACKGROUND

Previous sections of this document present a framework that collects sitewide information and uses it to formulate a general approach to developing alternatives to address the COCs present in the BGOU SWMUs. This framework also discusses key elements of the alternatives that are used as a basis for technology screening and development of SWMU-specific alternatives. This section (Section 5) of the document develops the candidate alternatives for SWMU 2 by expanding the general alternatives to address SWMU-specific conditions.

The C-749 Uranium Burial Ground (SWMU 2) is located within the west-central portion of the PGDP secured area. SWMU 2 encompasses an area of approximately 32,000 ft^2, with approximate dimensions of 160 ft by 200 ft. Records indicate that when the burial ground was in use, cells were excavated to an estimated depth of 7 to 17 ft. After the burial ground no longer was in use, the area was covered with a 6-inch thick clay cap and an 18-inch thick soil layer covered with vegetation (DOE 1995). Figure 5.1 illustrates the documented disposal at SWMU 2 (Union Carbide 1975).

SWMU 2 was used from 1951 to 1977 for the disposal of uranium and uranium-contaminated wastes. Disposal records for SWMU 2 indicate that 270 tons of uranium, 59,000 gal of oils, and 450 gal of TCE were disposed of in the unit (DOE 1999). Other wastes at the unit consist of 35 30-gal drums of uranyl fluoride. Disposal records indicate that uranium containing drummed wastes buried in the unit consist primarily of uranium metal from machine shop turnings, shavings, and sawdust. The most likely scenario is that the buried uranium is in the metallic state or is coated with uranium (IV) oxide. Neither of these forms of uranium is very susceptible to leaching. The kinetics of dissolution of the buried metal and uranium (IV) oxide is affected by the amount of oxygen present in the subsurface in proximity to the waste.

In August 1984, Cell 9 was excavated with the intent of removing TCE in the soil or drums due to concern about the integrity of TCE-containing drums (15 30-gal drums = 450 gal) reportedly disposed of in this area. It is reported that during excavation, 4 30-gal drums (one of these drums contained a uranium and TCE sludge and the others were of such poor integrity that the contents could not be ascertained) and 35 55-gal drums (30 of these drums contained uranium sludges, not TCE; one drum contained TCE sludge; and the rest were of such poor integrity their contents could not be ascertained) were recovered. The 30-gal and 55-gal drums containing TCE sludge were placed in overpacks for proper disposal (Ashburn 1984). The remaining excavated materials were returned to the cell and covered with soil; the sludge from the recovered drums contain TCE, uranium and PCBs.

5.1.1 Nature and Extent of Contamination

Review of the SWMU 2 waste disposal history suggests the presence of a number of source materials of concern, including some identified as PTW.

- 270 tons of uranium (e.g., shavings and sawdust packed in oil);
- Buried drums of uranium-contaminated TCE and any high soil concentrations of TCE present under and adjacent to the drums;
- Buried drums of uranyl fluoride solution and high soil concentrations of uranyl fluoride solution present under and adjacent to the drums; and

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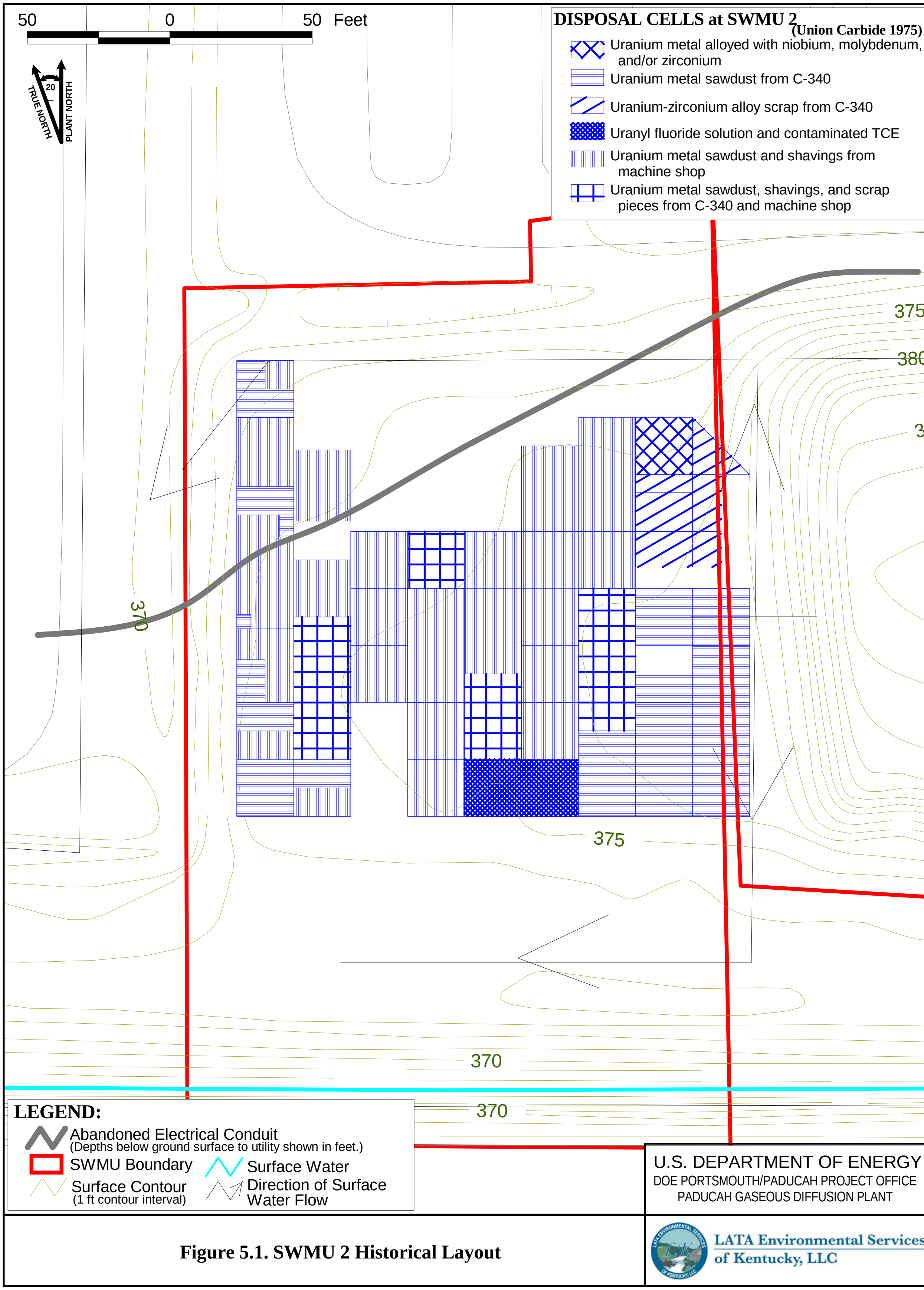

Figure 5.1. SWMU 2 Historical Layout

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· High concentrations of TCE and *cis*-1,2, dichloroethene (a degradation product of TCE) in soil on the eastern side of SWMU 2.

· PCBs, if present at concentrations greater than 500 ppm.

Radionuclides. Consistent with the presence of source materials, uranium isotopes frequently were detected above background and risk-based concentrations in soils (see Appendix A, Figures A.1 and A.2). Other radionuclides were in some cases present above screening levels at some of these locations; however, the dominant COC for direct contact with soils remains uranium-238. Although cesium-137 was detected at elevated concentrations (43 and 51 pCi/g) in sediment samples at two locations outside the SWMU boundary (2-6 and 2-15), the maximum concentration within the SWMU boundary was 0.27 pCi/g. The sediment sample, SWMU2-15, is from an area being addressed in the SWOU, thus, sediments in this location will be addressed as part of the SWOU on-site actions.

PCBs. The sludge in drums recovered in the 1984 excavation of Cell 9 contained PCBs (1,500 to 7,900 mg/kg); however, other portions of the source material (not associated with Cell 9) at SWMU 2 may contain PCBs. Because small pieces of uranium metal may be pyrophoric (spontaneously burn in air), operating practices of that time often placed these pieces in drums and submerged them in oil to avoid contact with air. It is possible that the oils used may have included some PCB-contaminated oils. Such oils are resistant to chemical and biological degradation and from leaching by percolating waters. In addition, oils, as they slowly degrade, consume oxygen, which lowers the oxidation-reduction potential. Under such conditions, uranium dissolution is known to be negligible (ORNL 1998). There is the potential that the 59,000 gal of oil with which the uranium was packaged in drums contains PCBs at concentrations greater than 500 ppm. Under EPA guidance, PCBs greater than 500 ppm are considered PTW under an industrial exposure scenario. Absent additional characterization (sampling and analysis) of the buried waste, it is uncertain whether PCBs are present at SWMU 2 at levels greater than 500 ppm. PCBs were detected in several soil samples, occasionally exceeding the NAL (see Figures A.1 and A.2); however, detections at these locations do not correlate with a buried PCB in oil source. The maximum concentration in soil was below 10 mg/kg.

Solvents. The waste unit disposal summary indicates drums containing TCE were disposed of in the SWMU at Cells 8 and 9. TCE and its degradation products, *cis*-1,2-DCE and vinyl chloride, were detected at high levels (140 mg/kg, 130 mg/kg, and 1.4 mg/kg, respectively) at a depth of 12 ft bgs on the eastern side of the burial unit and within Burial Cell 6 (See Figure A.3); however, this area is not the area where the TCE drums were dispositioned. The concentration of 140 mg/kg is below the soil saturation concentration (C_{sat}) of 690 mg/kg that is used to estimate the presence of a solvent phase. TCE was detected in soil at 9 additional locations with concentrations from 0.0021 mg/kg to 0.0428 mg/kg. TCE was the most widely detected organic contaminant in RGA groundwater at SWMU 2; however, there is an upgradient contribution to the RGA TCE concentrations. The hydrogeological assessment of the SWMUs 2 and 3 areas (PRS 2007) determined that an upgradient source is responsible for some if not all of the TCE levels in the area. It is difficult to separate any potential impacts to the RGA from SWMU 2 due to the migration of contamination from upgradient areas. Based upon the disposal information and the sampling data, the PTW-level TCE sources are limited to Cells 6, 8, and 9.

Technetium-99. No documentation of Tc-99 disposal at SWMU 2 exists; however, during the years of feed plant operation from 1953 to 1964 and from 1968 intermittently through 1977, recycled uranium feed material from nuclear reactors was reprocessed through the feed plant, resulting in the introduction of reactor-produced radioactive impurities, such as Tc-99, into the enrichment process. It is possible that a portion of the uranium-contaminated wastes disposed of in burial grounds at PGDP contains technetium 99 from reprocessing activities (DOE 1994b); however, Tc-99 is not a target compound at SWMU 2 based on soil data. It was identified as having the potential to impact groundwater, but the modeled concentrations did not exceed the MCL. More importantly, it was detected above background in only 3 surface samples (maximum concentration of 14.6 pCi/g), and was not found above background in 57 subsurface soil samples, suggesting no evidence of a release from SWMU 2.

Arsenic. Arsenic was detected above the background in 10 of 32 soil samples, only 1 of these at a depth greater than 20 ft bgs. Arsenic above background concentrations poses a potential direct contact risk as well as a potential concern for migration to groundwater. The distribution of arsenic at SWMU 2 is shown on Figures A.1 to A.3.

5.1.2 Risk Summary

The primary threat from SWMU 2 is associated with direct contact exposure to buried wastes.

Unacceptable direct contact risks to industrial workers exposed to SWMU 2 soils were identified in the BHHRA. The COCs include arsenic, uranium-235, and uranium-238. The BHHRA identified the COCs based on samples collected to depths of 8 ft, so this evaluation presents COCs for both surface and subsurface soils. Additional data collected after the BHHRA were included in a review to address uncertainties. Figures A.1 (surface soil) and Figure A.2 (subsurface soils) in Appendix A, identify where COCs are present that contribute to an unacceptable risk.

The BGOU RI BHHRA also identified COCs present in soil that may migrate to the RGA at levels that would limit future residential use. These were reviewed and the list refined (see Appendix B). Arsenic, *cis*-1,2-DCE, and TCE were identified as target chemicals to be addressed in this FS. All were found to have the potential (under certain conditions) to cause an exceedance of the MCL at the SWMU boundary.

Drainageways are present adjacent to this waste unit. As illustrated on Figure A.1, sediments from locations west of the site have been remediated as part of the SWOU. Contaminants found in other drainageways are not associated with SWMU 2 and will be managed as part of the SWOU.

The SERA identified COPCs in surface soils. Actions taken to address human health in this FS will reduce potential exposures to these COPCs. Residual risks will be evaluated in a future sitewide ecological risk assessment.

5.1.3 Hydrogeological Interpretation

The study area geology and hydrogeology is summarized below, as documented in the BGOU RI (DOE 2010b). Because SWMUs 2 and 3 are adjacent to each other, their hydrogeological interpretation is discussed as one.

Stratigraphy. The burial cells of SWMU 2 are excavated into the HU1 loess member (silt with some clay) of the UCD. Some waste cells likely extend to near the base of the HU1 unit, at a depth of 18.5 ft. The underlying HU2 interval consists of upper and lower sand and gravel horizons, separated by an intervening clayey silt unit, to a depth of 40 ft. A 9-ft thick silty clay interval (HU3) separates the HU2 sand and gravel horizons from the basal HU4 sand and the sands and gravels of the Lower Continental Deposits (HU5). SWMU 3 rests upon the top of the UCD.

UCRS Groundwater Flow and Hydraulic Potential. The SWMU 2 Data Summary and Interpretation Report (DOE 1997) documents the depth and gradient of the water table using measurements from shallow MWs and piezometers. Four rounds of measurements of water level during a one-week period in August 1996, consistently demonstrate that the water table occurred within 10 ft of land surface, sloping toward a ditch on the west side. With water at this depth, much of the buried waste at SWMU 2 would be saturated. The westward slope of the water table below SWMU 2 indicates that the water table would be at a similar depth beneath SWMU 3, except for the presence at SWMU 3 of a Subtitle C cap and leachate collection and treatment system that limits infiltration to the UCRS.

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

RGA Groundwater Flow and Hydraulic Potential. The northward groundwater flow beneath SWMU 3 is an intermediate flow path between the hydraulic conductivity "expressways" delineated by the Southwest Plume (to the south of SWMU 3) and the Northwest Plume (to the north of SWMU 3) and is related to seasonal variations in potentiometric head.

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

5.2 SWMU-SPECIFIC RAOs

RAOs that are specific to SWMU 2 were developed based on the findings and observations from the BGOU RI Report. The SWMU-specific RAOs are directed toward conditions related to the waste materials and affected soils, the surface soils, and the subsurface soils at the SWMU.

The burial cells contain hazardous materials (including potentially pyrophoric uranium, solvents, and PCBs) that may be considered PTW. In addition, impacts in soils have been identified that pose unacceptable risks to future industrial and future outdoor workers and may migrate to RGA groundwater at levels that would limit future residential use.

SWMU-Specific RAO for Protection of Groundwater. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination (arsenic, TCE, and *cis*-1,2-DCE) that could result in an exceedance in RGA groundwater of the MCL (or risk-based concentration for residential use of groundwater in the absence of an MCL).

SWMU-Specific RAO for Protection of Direct Contact with Waste. Prevent exposure to waste that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Waste: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for a future outdoor worker

SWMU-Specific RAO for Protection of Direct Contact with Contaminated Soils. Prevent exposure to contaminated soils (arsenic, uranium-235 and uranium-238) that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

SWMU-Specific RAO for PTW. Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

The PRGs identified for target compounds in soil to be addressed in this FS for protection of groundwater and direct contact at SWMU 2 are listed in Table 5.1.

Table 5.1. PRGs for SWMU 2

COC	Groundwater Protective PRG for Soil (mg/kg)*	Direct Contact PRG Surface Soil (mg/kg) (pCi/g)*	Direct Contact PRG Subsurface Soil (mg/kg) (pCi/g)*
Arsenic	Background**	12	7.9
cis-1,2-DCE	1.34	N/A	N/A
TCE	0.311	N/A	N/A
Uranium-235+D	N/A	1.975	22.75
Uranium-238+D	N/A	8.5	58.5

*mg/kg for chemicals or pCi/g for radionuclides.
**Background = 12 mg/kg surface soil; 7.9 mg/kg subsurface soils.

Locations where these PRGs are exceeded in soil are shown on figures in Appendix A. These PRGs will not be applied at sediment locations that are being addressed as part of the SWOU.

5.3 DEVELOPMENT OF SWMU-SPECIFIC ALTERNATIVES

Section 3 developed seven general alternatives appropriate for the four SWMUs addressed in this FS. These general alternatives include multiple containment and treatment process options because each SWMU has unique characteristics, and one RPO may not be applicable or effective to address the differing conditions at different SWMUs. The effectiveness of the individual containment and treatment process options are evaluated in this section against the specific needs of SWMU 2 with the containment and treatment process options deemed most effective at SWMU 2 retained (Table 5.2). These retained containment and process options are then incorporated into the general alternatives to form fully developed SWMU-specific alternatives that then are subjected to detailed analysis. The detailed analysis evaluates a broad range of options that may be recombined into alternatives, even if that specific combination was not evaluated in the detailed analysis.

5.3.1 Surface Cover Process Options Evaluation and Screening

Four general surface cover process options are carried forward from Section 3 and include the following:

- 1-ft soil cover (a)
- 18-inch clay/6-inch soil (b)
- Subtitle C cap (c)
- Subtitle D cap (d)

Table 5.2. Process Option Effectiveness Evaluation

<table>
<tr><th rowspan="2">Process Option Identifier</th><th rowspan="2">Process Option Description</th><th colspan="3">Effectiveness</th><th colspan="2">Implementability</th><th colspan="2">Relative Cost</th></tr>
<tr><th>Long-Term Effectiveness</th><th>Short-Term Effectiveness</th><th>Demonstrated Effectiveness and Reliability</th><th>Technical</th><th>Administrative</th><th>Capital</th><th>O&M</th></tr>
<tr><td colspan="9">General Response Action—Containment Technology—Surface Barriers</td></tr>
<tr><td>a</td><td>1-ft cover</td><td>Moderate for direct contact</td><td>High</td><td>Low to Moderate</td><td>High</td><td>High</td><td>Moderate—Lowest capital cost among evaluated covers</td><td>Moderate</td></tr>
<tr><td>b</td><td>18-inch clay/6-inch soil cover</td><td>Moderate for direct contact</td><td>High</td><td>Low to moderate</td><td>High</td><td>High</td><td>Moderate</td><td>Moderate</td></tr>
<tr><td>c</td><td>Subtitle C cap</td><td>Moderate for direct contact</td><td>Moderate to High</td><td>Moderate to High</td><td>Moderate</td><td>High</td><td>Moderate—Highest capital cost of the evaluated covers</td><td>Moderate</td></tr>
<tr><td>d</td><td>Subtitle D cap</td><td>Moderate for direct contact</td><td>Moderate to High</td><td>Moderate to High</td><td>Moderate</td><td>High</td><td>Moderate</td><td>Moderate</td></tr>
<tr><td colspan="9">General Response Action—Treatment Technology—Thermal</td></tr>
<tr><td rowspan="2">t1</td><td rowspan="2">ERH</td><td>High for VOCs only</td><td>Moderate</td><td>Moderate to High</td><td rowspan="2">Low to Moderate</td><td rowspan="2">Moderate</td><td rowspan="2">Moderate to High</td><td rowspan="2">Low to Moderate: ERH alone will not eliminate the need for continued monitoring</td></tr>
<tr><td colspan="3">ERH is expected to be effective at removing TCE and its daughter products at PGDP. TCE removed by ERH will be treated ex situ. Limitations of ERH include the inability to treat semi and nonvolatile organic and inorganic contaminants. The heterogeneous stratigraphy and the variable unsaturated zone complicate the collection of volatilized VOCs.</td></tr>
<tr><td colspan="9">Technology—Physical Chemical</td></tr>
<tr><td rowspan="2">t2</td><td rowspan="2">DPE</td><td>High for VOCs liquids and solutions</td><td>High</td><td>Moderate</td><td rowspan="2">High</td><td rowspan="2">Moderate</td><td rowspan="2">Moderate</td><td rowspan="2">Moderate</td></tr>
<tr><td colspan="3">This technology does not address nonmobile or sparingly mobile contaminants effectively; thus, this technique is expected to be effective on TCE and its daughter products, Tc-99, uranyl fluoride, water (and water-carried COCs), and liquid PCBs, but generally ineffective on other constituents.</td></tr>
</table>

Table 5.2. Process Option Effectiveness Evaluation (Continued)

Process Option Identifier	Process Option Description	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
Technology—Chemical								
t3	Chemical injection (ZVI)	High to Moderate	High	Moderate	High	Moderate	Moderate	Moderate
		Treatment of chlorinated ethenes typically occurs rapidly as long as there is good contact between ZVI and chlorinated ethenes, which further emphasizes the importance of effective subsurface delivery, especially if COCs are contained in drums. The rate of treatment of uranium, Tc-99, and PCBs in the PGDP matrices is uncertain.						
Technology—Biological								
t4	Biological treatment	Moderate to High	High	High	Moderate	Moderate	Low to Moderate	Moderate
		Enhanced biological treatment through reductive dechlorination also would reduce the oxidation reduction potential and tend to reduce the mobility of uranium and Tc-99. The persistence of this effect is uncertain.						
Alternate Disposal								
WDF	On-site WDF	A potential on-site WDF will be used for disposal of BGOU wastes if available and if wastes meet the WAC.						

An evaluation of all four covers shows that the 1-ft soil cover and 18-inch clay/6-inch soil cover score significantly lower than the Subtitle C and Subtitle D caps for demonstrated effectiveness and reliability. This is because while all four covers effectively will prevent direct contact with surface soils, waste, and soils in close proximity to the waste, only the Subtitle C and Subtitle D caps sufficiently reduce groundwater infiltration to be protective of groundwater. Based on the shallow depth to water under current conditions at SWMU 2 and the specific need for infiltration control at SWMU 2, the 1-ft soil cover and 18-inch clay/6-inch soil covers are screened from consideration for use as a process option at SWMU 2.

A Subtitle C cap is the most protective of the evaluated covers and is selected as the representative process option for the surface barrier technology. Because the Subtitle C cap is seen as more protective than the Subtitle D cap, the Subtitle D cap is screened from further consideration for use as a process option at SWMU 2.

Additionally, to further limit contact with waste, an additional 2 ft intruder barrier constructed from Type H riprap will be placed over the cover. This will result in a surface barrier approaching 7-ft thick. This cap is evaluated in the detailed analysis. The costing presents the intruder barrier as a line item so that the Subtitle C cap without the intruder barrier can be evaluated separately.

5.3.2 Treatment Technologies and Process Options Evaluation and Screening

The four treatment process options carried forward from Section 3 for consideration at SWMU 2 include the following:

- ERH (t1)
- DPE (t2)
- Chemical injection (ZVI)(t3)
- Enhanced biological treatment (t4)

These treatment process options alone or in combination will provide varying degrees of effectiveness in treating the COCs. These options are targeted to address the mobile PTW located at SWMU 2. These process options will be retained for development into SWMU-specific alternatives.

5.3.3 Development of SWMU-Specific Alternatives and Screening

This section combines the general alternatives developed in Section 3 with SWMU-specific considerations for containment and treatment process options to form SWMU-specific alternatives. General alternatives that rely on process options not effective at SWMU 2 will not be developed into SWMU-specific alternatives. Those alternatives developed in this section will undergo detailed and comparative evaluation.

Table 5.3 includes the SWMU-specific alternatives developed for SWMU 2.

These alternatives are evaluated with regard to the NCP criteria to potentially reduce the number of alternatives that will undergo detailed analysis. This screening evaluation is summarized in Table 5.4. For SWMU 2, none of the alternatives were screened from further analysis by this process; thus, all of the following alternatives have been subjected to detailed analysis.

Alternative 1: No Action. Overall effectiveness of Alternative 1 is low because no action is performed and therefore long-term threats from wastes and contamination are not addressed. Direct contact risk currently is addressed through site controls maintained outside of CERCLA; thus short-term effectiveness

Table 5.3. SWMU-Specific Remedial Alternative for SWMU 2

Alternative	Name	Key features
1	No Action	• No action
2	Limited Action (LUCs, and Monitoring)	• Monitoring • LUCs
4.c.t1	Subtitle C Cap, ERH, LUCs, and Monitoring	• Subtitle C cap • ERH • Monitoring • LUCs
4.c.t2	Subtitle C Cap, DPE, LUCs, and Monitoring	• Subtitle C cap • DPE • Monitoring • LUCs
4.c.t3	Subtitle C Cap, ZVI, LUCs, and Monitoring	• Subtitle C cap • Chemical injection (ZVI) • Monitoring • LUCs
4.c.t4	Subtitle C Cap, Bio, LUCs, and Monitoring	• Subtitle C cap • Biological treatment • Monitoring • LUCs
5.CR	Excavation and Disposal with CR	• Installation of sheet pile delineating excavation bounds • Excavation of buried waste materials and affected soils to a maximum of 20 ft bgs • Postremediation sampling and analysis • WAC sampling and analysis • Transportation of waste materials and affected soils to disposal facility • Evaluation of off-site disposal • Assessment of contingent treatment remedies if PRGs are not met at bottom of excavation; contingent treatments: ERH (t1), ZVI (t3), or Bio (t4) Backfill of excavated areas with clean soil
5.CR.WDF	Excavation and Disposal, WDF, with CR	• Installation of sheet pile delineating excavation bounds • Excavation of buried waste materials and affected soils to a maximum of 20 ft bgs • Postremediation sampling and analysis • WAC sampling and analysis • Transportation of waste materials and affected soils to disposal facility • Evaluation of disposal at a potential on-site WDF • Assessment of contingent treatment remedies if PRGs are not met at bottom of excavation; contingent treatments: ERH (t1), ZVI (t3), or Bio (t4) • Backfill of excavated areas with clean soil

Table 5.3. SWMU Specific Remedial Alternative for SWMU 2 (Continued)

Alternative	Name	Key features
6.c.CR	Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR •	• Installation of sheet pile delineating excavation bounds • Excavation of buried waste materials and affected soils to a maximum of 20 ft bgs targeted on PTW • Postremediation sampling and analysis • WAC sampling and analysis • Physical/chemical waste treatment, if necessary • Transportation of waste materials and affected soils to disposal facility • Evaluation of off-site disposal but acknowledges potential on-site WDF may be considered • Assessment of contingent treatment remedies if PRGs are not met at bottom of excavation; contingent treatments: ERH (t1), ZVI (t3), or Bio (t4) • Backfill of excavated areas • Placement of Subtitle C cap • LUCs • Monitoring
7.c.t2.CR	Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR	• Excavation of buried waste materials and affected soils to a maximum of 20 ft bgs targeted on PTW • Postremediation sampling and analysis • WAC sampling and analysis • Physical/chemical waste treatment, if necessary • Transportation of waste materials and affected soils to disposal facility • Evaluation of off-site disposal but acknowledges potential on-site WDF may be considered • Assessment of contingent treatment remedies if PRGs are not met at bottom of excavation; contingent treatments: ERH (t1), ZVI (t3), or Bio (t4) • Backfill of excavated areas • Installation *in situ* source treatment (DPE) • Placement of Subtitle C Cap • LUCs • Monitoring

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Table 5.4. SWMU Specific Remedial Alternative Screening Summary for SWMU 2

	Alternative 1	Alternative 2	Alternative 4.c.t1	Alternative 4.c.t2	Alternative 4.c.t3	Alternative 4.c.t4	Alternative 5.CR	Alternative 5.CR.WDF	Alternative 6.c.CR	Alternative 7.c.t2.CR
Screening Criteria	**No Action**	**Limited Action (LUCs and Monitoring)**	**Subtitle C Cap, ERH, LUCs, and Monitoring**	**Subtitle C Cap, DPE, LUCs, and Monitoring**	**Subtitle C Cap, ZVI, LUCs, and Monitoring**	**Subtitle C Cap, Bio, LUCs, and Monitoring**	**Excavation and Disposal with CR**	**Excavation and Disposal, WDF with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR**
Overall Effectiveness	Low	Low to Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate to High	Moderate to High
Short-term	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Long-term	Low	Low to Moderate	Moderate	Moderate to High	Moderate	Moderate	High	High	Moderate to High	High
Overall Implementability	High	High	Moderate	Moderate to High	Moderate to High	Moderate to High	Moderate	Moderate	Moderate	Moderate
Technical	High	High	Low to Moderate	Moderate	Moderate	Moderate to High	Moderate	Moderate	Moderate	Moderate
Administrative	High	High	Moderate to High	Moderate to High	Moderate to High	Moderate to High	Moderate	Moderate	Moderate	Moderate
Overall Cost	Low	Low	Moderate	Moderate	Moderate	Moderate	High	High	Moderate	Moderate to High
Capital	Low	Low	Moderate	Moderate	Moderate	Moderate	High	Moderate to High	Moderate	Moderate
O&M	Low	Low	Moderate	Moderate	Low	Moderate	Low	Low	Moderate	Moderate

is rated moderate. This alternative does not allow for maintenance of these controls; thus, the alternative does not meet the threshold criterion of protection of human health and the environment. Implementability is rated high and costs are low under the no action alternative because no technical, administrative, capital cost, or long-term operational costs are incurred because no remedial actions are taken.

Alternative 2: Limited Action (LUCs and Monitoring). Alternative 2 offers low to moderate overall effectiveness. Short-term effectiveness is moderate as direct contact is addressed through current site controls maintained outside of CERCLA; and these controls are extended indefinitely using LUCs. Thus, risks to current and future site workers can be effectively controlled. Alternative 2 does not address mobile COCs or PTW threats to groundwater. Alternative 2 does mitigate some of the uncertainties associated with leaving waste in place by monitoring any changes in SWMU status or condition that may warrant a response or action in the future. Long-term effectiveness is considered low to moderate, somewhat better than the no action alternative. Because of the current site controls and LUCs, this alternative meets the threshold criterion of protection of human health and the environment.

Alternative 2 presents no challenges to implementability, either administrative or technical, and is considered to have high overall implementability. Likewise, the costs are low because costs are considered minimal for limited action with some capital costs associated with LUCs, installation of MWs, and O&M costs associated with upkeep and monitoring of MWs.

Alternative 4.c.t1: Subtitle C Cap, ERH, LUCs, and Monitoring. Overall effectiveness of Alternative 4.c.t1 is moderate. Long-term effectiveness is moderate, because the source treatment only addresses the VOC PTW at the SWMU, and it does not sufficiently address the non-VOC PTW nor other mobile PTW. Short-term effectiveness is considered moderate due to risks associated with the ERH and cover installation. Implementation of Alternative 4.c.t1 would involve some significant technical challenges associated with installation of the ERH system without first removing any drums that may remain; thus it is rated low to moderate. Administrative implementability would be moderate to high. Overall implementability would be moderate. Moderate costs would be expected for both short-term capital (cap and ERH elements) and long-term operational costs (mainly due to monitoring).

Alternative 4.c.t2: Subtitle C Cap, DPE, LUCs, and Monitoring. Overall effectiveness of Alternative 4.c.t2 is moderate. DPE does not remove or treat nonmobile uranium and has limited effectiveness on nonmobile PCBs. It is, therefore, evaluated to have a moderate to high long-term effectiveness that is based primarily on its effective control of any mobile COCs. Short-term effectiveness is considered moderate. Implementation of Alternative 4.c.t2 would involve some technical challenges associated with installation of the DPE system without first removing drums, but the extraction wells can be located in the areas between the burial cells. Alternatively, the extraction wells can be placed diagonally or horizontally to avoid waste conflicts. Technical implementability is rated moderate. Administrative implementability would be moderate to high. Overall implementability would be moderate to high. Moderate costs would be expected for both short-term capital (cap, DPE system, *ex situ* treatment elements) and long-term operational costs (monitoring and long-term extraction and *ex situ* treatment.

Alternative 4.c.t3: Subtitle C Cap, ZVI, LUCs, and Monitoring. Effectiveness of Alternative 4.c.t3 is moderate with short-term exposure risks associated with drilling, chemical injection, and Subtitle C cap installation. Long-term effectiveness is approximately the same as Alternative 4.c.t2, in that ZVI injection should address VOC contamination. Although the DPE in Alternative 4.c.t.2 also will maintain control of other mobile constituents for an extended period of time, the ZVI injection will react with the uranyl fluoride to reduce its mobility and also will react with PCBs with which it comes into contact. Thus, overall the short-term effectiveness slightly favors the ZVI process but the long-term effectiveness favors DPE. Overall implementability of Alternative 4.c.t3 is substantially the same as 4.c.t2 and is rated moderate to high. Capital costs would be expected to be moderate, but long-term operational costs will be lower than Alternative 4.c.t2 due to monitoring and limited time *in situ* treatment.

Alternative 4.c.t4: Subtitle C Cap, Bio, LUCs, and Monitoring. Overall effectiveness of Alternative 4.c.t4 is moderate. Short-term exposure risks are slightly less than other treatment methods because biological amendments can be applied more easily with a variety of delivery systems. Short-term effectiveness is rated moderate. Long-term effectiveness is evaluated as moderate because the alternative leaves wastes in place, and biological treatment is not effective for non-VOC PTW at SWMU 2. Implementation of Alternative 4.c.t4 would be moderate to high as amendment application can be accomplished without direct contact with the wastes. Administrative implementability would be moderate to high. Overall implementability would be moderate to high. Moderate costs would be expected for both short-term capital and long-term operational costs mainly due to monitoring and *in situ* treatment for a period of time expected to be longer than that needed for ZVI injection.

Alternative 5.CR: Excavation and Disposal with CR. This alternative contemplates excavation of all of the buried wastes and associated affected soils up to 20 ft bgs. Short-term exposure for site workers would be greatest for Alternative 5. Short-term effectiveness is rated as moderate because of risks associated excavation of the waste. While risks can be mitigated through procedure and rigor to health and safety standards, there remains uncertainty as to the nature of the uranium disposed of at SWMU 2 (still pyrophoric?). Long-term effectiveness is evaluated as high because PRGs will be met either through removal of wastes alone or by excavation combined with a subsequent contingent treatment remedy. Overall implementability is moderate, mostly because of the technical and administrative challenges associated with excavation of potentially pyrophoric materials. Excavated materials will be treated as needed to meet the WAC of the disposal facility; thus, there will be some reduction in toxicity, mobility, or volume that accrues to the excavation. Capital costs are greater for this alternative; however, O&M costs would be low if clean site closure can be achieved. Overall costs are high.

Alternative 5.CR.WDF: Excavation and Disposal, WDF with CR. The evaluation of this alternative is the same as for Alternative 5.CR, except that capital costs are estimated to be lower for this alternative due to use of a potential on-site disposal facility for excavated waste and soil. Excavated materials will be treated as needed to meet the waste acceptance criteria of the disposal facility; thus, there will be some reduction in toxicity, mobility, or volume that accrues to the excavation. Overall costs are moderate to high.

Alternative 6.c.CR: Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR. This alternative contemplates excavation of wastes and associated soils from Cells 6, 8, and 9. These are the cells with the buried TCE (including the cell with high concentration of TCE in soil) and uranyl fluoride. Short-term exposure for site workers is lower than for Alternative 5 because the scope of excavation is reduced and cells with potential pyrophoric material are not to be excavated; therefore, short-term effectiveness is rated as moderate. Long-term effectiveness is evaluated as moderate to high because the mobile PTW source term will be removed from the SWMU. Excavated materials will be treated as needed to meet the WAC of the disposal facility; thus, there will be some reduction in toxicity, mobility, or volume that accrues to the excavation.

This alternative will not remove uranium (except for the uranyl fluoride in Cell 8). The remaining uranium will be contained within the SWMU. Depending upon whether there is residual contamination remaining at the bottom of the cell excavation, a contingent treatment remedy may be initiated to address mobile COCs. Overall implementability is moderate mostly because of the technical and administrative challenges associated with excavation and disposal. Capital costs are moderate for this alternative and O&M costs will be moderate. Overall costs are moderate. Because wastes are left in place, LUCs will need to be established to ensure the long-term permanence of the remedy.

Alternative 7.c.t2.CR: Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR. This alternative contemplates excavation of wastes and associated soils from Cells 6, 8, and 9. These are the cells with the buried TCE (including the cell with high concentration of TCE in soil) and uranyl fluoride. Short-term exposure for site workers is less than for Alternative 5 because the scope of excavation is reduced and cells with potential pyrophoric material are not to be excavated; therefore, short-term effectiveness is rated as moderate. Long-term effectiveness is evaluated as high because much of the mobile PTW source term will be removed from the SWMU. Additionally, DPE is installed to capture liquid and vapor phase COCs from the source term and will reduce the water table such that the wastes are no longer in water. This alternative will not remove all uranium at the site. The remaining uranium will be contained within the SWMU. Depending upon postexcavation conditions, a contingent treatment remedy may be initiated at the bottom of the excavation, although, except in extreme cases, DPE can be configured to address residual mobile deep contamination. Overall implementability is moderate due to technical and administrative challenges associated with excavation and disposal. Capital costs are moderate for this alternative. O&M costs will be moderate. Overall costs are moderate.

All evaluated alternatives will be brought forward to detailed analysis. Each alternative is distinct in its characteristics and should undergo detailed evaluation.

5.4 DETAILED ANALYSIS OF ALTERNATIVES

5.4.1 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 implement remedial activities for SWMU 2 or to reduce the potential hazard to human or ecological receptors. Alternative 1 does not address PTW or any of the COCs identified in SWMU 2 soils that pose an unacceptable risk under some future use scenarios because no action is taken.

5.4.1.1 Threshold criteria

5.4.1.1.1 Overall protection of human health and the environment

Alternative 1 does not meet the threshold criterion of protection of human health and the environment under some future use conditions because wastes are left in place and the plant controls maintained outside of CERCLA are not permanent. This alternative would not be protective of groundwater under some future use scenarios. None of the PTW is treated by this alternative.

5.4.1.1.2 Compliance with ARARs

Although no ARARs have been identified for Alternative 1, compliance with ARARs has not been evaluated, given that this alternative does not meet the other threshold criterion.

5.4.1.2 Balancing criteria

5.4.1.2.1 Long-term effectiveness and permanence

Alternative 1 provides no long-term effectiveness or permanence because there is no mechanism to maintain or extend site controls maintained outside of CERCLA. Future leaching of contaminants to the RGA may result in concentrations above their MCL or risk-based value without being detected because there is no provision for monitoring the RGA in the vicinity of SWMU 2. Alternative 1 leaves the risk or hazard from direct contact with radioactive, inorganic, VOCs, or PCBs at current levels at the SWMU. The alternative does not provide any long-term remedy to manage residual risk at this SWMU.

5.4.1.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 1 does not reduce toxicity, mobility, or volume through treatment.

5.4.1.2.3 Short-term effectiveness

No actions would be implemented under Alternative 1; therefore, no risks associated with remediation would be incurred by site workers, the public, or the environment. There would be no change to existing conditions. RAOs would not be met due to implementation of this remedy.

5.4.1.2.4 Implementability

The No Action alternative can be implemented readily. If future remedial action is necessary, this alternative would not impede its implementation.

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

5.4.1.2.5 Cost

The preliminary cost estimates for Alternative 1 serve as a baseline for comparison of the other remedial alternatives. These cost estimates are based upon FS-level scoping and are intended to aid with selection of a preferred alternative. There are no capital or O&M costs associated with Alternative 1.

5.4.2 Alternative 2—Limited Action (LUCs and Monitoring)

This alternative eliminates direct contact risk to surface and subsurface soils through the use of existing site controls, as extended indefinitely into the future by LUCs. This alternative also mitigates the uncertainties associated with leaving waste in place by monitoring any changes in SWMU status or condition that may warrant a response or action.

This alternative will consist of the following actions as necessary:

- Perform RD;
- Develop a LUCIP to implement LUCs; and
- Install MWs and conduct groundwater and surface water monitoring, as needed.

5.4.2.1 Overall protection of human health and the environment

Alternative 2 meets the threshold criterion of protection of human health and the environment by limiting the direct contact with affected surface and subsurface soils and wastes. While direct contact can be well-controlled through existing plant controls and LUCs, there is an uncertainty concerning the threats to groundwater. This uncertainty is addressed under this alternative by LUCs and monitoring that limit access to groundwater until it can be demonstrated that SWMU 2 does not unacceptably impact the RGA groundwater.

5.4.2.2 Compliance with ARARs

Alternative 2 meets the threshold criterion of compliance with action-specific ARARs. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.2.3 Long-term effectiveness and permanence

Alternative 2 provides low to moderate long-term effectiveness and permanence based on either continued DOE control of the site or enforceable LUCs to limit unacceptable exposure.

5.4.2.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 2 does not include any alternative-specific treatment technologies; therefore, there is no credit for reduction in toxicity, mobility, or volume through treatment.

5.4.2.5 Short-term effectiveness

Implementation of Alternative 2 is effective quickly and includes only minor potential for worker exposure to contaminated surface soils and groundwater during monitoring well installation or environmental sampling. PGDP worker protection programs will make worker exposure unlikely.

Implementation of Alternative 2 would not have any detrimental impact on the community.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative. Risk assessment and mitigation for ecological receptors in nearby drainage ditches are within the scope of the Surface Water OU.

At the time that implementation of each component of Alternative 2 is completed, RAOs will be met to some degree. Implementation of Alternative 2 is expected to take several months.

5.4.2.6 Implementability

Activities to be conducted under Alternative 2 include continuing/expanding existing environmental media monitoring.

Implementation of the remedial action components of Alternative 2 is technically feasible.

Implementation of Alternative 2 would use standard construction methods, materials, and equipment that are available from vendors and contractors.

5.4.2.7 Cost

Estimated capital and O&M costs for Alternative 2 include development of LUCs and installation and sampling of an MW network. Costs are considered low, and thus, the cost ranking for this alternative is high.

5.4.3 Alternative 4.c.t1: Subtitle C Cap, ERH, LUCs, and Monitoring

Alternative 4.c.t1 controls direct contact to surface soils, subsurface soils, and wastes by maintaining current site controls followed by LUCs and placing a Subtitle C cap over SWMU 2. VOC and TCE DNAPL will be treated using ERH.

Alternative 4.c.t1 includes the following:

- Although the locations of the major VOC sources are known, the RD may include a focused investigation to further delineate VOC PTW source(s);
- TCE DNAPL/soil source treatment using ERH, including off-gas treatment;
- Process monitoring;
- Postremediation sampling;
- Construction of a Subtitle C cap over SWMU 2;
- Monitoring; and
- LUCs.

Additional data may be collected to delineate any TCE DNAPL/soil source and support the RD effort, although the C-400 experience allows deployment of an ERH remedy without further data collection.

ERH has been implemented at C-400 Building at the PGDP. If the TCE DNAPL/source is found to have migrated beyond the UCRS, ERH would no longer be a practical alternative because it is not effective for the RGA at PGDP due to the elevated energy input from high groundwater velocity and heat transfer.

Implementation of an ERH system would be employed where TCE DNAPL or high concentrations of TCE in soil sources are identified in or beneath the buried waste. The *in situ* ERH treatment system would be designed to treat TCE and its degradation products and would be implemented as follows: (1) continuing/expanding the environmental media monitoring to identify potential TCE source areas and track contaminant migration during and after treatment; (2) if necessary, a partial excavation of the waste disposal area above the TCE DNAPL source area to remove buried waste, including debris or metallic waste that could interfere with the installation or operation; (3) construction of the treatment operations; (4) process optimization and remedial treatment; and (5) postremediation sampling. Upon completion of the TCE DNAPL/source treatment, conductors and equipment in the electrodes would be recovered to the extent practicable and the casing and graphite would be abandoned in place and a surface cover would be installed over the SWMU. A Subtitle C cap would be designed to provide a protective barrier to prevent exposure to surface soils containing residual contamination.

Upon completing ERH treatment, a Subtitle C cap would be constructed over the entire unit. The cover would be contoured to promote runoff and to reduce the potential for direct exposure to affected surface soil, subsurface soil, and wastes present at SWMU 2. Additionally, a 2-ft thick layer of Type H riprap will be placed over the Subtitle C cap to further limit the potential for contact with the remaining waste. (NOTE: although the riprap intruder barrier is included in this alternative, its cost is presented as a line item in the estimate so the remedy without the intruder barrier also may be evaluated.

This alternative is protective for low mobility contaminants, such as uranium, and provides some protection from leaching of the residual mobile VOCs and uranyl fluoride through limiting water infiltration.

A monitoring program would be implemented to monitor the ERH performance and the groundwater in the upper RGA. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs as necessary to monitor upgradient and downgradient groundwater contaminant levels. Because waste is left in place, LUCs also would be implemented to extend plant controls indefinitely.

5.4.3.1 Threshold criteria

5.4.3.1.1 Overall protection of human health and the environment

Construction of a Subtitle C cap over the unit would limit the potential exposure to workers from contaminated soils or wastes. LUCs (see Section 2.4.1.1) would ensure that the cap is not disturbed and protect current and future site workers and the public.

ERH treatment would remove TCE PTW from SWMU 2 and be protective of groundwater for VOCs. Uranium and PCBs would not be addressed by ERH. Implementation of additional groundwater monitoring would allow verification of the protectiveness of the remedy at minimizing the potential for exposure to contaminated groundwater.

5.4.3.1.2 Compliance with ARARs

This alternative will meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.3.2 Balancing criteria

5.4.3.2.1 Long-term effectiveness and permanence

This alternative is designed to provide protection against exposure to waste, surface soils, and subsurface soils, and treat VOCs. Although the toxicity and volume of the VOCs would be decreased by the ERH treatment, there would be no measurable impact on the remaining COCs. The long-term effectiveness and permanence of this alternative for VOC source remediation, therefore, is high; however, when evaluated against all SWMU 2 threats, it is moderate. Uranium and PCBs would remain in place, but are not mobile. Potential migration of uranyl fluoride to groundwater would be reduced somewhat by a Subtitle C cap that limits infiltration of rainwater.

The overall effectiveness of this alternative is penalized, because it does not address PTW through treatment. While PCBs and uranium reliably can be contained below a Subtitle C cap, uranyl fluoride is more mobile and may not be reliability contained.

In combination with the Subtitle C cap, in-place site controls and LUCs will ensure the cap is not breached and thus protect current and future site workers and the public. Monitoring will be conducted to confirm that the remedy remains protective.

5.4.3.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 4.c.t1 will treat TCE DNAPL/sources and other VOCs present at the site; however, non-VOC waste and contaminated soil would remain in place. The presence of a surface cover would limit water infiltration into the burial unit, reducing the mobility of leachable contaminants. Reduction of toxicity, mobility, or volume through treatment is rated low to moderate.

5.4.3.2.3 Short-term effectiveness

Implementation of Alternative 4.c.t1 will not have a detrimental impact on the community.

Implementation of Alternative 4.c.t1 has the potential for worker exposure to contaminated surficial soils, subsurface soil, waste, and groundwater during installation of additional monitoring points, during environmental sampling, and during ERH and cap construction activities. PGDP worker protection programs will make significant worker exposure unlikely.

The short-term effectiveness of Alternative 4.c.t1 is moderate for the ERH treatment process to remediate a TCE source. Installation of electrode/vapor recovery wells and monitoring equipment will encounter contaminated soils. Soil cuttings produced during installation of electrode/vapor recovery wells will be managed in accordance with the work control documents prepared during the RD/RAWP. Installation and operation of the *in situ* DNAPL/source treatment system will be conducted by trained personnel in accordance with procedures. Site preparation and ERH source treatment system operation is expected to require 12 to 18 months. The Subtitle C cap will be effective upon completion. There will be some potential for risk that accrues to the workers and the public associated with the construction of the cap.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.3.2.4 Implementability

Activities to be conducted under Alternative 4.c.t1 include continuation/expansion of existing environmental media monitoring to track contaminant migration and construction of a surface cover.

Implementation of the remedial action components of Alternative 4.c.t1 is technically feasible; however, this assumes that electrode installation is located below any metallic debris or waste that could conflict with the ERH operation. Implementation of Alternative 4.c.t1 uses standard construction methods, materials, and equipment that are available from vendors and contractors.

Overall implementability of Alternative 4.c.t1 ERH installation is moderate due to the potential presence of drum remnants that may interfere with ERH electrode deployment and operation.

Equipment, personnel, and services required to implement this alternative are available commercially, but the field of experienced ERH vendors is limited. No additional development of these technologies would be required.

Implementation of Alternative 4.c.t1 using ERH is administratively feasible. For example, the electrode/vapor extraction wells used for ERH would be constructed and abandoned according to the requirements of KY regulations. Recovered vapor would be treated to meet allowable emission levels prior to discharge.

5.4.3.2.5 Cost

Estimated capital and O&M costs for Alternative 4.c.t1 address construction and maintenance of the cap and the ERH system, installation/supplementation of a monitoring well network, and sampling and analysis of MWs and ERH off gases. Cost is rated as moderate.

5.4.4 Alternative 4.c.t2: Subtitle C Cap, DPE, LUCs, and Monitoring

Alternative 4.c.t2 limits direct contact with surface soils, subsurface soils, and waste by the Subtitle C cap, and the integrity of this cap is preserved through in-place plant controls currently maintained outside of CERCLA extended, as needed, with LUCs. The remaining mobile contaminants will be extracted and treated using DPE.

Alternative 4.c.t2 includes the following:

- An RD that does not need any additional delineation of the PTW sources because the DPE will treat the entire SWMU volume;
- Source treatment using DPE, including treatment of mobile PTW;
- Process monitoring;
- Construction of a Subtitle C cap over SWMU 2;
- Monitoring; and
- LUCs.

No additional data would be required to support the RD in that DPE would be applied to the entire SWMU.

DPE is described in Section 2. Extracted groundwater would require treatment to remove organic contaminants, such as VOCs, and inorganic contaminants (e.g., uranium). Treatment could be provided by the existing Northwest Plume Pump-and-Treat System or construction of a new water treatment facility.

DPE will capture mobile COCs at SWMU 2, such as TCE and uranyl fluoride solution. It will also capture some lower mobility liquid COCs, such as oils or PCBs as the water table is drawn down using DPE.

Immobile COCs, such as uranium and matrix adsorbed PCBs, will be contained reliably under a Subtitle C cap, which will be constructed over the entire unit. The cover would be contoured to promote runoff and to reduce potential direct exposure to affected soils and wastes at SWMU 2. Finally, a 2-ft thick layer of Type H riprap will be placed as an intruder barrier to further limit the potential for contact with the remaining waste.

A monitoring program would be implemented to monitor the DPE processes and the upper RGA. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels. LUCs also would be implemented to ensure that the cap is not disturbed and the limitations on direct contact are maintained indefinitely.

5.4.4.1 Threshold criteria

5.4.4.1.1 Overall protection of human health and the environment

Construction of a Subtitle C cap over the unit would eliminate the potential exposure to workers from wastes and contaminated soils. LUCs would extend the in-place plant controls to ensure the cap remains in place and thus protect current and future site workers and the public.

DPE treatment will remove mobile COCs, including TCE and uranyl fluoride solution. DPE will remove liquid PCBs if sufficient quantities exist such that they are mobile in the environment (and not adhered to solid matrices). In addition, DPE will draw down the water table and extract any liquid or dissolved COCs. Uranium metal and nonmobile PCBs would not be addressed by DPE. Implementation of DPE process and additional groundwater monitoring would provide an indirect protection, as monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance. Monitoring the liquids extracted from the SWMU will help identify whether there are any mobile COCs remaining at the SWMU.

5.4.4.1.2 Compliance with ARARs

This alternative will meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.4.2 Balancing criteria

5.4.4.2.1 Long-term effectiveness and permanence

This alternative is designed to provide protection against exposure to waste and surface and subsurface soils, treat mobile PTW, and contain remaining wastes and affected soils. DPE will reduce the toxicity and volume of mobile COCs, but will not affect the nonmobile COCs. DPE will remove TCE, uranyl fluoride solution, and other mobile COCs within the SWMUs capture zones. The long-term effectiveness and permanence of this alternative for source remediation is moderate to high, although the DPE system would remain in place into the foreseeable future. Uranium would remain in place and would constitute a low risk in association with leaching to groundwater. Uranyl fluoride that is migrating to groundwater would be captured by the DPE system, The Subtitle C cap also would limit migration of uranyl fluoride by controlling infiltration of rainwater.

The overall effectiveness of this alternative is penalized because it does not address PTW uranium or PCBs through treatment; however both nonmobile uranium and PCBs can be reliably contained by a Subtitle C cap.

The integrity of the Subtitle C cap will be maintained, and in-place plant controls will be extended, as necessary by LUCs to protect current and future site workers and the public.

5.4.4.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 4.c.t2 will remove TCE, water, uranyl fluoride, and mobile PCBs present at the site; however, nonmobile contaminants will remain in place. The presence of a surface cover will limit water infiltration into the burial unit, limiting the potential for migration of contaminants.

5.4.4.2.3 Short-term effectiveness

Implementation of Alternative 4.c.t2 will not have a detrimental impact on the community.

Implementation of Alternative 4.c.t2 has the potential for worker exposure to contaminated surficial soils, subsurface soils, wastes, and groundwater during installation of DPE, the cap, and the additional monitoring points. PGDP worker protection programs will make significant worker exposure unlikely.

The short-term effectiveness of Alternative 4.c.t2 is moderate. Installation of DPE recovery wells and collection system equipment will encounter contaminated soils. Soil cuttings produced during installation will be managed in accordance with the work control documents prepared during the RD/RAWP. Installation and operation of the DPE system will be conducted by trained personnel in accordance with procedures. Site preparation, DPE installation, and cover installation is expected to require 12 to 18 months.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.4.2.4 Implementability

Alternative 4.c.t2 is implementable in that all of the elements of the alternative are items that have been installed at the site.

The locations of DPE and MWs are assumed to be placed outside the waste cells to the extent practical to minimize the impact on these activities by remaining debris or drums. Implementation of Alternative 4.c.t2 uses standard construction methods, materials, and equipment that are available from vendors and contractors.

Overall implementability of Alternative 4.c.t2 is moderate.

Equipment, personnel, and services required to implement this alternative are available commercially. No additional development of these technologies would be required.

Implementation is feasible administratively. For example, the DPE wells would be constructed and abandoned according to the requirements of KY regulations. Recovered liquids and vapors would be treated to meet allowable emission levels prior to discharge.

5.4.4.2.5 Cost

Estimated capital and O&M costs for Alternative 4.c.t2 address construction and maintenance of the surface cover, installation of the DPE system and supplemental MW network, and sampling and analysis of the MWs.

5.4.5 Alternative 4.c.t3: Subtitle C Cap, ZVI, LUCs, and Monitoring

Alternative 4.c.t3 controls direct contact to surface soils, subsurface soils, and wastes through placement of a Subtitle C cap. The integrity of this cap currently maintained outside of CERCLA is extended using LUCs, as necessary. This alternative also includes injection of ZVI to treat VOCs. ZVI may be somewhat effective in treating PCBs and uranyl fluoride through reductive dechlorination. Alternative 4.c.t3 includes the following:

- An RD that does not require any additional delineation because ZVI treatment will be used in all the SWMU 2 cells;
- Source treatment using chemical injection (ZVI);
- Process monitoring;
- Postremediation sampling, as necessary;
- Construction of a Subtitle C cap over SWMU 2;
- Monitoring; and
- LUCs.

Implementation of high pressure chemical injection of ZVI requires the installation of closely spaced injection points (10 to 15 ft centers, typically) through which microscale ZVI can be pressure injected into the waste cells. Generation of confluent coverage in the subsurface is an important concern for this application method. ZVI testing (Clausen and Richards 1994) has been performed at the bench scale using PGDP samples with effective treatment of TCE and daughter products. ZVI injection also may stabilize other mobile inorganic constituents, including Tc-99 and uranyl fluoride. ZVI also could be delivered through the entire depth of the UCRS at Cells 8, 9, and 6 if the TCE or uranyl fluoride source has migrated below the UCRS.

Upon completing treatment, a Subtitle C cap will be constructed over the entire unit. The cover would be contoured to promote runoff and to limit the potential for direct exposure to affected soils and wastes.

A monitoring program would be implemented to monitor treatment system performance and the upper RGA. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels. LUCs also would be implemented to ensure that the cap is not disturbed so that limitations on access to materials under the cap remain indefinitely.

5.4.5.1 Threshold criteria

5.4.5.1.1 Overall protection of human health and the environment

Construction of a Subtitle C cap over the unit would eliminate the potential exposure to workers from contaminated soil. The cap would limit direct contact to current and future site workers and the public. Existing plant controls, extended as necessary, will ensure that the cap is not breached; thus, the limitations are maintained indefinitely.

ZVI treatment would treat VOC PTW at SWMU 2 and be protective of groundwater for VOCs. ZVI treatment will have some beneficial impacts on treating PCBs and uranyl fluoride; however, the degree of treatment will vary depending upon the form of the residual COCs and their location in the waste matrix. Implementation of additional monitoring would provide an indirect protection, as monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance.

5.4.5.1.2 Compliance with ARARs

This alternative will meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.5.2 Balancing criteria

5.4.5.2.1 Long-term effectiveness and permanence

This alternative is designed to provide protection against exposure to waste, surface soils, and subsurface soil, and treat PTW. The long-term effectiveness and permanence of this alternative for VOC source remediation is high; however, the effectiveness at treating PTW uranium is negligible; there may be some treatment of PCBs and uranyl fluoride.

The Subtitle C cap will limit direct contact with soils and wastes. In-place plant controls extended as necessary by LUCs would allow the limitations established by the Subtitle C cap to protect current and future site workers and the public.

5.4.5.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 4.c.t3 will destroy TCE DNAPL/sources and other VOCs present at the site and create a reducing environment that will treat PCBs and uranyl fluoride. The presence of a Subtitle C cap will reduce water infiltration into the burial unit, limiting the potential for migration of mobile contaminants.

5.4.5.2.3 Short-term effectiveness

Implementation of Alternative 4.c.t3 will not have any detrimental impact on the community.

Implementation of Alternative 4.c.t3 has the potential for worker exposure to contaminated surface soils, subsurface soils, wastes, and groundwater during construction activities. PGDP worker protection programs will make worker exposure unlikely.

The short-term effectiveness of Alternative 4.c.t3 is moderate for the *in situ* TCE DNAPL/source treatment process to remediate a TCE source.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.5.2.4 Implementability

Activities to be conducted under Alternative 4.c.t3 include continuing/expanding existing monitoring to track contaminant migration, construction of a surface cover, and treatment using ZVI, including performance monitoring.

Implementation of the remedial action components of Alternative 4.c.t3 is technically feasible. Implementation of Alternative 4.c.t3 would use standard construction methods, materials, and equipment that are available from vendors and contractors. Specific ZVI injection techniques or ZVI product may be subject to sole source availability.

Overall implementability of Alternative 4.c.t3 is moderate to high.

Implementation of Alternative 4.c.t3 is administratively feasible.

5.4.5.2.5 Cost

Estimated capital and O&M costs for Alternative 4.c.t3 address construction and maintenance of the surface cover, source treatment using chemical injection of ZVI, and performance and environmental monitoring.

5.4.6 Alternative 4.c.t4: Subtitle C Cap, Bio, LUCs, and Monitoring

Alternative 4.c.t4 controls direct contact to surface soils, subsurface soils, and wastes through the placement of a Subtitle C cap. Breaching of the cap will be controlled by maintaining current site controls followed by LUCs. This alternative also includes injection of *in situ* biological treatment for treatment of the VOC PTW.

Alternative 4.c.t4 includes the following:

- An RD that does not necessarily require additional investigation to identify the major VOC source areas;
- VOC source treatment using enhanced biological treatment;
- Performance monitoring and postremediation sampling;
- Construction of a Subtitle C cap over the unit;
- Monitoring; and
- LUCs.

In situ enhanced biological treatment is recognized as a proven remediation technology for chlorinated ethenes over a wide concentration range. Implementation may require some characterization of *in situ* geochemical conditions to refine design criteria; however, biodegradation is naturally occurring at SWMU 2 as evidenced by the presence of daughter products. Enhanced biological treatment would utilize injections of amendments, such as emulsified vegetable oil, lactate, or other fermentable organic substrates, with the possible enhancement of native dechlorinating organisms by injecting a commercially available dechlorinating microbial culture. Enhanced biological treatment through reductive dechlorination also would reduce the oxidation reduction potential and tend stabilize mobile uranium and technetium.

Upon completing treatment, a Subtitle C cap will be constructed over the entire unit. The cover would be contoured to promote runoff and to reduce potential direct exposure to soil and waste present at SWMU 2.

A monitoring program would be implemented to monitor remedy performance, including impacts on the upper RGA. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels. LUCs also would be implemented to ensure that the cap is not disturbed so that limitations on access to materials under the cap remain indefinitely.

5.4.6.1 Threshold criteria

5.4.6.1.1 Overall protection of human health and the environment

Construction of a Subtitle C cap over the unit would eliminate the potential exposure of current and future site workers and the public from contaminated soils and wastes. The limits on exposure would be maintained through in-place plant controls extended, as necessary through LUCs.

Enhanced biological treatment will destroy VOC PTW and be protective of groundwater for VOCs. Enhanced biological treatment also will create a reducing environment, which will reduce mobility of uranyl fluoride. Implementation of additional groundwater monitoring would provide an indirect protection, as monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance.

5.4.6.1.2 Compliance with ARARs

Alternative 4.c.t4 will meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.6.2 Balancing criteria

5.4.6.2.1 Long-term effectiveness and permanence

Alternative 4.c.t4 is designed to provide protection against exposure to surface soils, subsurface soils, and waste through the use of a Subtitle C cap. The enhanced biological treatment component would treat VOC PTW. The long-term effectiveness and permanence of Alternative 4.c.t4 for source remediation is high for VOCs, but not as effective or permanent in addressing other PTW. Potential migration of COC migration to groundwater would be reduced by the Subtitle C cap that limits infiltration of rainwater.

The Subtitle C cap will limit direct contact with soil and waste. In-place plant controls extended as necessary by LUCs would allow the limitations established by the Subtitle C cap to protect current and future site workers and the public.

5.4.6.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 4.c.t4 will destroy TCE sources and other VOCs present at the site through enhanced biological treatment; however, non-VOC contaminants would remain in place. The presence of a Subtitle C cap will limit water infiltration into the burial unit, limiting the potential for migration of mobile contaminants.

5.4.6.2.3 Short-term effectiveness

Implementation of Alternative 4.c.t4 will not have any detrimental impact on the community.

Implementation of Alternative 4.c.t4 has the potential for worker exposure to contaminated surficial soils, subsurface soils, wastes, and groundwater during construction activities. PGDP worker protection programs will make worker exposure unlikely.

The short-term effectiveness of Alternative 4.c.t4 is moderate to high for the *in situ* enhanced biological treatment.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.6.2.4 Implementability

Activities to be conducted under Alternative 4.c.t4 include installation of an enhanced biological treatment system, continuing/expanding monitoring to track contaminant migration, and construction of a Subtitle C cap.

Implementation of the remedial action components of Alternative 4.c.t4 is feasible technically. Implementation of Alternative 4.c.t4 will use standard construction methods, materials, and equipment that are available from vendors and contractors.

Overall implementability of Alternative 4.c.t4 for enhanced biological treatment is moderate to high. Although other treatment alternatives may be greatly affected by subsurface waste or debris, biological treatment may be less affected because it could be implemented using infiltration gallery methods.

Equipment, personnel, and services required to implement this alternative are readily available commercially. No additional development of these technologies would be required. Contractors possessing the required skills and experience are available.

Implementation of Alternative 4.c.t4 for enhanced biological treatment is feasible administratively.

5.4.6.2.5 Cost

Estimated capital and O&M costs for Alternative 4.c.t4 include costs to construct the Subtitle C cap, maintenance of the cap, installation of monitoring network, and well sampling and analysis. In addition, there is a capital cost associated with enhanced biological treatment.

5.4.7 Alternative 5.CR: Excavation and Disposal with CR

Alternative 5.CR incorporates the GRAs of removal, LUCs, and monitoring, as needed. Alternative 5.CR envisions excavation of buried materials and associated affected soils to a depth of 16–20 ft; waste disposal characterization sampling; excavation pit dewatering; and packaging, transporting, and disposing of wastes in accordance with the WAC of the to-be-selected disposal facilities. Areas not subjected to excavation will be addressed by LUCs and monitoring. This alternative is described in detail in Section 3.

Excavation of SWMU 2 would include the following activities:

- Installation of sheet piles around the perimeter of the waste unit;
- Excavation of buried materials and contaminated soils within the waste unit;
- Drum removal (if drums found intact);
- Waste and soil characterization sampling;
- Excavation pit dewatering;
- Waste packaging, transportation and disposal;
- Excavation floor sampling;
- Waste treatment (as needed);
- Backfill excavation; and
- Implement contingent treatment remedy if soil at bottom of excavation does not meet PRGs.

Due to the proximity of surrounding site features to the north, east, and west of the SWMU 2 disposal area, sheet pile will be installed along at least those three sides of the excavation. This significantly will reduce the excavation footprint and reduce the spoils that will need to be managed at the excavation. The south side of the excavation will be sloped to allow personnel and equipment access and egress.

Historical records state the wastes were disposed of in individual cells. That is, wastes were not disposed of in a random manner across a large area. The excavation approach will focus on removing the waste contents of individual cells and segregating the waste from surrounding soils. This approach will minimize the volume of waste that will need specialized treatment, such as waste containing potentially pyrophoric uranium and/or PCB contamination.

The waste material and affected soils will be excavated with mechanized equipment such as loaders and trackhoes.

If intact drums are found, they may be overpacked, removed, and managed separately.

The excavation alternative includes the removal of waste and associated soils to a maximum depth of 20 ft bgs. Excavation will progress until visible wastes have been removed and the appropriate target concentrations are met. It is anticipated that target concentrations would be met before reaching a depth of approximately 16 ft, a depth that also corresponds with typical maximum depths for utility installations at PGDP (therefore, it is protective of industrial and outdoor worker).

Should excavation proceed to 20 ft and excavation floor sampling cannot confirm that PRGs have been met, this alternative includes contingency remedies to address mobile constituents present below 20 ft.

Postremediation samples will be collected to determine the effectiveness of remediation and to ascertain when excavation is complete. The eventual evaluation of soil COC concentrations will be based on a cumulative ELCR and cumulative HI calculation using postremediation sampling results. If these cumulative targets are met at all sampling locations, no additional monitoring will be necessary.

Disposal options include off-site disposal facilities, as well as a potential on-site WDF. Implementation of Alternative 5.CR would need to consider the possibility that mobile source contaminants may have migrated beyond the original waste cell burial area and may require additional treatment to meet remediation objectives.

Excavation activities would be performed in accordance with a HASP designed for handling pyrophoric uranium. The excavation and handling of this uranium presents challenges for the remedial action contractor. Detailed information regarding handling of uranium waste would be provided in the RAWP.

Alternative 5.CR for SWMU 2 assumes that 60% of the total SWMU area would be excavated and that mobile source contaminants also would be removed as part of the excavated material within the maximum excavation depth of 20 ft. Excavation and disposal of waste materials and affected soils from this SWMU are based on removal of approximately 12,055 yd^3 (loose) of contaminated waste materials. The loose volume of this excavated waste is approximately 32,240 yd^3 to account for expansion upon removal with the nonhazardous solid waste being disposed of at PGDP on-site C-746-U Landfill (4,805 yd^3). The TSCA/MLLW (1,919 yd^3) would receive off-site treatment and be disposed of either at a licensed commercial or federal facility. The MLLW (5,331 yd^3) would be disposed of at either a licensed commercial or federal facility. The following provides assumptions for the area and volumes of excavated waste from SWMU 2:

- Additional assumptions for excavation, transportation, disposal, treatment, excavation, dewatering, etc., for SWMU 2 can be found in Appendix E.

- Alternative 5.CR will address PTW and COCs through excavation and removal. Removal will be followed by treatment as needed to meet the WAC of the disposal facility. In addition, this alternative allows for contingent treatment alternatives to be employed should excavation to 20 ft bgs not be sufficient to meet PRGs. This alternative addresses all PTW and will eliminate uncertainties associated with buried COCs.

5.4.7.1 Threshold criteria

5.4.7.1.1 Overall protection of human health and the environment

Alternative 5.CR would meet this threshold criterion. Potential short-term risks to remediation workers due to direct contact with the waste material and inhalation hazards are much larger for this alternative than for any of the other alternatives. In addition, potential risks to the public and the environment, as a result of potential shipping and handling concerns, should be considered for off-site shipments. These potential impacts on the public are reduced greatly for disposal in a potential on-site WDF.

Waste and contaminated soils would be removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting RAOs for waste in the former burial cells. Additional treatment or excavation may be necessary to provide protection from mobile contaminants remaining below the excavation depth of 20 ft should they be identified during the course of excavation.

5.4.7.1.2 Compliance with ARARs

Alternative 5.CR would meet this threshold criterion. Excavation would remove all COCs to sufficient levels to meet the RAO. ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.7.2 Balancing criteria

5.4.7.2.1 Long-term effectiveness and permanence

Excavation eliminates on-site contaminant migration, since no wastes or associated contaminated soils would remain in the SWMU; therefore, this alternative offers a high degree of risk reduction, effectiveness, and permanence. Excavated materials will be treated to meet the WAC of the disposal facility.

Alternative 5.CR would eliminate unacceptable threats from direct contact with wastes, surface soils, or subsurface soils. Alternative 5.CR eliminates uncertainties associated with the source term.

5.4.7.2.2 Reduction of toxicity, mobility, or volume through treatment

This alternative reduces or eliminates the toxicity, mobility, and volume of contaminants from the unit by removal of constituents and *ex situ* treatment of excavated wastes. The removal and disposal of waste and contaminated soil from a burial cell containing COCs to an appropriate disposal facility prevents those contaminants from migrating to the groundwater.

5.4.7.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU are expected only as they relate to transport of excavated materials to off-site disposal locations. This risk would be reduced greatly by disposing of waste in a potential on-site WDF.

There is some limited potential for pyrophoric uranium at SWMU 2 to combust, creating short-term health concerns for remediation workers, the surrounding public, and the environment. Implementation of Alternative 5.CR would incorporate measures to prevent or mitigate such an event. Short-term exposures of workers to COCs could occur during implementation of Alternative 5.CR. Worker risks are not expected to exceed acceptable limits because these activities will be conducted under an approved HASP; thus, risks from handling waste/contaminated soils would be mitigated through adherence to health and safety protocols.

The RAOs for SWMU 2 would be achieved immediately following completion of excavation and disposal activities. Excavation, treatment, and disposal of residuals could be accomplished in approximately three years, but may necessitate an additional period of time if deeper sources of contaminants are identified during the RD or remedial action.

Excavation and disposal would be conducted by trained personnel in accordance work planning documents to maintain a work environment that minimizes injury or exposure to risks to human health or the environment.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.7.2.4 Implementability

Alternative 5.CR is technically and administratively feasible and implementable. The equipment and technologies associated with implementation of this alternative have been proven to be feasible technically and are available from contractors or vendors. The implementability of construction-related activities during excavation and backfilling at SWMU 2 subject to Alternative 5.CR is very similar to that carried out routinely at other sites, so it is considered high. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely and, if properly implemented, are proven to be safe. Some excavated waste materials and affected soils may be radioactive, PCB contaminated, or mixed. Treatment of potentially pyrophoric wastes with multiple regulatory classifications is more complex and will be treated off-site. On-site treatment processes would comply with ARARs.

5.4.7.2.5 Cost

Costs are provided for excavation and disposal of SWMU 2 in Appendix E. Costs were estimated for transportation and disposal of wastes at an off-site facility. O&M costs depend on the status of the SWMU upon completion of excavation. Cost would be low if SWMU closure can be achieved upon completion of excavation without the need for a long-term monitoring program.

5.4.8 Alternative 5.CR.WDF: Excavation and Disposal, WDF with CR

This alternative is the same as Alternative 5.CR, except that it considers disposal at a potential on-site WDF as the primary disposal pathway. The evaluation of the alternative against the balancing criteria is identical to that provided for Alternative 5.CR, except for the cost criterion.

5.4.9 Alternative 6.c.CR: Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR

This alternative would involve the removal of wastes and contaminated soils associated with the mobile constituents disposed in SWMU 2—Cell 6 (soils with high TCE concentrations), Cell 8 (uranyl fluoride drums), and Cell 9 (TCE drums)—followed by covering the remaining wastes with a Subtitle C cap. The 270 tons of uranium would remain along with as much as 59,000 gal of oil that contains PCBs. These COCs are considered nonmobile. This alternative includes the following:

- Installation of sheet piles around the perimeter of the waste cells to be excavated;
- Excavation of buried materials and contaminated soils;
- Operation of emission control equipment during excavation;
- Cover soil and waste disposal characterization sampling;
- Excavation pit dewatering;
- Initiate contingent treatment remedy, if necessary;
- Segregation, bulking, and consolidation of compatible waste groups; and
- Install Subtitle C cap.

Approximately 3% of the total SWMU area would require excavation and disposal under this alternative. Costs for excavation and disposal of waste materials and affected soils from this SWMU are based on removal of approximately 950 yd^3 (loose) of waste materials plus associated soils. The LLW/MLLW (850 yd^3) would be disposed of either at a permitted commercial or federal disposal site or a potential on-site WDF, if available. The remaining soils would we disposed of at the existing on-site 746-U Landfill. Additional assumptions for excavation, transportation, disposal, treatment, excavation, dewatering, etc., for SWMU 2 can be found in Appendix E.

A monitoring program would be implemented to monitor the progress of the remedy, including impacts on the upper RGA. The monitoring program will utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels.

Dewatering during excavation would follow as described in Alternative 5.CR.

Alternative 6.c.CR removes uranyl fluoride and TCE through selective excavation. This alternative would utilize containment to prevent direct contact to potentially pyrophoric uranium and any associated PCB-containing oils. Alternative 6.c.CR will limit water infiltration as a result of the surface cover to limit movement of mobile constituents.

As described in Alternative 5.CR, excavation will be advanced to a maximum depth of 20 ft. Should clean margins not be reached at the floor of the excavation, then a contingent deep source treatment will be considered for implementation. The specific treatment method implemented will be dependent upon the COCs and degree of contamination remaining.

5.4.9.1 Threshold criteria

5.4.9.1.1 Overall protection of human health and the environment

Alternative 6.c.CR would meet this threshold criterion. Waste and contaminated soil would be removed physically from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting RAOs for waste in the former burial cells. Additional treatment or excavation may be necessary to provide protection from mobile contaminants below the excavation depth, should they be identified.

5.4.9.1.2 Compliance with ARARs

Alternative 6.c.CR would meet this threshold criterion. Selective excavation would remove COCs known to be mobile, namely uranyl fluoride and TCE-contaminated soils, to sufficient levels to meet the RAOs and ARARs for this alternative. The ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.9.2 Balancing criteria

5.4.9.2.1 Long-term effectiveness and permanence

Selective excavation removes mobile waste constituents. This activity, when combined with containment using a Subtitle C cap, provides moderate to high long-term effectiveness and permanence. Postexcavation treatment processes manage or remove hazardous characteristics or destroy the COCs in the excavated material.

Risks associated with direct contact with wastes, surface soils, and subsurface soils would be eliminated since the primary source and associated contaminated soils would be covered or removed. Alternative 6.c.CR reduces uncertainties associated with these soils in terms of continued contributions to the hydrogeological system by removal of mobile contaminants.

5.4.9.2.2 Reduction of toxicity, mobility, or volume through treatment

This alternative selectively removes mobile contaminants, thus reducing or eliminating the toxicity, mobility, and volume of contaminants from the unit. The extracted contaminants are treated prior to disposal in a manner that meets the WAC of the disposal facility. This alternative does leave the majority of waste in place; however, these wastes are nonmobile, thus reliably contained by a Subtitle C cap. The removal and disposal of waste and contaminated soil from a burial cell containing COCs to an appropriate disposal facility prevents those contaminants from migrating to the groundwater beneath SWMU 2.

5.4.9.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU would not be expected; however, there is a slim potential that excavation workers would encounter pyrophoric uranium at SWMU 2 that may combust, creating health concerns for remediation workers, the surrounding public, and the environment. Cells 6, 8, and 9 are not known to contain pyrophoric uranium. Implementation of Alternative 6.c.CR would incorporate measures to prevent or mitigate such an event. Alternative 6.c.CR includes a potential risk to the public from transportation of the LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities. This risk would be substantially less than that for Alternative 5.CR due to the reduced volume of transported and disposed of waste. This risk would be further reduced by disposing of waste in a potential on-site WDF; however, given the selective nature of excavation activities, this reduces the risk of encountering pyrophoric uranium.

Short-term exposures of workers to COCs could occur during implementation of Alternative 6.c.CR. Risks from handling waste/contaminated soils would be mitigated 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, site-specific HASP.

Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures, documented safety analyses, HASPs, and safe work practices to maintain a work environment that minimize injury or exposure to risks to human health or the environment.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.9.2.4 Implementability

Alternative 6.c.CR is technically and administratively feasible and implementable. The equipment and technologies associated with implementation of this alternative have been proven to be feasible technically and are available from contractors or vendors. The implementability of construction-related activities during excavation and surface cover construction at SWMU 2 subject to Alternative 6.c.CR is very similar to that carried out routinely at other sites, so it is considered high. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely and, if properly implemented, are proven to be safe. Some excavated waste materials and affected soils may be radioactive, PCB contaminated, or mixed. 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 would comply with ARARs.

An option for disposal of waste and residuals at a potential on-site WDF was considered under Alternative 6.c.CR. The primary difference would be the elimination of waste leaving PGDP, related off-site transportation issues, and the cost for disposal. This will be further considered should this alternative be implemented and there is an on-site WDF at time of implementation.

5.4.9.2.5 Cost

Costs were estimated for excavation, transportation, and disposal of wastes at an off-site facility, as well as for an option to dispose of waste at a potential on-site WDF, and construction of a surface cover. O&M costs are expected to be moderate due to long-term monitoring of groundwater and repair and maintenance of the surface cover. Transportation and disposal costs for Alternative 6.c.CR would be a fraction of those for Alternative 5.CR due to the much lower volume of excavated materials. Cost estimates for this alternative are included in Appendix E.

5.4.10 Alternative 7.c.t2.CR: Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR

This alternative is essentially the same as Alternative 6.c.CR, except that it includes DPE as a base component to the alternative. The DPE would serve to treat any residual TCE present in the SWMU 2 cells and would serve to dewater the rest of the SWMU.

This alternative would involve the removal of wastes and contaminated soils associated with Cell 6 (soils with high TCE concentrations), Cell 8 (uranyl fluoride drums), and Cell 9 (TCE drums), followed by surface coverage of remaining wastes. This alternative would leave the 270 tons of uranium in place as well as the 59,000 gal of oil potentially containing PCBs. These COCs are considered nonmobile in the SWMU environment. This alternative includes the following:

- Installation of sheet piles around the perimeter of the waste cells to be excavated;
- Excavation of buried materials and contaminated soils;
- Operation of emission control equipment;
- Cover soil and waste disposal characterization sampling;
- Excavation pit dewatering;
- Install DPE system;
- Initiate contingent treatment remedy, if necessary;
- Segregation, bulking, and consolidation of compatible waste groups; and
- Install Subtitle C cap.

Approximately 3% of the total SWMU area would require excavation and disposal under this alternative. Costs for excavation and disposal of waste materials and affected soils from this SWMU are based on removal of approximately 950 yd^3 (loose) of waste materials plus associated soils. The LLW/MLLW (850 yd^3) would be disposed of either at a permitted commercial or federal disposal site or a potential on-site WDF, if available. The remaining soils would be disposed of at the existing on-site 746-U Landfill.

Additional assumptions for excavation, transportation, disposal, treatment, excavation, dewatering, etc., for SWMU 2 can be found in Appendix E.

A monitoring program would be implemented to monitor the remedy performance, including impacts to the upper RGA. The monitoring program will utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels.

Dewatering during excavation would follow as described for Alternative 5.CR.

Alternative 7.c.t2.CR removes uranyl fluoride and TCE through selective excavation. This alternative would utilize containment with a Subtitle C cap to prevent direct contact to residual wastes and affected soils. This alternative also dewaters the subsurface and limits water infiltration using the Subtitle C cap. As described for Alternative 5.CR, excavation will be advanced to a maximum depth of 20 ft. Should clean margins not be reached at the floor of the excavation, then a contingent deep source treatment will be considered for implementation. The specific treatment method implemented will be dependent upon the COCs and degree of contamination remaining.

5.4.10.1 Threshold criteria

5.4.10.1.1 Overall protection of human health and the environment

Alternative 7.c.t2.CR would meet this threshold criterion. Mobile wastes and associated contaminated soil would be physically removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting RAOs. Additional treatment or excavation may be necessary to provide protection from mobile contaminants below the excavation depth. This alternative includes the installation of a DPE system as a base component of the alternative. This inclusion will ensure long-term protection of groundwater by capturing leachate that may migrate through the SWMU, removing mobile constituents, including vapor phase VOCs. Monitoring extracted materials would demonstrate when the mobile constituents have been captured to a level that is protective of the groundwater beneath SWMU 2.

5.4.10.1.2 Compliance with ARARs

Alternative 7.c.t2.CR will meet this threshold criterion. The ARARs for this alternative are summarized in Appendix F. This alternative can be developed in a manner that complies with ARARs.

5.4.10.2 Balancing criteria

5.4.10.2.1 Long-term effectiveness and permanence

The long-term effectiveness and permanence of this alternative is rated as moderate to high. Mobile wastes and PTW will be removed through targeted excavation. Migration of nonmobile wastes will be further slowed by a Subtitle C cap. Additionally, any COCs migrating through the unit will be captured by DPE. This improves the long-term effectiveness and permanence rating.

5.4.10.2.2 Reduction of toxicity, mobility, or volume through treatment

This alternative removes mobile contaminants, thus reducing or eliminating the mobility and volume of contaminants from the unit. This alternative does leave the nonmobile uranium and associated oils potentially containing PCBs; however, these nonmobile wastes are reliably contained with a Subtitle C cap. The removal and disposal of waste and contaminated soil from a burial cell containing COCs to an appropriate disposal facility prevents those contaminants from migrating to the groundwater. Additionally, any COCs migrating from the unit will be captured by DPE.

5.4.10.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU would not be expected; however, there is a slim potential that excavation workers would encounter pyrophoric uranium at SWMU 2 that may combust, creating health concerns for remediation workers, the surrounding public, and the environment. Cells 6, 8, and 9 are not known to contain pyrophoric uranium. Implementation of Alternative 7.c.t2.CR would incorporate measures to prevent or mitigate such an event. Alternative 7.c.t2.CR includes a potential risk to the public from transportation of the LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities; however, this risk is much lower than that for Alternative 5.CR due to the much lower volume of transported material. Even this small risk would be reduced greatly by disposing of waste in a potential on-site WDF. Risks from handling waste/contaminated soils would be mitigated 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, site-specific HASP.

Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures, DSAs, HASPs, and safe work practices to maintain a work environment that minimizes injury or exposure to risks to human health or the environment.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

5.4.10.2.4 Implementability

The implementability rating given to Alternative 7.c.t2.CR is moderate.

5.4.10.2.5 Cost

Costs were estimated for excavation, transportation, and disposal of wastes at an off-site facility, as well as for an option to dispose of waste at a potential on-site WDF, construction of a surface cover, and installation of DPE. O&M costs are expected to be moderate due to long-term monitoring of groundwater, repair and maintenance of the surface cover, and repair and maintenance of the DPE system. Transportation and disposal costs for Alternative 7.c.t2.CR would be much lower than those for Alternative 5.CR. Costs are increased somewhat from Alternative 6.c.CR because of the DPE. Estimates for this alternative are included in Appendix E.

5.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis summary for contaminated source area alternatives for SWMU 2 is presented in Table 5.5. This comparative analysis includes a numerical averaging of ratings for each of the five balancing criteria developed on a 0–9 point scale, as follows:

Rating	Numerical Range
Low	1
Low to Moderate	3
Moderate	5
Moderate to High	7
High	9

5.5.1 Threshold Criteria

Source area remedial alternatives are compared with respect to the threshold criteria in the following sections.

5.5.1.1 Overall protection of human health and the environment

Alternative 1 does not meet the threshold criterion of overall protection of human health and the environment. Alternative 1 would not treat, contain, or remove waste.

Alternative 2 meets the threshold criterion as long as it incorporates LUCs to address the potential for future use of affected groundwater.

Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 meet the threshold criterion providing a ~moderate level of long-term effectiveness and a moderate level of short-term effectiveness.

Alternatives 5.CR and 5.CR.WDFwould meet the threshold criterion providing a high level of long term effectiveness and permanence due to addressing all COCs and not leaving waste or affected soil in place.

Alternative 6.c.CR meets threshold criterion for overall protection of human health and the environment through selective excavation and disposal of mobile COCs, followed by construction of a surface cover to prevent direct contact exposure and limit water infiltration. Monitoring is a major component of this

Table 5.5. Summary of Comparative Analysis of Alternatives for SWMU 2

	Alternative 1	Alternative 2	Alternative 4.c.t1	Alternative 4.c.t2	Alternative 4.c.t3	Alternative 4.c.t4	Alternative 5.CR	Alternative 5.CR.WDF	Alternative 6.c.CR	Alternative 7.c.t2.CR
Evaluation Criteria	**No Action**	**Limited Action (LUCs, and Monitoring)**	**Subtitle C Cap, ERH, LUCs, and Monitoring**	**Subtitle C Cap, DPE, LUCs, and Monitoring**	**Subtitle C Cap, ZVI, LUCs, and Monitoring**	**Subtitle C Cap, Bio, LUCs, and Monitoring**	**Excavation and Disposal with CR**	**Excavation and Disposal, WDF with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, LUCs, and Monitoring with CR**	**Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, and Monitoring with CR**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Low to Moderate (3)	Moderate (4)	Moderate to High (6)	Moderate (5)	Moderate (4)	High (9)	High (9)	Moderate to High (6)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low (1)	Low (1)	Low to Moderate (3)	Moderate (5)	Moderate (4)	Low to Moderate (3)	High (9)	High (9)	Moderate to High (7)	Moderate to High (7)
Short-Term Effectiveness	Low (1)	Moderate (4)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (5)	Moderate to High (6)
Implementability	High (9)	High (9)	Moderate (4)	Moderate to High (6)	Moderate (5)	Moderate to High (6)	Moderate (4)	Moderate (4)	Moderate (5)	Moderate (5)
Cost * Present Worth Cost	High (9) $0	High (9) $3,301,000	Moderate (5) $22,195,000	Moderate (5) $ 17,009,000	Moderate (5) $29,885,000	Moderate (5) $9,282,000	Low (1) $179,233,000	Low (1) $172,609,000	Moderate (5) $39,107,000	Moderate (5) $49,966,000
Average Balancing Criteria Rating	4.0	5.2	4.2	5.4	4.8	4.6	5.4	5.4	5.6	6.2

* High overall cost rating corresponds to a low project cost relative to the site.
CR = contingent remedy should PRGs not be met by excavation. Components could include t1, t3, or t4. CR includes LUCs and monitoring. Costs do not include CR implementation.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

alternative. Although excavation activities moderately increase short-term risk, they decrease long-term risk.

Alternative 7.c.t2.CR meets the threshold criterion by targeted removal of mobile COCs followed by containment with long-term DPE to capture COCs that migrate beneath the SWMU.

5.5.1.2 Compliance with ARARs

No ARARs have been identified for Alternative 1, the No Action alternative.

Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 meet ARARs and can be designed to maintain this compliance.

Alternatives 5.CR and 5.CR.WDF would meet this criterion. This alternative would remove the wastes and affected soils by excavation such that the residual soils would meet target concentrations.

Alternative 6.c.CR would meet this threshold criterion.

Alternative 7.c.t2.CR would meet this threshold criterion.

5.5.2 Balancing Criteria

Source area alternatives are compared with respect to the balancing criteria in the following sections.

5.5.2.1 Long-term effectiveness and permanence

Alternative 1 would not be effective. Although in-place plant controls limit direct contact with wastes and affected soils, this alternative does not provide for maintaining these limitations; thus, the alternative would not be effective in the long-term, or permanent.

Alternative 2 would be effective as long as in-place plant controls are extended by LUCs to limit both direct contact with wastes and affected soils and contact with affected groundwater.

Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 provide a ~moderate degree of long-term effectiveness and permanence. These alternatives include a physical barrier between receptors and wastes and associated affected soils, thus preventing direct contact and the associated risk. They also would reduce contaminant migration so that COCs remaining in place at levels above their target concentrations would make only minor contribution to contamination of the RGA groundwater. LUCs would ensure that the Subtitle C cap is not breached and that direct contact with wastes and affected soils is controlled. The need for LUCs to limit contact with affected groundwater will be evaluated as part of a LUCIP that uses monitoring to evaluate the SWMU2 impacts on RGA groundwater.

Alternatives 5.CR and 5.CR.WDF provide a high degree of long-term effectiveness and permanence. Achieving clean closure would obviate the need for follow-on monitoring.

Alternative 6.c.CR provides a moderate to high degree of long-term effectiveness and permanence by removing mobile contaminant sources. Residual direct contact risk still would be present under this alternative because nonmobile buried waste would remain in place; however, the risk would be minimized by construction of Subtitle C cap and application of LUCs. The cap/LUCs combination would reliably contain the nonmobile COCs.

Alternative 7.c.t2.CR provides a high degree of long-term effectiveness and permanence. In addition to removing mobile COCs and capping the residual wastes, the unit will be dewatered in an accelerated fashion in a manner that also will capture residual mobile constituents. This alternative minimizes the potential for exposure to pyrophoric uranium and the costs associated with treatment and disposal of the nonmobile pyrophoric uranium and PCB-containing oil.

5.5.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of COCs in waste or soil at SWMU 2.

Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 reduce the toxicity or volume of waste through treatment (although for t2, the treatment occurs *ex situ*). Alternatives 5.CR and 5.CR.WDF reduce mobility and volume of waste through excavation and *ex situ* treatment needed to meet WAC requirements of a receiving facility Alternatives 6.c.CR and 7.c.t2.CR remove mobile waste constituents through excavation. Alternative 7.c.t2.CR also reduces volume of COCs through extraction and *ex situ* treatment. Alternatives 4.c.t1, 4.c.t2, 4.c.t3, 4.c.t4, 6.c.CR, and 7.c.t2.CR reduce contaminant mobility through the cap controlling infiltration of precipitation that otherwise would migrate through the waste material and enhance the potential for mobility of COCs.

5.5.2.3 Short-term effectiveness

The short-term effectiveness of Alternative 1 is low because RAOs would not be attained. No actions would be implemented; therefore, there would be no impacts to workers or community.

The short-term effectiveness of Alternative 2 is moderate because the alternative is quickly accomplished, and no site actions would be implemented that would have impacts to workers or the community.

The short-term effectiveness of Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 is moderate even though these alternatives are more effective than Alternative 2 because of the higher degree of intrusive work required and the potential for adverse impacts to workers or the community.

The short-term effectiveness of Alternative 5.CR and 5.CR.WDF is moderate though this alternative is the most effective because of the increased potential for contact to workers and the community during excavation. The option to dispose of excavated waste in a potential on-site WDF would improve the short-term effectiveness slightly by eliminating risks associated with wastes leaving the site. Active remedial action could be completed in a period of one to three years.

Alternative 6.c.CR presents moderate short-term effectiveness as excavation activities are not as extensive as for Alternative 5.CR or Alternative 5.CR.WDF. The alternative is less effective, but the potential impacts to the community and the workers also are lower. The option to dispose of excavated waste in a potential on-site WDF would slightly improve the short-term effectiveness by eliminating risks associated with wastes leaving the site.

Alternative 7.c.t2.CR presents moderate to high short-term effectiveness because the mobile COCs are well-addressed both with limited excavation and DPE, but the potential impacts to the community and the workers are lower than for Alternatives 5.CR or 5.CR.WDF.

5.5.2.4 Implementability

Alternative 1 would be the most readily implementable alternative because no construction or invasive action would be taken.

Alternative 2 would be nearly as implementable because the only activities are administrative (LUCs) or monitoring—activities that are routinely implemented at PGDP.

The implementability of Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 generally is moderate to moderate to high because the technologies are proven and readily available.

Alternatives 5.CR, 5.CR.WDF, 6.c.CR, and 7.c.t2.CR have moderate implementability that varies slightly with the degree of excavation and the amount of pyrophoric uranium that will be affected.

5.5.2.5 Cost

Capital and O&M costs for alternatives at SWMU 2 are presented in Appendix E with Present Worth cost summarized in Table 5.5.

5.5.3 Summary of Comparative Analysis of Alternatives

Table 5.5 presents a summary of the comparative analysis of alternatives that includes a balancing criteria rating derived from averaging the scores for the balancing criteria for each alternative.

Alternative 1 does not meet the threshold criterion of overall protection of human health and the environment.

Alternative 2 balances a high implementability and high cost rating (low cost) against a low to moderate long-term effectiveness and permanence, reduction in toxicity, mobility, and volume, and short-term effectiveness. Alternatives 4.c.t1, 4.c.t2, 4.c.t3, and 4.c.t4 balance moderate cost and moderate to high implementability with moderate long-term effectiveness and permanence, reduction in toxicity, mobility, and volume and short-term effectiveness.

Alternatives 5.CR and 5.CR.WDF balance a high cost (low cost rating) against high long-term effectiveness and permanence and reduction in toxicity, mobility, and volume through treatment.

Alternative 6.c.CR balances a moderate cost with a moderate to high long-term effectiveness and permanence.

Alternative 7.c.t2.CR balances a moderate cost with a high long-term effectiveness and permanence and a moderate to high reduction in toxicity, mobility, and volume through treatment. All alternatives that leave waste in place include a Subtitle C cap with additional riprap as an intruder barrier to further limit access to the waste and associated soils. This cap will be effective at controlling access to the waste and associated soil, as well as limiting groundwater infiltration.

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6. SWMU 3

6.1 SWMU 3 HISTORY AND BACKGROUND

Previous sections of this document present a framework that collects sitewide information and uses it to formulate a general approach to developing alternatives to address the COCs present in the BGOU SWMUs. This framework also discusses key elements of the alternatives that are used as the basis for technology screening and development of SWMU-specific alternatives. This section (Section 6) of the document develops the candidate alternatives for SWMU 3 by expanding the general alternatives to address SWMU-specific conditions.

The C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3) is 1.2 acres located in the west-central portion of the secured area. The unit originally was constructed as a rectangular, aboveground surface impoundment measuring 387 ft by 137 ft, with a floor area of approximately 53,000 ft^2. The floor of the surface impoundment was constructed of well-tamped earth and clay dikes to a height of 6 ft. The C-404 impoundment was designed with an overflow weir at its southwest corner. From the weir, the surface impoundment effluent flowed west in a ditch (not the NSDD) and eventually discharged through what is now KPDES Outfall 015. Figure 6.1 shows C-404 along with a schematic of this design. Historical effluent/leachate discharges later were rerouted to the NSDD via what is now an abandoned pipeline.

SWMU 3 operated as a surface impoundment from approximately 1952 until early 1957. During this time, all influents to the impoundment originated from C-400. In 1957, the C-404 surface impoundment was converted to a solid WDF for solid uranium-contaminated wastes. The waste consists of uranium precipitated from aqueous solutions, uranium tetrafluoride (UF_4), uranium metal, uranium oxides, degreasing sludge, and radioactively contaminated trash. There are no records documenting the cleanout of sludges and sediments from the pond when it was converted to a landfill. When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. Leachate was pumped from the sump through an underground transfer line. The transfer line discharged into a northeast-southwest ditch just east of C-404. From this ditch, the leachate flowed into the NSDD. NSDD historically carried PGDP effluents north to Little Bayou Creek. The date of termination of the leachate discharge through the underground transfer line into the NSDD has not been determined. It is known that, prior to landfill closure in 1986, this underground transfer line to the NSDD was not in operation and leachate from the C-404 Landfill was being collected in the sump for treatment at the C-400-D Lime Precipitation Unit in the C-400 Facility. At some time following closure of the C-404 Landfill, treatment of leachate from C-404 at C-400 was discontinued, and treatment of the leachate was transferred to the C-752 Remedial Action Waste Holding Facility. Some of the constituents found in the leachate and their ranges have included fluoride (4.8–10 mg/L), TCE (ND–0.3 mg/L), PCBs (0.41–1.18 µg/L), Np-237 (0.42–11.7 pCi/L), Tc-99 (90.6–365 pCi/L), U-234 (66–3,390 pCi/L), U-235 (156–1,050 pCi/L), and U-238 (2,160–37,900 pCi/L).

The upper tier of waste within C-404 contains drummed waste similar to that collected in the impoundment plus smelter furnace liners and drums of extraction-procedure, characteristically hazardous, waste [RCRA waste codes D006 (for cadmium), D008 (for lead), and D010 (for selenium)]. The drums of characteristically hazardous waste were produced in C-400 during treatment of wastes including sodium bisulfate solution, hydrochloric acid, chromic acid, nickel stripper solution, miscellaneous acids and alkalis, and aqueous solutions containing metals. A partial clay cap was installed on the eastern end of the landfill in 1982 (DOE 1987). Subsequently, the entire unit was covered with a Subtitle C cap; thus, the SWMU 3 unit is an abovegrade unit.

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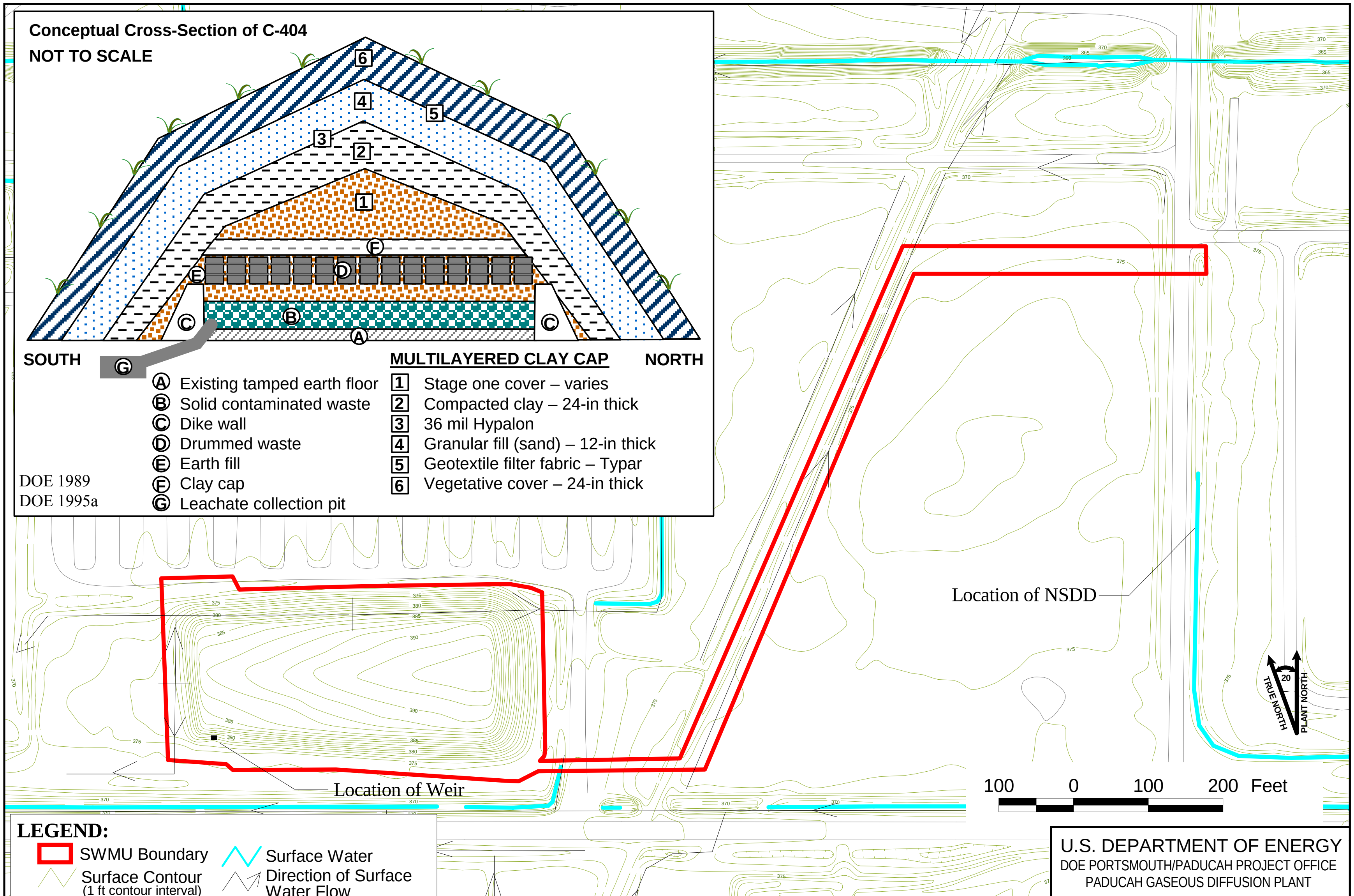

Figure 6.1. SWMU 3 Historical Layout

LATA Environmental Services of Kentucky, LLC

Figure No. \BGOU\d2-ri sect1.apr
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6.1.1 Nature and Extent of Contamination

SWMU 3 extends to the area under the cap within the former surface impoundment area that received the wastes plus the ditch adjacent to the waste unit that potentially was affected from historical releases from the SWMU.

The source area of SWMU 3 contains approximately 6,615,000 lb of uranium-contaminated waste that has been identified as PTW. No other wastes have been identified as PTW at SWMU 3. The historical record is inconclusive about whether pyrophoric uranium is present in SWMU 3. The total volume is approximately 260,000 ft^3. Some uranium-contaminated waste also may be contaminated with TCE, radionuclides, and metals. In 1986, the disposal of waste at C-404 Landfill was halted, and a portion of the disposed of waste was found to be RCRA-hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987. It currently is regulated under RCRA as a land disposal unit and compliance is monitored under a RCRA post closure permit issued in 1992. The closure plan requires continued groundwater monitoring (DOE 1989). A permit modification was submitted in May 2008, revising the MW network for the unit to add a new upgradient well, MW420 (DOE 2008). MW420 is screened in the upper RGA. The permit conditions are summarized in Appendix G.

No surface soil samples were collected from the surface of the Subtitle C cap. There were surface samples collected in the ditch. Subsurface soil samples collected from angled borings beneath the unit indicate the presence of U-238 and U-234 above background in a few locations. Uranium and uranium isotopes were not detected above background in any samples below 20 ft.

6.1.2 Risk Summary

Appendix B and Appendix C outline the potential risks posed by contaminants detected in soil that must be addressed in this FS, as developed through a review of the BHHRA and COCs, refining these as appropriate, addressing uncertainties with a review of data collected subsequent to completion of the BHHRA. The WAG 22 BHHRA evaluated risks using combined data from SWMUs 2 and 3. In addition, the BHHRA identified the COCs based on samples collected to depths of 8 ft, so these would be considered COCs for both surface and subsurface soils.

The primary threat from the SWMU is associated with the potential for risks to persons who may be exposed to waste. Although unacceptable direct contact risks were identified for industrial workers exposed to affected soils in the combined SWMU 2 and SWMU 3 BHHRA, a review of the current data shows the concentrations of these radionuclides in soils at SWMU 3 are much lower than at SWMU 2 and the unacceptable direct contact risks accrue to SWMU 2. For example, the maximum concentration of U-238 of 22.4 pCi/g corresponds to an ELCR of 1.9E-5 in a sample collected at an end depth of 10 ft. Nevertheless, the COCs that include U-235 and U-238 are retained as target compounds. Additional data collected after the BHHRA were included in a review to address uncertainties.

The BGOU RI BHHRA also identified COCs that may migrate to the RGA at levels that would limit future residential use. These were reviewed and the list refined (see Appendix B). Tc-99 was the only target chemical associated with SWMU 3 identified as needing to be addressed in this FS with a modeled concentration in RGA groundwater at the SWMU boundary exceeding the MCL.

The evaluation of sample results from the ditch is presented in Appendix D. It concludes that no PRGs need to be developed because the risk is within the acceptable range.

6.1.3 Hydrogeological Interpretation

The study area geology and hydrogeology is summarized below, as documented in the BGOU RI (DOE 2010b). Because SWMUs 2 and 3 are adjacent to each other, their hydrogeological interpretation is discussed as one.

Stratigraphy. The burial cells of SWMU 3 are constructed immediately above the HU1 loess member (silt with some clay) of the UCD. This is different from conditions at SWMU 2 where the burial cells were excavated into the HU1. Although SWMU 3 is constructed above HU`1, some waste cells in SWMU 2 likely extend to near the base of the HU1 unit, at a depth of 18.5 ft. The underlying HU2 interval consists of upper and lower sand and gravel horizons, separated by an intervening clayey silt unit, to a depth of 40 ft. A 9-ft thick silty clay interval (HU3) separates the HU2 sand and gravel horizons from the basal HU4 sand and the sands and gravels of the LCD (HU5).

UCRS Groundwater Flow and Hydraulic Potential. The SWMU 2 Data Summary and Interpretation Report (DOE 1997) documents the depth and gradient of the water table in the vicinity of SWMU 3 using measurements from shallow MWs and piezometers. Four rounds of measurements of water level during a one-week period in August 1996 consistently demonstrate that the water table occurred within 10 ft of land surface, sloping toward a ditch on the west side. The RCRA compliance monitoring for SWMU 3 indicates differing conditions at SWMU 3—gradients vary but are net northward. The depth to water is typically greater than 10 ft bgs. Because SWMU 3 is an aboveground facility with a Subtitle C cap, the actual saturation level within the waste is unknown; however, the rate of dewatering of the SWMU contents is nearly constant (from a review of leachate data) and the combined with a 10+ ft difference between the bottom of the wastes and the top of the water table indicates that the bulk of the landfill wastes are in unsaturated conditions.[6]

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

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

The northward groundwater flow beneath SWMU 3 is an intermediate flow path between the hydraulic conductivity "expressways" delineated by the Southwest Plume (to the south of SWMU 3) and the Northwest Plume (to the north of SWMU 3) and is related to seasonal variations in potentiometric head.

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[6] The continuing recovery of leachate from the facility indicates that the unit is still dewatering and that some portion of the base of the disposal cell must be saturated.

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

6.2 SWMU-SPECIFIC RAOs

RAOs that are specific to SWMU 3 were developed based on the findings and observations from the BGOU RI Report. The SWMU-specific RAOs are directed toward conditions related to the waste materials and affected soils, the surface soils, and the subsurface soils at the SWMU.

Approximately 6,615,000 lb of uranium-contaminated waste and waste in buried drums present a threat should exposure occur. The uranium is not known to be mobile; leachate is collected from the base of the unit; thus, uranium is unlikely to pose a threat to underlying soil and groundwater.

SWMU-specific RAO for protection of groundwater. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination (Tc-99) that could result in an exceedance in RGA groundwater of the MCL (or risk-based concentration for residential use of groundwater in the absence of an MCL).

SWMU-Specific RAO for protection of direct contact with waste. Prevent exposure to waste that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Waste: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for a future outdoor worker

SWMU-specific RAO for protection of direct contact with contaminated soils. Prevent exposure to contaminated soils (uranium-235 and uranium-238) that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors.[7] The acceptable cumulative risk levels for this RAO are defined as follows:

- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

SWMU-Specific RAO for PTW. Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

PRGs were developed consistent with the approach described in Section 2.

The PRGs identified for target compounds to be addressed in this FS for protection of groundwater and direct contact at SWMU 3 are listed in Table 6.1. There is no PRG for surface soil because no surface soil samples were collected from the top of the cap.

[7] No surface soil data were collected at the waste unit. The surface samples in the discharge ditch are evaluated separately in Appendix D.

Table 6.1. Soil PRGs for SWMU 3

COC	Soil PRG Protective of Groundwater (pCi/g))	Direct Contact PRG Surface Soil* (pCi/g)	Direct Contact PRG Subsurface Soil (pCi/g)
Technetium-99	38.5	N/A	N/A
Uranium-235+D	N/A	N/A	22.75
Uranium-238+D	N/A	N/A	58.5

*Surface soil samples from cap not collected.

Locations where these PRGs are exceeded are shown on figures in Appendix A (A.4, A.5, and A.6). These figures also show the discharge ditch sample areas that were evaluated in Appendix D. The risks and hazards for each sample collected subsequent to the BHHRA show no additional COCs or noncancer hazards need to be addressed in this FS.

6.3 DEVELOPMENT OF SWMU-SPECIFIC ALTERNATIVES

Section 3 developed seven general alternatives that can be used as remedial actions across the four BGOU SWMUs included in this FS. These general alternatives include multiple containment and treatment process options as an acknowledgement that each SWMU has unique characteristics and one RPO may not be applicable or effective across multiple SWMUs. The effectiveness of the containment and treatment process options are evaluated in this section against the specific needs of SWMU 3 (Table 6.2) with process options deemed most effective retained. These retained process options are then incorporated into the general alternatives to form fully developed SWMU-specific alternatives. The remaining process options are screened from further consideration.

6.3.1 Surface Cover Process Options Evaluation and Screening

Four surface cover process options are carried forward from the Section 3 evaluation for SWMU-specific evaluation. These process options include the following:

- 1-ft soil cover (a)
- 18-inch clay/6-inch soil (b)
- Subtitle C cap (c)
- Subtitle D cap (d)

All four of the covers are evaluated moderate for long-term effectiveness. All covers will prevent direct contact with surface soil. The waste related COCs identified at SWMU 3 are contained reliably by the existing Subtitle C cap system, including leachate collection. This cover controls rainwater infiltration and manages direct contact to the waste; however, there is an uncertainty associated with direct contact to the surface soil that results from a lack of recent surface soil data. This uncertainty could be addressed with a 1-ft soil cover to limit direct contact with the surface soil.

Based on this limited need, process option a (1-ft soil cover) is retained as the representative surface cover process option (in addition to the existing Subtitle C cap).

6.3.2 Treatment Technologies and Process Options Evaluation and Screening

Treatment process options t1, t2, t3, and t4 are either not applicable to the specific conditions of SWMU 3 or would not provide effective treatment of COCs or PTW at SWMU 3. The elemental uranium considered PTW at SWMU 3 cannot be treated to change its elemental nature. General alternatives that

Table 6.2. Process Option Screening for Remedial Alternatives Developed for SWMU 3

Process Option Identifier	Process Option Description	Effectiveness			Implementability		Relative Cost	
		Long-term Effectiveness	Short-term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
General Response Action—Containment Technology—Surface Barriers								
a	1-ft cover	Moderate to High for direct contact	High	Moderate to High when combined with existing features	High	High	Low	Moderate
b	18-inch clay/6-inch soil cover	Moderate to High for direct contact	High	Moderate to High when combined with existing features Moderate	High	High	Low	Moderate
c	Subtitle C cap	Moderate to High for direct contact	Moderate to High	Moderate to High	High (already implemented)	High	Low	Moderate
d	Subtitle D cap	Moderate to High for direct contact	Moderate to High	Moderate to High	Moderate to High	High	Moderate	Moderate
General Response Action—Treatment Technology—Thermal								
t1	Electrical resistance heating	There are no VOCs in sufficient quantity or concentration at SWMU 3 that would make ERH an effective treatment process option.						
Technology—Physical Chemical								
t2	Dual-phase extraction	DPE would not be effective at SWMU 3. The existing Subtitle C cap already controls rainwater infiltration. Additionally, any infiltrating moisture would be captured in the existing sump.						
Technology—Chemical								
t3	Chemical injection (ZVI)	Chemical injection (ZVI) is not applicable at SWMU 3. While ZVI would maintain reducing conditions in the SWMU, there is too much debris in the waste for an injection system to effectively distribute injectant and the PTW (elemental uranium) would remain.						
Technology—Biological								
t4	Biological treatment	Biological treatment would not be effective for the COCs at SWMU 3.						
Existing Features								
t56	SWMU 3 leachate collection system	This is an existing feature; thus, this process option is available only to SWMU 3.						

Table 6.2. Process Option Screening for Remedial Alternatives Developed for SWMU 3 (Continued)

Process Option Identifier	Process Option Description	Effectiveness			Implementability		Relative Cost	
		Long-term Effectiveness	Short-term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	O&M
Alternate Disposal								
WDF	On-site WDF	A potential on-site WDF will be used for disposal of BGOU wastes if available and if waste meets the WDF WAC.						

rely upon treatment, other than treatment of SWMU 3 leachate, will be screened from consideration and will not be developed into SWMU-specific alternatives.

Process option t5 recognizes the continued use of the existing SWMU 3 leachate collection sump and subsequent leachate treatment.

An option is to use the potential on-site WDF to dispose of materials excavated from SWMU 3. Although there is a slight improvement in the short-term effectiveness criterion, the primary impact of this option is a reduction in the cost of excavation and disposal.

6.3.3 SWMU 3 Ditch

When the C-404 impoundment was converted into a disposal facility, a sump was installed where the weir had been. Leachate was pumped from the sump through an underground transfer line. The transfer line discharged into a northeast-southwest ditch just east of C-404. From this ditch, the leachate flowed into the NSDD. The date of termination of the leachate discharge through the underground transfer line into the NSDD has not been determined. It is known that, prior to landfill closure in 1986, this underground transfer line to the NSDD was not in operation and leachate from the C-404 Landfill was being collected in the sump for treatment at the C-400-D Lime Precipitation Unit in the C-400 Facility. At some time following closure of the C-404 Landfill, treatment of leachate from C-404 at C-400 was discontinued, and treatment of the leachate was transferred to the C-752 Remedial Action Waste Holding Facility.

Shallow borings during the RI period identified above-background concentrations of COCs within the ditch area The ditch samples were evaluated in Appendix D of this FS. It concludes that no PRGs need to be developed because the risk is within the acceptable range.

6.3.4 Development of SWMU-Specific Alternatives and Screening

This section combines the general alternatives developed in Section 3 with SWMU-specific consideration for containment and treatment process options to form SWMU-specific alternatives. General alternatives that rely on process options not effective at SWMU 3 will not be developed into SWMU-specific alternatives. Those alternatives developed in this section will undergo detailed and comparative evaluation. Table 6.3 lists the SWMU-specific alternatives identified for consideration at SWMU 3.

6.3.5 Summary of Alternatives Retained for Detailed Analysis

The alternatives listed in Table 6.3 are carried forward for detailed analysis at SWMU 3. These alternatives are adapted from the general list of alternatives developed in Section 3 to meet SWMU-specific requirements. Alternative 1 (no action) is not effective, but it is retained for further consideration in the detailed analysis as a baseline alternative to which all other alternatives are compared, as required by CERCLA. All other alternatives are found to be protective of human health and the environment; thus, they will be considered for detailed and comparative evaluation.

6.3.5.1 Alternative 1: No Action

Alternative 1 recognizes that there is a Subtitle C cap present on SWMU 3 and that leachate currently is collected from a leachate collection sump and treated as needed prior to discharge/disposal. Direct contact to buried waste and associated soils is controlled by existing plant controls maintained outside of CERCLA; however, this alternative has no provisions to ensure that these controls or elements will be maintained. Thus, this alternative does not meet the threshold criterion of protection of human health and the environment. Effectiveness for this alternative is considered low. Short-term effectiveness is high

Table 6.3. SWMU-Specific Remedial Alternative for SWMU 3

Alternative	Name	Key Features
1	No Action	· No action
2.t5	Limited Action (LUCs and Monitoring) with Existing Feature	· LUCs · Monitoring · Recognizes existing Subtitle C cap, leachate collection, and treatment
3.a.t5	Soil Cover, LUCs, and Monitoring with Existing Feature	· Additional 1 ft clean soil cover · LUCs · Monitoring · Recognizes existing Subtitle C cap, leachate collection, and treatment
5	Excavation and Disposal	· Excavation of buried waste materials and affected soils to 1 ft below the original holding pond bottom elevation · Treatment or disposal of residual groundwater, as indicated by sampling · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transportation of waste materials and affected soils to disposal facility (on-site or off-site, as available and deemed appropriate) · Backfill of excavated areas with clean soil
5.WDF	Excavation and Disposal at On-site WDF	· Same activities as Alternative 5 with exception of disposal pathway

because there are no current risks associated with the no action alternative; however, Alternative 1 is rated low in long-term effectiveness and permanence. The rating for implementability is high and the cost is low due to no remedial measures being initiated.

6.3.5.2 Alternative 2.t5: Limited Action (LUCs and Monitoring) with Existing Feature

Alternative 2.t5 recognizes that there is a Subtitle C cap present on SWMU 3 and that leachate currently is collected from a leachate collection sump and properly treated. Direct contact to waste and associated soils currently is controlled by existing plant controls maintained outside of CERCLA. In order to maintain protectiveness, LUCs will have to be implemented to limit exposure to wastes and COCs remaining in the SWMU once the current plant controls no longer are in effect. Overall effectiveness of this alternative is high, but long-term effectiveness is moderate to high since waste is left in place. Implementability also is considered high. Overall costs are considered low; thus, the cost rating is high. Capital and O&M costs are mainly associated with development of a LUCIP and monitoring.

6.3.5.3 Alternative 3.a.t5: Surface Cover, LUCs, and Monitoring with Existing Feature

Alternative 3.a.t5 is the same as Alternative 2, except it augments the existing cover with additional soil cover to address the uncertainty associated with direct contact risk with surface soils. LUCs are required to ensure that the surface cover is not breached and that direct contact with buried soils and wastes is prevented. It offers high short-term effectiveness, but recognizes small short-term risks to site workers during augmentation of the existing Subtitle C cap. Long-term effectiveness is moderate to high for Alternative 3 because contaminants remain in place, but reliably contained. Implementability is high under this alternative, as there are no physical impediments to implementing the remedy. Overall costs are considered low (high cost rating).

6.3.5.4 Alternative 5: Excavation and Disposal

Alternative 5, excavation, would remove the existing cover, wastes, and associated soil to 1 ft below the original holding pond bottom elevation. These wastes would be disposed of either on-site or off-site with waste and soil receiving treatment on-site or off-site, as necessary, (as defined in the RAWP) to meet the WAC of the receiving facility. This alternative will include a contingent excavation of an additional 1ft to address any residual nonmobile COCs. Excavation and disposal is moderate to high in overall effectiveness. Short-term effectiveness is the lowest of the SWMU 3 alternatives because site workers have increased potential risk associated with excavation; however, this is balanced by the highest long-term effectiveness and permanence of the alternatives because PTW and COCs would be removed. Overall implementability is moderate mostly for reasons associated with technical and administrative challenges associated with excavation and disposition of wastes. Capital costs are high; thus, the cost ranking is low, but this is balanced by lower O&M costs that are lower than those for other alternatives.

6.3.5.5 Alternative 5.WDF: Excavation and Disposal, WDF

Alternative 5.WDF is identical to Alternative 5, except that it recognizes the potential for an on-site WDF. Wastes meeting the WAC of the potential WDF would be disposed of there. Wastes requiring treatment prior to disposal would be treated on-site or off-site, as necessary, and transported to the WDF for disposal.

The short-term effectiveness of Alternative 5.WDF is improved over Alternative 5 because of reduced risk to the public associated with reduced truck traffic leaving the PGDP. Decreased disposal costs improve the cost rating; however, the overall cost remains high (and the cost rating low).

6.3.6 General Alternatives Eliminated from Detailed Analysis for SWMU 3 Source Areas

As stated in Section 6.3.2, general alternatives that rely upon treatment (e.g., t1, t2, t3, and t4) are not effective to address the specific issues at SWMU 3 because the buried uranium cannot be treated effectively to eliminate its inherent hazards (radioactivity and toxicity). Therefore, those general alternatives that rely upon treatment are screened from further consideration at SWMU 3, and no SWMU-specific alternatives are developed for those general alternatives.

Table 6.4 summarizes the results of alternative effectiveness screening and SWMU-specific alternative development for SWMU 3. Alternatives that were screened out at this step are shaded grey on the table.

6.3.6.1 Alternative 4—Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring

There are no treatments that are effective in addressing uranium. Because these treatments are not effective at SWMU 3, this general alternative is not developed into a SWMU-specific alternative.

6.3.6.2 Alternative 6—Targeted Excavation and Disposal, Surface Cover, LUCs, and Monitoring

As indicated for Alternative 4, there are no treatments that are effective in addressing uranium. Targeted excavation is not considered because there are no identified areas of the SWMU that are hot spots whose

Table 6.4. SWMU-Specific Remedial Alternative Screening Summary for SWMU 3

	1	2.t5	3.a.t5	4	5	5.WDF	6	7
Screening Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal**	**Excavation and Disposal, WDF**	**Targeted Excavation and Disposal, Surface Cover, LUCs, Monitoring**	**Targeted Excavation and Disposal, Surface Cover, *In Situ* Source Treatment, LUCs, and Monitoring**
Overall Effectiveness	Low	High	High	N/A	Moderate to High	Moderate to High	N/A	N/A
Short-term	High	High	High	N/A	Moderate	Moderate	N/A	N/A
Long-term	Low	Moderate to High	Moderate to High	N/A	High	High	N/A	N/A
Overall Implementability	High	High	High	N/A	Moderate to High	Moderate to High	N/A	N/A
Technical	High	High	High	N/A	Moderate to High	Moderate to High	N/A	N/A
Administrative	High	High	High	N/A	High	High	N/A	N/A
Overall Cost	Low	Low	Low	N/A	High	High	N/A	N/A
Capital	Low	Low	Low	N/A	High	High	N/A	N/A
Operation and Maintenance	Low	Low	Low	N/A	None	None	N/A	N/A

N/A = Not applicable based on-site conditions or nature of contamination present at the SWMU.
Alternatives shaded gray were screened out at this step.

removal would substantially decrease the amount of residual risk or eliminate the need for some LUCs. Because these remedies are not effective at SWMU 3, this general alternative is not developed into a SWMU-specific alternative.

6.3.6.3 Alternative 7—Targeted Excavation and Disposal, Surface Cover, *In Situ* Treatment, LUCs, and Monitoring

As indicated for Alternative 6, there are no treatments that are effective in addressing uranium. Targeted excavation is not considered because there are no identified areas of the SWMU that are hot spots whose removal would substantially decrease the amount of residual risk or eliminate the need for some LUCs. Because these remedies are not effective at SWMU 3, this general alternative is not developed into a SWMU-specific alternative.

6.4 DETAILED ANALYSIS OF ALTERNATIVES

6.4.1 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. A Subtitle C cap and a leachate collection system are in place at SWMU 3, which is a closed unit under the jurisdiction of the Kentucky RCRA program. Under this alternative, SWMU 3 will continue to be monitored and managed in accordance with the requirements of the RCRA permit. A summary of the current postclosure care requirements of the RCRA permit are summarized in Appendix G.

Alternative 1 acknowledges the existence of a Subtitle C cap at SWMU 3 and current permit conditions.

6.4.1.1 Threshold criteria

6.4.1.1.1 Overall protection of human health and the environment

This alternative is not protective of human health and the environment because this alternative has no element that would extend controls or containment as long as waste is in place. Waste (including PTW) is not treated or removed at SWMU 3, but a cover is in place to control access to the waste and soils in close proximity to the waste. No additional controls would be implemented to protect site workers or the public. This alternative includes no elements to extend controls beyond the RCRA-designated period or the DOE control period.

No ecological impacts at the BGOU are anticipated under this alternative (or any other alternative at SWMU 3). The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative.

6.4.1.1.2 Compliance with ARARs

There are no actions for Alternative 1; thus, there are no action-specific ARARs.

6.4.1.2 Balancing criteria

6.4.1.2.1 Long-term effectiveness and permanence

Existing site controls prevent exposure to the waste and underlying groundwater. The potential for leaching of contaminants to the RGA currently is reduced or prevented by the existing Subtitle C cap, compacted soil liner, and leachate collection system. This alternative does not provide any long-term controls to manage residual risk at this SWMU; thus, it has low long-term effectiveness and permanence.

6.4.1.2.2 Reduction of toxicity, mobility, or volume through treatment

This alternative does reduce toxicity, mobility, or volume through treatment to a small degree associated with leachate that currently is collected and treated.

6.4.1.2.3 Short-term effectiveness

No actions would be implemented under Alternative 1; therefore, no additional risks to workers, the public, or the environment would be incurred. The existing elements cause Alternative 1 to be effective in the short-term.

6.4.1.2.4 Implementability

The No Action alternative is implementable. If future monitoring in accordance with the post-closure permit indicates that additional remedial action is necessary, this alternative would not impede implementation of other remedial activities in the future.

The ongoing public awareness program would require regular coordination with the DOE, KY, and EPA.

6.4.1.2.5 Cost

The preliminary cost estimates for Alternative 1 serve as a baseline for comparison of the other remedial alternatives. These cost estimates are based upon FS-level scoping and are intended to aid with selection of a preferred alternative. There are no capital or O&M costs associated with Alternative 1; thus, the cost rating is high.

6.4.2 Alternative 2.t5—Limited Action (LUCs and Monitoring) with Existing Feature

Alternative 2.t5 includes LUCs extending the protectiveness of existing features indefinitely and monitoring to ensure that the alternative remains protective. The LUCs and monitoring will be outlined in the RAWP. Alternative 2.t5 includes the existing Subtitle C cap and the leachate collection and treatment system.

6.4.2.1 Threshold criteria

6.4.2.1.1 Overall protection of human health and the environment

Alternative 2.t5 is protective of human health and the environment due to the existing Subtitle C cap and leachate collection and treatment system combined with existing plant controls that are extended indefinitely with LUCs (see Section 2.4.1.1).

6.4.2.1.2 Compliance with ARARs

Alternative 2.t5 is compliant with ARARs and does not have any action-specific ARARs.

6.4.2.2 Balancing criteria

6.4.2.2.1 Long-term effectiveness and permanence

Alternative 2.t5 is effective long-term because the protectiveness of existing features and existing plant controls are extended indefinitely.

6.4.2.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 2.t5 has some reduction of toxicity, mobility, or volume through treatment due to the small amount of treatment associated with the leachate collection and treatment system.

6.4.2.2.3 Short-term effectiveness

Alternative 2.t5 would not present any additional risks to the community. There are slight incremental risks to site workers during the construction, development, and sampling of MWs that would be managed through the implementation of HASPs.

6.4.2.2.4 Implementability

Alternative 2.t5 is implementable. There are slight administrative implementability issues in migrating management of SWMU 3 (C-404) from RCRA to CERCLA.

6.4.2.2.5 Cost

The monitoring and O&M costs incurred under Alternative 2.t5 would be low; thus, the cost ranking is high.

6.4.3 Alternative 3.a.t5—Surface Cover, LUCs, and Monitoring with Existing Feature

Alternative 3.a.t5 is the same as Alternative 2.t5, except that it augments the existing Subtitle C cap with additional soil cover to address the uncertainty associated with the existing cover; thus, it mitigates direct contact risk with surface soils on the existing Subtitle C cap.

Alternative 3.a.t5 provides marginally more protection to potentially affected surface soil than Alternative 2.t5 and addresses residual uncertainty associated with the quality of the surface soil on the cap.

6.4.3.1 Threshold criteria

6.4.3.1.1 Overall protection of human health and the environment

This alternative is protective of human health and the environment through a combination of containment and LUCs. The waste is reliably contained and leachate is collected and treated. The existing Subtitle C cap, existing site controls, and plant controls/LUCs prevent direct contact with the waste while an additional soil cover increases protection against the uncertainty of direct contact with the surface soil.

6.4.3.1.2 Compliance with ARARs

Alternative 3.a.t5 is compliant with ARARs. There are no additional action-specific ARARs associated with Alternative 3.a.t5.

6.4.3.2 Balancing criteria

6.4.3.2.1 Long-term effectiveness and permanence

Alternative 3.a.t5 would have long-term effectiveness and permanence comparable to that for Alternative 2.t5.

6.4.3.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternative 3.a.t5 has comparable reduction of toxicity, mobility, or volume through treatment to Alternative 2.t5.

6.4.3.2.3 Short-term effectiveness

Alternative 3.a.t5 would not present any additional risks to the community. Risks to site workers during installation of the soil cover, development, and sampling of MWs would be managed through the implementation of HASPs. Short-term effectiveness for this alternative is comparable to Alternative 2.t5.

6.4.3.2.4 Implementability

Alternative 3.a.t5 is implementable. There are slight administrative implementability issues in migrating management of SWMU 3 (C-404) from RCRA to CERCLA.

6.4.3.2.5 Cost

Modification of the existing Subtitle C cap and long-term monitoring and O&M costs incurred under Alternative 3.a.t5 would be low; thus, the cost ranking is high.

6.4.4 Alternatives 5 and 5.WDF—Excavation and Disposal (with on-site or potential WDF disposal)

Alternatives 5 and 5.WDF are identical other than waste disposal pathways. Alternative 5 anticipates waste disposal using existing pathways (commercial or federally owned) while Alternative 5.WDF anticipates waste disposal at a potential on-site WDF. Both alternatives include the following tasks: removal of the Subtitle C cap, excavation of buried materials and contaminated soils; waste disposal characterization sampling; waste packaging, on-site or off-site waste treatment, as needed, transporting and disposing of wastes; and site restoration. These tasks are described in detail in Section 3.

Based on the original C-404 design drawings, the floor of the original impoundment was at elevation 373 ft. For estimating purposes, a 1 ft over-excavation is assumed. For estimating purposes, it is assumed that all soils above elevation 372 will be removed with a contingency included to remove one additional ft of soil (to elevation 371).

Excavation and disposal of waste materials and affected soils for Alternatives 5 and 5.WDF are based on removal of the entire area of SWMU 3 (137 ft x 387 ft) to a depth of approximately 4 ft below pond bottom. This excavation will generate approximately 28,000 yd^3 (loose) of contaminated waste materials. The LLW/MLLW (20,000 yd^3) would be disposed of off-site at a licensed commercial or federal facility or a potential on-site WDF, if available. The remaining soil volume would be disposed of at PGDP on-site C-746 U Landfill (7,000 yd^3).

Additional assumptions for excavation, transportation, disposal, treatment, excavation dewatering, etc., for SWMU 3 can be found in Appendix E. Excavation would remove waste materials and affected soils to comply with PRGs. This alternative provides the best long-term protection and also best addresses uncertainties associated with wastes disposed of within SWMU 3.

Any depression left as a result of excavation will be restored, as detailed in the RAWP, and will be consistent with future site use. This may include regrading the area to drain, backfilling to existing grades, or maintaining the depression as a detention basin or potential wetland area.

6.4.4.1 Threshold criteria

6.4.4.1.1 Overall protection of human health and the environment

Alternatives 5 and 5.WDF meet this threshold criterion. Potential short-term risks to remediation workers due to direct contact with the waste material and affected soils and inhalation hazards are much larger than any of the other alternatives. In addition, potential risks to the public and the environment as a result of potential shipping and handling concerns are associated with off-site shipments. These concerns are reduced for disposal in a potential on-site WDF.

Waste and contaminated soil will be removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting RAOs for waste and associated soils in SWMU 3.

6.4.4.1.2 Compliance with ARARs

Alternatives 5 and 5.WDF meet this threshold criterion. ARARs for this alternative are summarized in Appendix F.

6.4.4.2 Balancing criteria

6.4.4.2.1 Long-term effectiveness and permanence

Excavation of the contents of the SWMU offers the best long-term effectiveness and permanence. Treatment processes supplement this action to remove the COCs from the SWMU.

Risks associated with direct contact with waste and surface soils will be eliminated since the source and associated contaminated soils will be removed. Alternatives 5 and 5.WDF best address uncertainties associated with wastes and soils in terms of minimizing contributions to the hydrogeological system or residual site risk. Long-term effectiveness and permanence is rated high.

6.4.4.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives reduce the toxicity and volume of COCs remaining at SWMU 3 (though not through treatment). The reduction of toxicity, mobility, or volume through treatment rating is moderate.

6.4.4.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU are expected to be minimal. Alternative 5, however, includes some risk to the public from transportation of the LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities. This risk is reduced in Alternative 5.WDF by disposing of waste in a potential on-site WDF.

Short-term exposures of workers to COCs could occur during implementation of both Alternatives 5 and 5.WDF. Potential exposure pathways include direct contact with soil (ingestion, inhalation) and exposure to external penetrating radiation. Worker risks are not expected to exceed acceptable limits because exposure frequency and duration are less than those evaluated in the baseline risk assessment and will be subject to health and safety protocols. To protect workers, PPE, ambient conditions monitoring, and decontamination protocols would be used in accordance with an approved, site-specific HASP. Short-term effectiveness is moderate for Alternatives 5 and 5.WDF.

6.4.4.2.4 Implementability

Alternatives 5 and 5.WDF are 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. The implementability of construction-related activities during excavation and backfilling at SWMU 3 subject to Alternatives 5 and 5.WDF is very similar to that carried out routinely at other sites, so it is considered high. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely. Excavated waste materials and affected soils may be LLW, RCRA hazardous, or mixed wastes. Treatment of wastes with multiple regulatory classifications is more complex and may require more than one treatment process. Wastes requiring treatment prior to disposal will be treated on-site or off-site in accordance with the to-be-developed RAWP. On-site treatment processes to manage incidental rainwater that has come in contact with waste or impacted soil will comply with ARARs.

An option for disposal of waste and residuals at a potential on-site WDF was considered under Alternative 5.WDF. The primary difference is the elimination of waste leaving the PGDP, related off-site transportation issues, and the cost for disposal. At this time, no capacity exists at PGDP for disposal of these wastes.

6.4.4.2.5 Cost

Alternative 5 costs are estimated assuming transportation, treatment, and disposal of wastes at an off-site facility. Alternative 5.WDF costs are estimated assuming off-site treatment of some wastes, but all wastes being disposed of on-site, including the use of a potential on-site WDF. Excavation and disposal costs are high; thus, the cost ranking is low.

O&M costs are expected to be low upon successful clean closure of SWMU 3 because no monitoring program would be necessary.

6.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis summary for source area alternatives for SWMU 3 is presented in Table 6.5.

6.5.1 Threshold Criteria

Source area remedial alternatives are compared with respect to the threshold criteria in the following sections.

6.5.1.1 Overall protection of human health and the environment

Alternative 1 does not meet the threshold criterion of overall protection of human health and the environment. It does not ensure that the existing site controls maintained outside of CERCLA that currently prevent contact with the buried waste will continue indefinitely.

All other alternatives retained for detailed evaluation meet the threshold criterion of overall protection of human health and the environment.

Alternatives 1, 2.t5, and 3a.t5 would not treat or remove waste other than what currently is being accomplished through leachate treatment. Alternative 3.a.t5 also addresses the uncertainty of direct contact with existing surface soil by placing a 1ft cover over the exiting surface.

The short-term risks associated with excavation under Alternatives 5 and 5.WDF can be mitigated by proper administrative, engineering, and physical controls in achieving long-term risk reduction, but those risks still remain.

Only Alternatives 5 and 5.WDF address PTW through treatment or removal.

6.5.1.2 Compliance with ARARs

ARARs are not applicable to Alternative 1 as no action takes place. Alternatives 2.t5, 3.a.t5, 5, and 5.WDF will meet ARARs through design and planning during preparation of the RAWP.

6.5.2 Balancing Criteria

Source area alternatives are compared with respect to the balancing criteria in the following sections.

6.5.2.1 Long-term effectiveness and permanence

The long-term effectiveness of Alternatives 2.t5 and 3.a.t5 are comparable and implemented though the existing Subtitle C cap, and LUCs. Alternatives 5 and 5.WDF provide the highest degree of long-term effectiveness and permanence by removing the waste and affected soil above target concentrations from the site and treating as necessary to meet the WAC of a disposal facility.

6.5.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternatives 2.t5 and 3.a.t5 do not significantly reduce the toxicity, mobility, or volume through treatment of COCs in waste or soil at SWMU 3 (other than the continued treatment of leachate). These rate low on this criterion.

Alternatives 5 and 5.WDF reduce toxicity and volume at the SWMU (but not through treatment because the PTW moiety [uranium] cannot be treated or destroyed). These alternatives rate moderate on this criterion.

6.5.2.3 Short-term effectiveness

The short-term effectiveness of Alternative 2.t5 and 3.a.t5 is high because the existing feature (Subtitle C cap and leachate treatment) is protective without any additional actions (or risk) to site workers or the community.

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Table 6.5. Summary of Comparative Analysis of Source Area Alternatives for SWMU 3

	Alternative 1	Alternative 2.t5	Alternative 3.a.t5	Alternative 5	Alternative 5.WDF
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal**	**Excavation and Disposal, WDF**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness	Low (0)	Moderate to High (7)	Moderate to High (7)	High (9)	High (9)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low to Moderate (2)	Low to Moderate (2)	Low to Moderate (2)	Moderate (4)	Moderate (4)
Short-Term Effectiveness	Moderate (4)	Moderate to High (7)	Moderate to High (7)	Moderate (5)	Moderate to High (6)
Implementability	High (9)	High (9)	High (9)	Moderate to High (6)	Moderate to High (6)
Cost * Present Worth Cost	High (9) $0	High (9) $3,538,000	High (9) $4,212,000	Low (0) $138,694,000	Low (1) $43,018,000
Average Balancing Criteria Rating	4.8	6.8	6.8	4.8	5.2

*High overall cost rating corresponds to a low project cost relative to the site.
t5 = Alternatives 2 and 3 include impact of existing feature, Subtitle C cap and leachate collection and treatment system.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

Alternative 3.a.t5 poses only minor incremental risk to site workers to augment the cover. The short-term effectiveness of Alternatives 5 and 5.WDF are considered moderate due to risks to remediation workers during excavation activities. Disposal at a potential on-site WDF (Alternative 5.WDF) results in somewhat higher overall short-term effectiveness by eliminating risks associated with over-the-road transportation to a disposal facility.

6.5.2.4 Implementability

Alternatives 1 and 2.t5 both would be readily implementable because no construction or invasive action would be taken.

Implementation of Alternative 3.a.t5 is also readily implementable using standard design and construction techniques.

Alternatives 5 and 5.WDF are considered to be technically and administratively implementable, but do not rate as highly on overall implementability as Alternatives 1, 2.t5, and 3.a.t5 because of the associated construction and soil management activities.

6.5.2.5 Cost

Capital and O&M costs for alternatives at SWMU 3 are presented in Appendix E. Costs were estimated for transportation and disposal of wastes at an off-site facility as well as for an option to dispose of waste at a potential on-site WDF. Costs for Alternatives 1, 2.t5, and 3.t5 are low; thus, the cost rating is high. Costs for Alternatives 5 and 5.WDF are high; thus, the cost rating is low.

6.5.3 Summary of Comparative Analysis of Alternatives

SWMU 3 is a closed landfill under the jurisdiction of the Kentucky RCRA program. The existing Subtitle C cap at SWMU 3 already provides protection to site workers, reliably contains the waste in the SWMU, and minimizes migration of contamination by means of infiltration control and a leachate collection system.

Alternative 3.a.t5 includes the features of Alternative 2.t5, but augments the existing cover with additional soil to mitigate uncertainties associates with the current surface soil. This slightly raises the cost, but also raises the long-term effectiveness.

Alternative 5 scores best on long-term effectiveness and permanence, but the large additional costs may not be justified because the wastes buried in SWMU 3 are not highly mobile and already are reliably contained.

Alternative 5.WDF scores as well as Alternative 5 on long-term effectiveness and permanence. It scores better than Alternative 5 due to the reduced cost and reduced risk associated with over-the-road waste transportation; however, its implementability is subject to the construction of the on-site WDF. Even with the somewhat reduced cost, the large additional cost may not be justified because the wastes are not highly mobile and already are reliably contained.

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7. SWMU 7

7.1 SWMU 7 HISTORY AND BACKGROUND

Previous sections of this document present a framework that collects sitewide information and uses it to formulate a general approach to developing alternatives to address the COCs present in the BGOU SWMUs. This framework also discusses key elements of the alternatives that are used as the basis for technology screening and development of SWMU-specific alternatives. This section (Section 7) of the document develops the candidate alternatives for SWMU 7 by expanding the general alternatives to address SWMU-specific conditions.

The C-747-A area is located in the northwest corner of PGDP secured area. SWMU 7 comprises the eastern two-thirds of C-747-A. The SWMU is bounded on the north and south sides by perimeter ditches, on the west side by the C-747-A Burn Area (SWMU 30), and on the east side by the C-746-E Contaminated Scrap Yard. SWMU 7 covers approximately 240,900 ft^2 and includes six discrete burial pit areas described below and illustrated in Figure 7.1 (DOE 1998b).

- Pit B—This pit is approximately 60 by 172 ft. According to the Phase II SI geophysical survey, the actual excavation extends beyond the designated boundaries and may connect with the adjacent burial pit (Pit C). A geophysical survey conducted for the BGOU RI interprets B and C as separate pits.

- Pit C—This pit is approximately the same size as Pit B. Based on the Phase II geophysical survey, Pit C and Pit B may be one continuous pit; however, a geophysical survey conducted for this RI interprets B and C as separate pits.

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

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

- Pits F1–F5—These pits are all small (average size of each pit is approximately 20 by 80 ft). Engineering drawings indicate a sixth "F" pit that was not labeled, which is nevertheless included with the F pits.

- Pit G—This pit was determined to be approximately 27 by 122 ft.

Records indicate the burial cells, in general, were excavated to a depth of 6 to 7 ft bgs, filled with wastes, and covered with approximately 3 ft of earth (Union Carbide 1978); however, geophysical surveys during the Phase II SI indicated waste in pits to a depth of 8–15 ft (CH2M HILL 1992).

In addition to the burial cells, storage areas were located within portions of SWMU 7 that were sampled as part of the Soils Operable Unit.

The C-747-A UF_4 Drum Yard (SWMU 12) was used between 1978 and 2000, for the storage of emptied, rinsed, and crushed drums that had contained UF_4. The stockpile of radiologically contaminated scrap drums, locally known as Drum Mountain, formerly was located on the southeast corner covering Pit G, which was reported to contain noncombustible, contaminated, and uncontaminated trash and equipment of the SWMU 7 burial grounds. Interviews with a former operator who worked in the SWMU 7 area indicate Drum Mountain was created only after the area between the F Pits and Pit G had been filled with similar material. This interview was corroborated by geophysical evidence.

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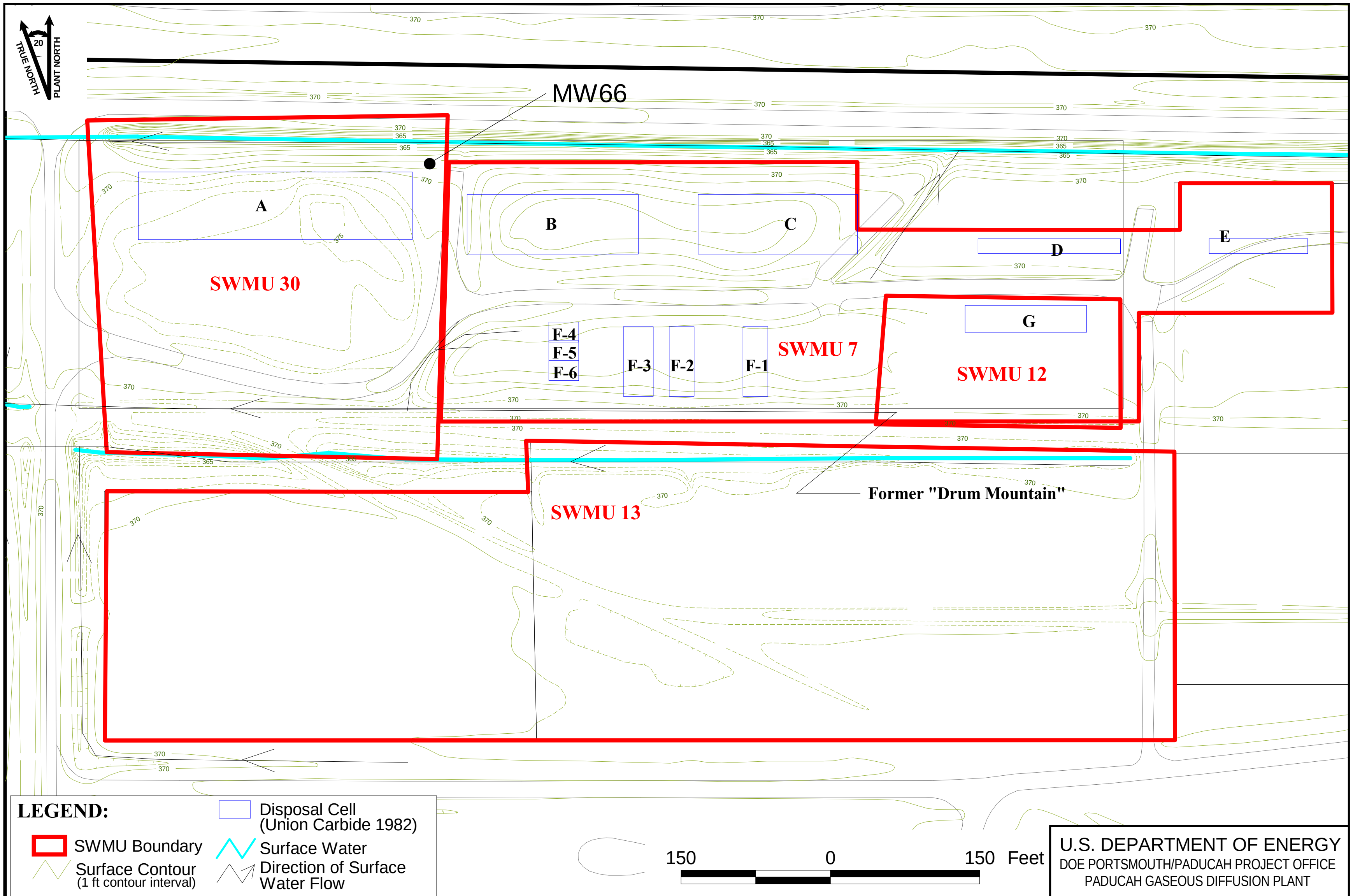

Figure 7.1. SWMUs 7 and 30 Historical Layout

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The C-746-E Contaminated Scrap Yard (SWMU 14) was used for the storage of uranium-contaminated scrap metal, including ferrous alloys, copper and copper alloys, nickel-plated steel, Monel®, and aluminum from the 1950s through 2005. A portion of SWMU 14 was located above Burial Pit E. The aboveground material from these storage yards has been removed.

The additional surface and subsurface soil data collected within the boundaries of SWMU 7 as part of the Soils Operable Unit are incorporated into the decision process for this BGOU FS. The land surface slopes within SWMU 7. Burial Pits B and C form a slight hill on the north side of SWMU 7 and Burial Pit F forms a lesser mound on the south side of the SWMU. Pit D underlies a level area north of where Drum Mountain once was located. Shallow drainage swales occur on the west side of Burial Pit B, between Burial Pits C and D. The surface water that drains from SWMU 7 into the surrounding ditches is ultimately carried west through Outfall 001 into Bayou Creek. In 2002, a sedimentation basin was constructed to contain runoff from PGDP scrap yards. Runoff flows into the sedimentation basin and is released periodically into Outfall 001. The ground surface of the west half of the SWMU is covered by grassy vegetation, except where gravel roads extend through the site. A PGDP scrap metal project covered the west half of the SWMU, with 1 to 2 ft of gravel as a working base for truck and tractor traffic. This gravel also prevents exposure to soil contaminated from the historical use of the area to store scrap in the former Drum Mountain.

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

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

- Pit B—Buried material includes noncombustible trash and contaminated and noncombustible material and equipment (however, no specific disposal records exist).

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

- Pit D—Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases from C-410 used during the fluorination process of UF_4 to UF_6.

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

- Pits F1–F5—Documented buried material consists of uranium-contaminated scrap metal and equipment and empty uranium and magnesium powder drums (engineering drawings indicate there was a sixth "F" pit that was not numbered).

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

In addition to these burial cells, the Phase II SI geophysical investigation also identified another anomaly in the shape of a rough circular area (15-ft diameter) between SWMU 30 and SWMU 7, west of the F4 and F5 Pits. There is no information confirming the presence or the nature of any buried wastes associated with this anomaly. NOTE: a second circular geophysical anomaly located in SWMU 30, approximately 43 ft in diameter is interpreted to be the foundation and remnants of the incinerator.

7.1.1 Nature and Extent of Contamination

Sources of contamination at SWMU 7 are known to include uranium and various metals. TCE (including degradation products) present in UCRS as DNAPL and/or high concentration TCE residual soil contamination is identified as PTW. Excavation of test pits and analysis of drummed wastes at the TP-3 and TP-5 areas during the 1992 site investigation identified no PTW. NOTE: the test pit investigation was designed to evaluate whether the geophysical anomalies that indicated buried metal have buried wastes rather than the empty drums reported to have been disposed. No buried drummed waste was found. No other sources of PTW have been identified for SWMU 7.

Buried Waste. Buried drums of waste were removed from a shallow test pit excavated in SWMU 7 during the Phase II Site Investigation in 1991. Analyses of samples of the drummed waste and surrounding soils collected from Test Pit 5 (TP-5) at depths of less than 5 ft indicated the following: (1) contaminants present in TP-5 samples also were detected in subsurface soil samples collected elsewhere in SWMU 7; (2) concentrations detected in TP-5 samples were generally below screening levels (background and NALs); and (3) elevated concentrations of U-235 and U-238 were detected in TP-5 samples, at similar concentrations to those detected in other SWMU 7 subsurface soil samples. TCE was not detected in the TP-5 samples. The data are consistent with the reported nature of the waste as empty drums. The nature and extent of the TP-3 and TP-5 contents is apparently similar to the waste and subsurface soil contamination found elsewhere in SWMU 7 and can be addressed using the same alternatives. These areas were not found to contain PTW.

This discussion of nature and extent is focused on chemicals of concern at SWMU 7. The target compounds were identified based on the results of the BHHRA, and a comprehensive review of all data collected subsequent to completion of the risk assessment. The collected data were evaluated, as discussed in Appendix C, to confirm consistency with conclusions of the BHHRA in identifying the appropriate COCs and refining that list as appropriate. Appendix A contains figures that show concentrations of chemicals of interest that exceed the PRGs identified for SWMU 7 in Section 2.2.3. For direct contact pathways, surface soil impacts are shown in Figure A.7 and subsurface (1–20 ft) in A.8. Figure A.9 highlights locations where soils have levels of contaminants that may potentially migrate and impact RGA groundwater. The presence and distribution of these target compounds are discussed in this section.

Radionuclides. Soil results confirm that uranium isotopes are widely present across the site at depths from 0–20 ft and are at background levels at depths greater than 20 ft. Other radionuclides of concern for direct contact exposures are less frequently present.

Tc-99 was identified as being present in RGA groundwater in a well at the SWMU boundary with a concentration of 909 pCi/L, slightly exceeding the MCL. However, it is unclear how much of the Tc-99 has SWMU 7 as its source because Tc-99 concentrations in the RGA upgradient of SWMU 7 exceed the MCL. There were 6 locations where Tc-99 concentrations in soil exceeded screening values for protection of groundwater; however, all of these samples were taken from surface soil locations collected from the adjacent drainageway. Thus, the source of the Tc-99 is not likely the result of migration from SWMU 7. By comparison, Tc-99 was detected slightly above background in only 1 of 36 samples at depths greater than 20 ft (at a concentration of 2.97 pCi/g compared to the background of 2.8 pCi/g). Tc-99 was detected in RGA wells; but the majority (if not all) of the RGA impacts are attributed to the Northwest Plume, which passes beneath SWMU 7.

Metals. Although metals were potentially associated with the source materials, most were found at below background or risk-based-screening levels. Uranium isotopes are present at levels consistent with the presence of uranium. Uranium contributes to the noncancer hazard and is retained as a target compound.

Arsenic was found at background concentrations in the BGOU data included in the RI; however, arsenic was detected at somewhat higher concentrations in selected samples collected for the Soils OU. Arsenic was retained as a COC for SWMU 7 based on results of elevated concentrations in samples analyzed by SW846-6020. Other Soils OU samples were analyzed using X-ray fluoroscopy (XRF), which appeared to reliably identify whether concentrations were above or below a threshold value of 12 mg/kg—the surface background concentration. NOTE: XRF results showed a high percentage of false positive and negatives when comparing the results to a lower threshold value (e.g., like the subsurface background of 7.9 mg/kg). Although all data are shown on Figures A.8 and A.9, XRF concentrations reported below 12 mg/kg are considered uncertain and likely below background.

Total PAH compounds were detected infrequently and present above the PRG only at locations with uranium isotopes also present above their PRGs.

Three VOCs (TCE, vinyl chloride, and 1,1-DCE) were identified as target compounds in subsurface soil due to their potential impacts to groundwater. Modeling completed in the RI estimated each of these could migrate to the RGA at concentrations that would cause them to exceed their MCLs in RGA groundwater at the SWMU boundary. The TCE anaerobic biodegradation product, *cis*-1,2-DCE, also was frequently detected but not predicted to exceed MCLs in the RGA; however, its presence and concentrations confirm biodegradation is occurring in the UCRS. TCE and its reductive dechlorination products, *cis*-1,2-DCE and vinyl chloride, were the most frequently detected organic contaminants in UCRS groundwater samples.

VOCs also were detected in the RGA groundwater with TCE the dominant compound. VOCs in the RGA largely are attributed to the Northwest Plume; however, a TCE DNAPL/soil source has been presumed potentially to exist near Pit B. The analyses of groundwater samples from MW66 (an upper RGA well located between Burial Pits A and B of SWMUs 30 and 7, respectively) reveal intermittent abrupt rises in concentration ("spikes") of dissolved TCE that correlate to periods of higher hydraulic head. TCE spikes exceeded 10,000 μg/L through 2002; one explanation of these concentrations is that they may be associated with the presence of DNAPL coming from SWMU 7. Alternatively, they may be sourced from DNAPL from C-400. Since 2002, the spikes have continued but concentrations have remained below 10,000 μg/L. The DNAPL source postulated in the SWMUs 7 and 30 RI report (DOE 1998a) was investigated and not found in soil samples or in test pit samples. Thus, although several investigations have occurred, the presence of TCE DNAPL or high soil TCE concentrations within SWMU 7 has not been confirmed. The presence of TCE in MW66 is not accompanied by detections of vinyl chloride, 1,1-DCE, or 1,2-DCE, the fingerprint of constituents with some potential to be sourced in SWMU 7. It appears that the majority (if not all) of the measurable TCE in MW66 is coming from upgradient sources. The average concentration in MW-66 over the past 6 semiannual samples is 1,400 ug/L and appears to be stable to declining.

Additional SWMU 7 investigations are not expected to provide value because previous investigations have not found any large TCE hot spots, and TCE migrating to the RGA from SWMU 7 will be collected by the Northwest Plume Pump-and-Treat System shortly after contaminants leave the SWMU. The monitoring program designed for SWMU 7 will be designed and implemented in an attempt to resolve the uncertainty concerning the source of the historical TCE concentration spikes seen in MW66. As noted above, a TCE DNAPL or significant soil source and the associated TCE degradation products constitute PTW.

7.1.2 Risk Summary

The risks posed by contaminants detected at SWMU 7 that are addressed in this FS were identified through a review of the BHHRA, refining these as appropriate (See Appendices B and C), and addressing any uncertainties with a review of data collected subsequent to completion of the BHHRA. For SWMU 7, the additional data collected for the BGOU RI primarily were collected at depths greater than 10 ft to better characterize potential releases from the source areas; however, additional soil samples to a depth of 10 ft collected as part of Soils Operable Unit SWMU 12 and SWMU 14 investigations also were incorporated into BGOU data set.

Although there is a substantial soils data set, there are few samples associated with the source term. The FS assumes that direct contact with buried wastes would pose an unacceptable threat under some future use scenarios; however, historical evaluations of the SWMU indicate that the threats from the apparently-inert buried wastes are roughly comparable to those from exposure to the surface and subsurface soils.

Unacceptable direct contact risks to future industrial and future outdoor workers from exposure to surface and subsurface soils were identified in the BHHRA. The COCs that are target compounds to be addressed in this FS include uranium and uranium isotopes, Np-237, Pu-239, Total PAHs, and arsenic. Metals identified as contributing to the noncancer hazard were further reviewed (Appendix C) and verified that no unacceptable noncancer hazard is present at SWMU 7. Isolated locations with an HI > 1 were infrequent and collocated with more significant impacts by the target compounds that will be addressed in the remedial actions.

The BGOU RI BHHRA also identified COCs that may migrate to the RGA at levels that would prevent unrestricted future residential use. These were reviewed and the list refined (see Appendix B). Arsenic; Tc-99; TCE; 1,1-DCE; and vinyl chloride were identified as COCs in the risk assessment and had modeled concentrations (using conservative concentration assumptions) at the SWMU boundary above the MCLs. The Tc-99 mobility may be over-estimated at SWMU 7 because its mobility is evaluated in the subsurface soils, but the only locations with concentrations exceeding screening levels were surface sample locations.

No completed migration pathway from the SWMU 7 burial cells to the adjacent ditches was identified. No seeps originating from SWMU 7 were identified, and water has not been determined to overflow from the cells into the ditch.

The SERA identified COPCs in surface soils. Actions taken to address human health in this FS will reduce potential exposures to these COPCs. Residual risks will be evaluated in a future sitewide ecological risk assessment.

7.1.3 Hydrogeological Interpretation

The study area geology and hydrogeology is summarized below, as documented in the BGOU RI (DOE 2010b). Because SWMUs 7 and 30 are adjacent to each other, their hydrogeological interpretation is discussed as one.

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

In the area of SWMUs 7 and 30, the RGA consists of an intermittent HU4 sand overlying 20 to 40 ft of the HU5 sand with gravel layers. The top of the RGA commonly occurs at depths of 45 to 60 ft.

UCRS Groundwater Flow and Hydraulic Potential. The SWMUs 7 and 30 RI (DOE 1998a) found that a shallow water table exists approximately 5 ft bgs and within the burial cells. UCRS piezometer and well measurements documented a strong downward gradient within the area UCRS. The vertical downward hydraulic gradient is more than 10 times the lateral hydraulic gradient at SWMUs 7 and 30. This, along with lack of connectivity with shallow sand and gravel strata, leads to predominantly downward groundwater flow through the UCRS. These trends suggest that dissolved contaminants from the burial grounds have the potential to migrate into the RGA.

The elevation of the water table is above the elevation of the ditches that bound SWMUs 7 and 30 on the north and south sides.[8] Seeps have been observed along the bank of the northern bounding ditch in SWMU 30 following heavy rains during the spring, but seeps or flow into the ditch have not been observed from SWMU 7 and are not observed in SWMU 30 during the dry season. These observations indicate that the UCRS groundwater flow vector must be oriented steeply downward and that the area contributing infiltration to the ditches typically is limited to a thin border along the ditches. Additional field investigation was conducted along the bank of the northern ditch during the spring and summer of 2011 following heavy rainfall. The 2011 spring was a time of historic flooding. Observations indicated that no seeps originate from SWMU 7, the SWMU 7 burial cells do not extend to the ditch, and water does not overflow from the cells into the ditch. The investigation also identified that seeps to the ditch do originate from SWMU 30 apparently as the result of water overflowing from the burial pit "bathtub" during the wet season.

RGA Groundwater Flow and Hydraulic Potential. The high-contamination core of the Northwest Plume passes beneath the west end of SWMU 7 in the RGA. RGA flow beneath SWMUs 7 and 30 is to the northwest, as defined by the TCE and Tc-99 plumes orientation. The historical south well field of the Northwest Plume Pump-and-Treat System is located approximately 650 ft to the northwest of SWMU 7. Two new extraction wells were installed east of the south well field and put into operation in 2010. EW232 and EW233 extract groundwater at approximately 110 gpm each. As a result of this optimization, the RGA groundwater flow vector has moved more northerly. Nevertheless, the SWMU 7 RGA groundwater remains within the capture zone of the Northwest Plume Pump-and-Treat System. A pumping test of EW231, an extraction well of the south well field, determined the hydraulic conductivity of the area RGA to be approximately 1,300 ft/day.

The TCE concentrations in MW66, located near the boundary between SWMUs 7 and 30, exhibit spikes that can be correlated with similar TCE spikes at MW248 near the south well field. Concentrations in MW66 and MW248 have been decreasing over time; however, the rate of decrease has been somewhat obscured by the intermittent concentration spikes. The distance between the two wells (650 ft) that exhibit this spiking behavior divided by the time lag between TCE "events" in MW66 and MW248 (six months) would suggest the local groundwater flow rate is ~3.5 ft/day if these two wells have the same source for the spikes. These wells are located along the western edge of the high concentration portion of the plume, thus, the spikes may be just as well explained due to plume wobble that occurs due to seasonal changes in the potentiometric surfaces along the western plume boundary. Typical groundwater flow rates in the Northwest Plume are thought to range from 1 to 3 ft/day. The RGA groundwater flow velocity beneath SWMUs 7 and 30 is accelerated by groundwater extraction in the south well field and the new wells located to the east. The absolute direction of the local flow vectors have been modified by the Northwest Plume Pump-and-Treat System optimization.

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[8] The bottom elevation of the ditches on the north and south sides of SWMUs 7 and 30, as well as piezometer measurements within SWMUs 7 and 30, provided definitive control of the water table in those areas.

7.2 SWMU-SPECIFIC RAOs

RAOs that are specific to SWMU 7 were developed based on the findings and observations from the BGOU RI Report. The SWMU-specific RAOs are directed toward conditions related to the waste materials and affected soils, the surface soils, and the subsurface soils at the SWMU.

The lack of information concerning the source term results in the assumption that direct contact with the source term is expected to pose unacceptable risks under some future use scenarios. Impacts from contact with soils have been identified that pose unacceptable risks to future industrial and outdoor workers. Although DNAPL and/or high concentrations of TCE (PTW) are considered to be present at SWMU 7, none of the previous investigations have identified hot spots with PTW-level concentrations of VOCs in soils or test pits. Soil contaminants are present that may migrate to the RGA groundwater at levels that would limit future residential use, including elevated concentrations of TCE and its degradation products. The fingerprint of the SWMU 7 UCRS water concentrations, as well as the concentration range, is significantly different from the concentration profile seen in MW66, suggesting only a limited SWMU 7 contribution.

These risks result in the following SWMU-specific RAOs.

SWMU-Specific RAO for Protection of Groundwater. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination (arsenic; TCE; 1,1-DCE; vinyl chloride; and Tc-99) that could result in an exceedance in RGA groundwater of the MCL (or risk-based concentration for residential use of groundwater in the absence of an MCL).

SWMU-Specific RAO for Protection of Direct Contact with Waste or Associated Soils. Prevent exposure to waste associated soil that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

COCs in affected soils include arsenic, uranium/uranium isotopes, neptunium-237, plutonium-239, and Total PAHs.

SWMU-Specific RAO for PTW. Treat or remove PTW wherever practicable, consistent with 40 *CFR* § 300.430 (a)(1)(iii)(A).

The PRGs identified for target compounds to be addressed in this FS at SWMU 7 listed in Table 7.1.

Table 7.1. Soil PRGs at SWMU 7

COC	Soil to Groundwater PRG (mg/kg) (pCi/g)*	Direct Contact PRG Surface Soil (mg/kg) (pCi/g)*	Direct Contact PRG Subsurface Soil (mg/kg) (pCi/g)*
Arsenic	Background**	12	7.9
1,1-DCE	0.773	N/A	N/A
TCE	0.234	N/A	N/A

Table 7.1. Soil PRGs at SWMU 7 (Continued)

COC	Soil to Groundwater PRG (mg/kg) (pCi/g)*	Direct Contact PRG Surface Soil (mg/kg) (pCi/g)*	Direct Contact PRG Subsurface Soil (mg/kg) (pCi/g)*
Vinyl chloride	0.533	N/A	N/A
Technetium-99	38.5	N/A	N/A
Total PAHs	N/A	0.296	2.425
Neptunium-237+D	N/A	1.355	16.4
Plutonium-239+D	N/A	N/A	81
Uranium-234+D	N/A	94.5	141.5
Uranium-235/236	N/A	1.975	22.75
Uranium-238+D	N/A	8.5	58.5
Uranium (metal)	N/A	535	290

*mg/kg for chemicals or pCi/g for radionuclides.
**Background = 12 mg/kg surface soil; 7.9 mg/kg subsurface soils.

The presence of TCE DNAPL or high TCE concentration residual soil contamination in the UCRS at SWMU 7 is one explanation of the source of the historical groundwater concentration spikes from MW66, but its presence has not been confirmed by other RGA wells or by UCRS soil, groundwater, or test pit samples. Alternatives have been formulated to address the risks associated with the PTW, with supplemental technologies to address a TCE DNAPL or soil source at SWMU 7. An alternative that incorporates TCE DNAPL/soil source remediation RPOs will be formulated fully and considered in this FS, though the location of TCE DNAPL is not currently known. If an excavation alternative were to be implemented at SWMU 7, TCE DNAPL/soil source is expected to be removed as part of the excavation; therefore, supplemental technologies for treating the residual TCE DNAPL or soil source would be employed only if the TCE/DNAPL remains after excavation.

7.3 DEVELOPMENT OF SWMU SPECIFIC ALTERNATIVES

Section 3 developed seven general alternatives appropriate for the four BGOU SWMUs addressed in this FS. These general alternatives include multiple containment and treatment process options as an acknowledgement that each SWMU has unique characteristics and one RPO may not be applicable or effective to address the differing conditions at different SWMUs. The effectiveness of the individual containment and treatment process options are evaluated in this section against the specific needs of SWMU 7 with the containment and treatment process options deemed most effective at SWMU 7 retained (Table 7.2). These retained containment and process options then are incorporated into the general alternatives to form fully developed SWMU-specific alternatives. The remaining process options are screened from further consideration at this SWMU.

7.3.1 Surface Cover Process Options Evaluation and Screening

Four general surface cover process options are carried forward from Section 3 and include the following:

- 1-ft soil cover (a)
- 18-inch clay/6-inch soil cover (b)
- Subtitle C cap (c)
- Subtitle D cap (d)

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Table 7.2 Process Option Effectiveness Evaluation

Process Option Identifier	Process Option Description	Effectiveness			Implementability		Relative Cost	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	Operation and Maintenance
General Response Action—Containment Technology—Surface Barriers								
a	1-ft cover	Moderate for direct contact	High	Moderate	High	High	Moderate—Lowest capital cost among evaluated covers	Moderate
b	18-inch clay/6-inch soil cover	Moderate for direct contact	High	Moderate	High	High	Moderate	Moderate
c	Subtitle C cap	Moderate for direct contact	Moderate to high	Moderate to high	Moderate	High	Moderate—Highest capital cost of the evaluated covers	Moderate
d	Subtitle D cap	Moderate for direct contact	Moderate to high	Moderate to high	Moderate	High	Moderate	Moderate
General Response Action—Treatment Technology—Thermal								
t1	Electrical resistance heating	High in UCRS-demonstrated at Paducah Gaseous Diffusion Plant	High—*In situ* process	High	High	Moderate—air emissions	Moderate	High energy costs during implementation; none after completion
Technology—Physical Chemical								
t2	Dual-phase extraction	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation of the soil	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Moderate to high—effectiveness increases when combined with in *in situ* thermal process option	High	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Moderate	Moderate
Technology—Chemical								
t3	Chemical injection (ZVI)	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation of soils; untested on DNAPLs in RGA	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Uncertain for DNAPLs	Low in UCRS Uncertain in RGA	Moderate—_may require drilling into contaminated areas resulting in contact with buried waste	Moderate to high depending on the grade of ZVI used	Low to moderate—primarily monitoring, but multiple injections may be required to treat DNAPL
Technology—Biological								
t4	Biological treatment	Uncertain in UCRS due to low permeability, heterogeneity, and variable saturation of soils; untested on DNAPLs in RGA	Moderate—may require drilling into contaminated areas resulting in contact with buried waste	Moderate to high	Moderate	Moderate	Moderate	Moderate
Existing Features								
t6	Utilize existing Northwest Plume Pump-and-Treat System	High	High	High	High	High	Low	Low
Alternate Disposal								
WDF	On-site WDF	A potential on-site WDF will be used for disposal of BGOU wastes if available and if wastes meet the WDF WAC.						

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All four process options will be effective in preventing direct contact. If this were the only consideration, the 1-ft soil cover likely would be selected as the representative process option.

At SWMU 7, however, there is an uncertainty as to whether there are significant threats to RGA groundwater from, for example, TCE PTW. A primary differentiator among the four evaluated covers is their ability to control rainwater infiltration through the waste. If properly graded to drain, the 1 ft soil cover will saturate and shed some water, but the 18-inch clay/6-inch soil cover will be more effective at ensuring that the cover has a lower permeability than the underlying UCRS soils. Process options c and d include elements to restrict infiltration even more severely; however, SWMU 7 is located just upgradient of the Northwest Plume Pump-and-Treat System. For these reasons, an 18-inch/6-inch cover will be sufficient to limit local infiltration and any infiltration that mobilizes residual contamination will be captured by the pump-and-treat system once the material percolates through the UCRS (estimated to take decades because the UCRS is not very permeable at SWMU 7). A Subtitle D cap (d) is retained as a representative process option for surface covers at SWMU 7.

Option d (Subtitle D cap) and Option b (an 18-inch local clay/6-inch local soil cover) will be retained for evaluation.

7.3.2 Treatment Technologies and Process Options Evaluation and Screening

Four treatment options are carried forward from Section 3 and screened for suitability in this section, as follows:

- ERH (t1)
- DPE (t2)
- Chemical injection (ZVI) (t3)
- Enhanced biological treatment (t4)

Treatment process options t1, t3, and t4 will be effective to treat VOCs at SWMU 7 and will be developed into SWMU-specific alternatives.

Treatment process option t2, DPE is screened from further consideration at this stage of the evaluation and will not be incorporated into SWMU 7 alternatives. While potentially effective in addressing the VOC COCs at SWMU 7, there is little value to installing an extraction system in the SWMU 7 UCRS when the RGA extraction wells are located just downgradient of the SWMU boundary, duplicating much (if not all) of the treatment process already being accomplished by the Northwest Plume Pump-and-Treat System.

The Northwest Plume Pump-and-Treat System is an existing feature that is recognized and evaluated for continued use as a remedy process option (t6) at SWMU 7.

Excavation of the burial cells at SWMU 7 is retained as a process option. Thus, the potential on-site WDF will be evaluated to dispose of materials excavated from SWMU 7. Although there would be a slight improvement in the short-term effectiveness criterion for the WDF option, the primary impact of considering this option is a significant reduction in the cost of excavation and disposal.

7.3.3 Development of SWMU-Specific Alternatives and Effectiveness Screening

This section combines the general alternatives developed in Section 3 with SWMU-specific considerations for containment and treatment process options to form SWMU-specific alternatives. Those alternatives developed in this section will undergo detailed and comparative evaluation.

Table 7.3 includes the SWMU-specific alternatives developed for SWMU 7.

These alternatives are evaluated with regard to the NCP criteria to potentially reduce the number of alternatives that will undergo detailed analysis. This screening evaluation is summarized in Table 7.4. For SWMU 7, none of the alternatives were screened from further analysis by this process; thus, all of the following alternatives have been subjected to detailed analysis.

7.3.3.1 Alternative 1: No Action

Overall effectiveness of Alternative 1 is low because no action is performed. Though threats from direct contact with wastes and contamination are currently managed using controls maintained outside of CERCLA, there are no provisions to maintain these controls, thus, the effectiveness and permanence is low. Both implementability and the cost rating are high under the no action alternative because no technical, administrative, capital cost, or long-term operational cost are incurred because no remedial actions are taken.

7.3.3.2 Alternative 2.t6: Limited Action (LUCs and Monitoring) with Existing Feature

Alternative 2.t6 offers moderate to high effectiveness with only limited short-term risks to site workers associated with installation of monitoring field components. Alternative 2.t6 controls direct contact risk by recognizing current site controls and extending them as necessary. Alternative 2.t6 mitigates the uncertainties associated with leaving waste in place by monitoring any changes in SWMU status or condition that may warrant a response or action in the future. Alternative 2.t6 also recognizes that SWMU 7 is located immediately upgradient of and within the zone of capture of the Northwest Plume Pump-and-Treat System; thus, any COCs that were to migrate from SWMU 7 to the RGA would be captured by the Northwest Plume Pump-and-Treat System almost immediately after it passes the SWMU boundary. There is no treatment of TCE DNAPL PTW in SWMU 7, but TCE migrating from SWMU 7 is extracted and treated.

Alternative 2.t6 presents no challenges to implementation, either administratively or technically, and is considered overall to be of high implementability. Likewise, the cost rating is high because costs are considered minimal for limited action with some capital costs associated with LUCs, installation of monitoring wells, and O&M costs associated with upkeep and monitoring of wells.

While expressly identified in Alternative 2.t6, all alternatives will benefit from the operation of the Northwest Plume Pump-and-Treat System because the SWMU is within the RGA zone of capture of the system. Eventually, any COCs released to the RGA will be captured by the Northwest Plume Pump-and-Treat System. Previous investigations have not identified any buried, drummed mobile COCs; thus, any mobile constituents have had decades to migrate to the RGA. Thus, although TCE DNAPL may have been historically present at SWMU 7, it is unlikely that any large volumes of TCE DNAPL remain in the cells or UCRS at SWMU 7.

The extraction wells associated with this system are located north of the SWMU 7 administrative boundary, but within the site boundary of PGDP. Any COCs escaping from SWMU 7 and entering the RGA would be quickly captured by the Northwest Plume Pump-and-Treat System and, therefore, treated. The Northwest Plume Pump-and-Treat System is anticipated to operate into the foreseeable future. Eventual suspension of operations must consider the results of monitoring of wells located in the vicinity of SWMUs 7 and 30.

Table 7.3. SWMU Specific Remedial Alternative for SWMU 7

Alternative	Name	Key Features
1	No Action	· No action
2.t6	Limited Action (LUCs and Monitoring) with Existing Feature	· Recognize Northwest Plume Pump-and-Treat System · LUCs · Monitoring
3.b.t6	18/6 Cover, LUCs, and Monitoring with Existing Feature	· 18-inch clay/6-inch soil cover · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
3.d.t6	Subtitle D Cap, LUCs, and Monitoring with Existing Feature	· Subtitle D cap · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.b.t1.t6	18/6 Cover, ERH, LUCs, and Monitoring with Existing Feature	· 18-inch clay/6-inch soil cover · ERH · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.d.t1.t6	Subtitle D Cap, ERH, LUCs, and Monitoring with Existing Feature	· Subtitle D cap · ERH · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.b.t3.t6	18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature	· 18-inch clay/6-inch soil cover · Chemical injection (ZVI) · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.d.t3.t6	Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature	· Subtitle D cap · Chemical injection (ZVI) · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.b.t4.t6	18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature	· 18-inch clay/6-inch soil cover · Biological treatment · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring
4.d.t4.t6	Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature	· Subtitle D cap · Biological treatment · Recognize Northwest Plume Pump-and-Treat System, · LUCs · Monitoring

Table 7.3 SWMU Specific Remedial Alternatives for SWMU 7(Continued)

Alternative	Name	Key Features
5.t6.CR	Excavation and Disposal with Existing Feature and CR	· Excavation of waste and affected soils in burial pits to 20 ft bgs · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transport to disposal facility · Evaluation of off-site disposal · Assessment of contingent treatment remedies, if PRGs are not met at bottom of excavation. Contingent Treatments: ERH (t1), ZVI (t3), or Bio (t4) · Backfill of excavated areas · Recognize Northwest Plume Pump-and-Treat System · LUCs · Monitoring
5.t6.CR.WDF	Excavation and Disposal, WDF with Existing Feature and CR	· Excavation of waste and affected soils in burial pits to 20 ft bgs · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transport to disposal facility · Evaluation of disposal at a potential on-site WDF · Assessment of contingent treatment remedies, if PRGs are not met at bottom of excavation. Contingent Treatments: ERH (t1), ZVI (t3), or Bio (t4) · Backfill of excavated areas · Recognize Northwest Plume Pump-and-Treat System · LUCs · Monitoring
6.b.t6.CR	Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR	· Excavation of waste and affected soils to 20 ft bgs · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transportation to disposal facility · Evaluation of off-site disposal but acknowledges potential on-site WDF may be considered · Assessment of contingent treatment remedies, if PRGs are not met during excavation. Contingent Treatments: ERH (t1), ZVI (t3), or Bio (t4) · Backfill of excavated areas · 18-inch clay/6-inch soil cover · Recognize Northwest Plume Pump-and-Treat System · LUCs · Monitoring

Table 7.3 SWMU Specific Remedial Alternatives for SWMU 7(Continued)

Alternative	Name	Key Features
6.d.t6.CR	Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR	· Excavation of waste and affected soils to 20 ft bgs · Interim and post-remediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transportation to disposal facility · Evaluation of off-site disposal but acknowledges potential on-site WDF may be considered · Assessment of contingent treatment remedies if PRGs are not met during excavation. Contingent Treatments: ERH (t1), ZVI (t3), or Bio (t4) · Backfill of excavated areas · Placement of Subtitle D cap · Recognize Northwest Plume Pump-and-Treat System LUCs, monitoring

Additionally, any action alternative that leaves waste or contamination (above PRGs) in place will include the application of LUCs and monitoring. For purposes of this FS, this is accomplished by incorporating the essential features of Alternative 2.t6 into subsequent alternatives by reference.

7.3.3.3 Alternative 3.b.t6: 18/6 Cover, LUCs, and Monitoring with Existing Feature

Alternative 3.d.t6: Subtitle D Cap, LUCs, and Monitoring with Existing Feature

Long-term effectiveness is moderate to high for both alternatives. Construction of the cover provides long-term protection from direct contact exposure threats (to soils and wastes) when coupled with plant controls/LUCs that control access to the SWMU once the cover is installed. Additionally, any mobile COCs that do leave the SWMU will be captured by the Northwest Plume Pump-and-Treat System. Short term effectiveness is high with only minor potential risks to site workers. Implementability is high. Both alternatives can be accomplished readily with standard construction techniques. Implementability is high under these alternatives. Materials for surface cover construction are common and routine construction methods would be needed to implement the cap. Administrative implementability would be moderate to high with few challenges associated with Alternative 3.d.t6. The overall cost ranking is moderate to high with the 18-inch clay/6-inch soil cover ranked higher because of its lower cost. Both covers are expected to substantially reduce infiltration; thus, this will reduce further the potential for migration of COCs to the RGA.

7.3.3.4 Alternative 4.b.t1.t6: 18/6 Cover, ERH, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t1.t6: Subtitle D Cap, ERH, LUCs, and Monitoring with Existing Feature

This alternative targets a small area presumed to have a TCE DNAPL; however, the location of this DNAPL has not been confirmed. There is an uncertainty whether the presence of DNAPL can be confirmed, given the historical inability to find it previously. Overall effectiveness of Alternatives 4.b.t1.t6 and 4.d.t1.t6 is moderate. Long-term effectiveness is moderate to high. The alternative also addresses VOC PTW at the SWMU and direct contact risks are mitigated through the surface barriers. Short-term effectiveness is considered moderate due to risks associated with ERH implementation and surface cover installation. Implementation of these alternatives involves some technical risk associated with installation of the ERH system without first removing drum remnants or other metallic wastes and is rated moderate to low—recognizing that there are large areas with buried empty drums. Administrative implementability would be high. Overall implementability would be moderate to low. Moderate costs would be expected for both short-term capital and long-term operational costs mainly due to monitoring and *in situ* treatment.

7.3.3.5 Alternative 4.b.t3.t6: 18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t3.t6: Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature

This alternative also proposes to treat the presumed limited area of TCE DNAPL, though this area has not been located. Overall effectiveness of Alternative 4.b.t3.t6 and 4.d.t3.t6 is moderate. Long-term effectiveness is moderate to high. The alternative addresses VOC PTW at the SWMU and direct contact risks are mitigated through the surface barriers. Short-term effectiveness is considered moderate due to risks associated with chemical injection and surface cover installation. Long-term effectiveness is considered moderate to high. Technical implementability is moderate. Although there may be some technical issues with injecting through the waste cells, these are expected to be less severe than with ERH. Administrative implementability would be high. Overall implementability would be moderate. Moderate costs would be expected for both short-term capital and long-term operational costs mainly due to monitoring and *in situ* treatment.

7.3.3.6 Alternative 4.b.t4.t6: 18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t4.t6: Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature

This alternative also proposes to treat the presumed limited area of TCE DNAPL, though this area has not been located. Overall effectiveness of these alternatives is moderate. Short-term effectiveness is rated moderate. Long-term effectiveness is evaluated as moderate to high. Implementability of these alternatives would be moderate to high as amendment application can be accomplished without direct contact with the wastes. Administrative implementability would be moderate to high. Overall implementability would be moderate. Moderate costs would be expected for both short-term capital and long-term operational costs mainly due to monitoring and *in situ* treatment.

7.3.3.7 Alternative 5.t6.CR: Excavation and Disposal, LUCs, and Monitoring with Existing Feature and CR

Alternative 5.t6.CR.WDF: Excavation and Disposal, WDF with Existing Feature and CR

This alternative contemplates excavation of the identified waste pits. Short-term exposure for site workers would be greatest for Alternatives 5.t6.CR and 5.t6.CR.WDF. Short term effectiveness is rated as moderate because of risks associated excavation of the waste. Long term effectiveness is evaluated as high because PRGs should be met either through removal of wastes alone or by a subsequent contingent treatment remedy. Overall implementability is moderate, mostly due to technical and administrative challenges associated with applying contingent remedies. Capital costs are greater for this alternative; also operations and maintenance costs would be low if site closure can be achieved. Overall costs are high; thus, the cost ranking is low. The cost ranking will still be low even if excavated materials can be managed at the proposed WDF.

7.3.3.8 Alternative 6.b.t6.CR: Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR

Alternative 6.d.t6.CR: Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR

This alternative contemplates excavating the wastes expected most likely to contain TCE DNAPL PTW, followed by a CR at the bottom of the excavation, if necessary. Short-term exposure for site workers is somewhat less than for these alternatives than for Alternative 5 because the scope of excavation is reduced; therefore, short-term effectiveness is rated as moderate. Overall implementability is moderate mostly with technical and administrative challenges associated with excavation and disposal. Capital costs are high for this alternative; thus, the cost ranking will be low.

Table 7.4 summarizes the results of alternative screening and SWMU-specific alternative development for SWMU 7.

7.4 DETAILED ANALYSIS OF ALTERNATIVES

Alternatives retained after screening undergo detailed evaluation in this section, using the process described in EPA (1988) and the NCP. Each alternative is assessed against two threshold criteria and five balancing criteria designed to address CERCLA requirements and additional considerations for appropriate remedial alternative selection. The extent to which the criteria are met by each alternative is evaluated in the context of the specific conditions and the associated risks identified at SWMU 7.

7.4.1 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 implement remedial activities for SWMU 7 or to reduce the potential hazard to human or ecological receptors.

PTW/COCs would not be treated under this alternative as no remedial actions would be performed.

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Table 7.4. SWMU Specific Remedial Alternative Screening Summary for SWMU 7

Alternative	Description	Effectiveness			Implementability		Relative Cost	
		Long-term Effectiveness	Short-term	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	Operation and Maintenance
1	No Action							
2.t6	Limited Action (LUCs and Monitoring) with Existing Feature							
3.b.t6	18/6 Cover, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate to high	High	High	High	Low	Low
3.d.t6	Subtitle D Cap, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate to high	High	High	High	Low to moderate	Low
4.b.t1.t6	186 Cover, ERH, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate	Moderate to high	Moderate to low	High	Moderate	Low
4.d.t1.t6	Subtitle D Cap, ERH, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate	Moderate to high	Moderate to low	High	Moderate	Low
4.b.t3.t6	18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate	Moderate to high	Moderate	High	Moderate	Low
4.d.t3.t6	Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature	Moderate to high	Moderate	Moderate to high	Moderate	High	Moderate	Low
4.b.t4.t6	18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature	Moderate to high	High	Moderate to high	High	High	Moderate	Low
4.d.t4.t6	Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature	Moderate to high	High	Moderate to high	High	High	Moderate	Low
5.t6	Excavation and Disposal with Existing Feature and CR	High	Moderate to Low	High	Low	High	High	Low
5.t6.CR.WDF	Excavation and Disposal, LUCs, and Monitoring, WDF with Existing Feature and CR							
6.b.t6.CR	Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR	Moderate to high	Moderate	High	Moderate	High	High	Moderate
6.d.t6.CR	Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR	Moderate to high	Moderate	High	Moderate	High	High	Moderate

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7.4.1.1 Threshold criteria

7.4.1.1.1 Overall protection of human health and the environment

This alternative does not meet the threshold criterion because though existing plant controls limit contact with wastes and affected soils, there is an unacceptable risk associated with some future use scenarios that is not addressed.

7.4.1.1.2 Compliance with ARARs

No ARARs have been identified for Alternative 1.

7.4.1.2 Balancing criteria

7.4.1.2.1 Long-term effectiveness and permanence

Alternative 1 would not provide long-term effectiveness or permanence because it does not limit future exposure to waste and affected soil.

7.4.1.2.2 Reduction of toxicity, mobility, or volume through treatment

Reduction of toxicity, mobility, or volume through treatment would not be applicable to the No Action alternative because it does not include treatment.

7.4.1.2.3 Short-term effectiveness

No actions would be implemented under Alternative 1; therefore, no additional risks to workers, the public, or the environment would be incurred. There would be no short-term change to existing conditions.

7.4.1.2.4 Implementability

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

The ongoing public awareness program would require regular coordination with DOE, KY, and EPA.

7.4.1.2.5 Cost

The preliminary cost estimates for Alternative 1 serve as a baseline for comparison of the other remedial alternatives. These cost estimates are based upon FS-level scoping and are intended to aid with selection of a preferred alternative. There are no capital or O&M costs associated with Alternative 1; thus, the cost ranking is high.

7.4.2 Alternative 2.t6—Limited Action (LUCs and Monitoring) with Existing Feature

Alternative 2.t6 would utilize the existing Northwest Plume Pump-and-Treat System (without modification), along with LUCs and monitoring.

Alternative 2 would rely on the Northwest Plume Pump-and-Treat System for treatment of TCE that migrated from the unit; however, no *in situ* TCE DNAPL treatment is included. The existing in-plant controls would be extended as necessary with LUCs. The performance of this alternative will be evaluated with monitoring. The LUCs will be extended to ensure that decisions concerning the operation of the Northwest Plume Pump-and-Treat system will incorporate monitoring information from SWMU 7.

7.4.2.1 Threshold criteria

7.4.2.1.1 Overall protection of human health and the environment

This alternative would be protective of human health and ecological impacts although there is some uncertainty associated with COCs present in surface soils. These uncertainties could be managed by LUCs prohibiting any direct contact. Risks to future off-site groundwater users would be controlled by the Northwest Plume Pump-and Treat System. The limited action alternative would not prevent leaching of contaminants, including TCE DNAPL/PTW/soil source, from SWMU 7 into RGA groundwater beneath the SWMU, but any impacts to groundwater originating from SWMU 7 would be mitigated by the pump-and-treat system.

Buried waste and contaminated soils would be left in place. LUCs would provide protection against exposure by current and future workers.

7.4.2.1.2 Compliance with ARARs

This alternative will comply with ARARs, as summarized in Appendix F. Existing plant controls are recognized, and LUCs would be put in place to prevent direct contact exposure to wastes, contaminated soils, and groundwater, as necessary.

7.4.2.2 Balancing criteria

7.4.2.2.1 Long-term effectiveness and permanence

Alternative 2.t6 would provide moderate to high long-term effectiveness and permanence.

Under the current pump-and-treat system configuration, this alternative would capture and treat affected RGA groundwater impacted by a TCE DNAPL/soil source, which indirectly reduces the mass (volume) and mobility of PTW. The rate of PTW treatment will depend upon the degree to which it migrates to the RGA.

Buried waste and contaminated soils would be left in place. LUCs would provide protection against potential direct contact exposure by current and future workers.

7.4.2.2.2 Reduction of toxicity, mobility, or volume through treatment

Reduction of toxicity, mobility, or volume through treatment is considered low to moderate because the only treatment occurs outside the SWMU at the Northwest Plume Pump-and-Treat System for all alternatives for SWMU 7. In addition, the majority of buried LLTW and contaminated soils would be left in place at levels similar to current levels with no significant reduction in toxicity, mobility, or volume.

7.4.2.2.3 Short-term effectiveness

Implementation of Alternative 2.t6 has only limited potential for worker exposure to contaminated surficial soils, subsurface soils, and groundwater during installation of additional monitoring points, if needed, and during environmental sampling. This alternative does not remove or treat the TCE DNAPL PTW.

7.4.2.2.4 Implementability

The limited action alternative can be implemented readily. If future remedial action is necessary, this alternative would not impede implementation of such action.

The ongoing public awareness program would require regular coordination with DOE, KY, and EPA.

7.4.2.2.5 Cost

Costs associated with the existing pump-and-treat system are not incurred in the SWMU-specific alternative and are not associated with Alternative 2.t6. Other costs are low; thus, the cost ranking is high.

7.4.3 Alternative 3.b.t6: 18/6 Cover, LUCs, and Monitoring with Existing Feature

Alternative 3.d.t6: Subtitle D Cap, LUCs, and Monitoring with Existing Feature

Alternative 3.b.t6 and Alternative 3.d.t6 control direct contact to surface soils and wastes by maintaining current site controls, supplemented as necessary by LUCs, and placing a surface cover over SWMU 7 to limit direct contact with wastes or affected soils. Any remaining mobile wastes within SWMU 7, such as TCE, will migrate much more slowly through the UCRS and eventually be captured by the Northwest Plume Pump-and-Treat System.

This alternative will consist of the following, as necessary:

- Perform RD
- Install 18-inch (local) clay/6-inch (local) soil cover or Subtitle D cap
- Monitor, as necessary
- Implement LUCAP

7.4.3.1 Threshold criteria

7.4.3.1.1 Overall protection of human health and the environment

Construction of a surface cover over the SWMU will reduce the potential for worker exposure to waste or contaminated soil. When combined with LUCs to ensure the covers are maintained and not breached, exposure pathways will be controlled. Like other alternatives for SWMU 7, this alternative will provide some reduction in toxicity, mobility, or volume of mobile contaminants that migrate to the RGA and are captured by the Northwest Plume Pump-and-Treat System.

The 18-inch/6-inch cover will be less permeable than the underlying UCRS unit, limiting rainwater infiltration through the waste and preventing a bathtub effect. The Subtitle D cap will be much more effective at limiting rainwater infiltration; however, migration through the UCRS is already slow. The additional limits on migration to groundwater (above that provided by the "b" cap) will not provide substantive additional benefit and may impede the rate of cleanup. The wastes have been buried in SWMU 7 for more than 50 years. COCs that are mobile enough to be carried with infiltrating rainwater already have migrated from the SWMU. Thus, as long as the surface cover is less permeable than the UCRS, there will be no bathtub effect that poses a surface water threat; the RGA groundwater will be captured by the pump-and-treat system and the rate of migration to the RGA will slow.

7.4.3.1.2 Compliance with ARARs

These alternatives will meet this threshold criterion by complying with potential action-specific ARARs. ARARs for this alternative are summarized in Appendix F.

7.4.3.2 Balancing criteria

7.4.3.2.1 Long-term effectiveness and permanence

These alternatives are designed to provide protection against exposure to surface soil, waste, and soil in close proximity to the waste and capture any mobile wastes leaving the SWMU. LUCs will ensure that these covers are not breached; thus, the remedy will maintain its effectiveness and permanence.

7.4.3.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives reduce toxicity, mobility, or volume through treatment by the mobile wastes leaving the SWMU and being captured by the Northwest Plume Pump-and-Treat System; however, the cap will reduce the mobility of any residual mobile COCs at SWMU 7 by reducing the volume of infiltrating rainwater.

7.4.3.2.3 Short-term effectiveness

Both alternatives could be implemented and be effective in a relatively short time frame. Implementation would not have any detrimental impact on the community.

Implementation includes some small potential for worker exposure to contaminated surface soils and groundwater during environmental sampling and construction.

7.4.3.2.4 Implementability

Implementation of these alternatives is high because they use standard construction methods, materials, and equipment that are available from vendors and contractors.

7.4.3.2.5 Cost

The cost to construct an 18-inch clay/6-inch soil cover is low to moderate. The cost ranking is moderate to high. The cost to construct a Subtitle D cap is low to moderate, but higher than an 18/6 cover; thus, the cost ranking is moderate to high.

7.4.4 Alternative 4.b.t1.t6: 18/6 Cover, ERH, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t1.t6: Subtitle D cap, ERH, LUCs, and Monitoring with Existing Feature

TCE/DNAPL PTW in the presumed DNAPL hot spot will be treated using ERH. Any remaining mobile waste within SWMU 7 will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System. Exposure to the residual wastes and affected soils will be controlled with the cover. As with Alternatives 3.b.t6 and 3.d.t6, the two surface covers differ only slightly in the detailed analysis due to the somewhat higher cost of the Subtitle D cap. The Subtitle D cap reduces infiltration better, but this reduced infiltration has limited benefit because mobile COCs have had decades to migrate and any residual migration will allow the COCs to be captured by the Northwest Plume Pump-and-Treat System.

These alternatives control direct contact using the covers and existing plant controls, extended with LUCs as necessary.

This alternative will consist of the following, as necessary:

- RD and focused investigation to characterize and delineate TCE/DNAPL source(s);
- TCE/DNAPL soil source treatment of hot spot using ERH, including off-gas treatment;
- Process monitoring;
- Postremediation sampling;
- Construction of a surface cover over SWMU 7;
- Monitoring; and
- LUCs.

The location of the hot spot would have to be identified as part of the RD effort.

ERH has been implemented at the C-400 Building at PGDP. If during exploratory characterization, the TCE DNAPL/source is found to have migrated beyond the UCRS, ERH no longer would be a practical alternative due to the elevated energy input required for ERH to be effective in the RGA due to the high groundwater velocity and heat transfer in the RGA near SWMU 7. Implementation of an ERH system would be employed where TCE DNAPL or high concentrations of TCE in soil sources are identified beneath the buried waste. The *in situ* ERH treatment system would be designed to treat TCE and its degradation products and would be implemented as follows: (1) continuing/expanding the monitoring to identify potential TCE source areas and track contaminant migration during and after treatment; (2) if necessary, a partial excavation of the waste disposal area above the TCE DNAPL source area to remove buried waste, including debris or metallic waste that could interfere with the installation or operation; (3) construction of the treatment operations; (4) process optimization and remedial treatment; and (5) postremediation sampling. Upon completion of the TCE DNAPL/source treatment, conductors and equipment in the electrodes would be recovered to the extent practicable, and the casing and graphite would be abandoned in place.

Upon completion of ERH treatment, a surface cover would be constructed over the entire unit. The surface cover would be contoured to promote runoff and to reduce potential direct exposure to impacted surface soil present at SWMU 7. Due to the generally low concentrations of COCs present in SWMU 7 soils, combined with the extended time since they were place, the residuals are expected to have low mobility; thus, an 18/6 cover is appropriate.

This containment component of the alternative is protective for low mobility contaminants such as uranium, neptunium, plutonium, and PAHs and provides some protection from leaching of technetium and residual 1,1-DCE; *cis*-1,2-DCE; and vinyl chloride through limiting water infiltration.

7.4.4.1 Threshold criteria

7.4.4.1.1 Overall protection of human health and the environment

Construction of a cover over the unit would eliminate the potential exposure to workers from waste and contaminated soil. The protectiveness of the cover would be maintained by plant controls, extended as necessary by LUCs. The LUCs would include a requirement to incorporate consideration of monitoring data from SWMU 7 in the evaluation of the Northwest Plume Pump-and-Treat System.

ERH treatment would remove PTW from SWMU 7 and be protective of groundwater for VOCs. Tc-99 would not be addressed by ERH, but would be captured in the Northwest Plume Pump-and-Treat System.

Implementation of additional groundwater monitoring would provide an indirect protection, because monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance.

7.4.4.1.2 Compliance with ARARs

These alternatives will meet this threshold criterion by complying with potential ARARs. ARARs for this alternative are summarized in Appendix F.

7.4.4.2 Balancing criteria

7.4.4.2.1 Long-term effectiveness and permanence

These alternatives are designed to provide protection against exposure to waste in surface soils and treat PTW. Since the toxicity or volume of the remaining waste and contaminated environmental media associated with direct contact risks would remain near current levels and concentrations (assuming limited degradation and negligible natural attenuation of residual waste and contaminants), some direct contact risk would remain. The *in situ* VOC treatment component would remove any PTW identified during the RDSI phase, along with other VOCs. The long-term effectiveness and permanence of this alternative for VOC source remediation, therefore, is high. Tc-99 would remain in place and would constitute a low risk in association with leaching to groundwater. Potential migration of Tc-99 to groundwater would be reduced by SWMU cover that limits infiltration of rain water.

LUCs would ensure the remedy maintains protectiveness.

7.4.4.2.2 Reduction of toxicity, mobility, or volume through treatment

Alternatives 4.b.t1.t6 and 4.d.t1.t6 will remove TCE/DNAPL sources and other VOCs present at the site; however, non-VOC shallow subsurface contaminants would remain in place. The presence of a surface cover would limit water infiltration into the burial unit, limiting the potential for migration of leachable contaminants.

7.4.4.2.3 Short-term effectiveness

Implementation of these alternatives would not have any detrimental impact on the community.

Implementation of these alternatives has the potential for worker exposure to contaminated surficial soils, subsurface soils, and groundwater during installation of additional monitoring points (if needed), during environmental sampling and construction activities. Potential exposure pathways include inhalation of dust containing surficial soils, dermal contact with soils, dermal contact with contaminated groundwater, and exposure to external penetrating radiation. PGDP worker protection programs will make worker exposure unlikely.

At the time that implementation of each component of these alternatives is completed, these alternatives will be effective. Monitoring suggests no significant Tc-99 impacts to RGA groundwater originating from SWMU 7; therefore, the presence of Tc-99 in surface soils at SWMU 7 should be a minor consideration in alternative selection. The potential for direct contact with radioactive and inorganic contaminants would be addressed by installation of the soil cover. PTW and groundwater protection from VOCs would be met by *in situ* treatment and the existing features. Implementation of these alternatives may take two-plus years to achieve (needed to allow time for the RDSI).

The short-term effectiveness of these alternatives is moderate to high for the *in situ* TCE/DNAPL source treatment process to remediate a TCE source. In the case of ERH, installation of electrode/vapor recovery wells and monitoring equipment would encounter contaminated soils. Soil cuttings produced during installation of electrode/vapor recovery wells would be managed in accordance with the HASP, waste characterization plan, and waste management plan prepared during the RD/RAWP. Installation and operation of the *in situ* DNAPL/source treatment system would be conducted by trained personnel in accordance with procedures. Site preparation and *in situ* DNAPL/source treatment system operation is expected to require 12 to 18 months for ERH.

7.4.4.2.4 Implementability

Activities to be conducted under these alternatives include continuing/expanding monitoring to identify the source area locations, track contaminant migration, and construct a surface cover.

Implementation of the remedial action components is feasible technically. Implementation of these alternatives would use standard construction methods, materials, and equipment that are available from vendors and contractors.

Overall implementability of these alternatives for TCE/DNAPL source treatment using ERH is moderate.

Equipment, personnel, and services required to implement this alternative are available commercially, but the field of experienced ERH vendors is limited. No additional development of these technologies would be required. Some significant site preparation likely would be required to remove buried metal.

Implementation of these alternatives for TCE/DNAPL source treatment using ERH is feasible administratively. For example, the electrode/vapor extraction wells used for ERH would be constructed and abandoned according to the requirements of KY regulations. Recovered vapor would be treated to meet allowable emission levels prior to discharge.

7.4.4.2.5 Cost

The cost to construct an 18-inch/6-inch cover and implement ERH is moderate to high. The cost ranking is low to moderate. The cost to construct a Subtitle D cap and implement ERH is moderate to high; thus, the cost ranking is low to moderate.

7.4.5 Alternative 4.b.t3.t6: 18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t3.t6: Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature

These alternatives include injection of ZVI to create or maintain a reduced environment for treatment of the hot spot TCE/DNAPL source term. Additionally, any remaining mobile waste within SWMU 7 not effectively treated will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System. Direct contact with wastes and affected soil will be controlled with the cap/cover. As with Alternatives 3.b.t6 and 3.d.t6, the two surface covers differ only slightly in the detailed analysis that is associated with the higher cost of the Subtitle D cap. The Subtitle D cap reduces infiltration better, but this reduced infiltration has limited benefit because mobile COCs have had decades to migrate already, and this migration would allow the COCs to be captured by the Northwest Plume Pump-and-Treat System.

These alternatives control direct contact with the covers and site controls/LUCs. Residual VOCs will be treated using ERH. Any remaining mobile wastes within SWMU 7 will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System.

These alternatives include the following:

- RD to design system and locate TCE source(s);
- TCE/DNAPL soil source treatment using chemical injection (ZVI);
- Process monitoring;
- Postremediation sampling;
- Construction of a surface cover over SWMU 7;
- Monitoring; and
- LUCs.

The location of the hot spot would have to be identified as part of the RD effort.

Implementation of high pressure chemical injection of ZVI requires the installation of closely spaced injection points (10 to 15 ft centers, typically) through which microscale ZVI can be pressure injected into pressure induced fractures. Generation of confluent coverage in the subsurface is an important concern for this application method. ZVI testing (Clausen and Richards 1994) has been performed at the bench scale using PGDP samples with effective treatment of TCE and daughter products. ZVI injection also may stabilize other mobile inorganic phases, such as technetium and uranium. ZVI also could be deployed if TCE/DNAPL source has migrated below the UCRS; however, effective delivery of ZVI in the subsurface remains the key technical challenge for this technology.

Upon completing treatment, a surface cover will be constructed over the entire unit. The cover would be contoured to promote runoff and to reduce potential direct exposure to impacted surface soil present at SWMU 7.

This cover component of the alternative is protective for low mobility contaminants such as uranium, neptunium, plutonium, and PAHs and provides some protection from leaching of technetium and residual 1,1-DCE; *cis*-1,2-DCE; and vinyl chloride through limiting water infiltration.

A monitoring program would be implemented that would, at a minimum, monitor the upper RGA. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs as necessary to monitor upgradient and downgradient groundwater contaminant levels. LUCs also would be implemented to extend existing site controls and ensure that decisions concerning the Northwest Plume Pump-and-Treat System incorporate the information from SWMU 7.

7.4.5.1 Threshold criteria

7.4.5.1.1 Overall protection of human health and the environment

Construction of a surface cover over the unit would eliminate the potential exposure to workers from wastes and affected soils. The effectiveness of the cover would be extended as necessary by LUCs.

ZVI treatment would treat PTW from SWMU 7 and be protective of groundwater for VOCs. ZVI treatment also would reduce Tc-99 mobility, but the degree of reduction is difficult to quantify and may not be permanent; however, SWMU 7 is not considered to be a significant potential source of Tc-99. Any residual mobile constituents not treated by ZVI will be captured in the Northwest Plume Pump-and-Treat System, should it leach to the RGA during the time that the system is operable. Implementation of additional groundwater monitoring would provide an indirect protection, as monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance.

7.4.5.1.2 Compliance with ARARs

This alternative will meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F.

7.4.5.2 Balancing criteria

7.4.5.2.1 Long-term effectiveness and permanence

These alternatives are designed to provide protection against exposure to waste and associated surface and subsurface soils and treat PTW. The *in situ* VOC treatment component would treat PTW along with other VOCs. The long-term effectiveness and permanence of this alternative for VOC source remediation, therefore, is high. Tc-99 would remain in place and would constitute a low risk in association with leaching to groundwater. ZVI injection would create a reducing environment; the cover would further reduce mobility.

LUCs and monitoring would ensure that the remedy remains protective.

7.4.5.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives will destroy TCE/DNAPL sources and other VOCs present at the site and create a reducing environment to slow migration of other non-VOC shallow subsurface contaminants to the extent that the affected areas can be located. The presence of a cover will reduce water infiltration into the burial unit, limiting the potential for migration of leachable contaminants. Any COCs that migrate from SWMU 7 will be captured and treated by the Northwest Plume Pump-and-Treat system.

7.4.5.2.3 Short-term effectiveness

Implementation of these alternatives would not have any detrimental impact on the community.

Implementation of these alternatives has the potential for worker exposure to contaminated surficial soils, subsurface soils, and groundwater during installation of additional monitoring points (if needed), during environmental sampling and construction activities. PGDP worker protection programs will make worker exposure unlikely.

At the time that implementation of each component of these alternatives is completed, the alternative will be effective. Tentatively, implementation of these alternatives is expected to take two-plus years, but would depend on subalternative selection.

The short-term effectiveness of these alternatives is moderate to high for the *in situ* TCE DNAPL/source treatment process to remediate a TCE source.

7.4.5.2.4 Implementability

Activities to be conducted under these alternatives include continuing/expanding monitoring to track contaminant migration, *in situ* treatment, and construction of a surface cover.

Implementation of the remedial action components of these alternatives is feasible technically. Implementation of these alternatives would use standard construction methods, materials, and equipment that are available from vendors and contractors. Specific ZVI injection techniques or ZVI product may be subject to sole source availability.

Overall implementability of these alternatives for TCE/DNAPL source treatment using ZVI injection is moderate.

Implementation of these alternatives is administratively feasible.

7.4.5.2.5 Cost

The cost to construct a cover and implement ZVI is moderate. The cost ranking is moderate. The cost to implement ERH is moderate; thus, the cost ranking is moderate.

7.4.6 Alternative 4.b.t4.t6: 18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature

Alternative 4.d.t4.t6: Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature

These alternatives include injection of *in situ* biological amendments to treat the source term. Additionally, any remaining mobile wastes within SWMU 7 not effectively treated will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System. The residual COCs present in the wastes and affected soils will be managed using the cover. As with Alternatives 3.b.t6 and 3.d.t6, the two surface covers differ only slightly in the detailed analysis that is associated with the higher cost of the Subtitle D cap. The Subtitle D cap reduces infiltration better, but this reduced infiltration has limited benefit because mobile COCs have had decades to migrate already and this migration would allow the COCs to be captured by the Northwest Plume Pump-and-Treat System.

These alternatives control direct contact with the covers and site controls/LUCs. Residual VOCs will be treated using Bio. Any remaining mobile wastes within SWMU 7 will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System.

Alternative 4 includes the following:

- RD and focused investigation to identify PTW hot spot;
- TCE DNAPL/soil source treatment using Bio;
- Postremediation sampling;
- Construction of a surface cover over the entire unit;
- Monitoring; and
- LUCs.

The location of the hot spot would have to be identified.

In situ enhanced biological treatment is recognized widely as a robust and proven remediation technology for chlorinated ethenes over a wide concentration range. Implementation requires characterization of *in situ* geochemical conditions to refine design criteria. Enhanced biological treatment would utilize injections of amendments, such as emulsified vegetable oil, lactate, or other fermentable organic substrates, with the possible enhancement of native dechlorinating organisms by injecting a commercially available dechlorinating microbial culture. Enhanced biological treatment through reductive dechlorination also would reduce the oxidation reduction potential and tend stabilize uranium and technetium.

Upon completing of treatment, a cover will be constructed over the entire unit. The cover would be contoured to promote runoff and to reduce potential direct exposure to impacted surface soil present at SWMU 7. This component of the alternative is protective for low mobility contaminants, such as uranium, neptunium, plutonium, and PAHs, and provides some protection from leaching of technetium and residual 1,1-DCE; *cis*-1,2-DCE; and vinyl chloride through limiting water infiltration.

A monitoring program would be implemented to monitor the upper RGA at a minimum. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs as necessary to monitor upgradient and downgradient groundwater contaminant levels. LUCs also would be implemented.

7.4.6.1 Threshold criteria

7.4.6.1.1 Overall protection of human health and the environment

Construction of a surface cover over the unit would eliminate the potential exposure to workers from direct contact with wastes or contaminated soils. The protectiveness of the covers would be maintained by the existing plant controls, extended, as necessary by LUCs. Additional LUCs would ensure that Northwest Plume Pump-and-Treat system decisions evaluate data from SWMU 7.

Enhanced biological treatment will address PTW from SWMU 7 and be protective of groundwater for VOCs. Enhanced biological treatment also will reduce Tc-99 mobility; however, the degree and permanence of the reduction is uncertain. Any residual mobile constituents not treated with these alternatives will be captured in the Northwest Plume Pump-and-Treat System, should they leach to the RGA. Implementation of additional groundwater monitoring would provide an indirect protection, as monitoring contaminant migration allows for minimizing the potential for exposure to contaminated environmental media through early identification and avoidance.

7.4.6.1.2 Compliance with ARARs

These alternatives meet this threshold criterion by complying with potential chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix F.

7.4.6.2 Balancing criteria

7.4.6.2.1 Long-term effectiveness and permanence

These alternatives are designed to provide protection against exposure to waste and associated soils. The enhanced biological treatment component would treat PTW along with other VOCs. The long-term effectiveness and permanence of these alternatives for TCE/DNAPL source remediation is therefore high. Tc-99 would remain in place, but constitutes a low risk in association with leaching to groundwater. Nonmobile COCs will be properly managed by containment. Mobile COCs will be addressed, to some extent, by a reduction in mobility due to the cover that limits infiltration of rain water.

LUCs and monitoring will ensure that the remedy is not breached and that remedy remains protective.

7.4.6.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives will destroy TCE sources and other VOCs present at the site through enhanced biological treatment. However, non-VOC shallow subsurface contaminants would remain in place. The presence of a cover would limit water infiltration into the burial unit, limiting the mobility of residual leachable contaminants. The Northwest Plume Pump-and-Treat system will capture and treat mobile constituents that migrate from SWMU 7.

7.4.6.2.3 Short-term effectiveness

Implementation of these alternatives will not have any detrimental impact on the community.

Implementation of these alternatives has the potential for worker exposure to contaminated surficial soils, subsurface soils, wastes, and groundwater during installation of additional monitoring points (if needed), during environmental sampling, and during construction activities. PGDP worker protection programs will make worker exposure unlikely.

The short-term effectiveness of these alternatives is moderate to high for the *in situ* enhanced biological treatment.

7.4.6.2.4 Implementability

Activities to be conducted under these alternatives include continuing/expanding monitoring to track contaminant migration, *in situ* treatment of the PTW hotspot using Bio, and construction of a surface cover.

Implementation of the remedial action components of these alternatives is technically feasible. Implementation of these alternatives would use standard construction methods, materials, and equipment that are available from vendors and contractors.

Overall implementability of these alternatives for enhanced biological treatment is high. While other treatment alternatives considered may be impacted by subsurface waste or debris, biological treatment can be implemented using a surface infiltration gallery method that is not impacted by subsurface obstacles.

Equipment, personnel, and services required to implement this alternative are readily commercially available. No additional development of these technologies would be required. Contractors possessing the required skills and experience are available.

Implementation of these alternatives for enhanced biological treatment is administratively feasible.

7.4.6.2.5 Cost

Estimated capital and O&M costs for these alternatives address construction and maintenance of the cover, bio treatment, installation of a monitoring well network, and well sampling and analysis. The costs are considered moderate; thus, the cost ranking is considered moderate.

7.4.7 Alternative 5.t6.CR: Excavation and Disposal, LUCs, and Monitoring with Existing Feature and CR

Alternative 5.t6.CR.WDF: Excavation and Disposal, LUCs, and Monitoring, WDF with Existing Feature and CR

This alternative would involve excavation to remove waste from the burial pits and the associated affected soils to a maximum depth of 20 ft. Should PRGs not be met by excavation at this depth, an analysis of the site and a contingent treatment alternatives will be implemented to address the residual contamination. The selected contingent treatment remedy will depend on the site conditions found, such as area, depth of contamination, and COC concentrations found. It is anticipated that treatment will consist of either ERH, chemical injection (ZVI), enhanced biological treatment, or no additional action taken due to recognizing the role of the Northwest Plume Pump-and-Treat System.

The excavation component of this alternative would include the following:

- Confirmation of the locations of the disposal cells by reviewing exiting geophysical investigations or conducting a supplemental investigation to confirm cell locations;
- Installation of sheet piles, as needed, around the perimeter of the disposal cells;
- Excavation of buried materials and contaminated soils within the identified disposal cells;
- Excavation of identified surface soil hot spots, cover soil and waste disposal characterization sampling;
- Excavation pit dewatering;
- Segregation, bulking, and consolidation of compatible waste groups;
- Confirmation and WAC sampling and analysis
- Disposition of waste materials and affected soils; and
- Initiation of contingent treatment remedy if needed.

Disposal options were discussed in Section 2.4.1.6 and include off-site disposal facilities, as well as a potential on-site WDF.

Alternatives 5.t6.CR and 5.t6.CR.WDF for SWMU 7 use the estimate that approximately 40% of the total SWMU would be excavated; this corresponds to the locations of the historical burial cells and associated soils, and the estimated TCE source area. Costs for excavation and disposal of waste materials and affected soils from SWMU 7 are based on removal of approximately 64,000, yd^3 (loose) of contaminated waste materials. The LLW/MLLW waste (41,000 yd^3) would be disposed of either at a commercial or federally owned disposal facility or a potential on-site WDF, if available. The remaining volume would be disposed of at the C 746-U Landfill.

Additional assumptions for excavation, transportation, disposal, treatment, excavation dewatering, etc., for SWMU 7 can be found in Appendix E.

Alternatives 5.t6.CR and 5.t6.CR.WDF will remove the potential for direct contact wastes (e.g., uranium and other radionuclides, Total PAHs) and associated affected soils by excavation and disposal. This alternative also would remove risks associated with TCE/DNAPL sources removed through excavation.

7.4.7.1 Threshold criteria

7.4.7.1.1 Overall protection of human health and the environment

These alternatives will meet this threshold criterion. Potential short-term risks to remediation workers due to direct contact with the waste material are greater than some of the other alternatives evaluated for this SWMU. In addition, potential risks to the public and the environment as a result potential shipping and handling concerns should be considered for off-site shipments. These concerns are reduced for disposal in a potential on-site WDF. These risks may be mitigated by proper engineering and administrative precautions, while achieving the long-term risk reduction.

Wastes and contaminated soils, including any TCE/DNAPL soil source, would be removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF; thus, PTW would be addressed.

7.4.7.1.2 Compliance with ARARs

Alternative 5 will meet this threshold criterion. ARARs for this alternative are summarized in Appendix F.

7.4.7.2 Balancing criteria

7.4.7.2.1 Long-term effectiveness and permanence

Excavation offers the best long-term effectiveness and permanence because it removes the waste and associated soil.

Alternatives 5.t6.CR and 5.t6.CR.WDF allow for risks and uncertainties associated with contaminants in the SWMU to be greatly reduced or eliminated. Risks associated with direct contact with waste and surface soils will be eliminated since the primary source and associated contaminated soils will be removed. These alternatives allow for a maximum reduction of uncertainties associated with these soils in terms of continued contributions to the hydrogeological system. Because waste is removed, there would be no long-term maintenance needed.

The long-term effectiveness and permanence of these alternatives for source remediation is high because the excavation process will remove any source identified at SWMU 7. The TCE source removal will protect the future on-site and off-site groundwater user from SWMU 7 impacts.

7.4.7.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives would reduce or eliminate the mobility and volume of contaminants from the unit, including PTW, by their removal. The toxicity of the residual soils would be reduced drastically and/or eliminated. Excavated materials would be segregated and treated on-site and/or off-site, reducing their toxicity and destroying selected COCs. The removal and disposal of waste and contaminated soil from an unlined burial cell containing COCs to an appropriate disposal facility prevents those contaminants from migrating to the groundwater. COCs that already have migrated to beneath the unit or to the RGA will be collected and treated, further reducing the toxicity through treatment.

7.4.7.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU would not be expected. Alternative 5.t6.CR, however, includes a potential risk to the public from transportation of the LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities. This risk would be reduced greatly by disposing of waste in a potential on-site WDF per Alternative 5.t6.CR.WDF.

Short-term exposures of workers to COCs could occur during implementation of these alternatives. Worker risks are not expected to exceed acceptable limits because exposure frequency and duration are less than those evaluated in the BHHRA. Typically, 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, site-specific HASP.

The short-term effectiveness of these alternatives is moderate to high. These alternatives include TCE/DNAPL source removal.

Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures, DSAs, HASPs, and safe work practices to maintain a work environment that minimizes injury or exposure to risks to human health or the environment.

The PRGs for radioactive and inorganic contaminants would be achieved following completion of excavation. The goal would be to remove VOCs in subsurface soil to achieve PRGs protective of groundwater (see Table 2.2). Should this goal not be met, this alternative provides for contingency treatment remedies to be implemented depending upon site conditions.

7.4.7.2.4 Implementability

For removal of buried wastes and associated soils to a maximum depth of 20 ft, Alternatives 5.t6.CR and 5.t6.CR.WDF are considered to be technically and administratively feasible and implementable. The equipment and technologies associated with implementation of these alternatives have been proven to be feasible technically and are available from contractors or vendors. The implementability of construction-related activities during excavation and backfilling at SWMU 7 subject to these alternatives is similar to that carried out routinely at other sites. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely and, if properly implemented, are proven to be safe. Some excavated waste materials and affected soils may be radioactive, RCRA hazardous, or mixed. Treatment of wastes with multiple regulatory classifications is more complex and may require off-site treatment.

Equipment, personnel, and services required to implement this alternative are available commercially. No additional development of these technologies would be required. Contractors possessing the required skills and experience are available.

Implementation of these alternatives for TCE/DNAPL source remediation is feasible administratively.

An option for disposal of waste and residuals at a potential on-site WDF was considered and costs estimated under Alternative 5.t6.CR.WDF. The primary difference would be the elimination of waste leaving the PGDP, related off-site transportation issues, and the cost for disposal. At this time, no capacity for disposal of these wastes exists at PGDP.

7.4.7.2.5 Cost

Costs were estimated for transportation and disposal of wastes at an off-site facility as well as for an option to dispose of waste at a potential on-site WDF. O&M costs are dependent upon the status of the SWMU upon completion of excavation. O&M costs will be low if SWMU closure can be achieved upon completion of excavation, and a long-term monitoring program is minimal or unnecessary. Costs for excavation are high; thus, the cost ranking is low.

7.4.8 Alternative 6.b.t6.CR: Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR

Alternative 6.d.t6.CR: Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR

These alternatives are comprised of excavation targeted to remove PTW followed by implementation of contingent *in situ* treatment to remove or destroy additional PTW. Upon the completion of excavation and contingent *in situ* treatment, a cover will be placed over the SWMU. This alternative also includes LUCs and monitoring because waste will be left in place. Finally, these alternatives recognize the Northwest Plume Pump-and-Treat System. The potential risks associated with direct contact with residual waste and affected soil will be managed with the covers, LUCs, and monitoring. As with Alternatives 3.b.t6 and 3.d.t6, the two surface covers differ only slightly in the detailed analysis that is associated with the higher cost of the Subtitle D cap. The Subtitle D cap reduces infiltration better, but this reduced infiltration has limited benefit because mobile COCs have had decades to migrate already and this migration would allow the COCs to be captured by the Northwest Plume Pump-and-Treat System.

These alternatives control direct contact with the covers and LUCs and recognizes the effectiveness of existing site controls; however, site COCs (including PTW) will be excavated from the burial cells and residual COCs will be addressed with a CR, if needed. Additionally, any remaining mobile wastes within SWMU 7 not effectively treated by the excavation will migrate to the RGA and be captured by the Northwest Plume Pump-and-Treat System.

These alternatives assume that only the treatment area located on Figure 7.2 will be excavated to a maximum depth of 20 ft. Excavation and disposal of waste materials and affected soils from SWMU 7 are based on removal of approximately 4,100, yd^3 of contaminated waste materials. The LLW/MLLW waste (3,200 yd^3) would be disposed of either at a commercial or federally owned disposal facility or a potential on-site WDF, if available. The remaining volume would be disposed of at the C 746-U Landfill.

Additional assumptions for excavation, transportation, disposal, treatment, excavation dewatering, etc., for SWMU 7 can be found in Appendix E.

A monitoring program would be implemented to monitor the upper RGA at a minimum. The monitoring program would utilize existing PGDP MWs and additional groundwater MWs, as necessary, to monitor upgradient and downgradient groundwater contaminant levels. LUCs and monitoring also would be implemented to monitor the remedy's protectiveness and ensure that the cover is not breached.

These alternatives would remove soil and subsurface contaminants from the targeted areas, and TCE/DNAPL sources would be removed or treated by *in situ* methods as necessary to remove their associated risks.

7.4.8.1 Threshold criteria

7.4.8.1.1 Overall protection of human health and the environment

These alternatives would meet this threshold criterion. Potential short-term risks to remediation of workers due to direct contact with the waste material are greater than some of the other alternatives evaluated for this SWMU; however, they would be much less than for the alternatives that require excavation of the burial cells. In addition, potential risks to the public and the environment as a result potential shipping and handling concerns should be considered for off-site shipments. These concerns are reduced greatly for disposal in a potential on-site WDF. These risks may be mitigated by proper engineering and administrative precautions, while achieving the long-term risk reduction.

Waste and contaminated soil will be removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting all RAOs for waste in the former burial cells.

In situ soil source treatment will remove or destroy PTW.

7.4.8.1.2 Compliance with ARARs

These alternatives would meet this threshold criterion. ARARs for this alternative are summarized in Appendix F.

7.4.8.2 Balancing criteria

7.4.8.2.1 Long-term effectiveness and permanence

Excavation will be targeted to remove PTW to a depth required to meet PRGs or a maximum of 20 ft. If PRGs have not been met, a contingent treatment remedy can be initiated. These alternatives offer a high degree of risk reduction. Other LLTW would be contained under the surface cover.

7.4.8.2.2 Reduction of toxicity, mobility, or volume through treatment

These alternatives reduce or eliminate the mobility and volume of contaminants within targeted excavation area.

These alternatives allow for a contingent treatment remedy. The toxicity of the areas subjected to contingent treatment would be reduced drastically and/or eliminated. The Northwest Plume would treat any mobile COCs migrating from SWMU 7. The cover would reduce the mobility of the mobile COCs left in place.

7.4.8.2.3 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU would not be expected. Alternative 6 includes a potential risk to the public from transportation of LLW or hazardous wastes/liquids to off-site disposal and/or treatment facilities. This risk would be reduced greatly by disposing of waste in a potential on-site WDF.

Short-term exposures of workers to COCs could occur during implementation of these alternatives. Worker risks are not expected to exceed acceptable limits because exposure frequency and duration are less than those evaluated in the BHHRA. Typically, 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, site-specific HASP.

The short-term effectiveness of these alternatives is moderate to high. The alternatives include TCE/ DNAPL source removal, if supported by engineering data collected to characterize and delineate any TCE source.

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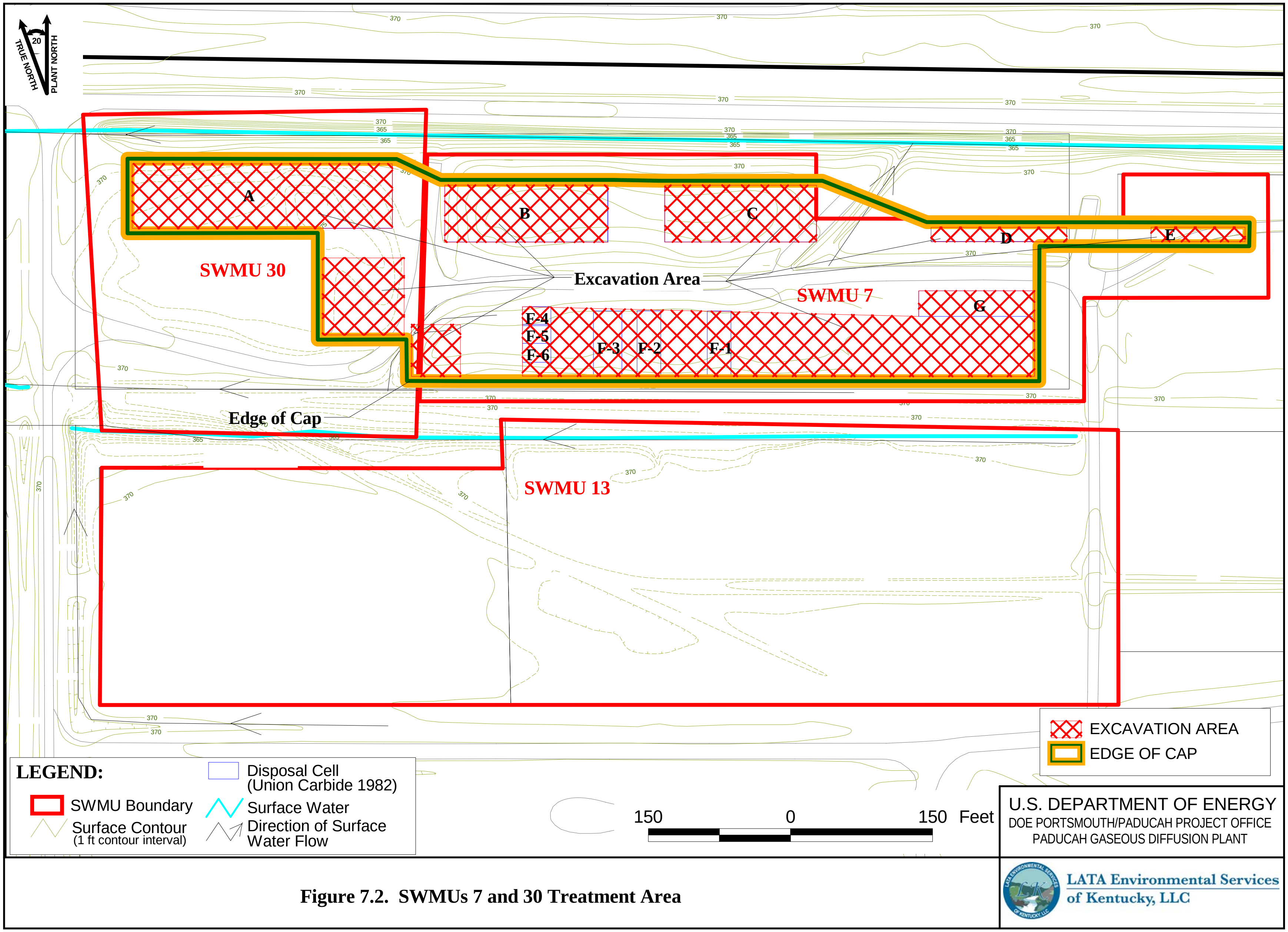

Figure 7.2. SWMUs 7 and 30 Treatment Area

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DATE 09-17-09

Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures, DSAs, HASPs, and safe work practices to maintain a work environment that minimizes injury or exposure to risks to human health or the environment.

The PRGs for radioactive and inorganic contaminants would be achieved following completion of excavation. The goal would be to remove VOCs in subsurface soil to achieve PRGs protective of groundwater (see Table 2.2). Should this goal not be met, this alternative provides for contingency treatment remedies to be implemented depending upon site conditions.

7.4.8.2.4 Implementability

These alternatives are considered to be technically and administratively feasible and implementable. The equipment and technologies associated with implementation of these alternatives have been proven to be feasible technically and are available from contractors or vendors. The implementability of construction-related activities during excavation and backfilling at SWMU 7 subject to these alternatives is similar to that carried out routinely at other sites. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely and, if properly implemented, are proven to be safe. Some excavated waste materials and affected soils may be radioactive, RCRA hazardous, or mixed. Treatment of wastes with multiple regulatory classifications is more complex and may be treated on- or off-site in accordance with the RAWP prior to land disposal.

Overall implementability of these alternatives for the TCE/DNAPL source is moderate. Some of the contingent source treatments may be affected by scrap or debris located in the SWMU.

Equipment, personnel, and services required to implement this alternative are readily commercially available. No additional development of these technologies would be required. Contractors possessing the required skills and experience are available.

Implementation of excavation, surface cover installation, and contingent treatments is feasible administratively. An option for disposal of waste and residuals at a potential on-site WDF was considered under these alternatives. The primary difference would be the elimination of waste leaving the PGDP, related off-site transportation issues, and the cost for disposal. At this time, no capacity for disposal of these wastes exists at PGDP.

7.4.8.2.5 Cost

Costs were estimated for excavation, transportation, and disposal of wastes at an off-site facility. An option to dispose of waste at a potential on-site WDF can be considered if available, should either of these alternatives be implemented. Costs include construction of a surface cover. Cost will be high; thus, the cost ranking is low.

7.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis summary for source area alternatives at SWMU 7 is presented in Table 7.5.

7.5.1 Threshold Criteria

Source area remedial alternatives are compared with respect to the threshold criteria in the following sections.

Table 7.5. Summary of Comparative Analysis of Alternatives for SWMU 7*

	Alternative 1	**Alternative 2.t6**	**Alternative 3.b.t6**	**Alternative 3.d.t6**	**Alternative 4.b.t1.t6**	**Alternative 4.d.t1.t6**
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**18/6 Cover, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, LUCs, and Monitoring with Existing Feature**	**18/6 Cover, ERH, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, ERH, LUCs, and Monitoring with Existing Feature**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Moderate to High (6)	Moderate to High (7)	Moderate to High (7)	High (8)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low to Moderate (0)	Low to Moderate (3)	Low to Moderate (3)	Low to Moderate (3)	Moderate (4)	Moderate (4)
Short-Term Effectiveness	Low (1)	Moderate to High (7)	Moderate to High (7)	Moderate to High (7)	Moderate (5)	Moderate (5)
Implementability	High (9)	High (9)	High (9)	High (8)	Moderate (5)	Moderate (5)
Cost* Present Worth Cost	High (9) $0	High (9) $3,700,000	High(9) $5,903,000	Moderate to High (7) $8,190,000	Low (1) $33,279,000	Low (1) $35,821,000
Average Balancing Criteria Rating	3.8	6.8	7.0	6.4	4.6	4.6

Table 7.5. Summary of Comparative Analysis of Alternatives for SWMU 7* (Continued)

	Alternative 4.b.t3.t6	Alternative 4.d.t3.t6	Alternative 4.b.t4.t6	Alternative 4.d.t4.t6	Alternative 5.t6.CR	Alternative 5.t6. Contingent Remedy.WDF	Alternative 6.b.t6.CR	Alternative 6.d.t6.CR
Evaluation Criteria	**18/6 Cover, ZVI, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, ZVI, LUCs, and Monitoring with Existing Feature**	**18/6 Cover, Bio, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, Bio, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal, LUCs, and Monitoring with Existing Feature and CR**	**Excavation and Disposal, LUCs, and Monitoring, WDF with Existing Feature and CR**	**Targeted Excavation and Disposal, 18/6 Cover, LUCs, and Monitoring with Existing Feature and CR**	**Targeted Excavation and Disposal, Subtitle D Cap, LUCs, and Monitoring with Existing Feature and CR**
Overall Protection of Human Health and the Environment	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	High (8)	High (8)	Moderate to High (7)	Moderate to High (7)	High (8)	High (8)	High (8)	High (8)
Reduction in Toxicity, Mobility, or Volume through Treatment	Moderate (4)	Moderate(4)	Moderate(4)	Moderate(4)	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (5)
Short-Term Effectiveness	Moderate (5)	Moderate (5)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)
Implementability	Moderate to High (6)	Moderate to High (6)	Moderate to High (6)	Moderate (5)	Moderate (4)	Moderate (4)	Moderate (4)	Moderate (4)
Cost* Present Worth Cost	Moderate to High(7) $9,918,000	Moderate (5) $12,125,000	Moderate to High (7) $9,160,000	Moderate (5) $11,366,000	Low (0) $73,306,000	Low (0) $31,016,000	Low to Moderate (3) $19,243,000	Low to Moderate (3) $21,755,000
Average Balancing Criteria Rating	6.0	5.6	5.8	5.0	4.2	4.2	4.8	4.8

*High overall cost rating corresponds to a low project cost relative to the site.
CR = contingent remedy should PRGs not be met by excavation. Components could include t1, t3, or t4. CR includes LUCs and monitoring. Costs do not include CR implementation.
t6 = Alternatives 2 through 7 include impact of existing Northwest Plume Pump-and-Treat System.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

7.5.1.1 Overall protection of human health and the environment

Alternative 1 does not meet the threshold criterion of overall protection of human health and the environment because there are no provisions to ensure that direct contact with the waste and affected soils is precluded should existing plant controls be lost.

Alternative 2.t6 would meet the threshold criterion for direct contact because exposure to affected materials is controlled. LUCs would also have to be extended to limit contact with groundwater both beneath the SWMU and downgradient of the SWMU; however, Alternative 2.t6 does not treat PTW, except PTW that migrates to the RGA and is treated by the Northwest Plume Pump-and-Treat System.

Alternatives 3.b.t6 and 3.d.t6 would meet the threshold criterion. Industrial and outdoor workers would be protected from direct contact by the physical barrier of the surface cover and this protection would be maintained by LUCs. LUCs would limit contact with affected groundwater as needed. The public would be protected by site controls to monitor and ensure the integrity of the containment.

Alternatives 4.b.t1.t6. 4.d.t1.t6, 4.b,t3.t6, 4.d.t3.t6, 4.b.t4.t6, and 4.d.t4.t6 would meet the threshold criterion. Industrial and outdoor workers would be protected from direct contact by the physical barrier of the surface cover and this protection would be maintained by LUCs. LUCs would limit contact with affected groundwater as needed. The public would be protected by site controls to monitor and ensure the integrity of the containment. Additionally, *in situ* source treatment would be implemented to treat PTW. Any contaminants that migrate to the RGA despite source treatment are treated by the Northwest Plume Pump-and-Treat System.

Alternatives 5.t6.CR and 5.t6.CR.WDF would meet the threshold criterion by removing waste and contaminated soil from the SWMU down to a maximum of 20 ft bgs. These alternatives would treat PTW. These alternatives could remove enough waste and contaminated soil, including TCE/DNAPL source so that the remaining soil at the SWMU would meet soil target concentrations and attain MCLs or risk-based values in RGA groundwater at the UCRS-RGA boundary beneath the SWMU. Any contaminants that migrate toward the RGA despite source removal would be treated by a CR or captured by the Northwest Plume Pump-and-Treat System.

Alternatives 6.b.t6.CR and 6.d.t6.CR would meet the threshold criterion by removing waste and contaminated soil. These alternatives would treat TCE/DNAPL source PTW from the SWMU. This alternative could remove enough waste and contaminated soil so that the remaining soil at the SWMU would meet soil target concentrations and attain MCLs or risk-based values in RGA groundwater at the UCRS-RGA boundary beneath the SWMU. Any contaminants that migrate toward the RGA despite source removal would be treated by a CR or captured by the Northwest Plume Pump-and-Treat System.

7.5.1.2 Compliance with ARARs

No ARARs have been identified for Alternative 1, the No Action alternative.

All of the remaining alternatives have been developed in compliance with ARARs.

7.5.2 Balancing criteria

Alternatives are compared with respect to the balancing criteria in the following sections.

7.5.2.1 Long-term effectiveness and permanence

Alternative 1 would not be effective over the long term or permanent. The risk posed by waste material and COCs in soil would remain unabated. No additional controls would be implemented to protect current and future site workers or the public.

Alternative 2.t6 provides a moderate to high degree of long-term effectiveness and permanence because it limits exposure to COCs, has those limitations maintained by LUCs, and relies on existing features, such as contaminant capture by the Northwest Plume Pump-and-Treat System. Alternative 2.t6, however, treats PTW only to the extent that it the PTW migrates from the unit and is captured by the Northwest Plume Pump-and-Treat System. The protection against direct contact is lower than for the Alternative 3, 4, 5, or 6 combinations.

Alternative 3.b.t6 or 3.d.t6 provide a moderate to high degree of long-term effectiveness and permanence because they are effective in controlling direct contact with surface contamination through containment and LUCs. These alternatives, however, treat PTW only to the extent that it migrates from the unit and is captured by the Northwest Plume Pump-and-Treat System.

The Alternative 4 combinations provide a moderate to high degree of long-term effectiveness and permanence, depending on the *in situ* source treatment used, because they are effective in controlling direct contact with surface contamination through containment and LUCs and treat the PTW source term. These alternative combinations score higher than Alternatives 3.b.t6 and 3.d.t6 in treatment of PTW; however, given the time that has elapsed since the PTW was disposed of at SWMU 7 and the potential for it to migrate to the RGA, this additional treatment may not have a major impact on the effectiveness of the remedy because there may not be significant mass of PTW remaining.

Alternative 5 and 6 combinations provide a high degree of long-term effectiveness and permanence due to the removal of COCs, including PTW. Residual risk will be the lowest under these alternatives. Long-term controls may not be required under these alternatives provided that waste material and contaminated soil can be removed to attain soil target concentrations. Should residual TCE/DNAPL remain upon completion of excavation for Alternative 5 and 6 combinations, *in situ* TCE DNAPL/source treatment will be applied to meet target concentrations.

7.5.2.2 Reduction of toxicity, mobility, or volume through treatment

All alternatives have some reduction in toxicity and volume associated with the Northwest Plume Pump-and-Treat System. Alternatives 4, 5, and 6 combinations will have additional reductions (although some of those reductions are due to removal and not treatment).

7.5.2.3 Short-term effectiveness

The short-term effectiveness of Alternative 1 is low because the remedy never reaches the threshold level of effectiveness.

Little construction is required to implement Alternative 2.t6; therefore, there is little risk to workers during construction activities. LUCs could be implemented rapidly, as needed, to extend protections to site workers should plant controls be lost, protecting site workers from direct contact exposure; however, a temporal penalty is assessed to Alternative 2.t6 as this alternative relies on the performance of the Northwest Plume Pump-and-Treat System to be effective. Overall, short-term effectiveness is moderate to high.

Alternative 3 combinations are rated moderate to high. The remedies can be implemented and become effective quickly. There is some risk to workers but these risks are manageable through adherence to the HASP.

Alternative 4 combinations are rated moderate, due to implementation of *in situ* technologies in addition to installation of a surface cover. These remedies can be implemented and become effective quickly. There is some incremental risk to workers, but these risks are manageable through adherence to the HASP.

The short-term effectiveness of Alternatives 5 and 6 is moderate though the remedies can be implemented quickly and be effective because of the increased potential for contact to workers and the community during excavation. The option to dispose of excavated waste in a potential on-site WDF would improve the short-term effectiveness by eliminating risks to workers and the public associated with waste leaving the site.

7.5.2.4 Implementability

Alternative 1 would be the most readily implementable because no construction or invasive action would be taken.

The implementability of Alternative 2.t6 is high because the technology is readily available and the complexity is low. The implementability for the DNAPL component of Alternative 4 is moderate to high for ZVI and bio and moderate for ERH.

The implementability of Alternatives 5 and 6 is considered moderate because equipment, personnel, and services required to implement this alternative are readily available and routinely used.

7.5.2.5 Cost

Capital and O&M costs for alternatives at SWMU 7 are presented in Appendix E. Costs were estimated for transportation and disposal of wastes at an off-site facility as well as for an option to dispose of waste at a potential on-site WDF.

8. SWMU 30

8.1 SWMU 30 HISTORY AND BACKGROUND

Previous sections of this document present a framework that collects sitewide information and uses it to formulate a general approach to developing alternatives to address the COCs present in the SWMUs. This framework also discusses key elements of the alternatives that are used as the basis for technology screening and development of SWMU-specific alternatives. This section (Section 8) of the document develops the candidate alternatives for SWMU 30 by expanding the general alternatives to address SWMU-specific conditions.

SWMU 30 is located in the northwestern section of the PGDP secured area and includes the western one-third of C-747-A. It consists of a historical burn and burial cell (Burial Pit A) and is the location of a former incinerator. The SWMU is bounded on the north and south sides by ditches, on the west side by a plant road, and on the east side by SWMU 7 (Figure 7.1). The unit encompasses approximately 128,000 ft^2. Burial Pit A is reported to extend to a depth of 12 ft and is covered with 4 ft of earth. The land surface slopes gently with a slight mound over the burial cell. Grassy vegetation covers the ground, except where gravel roads extend through the site.

SWMU 30 was used from 1951 to 1970 to burn combustible trash, which may have contained uranium including uranium in the form of metallic dust and shavings. An incinerator was constructed for use at SWMU 30, but the extent of its use is uncertain. The incinerator was a steel mesh, "tee pee" shaped structure primarily used to burn paper, wood, cardboard, and other combustibles. Ash and debris were buried belowground in Burial Pit A beginning in 1962, when use of the on-site incinerator was discontinued. It is assumed that ash from the incineration was buried at SWMU 30 rather than taken elsewhere at the site. Site maps and a surface electromagnetic geophysical survey of the Phase II SI identified the location of Burial Pit A. Prior to identification during Phase II SI surface geophysics testing, it was believed that remnants of the former incinerator were not present. Further research identified images of the incinerator at the location. This disposal site covers an area of about 250 ft by 50 ft. Geophysical data from the Phase II SI indicate that the actual area of excavation extends to the north and east beyond the rectangular outline shown on facility drawings. Material disposed of in Pit A included contaminated and uncontaminated trash, ash, and debris.

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

8.1.1 Nature and Extent of Contamination

The information on the activities at SWMU 30 suggests potential sources of uranium and residuals from combustion of a variety of materials. No wastes have been identified as PTW at SWMU 30. SWMU 30 contains low-level threat wastes.

The presence of waste-related impacts in surface and subsurface soils was characterized in the BGOU RI. Appendix A contains figures that show concentrations of chemicals of interest that exceed screening values. For direct contact pathways, surface soil impacts are shown in Figure A.10 and subsurface (1–20 ft) in Figure A.11. Figure A.12 highlights locations where soils have levels of contaminants that potentially may migrate and impact RGA groundwater.

The soil sampling results indicate that one or more uranium isotopes were detected above background in each of the surface soil samples, approximately 60% of the samples in the interval from 1–20 ft, and not detected above background in any of the samples at depths greater than 20 ft. Concentrations are highest in surface soils, the maximum and average concentrations of U-238 decrease more than a factor of 10 in the interval from 1–20 ft. Np-237 and Pu-239 also were detected above background in surface soils; however, Pu-239 did not exceed the industrial worker NAL at any of these locations, while and Np-237 exceeded in three locations. Similar to the distribution of radionuclides, some metals show a higher frequency of exceeding background concentrations in surface soils, occasionally present above screening values.

The history of the waste unit does not suggest significant contributions of VOCs would be present. The soil data showed one detection of TCE (0.0374 mg/kg at a depth of 30 ft) and one detection of 1,1-DCE (0.005 mg/kg at a depth of 60 ft). In the four water samples collected from open boreholes in the UCRS within the SWMU boundary, TCE was not detected and is not present at concentrations above the MCL. The highest concentration of TCE within the RGA is at MW66, a well located along the eastern edge of SWMU 30; thus it is not downgradient from the waste unit.

Total PAHs may be present associated with the combustion done at the site. Total PAHs were detected in 7 of 11 surface soil locations in concentrations from 0.002 to 12.5 mg/kg. Two of the 3 highest concentrations were in ditch samples at the southern boundary of the site. PAHs were detected in only 2 subsurface locations at concentrations below screening values. This pattern is similar to that of other chemicals of interest in that the greater residual concentrations at SWMU 30 remain near the surface.

Total PCBs were detected at the site, with the highest frequency of detection and concentrations in surface samples. They were not detected at depths greater than 20 ft.

Tc-99 is not known to be associated with activities at this SWMU, but was detected above background. Tc-99 was not detected above background in any samples collected at depths greater than 20 ft, and above background in only 1 of 10 samples collected at depths from 1–20 ft. There were four surface locations with Tc-99 above background; two of these that also had the highest concentrations were in the drainage ditch to the south of the site. Tc-99 was not detected in any of the water samples collected from borings or monitoring wells in the UCRS. The MCL was exceeded only in the RGA well MW66, a well not located downgradient from the waste unit.

8.1.2 Risk Summary

This FS addresses the current and potential future risks posed by contaminants detected in soil based on a review of the BHHRA with COCs refined as appropriate (see Appendix B and C). This FS also addressed uncertainties and reviews data collected subsequent to completion of the BHHRA. For SWMU 30, the additional data collected for the BGOU RI primarily were collected at depths greater than 10 ft to better characterize potential releases from the source areas.

The primary uncertainty is associated with the threat from direct contact with the waste. For purposes of the FS, the source term is assumed to contain COCs at levels that pose an unacceptable risk under at least some future use scenarios. Unacceptable direct contact risks associated with COCs in soils accrue to future industrial and future outdoor workers per the BHHRA. The COCs in soil to be addressed in this FS include uranium and uranium isotopes, neptunium-237, plutonium-239, Total PAHs and Total PCBs. Metals identified as contributing to the noncancer hazard were further reviewed (Appendix C) and several were below background and NALs or removed based on updated toxicity or exposure information; however, Figures A.10 and A.11 identify locations where an HI of 1 is exceeded. These exceedances are infrequent, and collocated with more significant impacts by the target compounds used to guide the remedial actions.

The BGOU RI BHHRA also identified COCs that may migrate to the RGA at levels that would limit future residential use. These were reviewed and the list refined (see Appendix B). Arsenic soil concentrations were below background. TCE and 1,1-DCE (each detected in only one soil sample) were identified as COCs in the risk assessment, but were below MCLs at the SWMU boundary and did not exceed the PRG developed for protection of the RGA beneath the SWMU.

The Tc-99 modeled concentration in RGA groundwater at the SWMU boundary was below the MCL (287 pCi/L). Two locations with concentrations above the screening level were identified in surface samples in an adjacent drainageway at locations subsequently covered. Further review of these data suggests migration of Tc-99 is not a potential threat to be addressed in this FS for this site. Tc-99 is potentially highly mobile; however, the distribution of Tc-99 at the SWMUs suggests vertical migration through the UCRS may be limited, and the Tc-99 in the RGA in the vicinity of SWMU 30 is sourced from upgradient.

- Similar to other BGOU sites, the highest concentrations and frequency of detection remain in samples collected in the 0–1 ft interval.

- Tc-99 was detected above background in only 1 of 20 subsurface soil locations.

- The site activities occurred 40–60 years ago. If Tc-99 present in these soils behaved consistently with expected mobility, it no longer would be a significant soil source to groundwater.

Drainageways are located adjacent to the site. Much of the contamination at the SWMU is in surface soils, and contaminants have the potential to migrate to these drainageways via runoff. In addition, it was determined during the FS that the potential exists for leachate from buried waste to discharge from SWMU 30 into the adjoining ditches to the north.

The SERA identified COPCs in surface soils. Actions taken to address human health in this FS will reduce potential exposures to these COPCs. Residual risks will be evaluated in a future basewide ecological risk assessment.

8.1.3 Hydrogeological Interpretation

The study area geology and hydrogeology are summarized below, as documented in the BGOU RI (DOE 2010b). Because SWMUs 7 and 30 are adjacent to each other, their hydrogeological interpretation is discussed as one.

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

In the area of SWMUs 7 and 30, the RGA consists of an intermittent HU4 sand overlying 20 to 40 ft of the HU5 sand with gravel layers. The top of the RGA commonly occurs at depths of 45 to 60 ft.

UCRS Groundwater Flow and Hydraulic Potential. The SWMUs 7 and 30 RI (DOE 1998a) determined that a shallow water table exists approximately 5 ft bgs and within the burial cells. UCRS piezometer and well measurements document a strong downward gradient within the UCRS. The vertical downward hydraulic gradient is more than 10 times the lateral hydraulic gradient at SWMUs 7 and 30. This condition, along with lack of connectivity among shallow sand and gravel strata, leads to predominantly downward groundwater flow through the UCRS. These trends result in the dissolved contaminants from the burial grounds having the potential to migrate into the RGA.

The elevation of the water table is above the elevation of the ditches that bound SWMUs 7 and 30 on the north and south sides.[9] Seeps have been observed intermittently along the bank of the northern bounding ditch adjacent to SWMU 30 following heavy rains at certain times of the year, but seeps or flow into the ditch are not discernable under dry season conditions. These observations suggest that there is limited lateral flow through the UCRS silts and clays; however, groundwater can overflow lower-permeability matrix materials at locations where the burial cell walls are thin or missing. With the UCRS groundwater flow vector oriented steeply downward, the area generating an intermittent seep is limited to a thin border along the ditches.

RGA Groundwater Flow and Hydraulic Potential. The high-contamination core of the Northwest Plume passes beneath SWMU 30 and the west end of SWMU 7 in the RGA. RGA flow in SWMUs 7 and 30 is to the northwest, as defined by the plume orientation. The historical south well field of the Northwest Plume Pump-and-Treat System is located approximately 650 ft to the northwest of SWMU 7. A pumping test of EW231, an extraction well of the south well field, determined the hydraulic conductivity of the area RGA to be approximately 1,300 ft/day. In August 2010, the Northwest Plume Pump-and-Treat System was optimized by the installation and operation of two higher capacity extraction wells located north of SWMU 7, but east of EW231. EW232 and EW233 extract groundwater at approximately 110 gpm each. This optimization has changed the local flow direction of the RGA somewhat; however, all the RGA groundwater beneath SWMU 30 (as well as SWMU 7) is well within the capture zone of the Northwest Plume Pump-and-Treat System.

The TCE concentrations in MW66, located near the boundary between SWMUs 7 and 30, exhibit spikes in TCE concentrations that can be correlated with similar TCE spikes at MW248 in the south well field. Concentrations have been decreasing over time; however, the rate of decrease is obscured by the intermittent concentration spikes. The distance between the two wells (650 ft) that exhibit spiking behavior divided by the time lag between TCE "events" in MW66 and MW248 (6 months) would suggest the local groundwater flow rate is ~3.5 ft/day, if they have the same source for the spikes. Typical groundwater flow rates in the Northwest Plume are thought to range from 1 to 3 ft/day. The RGA groundwater flow velocity beneath SWMUs 7 and 30 is accelerated by groundwater extraction in the south well field, and the absolute direction of the local flow vectors have been modified by the Northwest Plume Pump-and-Treat System optimization.

8.2 SWMU-SPECIFIC RAOs

RAOs that are specific to SWMU 30 were developed based on the findings and observations from the BGOU RI Report. The SWMU-specific RAOs are directed toward conditions related to the waste materials and affected soils, the surface soils, and the subsurface soils at the SWMU.

[9] The bottom elevation of the ditches on the north and south sides of SWMUs 7 and 30, as well as well and piezometer measurements within SWMUs 7 and 30, provide control of the water table in those areas.

Impacts to soils have been identified that pose unacceptable risks to future industrial and outdoor workers. The waste materials remaining at SWMU 30 are assumed to pose risks equal or exceeding those identified for direct contact to soils. No wastes have been identified as PTW at SWMU 30. No soil impacts are identified that will result in impacts to the RGA groundwater that would limit future residential use.

SWMU-Specific RAO for protection of direct contact with waste. Prevent exposure to waste that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Waste: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for a future outdoor worker

SWMU-specific RAO for protection of direct contact with contaminated soils. Prevent exposure to contaminated soils (uranium and uranium isotopes, neptumium-237, plutonium-239, Total PAHs and Total PCB) that exceeds target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative risk levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

The PRGs identified for target compounds to be addressed in this FS for protection of future industrial worker and outdoor workers at SWMU 30 are listed in Table 8.1.

Table 8.1. PRGs for SWMU 30

COC	Direct Contact PRGs Surface Soil (mg/kg) (pCi/g)*	Direct Contact PRGs Subsurface Soil (mg/kg) (pCi/g)*
Total PAHs	0.296	2.425
Total PCBs	10	10
Neptunium-237+D	1.355	16.4
Plutonium-239+D	N/A	81
Uranium-234+D	94.5	141.5
Uranium-235/236	1.975	22.75
Uranium-238+D	8.5	58.5
Uranium (metal)	535	290

*****mg/kg for chemicals or pCi/g for radionuclides.

8.3 DEVELOPMENT OF SWMU-SPECIFIC ALTERNATIVES

Section 3 developed seven general alternatives appropriate for the four SWMUs addressed in this FS. These general alternatives include multiple containment and treatment process options as an acknowledgement that each SWMU has unique characteristics and one RPO may not be applicable or effective to address the differing conditions at different SWMUs. The effectiveness of the individual containment and treatment process options are evaluated in this section against the specific needs of SWMU 30 with containment (Table 8.2) and process options deemed most effective at SWMU 30 retained. All retained containment treatment and process options then are incorporated into the general

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Table 8.2. Process Option Screening for Remedial Alternatives Developed for SWMU 30

Process Option Identifier	Process Option Description	Effectiveness			Implementability		Relative Cost Rating	
		Long-Term Effectiveness	Short-Term Effectiveness	Demonstrated Effectiveness and Reliability	Technical	Administrative	Capital	Operation and Maintenance
General Response Action—Containment Technology—Surface Barriers								
a	1-ft cover	High for direct contact	High	Moderate to High	High	High	High: Lowest capital cost among evaluated covers	Low
b	18-inch clay/6-inch soil cover	High for direct contact	High	Moderate to High	High	High	High	Low
c	Subtitle C cap	High for direct contact	Moderate to High	Moderate to High	High	High	Moderate: Highest capital cost of the evaluated covers	Low
d	Subtitle D cap	High for direct contact	Moderate to high	Moderate to High	High	High	Moderate	Low
General Response Action—Treatment Technology—Thermal								
t1	Electrical resistance heating	There are no identified COCs at SWMU 30 modeled to pose a risk to RGA groundwater at SWMU 30. Thermal treatment would be effective only for treating the direct contact risks associated with VOCs at SWMU 30. ERH is screened from further evaluation.						
Technology—Physical Chemical								
t2	Dual-phase extraction	There are no identified COCs at SWMU 30 modeled to pose a risk to RGA groundwater at SWMU 30. Physical/chemical technologies generally are not effective for treating the direct contact risks at SWMU 30. DPE is screened from further evaluation.						
Technology—Chemical								
t3	Chemical injection (ZVI)	There are no identified COCs at SWMU 30 modeled to pose a risk to RGA groundwater at SWMU 30. Chemical technologies generally are not effective for treating the direct contact risks at SWMU 30. Chemical injection (ZVI) is screened from further evaluation.						
Technology—Biological								
t4	Biological treatment	There are no identified COCs at SWMU 30 modeled to pose a risk to RGA groundwater at SWMU 30. Chemical technologies generally are not effective for treating the direct contact risks at SWMU 30. Biological treatment is screened from further evaluation.						
Existing Feature								
t6	SWMU 3 leachate collection system and subsequent treatment	This process option is available only to SWMU 3. It is not applicable to SWMU 30.						
t7	Utilize existing Northwest Plume Pump-and-Treat System	High	High	High	High	High	Low	Low

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alternatives to form fully developed SWMU-specific alternatives. The remaining process options are screened from further consideration at SWMU 30.

8.3.1 Surface Cover Process Options Evaluation and Screening

Four general surface cover process options are carried forward from Section 3 and include the following:

- 1-ft soil cover (a)
- 18-inch clay/6-inch soil cover (b)
- Subtitle C cap (c)
- Subtitle D cap (d)

The primary consideration in implementing a surface cover is to limit direct contact exposure to surface and subsurface contaminants. The Subtitle C and Subtitle D caps also will be effective at reducing/eliminating infiltration. Although the “a” and “b” covers will be designed and built to facilitate runoff, these covers will not be appropriate for those units where substantial decreases in infiltration are needed to meet PRGs.

None of the SWMU 30 COCs appear to pose a threat to RGA groundwater; thus, any of the four covers would be effective because they all limit direct contact exposure. All four of the covers are evaluated high to moderate for long-term effectiveness.

Process Options (a) and (d) prevent direct soil contact and are retained for use in developing SWMU 30 alternatives. Process Options b and c are more costly than Options a and d, respectively, without providing significantly better performance for SWMU 30, so they have been screened from further consideration for SWMU 30.

8.3.2 Treatment Technologies and Process Options Evaluation and Screening

Treatment Process Options t1, t2, t3, t4, and t5 either are not applicable to the specific conditions of SWMU 30 or would not provide effective treatment of COCs at SWMU 30. General alternatives that rely upon treatment will be screened from further consideration for SWMU 30 and will not be developed into SWMU-specific alternatives.

Treatment Process Option t6, which recognizes the Northwest Plume Pump-and-Treat System, is retained for development of SWMU-specific alternatives.

8.3.3 Development of SWMU-Specific Alternatives and Screening

This section combines the general alternatives developed in Section 3 with SWMU-specific considerations for containment and treatment process options to form SWMU-specific alternatives. Those alternatives developed in this section will undergo detailed and comparative evaluation.

Table 8.3 includes the SWMU-specific alternatives developed for SWMU 30.

These alternatives are summarized below and discussed with respect to the NCP criteria.

8.3.3.1 Alternative 1: No Action

Effectiveness of Alternative 1 is rated low because no action is performed; therefore, threats from wastes and contamination are not addressed. Both implementability and the cost rating are high under the No

Table 8.3. Remedial Alternatives Developed for SWMU 30

Alternative	Name	Key Features
1	No Action	· No action
2.t6	Limited Action (LUCs and Monitoring) with Existing Feature	· LUCs · Groundwater and surface water monitoring as necessary · Recognizes Northwest Plume Pump-and-Treat
3.a.t6	Soil Cover, LUCs, and Monitoring with Existing Feature	· 1 ft soil cover · LUCs · Groundwater and surface water monitoring as necessary · Recognizes Northwest Plume Pump-and-Treat System
3.d.t6	Subtitle D Cap, LUCs, and Monitoring with Existing Feature	· Subtitle D cap · LUCs · Groundwater and surface water monitoring as necessary · Recognizes Northwest Plume Pump-and-Treat System
5.t6	Excavation and Disposal with Existing Features	· Excavation of buried waste materials and affected soils · Treatment or disposal of water collected from excavation, as indicated by sampling · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transportation of waste materials to disposal facility · Evaluation of off-site disposal · Backfill (or approved alternative) of excavated areas
5.t6.WDF	Excavation and Disposal, WDF with Existing Features	· Excavation of buried waste materials and affected soils · Treatment or disposal of water collected from excavation, as indicated by sampling · Interim and postremediation sampling and analysis · WAC sampling and analysis · Physical/chemical waste treatment, if necessary · Transportation of waste materials to disposal facility · Evaluation of disposal at a potential on-site WDF · Backfill (or approved alternative) of excavated areas

Action alternative because no technical, administrative, capital cost, or long-term operational cost are incurred because no remedial actions are taken.

8.3.3.2 Alternative 2: Limited Action (LUCs and Monitoring) with Existing Feature

Alternative 2 offers moderate effectiveness with only limited short-term risks to site workers associated with installation of monitoring field components. Alternative 2 controls direct contact risk by maintaining current site controls and extending them as necessary with LUCs. Alternative 2 mitigates the uncertainties associated with leaving waste in place by monitoring changes in SWMU status or condition that may warrant a response or action. Alternative 2 also recognizes that SWMU 30 is located immediately upgradient of (and within the zone of capture of) the Northwest Plume Pump-and-Treat System. Thus, COCs that were to migrate from SWMU 30 to the RGA would be captured by the Northwest Plume Pump-and-Treat System shortly after they pass the SWMU boundary.

Alternative 2 (limited action) presents no challenges to implementability, either administrative or technical, and is considered to have high implementability. Likewise, the cost rating is high because costs are considered minimal for a limited action, with modest costs associated with LUCs, installation of monitoring wells, and O&M costs associated with upkeep and monitoring of wells.

While expressly identified in Alternative 2, all alternatives will benefit from the operation of the Northwest Plume Pump-and-Treat System because the SWMU is within the RGA zone of capture of the system. Thus, eventually, COCs released to the RGA will be captured by the Northwest Plume Pump-and-Treat System. The extraction wells associated with this system are located north of the SWMU 7 administrative boundary and located within the site boundary of PGDP. COCs escaping from SWMU 30 and entering the RGA would be captured by the Northwest Plume Pump-and-Treat System and, therefore, treated. The Northwest Plume Pump-and-Treat System is anticipated to operate into the foreseeable future. Development of LUCs should include ensuring that suspension of operations considers the results of monitoring of wells located in the vicinity of SWMUs 7 and 30.

Additionally, any alternative that leaves waste or contamination (above PRGs) in place [2, 3.a, 3.d, 5 (if necessary)] will include the application of LUCs and monitoring. For purposes of this FS, this is accomplished by incorporating the features of Alternative 2 into Alternatives 3.a, 3.d, and 5 by reference. Although there may be slight differences in the application of LUCs and monitoring, these differences will not affect the overall alternative development, evaluation, or selection processes.

8.3.3.3 Alternative 3.a.t6: Soil Cover, LUCs, and Monitoring with Existing Feature

Alternative 3.a.t6 offers a high effectiveness with limited short-term risks to site workers during construction of a surface cover. Long-term effectiveness is high for Alternative 3.a.t6 as construction of the cover provides additional long-term protection from nonmobile direct contact exposure threats when coupled with LUCs that control access to the SWMU once the cover is installed. Implementability is high under this alternative as the placement of a soil cover is performed routinely. Materials for cover construction are common and routine construction methods would be needed to implement the cap. Administrative implementability would be moderate to high with few challenges associated with Alternative 3.a.t6. The overall cost ranking is high with some degree of capital investment for cap construction and O&M costs associated with cap upkeep in addition to the monitoring costs.

As noted in Alternative 2.t6, though the source is known to be nonmobile, the Northwest Plume Pump-and-Treat System would capture COCs that migrate to the RGA and downgradient of this SWMU.

8.3.3.4 Alternative 3.d.t6: Subtitle D Cap, LUCs, and Monitoring with Existing Feature

Alternative 3.d.t6 offers high effectiveness with limited short-term risks to site workers during construction of the Subtitle D cap. Long-term effectiveness is high for Alternative 3.d.t6 as construction of the cover provides additional long-term protection from direct contact exposure threats when coupled with LUCs that control access to the SWMU once the cover is installed. Implementability is high under this alternative (though somewhat less implementable than the 1ft cover used in Alternative 3.a.t6). Materials for cover construction are common and routine construction methods would be needed to implement the cap. Administrative implementability would be moderate to high with few challenges associated with this alternative. The overall cost ranking is moderate to high with some degree of capital investment for cap construction and O&M cost associated with cap upkeep, in addition to monitoring costs.

8.3.3.5 Alternative 5.t6: Excavation and Disposal with Existing Feature

Alternative 5.t6.WDF Excavation and Disposal, WDF with Existing Feature

Alternatives 5.t6 and 5.t6.WDF, are moderate to high in overall effectiveness. Short-term effectiveness is moderate because site workers will have increased risk during the excavation, but this is balanced by the higher long-term effectiveness and permanence because COCs will be removed from the burial unit, likely eliminating the need for SWMU-specific monitoring or LUCs addressing the excavated areas. Overall implementability is moderate to high, mostly associated with technical and administrative challenges associated with excavation and management of excavated materials. The cost rating would be lower than with containment options; however, O&M costs would be lower than other alternatives. The overall cost rating range is low; however, the costs do vary significantly depending upon the disposal locations used in the evaluation.

8.3.4 General Alternatives Eliminated from Detailed Analysis for SWMU 30 Source Areas

As stated in Section 8.3.2, general alternatives that rely upon treatment either are not needed to address residual contamination or not effective to address the specific issues at SWMU 30. Therefore, those general alternatives that rely upon treatment (except for t6) are screened from further consideration at SWMU 30 and no SWMU specific alternatives are developed for those general alternatives.

Table 8.4 summarizes the results of alternative screening and SWMU-specific alternative development for SWMU 30. Alternatives that were screened out at this step are shaded grey on the table. Alternative 1 (no action) is not effective, but is retained for further consideration in the detailed analysis as a baseline alternative to which all other alternatives are compared, as required by CERCLA. Alternatives 4 and 7 are screened from further evaluation because no applicable treatment process options were retained through the effectiveness screening. Alternative 6 was screened from further evaluation because there are no delineated hot spot areas that effectively could be addressed by targeted excavation. Excavation of Burial Pit A is covered by Alternative 5 and still would require LUCs and monitoring for those areas not excavated.

8.4 DETAILED ANALYSIS OF ALTERNATIVES

8.4.1 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 is taken to implement remedial activities for SWMU 30 or to reduce the potential hazard to human or ecological receptors.

8.4.1.1 Overall protection of human health and the environment

No controls are included with the No Action alternative. Thus, this alternative does not meet the threshold criterion of protection of human health and the environment because the COCs remaining at the site pose an unacceptable threat under some future use scenarios, including an unrestricted future use. Although site controls existing outside of the remedy currently prevent a land use that would result in an unacceptable exposure, these controls are not established in a manner that would preclude future use that may pose an unacceptable risk.

8.4.1.2 Compliance with ARARs

No action-specific ARARs have been identified for Alternative 1, the No Action alternative.

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Table 8.4. SWMU-Specific Remedial Alternative Screening Summary for SWMU 30*

	1	2.t6	3.a.t6	3.d.t6	4	5.t6**	5.t6.WDF**	6**	7**
Screening Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, LUCs, and Monitoring with Existing Feature**	**Surface Cover, *In Situ* Source Treatment, LUCs and Long-Term Monitoring**	**Excavation and Disposal with Existing Feature**	**Excavation and Disposal, WDF with Existing Feature**	**Targeted Excavation and Disposal, Surface Cover, LUCs, Long-Term Monitoring, and CR**	**Targeted Excavation and Disposal, Surface Cover, LUCs, Long-Term Monitoring, and *In Situ* Source Treatment**
Overall Effectiveness	Low	High	Moderate to High	Moderate to High	N/A	High	High	N/A	N/A
Short-term	Low	High	High	Moderate to High	N/A	Moderate to High	Moderate to High	N/A	N/A
Long-term	Low	Moderate to High	Moderate to High	Moderate to High	N/A	High	High	N/A	N/A
Overall Implementability	High	High	High	High	N/A	Moderate	Moderate	N/A	N/A
Technical	High	High	High	Moderate	N/A	Moderate	Moderate	N/A	N/A
Administrative	High	High	High	High	N/A	High	High	N/A	N/A
Overall Cost	Low	Low	Low	Moderate	N/A	High	High	N/A	N/A
Capital	Low	Low	Low	Moderate	N/A	High	High	N/A	N/A
Operation and Maintenance	Low	Low	Low	Low	N/A	Low	Low	N/A	N/A

N/A = Not applicable based on-site conditions or nature of contamination present at the SWMU.
*Includes impact of existing Northwest Plume Pump-and-Treat System for all alternatives.
**Contingent remedies may be employed.
Alternatives shaded gray were screened out at this step.

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8.4.1.3 Long-term effectiveness and permanence

Alternative 1 does not provide long-term effectiveness or permanence because under some future scenarios, direct contact with wastes or contamination at levels above PRGs could occur. The alternative does not provide long-term controls to manage residual risk at this SWMU.

8.4.1.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 1 does not provide directly for a reduction of toxicity, mobility, or volume through treatment because there is no action taken; however, COCs leaving SWMU 30 and entering the RGA would be captured by the Northwest Plume Pump-and-Treat System for as long as that system is in operation.

8.4.1.5 Short-term effectiveness

This alternative is not considered to be effective in the short term because some potential exposure scenarios are not controlled sufficiently under all future use scenarios; however, there are no additional risks to workers, the public, or the environment incurred as a result of this alternative.

8.4.1.6 Implementability

The No Action alternative can be implemented readily. If future remedial action is necessary, this alternative would not impede implementation of other remedial activities.

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

8.4.1.7 Cost

The preliminary cost estimates for Alternative 1 serve as a baseline for comparison of the other remedial alternatives. These cost estimates are based upon FS-level scoping and are intended to aid with selection of a preferred alternative. There are no capital or O&M costs associated with Alternative 1; thus, the cost is low and the cost rating is high.

8.4.2 Alternative 2.t6—Limited Action (LUCs and Monitoring) with Existing Feature

This alternative eliminates direct contact risk to surface soils through existing plant controls that would be as extended, as necessary, by LUCs. This alternative also mitigates the uncertainties associated with leaving waste in place by monitoring any changes in SWMU status or condition that may warrant a response or action. This alternative recognizes the role played by the existing Northwest Plume Pump-and-Treat System.

This alternative will consist of the following actions as necessary:

- Perform remedial design;
- Develop a LUCAP; and
- Monitor, as needed.

8.4.2.1 Overall protection of human health and the environment

Alternative 2.t6 will meet the threshold criterion of protection of human health and the environment through the implementation of existing plant controls that would be extended, as necessary, by LUCs, that prevent contact with surface soils, subsurface soils, waste, and groundwater (as necessary). No waste-related COCs from SWMU 30 are identified as being a threat to RGA groundwater.

This criteria can be met through the use of LUCs. Additionally, while SWMU 30 poses no threats to groundwater, implementation of a monitoring program will be used to monitor continued attainment of this objective and/or identify any changes at the impacts from the SWMU.

8.4.2.2 Compliance with ARARs

Alternative 2.t6 meets the threshold criterion of compliance with chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix D.

8.4.2.3 Long-term effectiveness and permanence

Alternative 2.t6 provides moderate to high long-term effectiveness and permanence based on either continued DOE control of the site extended with enforceable LUCs to limit unacceptable exposure.

8.4.2.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 2.t6 does not include any alternative-specific treatment technologies; therefore, there is no credit for reduction in toxicity, mobility, or volume through treatment associated with the alternative. Should COCs migrate to the RGA and downgradient of SWMU 30, they will be captured by the Northwest Plume Pump-and-Treat System for as long as that system is in operation, reducing the toxicity and volume of COCs through treatment.

8.4.2.5 Short-term effectiveness

Implementation of Alternative 2.t6 is effective quickly and includes only minor potential for worker exposure to contaminated surface soils and groundwater during monitoring well installation or environmental sampling. Potential exposure pathways include inhalation of dust containing surface soils, dermal contact with surface or subsurface soils (depending on activity), and dermal contact with contaminated groundwater. PGDP worker protection programs will make worker exposure unlikely.

Implementation of Alternative 2 would not have detrimental impacts on the community.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. No known archaeological or historical sites or T&E species would be impacted by this alternative. Risk assessment for ecological receptors in nearby drainage ditches are within the scope of the Surface Water OU.

At the time that implementation of each component of Alternative 2.t6 is completed, the alternative will be effective. Implementation of Alternative 2.t7 is expected to take several months.

8.4.2.6 Implementability

Activities to be conducted under Alternative 2.t6 include continuing/expanding monitoring. Implementation of the remedial action components of Alternative 2.t6 is feasible technically.

Implementation of Alternative 2.t6 would use standard construction methods, materials, and equipment that are available from vendors and contractors.

8.4.2.7 Cost

Estimated capital and O&M costs for Alternative 2.t6 include development of LUCs, installation and sampling of an MW network, and surface water sampling and analysis, as needed. This alternative does not include any costs for operation of the Northwest Plume Pump-and-Treat System. Costs are considered low; thus, the cost ranking for this alternative is high.

8.4.3 Alternative 3a.t6: Soil Cover, LUCs, and Monitoring with Existing Feature

This alternative combines process options from the LUCs, monitoring, and containment GRAs. Unless identified otherwise, the LUCs and monitoring features shall be assumed to be comparable to Alternative 2.

A soil cover consisting of 12 inches of clean topsoil will provide a protective barrier over soils and waste cells containing residual contamination. The cover will prevent wind transport of contaminants and, in combination with plant controls, extended through LUCs, as necessary, to protect humans and wildlife from coming into direct contact with the contaminated materials. The soil cover will be sloped to facilitate runoff and is expected to be planted with native vegetation to reduce erosion and to support evapotranspiration. This type of cover will reduce infiltration somewhat; however, this alternative is not considered appropriate for sites that require control of infiltration to meet RAOs.

This alternative is suitable at SWMU 30 because there are no identified threats to groundwater from SWMU-sourced COCs. This alternative is expected to address the intermittent surface water issue by reducing the infiltration to the waste cells and reducing the permeability of the cover at the waste cell interface along the north ditch. In addition, this alternative will address some uncertainty related to the potential for groundwater contamination from SWMU 30 that arises because of limited source term data and relatively few monitoring wells, because this SWMU is immediately upgradient of the Northwest Plume Pump-and-Treat System.

The specific LUC details and monitoring programs will be developed in accordance with the LUCAP and the Environmental Monitoring Program (EMP) for the PGDP. If this alternative is selected, a design will be developed in the RAWP; also a LUCIP will be developed.

This alternative will consist of the following, as necessary:

- Perform remedial design;
- Install soil cover;
- Establish LUCs; and
- Install monitoring wells and conduct groundwater and surface water monitoring, as needed.

8.4.3.1 Overall protection of human health and the environment

Construction of a surface soil cover over the SWMU, in conjunction with LUCs will control the potential for exposure to contaminated soils and wastes. The elements directly attributable to this alternative will not provide a reduction in toxicity, mobility, or volume of contaminants; however, the Northwest Plume Pump-and-Treat System will contribute to reduction of toxicity or volume of SWMU 30 constituents that did migrate from the unit through the RGA groundwater.

Additionally, while SWMU 30 poses no threats to groundwater, implementation of a monitoring program will be used to monitor continued attainment of this objective and/or identify changes at the impacts from the SWMU.

8.4.3.2 Compliance with ARARs

Alternative 3.a.t6 meets this threshold criterion by complying with chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix D.

8.4.3.3 Long-term effectiveness and permanence

Alternative 3.a.t6 is designed to provide protection against exposure to waste, surface soil, and subsurface soil. The long-term effectiveness and permanence is moderate to high because the cover and plant controls/LUCs combine to limit exposure. Because the toxicity or volume of waste and contaminated environmental media is not expected to attenuate significantly, the LUCs will have to be maintained indefinitely to prevent unrestricted use of this facility; thus, there is some potential threat to long-term effectiveness associated with the challenge of maintaining LUCs indefinitely.

8.4.3.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 3.a.t6 recognizes there is no alternative-specific reduction in toxicity, mobility, or volume through treatment (although it also recognizes the role of the Northwest Plume Pump-and-Treat System as controlling RGA groundwater flow below SWMU 30 and capturing released COCs). COCs released to the RGA would be controlled by the Northwest Plume Pump-and-Treat System for as long as that system is in operation. Therefore, there is a potential for some reduction of toxicity, mobility or volume through treatment.

8.4.3.5 Short-term effectiveness

Alternative 3.a.t6 could be implemented and be effective in a relatively short time frame. Implementation of Alternative 3.a.t6 would not have detrimental impacts on the community.

Implementation of Alternative 3 includes the potential for worker exposure to contaminated soils or wastes or groundwater during cover construction and monitoring. PGDP worker protection programs will make worker exposure unlikely.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. In fact, surface soil quality will improve upon implementation. No known archaeological or historical sites or T&E species would be impacted by this alternative. Risk assessment for ecological receptors in nearby drainage ditches are within the scope of the Surface Water OU. At the time that implementation of each component, Alternative 3.a.t6 will be effective. Implementation of Alternative 3.a.t6 is expected to take several months.

8.4.3.6 Implementability

Activities to be conducted under Alternative 3.a.t6 include development of LUCs, construction of a soil cover, and continuing/expanding existing environmental media monitoring.

Implementation of the remedial action components of Alternative 3 is feasible technically.

Implementation of Alternative 3 would use standard construction methods, materials, and equipment that are available from vendors and contractors.

Based on observations during the summer of 2011, seeps from SWMU 30 into the ditch running parallel to the SWMU along its north border, indicate that infiltrated water may be spilling over a compromised sidewall that forms the combined waste cell/ditch wall. This suggests that the waste extends to near the edge of the ditch. Under this alternative, the waste pit/ditch interface will be addressed to minimize the potential for overflow of the waste cell into the ditch. The means of addressing this issue will be outlined in the RAWP.

8.4.3.7 Cost

The estimated capital and O&M costs for Alternative 3.a.t6 include costs for construction and maintenance of the soil cover as well as LUCs, and monitoring as outlined in Alternative 2.t6. The cost of this alternative is low; thus, the cost rating of this alternative is high.

8.4.4 Alternative 3.d.t6: Subtitle D Cap, LUCs, and Monitoring with Existing Feature

This alternative combines the design and installation of a Subtitle D cap with LUCs and monitoring. The components of the cap are detailed in Section 2.4. This cover limits exposure to wastes and contaminated media while also limiting infiltration of precipitation of surface water through the unit. As necessary, LUCs will be required to extend existing plant controls to ensure that the cover is not breached.

8.4.4.1 Overall protection of human health and the environment

Alternative 3.d.t6 meets this threshold criterion for SWMU 30 through a combination of a cover and LUCs. A cover provides a physical barrier between potential receptors and wastes/affected media, thus preventing direct contact and the associated risk. LUCs help ensure that this cover is not breached and also limits the potential for exposure to wastes and affected media.

The cover used in this alternative provides a significant reduction in infiltration of rainwater that will reduce the mobility of water-soluble contaminants, if present. Because the COCs at SWMU 30 are considered nonmobile and COCs are not present at levels that pose a groundwater threat, the reduction in infiltration does not reduce the SWMU-derived risk and comes at a significant cost premium. Given the location of the Northwest Plume Pump-and-Treat System nearby, there is no measurable value to RGA groundwater protection by the greater limit to infiltration.

8.4.4.2 Compliance with ARARs

Alternative 3.d.t6 will meet this threshold criterion by complying with chemical-, location-, and action-specific ARARs. ARARs for this alternative are summarized in Appendix D.

8.4.4.3 Long-term effectiveness and permanence

Alternative 3.d.t6 is designed to provide protection against exposure to waste, surface soil, and subsurface soil; thus, it is moderately to highly effective in regard to long-term effectiveness and permanence. The long-term effectiveness and permanence is moderate to high because the cover and LUCs combine to limit exposure. Because the toxicity or volume of waste and contaminated environmental media is not expected to attenuate significantly, the LUCs will have to be maintained indefinitely to prevent unrestricted use of this facility; thus, there is some potential threat to long-term effectiveness associated with the challenge of maintaining LUCs indefinitely.

8.4.4.4 Reduction of toxicity, mobility, or volume through treatment

Alternative 3.d.t6 recognizes there is no alternative-specific reduction in toxicity, mobility, or volume through treatment, although it also recognizes the role of the Northwest Plume Pump-and-Treat System as controlling RGA groundwater flow below SWMU 30. COCs released to the RGA would be controlled by the Northwest Plume Pump-and-Treat System for as long as that system is in operation; therefore, there is a potential for reduction of toxicity, mobility, or volume through treatment.

8.4.4.5 Short-term effectiveness

Alternative 3.d.t6 could be implemented and be effective in a relatively short time frame. Implementation of Alternative 3.d.t6 would not have detrimental impacts on the community.

Implementation of Alternative 3.d.t6 includes the potential for worker exposure to contaminated soils or wastes or groundwater during cover construction and monitoring. PGDP worker protection programs will make worker exposure unlikely.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. In fact, surface soil quality will improve upon implementation. No known archaeological or historical sites or T&E species would be impacted by this alternative. Risk assessment for ecological receptors in nearby drainage ditches are within the scope of the Surface Water OU. At the time that implementation of each component , the remedy will be effective. Implementation of Alternative 3.d.t6 is expected to take several months.

8.4.4.6 Implementability

Activities to be conducted under Alternative 3.d.t6 include development of LUCs, construction of a soil cover, and continuing/expanding existing environmental media monitoring.

Implementation of the remedial action components of Alternative 3.d.t6 is feasible technically.

Implementation of Alternative 3.d.t6 would use standard construction methods, materials, and equipment that are available from vendors and contractors.

Based on observations during the summer of 2011, seeps from SWMU 30 into the ditch running parallel to the SWMU along its north border, indicate that infiltrated water may be spilling over a compromised sidewall that forms the combined waste cell/ditch wall. This suggests that the waste extends to near the edge of the ditch. The cover in this alternative would reduce infiltration and minimize the potential for overflow of the waste cell into the ditch.

8.4.4.7 Cost

The estimated capital and O&M costs for Alternative 3.d.t6 include costs for construction and maintenance of the soil cover and implementation of LUCs and monitoring as outlined in Alternative 2.t6. The cost of this alternative is low to moderate, and the cost rating is moderate to high.

8.4.5 Alternative 5.t6: Excavation and Disposal with Existing Feature

Alternative 5.t6.WDF: Excavation and Disposal, WDF with Existing Feature

Alternatives 5.t6 and 5.t6.WDF incorporates the GRAs of removal, LUCs, and monitoring, as needed. These alternatives envision excavation of burial cells to the bottom of the waste (maximum depth of 16–20 ft); waste disposal characterization sampling; excavation pit dewatering; and packaging, transporting, and disposing of wastes in accordance with the WAC of the to-be-selected disposal facilities. Areas not subjected to excavation will be addressed by LUCs and monitoring. These alternatives are described in detail in Section 3.

These alternatives are based on excavating approximately 20% of the total SWMU 30 area—that area identified as affected per the geophysical survey. Excavation and disposal of waste materials is based on removal of approximately 15,000 yd^3 (in place) of contaminated waste materials. The loose volume of this excavated waste is approximately 18,000 yd^3 to account for expansion upon removal with nonhazardous solid waste being disposed of at the C-746-U Landfill (10,300 yd^3). The LLW/MLLW (7,500 yd^3) would be disposed of either off-site at a licensed commercial or federal facility or a potential on-site WDF, if available. The following provides assumptions for the area and volumes of excavated waste from SWMU 30:

Total SWMU area: 120,000 ft^2
Excavation area: 20,000 ft^2
Excavation depth: 20 ft (max)
In place volume: 14,815 yd^3
Loose volume: 17,778 yd^3
Nonhazardous solid waste volume: 10,300 yd^3
LLW volume: 5,625 yd^3
MLLW volume: 1,875 yd^3

Additional assumptions for excavation, transportation, disposal, treatment, excavation dewatering, etc., for SWMU 30 can be found in Appendix E.

Alternatives 5.t6 and 5.t6.WDF would remove risk from SWMU 30 through excavation and disposal. However, this alternative also relies on LUCs to address risks or uncertainties from areas not subjected to excavation. This alternative provides the best long-term effectiveness and permanence for those areas subject to excavation but at a much higher cost than other alternatives.

8.4.5.1 Overall protection of human health and the environment

Alternatives 5.t6 and 5.t6.WDF would meet this threshold criterion. There are manageable potential short-term risks to remediation workers due to direct contact with the waste material and inhalation hazards are much larger than any of the other alternatives evaluated for SWMU 30. In addition, there are manageable potential risks to the public and the environment that could result from shipping and handling of wastes sent off-site. Any exposure concerns are reduced for disposal in a potential on-site WDF or at the C-746-U Landfill.

Waste and contaminated soil will be removed from the SWMU and disposed of in one or more appropriate disposal facilities, including a potential on-site WDF, thus meeting all RAOs.

8.4.5.2 Compliance with ARARs

Alternatives 5.t6 and 5.t6.WDF would meet this threshold criterion. ARARs for this alternative are summarized in Appendix F.

8.4.5.3 Long-term effectiveness and permanence

Complete excavation offers the most effective and permanent management of contaminants because no wastes or associated contaminated soils would remain in the SWMU.

Alternatives 5.t6 and 5.t6.WDF allow for potential risks associated with contaminants in SWMU 30 to be reduced or eliminated. Risks associated with direct contact with waste and surface soils will be eliminated since the primary source and associated contaminated soils will be removed; however, since only 20% of the footprint is expected to be excavated, there is some uncertainty concerning whether there are buried wastes or affected soils in other locations within the SWMU boundary. These alternatives allow for a reduction of uncertainties associated with those excavated areas, but do rely on plant controls extended through LUCs, as necessary, to reduce the uncertainties in other areas.

8.4.5.4 Reduction of toxicity, mobility, or volume through treatment

These alternatives reduce or eliminate the toxicity, mobility, or volume of contaminants from the unit, though not by using treatment. Although no mobile COCs are known to be present at levels of concern in the SWMU, the removal and disposition of wastes and contaminated soil from the burial cell reduces the uncertainty associated with this determination. These alternatives rate low-to-moderate against this criterion.

8.4.5.5 Short-term effectiveness

Short-term risks to the community resulting from excavation activities at the SWMU are not expected. Potential risks resulting from migration of airborne contaminants to off-site locations would be controlled as detailed in the RAWP. These alternatives, however, include a potential risk to site workers and the public from excavation and transportation of the wastes, soil, or liquids to disposal and/or treatment facilities. The risks to the public would be reduced greatly by disposing of waste in a potential on-site WDF.

Short-term exposures of workers to COCs during implementation of Alternatives 5.t6 and 5.t6.WDF could occur. Worker risks are not expected to exceed acceptable limits because exposure frequency and duration are less than those evaluated in the BHHRA. Risks from handling waste/contaminated soils will 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, site-specific HASP.

The remedy would be effective immediately upon excavation for the excavated areas. Excavation, treatment, and disposal of residuals could be accomplished in approximately three years. Excavation and disposal would be conducted by trained personnel in accordance with standard radiological, engineering, and operational procedures, DSAs, HASPs, and safe work practices to maintain a work environment that minimizes injury or exposure to risks to human health or the environment. LUCs and monitoring will be applied to nonexcavated areas, as per Alternative 2.t6, to address uncertainties associated with the potential presence of buried wastes and/or affected soils at other areas within the SWMU boundary.

No ecological impacts at the BGOU are anticipated under this alternative. The BGOU is located at an active operational facility already disturbed by construction and operational activities and does not support any unique or significant ecological resources. Final backfill, cover soils, and vegetation will be improvements on existing conditions for ecological receptors. No known archaeological or historical sites or T&E species would be impacted by this alternative. Risk assessment and mitigation for ecological receptors in nearby drainage ditches is within the scope of the Surface Water OU.

8.4.5.6 Implementability

These alternatives are considered to be technically and administratively feasible and implementable. The equipment and technologies associated with implementation of this alternative have been proven to be feasible technically and are available from contractors or vendors. The implementability of construction-related activities during excavation and backfilling is very similar to that carried out routinely at other sites, so it is considered high. Likewise, sampling, analysis, transportation, and disposal at an approved location are performed routinely and, if properly implemented, are proven to be safe. Some excavated waste materials may be radioactive, RCRA hazardous, or mixed. Treatment of wastes or associated media with multiple regulatory classifications is more complex and may require more than one treatment process to make the excavated material suitable for transportation and/or land disposal. On-site treatment processes will comply with ARARs. An option for disposal of waste and residuals at a potential on-site WDF is considered in the costing of this alternative. The primary difference in implementability would be the elimination of excavated materials leaving the PGDP, related off-site transportation issues, and a reduced cost for disposal.

8.4.5.7 Cost

Costs were estimated for transportation and disposal of wastes at an off-site facility as well as for an option to dispose of waste at a potential on-site WDF.

Transportation and disposal costs for Alternatives 5.t6 and 5.t6.WDF are based on a total volume of approximately 18,000 yd^3 of excavated waste composed of nonhazardous solid and LLW/MLLW categories. It is assumed that all of the MLLW will require treatment prior to disposal. For estimating purposes, it is assumed that waste being disposed of off-site also would receive treatment off-site, if necessary. If a potential on-site WDF is available, the LLW/MLLW would be transported via trucks, dump-trailers, or equivalent for on-site disposal. Costs for this alternative are estimated to be high; therefore, the cost rating is low. The on-site disposal option will have somewhat lower costs; however, the cost rating will be slightly higher for the on-site disposal option.

8.5 COMPARATIVE ANALYSIS OF ALTERNATIVES

A comparative analysis summary for source area alternatives for SWMU 30 is presented in Table 8.2 and the corresponding costs for the alternatives are presented in Table 8.3.

8.5.1 Threshold Criteria

Source area remedial alternatives are compared with respect to the threshold criteria in the following sections.

8.5.1.1 Overall protection of human health and the environment

Alternative 1 does not meet the threshold criterion of overall protection of human health and the environment as it does not prevent direct contact risk. All other alternatives meet this threshold criterion, as follows.

- Alternative 2.t6 meets this threshold criterion by eliminating exposure pathways through current plant controls, extended by LUCs, as necessary.

- Alternative 3.a.t6 meets this threshold criterion through control of exposure to buried materials through containment and current plant controls, extended as necessary through LUCs. The soil cover will ensure surface drainage and will reduce infiltration somewhat. There are no unacceptable risks to groundwater from SWMU 30 COCs; thus, infiltration reduction is not required to meet PRGs. The infiltration reduction and placement of the cover are expected to address the intermittent seep.

- Alternative 3.d.t6 meets the threshold criterion through control of exposure to buried materials through containment and current plant controls/LUCs. This cover will ensure surface drainage and will reduce infiltration greatly. There are no unacceptable risks to groundwater from SWMU 30; thus, this alternative is not detectably more protective at a much higher cost. The infiltration reduction and placement of the cover is expected to address the intermittent seep.

· Alternatives 5.t6 and 5.t6.WDF meets the threshold criterion by removing waste and contaminated soil from the SWMU. This alternative will remove wastes and contaminated media so that the remaining soil in the excavated areas at the SWMU would meet soil target concentrations. The LUCs and monitoring would be used to supplement the excavation to address the uncertainty that those areas that are not known to be contaminated may have buried materials.

8.5.1.2 Compliance with ARARs

No ARARs have been identified for Alternative 1.

Alternative 2.t6 does not have physical actions; thus, it does not have action-specific ARARs.

Alternative 3.a.t6 meets this threshold criterion because the cover placement does not have action-specific ARARs.

Alternative 3.d.t6 meets the threshold criterion. In addition, this alternative would meet the standards of a Subtitle D cap that may be considered to be an ARAR.

Alternatives 5.t6 and 5.t6.WDF meet this threshold criterion.

8.5.2 Balancing Criteria

Source area alternatives are compared with respect to the balancing criteria in the following sections.

8.5.2.1 Long-term effectiveness and permanence

Alternative 1 would not be effective. While current plant controls prevent direct contact, Alternative 1 does not provide for LUCs to maintain this degree of protection in the long-term.

Alternative 2.t6 provides a moderate degree of long-term effectiveness through the implementation of LUCs.

Alternatives 3.a.t6 and 3.d.t6 provide a moderate to high degree of long-term effectiveness and permanence by providing protection against exposure to waste in surface soils and ensuring that that protection is maintained through LUCs. The Northwest Plume Pump-and-Treat System will supplement the LUCs by collecting COCs that migrate to the RGA. Alternative 3.d. also controls infiltration; however, there is no indication of an unacceptable risk from migration to groundwater.

Alternatives 5.t6 and 5.t6.WDF provide a high degree of long-term effectiveness and permanence for those excavated areas. Uncertainties are addressed through the application of LUCs and monitoring. This alternative has the highest effectiveness and permanence.

8.5.2.2 Reduction of toxicity, mobility, or volume through treatment

All alternatives recognize the existence of the Northwest Plume Pump-and-Treat System, and each takes approximately the same degree of credit for reduction of toxicity, mobility, or volume through treatment.

Alternatives 2.t6, 3.a.t6, and 3.d.t6 provide no incremental reduction. All of these alternatives score low on this criterion.

Alternatives 5.t6 and 5.t6.WDF reduce toxicity and volume by removal, treatment, and disposal of wastes and associated media. This alternative scores low to moderate for this criterion because the reduction is not accomplished through treatment.

8.5.2.3 Short-term effectiveness

The short-term effectiveness of Alternative 1 is low because it is not protective of human health and the environment; thus, it is not effective.

Alternative 2.t6 is considered highly effective. The alternative is effective quickly and there is very little risk to workers or the community.

Alternatives 3.a.t6 and 3.d.t6 are considered moderately to highly effective. Alternative 3.d.t6 scores slightly lower than Alternative 3.a because there is increased field activity required to install cover, which presents more potential risks to workers.

The short-term effectiveness of Alternatives 5.t6 and 5.t6.WDF is moderate when compared to the other alternatives based on the risks of increased fieldwork and transportation. Disposal at a potential on-site WDF would result in somewhat higher overall short-term effectiveness by eliminating risks associated with wastes leaving the site.

8.5.2.4 Implementability

Alternative 1 would be the most readily implementable alternative because no construction or invasive action would be taken.

The implementability of Alternatives 2.t6 and 3.a.t6 is high because the technology is readily available and the complexity is low.

The implementability of Alternative 3.d.t6 is moderate to high due to the increased complexity and quality requirements of a Subtitle D cap.

Alternatives 5.t6 and 5.t6.WDF are considered to have a moderate to high implementability due to the somewhat more extensive complexity of the work.

8.5.2.5 Cost

Cost rankings were developed to rank the low cost items with a high rating and high cost items with a low rating. Costs are summarized in Table 8.3. Alternatives 2.t6 and 3.a.t6 have high ratings for cost. Alternative 3.d.t6 has a moderate to high cost rating. Alternative 5.t6 has a low cost rating. Alternative 5 costs were estimated for transportation and disposal of wastes at an off-site facility as well as for an option to dispose of waste at a potential on-site WDF. The cost rating for the on-site disposal option Alternative 5.t6.WDF is slightly higher than that for the off-site disposal option.

Table 8.5. Summary of Comparative Analysis of Alternatives for SWMU 30*

	Alternative 1	Alternative 2.t6	Alternative 3.a.t6	Alternative 3.d.t6	Alternative 5.t6	Alternative 5.t6.WDF
Evaluation Criteria	**No Action**	**Limited Action (LUCs and Monitoring) with Existing Feature**	**Soil Cover, LUCs, and Monitoring with Existing Feature**	**Subtitle D Cap, LUCs, and Monitoring with Existing Feature**	**Excavation and Disposal with Existing Feature**	**Excavation and Disposal, and WDF with Existing Feature**
Overall Protection of Human Health and the Environment	Does not meet the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Compliance with ARARs	N/A	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion	Meets the threshold criterion
Long-Term Effectiveness, Permanence	Low (0)	Moderate to High (6)	Moderate to High (7)	Moderate to High (7)	High (8)	High (9)
Reduction in Toxicity, Mobility, or Volume through Treatment	Low (0)	Low (1)	Low (1)	Low (1)	Low to Moderate (2)	Low to Moderate (2)
Short-Term Effectiveness	Low (1)	Moderate to High (7)	Moderate to High (7)	Moderate to High (7)	Moderate (4)	Moderate (5)
Implementability	High (9)	High (9)	High (9)	High (8)	Moderate to High (7)	Moderate to High (7)
Cost * Present Worth Cost	High (9) $0	High (9) $3,549,000	High (9) $5,000,000	High (7) $7,322,000	Low to Moderate (3) $38,164,000	Low to Moderate (3) $17,629,000
Average Balancing Criteria Rating	3.8	6.4	6.6	6.0	4.8	5.2

*High overall cost rating corresponds to a low project cost relative to the site.
t6 = Alternatives 2 through 7 include impact of existing Northwest Plume Pump-and-Treat System.
WDF = Alternative includes the option of disposal in a potential On-Site Waste Disposal Facility.
Alternative Rating Guide: Balancing criteria are scored from 0 (worst) to 9 (best) for each alternative. The qualitative and numerical ratings correspond as follows:
9 = High; 7 = Moderate to High; 5 = Moderate; 3 = Low to Moderate; 1 = Low

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APPENDIX A

INFORMATION SUPPORTING EVALUATION OF BGOU COCs

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CONTENTS

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TABLES

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ACRONYMS

BHHRA	Baseline Human Health Risk Assessment
COC	contaminant of concern
ELCR	excess lifetime cancer risk
FS	feasibility study
HI	hazard risk
MCL	maximum contaminant level
NAL	no action levels
PRG	preliminary remediation goal
RAO	remedial action objectives
SWMU	solid waste management unit

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A.1 INFORMATION SUPPORTING EVALUATION OF BGOU COCs

This appendix provides figures illustrating the distribution of contaminants of concern (COCs), including supporting data used to further address uncertainties that are referred to in discussions in other sections of this report. These data are the Burial Grounds Operable Unit (BGOU) surface and subsurface soil results used to characterize potential releases from the waste. The soils data may not be representative of the contamination present within the units themselves. This feasibility study (FS) addresses potential impacts from waste and affected media. The soil data presented in this appendix identify the potential additional volume of impacted media that will need to be addressed over and above the buried wastes.

The figures in this appendix show where the target compounds to be addressed in this FS are at concentrations that exceed the preliminary remediation goals (PRGs) for direct contact (Table A.1; see Appendix C) and protection of groundwater (Table A.2; see Appendix B). The PRGs for direct contact are used to identify locations where actions may be required, with the general remedial action objectives (RAOs) set to meet the following targets for cumulative excess lifetime cancer risk (ELCR) and cumulative noncancer hazard risk (HI) at the solid waste management units (SWMUs).

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

The COCs for direct contact were identified in the Waste Area Grouping 22 Baseline Human Health Risk Assessment (BHHRA). The BGOU Remedial Investigation identified that samples collected subsequent to completion of that assessment pose an uncertainty. This uncertainty is addressed in this FS by identifying those specific sample locations in which the target RAO is exceeded by comparing concentrations at these locations to no action levels (NALs) and background (see Appendix C). This process was used to demonstrate that meeting PRGs is expected to allow the remedy to meet RAOs, identifying all locations where the RAO is exceeded and confirming that no additional chemicals in these additional data are needed to select the remedy. This concept was incorporated into development of the figures for SWMUs 2, 3, 7, and 30 to illustrate that the PRGs appropriately identify risks/hazards at these SWMUs.

Table A.1. PRGs for Direct Contact

Target Compound	Direct Contact PRGs		Basis	SWMU
	Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*		
Arsenic	12	20.8	Background/ NAL [b]**	2, 7
Uranium (soluble salts)	535	290	NAL[a]	7, 30
Uranium-234+D	94.5	142	NAL[b]	7, 30
Uranium-235/236	1.98	22.8	NAL[b]	7, 30
Uranium-235+D	1.98	22.8	NAL[b]	2,3
Uranium-238+D	8.50	58.5	NAL[b]	2, 3, 7, 30
Neptunium-237+D	1.36	16.4	NAL[b]	7, 30
Plutonium-239+D	N/A	81.0	NAL[b]	7, 30

Table A.1. PRGs for Direct Contact (Continued)

Target Compound	Direct Contact PRGs		Basis	SWMU
	Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*		
Total PAHs	0.296	2.42	NAL[b]	7, 30
Total PCBs	10	10	RM [c]	30

*mg/kg for chemicals or pCi/g for radionuclides.
**Background = 12 mg/kg surface soil; NAL[b] for subsurface soils.
N/A = not applicable.
NAL = no action level; NAL values are given in Table A.4 of the 2011 Risk Methods Document (DOE 2011b).
[a] The PRG for surface soil is 5 times the NAL for the industrial worker, and for subsurface soils, 5 times the NAL for the outdoor worker. These correspond to a noncancer hazard quotient of 0.5.
[b] The PRG for surface soil is 5 times the NAL for the industrial worker, corresponding to a cancer risk of 5E-6. For subsurface soils, the PRG is 50 times the NAL for the outdoor worker corresponding to a cancer risk of 5E-5.
[c] Risk management level for PCBs
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl

Table A.2. PRGs for Protection of Groundwater

SWMU	Target Compound	MCL (mg/L) (pCi/L)*	Groundwater Protective PRG for Soil (mg/kg) (pCi/g)*
2	Arsenic	0.01	16.9
	cis-1,2-DCE	0.07	1.34
	TCE	0.005	0.311
3	Technetium-99	900	21.2
7	Arsenic	0.01	16.9
	1,1-DCE	0.007	0.773
	TCE	0.005	0.234
	Technetium-99	900	21.2
	Vinyl chloride	0.002	0.533
30	Technetium-99	900	21.2

*mg/kg for chemicals or pCi/g for radionuclides.
See Appendix B for derivation of PRGs.
MCLs from Table A.14 of the Risk Methods Document (DOE 2011b).
The MCL listed above for technetium-99 is based on 4 mrem/yr, using historical dosimetry assumptions.
DCE = dichloroethene
MCL = maximum contaminant level
TCE = trichloroethene

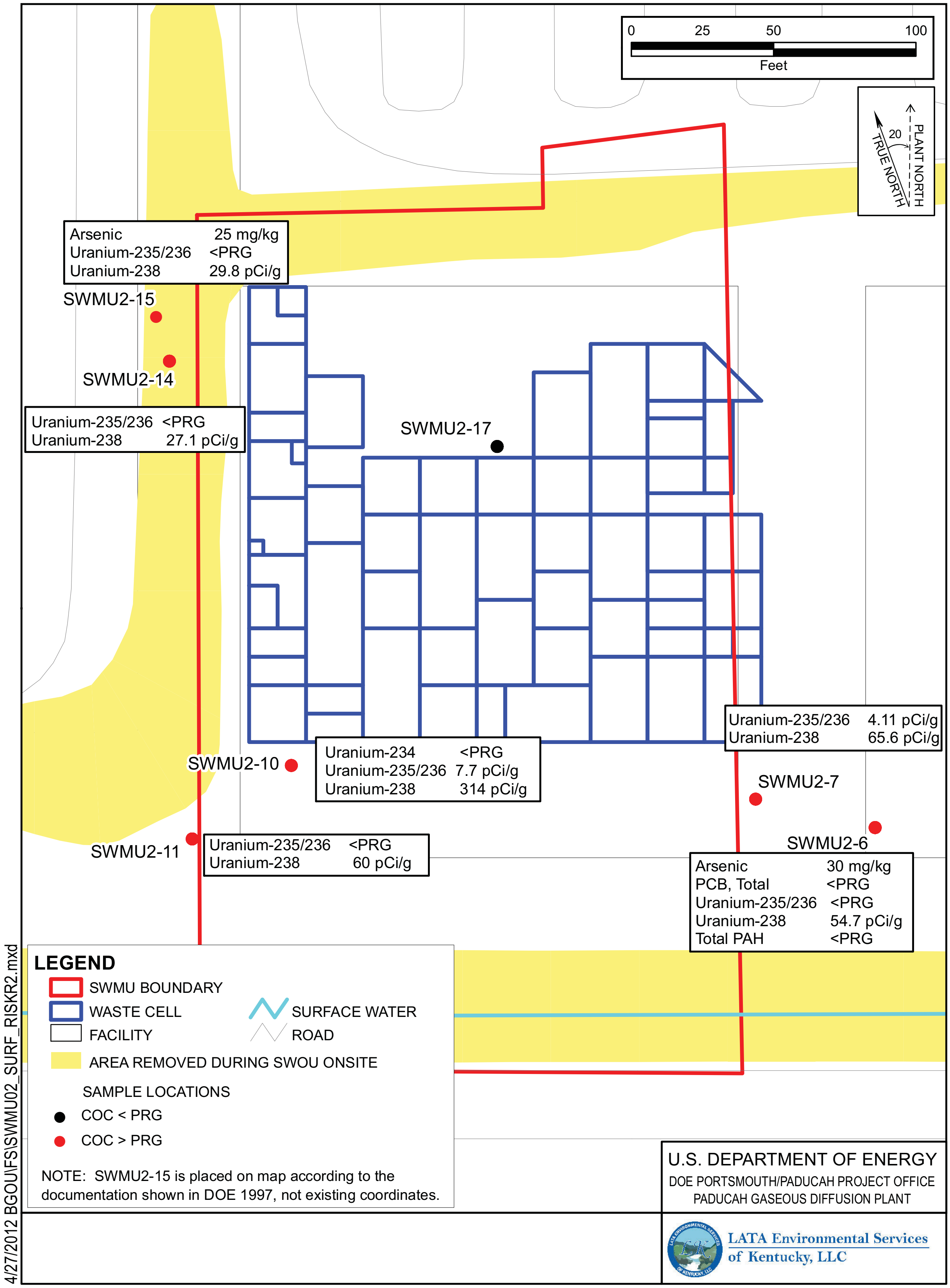
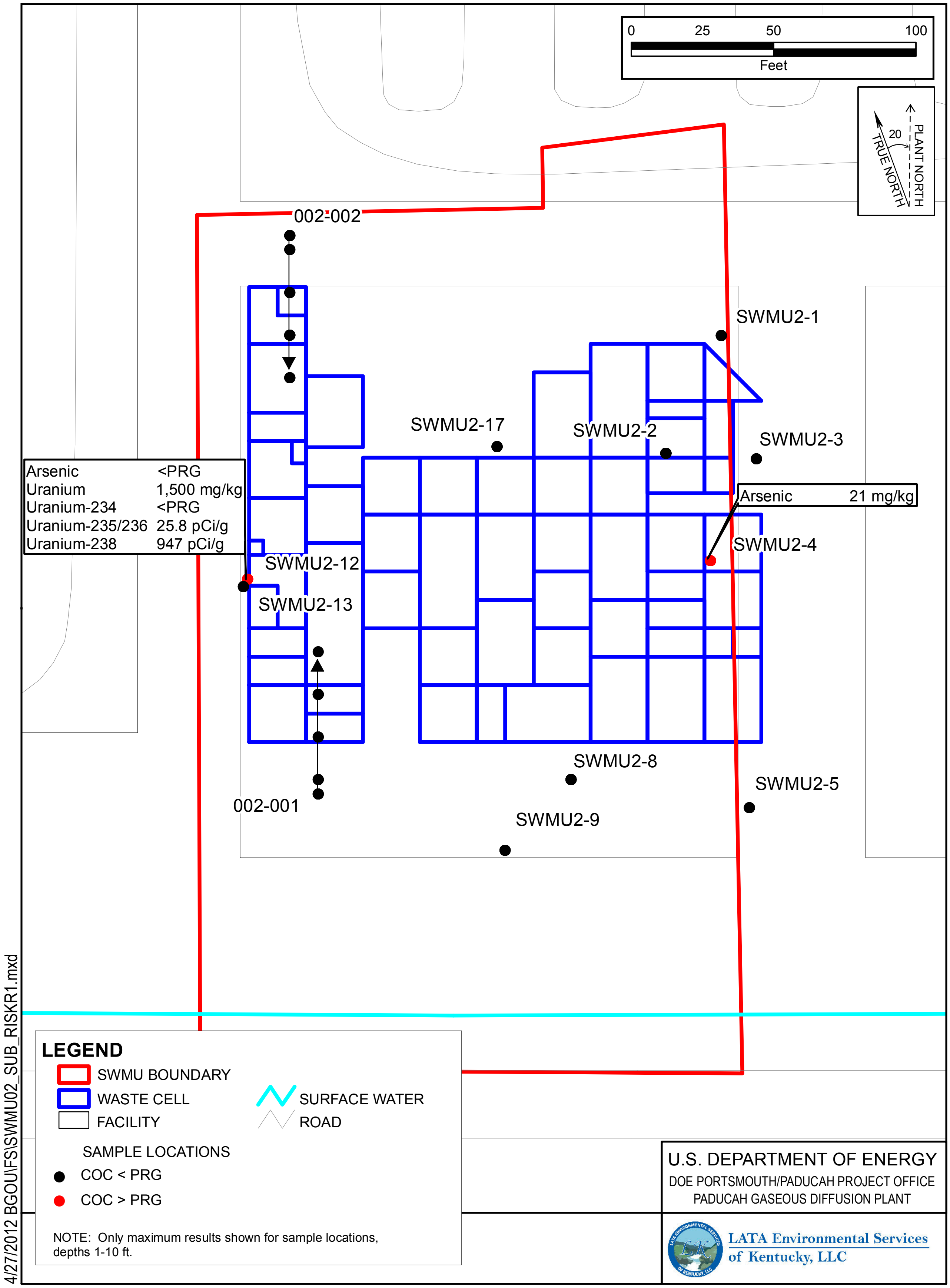


Figure A.1. SWMU 2—Future Industrial Worker Surface Soil


0
25
50
100
Feet
20
PLANT NORTH
TRUE NORTH
002-002
SWMU2-1
SWMU2-17
SWMU2-2
SWMU2-3
Arsenic <PRG
Uranium 1,500 mg/kg
Uranium-234 <PRG
Uranium-235/236 25.8 pCi/g
Uranium-238 947 pCi/g
Arsenic 21 mg/kg
SWMU2-4
SWMU2-12
SWMU2-13
SWMU2-8
SWMU2-5
002-001
SWMU2-9
LEGEND
SWMU BOUNDARY
WASTE CELL
FACILITY
SURFACE WATER
ROAD
SAMPLE LOCATIONS
COC < PRG
COC > PRG
NOTE: Only maximum results shown for sample locations, depths 1-10 ft.
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT
LATA Environmental Services of Kentucky, LLC
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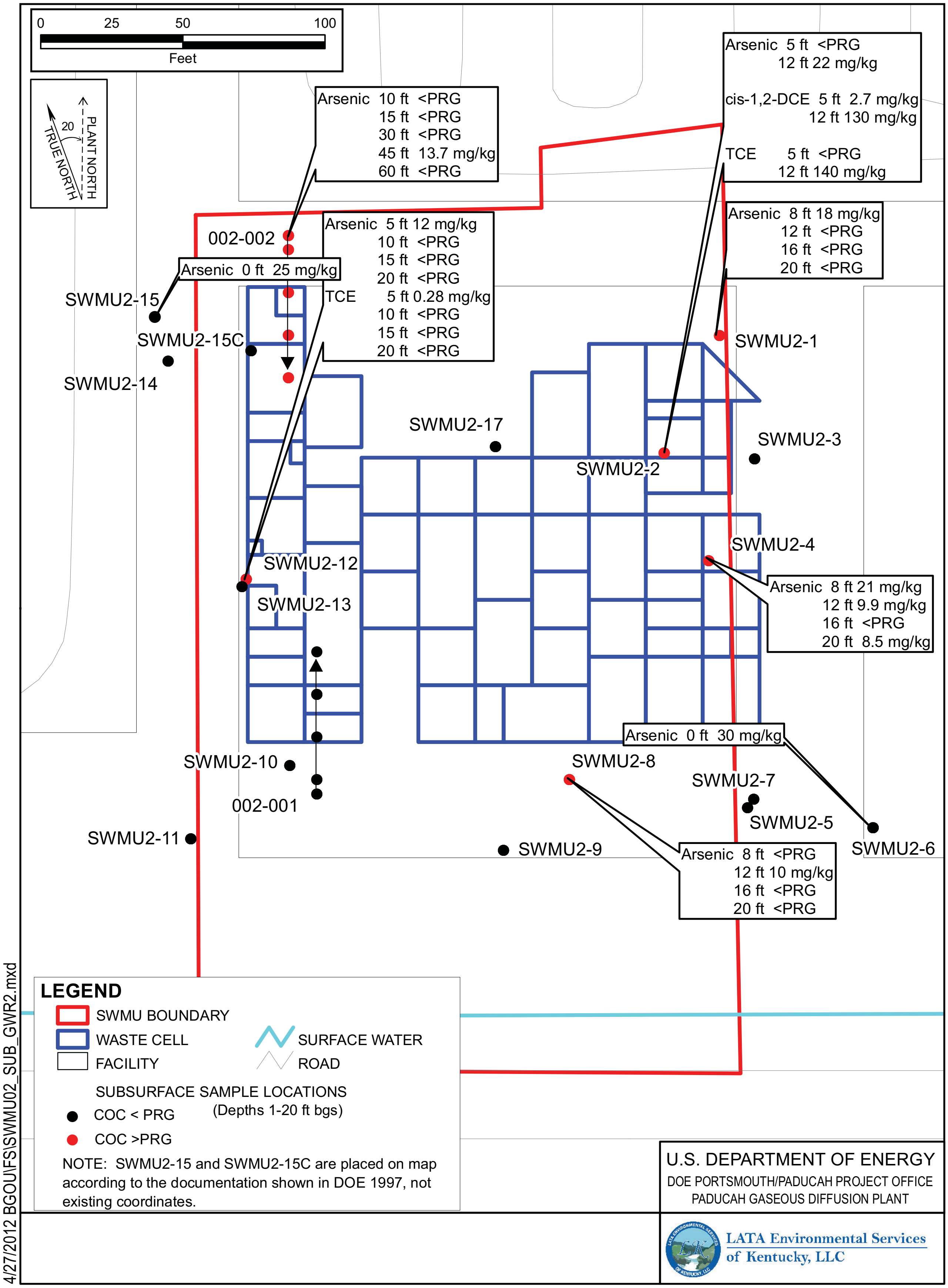

Figure A.3. SWMU 2—Protection of Groundwater

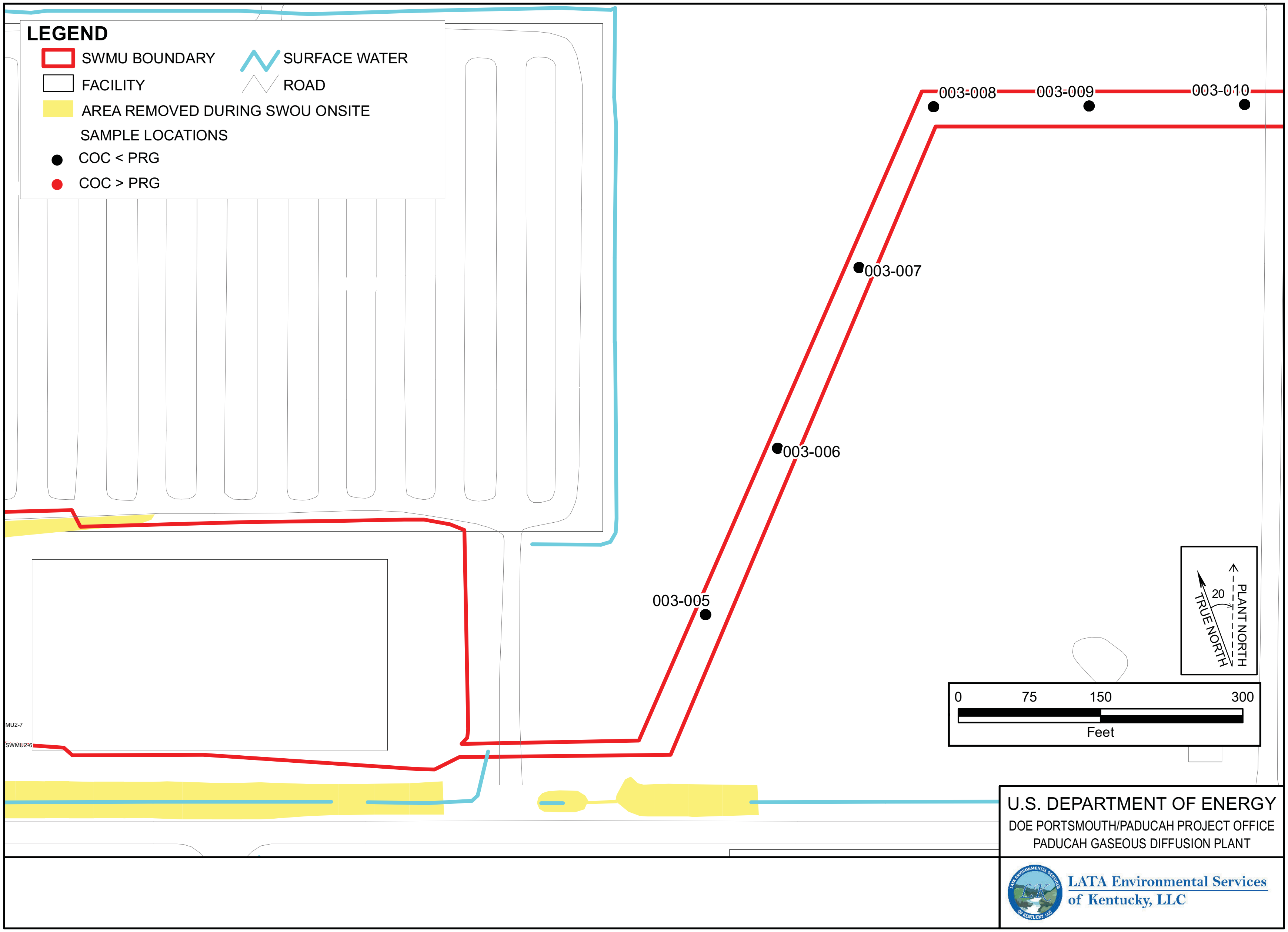

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Figure A.4. SWMU 3— Future Industrial Worker Surface Soil

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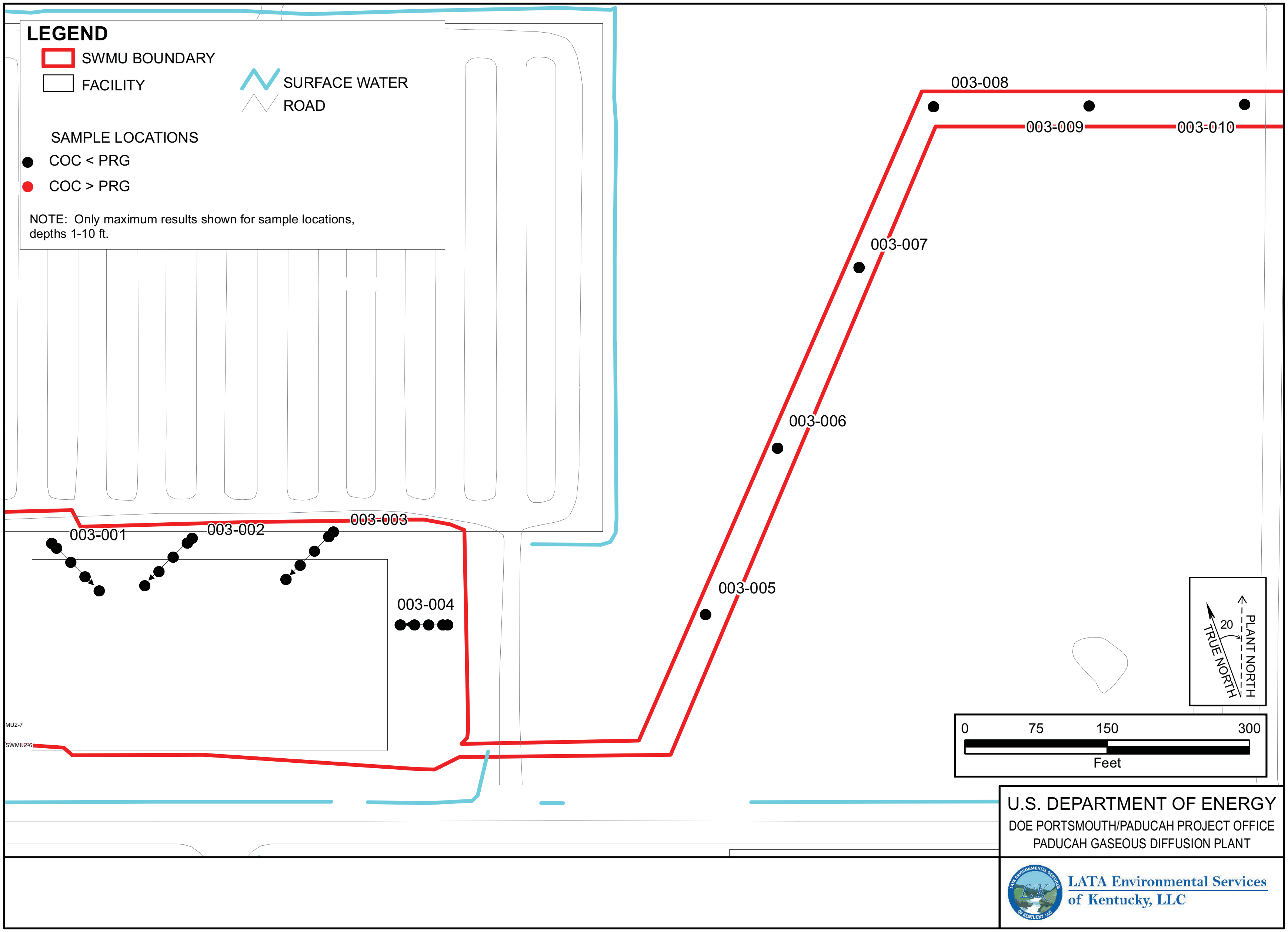

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Figure A.5. SWMU 3— Future Outdoor Worker Subsurface Soil

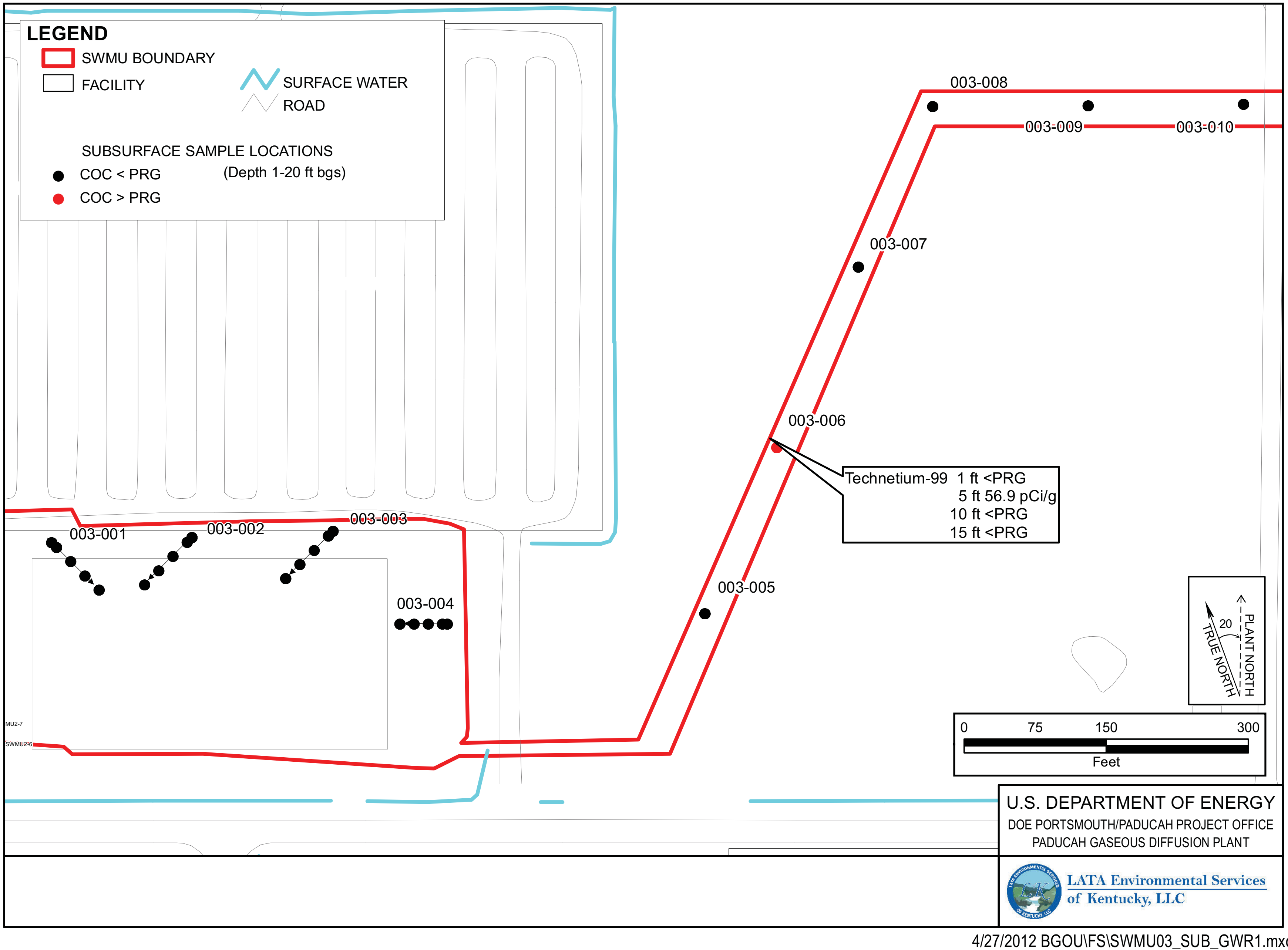

Figure A.6. SWMU 3—Protection of Groundwater

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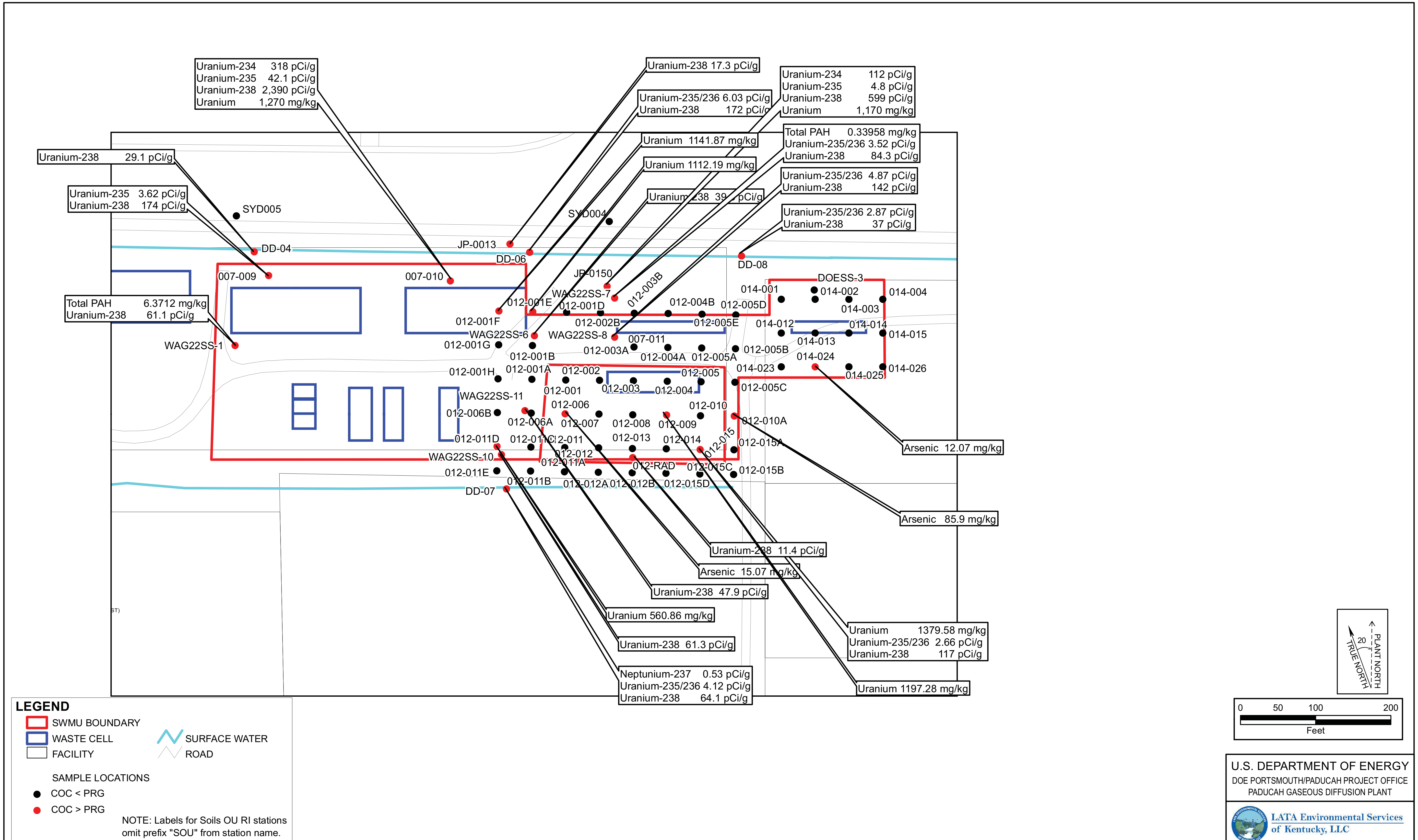

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Figure A.7. SWMU 7— Future Industrial Worker Surface Soil

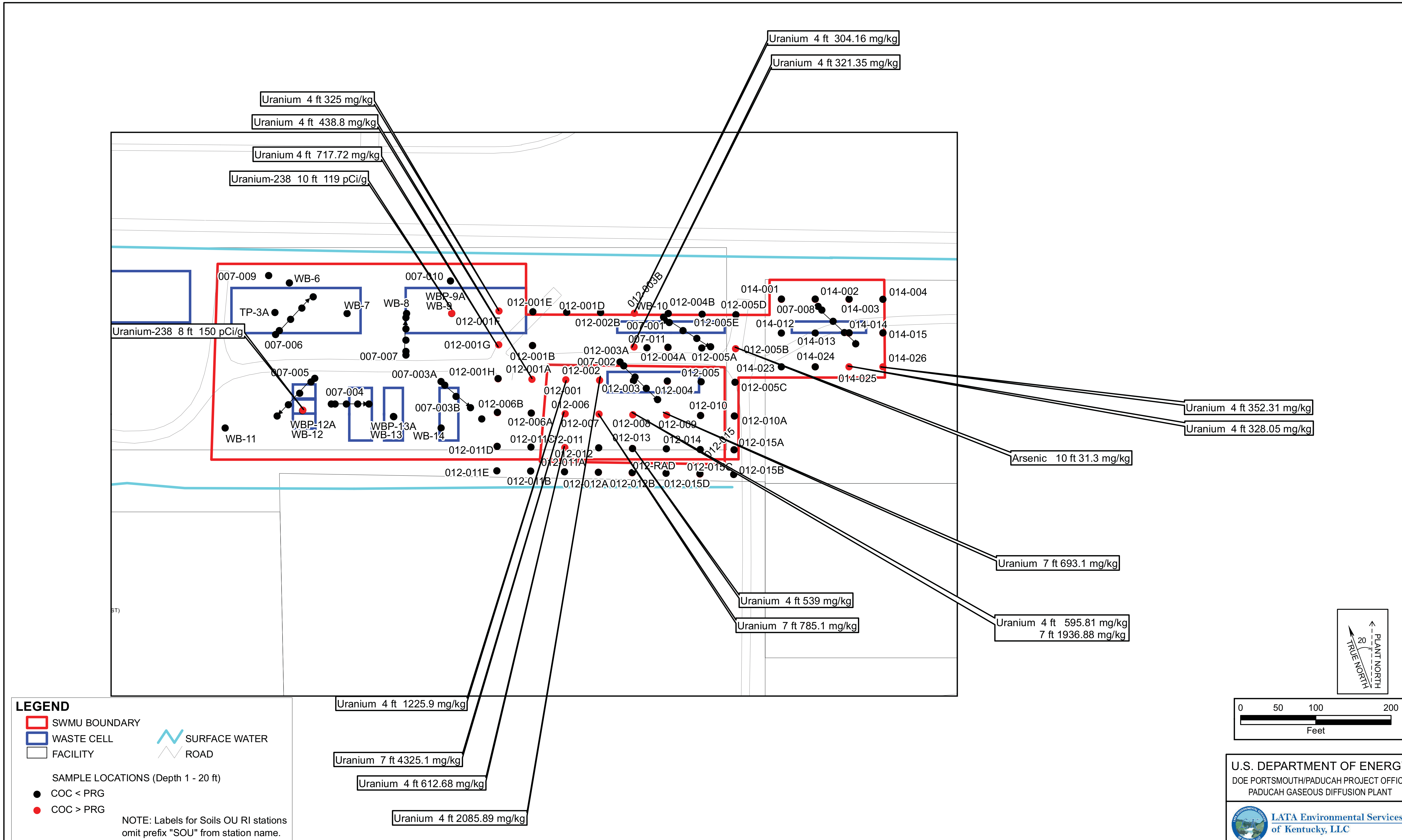

Figure A.8. SWMU 7— Future Outdoor Worker Subsurface Soil

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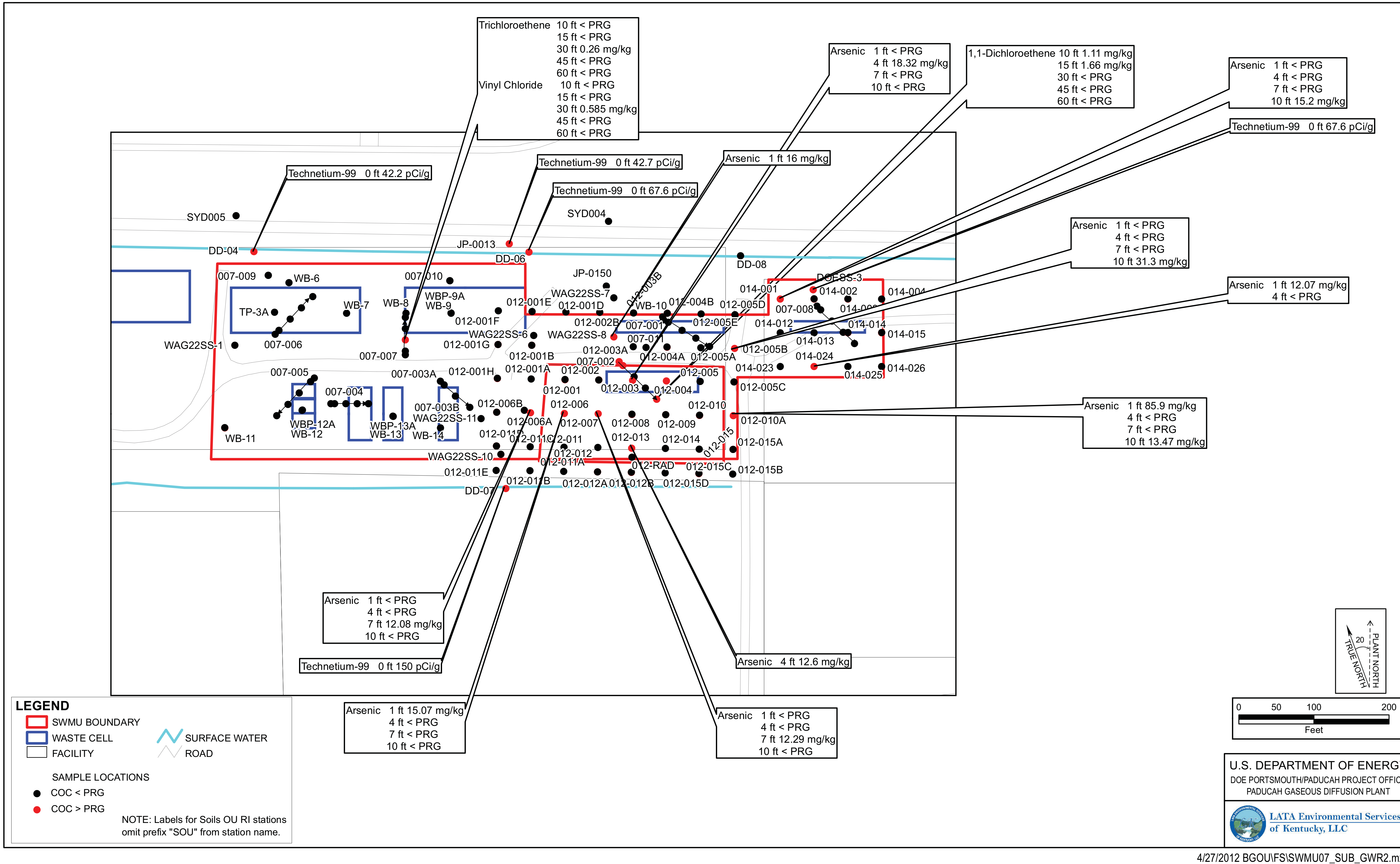

Figure A.9. SWMU 7—Protection of Groundwater

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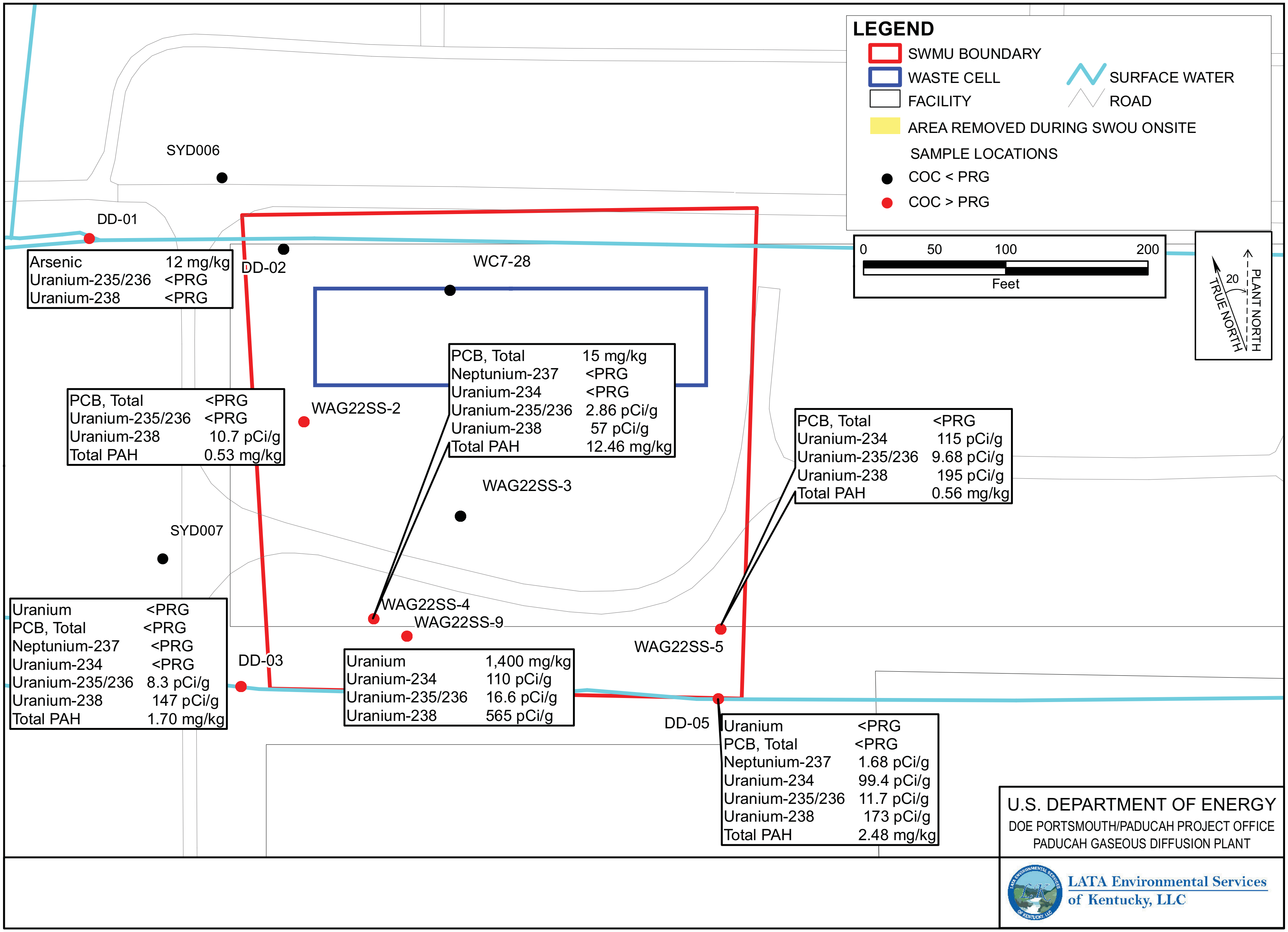

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Figure A.10. SWMU 30— Future Industrial Worker Surface Soil

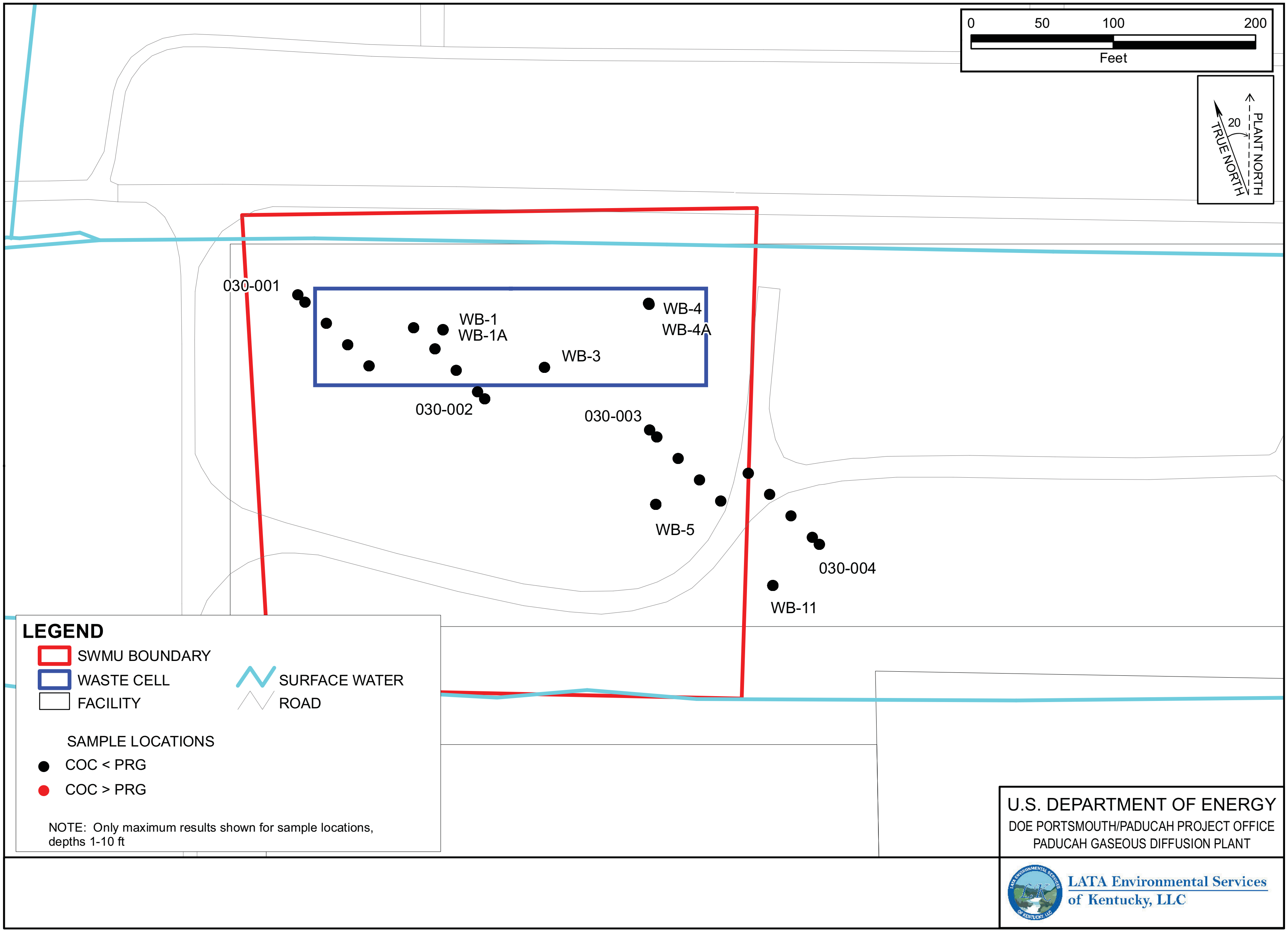

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Figure A.11. SWMU 30— Future Outdoor Worker Subsurface Soil

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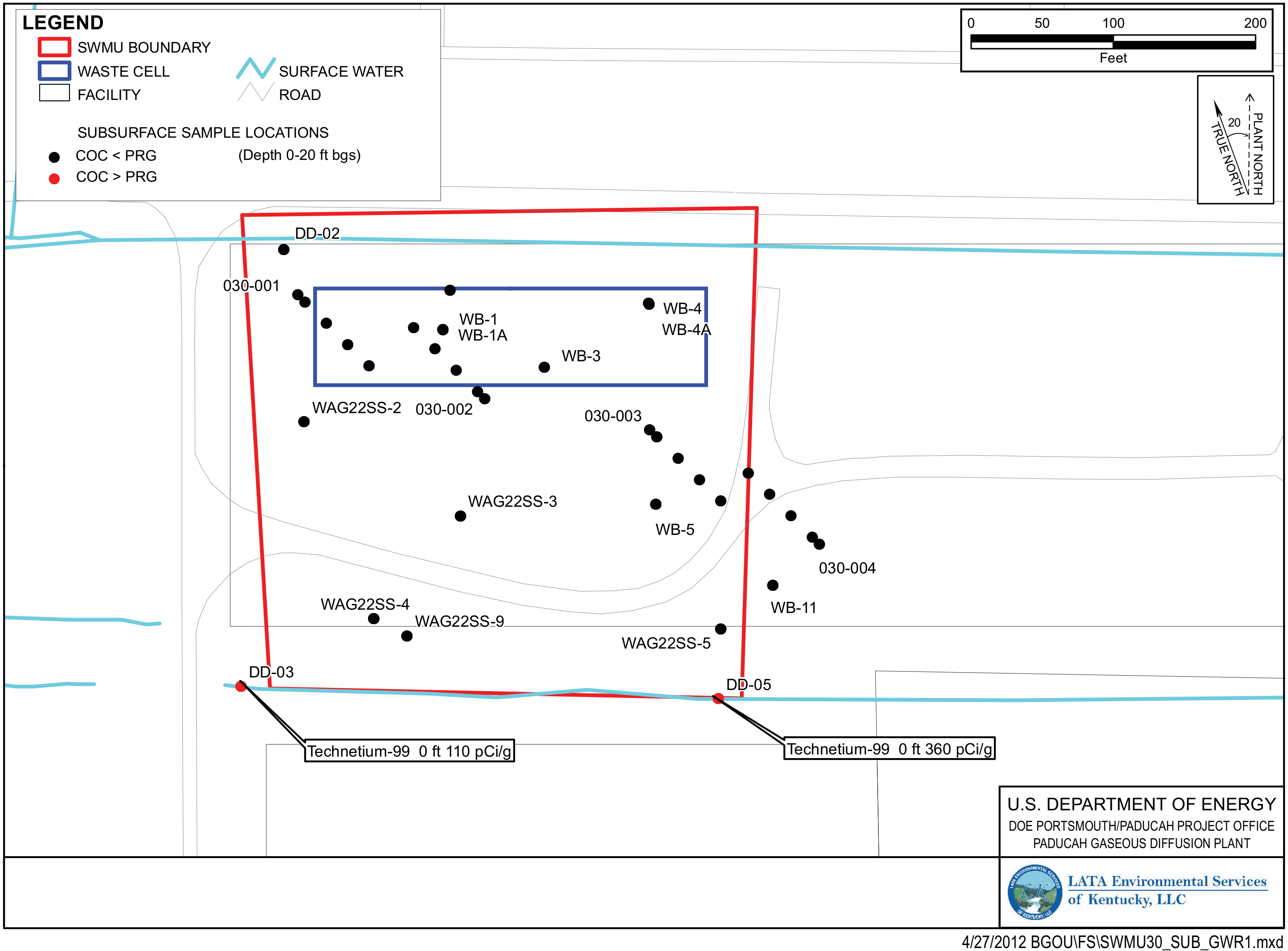

Figure A.12. SWMU 30—Protection of Groundwater

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APPENDIX B

DEVELOPMENT OF PRELIMINARY SOIL REMEDIATION GOALS FOR PROTECTION OF GROUNDWATER

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ACRONYMS

AT123D	Analytical Transient 1-,2-,3-Dimensional Model
BGOU	Burial Grounds Operable Unit
bgs	below ground surface
BHHRA	baseline human health risk assessment
COC	contaminant of concern
DAF	dilution attenuation factor
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCL	maximum contaminant level
NAL	no action level
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PRG	preliminary remediation goal
RGA	Regional Gravel Aquifer
RI	remedial investigation
SESOIL	Seasonal Soil Compartment Model
SSL	soil screening level
SWMU	solid waste management unit
Tc-99	technetium-99
TCE	trichloroethene
UCRS	Upper Continental Recharge System
VOC	volatile organic compound

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B.1. INTRODUCTION

This appendix accompanies the *Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1274&D1 (FS), which has been prepared to evaluate remedial alternatives for Solid Waste Management Units (SWMUs) 2, 3, 7, and 30 of the Burial Grounds Operable Unit (BGOU) at the Paducah Gaseous Diffusion Plant (PGDP). This appendix of the FS provides a discussion of development of preliminary remediation goals (PRGs) to address the following remedial action objective:

- Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination.

The PRGs are allowable soil concentrations of contaminants of concern (COCs) in the waste zone (0-20 ft bgs) that would not result in concentrations in the Regional Gravel Aquifer (RGA) groundwater exceeding maximum contaminant levels (MCLs), or in the absence of an MCL, a risk-based concentration for residential use of groundwater.

B.2. COCs AND GROUNDWATER CONCENTRATIONS USED TO CALCULATE GROUNDWATER-PROTECTIVE PRGs FOR SOIL

The BGOU Remedial Investigation (RI) baseline human health risk assessment (BHHRA) identified COCs that could limit future use of RGA groundwater, based on risks associated with modeled concentrations in the RGA at the SWMU boundary. For this FS, the groundwater target concentrations are MCLs, or in the absence of an MCL, a risk-based concentration for residential use of groundwater. The U.S. Environmental Protection Agency (EPA) provides guidance for use of MCL values at Comprehensive Environmental Response, Compensation, and Liability Act sites (EPA 1998).

As highlighted in Table B.1, several of the COCs had modeled groundwater concentrations that were not modeled to cause an exceedance of MCLs at the SWMU boundary, which is the point of compliance for containment alternatives. These COCs were evaluated further and are discussed in this appendix because the point of compliance for excavation scenarios is the RGA groundwater concentrations beneath the SWMU.

B.3. TARGET COCs FOR FS ALTERNATIVE EVALUATION

In this section, the list of COCs identified in the RI modeling (Table B.1) is revised by comparing predicted groundwater concentrations with MCLs, comparing measured soil concentrations to background concentrations, examining the frequency of detection, examining the migration time through the Upper Continental Recharge System (UCRS), and examining the effects of biodegradation.

In identifying target COCs, their presence in the RGA groundwater also was considered. A data screening process was developed to identify a list of COCs for the dissolved-phase plume in the RGA under the Paducah site. Although the list of groundwater COCs has not been finalized, the screening process was accepted in the August 17, 2010, Federal Facility Agreement managers meeting. These data were used to better understand the relationship between screening soils to identify potential for impacting the RGA as compared to groundwater patterns. This resulting groundwater data set summarizes the relative frequency of detections of analytes and frequency of exceedances of MCLs that are included in summaries of selected chemicals.

Table B.1. Model-predicted Concentrations in RGA Groundwater at the SWMU Boundaries

Analyte	Predicted Maximum Groundwater Concentration[a] (mg/L or pCi/L)[*]	MCL (mg/L or pCi/L)[*]
SWMU 2		
Arsenic	***3.54E-02***	0.01
cis-1,2-DCE	***1.15E+01***	0.07
Manganese	7.16E-01	[b]
Naphthalene	9.38E-04	[b]
PCB-1254	1.54E-03	[b]
PCB-1260	8.73E-05	[b]
Technetium-99	1.02E+02	900
Trichloroethene	***1.48E+00***	0.005
Uranium-234	1.58E+00	20 [c]
Uranium-238	1.81E+00	20 [c]
Uranium	9.86E-03	0.03[e]
SWMU 3		
Arsenic	***3.29E-02***	0.01
Manganese	8.95E-01	[b]
Technetium-99	***5.560E+03***	900
Uranium-238	1.59E+01	20 [c]
Uranium	***4.89E-02***	0.03[e]
SWMU 7		
1,1-DCE	***8.98E-02***	0.007
Arsenic	***1.78E-02***	0.01
cis-1,2-DCE	2.35E-02	0.07
Manganese	3.32E-01	[b]
PCB-1254	5.23E-05	[b]
Technetium-99	***9.09E+02***	900
Trichloroethene	***1.09E-02***	0.005
Uranium-234	7.94E+00	20 [c]
Uranium-238	7.59E+00	20 [c]
Uranium	3.46E-03	0.03[e]
Vinyl Chloride	***1.35E-02***	0.002
SWMU 30		
1,1-DCE	8.18E-05	0.007
Arsenic	***1.82E-02***	0.01
Manganese	3.78E-01	[b]
Selenium	1.51E-02	0.05
Technetium-99	2.87E+02	900
Trichloroethene	9.11E-04	0.005
Uranium-234	3.99E+00	20
Uranium-238	5.91E+00	20

Table B.1. Model-predicted Concentrations in RGA Groundwater at the SWMU Boundaries (Continued)

Analyte	Predicted Maximum Groundwater Concentration[a] (mg/L or pCi/L)*	MCL (mg/L or pCi/L)*
SWMU 30		
Uranium	8.40E-03	0.03

MCLs from Table A.14 of the Risk Methods Document (DOE 2011).
The MCL listed above for Tc-99 is based on 4 mrem/yr, using historical dosimetry assumptions.
*mg/L for chemicals, pCi/L for radionuclides
[a] Values in bold, italic font with highlight exceed the analyte's MCL.
[b] MCLs not available for these contaminants.

B.3.1 COC LIST REFINED BASED ON BACKGROUND

B.3.1.1 Manganese

Manganese was identified as a COC for residential use of groundwater at most BGOU SWMUs. Manganese is a major naturally occurring element in soils. Potential release from the soil matrix and the transport and concentrations in water are dependent on localized redox conditions. Distribution coefficient (K_d) values may describe interactions at the soil surface, but do not accurately estimate potential release from the bulk soil concentrations where much of the manganese is immobile and not available for exchange. Using the manganese K_d, the no action level (NAL) would be exceeded in water in equilibrium with soils at manganese concentrations above 1.6 mg/kg (a value below the minimum detected at any SWMU). As illustrated in Table B.2, manganese concentrations exceeded background (820 mg/kg) in 5 of 219 analyses. Four of these were subsurface soils distributed across two different SWMUs. Only one surface soil sample had a concentration above the background concentration of 1,500 mg/kg. Based on the findings that there are few above-background detections of manganese and the fact that the presence and migration of manganese is controlled by site geochemical conditions, manganese is eliminated as a COC for leaching to groundwater at SWMUs 2, 3, 7, and 30.

Table B.2. Summary of Manganese Soil Concentrations

SWMU	Depth	Detected Concentrations (mg/kg)			Frequency of	
		Minimum	Maximum	Average	Detection	Exceeding Background*
2	Surface	240	540	353	3/3	0/3
	Subsurface	18.8	1,200	315	29/29	2/29
3	Surface	116	558	324	6/6	0/6
	Subsurface	9.12	644	208	40/40	0/40
7	Surface	107	4,380	468	25/25	1/25
	Subsurface	4.88	4,330	250	86/86	2/86
30	Surface	250	669	397	11/11	0/11
	Subsurface	15.6	740	153	19/19	0/19

*Background: 1,500 mg/kg surface soil, 820 mg/kg subsurface soil

B.3.1.2 Arsenic

Arsenic was identified as a risk driver for groundwater at all four SWMUs evaluated in this FS. Modeled arsenic concentrations at the SWMU boundary ranged from 0.0178 to 0.0354 mg/L–concentrations above the MCL of 0.01 mg/L. Arsenic concentrations above the MCL are predicted even for SWMUs that have all soil concentrations below background, suggesting that, like manganese, the potential release and subsequent transport through the UCRS is more complex than assumed in the modeling. Arsenic was detected in RGA groundwater at concentrations greater than the MCL in 2 of 246 RGA groundwater samples collected between 2008–2010.

The concentrations of arsenic in soil at the SWMUs are summarized in Table B.3.

Arsenic was not detected above background in samples at SWMU 30 and in only 1 sample at SWMU 3 (at a concentration near background); based upon this review, arsenic is not considered a COC at these SWMUs, but still is retained as a COC for SWMUs 2 and 7 in this FS.

Table B.3. Summary of Arsenic Soil Concentrations

SWMU	Depth	Detected Concentrations (mg/kg)			Frequency of	
		Minimum	Maximum	Average	Detection	Exceeding Background*
2	Surface	3.4	30	19.5	3/3	2/3
	Subsurface	1.1	22	6.42	28/29	8/29
3	Surface	2.3	7.62	4.69	6/6	0/6
	Subsurface	0.956	8.25	2.83	36/40	1/40
7	Surface	2.4	85.9	9.61	15/26	1/26
	Subsurface	0.898	31.3	3.49	53/86	6/86
30	Surface	4.2	12	6.46	9/13	0/13
	Subsurface	0.954	4.03	2.72	15/19	0/19

*Background: 12 mg/kg surface soil, 7.9 mg/kg subsurface soil
SWMU 3 includes the ditch samples evaluated in Appendix D.
X-ray fluorescence spectrometer data collected at SWMU 7 is not included in this summary.

B.3.1.3 Selenium

Selenium was listed as a COC at SWMU 30, contributing to the hazard for residential use of groundwater; however, as shown on Table B.1, the concentration at the SWMU boundary (0.0152 mg/L) is below the MCL of 0.05 mg/L. More importantly, selenium exceeded background concentrations in only 1 of 32 soil samples at this SWMU, as summarized on Table B.4. Based on these factors, selenium is not considered a COC for this FS.

Table B.4. Summary of Selenium Soil Concentrations

SWMU	Depth	Detected Concentrations (mg/kg)			Frequency of	
		Minimum	Maximum	Average	Detection	Exceeding Background*
30	Surface	0.43	0.66	0.56	4/13	0/13
	Subsurface	0.69	1	0.85	2/19	1/19

* Background: 0.8 mg/kg surface soil, 0.7 mg/kg subsurface soil.

B.3.2 COC LIST REFINED BASED ON TRANSPORT

UCRS groundwater contamination migrates vertically to the RGA. Along the migration pathway, contaminants are potentially subjected to the effects of retardation (which, as the name implies, increases travel times to the RGA) and biodegradation that reduces concentrations along the migration pathway. Retardation, quantified by the K_d, does not reduce groundwater concentration along the migration pathway, it only delays the peak concentration arrival time. For this assessment, if the peak concentration arrival time is greater than 1,000 years, the contaminant is assumed to be immobile and Seasonal Soil Compartment Model (SESOIL) modeling is not warranted.

Defining chemicals as immobile (no loading to the RGA in 1,000-year travel time) is consistent with findings in the literature. Scientific evidence suggests that some chemicals become more resistant to desorption from soil as contact time increases (Loehr and Webster 1996; Alexander 1995; Pavlostathis and Mathavan 1992). Chemicals that have relatively low transport potential due to their high soil adsorption coefficients may, over time, become irreversibly adsorbed to soil and therefore immobile under normal conditions (Alexander 1995). This time period for reduced desorption to occur has been reported to be on the order of weeks or months for several chemicals while a 100-year time period has been used to identify immobile chemicals. For this FS, it is assumed that these chemicals do not pose a threat to groundwater if the travel time from the soil/waste contaminants to RGA groundwater is less than 1,000 years.

Figure B.1 shows the relationship between K_d and travel times to the RGA from typical UCRS source zone depths. In general, as simulated by SESOIL, the BGOU source zone depths extend from approximately 10 ft to 40 ft bgs. When retardation is minimal, as characterized by small K_d values, approximately 25 years is required for UCRS contamination to reach the water table. K_d values greater than 12 result in contaminant travel times in excess of 1,000 years. Thus, chemicals with K_d greater than 12 do not require SESOIL modeling.

The effects of biodegradation on expected RGA groundwater concentrations are evaluated by using the chemical specific K_d value and Figure B.1 to determine the expected travel time from the UCRS source zones to the RGA for a chemical of interest. That travel time is used along with the chemical specific biological half-life in the following equation to predict expected RGA groundwater concentrations.

$$M(t) = M_0 \times e^{-kt}$$

Where:

M_0 = initial concentration
$M(t)$ = concentration at the time of interest
e = 2.71828183
k = ln(2)/biodegradation half-life
t = migration time through the UCRS

The chemical's water solubility is used as the initial concentration. If the predicted RGA chemical concentration is below the MCL, or risk-based concentration for residential use of groundwater in the absence of an MCL, then additional SESOIL modeling is not required.

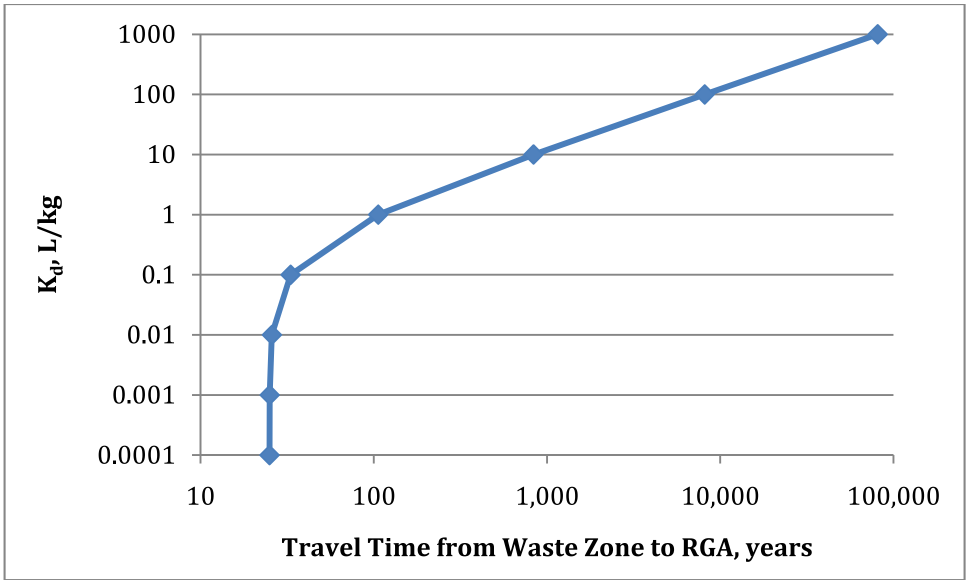

Figure B.1. K_d and Travel Time Relationship

B.3.2.1 Naphthalene

Naphthalene was identified as a COC based on contribution to the noncancer hazard for residential use of RGA groundwater by a future child resident at SWMU 2. Naphthalene was detected in the two sediment samples (SWMU2-15 and SWMU2-6), where high molecular weight polycyclic aromatic hydrocarbons also were present suggesting the presence of a mixture that will limit dissolution of naphthalene.

Biodegradation of naphthalene has been demonstrated to occur under both aerobic and anaerobic conditions, with rates that are more rapid under aerobic conditions. Howard et al. (1991) reports naphthalene half-lives in soil from 16.6 to 48 days based upon a soil-die away test and in groundwater from 24 hours (aerobic) to 258 days (anaerobic).

Naphthalene has a K_d of 0.953 [calculated from the soil organic carbon/water partition coefficient K_{oc} of 1,191 L/kg and the fraction of organic carbon (foc) of 0.0008 used in the SESOIL modeling for the BGOU RI]. Based on a K_d value of approximately 1, the travel time of dissolved naphthalene from the UCRS waste zone to the RGA is approximately 100 years (Figure B.1). The biological half-life of 257 days (SESOIL chemical data base) corresponds to the slower rate of degradation expected in anaerobic groundwater, a condition that occurs in the UCRS at some locations. Using a concentration of 31 mg/L, the solubility of naphthalene, 100 years biodegradation will reduce naphthalene concentrations to < 0.00001 mg/L before it reaches the RGA, and the concentration would be below the groundwater NAL of 0.176 µg/L (DOE 2011) in fewer than 13 years. The maximum dissolved naphthalene concentration will be much less than its solubility limit; thus, the dissolved concentration prediction for water at the point of migration to the RGA, as presented here, is much higher than reasonably would be expected. This finding is consistent with the observation that naphthalene was not detected in 168 RGA groundwater samples analyzed from 1995-2010.

Naphthalene was not analyzed in subsurface soils at SWMU 2; however, it was not detected in any of the 179 subsurface soil samples analyzed at the BGOU SWMUs, including SWMUs 5, 6, 7, and 30. This is consistent with predicted attenuation during the 100-year travel time to the RGA reducing concentrations such that no exceedances of the groundwater NAL would be expected. In addition, RGA groundwater is aerobic, a condition under which more rapid degradation would be expected. Based on these factors, naphthalene is not considered a COC, and PRGs are required to address this chemical in this FS.

B.3.2.2 Uranium

Uranium was identified as a COC contributing to the noncancer hazard for the child resident assuming future residential use of RGA groundwater at the SWMU boundary; however, uranium is predicted to exceed the MCL only at SWMU 3. For the other SWMUs, the predicted uranium concentration was approximately 3–9 times below the MCL. None of the uranium isotopes had predicted groundwater concentrations at the SWMU boundary above the MCLs.

The fate and transport modeling for the RI was completed to minimize the potential of eliminating COCs, so these may be further evaluated in the FS. The uranium K_d of 66.8 mL/g is applicable for the sand and gravel units of the RGA as used in the RI modeling. However, the magnitude of the UCRS K_d values range from 253 to 93,900 mL/g, with the value of 3,640 mL/g more applicable for transport through the UCRS clays and silts. Using the uranium K_d of 3,640 mL/g for the BGOU modeling, uranium will not reach the RGA within 1,000 years (Figure B.1). In addition, EPA published a technical brief that discusses the mobility of depleted uranium that states the following:

> Uranium transport generally occurs in oxidizing surface water and groundwater as the uranyl ion, UO_2^{2+}, or as uranyl fluoride or carbonate complexes. UO_2^{2+} and uranyl fluoride complexes dominate in acidic oxidizing waters, whereas the carbonate complexes dominate in near-neutral and alkaline oxidizing waters, respectively. In contrast, the uranous ion, U^{4+}, is essentially insoluble. An important point in considering uranium migration in soils is that when UO_2^{2+} is reduced to U^{4+} by humus, peat, or other organic matter or anaerobic conditions, it is essentially immobilized (EPA 2006).

While uranium in the waste zone may include more mobile forms or metallic uranium that may oxidize over time, properties of the UCRS would limit further migration. Anaerobic conditions are known to occur locally in the UCRS, as evidenced by the presence of anaerobic degradation products of chlorinated solvents (DOE 2010). The low redox potential in the UCRS favors U^{4+}, which is not likely to be eluted. K_d values for uranium may be influenced by other factors, including sorption to clays and pH (Table B.4).

Uranium will not reach the RGA within 1,000 years based on a reasonable K_d value in the UCRS of 3,640 mL/g (Figure B.1) and this is consistent with the fact that it was not detected in RGA groundwater above the MCL in any of 948 RGA groundwater samples collected between 2008 and 2010. In addition, uranium has a long half-life (4.47E+09 years—SESOIL data base) and, as such, it is unlikely that significant mass of daughter products, some of which are more mobile, will develop within the 1,000 year evaluation period. Thus, it was concluded that uranium would not contribute loading to the RGA groundwater that would result in that water exceeding the MCL.

B.3.2.3 PCBs

Polychlorinated biphenyls (PCBs) detected during the BGOU RI were the higher molecular weight (lower mobility) Aroclors, PCB-1254 and PCB-1260, identified as COCs for residential use of groundwater at SWMUs 2 and 7. Total PCBs typically were detected most frequently and at the highest concentrations in surface soils. Total PCBs were not detected in any of over 200 subsurface soil samples at SWMUs 2, 3, 7, and 30 at depths greater than 20 ft.

The K_d values for these PCBs range from 34 (PCB-1254) to 166 (PCB-1260) (DOE 2010). Consistent with the low mobility of PCBs and lack of presence in deeper soils, Total PCBs are not predicted to reach the RGA within 1,000 years (Figure B.1), and further SESOIL modeling is not required to demonstrate no load to the RGA.

B.3.3 DEVELOPMENT OF PRGs FOR PROTECTION OF GROUNDWATER

The evaluation of the RI identified COCs (Table B.1) reduced the number of COCs requiring further evaluation and potential development of soil PRGs to the analytes listed in Table B.5.

Table B.5. COCs Identified in this FS for Potential Development of Soil PRGs

SWMU	COCs*
2	**Arsenic; TCE; *cis*-1,2-DCE**; Tc-99
3	**Tc-99**
7	**TCE; Vinyl chloride; 1,1-DCE;** *cis*-1,2-DCE; **Tc-99**
30	TCE; 1,1-DCE; Tc-99

*COCs listed in bold were modeled to have the potential to exceed the MCL at the SWMU boundary.

The UCRS soil PRG is the maximum soil contaminant concentration that if left in place would not result in RGA groundwater concentrations above MCLs. All of the COCs above have MCLs. These PRGs would allow target RGA groundwater concentrations (MCLs) to be met at the SWMU boundary for containment remedies or beneath the waste for excavation/treatment scenarios.

COCs that exceeded the MCL at the SWMU boundary require development of PRGs and further evaluation of alternatives in this FS. In addition, the maximum soil concentration of those COCs that are predicted to be below the MCL at the SWMU boundary are compared to a soil screening level (SSL) derived based on meeting the MCL beneath the waste, and if exceeded, require further evaluation of alternatives in this FS. Those risk-based COCs identified in the BHHRA that do not exceed the MCLs at the SWMU boundary and do not have any soil concentrations above a soil screening level protective of the RGA beneath the waste, do not require further evaluation in this FS.

The PRGs for the organic constituents are derived using additional modeling consistent with the modeling completed in the RI. There are some greater uncertainties in the modeling for arsenic and Tc-99; therefore, the PRGs for these constituents were derived using a screening protocol as discussed below.

B.3.4 SCREENING PRGs FOR ARSENIC AND Tc-99

SSLs protective of groundwater for nonvolatile constituents are calculated

$$SSL = Cw \times DAF \times (K_d + n/BD)$$

Where:

SSL = screening level in soil (mg/kg)
Cw = target soil leachate concentration (mg/L)
DAF = Dilution Attenuation Factor
K_d = soil-water partition coefficient (L/kg)
n = volumetric moisture content of the unsaturated zone
BD = dry soil bulk density (kg/L)

Note: A conversion factor of 0.001 kg/g is used when water concentrations are in pCi/L and the SSL is in pCi/g.

The DAF reflects the mixing of UCRS and the upper portions of the RGA below a source area. The "Soils Operable Unit Dilution Attenuation Factor Evaluation" used a deterministic approach to identify a DAF of 58—a value similar to previously used values at PGDP. This screening incorporated a DAF of 58 into the derivation of the PRGs for arsenic and Tc-99.

B.3.4.1 Arsenic

Arsenic was retained as a COC for SWMUs 2 and 7. The EPA MCL-based SSL for protection of groundwater (DAF 1) for arsenic is 0.292 mg/kg (Risk Methods Document Table A.7a; DOE 2011). Using the PGDP DAF of 58, the SSL for a DAF 58 is 16.9 mg/kg, slightly above the surface-soil background concentration of 12 mg/kg; therefore, the arsenic PRG for protection of groundwater for SWMUs 2 and 7 is identified as 16.9 mg/kg.

B.3.4.2 Technetium-99

Tc-99 was identified in the RI as a COC at SWMUs 2, 3, 7, and 30 because modeling identified the potential for Tc-99 to exceed the MCL at the SWMU boundary for SWMUs 3 and 7. EPA has derived SSLs for radionuclides for the soil to groundwater pathway for radionuclides[1] and for Tc-99. The MCL-based SSL of 3.73 pCi/L was derived using the SSL equation shown above and using default assumptions. These include a DAF of 20, K_d of 0.007 L/kg and BD of 1.5 kg/L. For the derivation of the BGOU PRG, site specific inputs were used, as follows:

- DAF of 58
- BD = 1.46 kg/L (used in the UCRS modeling)
- K_d of 0.2 L/kg

While Tc-99 can be highly mobile, the groundwater monitoring data collected for SWMUs 3 and 7 do not indicate any SWMU-related exceedances of the Tc-99 MCL.

The BGOU soils data show that Tc-99 concentrations are highest in the surface soils, with 12 of 90 surface samples having concentrations above 16 pCi/g. Only 1 of 329 subsurface soil samples had a concentration above this level, suggesting Tc-99 is retained at the surface.

Table B.6 illustrates the impact of K_d on the travel time of Tc-99 and the calculated SSL associated with that K_d assumption. The velocity in the pore water is shown for infiltration rate of 4.2 and 6.6 inches/year. With a low K_d (0.007 L/kg), mobile Tc-99 would be removed from the 0-1 ft interval in less than 1 year. Using the K_d of 0.2 L/kg (used in the BGOU RI modeling) it also would migrate to subsurface soils fairly rapidly (less than 2 years).

[1] http://epa-prgs.ornl.gov/radionuclides/download/res_soil2GW_rad_prg_august_2010.pdf

Table B.6. Illustration of Time for Migration of Tc-99 Through Surface Soils as a Function of K_d

K_d L/kg	Retardation Factor	Time (years) to migrate 1 ft		SSL pCi/g
		Vpw = 14 inch/yr	Vpw= 22 inch/yr	
0.007	1	0.86	0.55	11.1
0.2	2	1.7	1.1	21.2
0.5	3.5	3.0	1.9	36.8
1	6	5.2	3.3	63
3	16	13.8	8.8	167

The SSL was calculated using n=0.3 and BD=1.46 kg/L.
Pore water velocities (Vpw) correspond to infiltration rate assumptions of 4.2 and 6.6 inches/yr.

For consistency with the BGOU RI modeling, a K_d of 0.2 L/kg is used in the screening analysis for the PRG. The PRG for Tc-99 is 21.2 pCi/g.

One or more samples exceed this PRG in SWMUs 3, 7, and 30—almost exclusively in surface soil. Given the preponderance of the exceedances in surface soil, it is apparent that the K_d of 0.2 L/g greatly overestimates the BGOU migration potential.Tc-99 is not retained as a COC requiring action in this FS at SWMU 2 because modeling did not identify a potential to exceed the MCL at the SWMU boundary, and the maximum concentration detected in soil of 14.6 pCi/L is below the PRG of 21.2 pCi/g.

B.3.5 MODELING APPROACH FOR DERIVATION OF PRGs FOR ORGANIC CONSTITUENTS

UCRS soil PRGs for the organic COCs at the various SWMUs were determined using SESOIL and AT123D models, the models used in the BGOU RI to estimate concentrations in the RGA groundwater at the SWMU boundary. The appropriateness of using the SESOIL model, including in saturated conditions, is discussed in Section B.3.8. A commercially available version of SESOIL (SEVIEW) was used with site-specific information in a manner consistent with the modeling in the approved RI, to simulate constituent transport through BGOU SWMUs.

The modeling completed in this FS evaluated the potential impact in RGA groundwater of contaminant concentrations in the waste zone (i.e., source layer 3 in SESOIL representing 10-20-ft depth interval). A soil PRG derived to be protective of RGA groundwater based on its presence at this depth interval would be protective for COCs in soils at depths from 0-10 ft.

The parameter values shown in Table B.7 for the organic COCs that were used in the modeling analyses for this FS are the same values as those used in the BGOU RI. The parameter values for the UCRS and used in the SESOIL model are provided in Table B.8. The parameter values for the RGA and used in the Analytical Transient 1-,2-,3-Dimensional Model (AT123D) model also are provided in Table B.8. These model parameters are the same as those used in the BGOU RI modeling analyses.

For SESOIL simulation purposes the UCRS was divided into four model layers which were again subdivided as shown in Figure B.2 (same as Figure 2.4 in the FS). Output from the SESOIL model was temporal contaminant loading rates to the RGA. For the AT123D simulations, the HU4 sand unit was assumed to be part of the RGA. To include the HU4 sand unit in the AT123D simulations, a weighted arithmetic hydraulic conductivity average was calculated for the composite HU4/RGA unit. The calculations assumed a 30-ft RGA thickness and hydraulic conductivity of 62.5 ft/d (2.2e-2 cm/s) and a 5-ft HU4 thickness and a hydraulic conductivity of 2.84 ft/d (1e-3 cm/s). Output from the AT123D modeling was the expected temporal contaminant concentrations in RGA groundwater at specified distances downgradient of the SWMUs.

Table B.7. Properties of Organic Chemicals Used in Deriving Soil PRGs

COC	Molecular Weight [c] (g/mol)	Solubility in water[c] (mg/L)	Diffusion in air[c] (cm^2/s)	Diffusion in water[c] (m^2/hr)	Henry's Constant[c] ($atm.m^3/mol$)	K_{oc} [c]	K_d [a] (L/kg)	Half Life (years)
cis-1,2-DCE	96.94	3.50E+03	0.07	4.07E-06	4.08E-03	35.5	0.028	Infinite
1,1-DCE	97	2.25E+03	0.09	3.74E-06	0.0261	65	0.013	Infinite
TCE	131	1,100	0.08	3.28E-06	0.0103	94	0.0752	26.6[b]
Vinyl Chloride	63	2,760	0.11	4.43E-07	0.027	18.8	0.0152	Infinite

[a] K_d of an organic compound depends on the soil's foc and compound's K_{oc}. K_d values presented for organic compounds are for UCRS soils (with foc value of 0.0008) only. K_d values used in AT123D are different due to the foc of 0.0002 in the RGA.
[b] The 26.6 year half-life for TCE is applied to the URCS only (not used in the RGA).
[c] Parameter values were obtained from the SESOIL chemical data base.

Table B.8. Site-Specific Soil and Aquifer Parameters for the BGOU SWMUs Used in Fate and Transport Modeling

Model	Parameter		Units	BGOU	Source
SESOIL	Soil Type		-	Silty Clay	BGOU RI Report, Table E.3.1, page E-22[1]
	Vadose Zone Dry Bulk Density		g/cm^3	1.46	
	Foc		-	0.0008	
	Intrinsic Permeability		cm^2	1.60E-10	
	Depth to water table		m	18.3 to 19.2	
	Percolation (Recharge Rate)		cm/yr	11	
AT123D	Hydraulic Gradient	SWMU 2, 3	m/m	2.00E-04	BGOU RI Report, Table E.3.2, page E-23[1]
		SWMU 7		3.00E-04	
		SWMU 30		3.60E-04	
	Hydraulic Conductivity		m/hr	19.05	
	Aquifer Bulk Density		kg/cm^3	1,670	
	RGA Thickness		m	9.14	
	foc		-	0.0002	

[1] BGOU RI Report (DOE 2010a)

B.3.6 PRG CALCULATIONS

BGOU PRGs for the COCs were determined using SESOIL and AT123D model predictions and chemical-specific MCLs. SESOIL simulations were performed using homogenous source layer concentrations and zero concentration for all other model layers. It should be noted that the higher concentration (source) layer (model layer 2) generates the same peak simulated leachate concentrations and RGA arrival time, with or without contamination being assigned to other SESOIL model layers. The SESOIL leachate concentration then was used as input to AT123D to predict RGA groundwater concentrations at the SWMU boundary when long-term monitoring and capping were evaluated and beneath the SWMU when all other remedial technologies were evaluated.

PRGs were determined using the following equation:

$$RG = MCL \cdot \frac{[C]^{leachate}}{[C]^{gw}} \cdot \frac{[C]^{soil}}{[C]^{leachate}}$$

where:

PRG = UCRS soil concentration preliminary remedial goal, mg/kg
MCL = chemical specific maximum contaminant level in groundwater, mg/L
$[C]^{leachate}$ = SESOIL predicted UCRS groundwater chemical concentration, mg/L
$[C]^{gw}$ = AT123D predicted maximum RGA groundwater chemical concentration, mg/L
$[C]^{soil}$ = SESOIL initial soil chemical concentration

Because the $[C]^{leachate}$ term appears in both the numerator and denominator, the term cancels and the equation reduces to:

$$RG = MCL \cdot \frac{[C]^{soil}}{[C]^{gw}}$$

Note that because the relationship between the maximum UCRS soil concentration and the maximum predicted RGA groundwater concentration is linear, the predicted UCRS soil PRG will remain the same regardless of whether actual or synthetic initial UCRS soil concentration data is used. For calculation ease, the majority of the SESOIL simulations used initial UCRS soil concentrations equal to 1 mg/kg. A few of the simulations used initial UCRS soil concentrations equal to 10,000 mg/kg, which were compared to companion simulations using 1 mg/kg initial UCRS soil concentrations. The larger UCRS initial soil concentration simulations were used to show linearity between the maximum UCRS soil concentration and the maximum predicted RGA groundwater concentration.

B.3.7 RESULTS

The organic COCs modeled in this FS to identify soil PRGs protective of RGA groundwater based on the SESOIL and AT123D modeling are summarized on Table B.9. These were modeled based on the current infiltration. The SESOIL and AT123D output data for these COCs in SWMUs 2, 7, and 30 are provided in Attachment B1, Attachment B2, and Attachment B3. There were no organic COCs that merit development of PRGs for SWMU 3.

Based on the modeling, a soil PRG was derived for each of the organic COCs that was identified in the BGOU RI as having concentrations above the MCL at the SWMU boundary. The maximum detected soil concentrations for each of these exceeded the PRG, indicating these COCs require further evaluation in this FS.

At SWMU 7, *cis*-1,2-dichloroethene (DCE) was not predicted to exceed the MCL in the RGA groundwater at the SWMU boundary. In addition, the maximum detected soil concentration was below the PRG; therefore, this COC requires no further evaluation in this FS. In addition, all of the volatile organic compounds (VOCs) are frequently co-located, so addressing the three COCs predicted to exceed the MCL would be protective and address any uncertainties in the modeling of *cis*-1,2-DCE.

At SWMU 30, both of the organic COCs identified based on their contribution to risk in the BHHRA were modeled to be in RGA groundwater at the SWMU boundary at concentrations below the MCLs. Each of these was detected in only one sample, at concentrations below the PRG derived based on modeling in this FS; therefore, these COCs require no further evaluation in this FS to be protective of RGA groundwater.

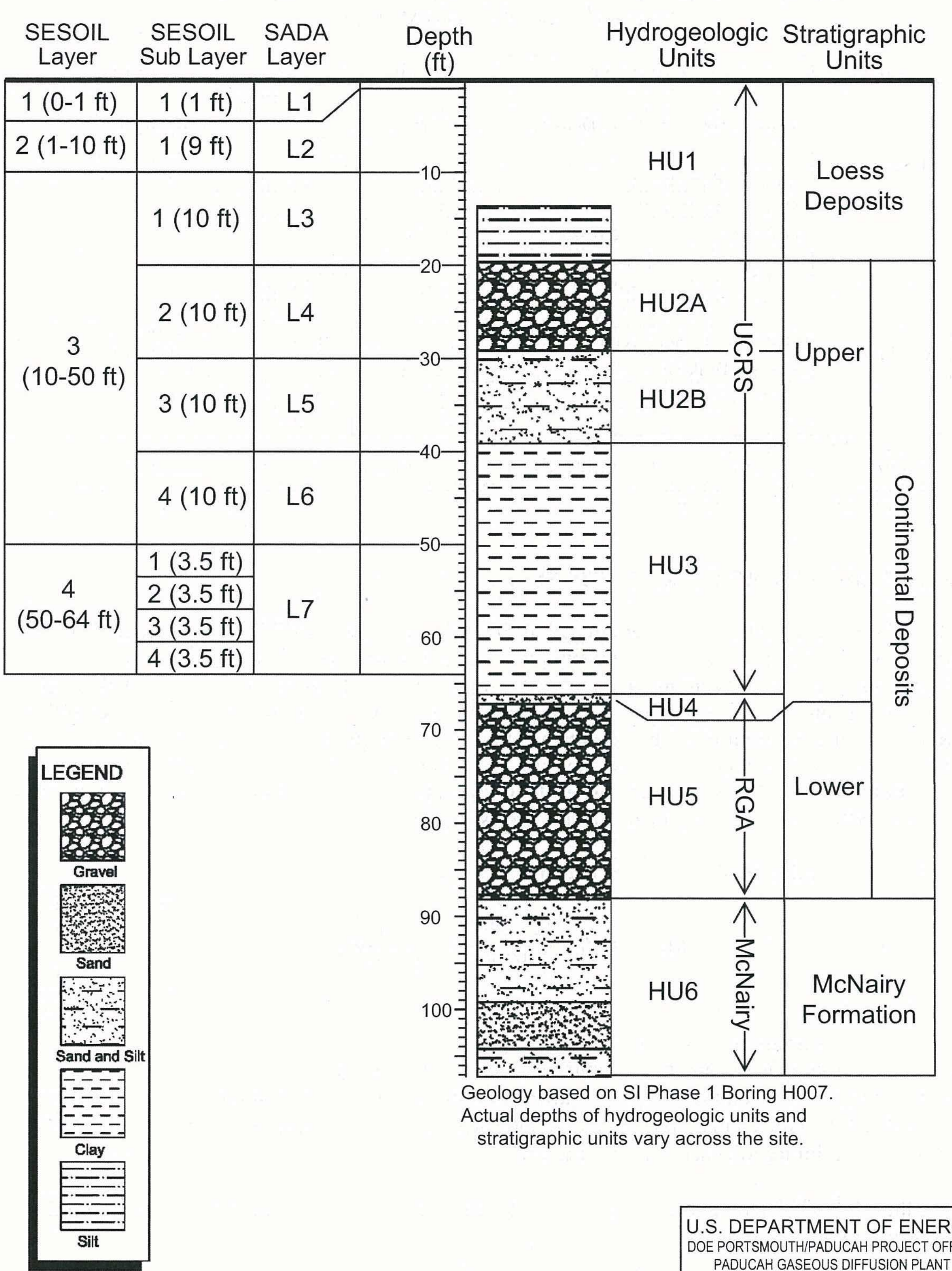

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Figure B.2. Conceptualization of the SADA and SESOIL Layers for Contaminant Loading

LATA Environmental Services of Kentucky, LLC

Table B.9. Summary of Modeling Results for PRGs Protective of RGA Groundwater

SWMU	COC*	MCL (mg/L)	AT123D Predicted Maximum RGA Groundwater Concentration (mg/L)	Groundwater Protective Soil PRG (mg/kg)	Maximum Soil Concentration mg/kg
2	***cis*-1,2-DCE**	0.07	0.052	1.34	130
	TCE	0.005	0.016	0.311	140
7	**1,1-DCE**	0.007	0.009	0.773	1.66
	cis-1,2-DCE	0.07	0.078	0.894	0.684
	TCE	0.005	0.021	0.234	0.26
	Vinyl chloride	0.002	0.0038	0.533	0.585
30	1,1-DCE	0.007	0.0009	7.53	0.005
	TCE	0.005	0.0033	1.5	0.0374

*COCs shown in bold were predicted in the BGOU RI modeling to exceed MCLs at the SWMU boundary.

B.3.8 MODEL UNCERTAINTY

SESOIL is a variable saturated analytical groundwater flow and transport code used to predict the temporal loading rate of dissolved contamination to an underlying aquifer. Variable saturation indicates that the code can simulate vertical flow and transport through both highly and minimally saturated soil columns.

The UCRS soil matrix at the BGOU SWMUs has varying degrees of saturation. SWMU 2 is considered highly saturated. Concerns have been raised regarding the ability of SESOIL to simulate contaminant migration at SWMU 2. Historical results from the vicinity of SWMU 2 indicate depth to initial encounter of groundwater as little as 10 ft bgs. This section evaluates the potential uncertainty associated with using SESOIL to estimate RGA contaminant concentrations in a highly saturated waste area, such as at SWMU 2.

SESOIL applies an infiltration rate to the top of the model (essentially a soil column) and the same volume of water leaves the bottom of the model independent of hydraulic conductivity or degree of saturation. Clean water entering the top of the model migrates vertically and contacts soil contamination. With contact, some of the soil contamination dissolves into the groundwater based on the assigned K_d—the ratio of contamination adhered to soil versus what is dissolved in groundwater. It is important to note that the K_d reaction is reversible and if “dirty” water encounters “clean” soil then some of the dissolved contamination will adhere to the soil. Given enough time, the soil contamination will dissolve into groundwater and exit the bottom of the model as leachate. It is important to note, the leachate loading will remain the same regardless of the degree of saturation. At a site like PGDP, SESOIL is appropriate, in part, because the majority of transport through the UCRS is vertical.

In addition to contamination leaving the SESOIL model domain through the bottom of the model as leachate, contamination can exit the model as vapor or be biodegraded. Because neither of these phenomena affect nonvolatile constituents (e.g., metals, radionuclides, and most semivolatile organic compounds), the simulation of the migration of nonvolatile constituents is not affected by the varying levels of saturation. Further discussion, therefore, focuses on impacts on the simulation of the migration of volatile constituents, such as TCE.

Where the model predicts unsaturated conditions in the soil column, volatile constituents can dissolve into air based on Henry’s Constant—the ratio of contamination in the vapor phase to that dissolved in water.

When contaminated vapor is close to the top of the model space, SESOIL calculates the contaminant mass that can exit out the top of the model (i.e., partition to air). The rate of contaminant volatilization is inversely proportional to the degree of saturation. Contamination located near land surface, where saturation is minimal, has a greater propensity for volatilization than contamination located in higher saturation zones, such are found in the vicinity of the water table. Under saturated conditions, volatilization is minimal, if it occurs at all.

Biodegradation rate in SESOIL is independent of saturation. Those contaminants that undergo biodegradation like TCE, or in the case of radionuclides have a half-life, will be degraded at the same rate regardless of the degree of saturation, assuming that the biodegradation mechanisms remain the same throughout the UCRS. As part of the PGDP modeling, a half-life for TCE degradation in the UCRS of 26.5 years was used (See Table 5.1, Page 5-4 of the RI; DOE 2010). No degradation was assumed to occur in the RGA although recent findings by the Kentucky Research Consortium for Energy and Environment have estimated the half-life in the RGA at between 3.2 to 11.3 years.

Whether saturated or unsaturated the infiltration rate to the SESOIL column is the same. If the infiltration rate is the same, the contaminant dissolution rate will be the same. Biodegradation is a function of time and in SESOIL is independent of the degree of saturation. Thus, if the infiltration rate remains constant, the biodegradation rate will remain constant regardless of the degree of saturation. Neither dissolution nor biodegradation changes with degree of saturation. However, what does change with differing saturation is the volatilization rate (i.e., the mass of contamination leaving the model as vapor). The remainder of this evaluation therefore will focus on the implications of under-predicting saturation at the BGOU SWMUs on predicted TCE leachate concentrations. Based on the proximity of a perched water table to ground surface, SESOIL under-predicts the degree of saturation present at some of the BGOU SWMUs. The implications are that the SESOIL simulation loses TCE mass to volatilization that, in reality, does not occur because the waste material is surrounded by perched groundwater.

The BGOU SESOIL simulations predict for the various BGOU SWMUs that between 3% and 30% of TCE exits the model as vapor (Table B.10). For SWMU 2, 7% of the TCE mass is predicted to exit as vapor. The variable saturated condition present in the source term in the UCRS limits vapor production, thus, some unknown portion of the contamination simulated to exit the system as vapor actually exits as dissolved contamination in groundwater.

For the BGOU SESOIL simulation for SWMU 2, the impact of the 100% saturated conditions would result in the under prediction of contaminant loading to the RGA by as much as 7%. (Note: this maximum under-prediction of 7% would assume the biodegradation of TCE as it moves through the entire thickness of the UCRS occurs with a half-life of 26.5 years. Although the actual half-life of TCE in the UCRS is uncertain, 26.5 years is likely an underestimate of the rate of degradation in an anaerobic environment like the UCRS (i.e., half-life is likely shorter); therefore, the under prediction due to saturated conditions is mitigated in part by the underestimation of degradation half-life.

Table B.10. SESOIL Percent Volatilization

SWMU	% Volatilized
2	7.17
7	3.47
30	10.37

SESOIL = Seasonal Soil Compartment Model
SWMU = solid waste management unit

For SWMU 2, the SESOIL modeling predicts a maximum TCE concentration of 1.48 mg/L beneath SWMU 2 at about 20 years from present. Thus, if there is no loss of TCE via volatilization (unit is fully saturated to the ground surface), the maximum possible concentration of TCE is expected to increase to 1.59 mg/L. Similarly, the peak concentration may occur slightly later at 21.5 years (rather than about 20 years).

Finally, a more detailed evaluation of the model shows that the TCE that exits via a vapor pathway comes preferentially from source areas located closer to ground surface in a single layer. At SWMU 2, the layer with the greatest TCE concentrations is 10-20 ft bgs, and other contaminated layers are present. Thus, it is likely that the actual amount of vapor exiting the system is less than 7% of the initial source term. For the actual amount of source term exiting the system as vapor to be 7%, all TCE would have to be located as a slug concentrated in one layer near the surface.

As noted previously, the variably saturated conditions have no impact on the simulated migration of contamination to the RGA for nonvolatile constituents. For volatile constituents, the rate of vapor production (and subsequent loss of source through the vapor pathway) is affected by variably saturated conditions. The actual impacts are uncertain, likely small and are likely mitigated in part by uncertainties in the degradation rate and source term configuration. In conclusion, use of SESOIL to simulate BGOU UCRS contaminant migration will yield reasonable predictions of temporal RGA groundwater concentrations for both saturated and unsaturated conditions and correspondingly generate equally reasonable UCRS soil PRGs. When considered together, these uncertainties are such that the PRGs derived are of sufficient quality for decision making within the FS.

B.3.9 SUMMARY OF PRGs FOR PROTECTION OF GROUNDWATER

Table B.11 summarizes the UCRS soil PRGs for the COCs present within the BGOU that are protective of RGA groundwater. The PRGs represent the maximum soil contaminant concentration that can be left in place at the BGOU SWMUs, so that the leachate associated with the soil contamination when entering the RGA will not result in groundwater concentrations above MCLs or risk-based concentrations for residential use of groundwater in the absence of MCLs. These PRGs assume that the precipitation infiltration regime remains constant.

Table B.11. Soil PRGs for Protection of RGA Groundwater

SWMU	COC	MCL* (mg/L) (pCi/L)	Groundwater Protective PRG for Soil** (mg/kg) (pCi/g)
2	Arsenic	0.01	16.9
	cis-1,2-DCE	0.07	1.34
	TCE	0.005	0.311
3	Technetium-99	900	21.2
7	1,1-DCE	0.007	0.773
	Arsenic	0.01	16.9
	TCE	0.005	0.234
	Technetium-99	900	21.2
	Vinyl chloride	0.002	0.533
30	Technetium-99	900	21.2

*mg/L except Tc-99, which has units of pCi/L mg/kg for chemicals, pCi/g for Tc-99.
MCLs from Table A.14 of the Risk Methods Document (DOE 2011).
The MCL listed above for Tc-99 is based on 4 mrem/yr, using historical dosimetry assumptions.

B.4. CONCLUSIONS

The COCs identified in the BHHRA included several constituents that are present at a level consistent with background concentrations, immobile, or would attenuate so that impacts from these COCs would not result in concentrations in the RGA groundwater exceeding MCLs, or in the absence of an MCL, a risk-based concentration for residential use of groundwater. Other COCs identified based on risk are not predicted to cause an exceedance of an MCL in RGA groundwater. MCLs are the target groundwater concentrations used to evaluate potential actions in this FS.

For SWMU 2, PRGs developed for *cis*-1,2-DCE and TCE based on modeling are a focus for evaluating alternatives in this FS. Arsenic is identified as a COC.

For SWMU 3, the PRG of 21.2 pCi/L for Tc-99 was identified to evaluate potential actions to reduce migration of this COC to RGA groundwater.

For SWMU 7, PRGs were provided for arsenic, Tc-99 and three VOCs. Each of these contaminants was identified as potentially exceeding the MCL in RGA groundwater.

For SWMU 30, further evaluation of potential migration of Tc-99 to the RGA is a consideration in this FS. Although the BGOU modeling did not indicate that the MCL would be exceeded at the SWMU boundary, soil concentrations above the PRG of 21.2 pCi/g were detected. The two VOCs identified as COCs were predicted to be below the MCLs at the SWMU boundary in the BGOU RI modeling. There were no concentrations exceeding the PRG to be protective of RGA groundwater beneath the waste unit as modeled in this FS.

B.5. REFERENCES

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ATTACHMENT B1

SWMU 2
SESOIL/AT123D MODEL OUTPUT

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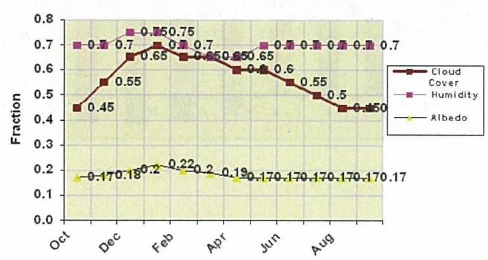
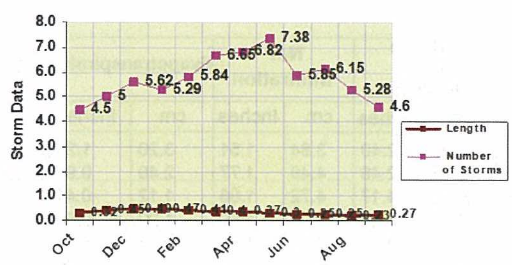
Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\PAVG100.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					

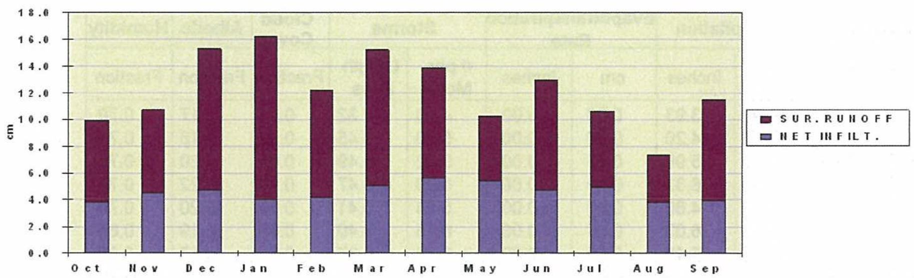


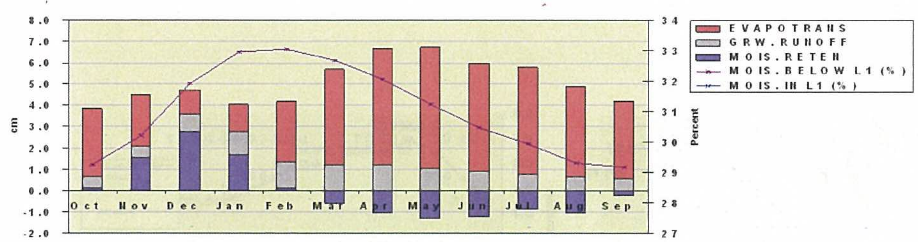


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS100.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	0.15	0.06	0.49	0.19	29.27	29.27
November	6.25	2.46	4.49	1.77	2.40	0.94	1.54	0.61	0.56	0.22	30.21	30.21
December	10.58	4.17	4.72	1.86	1.12	0.44	2.78	1.09	0.83	0.33	31.92	31.92
January	12.19	4.80	4.06	1.60	1.29	0.51	1.68	0.66	1.09	0.43	32.96	32.96
February	8.08	3.18	4.17	1.64	2.85	1.12	0.15	0.06	1.18	0.46	33.05	33.05
March	10.11	3.98	5.10	2.01	4.47	1.76	-0.59	-0.23	1.21	0.48	32.69	32.69
April	8.24	3.24	5.64	2.22	5.46	2.15	-1.02	-0.40	1.20	0.47	32.06	32.06
May	4.90	1.93	5.41	2.13	5.69	2.24	-1.32	-0.52	1.05	0.41	31.25	31.25
June	8.22	3.24	4.73	1.86	5.07	2.00	-1.24	-0.49	0.91	0.36	30.48	30.48
July	5.70	2.24	4.91	1.93	5.00	1.97	-0.88	-0.35	0.79	0.31	29.94	29.94
August	3.53	1.39	3.87	1.52	4.26	1.68	-1.02	-0.40	0.63	0.25	29.31	29.31
September	7.53	2.96	3.99	1.57	3.66	1.44	-0.22	-0.09	0.55	0.22	29.18	29.18
Total	91.41	35.99	54.93	21.63	44.45	17.50	0.00	0.00	10.47	4.12		

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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	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00

Soil Parameters

Bulk Density (g/cm3)	1.46
Effective Porosity (fraction)	0.45
Soil Pore Disconnectedness	10.00

Application Parameters

Area	cm 2	6.32E+6
	ft 2	6802.79
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 (M3atm/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 (cm2/sec)	7.36E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm2/sec)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	96.90		

Output File:
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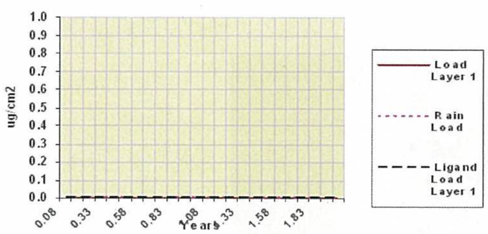
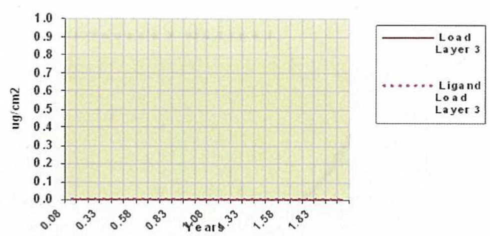
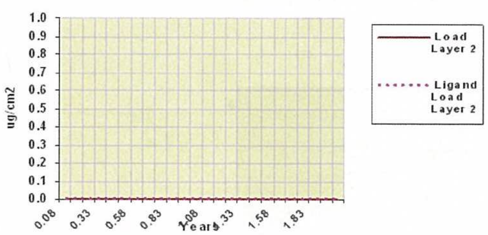
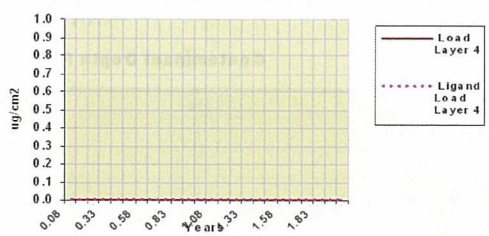
Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS12DIC.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\SSOIL.SOI
Application File: PGDP SWMU-2: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS12DIC.APL

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)										









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SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	1.107E+08	3.94
In Soil Air	1.223E+04	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	1.918E+04	0.00
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	1.349E+05	0.00
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	2.692E+09	95.73
Total Output	2.802E+09	99.68
Total Input	2.812E+09	
Input - Output	9.071E+06	

Maximum leachate concentration: 1.630E+00 mg/l

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\PAVG100.CLM

Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS12DIC.CHM

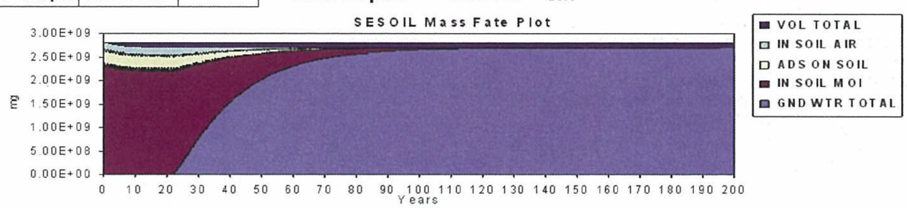
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\SSOIL.SOI

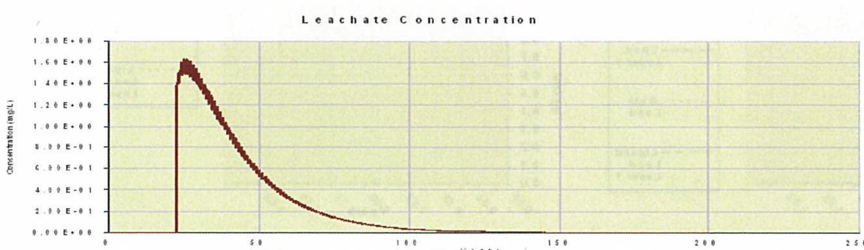
Application File: PGDP SWMU-2: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS12DIC.APL

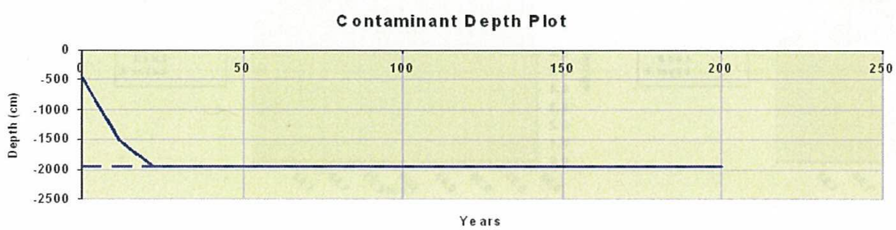
Starting Depth: 463.40 **cm**

Ending Depth: 1951.00 **cm**

Total Depth: 1951.50 **cm**

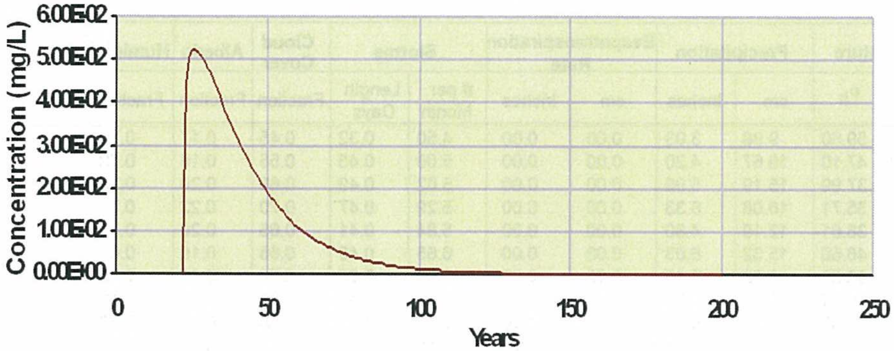






cis-1,2-DCE

AT123D Point of Compliance Report



Maximum Concentration: 5.230E-02 mg/L
Year of Maximum Concentration: 26.00

Output Coordinates

X:	12.56000 m	41.2068 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:	4.068E-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:	-1.256E+01	1.256E+01	-4.120E+01	4.120E+01
Y:	-1.256E+01	1.256E+01	-4.120E+01	4.120E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS100.ATI
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\CIS100.ATO

Climate Report

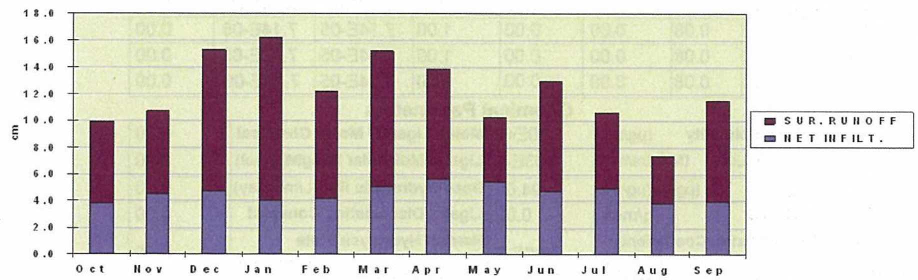
Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\PAVG100.CLM

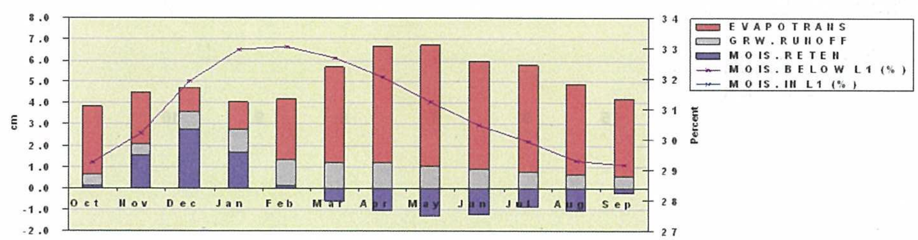
Month	Temperature		Precipitation		Evapotranspiration Rate		Storms		Cloud Cover	Albedo	Humidity
Units	°C	°F	cm	Inches	cm	Inches	# per Month	Length Days	Fraction	Fraction	Fraction
October	15.28	59.50	9.98	3.93	0.00	0.00	4.50	0.32	0.45	0.17	0.70
November	8.39	47.10	10.67	4.20	0.00	0.00	5.00	0.45	0.55	0.18	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 Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE100.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	0.15	0.06	0.49	0.19	29.27	29.27
November	6.25	2.46	4.49	1.77	2.40	0.94	1.54	0.61	0.56	0.22	30.21	30.21
December	10.58	4.17	4.72	1.86	1.12	0.44	2.78	1.09	0.83	0.33	31.92	31.92
January	12.19	4.80	4.06	1.60	1.29	0.51	1.68	0.66	1.09	0.43	32.96	32.96
February	8.08	3.18	4.17	1.64	2.85	1.12	0.15	0.06	1.18	0.46	33.05	33.05
March	10.11	3.98	5.10	2.01	4.47	1.76	-0.59	-0.23	1.21	0.48	32.69	32.69
April	8.24	3.24	5.64	2.22	5.46	2.15	-1.02	-0.40	1.20	0.47	32.06	32.06
May	4.90	1.93	5.41	2.13	5.69	2.24	-1.32	-0.52	1.05	0.41	31.25	31.25
June	8.22	3.24	4.73	1.86	5.07	2.00	-1.24	-0.49	0.91	0.36	30.48	30.48
July	5.70	2.24	4.91	1.93	5.00	1.97	-0.88	-0.35	0.79	0.31	29.94	29.94
August	3.53	1.39	3.87	1.52	4.26	1.68	-1.02	-0.40	0.63	0.25	29.31	29.31
September	7.53	2.96	3.99	1.57	3.66	1.44	-0.22	-0.09	0.55	0.22	29.18	29.18
Total	91.41	35.99	54.93	21.63	44.45	17.50	0.00	0.00	10.47	4.12		

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	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00

Soil Parameters

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

Application Parameters

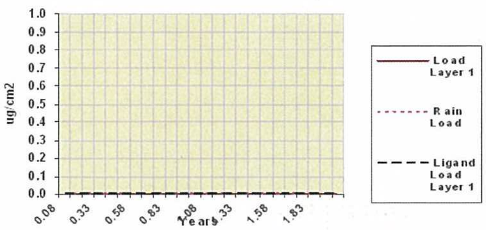
Area	cm^2	8.55E+6
	ft^2	9203.14
Latitude	degrees	37.0
Spill Index		1

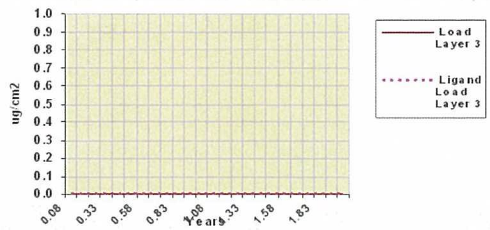
Chemical Parameters

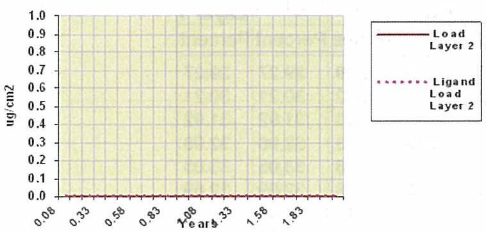
Water Solubility (µg/mL)	1.10E+3	**Moles Ligand / Moles Chemical**	0.00
Henry's Law (M^3atm/mol)	1.03E-2	**Ligand Molecular Weight** (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	94.00	**Base Hydrolysis Rate** (L/mol/day)	0.00
Valance (g/mole)	0.00	**Ligand Dissociation Constant**	0.00
Air Diffusion Coefficient (cm^2/sec)	7.90E-2	**Neutral Hydrolysis Rate** (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	.0	**Acid Hydrolysis Rate** (L/mol/day)	0.00
Molecular Weight (g/mol)	131.00		

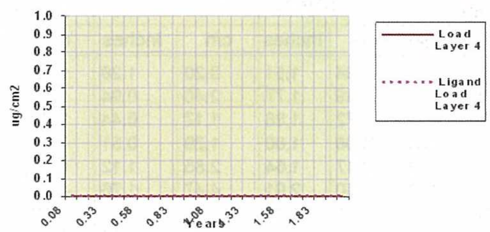
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE100.OUT
Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\SSOIL.SOI
Application File: PGDP SWMU-2: TCE (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE.APL

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 Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	7.698E+08	20.23
In Soil Air	3.167E+04	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	5.208E+04	0.00
Hydrol Soil	0.000E+00	0.00
Degrad Soil	5.762E+08	15.14
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	1.383E+05	0.00
Hydrol Mois	0.000E+00	0.00
Degrad Mois	1.627E+09	42.78
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	8.244E+08	21.67
Total Output	3.798E+09	99.83
Total Input	3.805E+09	
Input - Output	6.473E+06	

Maximum leachate concentration: 3.973E-01 **mg/l**

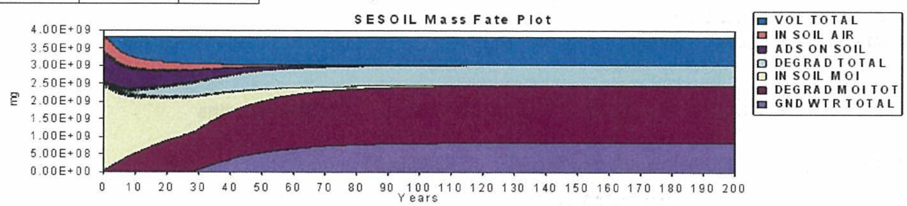
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\PAVG100.CLM

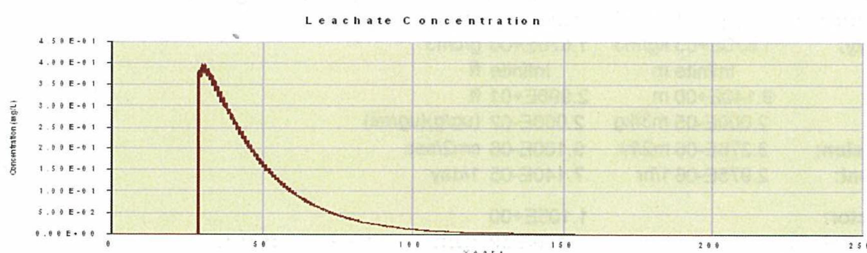
Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE.CHM

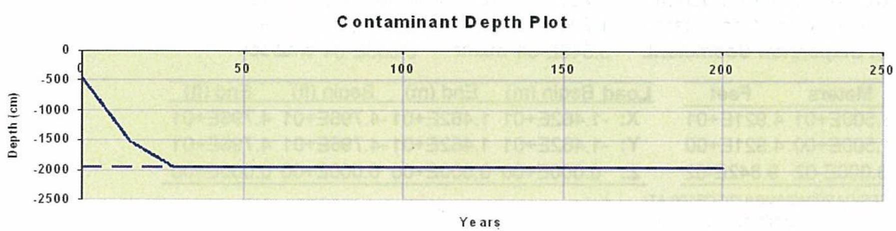
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\SSOIL.SOI

Application File: PGDP SWMU-2: TCE (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE.APL

Starting Depth: 462.00 **cm**
Ending Depth: 1951.00 **cm**
Total Depth: 1951.50 **cm**

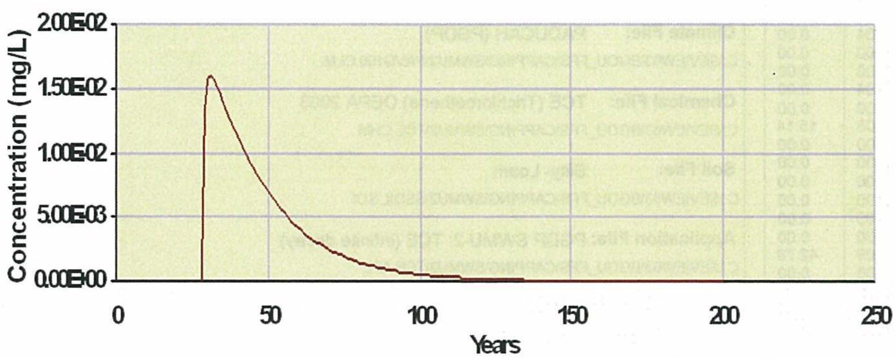






TCE

AT123D Point of Compliance Report



Maximum Concentration: 1.600E-02 mg/L
Year of Maximum Concentration: 31.00

Output Coordinates

X:	14.62000 m	47.9653 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:	3.276E-06 m2/hr	9.100E-06 cm2/sec		
Decay Coefficient:	2.975E-06 1/hr	7.140E-05 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:	-1.462E+01	1.462E+01	-4.796E+01	4.796E+01
Y:	-1.462E+01	1.462E+01	-4.796E+01	4.796E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE100.ATI
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU2\TCE100.ATO

ATTACHMENT B2

SWMU 7
SESOIL/AT123D MODEL OUTPUT

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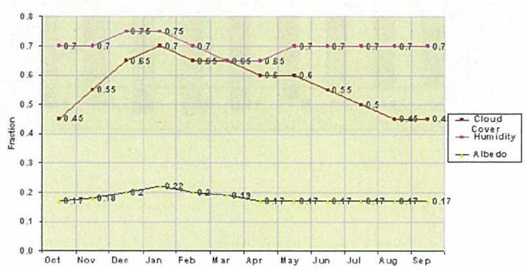
Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

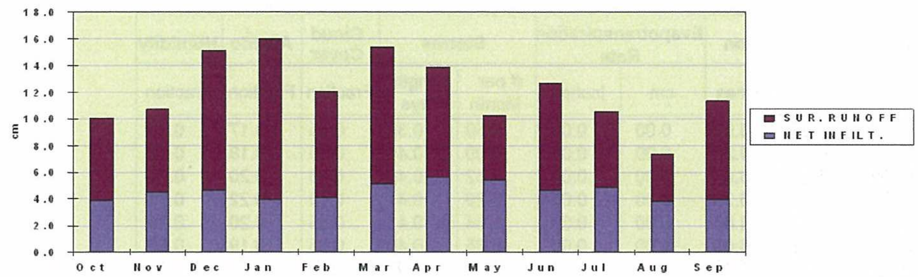
Month	Temperature		Precipitation		Evapotranspiration Rate		Storms		Cloud Cover	Albedo	Humidity
Units	°C	°F	cm	Inches	cm	Inches	# per Month	Length Days	Fraction	Fraction	Fraction
October	15.28	59.50	9.98	3.93	0.00	0.00	4.50	0.32	0.45	0.17	0.70
November	8.39	47.10	10.67	4.20	0.00	0.00	5.00	0.45	0.55	0.18	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					

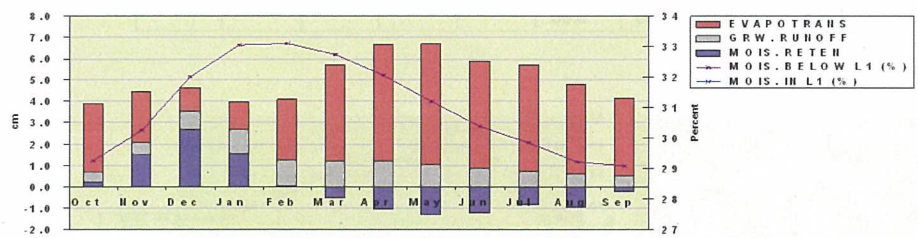


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DCE100.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 Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness (cm)	Thickness (feet)	Intrinsic Permeability (cm 2)	Organic Carbon Content (percent)	Adsorption Coefficient (µg/g / µg/mL)	Cation Exchange Capacity (mEq / 100 g soil)	Freundlich Exponent (unitless)	Solid Phase Degradation Rate (1/day)	Liquid Phase Degradation Rate (1/day)	Soil pH (pH)
1	1	30.5	1.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00

Soil Parameters

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

Application Parameters

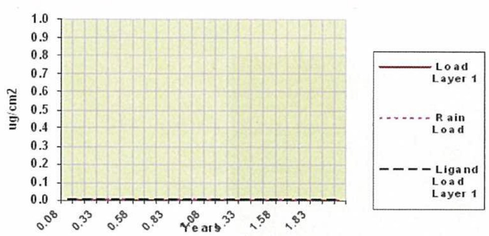
Area	cm ^{2}	2.60E+7
	ft ^{2}	2.79E+4
Latitude	degrees	37.0
Spill Index		1

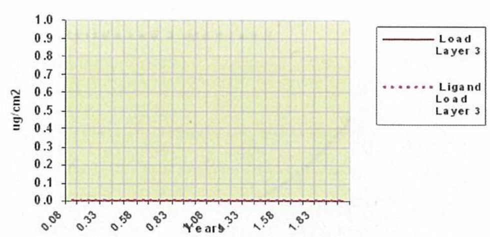
Chemical Parameters

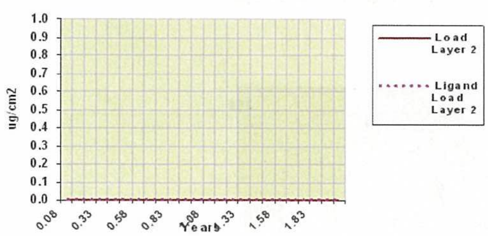
Water Solubility (µg/mL)	2.25E+3	Moles Ligand / Moles Chemical	0.00
Henry's Law (M^3-atm/mol)	2.61E-2	Ligand Molecular Weight (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	65.00	Base Hydrolysis Rate (L/mol/day)	0.00
Valance (g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient (cm^2/sec)	9.00E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	97.00		

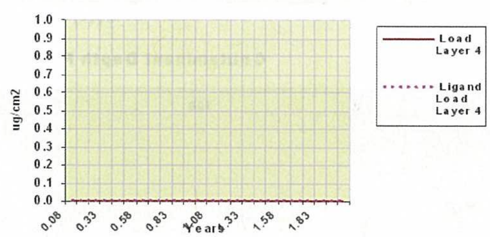
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DCE100.OUT
Chemical File: 1,1-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DICHLO.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI
Application File: PGDP SWMU-7: 1,1-dichloroethene (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DICHLO.APL

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 Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DCE100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	9.617E+09	83.13
In Soil Air	4.849E+06	0.04
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	2.164E+06	0.02
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	8.291E+06	0.07
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	1.919E+09	16.59
Total Output	1.155E+10	99.85
Total Input	1.157E+10	
Input - Output	1.777E+07	

Maximum leachate concentration: 2.088E-01 **mg/l**

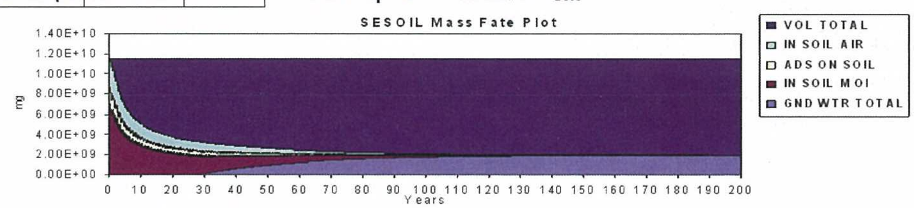
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

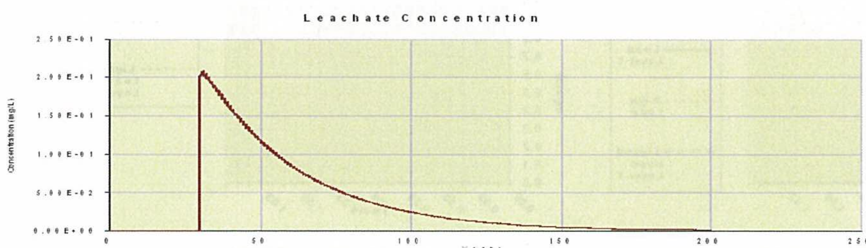
Chemical File: 1,1-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DICHLO.CHM

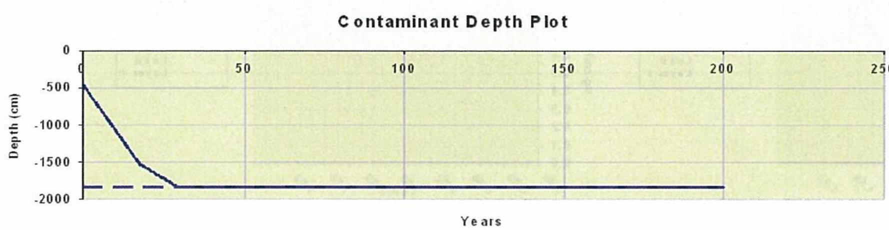
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI

Application File: PGDP SWMU-7: 1,1-dichloroethene (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DICHLO.APL

Starting Depth: 461.30 **cm**
Ending Depth: 1829.00 **cm**
Total Depth: 1829.50 **cm**

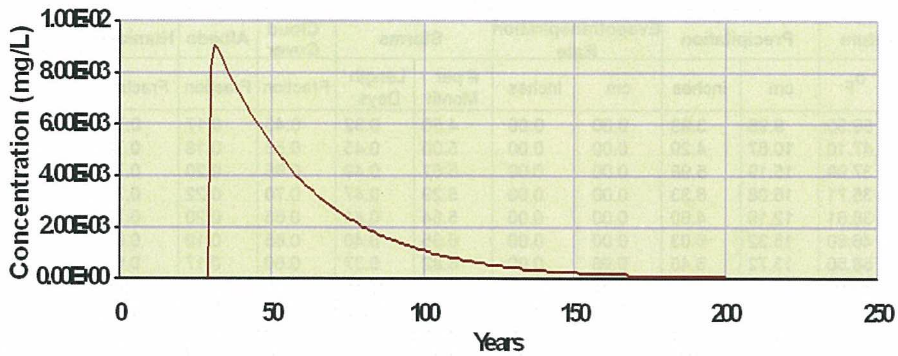






1,1-DCE

AT123D Point of Compliance Report



Maximum Concentration: 9.060E-03 mg/L
Year of Maximum Concentration: 31.00

Output Coordinates

X:	25.49000 m	83.6276 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):**		0.6500E+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:	3.744E-06 m2/hr	1.040E-05 cm2/sec		
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day		

Retardation Factor:	1.072E+00	
Retarded Darcy Velocity:	1.776E-02 m2/hr	4.933E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	2.665E-01 m2/hr	7.402E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	2.666E-02 m2/hr	7.405E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	5.446E-04 m2/hr	1.512E-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:	-2.549E+01	2.549E+01	-8.362E+01	8.362E+01
Y:	-2.549E+01	2.549E+01	-8.362E+01	8.362E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\11DCE100.ATI
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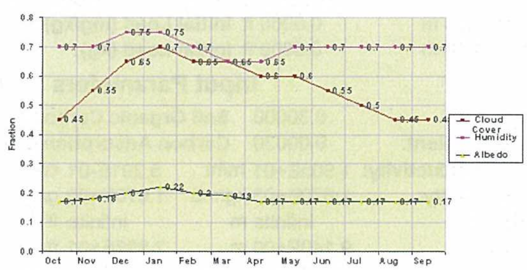
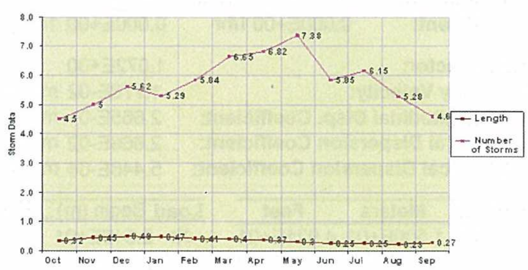
FORWARD

Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.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					

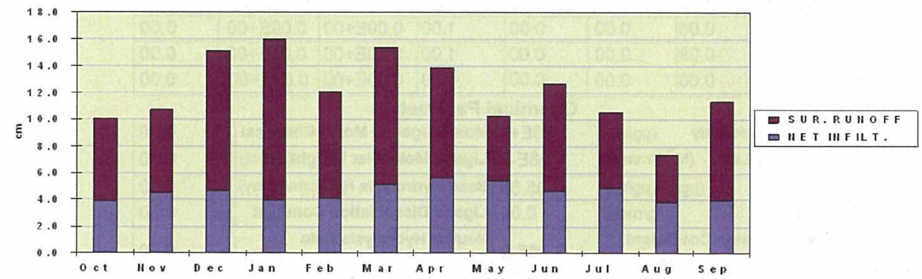


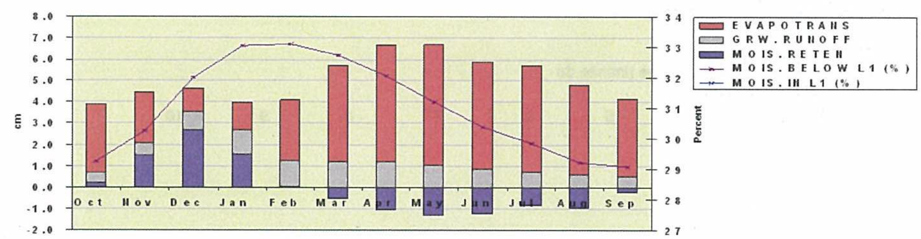


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS100.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 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	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00

Soil Parameters

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

Application Parameters

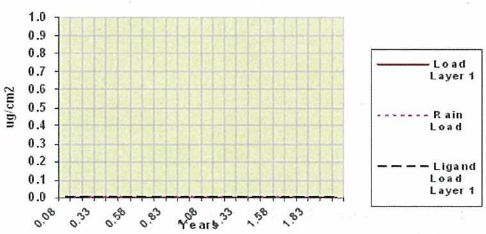
Area	cm^2	3.23E+7
	ft^2	3.47E+4
Latitude	degrees	37.0
Spill Index		1

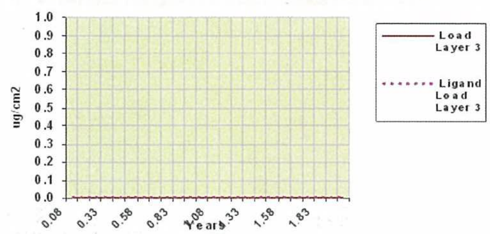
Chemical Parameters

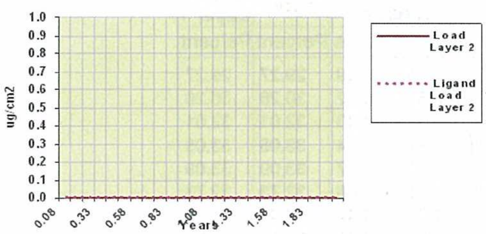
Water Solubility (µg/mL)	3.50E+3	Moles Ligand / Moles Chemical	0.00
Henry's Law (M^3atm/mol)	4.08E-3	Ligand Molecular Weight (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	35.50	Base Hydrolysis Rate (L/mol/day)	0.00
Valance (g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient (cm^2/sec)	7.36E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	96.90		

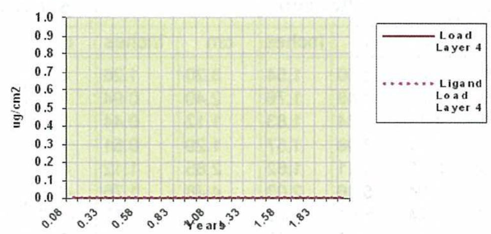
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS100.OUT
Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS12DIC.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI
Application File: PGDP SWMU-7: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS12DIC.APL

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)										









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SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	6.030E+08	4.20
In Soil Air	7.687E+04	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	1.198E+05	0.00
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	8.406E+05	0.01
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	1.372E+10	95.50
Total Output	1.432E+10	99.70
Total Input	1.437E+10	
Input - Output	4.259E+07	

Maximum leachate concentration: 1.649E+00 mg/l

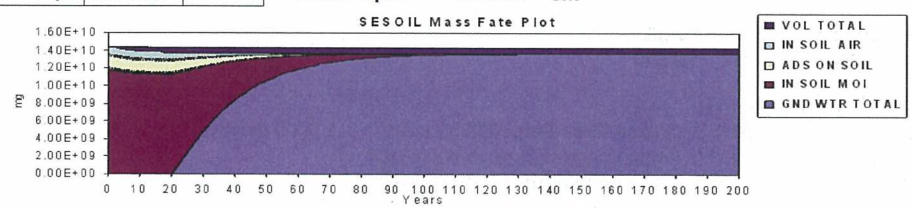
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

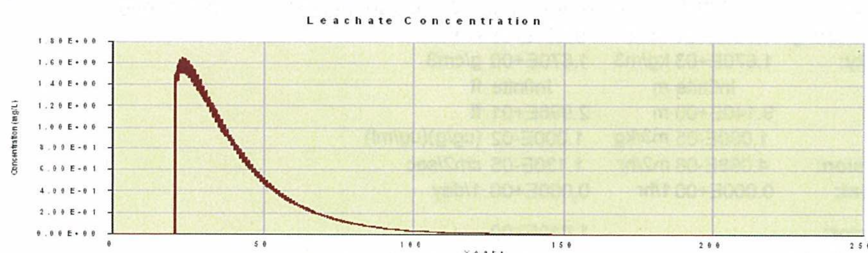
Chemical File: cis -1,2-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS12DIC.CHM

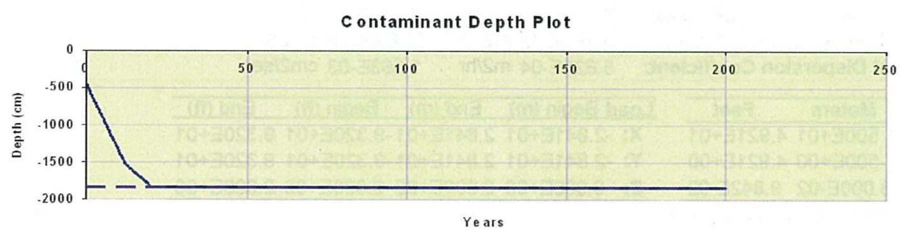
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI

Application File: PGDP SWMU-7: Cis-1,2-dichloroethene (infinite de
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\CIS12DIC.APL

Starting Depth: 463.20 cm
Ending Depth: 1829.00 cm
Total Depth: 1829.50 cm

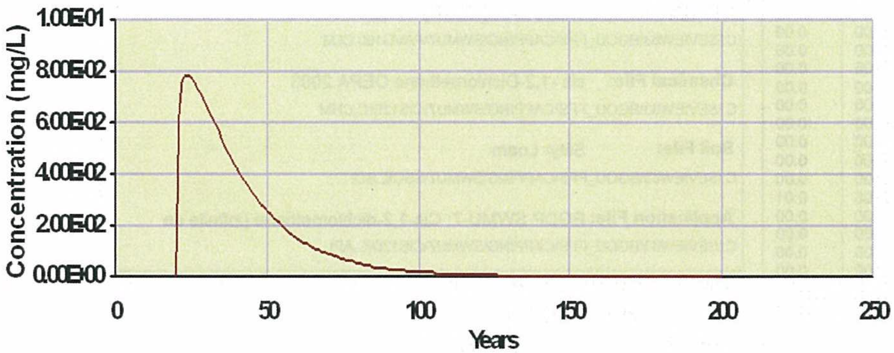






cis-1,2-DCE

AT123D Point of Compliance Report



Maximum Concentration: 7.830E-02 mg/L
Year of Maximum Concentration: 23.00

Output Coordinates

X:	28.41000 m	93.2075 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):**	0.3550E+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:	4.068E-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:	1.833E-02 m2/hr	5.091E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	2.749E-01 m2/hr	7.636E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	2.750E-02 m2/hr	7.638E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	5.628E-04 m2/hr	1.563E-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:	-2.841E+01	2.841E+01	-9.320E+01	9.320E+01
Y:	-2.841E+01	2.841E+01	-9.320E+01	9.320E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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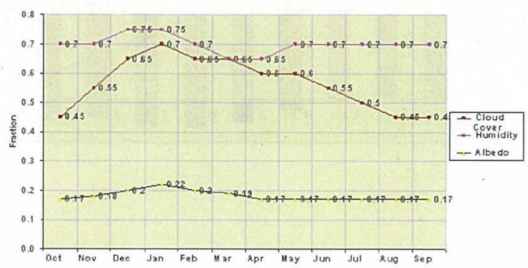
FORWARD

Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

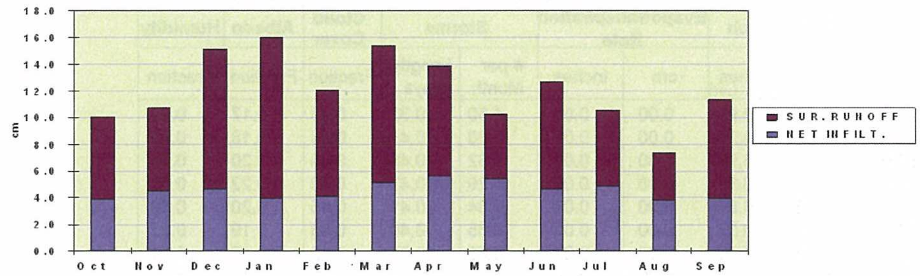
Month	Temperature		Precipitation		Evapotranspiration Rate		Storms		Cloud Cover	Albedo	Humidity
Units	°C	°F	cm	Inches	cm	Inches	# per Month	Length Days	Fraction	Fraction	Fraction
October	15.28	59.50	9.98	3.93	0.00	0.00	4.50	0.32	0.45	0.17	0.70
November	8.39	47.10	10.67	4.20	0.00	0.00	5.00	0.45	0.55	0.18	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					

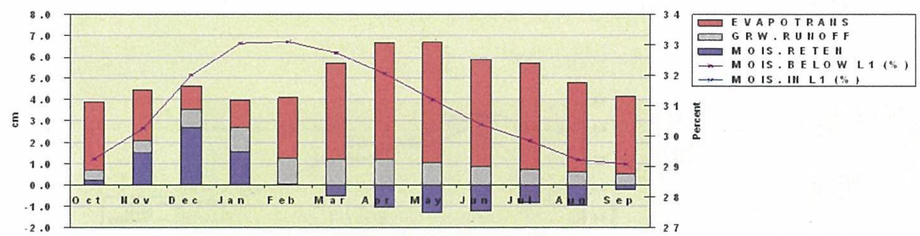


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE100.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 Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness (cm)	Thickness (feet)	Intrinsic Permeability (cm ^{2})	Organic Carbon Content (percent)	Adsorption Coefficient (µg/g / µg/mL)	Cation Exchange Capacity (mEq / 100 g soil)	Freundlich Exponent (unitless)	Solid Phase Degradation Rate (1/day)	Liquid Phase Degradation Rate (1/day)	Soil pH (pH)
1	1	30.5	1.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00

Soil Parameters

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

Application Parameters

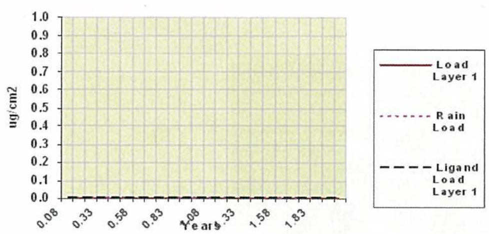
Area	cm ^{2}	3.34E+7
	ft ^{2}	3.59E+4
Latitude	degrees	37.0
Spill Index		1

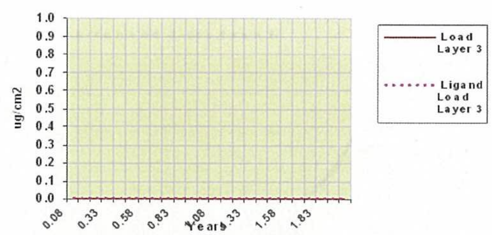
Chemical Parameters

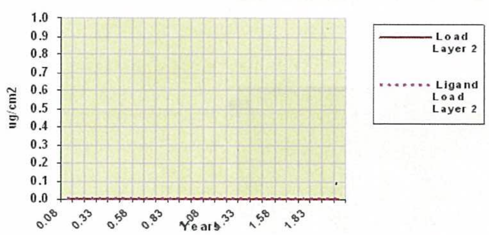
Water Solubility (µg/mL)	1.10E+3	Moles Ligand / Moles Chemical	0.00
Henry's Law (M ^{3} atm/mol)	1.03E-2	Ligand Molecular Weight (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	94.00	Base Hydrolysis Rate (L/mol/day)	0.00
Valance (g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient (cm ^{2}/sec)	7.90E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm ^{2}/sec)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	131.00		

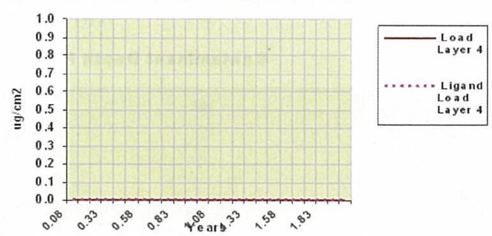
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE100.OUT
Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI
Application File: PGDP SWMU-7: TCE
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE.APL

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 Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	3.149E+09	21.19
In Soil Air	1.041E+05	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	1.702E+05	0.00
Hydrol Soil	0.000E+00	0.00
Degrad Soil	2.177E+09	14.65
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	4.510E+05	0.00
Hydrol Mois	0.000E+00	0.00
Degrad Mois	6.149E+09	41.38
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	3.362E+09	22.63
Total Output	1.483E+10	99.86
Total Input	1.486E+10	
Input - Output	2.042E+07	

Maximum leachate concentration: 4.332E-01 mg/l

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE.CHM

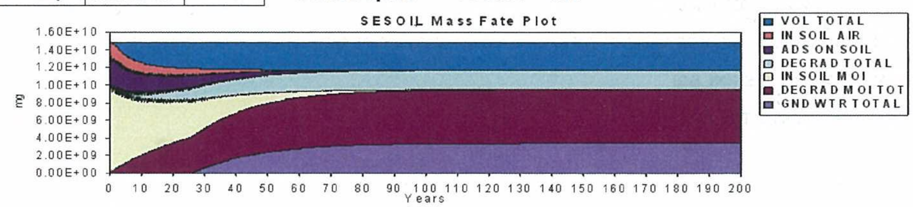
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI

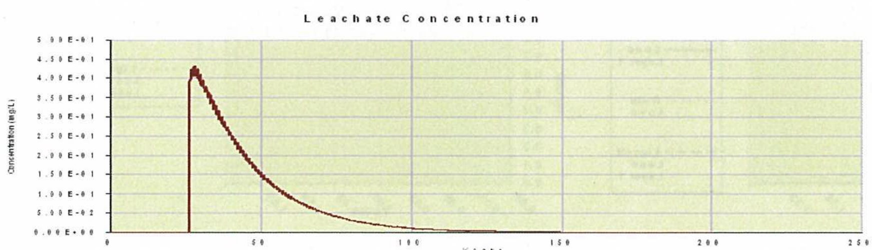
Application File: PGDP SWMU-7: TCE
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE.APL

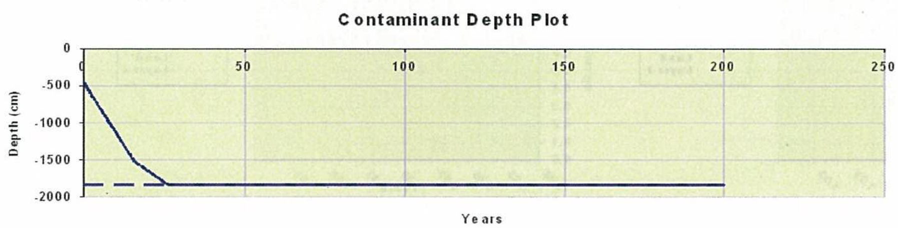
Starting Depth: 461.80 cm

Ending Depth: 1829.00 cm

Total Depth: 1829.50 cm

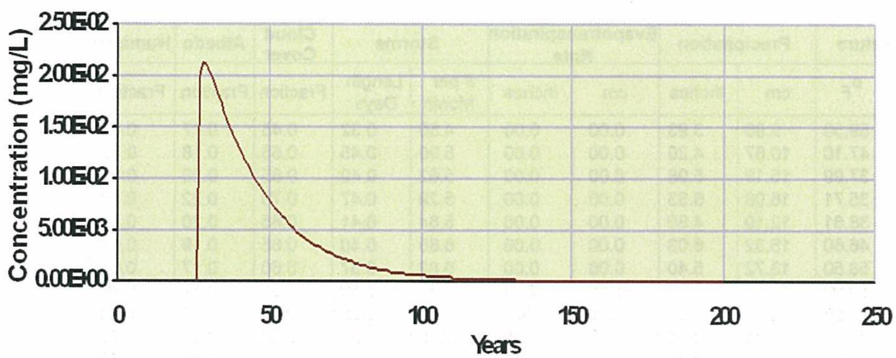






TCE

AT123D Point of Compliance Report



Maximum Concentration: 2.140E-02 mg/L
Year of Maximum Concentration: 28.00

Output Coordinates

X:	28.89000 m	94.7823 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):**	0.9400E+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:	3.276E-06 m2/hr		9.100E-06 cm2/sec	
Decay Coefficient:	2.975E-06 1/hr		7.140E-05 1/day	

Retardation Factor:	1.105E+00	
Retarded Darcy Velocity:	1.725E-02 m2/hr	4.791E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	2.587E-01 m2/hr	7.186E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	2.588E-02 m2/hr	7.188E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	5.272E-04 m2/hr	1.464E-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

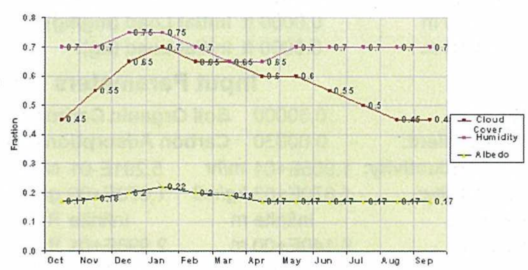
Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-2.889E+01	2.889E+01	-9.478E+01	9.478E+01
Y:	-2.889E+01	2.889E+01	-9.478E+01	9.478E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

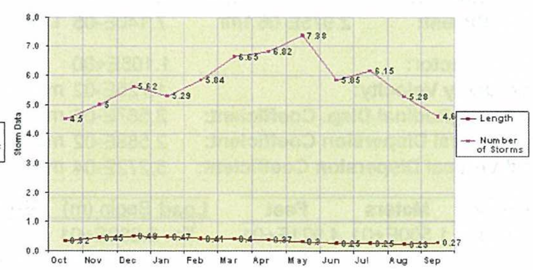
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE100.ATI
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\TCE100.ATO

Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.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					

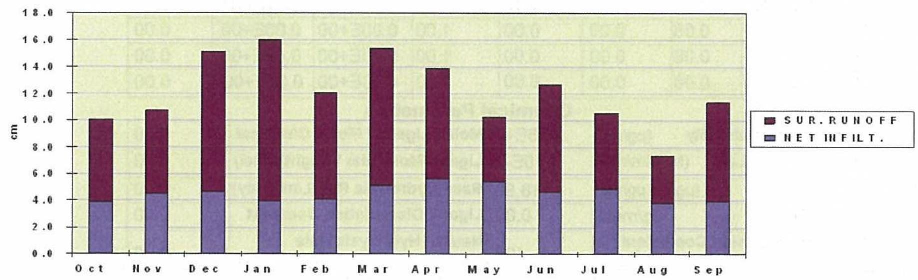


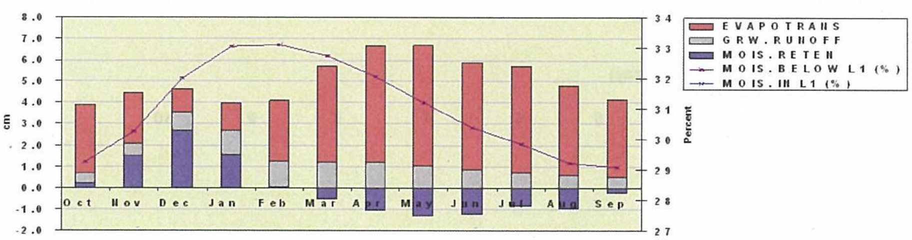


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VC100.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 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	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00

Soil Parameters

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

Application Parameters

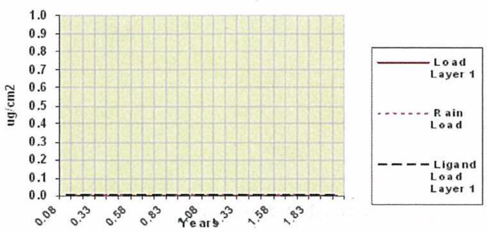
Area	cm^2	1.04E+7
	ft^2	1.11E+4
Latitude	degrees	37.0
Spill Index		1

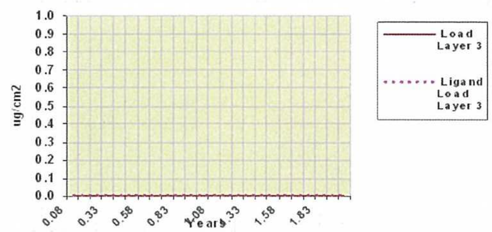
Chemical Parameters

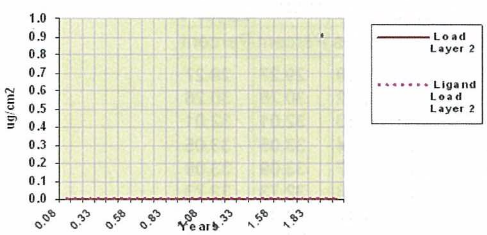
Water Solubility (µg/mL)	2.76E+3	**Moles Ligand / Moles Chemical**	0.00
Henry's Law (M^3atm/mol)	2.70E-2	**Ligand Molecular Weight** (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	18.80	**Base Hydrolysis Rate** (L/mol/day)	0.00
Valance (g/mole)	0.00	**Ligand Dissociation Constant**	0.00
Air Diffusion Coefficient (cm^2/sec)	.106	**Neutral Hydrolysis Rate** (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	.0	**Acid Hydrolysis Rate** (L/mol/day)	0.00
Molecular Weight (g/mol)	62.50		

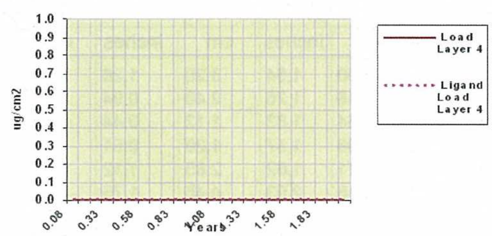
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VC100.OUT
Chemical File: Vinyl Chloride OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VINYLCHL.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI
Application File: PGDP SWMU-7: vanadium (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VCRG.APL

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 Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VC100.OUT

Maximum leachate concentration: 1.533E-01 mg/l

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	4.170E+09	90.11
In Soil Air	3.744E+05	0.01
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	4.672E+04	0.00
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	6.188E+05	0.01
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	4.518E+08	9.76
Total Output	4.623E+09	99.90
Total Input	4.628E+09	
Input - Output	4.688E+06	

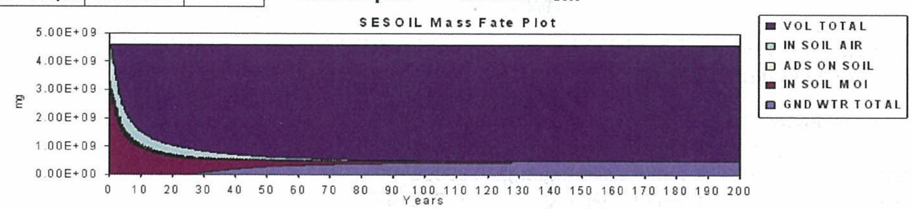
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\PAVG100.CLM

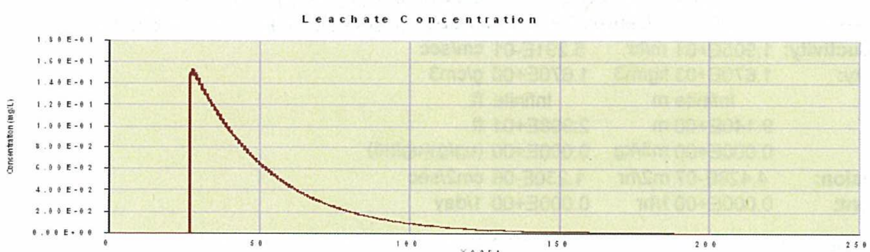
Chemical File: Vinyl Chloride OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VINYLCHL.CHM

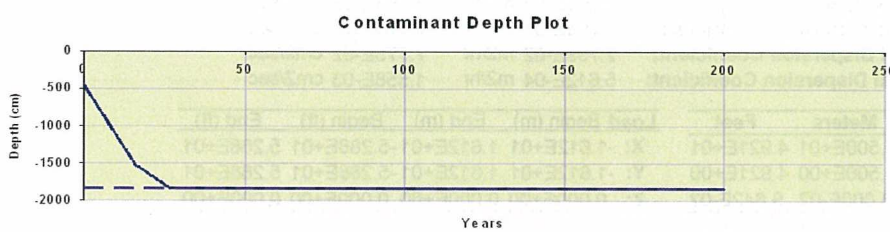
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\SSOIL.SOI

Application File: PGDP SWMU-7: vanadium (infinite decay)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VCRG.APL

Starting Depth: 461.70 cm
Ending Depth: 1829.00 cm
Total Depth: 1829.50 cm

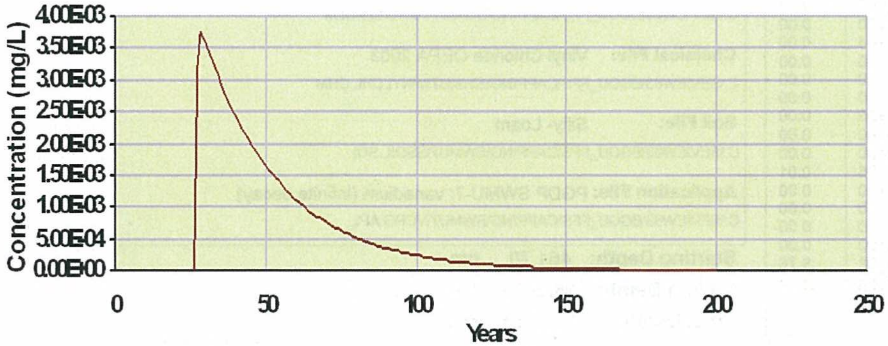






Vinyl Chloride

AT123D Point of Compliance Report



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

Output Coordinates

X:	16.12000 m	52.8865 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:	-1.612E+01	1.612E+01	-5.288E+01	5.288E+01
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

C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VC100.ATI
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU7\VC100.ATO

ATTACHMENT B3

SWMU 30
SESOIL/AT123D MODEL OUTPUT

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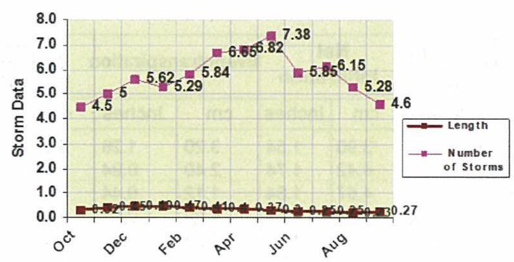
Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\PAVG100.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					



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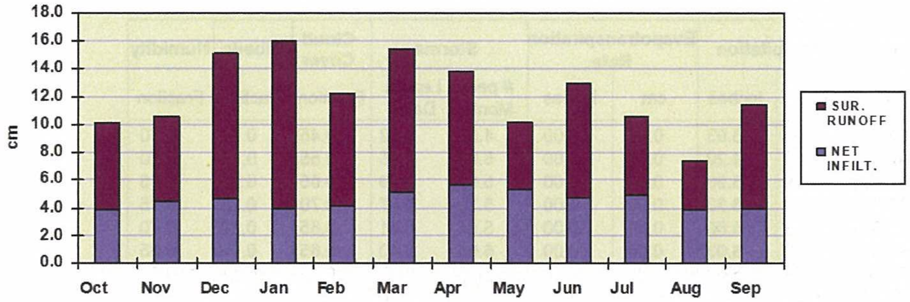
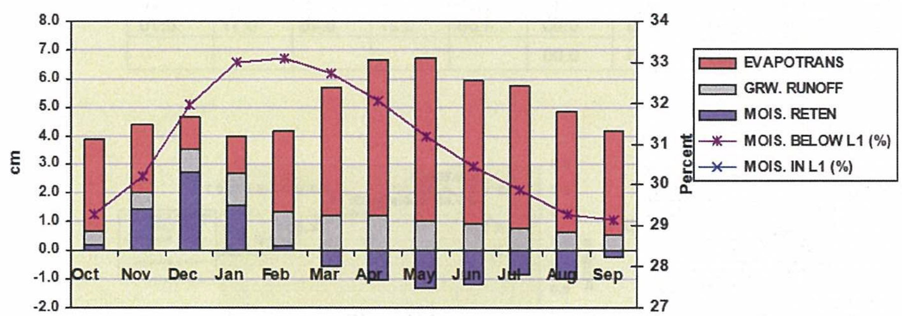
SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DCE100.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	6.19	2.44	3.90	1.54	3.20	1.26	0.21	0.08	0.49	0.19	29.27	29.27
November	6.15	2.42	4.42	1.74	2.40	0.94	1.46	0.57	0.56	0.22	30.21	30.21
December	10.50	4.13	4.67	1.84	1.12	0.44	2.72	1.07	0.84	0.33	31.97	31.97
January	12.04	4.74	4.00	1.57	1.29	0.51	1.60	0.63	1.10	0.43	33.00	33.00
February	8.12	3.20	4.19	1.65	2.85	1.12	0.14	0.06	1.20	0.47	33.09	33.09
March	10.25	4.04	5.15	2.03	4.48	1.76	-0.56	-0.22	1.23	0.48	32.73	32.73
April	8.21	3.23	5.61	2.21	5.46	2.15	-1.05	-0.41	1.20	0.47	32.06	32.06
May	4.84	1.91	5.37	2.11	5.66	2.23	-1.33	-0.52	1.03	0.41	31.20	31.20
June	8.24	3.24	4.75	1.87	5.04	1.98	-1.19	-0.47	0.90	0.35	30.44	30.44
July	5.69	2.24	4.92	1.94	4.97	1.96	-0.84	-0.33	0.78	0.31	29.90	29.90
August	3.53	1.39	3.89	1.53	4.24	1.67	-0.98	-0.39	0.62	0.24	29.27	29.27
September	7.48	2.94	3.97	1.56	3.64	1.43	-0.21	-0.08	0.54	0.21	29.13	29.13
Total	91.23	35.92	54.83	21.59	44.35	17.46	0.00	0.00	10.48	4.12		

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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	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	0.00E+00	0.00E+00	0.00

Soil Parameters

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

Application Parameters

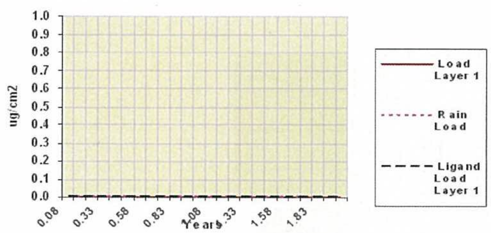
Area	cm^2	1.86E+6
	ft^2	2002.09
Latitude	degrees	37.0
Spill Index		1

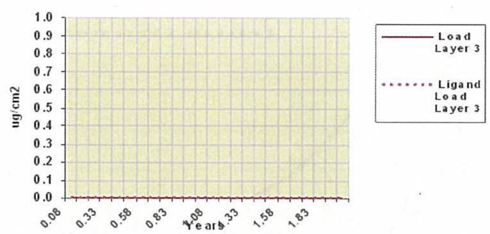
Chemical Parameters

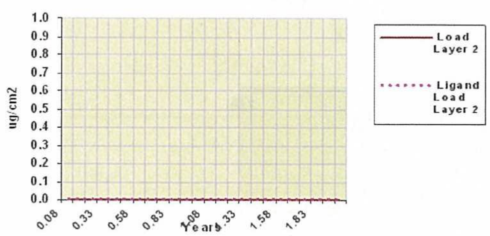
Water Solubility (µg/mL)	2.25E+3	Moles Ligand / Moles Chemical	0.00
Henry's Law (M^3atm/mol)	2.61E-2	Ligand Molecular Weight (g/mol)	0.00
K_{oc} (µg/g)/(µg/mL)	65.00	Base Hydrolysis Rate (L/mol/day)	0.00
Valance (g/mole)	0.00	Ligand Dissociation Constant	0.00
Air Diffusion Coefficient (cm^2/sec)	9.00E-2	Neutral Hydrolysis Rate (L/mol/day)	0.00
Water Diffusion Coefficient (cm^2/sec)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	97.00		

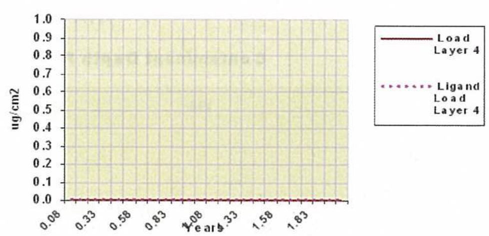
Output File:
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DCE100.OUT
Chemical File: 1,1-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DICHLO.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\SSOIL.SOI
Application File: PGDP SWMU-30: 1,1-dichloroethene (infinite decay
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DICHLO.APL

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)										









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SESOIL Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DCE100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	6.845E+08	82.71
In Soil Air	4.054E+05	0.05
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	1.814E+05	0.02
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	6.962E+05	0.08
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	1.404E+08	16.97
Total Output	8.263E+08	99.84
Total Input	8.277E+08	
Input - Output	1.319E+06	

Maximum leachate concentration: 2.068E-01 mg/l

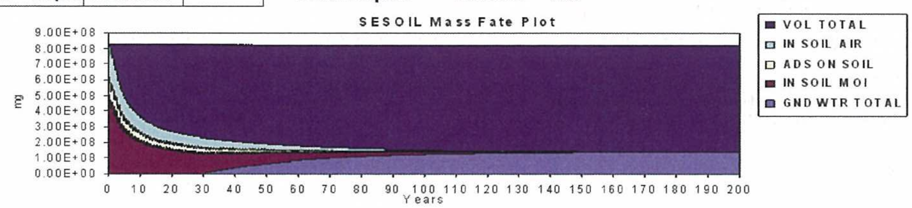
Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\PAVG100.CLM

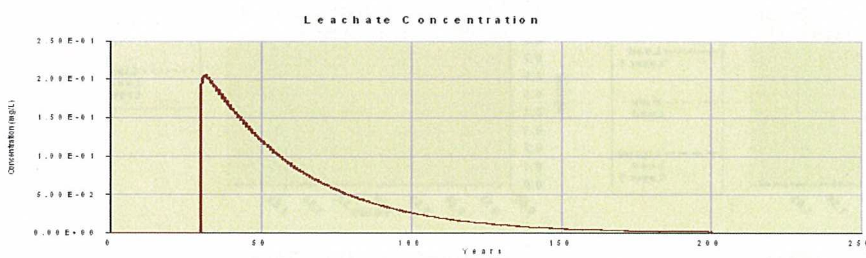
Chemical File: 1,1-Dichloroethene OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DICHLO.CHM

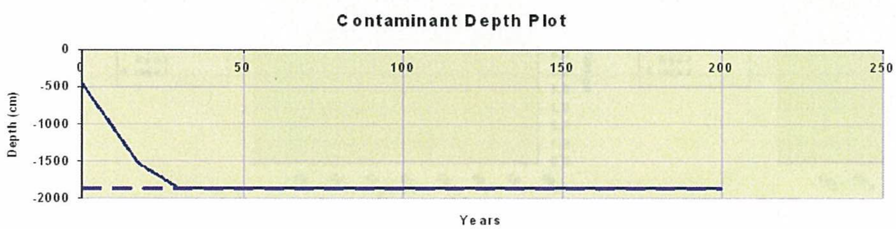
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\SSOIL.SOI

Application File: PGDP SWMU-30: 1,1-dichloroethene (infinite decay
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DICHLO.APL

Starting Depth: 461.30 cm
Ending Depth: 1859.00 cm
Total Depth: 1859.50 cm

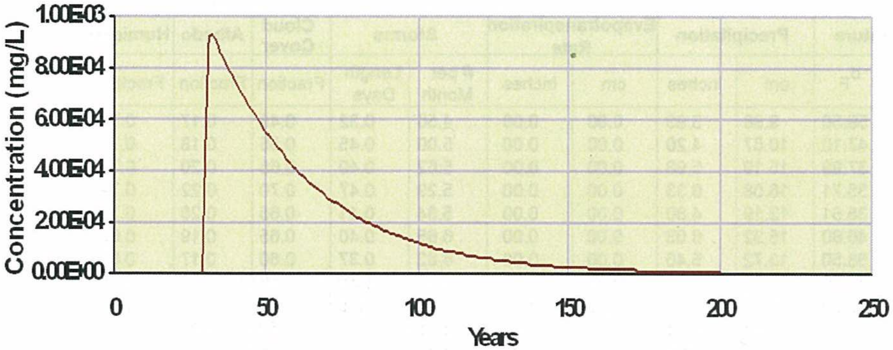






1,1-DCE

AT123D Point of Compliance Report



Maximum Concentration: 9.290E-04 mg/L
Year of Maximum Concentration: 32.00

Output Coordinates

X:	6.82000 m	22.3751 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:	0.00036		**Carbon Adsorption Coeff. (ug/g)/(ug/ml):**	0.6500E+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:	3.744E-06 m2/hr	1.040E-05 cm2/sec		
Decay Coefficient:	0.000E+00 1/hr	0.000E+00 1/day		

Retardation Factor:	1.072E+00	
Retarded Darcy Velocity:	2.132E-02 m2/hr	5.922E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	3.198E-01 m2/hr	8.883E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	3.199E-02 m2/hr	8.886E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	6.512E-04 m2/hr	1.808E-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

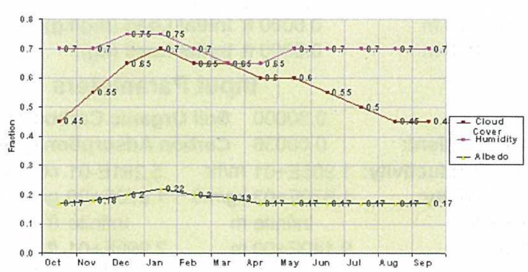
Load	Begin (m)	End (m)	Begin (ft)	End (ft)
X:	-6.819E+00	6.819E+00	-2.237E+01	2.237E+01
Y:	-6.819E+00	6.819E+00	-2.237E+01	2.237E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

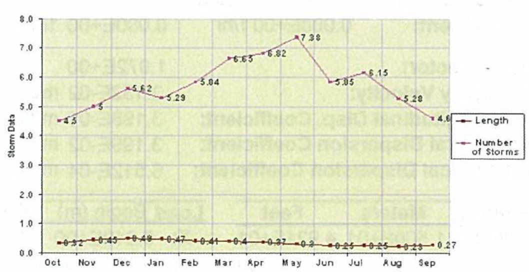
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DCE100.ATI
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\11DCE100.ATO

Climate Report

Location Description: PADUCAH (PGDP)
Climatic Input File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\PAVG100.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					

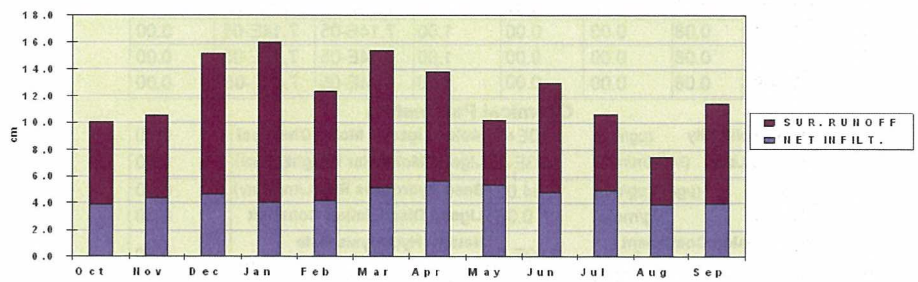


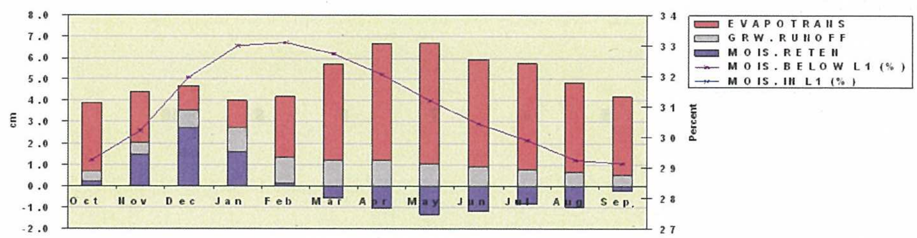


SESOIL Hydrologic Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE100.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	6.19	2.44	3.90	1.54	3.20	1.26	0.21	0.08	0.49	0.19	29.27	29.27
November	6.15	2.42	4.42	1.74	2.40	0.94	1.46	0.57	0.56	0.22	30.21	30.21
December	10.50	4.13	4.67	1.84	1.12	0.44	2.72	1.07	0.84	0.33	31.97	31.97
January	12.04	4.74	4.00	1.57	1.29	0.51	1.60	0.63	1.10	0.43	33.00	33.00
February	8.12	3.20	4.19	1.65	2.85	1.12	0.14	0.06	1.20	0.47	33.09	33.09
March	10.25	4.04	5.15	2.03	4.48	1.76	-0.56	-0.22	1.23	0.48	32.73	32.73
April	8.21	3.23	5.61	2.21	5.46	2.15	-1.05	-0.41	1.20	0.47	32.06	32.06
May	4.84	1.91	5.37	2.11	5.66	2.23	-1.33	-0.52	1.03	0.41	31.20	31.20
June	8.24	3.24	4.75	1.87	5.04	1.98	-1.19	-0.47	0.90	0.35	30.44	30.44
July	5.69	2.24	4.92	1.94	4.97	1.96	-0.84	-0.33	0.78	0.31	29.90	29.90
August	3.53	1.39	3.89	1.53	4.24	1.67	-0.98	-0.39	0.62	0.24	29.27	29.27
September	7.48	2.94	3.97	1.56	3.64	1.43	-0.21	-0.08	0.54	0.21	29.13	29.13
Total	91.23	35.92	54.83	21.59	44.35	17.46	0.00	0.00	10.48	4.12		

SESOIL Profile and Load Report

Layer No.	Number of Sub-Layers	Thickness (cm)	Thickness (feet)	Intrinsic Permeability (cm 2)	Organic Carbon Content (percent)	Adsorption Coefficient (µg/g / µg/mL)	Cation Exchange Capacity (mEq / 100 g soil)	Freundlich Exponent (unitless)	Solid Phase Degradation Rate (1/day)	Liquid Phase Degradation Rate (1/day)	Soil pH (pH)
1	1	30.5	1.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
2	1	274.0	8.99	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
3	4	0.1	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00
4	4	0.0	0.00	.160E-09	0.08	0.00	0.00	1.00	7.14E-05	7.14E-05	0.00

Soil Parameters

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

Application Parameters

Area	cm^2	3.34E+6
	ft^2	3595.15
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^3atm/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)	.0	Acid Hydrolysis Rate (L/mol/day)	0.00
Molecular Weight (g/mol)	131.00		

Output File:
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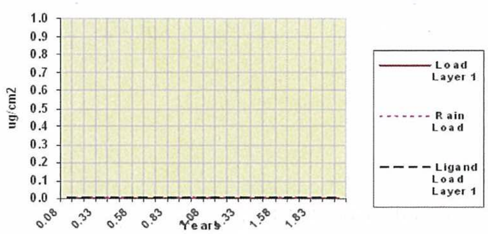
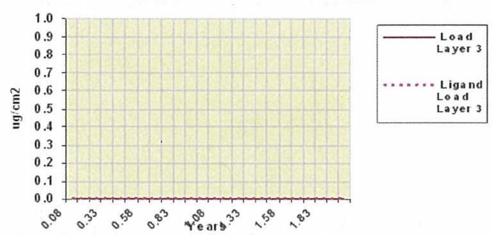
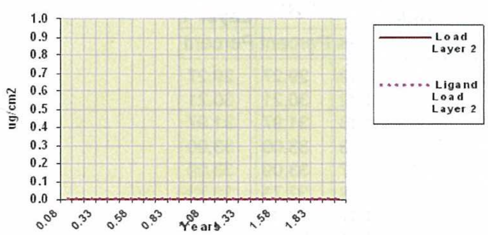
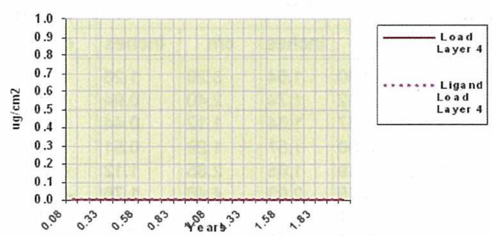
Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE.CHM
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\SSOIL.SOI
Application File: PGDP SWMU-30: TCE
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE.APL

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 Pollutant Cycle Report

Scenario Description:

SESOIL Output File: C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE100.OUT

SESOIL Process	Pollutant Mass (µg)	Percent of Total
Volatilized	3.103E+08	20.88
In Soil Air	1.084E+04	0.00
Sur. Runoff	0.000E+00	0.00
In Washld	0.000E+00	0.00
Ads On Soil	1.778E+04	0.00
Hydrol Soil	0.000E+00	0.00
Degrad Soil	2.197E+08	14.79
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	4.719E+04	0.00
Hydrol Mois	0.000E+00	0.00
Degrad Mois	6.205E+08	41.76
Other Trans	0.000E+00	0.00
Other Sinks	0.000E+00	0.00
Gwr. Runoff	3.332E+08	22.42
Total Output	1.483E+09	99.86
Total Input	1.486E+09	
Input - Output	2.066E+06	

Maximum leachate concentration: 4.238E-01 mg/l

Climate File: PADUCAH (PGDP)
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\PAVG100.CLM

Chemical File: TCE (Trichloroethene) OEPA 2003
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE.CHM

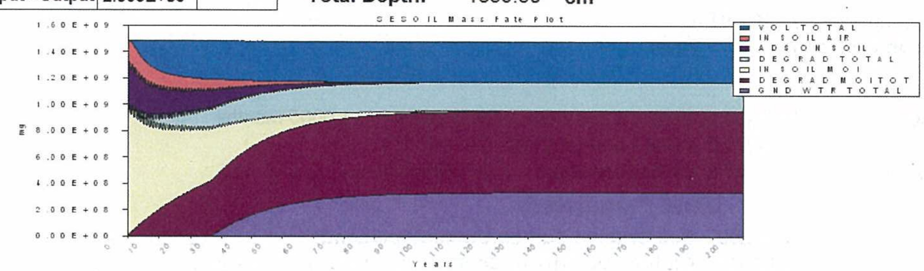
Soil File: Silty- Loam
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\SSOIL.SOI

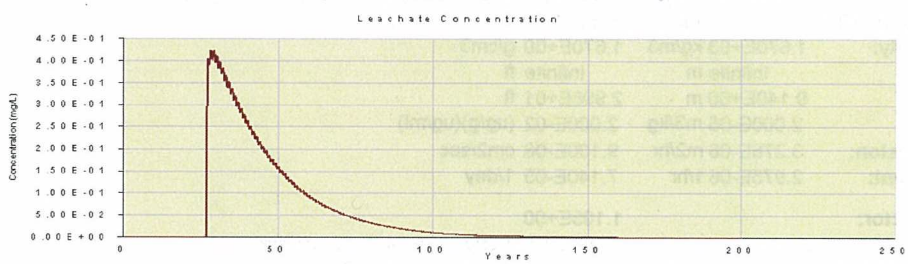
Application File: PGDP SWMU-30: TCE
C:\SEVIEW63\BGOU_FFS\CAPPING\SWMU30\TCE.APL

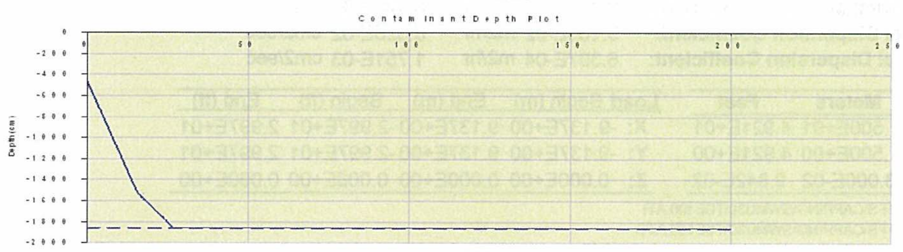
Starting Depth: 461.90 cm

Ending Depth: 1859.00 cm

Total Depth: 1859.50 cm

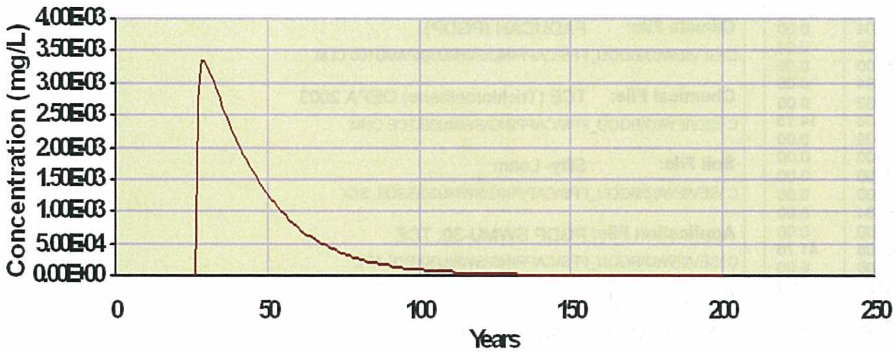






TCE

AT123D Point of Compliance Report



Maximum Concentration: 3.340E-03 mg/L
Year of Maximum Concentration: 29.00

Output Coordinates

X:	9.14000 m	29.9865 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:	0.00036	**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:	3.276E-06 m2/hr	9.100E-06 cm2/sec		
Decay Coefficient:	2.975E-06 1/hr	7.140E-05 1/day		

Retardation Factor:	1.105E+00	
Retarded Darcy Velocity:	2.069E-02 m2/hr	5.747E-02 cm2/sec
Retarded Longitudinal Disp. Coefficient:	3.104E-01 m2/hr	8.622E-01 cm2/sec
Retarded Lateral Dispersion Coefficient:	3.105E-02 m2/hr	8.625E-02 cm2/sec
Retarded Vertical Dispersion Coefficient:	6.307E-04 m2/hr	1.751E-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:	-9.137E+00	9.137E+00	-2.997E+01	2.997E+01
Y:	-9.137E+00	9.137E+00	-2.997E+01	2.997E+01
Z:	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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APPENDIX C

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS FOR SOIL THAT ENSURE PROTECTION OF INDUSTRIAL AND OUTDOOR WORKERS

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CONTENTS

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TABLES

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ACRONYMS

BGOU	Burial Grounds Operable Unit
BHHRA	baseline human health risk assessment
COC	contaminant of concern
COPC	chemical of potential concern
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GI	gastrointestinal
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
NAL	no action level
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
POC	point of contact
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RfD	reference dose
RGA	Regional Gravel Aquifer
RI	remedial investigation
RSL	regional screening goals
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
UCL	upper confidence level
WAG	waste area grouping
XRF	X-ray fluorescence spectrometer

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C.1. INTRODUCTION

This appendix accompanies the *Feasibility Study for Solid Waste Management Units 2, 3, 7, and 30 of the Burial Grounds Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1274&D1, which has been prepared to evaluate remedial alternatives for Solid Waste Management Units (SWMUs) 2, 3, 7, and 30 of the Burial Grounds Operable Unit (BGOU) at the U.S. Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP). The feasibility study (FS) will support remedy selection for these SWMUs in accordance with regulatory guidance and consistent with the scope of the BGOU FS. Appendix C details the approach taken to address the following general remedial action objective (RAO):

- Prevent exposure to waste and contaminated soils that present an unacceptable risk from direct contact.

The BGOU FS addresses impacts associated with exposure to wastes and media affected by these wastes. This appendix addresses the potential for impacts associated with soils to evaluate risks to support taking actions, as necessary, for protection of human health and the environment including addressing releases or potential releases from these source areas that may (or may have) affected soils and/or the surface water drainageways. Remedial decisions to address sediments located adjacent to the BGOU SWMUs primarily fall within the scope of the Surface Water Operable Unit (SWOU) Strategic Initiative. Thus, although ditches will be addressed as part of the post-PGDP shutdown activities for surface water, any indications that the BGOU SWMUs are sources to these ditches will be addressed in this FS.

Based on reasonably anticipated future use of the PGDP, the industrial workers are the only receptors likely to encounter the surface soils in these SWMUs; however, to support the evaluation of potential threats from direct contact with subsurface soils and buried waste in SWMUs 2, 3, 7, and 30, the impacts from potential exposure by outdoor workers also were evaluated. [Note that the future outdoor worker was referred to as an excavation worker in the BGOU Remedial Investigation (RI) Report (DOE 2010).] Under both scenarios, industrial and outdoor workers were evaluated for their potential to encounter contaminants of concern (COCs). These workers ultimately can be protected from undue exposure either by reducing the mass/volume of the COCs in these media or by reducing the workers' potential for exposure to the COCs, or a combination of both. Even if the outdoor worker scenario does not identify unacceptable risk from contact with affected soils, direct contact with waste remaining in SWMUs 2, 3, 7, and 30 will have to be controlled through administrative or engineering controls to address the uncertainty associated with the lack of information about the waste source term.

Identifying soil preliminary remediation goals (PRGs) is one method that supports an evaluation of achieving the RAO because the PRGs identify concentrations of COCs in soil that do not pose unacceptable risk under defined exposure scenarios. In addition, a PRG can be used to support treatment and/or removal alternatives by establishing where treatment/removal would be required. For this FS, achieving the SWMU-specific RAO is based on meeting the following target cumulative excess lifetime cancer risks (ELCRs) and cumulative noncancer hazard indices (HIs) for the industrial and outdoor worker receptors.

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for a future outdoor worker

This appendix describes the development of PRGs that are protective of industrial workers from direct contact with surface soil and outdoor workers from direct contact with subsurface soil at SWMUs 2, 3, 7, and 30. The COCs identified in the baseline human health risk assessment (BHHRA) for these receptors are the constituents for which PRGs potentially are to be developed. Evaluation of potential alternatives to meet this RAO and corresponding development of soil PRGs protective for future workers have the following additional considerations.

- PRGs will not be developed for COCs that are at/below background concentrations.

- The direct contact COCs for the future industrial and outdoor workers were identified in the Waste Area Grouping (WAG) 22 RI (DOE 1998) for SWMUs 7 and 30 and the WAG 22 RI Addendum (DOE 1994) for SWMUs 2 and 3. Where updated toxicity information indicates the chemical would not be a COC using current assumptions, no PRG would be required for that chemical for the remedy to be protective and meet the RAO.

- The BHHRA identified risks to the outdoor worker based on contact with contaminants in surface and subsurface soils (0–16 ft). To meet the RAO as stated, the PRGs for the outdoor worker would be derived only for those COCs present in the subsurface soil [1–16 ft below ground surface (bgs)]. PRGs for surface soil are to be based on the future industrial worker and would be the lower target concentration given the target cumulative ELCR 1E-5.

- Chemicals identified as COCs for the future workers that are present only in the drainageways without an identified BGOU source and are not a result of releases from the waste units are being addressed in the SWOU, guided by the applicable RAOs and PRGs for that operable unit. Evaluating alternatives to address these COCs is not within the scope of the BGOU FS (the RAO for this FS is not the appropriate basis for identifying PRGs for the SWOU); therefore, no PRGs are developed for these COCs.

PRGs are developed for the COCs that are not eliminated by the previous considerations. These soil contaminants present above the PRGs must be addressed by remedial alternatives developed in the FS. During the FS process, candidate remedial actions are examined in the context of their effectiveness in meeting the RAOs.

C.1.1 SUMMARY OF COCs FROM RI RISK ASSESSMENT

The BGOU RI included a BHHRA, which evaluated a variety of exposure scenarios for the COCs identified in the RI. Tables C.1 to C.4 (taken from the RI) summarize the results of the risk assessment (DOE 2010). The findings of the risk assessment form the basis for identification of the COCs to be evaluated and addressed by the remedial alternatives presented in the FS.

The reasonably anticipated current and future land use of PGDP is controlled industrial; the current land use controls and access controls are expected to be maintained either in their current form or as the result of additional actions contemplated as part of the FS alternatives. Additionally, no current or future use of affected groundwater drawn from the Regional Gravel Aquifer (RGA) at SWMUs 2, 3, 7, and 30 source areas is anticipated. Although the risk assessment prudently examined a range of potential land uses and receptors in order to estimate future risks under unrestricted future use, which is consistent with regulatory guidance and the approved BGOU RI Work Plan (DOE 2006), the future PGDP land use will be maintained as controlled industrial.

Table C.1. Summary of Risk Characterization for SWMU 2

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Current industrial worker/intruder at current concentrations (soil) (from WAG 22 RI Addendum[b])	1.2E-05	U-235 + daughters U-238 + daughters	83.8 10.7	External exposure	94.7	6.8E-03	*No COCs		*No COCs	
Future industrial worker at current concentrations (soil) (from WAG 22 RI Addendum[b])	1.2E-04	Arsenic U-235 + daughters U-238 + daughters	2.8 83.9 10.7	Ingestion External exposure	4.7 94.7	7.0E-02	*No COCs		*No COCs	
Future child rural resident at current concentrations (RGA groundwater only)	N/A	N/A	N/A	N/A	N/A	1.30E+03	Arsenic Manganese Uranium *cis*-1,2-DCE Naphthalene TCE	0.9 0.1 0.1 46.8 0.0 52.1	Ingestion Dermal Inhalation while showering Household inhalation	46.0 11.7 4.8 37.5

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Table C.1. Summary of Risk Characterization for SWMU 2 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future adult rural resident at current concentrations (RGA groundwater only)	4.72E-02	Arsenic Aroclor 1248 Aroclor 1268 TCE Tc-99 U-234 U-238	2.0 0.4 0.1 97.5 0.0 0.0 0.0	Ingestion Dermal Inhalation while showering Household inhalation	19.8 11.3 7.8 61.0	3.79E+02	Arsenic Manganese Uranium *cis*-1,2-DCE Naphthalene TCE	0.9 0.1 0.1 36.8 0.0 62.1	Ingestion Dermal Inhalation while showering Household inhalation	45.0 23.9 3.5 27.5
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	N/A	N/A	N/A	N/A	N/A	1.92E+02	Arsenic *cis*-1,2-DCE Naphthalene TCE	0.5 48 0.1 52	Ingestion Dermal Inhalation while showering Household inhalation	45 12.4 5.4 38
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	6.82E-03	Arsenic TCE	1.1 98.9	Ingestion Dermal Inhalation while showering Household inhalation	19.2 11.1 7.9 61.8	5.08E+01	Arsenic *cis*-1,2-DCE Naphthalene TCE	0.5 16.2 0.1 83.1	Ingestion Dermal Inhalation while showering Household inhalation	60 32 1 7.2
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	N/A	N/A	N/A	N/A	N/A	9.56E+01	*cis*-1,2-DCE TCE	47.4 52.6	Ingestion Dermal Inhalation while showering Household inhalation	45.4 11.8 4.9 38.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	3.42E-03	TCE	100	Ingestion Dermal Inhalation while showering Household inhalation	18.3 11.2 8.0 62.5	2.79E+01	*cis*-1,2-DCE TCE	37.3 62.7	Ingestion Dermal Inhalation while showering Household inhalation	44.4 24.1 3.6 27.9
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	N/A	N/A	N/A	N/A	N/A	2.25E+01	*cis*-1,2-DCE TCE	79.4 20.5	Ingestion Dermal Inhalation while showering Household inhalation	16.2 18.8 7.4 57.7
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)	1.28E-03	TCE	100	Ingestion Dermal Inhalation while showering Household inhalation	18.3 11.2 8.0 62.5	6.7E+00	*cis*-1,2-DCE TCE	61.2 38.7	Ingestion Dermal Inhalation while showering Household inhalation	15.5 37.7 5.3 41.5

Table C.1 is taken from Table 6.6 of the BGOU RI (DOE 2010).
Note: Excavation worker as referenced in the RI is now outdoor worker.
Note: N/A = 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 routes of exposure at this SWMU for this endpoint (may apply to ELCR or HI).
[a] Total ELCR and total HI represent total risk or hazard summed across all routes of exposure for all COCs.
[b] RI Addendum for WAG 22 (DOE 1994), Attachments 2-1 through 2-6. This risk assessment combined SWMUs 2 and 3.

Table C.2. Summary of Risk Characterization for SWMU 3

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Current industrial worker/intruder at current concentrations (soil) (from WAG 22 RI Addendum[b])	1.2E-05	U-235 + daughters U-238 + daughters	83.8 10.7	External exposure	94.7	6.8E-03	*No COCs		*No COCs	NE
Future industrial worker at current concentrations (soil) (from WAG 22 RI Addendum[b])	1.2E-04	Arsenic U-235 + daughters U-238 + daughters	2.8 83.9 10.7	Ingestion External exposure	4.7 94.7	7.0E-02	*No COCs		*No COCs	NE
Future child rural resident at current concentrations (RGA groundwater only)	N/A	N/A	N/A	N/A	N/A	2.03E+01	Arsenic Manganese Uranium	51.9 9.6 38.6	Ingestion Dermal	99.5 0.5
Future adult rural resident at current concentrations (RGA groundwater only)	1.20E-03	Arsenic Tc-99 U-238	72.4 25.3 2.3	Ingestion Dermal	99.8 0.2	5.83E+00	Arsenic Manganese Uranium	51.7 9.9 38.3	Ingestion Dermal	98.9 1.1
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	N/A	N/A	N/A	N/A	N/A	3.98E-01	Arsenic	100	Ingestion	97.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	1.32E-04	Arsenic Tc-99	24.6 75.4	Ingestion	99.9	1.12E-01	Arsenic	100	Ingestion	99.6
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	N/A	N/A	N/A	N/A	N/A		*No COCs		*No COCs	
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	7.46E-05	Tc-99	100	Ingestion	100		*No COCs		*No COCs	

Table C.2. Summary of Risk Characterization for SWMU 3 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	N/A	N/A	N/A	N/A	N/A		*No COCs		*No COCs	
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	4.41E-05	Tc-99	100.0	Ingestion	100		*No COCs		*No COCs	
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								

Table C.2 is taken from Table 6.7 of the BGOU RI (DOE 2010).
Note: Excavation worker as referenced in the RI is now outdoor worker.
Note: N/A = 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 routes of exposure.
[a] Total ELCR and total HI represent total risk or hazard summed across all routes of exposure for all COCs.
[b] RI Addendum for WAG 22 (DOE 1994), Attachment 2-1 through 2-6. This risk assessment combined SWMU 2 and 3.

Table C.3. Summary of Risk Characterization for SWMU 7

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Current industrial worker at current concentrations (soil) (from WAG 22 RI[b])	3.8E-03	Arsenic Beryllium Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 U-234 U-235 U-235/236 U-238	0.6 97.6 < 0.1 0.3 < 0.1 0.4 0.1 < 0.1 < 0.1 0.2 0.3 2.1	Ingestion Dermal External exposure	0.5 97.4 2.5	5.0E+00	Aluminum Antimony Arsenic Beryllium Chromium Iron Manganese Uranium Vanadium	4.1 4.4 2.6 9.6 13.6 20.6 10.7 13.7 17.7	Ingestion Dermal	3.6 96.4
Future industrial worker at current concentrations (soil) (from WAG 22 RI[b])	3.9E-03	Arsenic Beryllium Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 U-234 U-235 U-235/236 U-238	0.6 96.0 < 0.1 0.3 < 0.1 0.4 0.1 < 0.1 < 0.1 0.2 0.3 2.1	Ingestion Dermal External exposure	0.5 97.1 2.4	5.0E+00	Aluminum Antimony Arsenic Beryllium Chromium Iron Manganese Uranium Vanadium	4.1 4.4 2.6 9.6 13.6 20.6 10.7 13.7 17.7	Ingestion Dermal	3.6 96.4
Future child rural resident at current concentrations (soil) (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	3.7E+02	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Iron Manganese Nickel Uranium Vanadium Zinc Aroclor 1254	2.7 0.9 6.2 0.3 1.3 0.8 2.7 0.1 0.3 19.7 1.9 0.4 58.4 2.4 0.2 1.7	Ingestion Dermal Ingestion of vegetables from soil	1.4 7.7 90.9

Table C.3. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future adult rural resident at current concentrations (soil) (from WAG 22 RI[b])	3.4E-02	Arsenic Beryllium Aroclor 1254 Aroclor 1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 Pu-239 U-234 U-235 U-235/236 U-238	7.3 65.4 0.2 0.4 0.2 1.7 0.2 < 0.1 1.9 0.3 0.2 0.4 3.3 0.3 0.5 17.6	Ingestion Dermal External exposure Ingestion of vegetables from soil	0.5 33.0 1.9 64.6	1.1E+02	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Nickel Uranium Vanadium Zinc Aroclor 1254	2.7 0.8 6.5 0.3 1.1 0.8 2.3 0.3 19.8 1.6 0.4 59.5 2.0 0.2 1.7	Ingestion Dermal Ingestion of vegetables from soil	0.5 5.0 94.6
Future child rural resident at current concentrations (RGA groundwater only)	N/A	N/A	N/A	N/A	N/A	1.89E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Aroclor 1254 TCE Vinyl chloride	30.2 3.7 2.9 4.5 6.6 22.3 26.4 3.4	Ingestion Dermal contact Inhalation while showering Inhalation household use	60.9 21.0 2.0 16.0
Future adult rural resident at current concentrations (RGA groundwater only)	3.13E-03	Arsenic 1,1-DCE Total PCBs TCE Vinyl chloride Tc-99 U-234 U-238	15.1 66.4 0.2 4.1 11.9 1.6 0.4 0.4	Ingestion Dermal contact Inhalation while showering Inhalation during household use	61.2 3.7 4.9 30.3	6.39E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	25.5 3.2 2.5 3.1 4.5 31.4 27.1 2.7	Ingestion Dermal contact Inhalation while showering Inhalation household use	51.4 37.2 1.3 10.1

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FORWARD

Table C.3. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	N/A	N/A	N/A	N/A	N/A	1.45E+01	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	27.9 3.6 2.8 5.4 7.9 17.2 31.2 4.1	Ingestion Dermal contact Inhalation while showering Inhalation household use	62.3 18.7 2.2 16.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	2.98E-03	Arsenic 1,1-DCE Total PCBs TCE Vinyl chloride Tc-99 U-234 U-238	11.2 63.9 0.2 10.3 12.3 1.5 0.3 0.3	Ingestion Dermal contact Inhalation while showering Inhalation during household use	55.4 3.4 4.7 36.5	4.78E+00	Arsenic Manganese Uranium 1,1-DCE *cis*-1,2-DCE Total PCBs TCE Vinyl chloride	24.2 3.1 2.4 3.8 5.5 24.8 32.9 3.3	Ingestion of groundwater Dermal contact Inhalation household use	53.8 33.8 11.0
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	N/A	N/A	N/A	N/A	N/A	1.97E+00	Arsenic 1,1-DCE *cis*-1,2-DCE Total PCBs TCE	38.1 5.3 8.4 12.4 32.9	Ingestion Dermal contact Inhalation household use	66.3 15.8 15.9
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	4.11E-04	Arsenic 1,1-DCE TCE Vinyl chloride Tc-99	15.1 61.8 10.7 8.7 3.6	Ingestion Dermal contact Inhalation while showering Inhalation during household use	56.7 3.2 4.5 35.5	6.36E-01	Arsenic Total PCBs TCE	33.9 18.4 35.5	Ingestion Dermal contact	58.8 29.3
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	N/A	N/A	N/A	N/A	N/A	3.373E-01	TCE	61.0	Ingestion Inhalation household use	52.5 30.0
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	1.28E-04	1,1-DCE TCE Vinyl chloride Tc-99	72.6 12.3 9.5 5.7	Ingestion Dermal contact Inhalation while showering Inhalation during household use	49.6 3.6 5.3 41.4	1.15E-01	*No COCs		*No COCs	

Table C.3. Summary of Risk Characterization for SWMU 7 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU.								
Future child recreational user at current concentrations (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	7.3E-02	*No COCs		*No COCs	
Future teen recreational user at current concentrations (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	6.4E-02	*No COCs		*No COCs	
Future adult recreational user at current concentrations (from WAG 22 RI[b])	1.1E-05	Aroclor 1260 Benzo(a)pyrene Dibenzo(a,h)anthracene U-238	18.6 9.5 42.5 15.7	Ingestion of deer Ingestion of rabbit Ingestion of quail	10.0 70.9 21.8	7.5E-02	*No COCs		*No COCs	
Future excavation worker at current concentrations (soil) (from WAG 22 RI[b])	1.6E-03	Arsenic Beryllium Benzo(a)pyrene Dibenzo(a,h)anthracene Np-237 Pu-239 U-234 U-235 U-235/236 U-238	1.8 42.2 0.1 1.7 0.4 0.5 3.4 9.1 0.4 41.3	Ingestion Dermal External exposure	25.6 43.8 32.5	5.4E+00	Aluminum Antimony Arsenic Chromium Copper Iron Manganese Nickel Uranium Vanadium	5.0 11.3 3.4 17.6 2.9 21.3 11.0 3.9 7.5 10.9	Ingestion Dermal	18.4 81.5

Table C.3 is taken from Table 6.11 of the BGOU RI (DOE 2010).
Note: Excavation worker as referenced in the RI is now outdoor worker.
Note: N/A = 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 routes of exposure.
[a] Total ELCR and total HI represent total risk or hazard summed across all routes of exposure for all COCs.
[b] RI for SWMUs 7 and 30 (DOE 1998), Tables 1.59 through 1.68, excluding lead as a COC.

Table C.4. Summary of Risk Characterization for SWMU 30

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Current industrial worker at current concentrations (soil) (from WAG 22 RI[b])	3.7E-03	Arsenic Beryllium Aroclor 1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 U-234 U-235 U-235/236 U-238	0.5 97.5 0.1 0.1 0.8 0.1 0.3 0.1 < 0.1 < 0.1 0.2 0.3 1.4	Ingestion Dermal External exposure	0.5 97.3 1.7	4.4E+00	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium	5.1 3.7 2.7 10.8 3.5 13.5 19.8 11.3 9.0 17.6	Ingestion Dermal	2.9 97.1
Future industrial worker at current concentrations (soil) (from WAG 22 RI[b])	3.8E-03	Arsenic Beryllium Aroclor 1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 U-234 U-235 U-235/236 U-238	0.5 96.2 0.1 0.1 0.8 0.1 0.3 0.1 < 0.1 < 0.1 0.2 0.3 1.4	Ingestion Dermal External exposure	0.5 97.8 1.7	4.4E+00	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium	5.1 3.7 2.7 10.8 3.5 13.5 19.8 11.3 9.0 17.6	Ingestion Dermal	2.9 97.1
Future child rural resident at current concentrations (soil) (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	2.6E+02	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Mercury Nickel Uranium Vanadium Zinc Aroclor 1254	4.1 0.9 7.5 0.6 1.8 2.2 3.2 0.6 22.6 2.5 0.7 0.8 46.8 3.0 0.2 2.6	Ingestion Dermal Ingestion of vegetables from soil	1.3 9.4 89.3

Table C.4. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future adult rural resident at current concentrations (soil) (from WAG 22 RI[b])	3.2E-02	Arsenic Beryllium Aroclor 1254 Aroclor 1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene bis(2-ethylhexyl)phthalate Chrysene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 U-234 U-235 U-235/236 U-238	6.8 66.7 0.2 1.8 0.4 4.4 0.5 < 0.1 < 0.1 < 0.1 1.7 0.4 0.2 4.5 0.3 0.6 11.5	Ingestion Dermal External exposure Ingestion of vegetables from soil	0.5 35.4 1.3 62.8	7.9E+01	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Copper Iron Manganese Mercury Nickel Uranium Vanadium Zinc Aroclor 1254	4.1 0.8 7.9 0.6 1.5 2.2 2.9 0.6 22.8 2.1 0.7 0.9 47.5 2.4 0.2 2.7	Ingestion Dermal Ingestion of vegetables from soil	0.5 6.1 93.4
Future child rural resident at current concentrations (RGA groundwater only)	N/A	N/A	N/A	N/A	N/A	9.14E+00	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	63.8 8.8 3.2 14.7 5 4.6	Ingestion Dermal contact Inhalation while showering Inhalation household use	93.3 1.3 0.6 4.7
Future adult rural resident at current concentrations (RGA groundwater only)	5.44E-04	Arsenic 1,1-DCE TCE Tc-99 U-234 U-238	88.6 0.3 5.2 2.9 1 1.3	Ingestion Dermal contact Inhalation while showering Inhalation household use	95.3 0.9 0.4 3.4	3.31E+00	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	50.5 7.1 2.5 11.6 23.9 4.4	Ingestion Dermal contact Inhalation while showering Inhalation household use	88.8 9.8 0.2 1.2
Future child rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	N/A	N/A	N/A	N/A	N/A	6.14E+00	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	63.1 8.7 2.6 12.5 0.1 12.9	Ingestion of groundwater Dermal contact Inhalation while showering Inhalation household use	91.1 1.7 0.1 7.1
Future adult rural resident at modeled concentrations (RGA groundwater drawn at plant boundary)	3.75E-04	Arsenic 1,1-DCE TCE Tc-99 U-234 U-238	85.6 0.5 7.1 3.9 1 1.9	Ingestion Dermal contact Inhalation while showering Inhalation household use	93.6 1.1 0.6 4.7	2.10E+00	Arsenic Manganese Selenium Uranium 1,1-DCE TCE	52.9 7.4 2.2 10.5 0.4 26.6	Ingestion Dermal contact Inhalation while showering Inhalation household use	76.1 3 0 20.8

Table C.4. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future child rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	N/A	N/A	N/A	N/A	N/A	8.40E-01	Arsenic Selenium 1,1-DCE TCE Manganese	89.2 2.1 0.1 8.5 0.1	Ingestion Dermal contact Inhalation while showering Inhalation household use	94.2 1.1 0 4.6
Future adult rural resident at modeled concentrations (RGA groundwater drawn at property boundary)	6.85E-05	Arsenic 1,1-DCE TCE Tc-99	90.6 0.2 3.5 5.7	Ingestion Dermal contact Inhalation while showering Inhalation household use	96.7 0.7 0.3 2.3	2.76E-01	Arsenic Selenium 1,1-DCE TCE Manganese	77.9 1.8 0.3 19.9 0.1	Ingestion Dermal contact Inhalation while showering Inhalation household use	82 2 1.8 14.2
Future child rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	N/A	N/A	N/A	N/A	N/A	3.02E-02	Selenium 1,1-DCE TCE	20 0.6 79.3	Ingestion Dermal contact Inhalation household use	47.5 8.6 0.4 43.5
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Little Bayou seeps)	2.45E-06	1,1-DCE TCE Tc-99	1.8 32.9 65.3	Ingestion Dermal contact Inhalation while showering Inhalation household use	72.1 3.7 2.7 21.4	9.17E-03	Selenium 1,1-DCE TCE	18.9 2.3 78.8	Ingestion Dermal contact Inhalation while showering Inhalation household use	44.7 17 18.3 20
Future child rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU								
Future adult rural resident at modeled concentrations (RGA groundwater drawn at Ohio River)		Not a POE for groundwater from this SWMU								
Future child recreational user at current concentrations (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	4.2E-02	*No COCs		*No COCs	
Future teen recreational user at current concentrations (from WAG 22 RI[b])	N/A	N/A	N/A	N/A	N/A	3.8E-02	*No COCs		*No COCs	

Table C.4. Summary of Risk Characterization for SWMU 30 (Continued)

Receptor	Total ELCR[a]	COCs	% Total ELCR	Routes of Exposure	% Total ELCR	Total HI[a]	COCs	% Total HI	Routes of Exposure	% Total HI
Future adult recreational user at current concentrations (from WAG 22 RI[b])	1.5E-05	Aroclor 1260 Benzo(a)pyrene Dibenzo(a,h)anthracene	48.2 12.9 20.8	Ingestion of deer Ingestion of rabbit Ingestion of quail	8.7 80.0 11.3	4.3E-02	*No COCs		*No COCs	
Future excavation worker at current concentrations (soil) (from WAG 22 RI[b])	1.2E-03	Arsenic Beryllium Aroclor 1248 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Np-237 Pu-239 U-234 U-235 U-235/236 U-238	1.9 93.7 0.1 0.1 0.8 0.1 0.4 0.1 0.3 0.2 0.8 0.1 0.8 0.6	Ingestion Dermal External exposure	6.3 91.7 3.3	4.5E+00	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Copper Iron Manganese Uranium Vanadium	4.6 6.3 3.3 3.8 3.0 10.2 7.6 19.8 14.3 12.2 12.7	Ingestion Dermal	26.4 73.5

Table C.4 is taken from Table 6.12 of the BGOU RI (DOE 2010).
Note: Excavation worker as referenced in the RI is now outdoor worker.
Note: N/A = ELCR not applicable to child and teen cohorts. ELCR for adult is for lifetime exposure and takes into account exposure as child and teen.
[a] Total ELCR and total HI represent total risk or hazard summed across all routes of exposure for all COCs.
[b] RI for SWMUs 7 and 30 (DOE 1998), Tables 1.59 through 1.68, excluding lead as a COC.

The COCs carried forward for evaluation in this FS are those identified in the risk assessment for the future industrial worker and future outdoor worker. For SWMUs 7 and 30, the industrial worker evaluation included exposures to surface soils (0–1 ft bgs) and the outdoor worker evaluation included potential exposure to surface and subsurface soils and waste from 0–16 ft bgs, consistent with current protocols. The WAG 22 risk assessment for SWMUs 2 and 3 evaluated only the industrial worker; however, the samples were collected to depths of 8 ft bgs. For this FS, it is assumed that these samples represent COCs for both surface and subsurface soils; thus PRGs may be developed consistent with the assumptions for the RAO. The COCs identified in the BHHRA for SWMUs 2, 3, 7, and 30 are summarized in Table C.5.

Table C.5. Summary of COCs Identified for Future Industrial Worker and Future Outdoor Worker at BGOU SWMUs 2, 3, 7, and 30

	SWMU 2	SWMU 3	SWMU 7	SWMU 30
Carcinogenic COCs (ELCR > 1E-06)	Arsenic U-235 U-238	Arsenic U-235 U-238	Arsenic Beryllium Total PAHs Np-237 U-234 U-235 U-235/236 U-238 *Pu-239*	Arsenic Beryllium Total PCBs Total PAHs Np-237 U-234 U-235 U-235/236 U-238 *Pu-239*
Noncancer Hazard COCs (HQ > 0.1)	None	None	Aluminum Antimony Arsenic Beryllium Chromium Iron Manganese Uranium Vanadium *Nickel*	Aluminum Antimony Arsenic Beryllium Cadmium Chromium Iron Manganese Uranium Vanadium *Copper*

Reference: BGOU RI (DOE 2010)
Analytes in italics identified as COCs only for outdoor worker scenario.
Analytes not italicized are COCs for both future industrial and outdoor worker scenarios.

As discussed in the uncertainty discussion in the BGOU RI (DOE 2010), the risk assessments were not updated with data collected after the previous WAG 22 risk assessments for these SWMUs to reevaluate direct contact risks. For SWMU 3, additional samples from the adjacent ditch are evaluated in this FS in Appendix D. SWMU 3 results discussed in this section refer only to the source area.

Where additional data confirm the presence of the COCs identified in the BHHRA, these data are used in this FS to provide additional spatial information on the extent of the impacts when comparing to the PRGs. To determine if additional COCs would be identified for the additional samples collected within or adjacent to the SWMU boundary using these more recent data, these data were compared with no action levels (NALs) and discussed in the following evaluations because they may impact the selection of alternatives.

C.1.2 REFINEMENT OF COC LIST FOR NATURALLY OCCURRING METALS

The FS evaluation begins with the full list of COCs identified in the RI Report (DOE 2010), as summarized in Table C.5. This list has been refined based on additional comparisons to background, updated toxicity and exposure parameter information, additional screening criteria, and/or clarification of the chemical concentration patterns. While some refinements may be SWMU-specific, a number of the COCs are evaluated based on overall patterns across the BGOU.

This section reviews the concentrations of the 12 naturally occurring metals identified on Table C.5 as COCs contributing to the noncancer hazard for the industrial worker and/or outdoor worker at SWMUs 7 and 30. No COCs were identified at SWMUs 2 and 3 for noncancer hazards. Cumulative noncancer HIs for future outdoor and/or industrial worker scenarios at SWMUs 7 and 30 were unacceptable (HI > 1). Although exceeding an HI of 1, HIs were not greatly elevated, with a maximum of 5.4. The data on this table include all results for these metals, with the exclusion of the Soils OU data analyzed by X-ray fluorescence spectrometer (XRF). These results are discussed separately.

The 12 naturally occurring metals identified as COCs at one or both of the SWMUs that contributed to an HI > 1 are summarized on Table C.6. This table shows the frequencies of exceeding background and compares the maximum concentration to the industrial worker NALs (surface soil) and outdoor worker NALs (subsurface soils) from the Risk Methods Document (DOE 2011). For arsenic, beryllium, and chromium, the NALs are those based on the noncancer hazard.

As discussed in Appendix B, arsenic is retained as a COC for SWMUs 2 and 7. Manganese is within background concentrations at these SWMUs. Other metals that infrequently exceed background include iron and vanadium.

COCs with a concentration below the current NAL (HI = 0.1) typically would not be identified as a COC for further risk analysis using the current assumptions for these worker scenarios; this would be a lower bound PRG for potential remedial actions. Six of the 12 metals had no exceedances of the NALs, while others, including aluminum and antimony, had values only slightly exceeding the NAL. In addition to a comparison to NALs, a comparison to EPA regional screening levels (RSLs) also was conducted.

Table C.6. COCs Contributing to the Noncancer Hazards to Future Industrial and Outdoor Worker at SWMUs 7 and 30

Analysis	SWMU/Depth	Average (mg/kg)	Maximum (mg/kg)	Background[1] (mg/kg)	Frequency of Exceeding Background	NAL	HQ*	Comments
Aluminum	7 S	7,660	14,000	13,000	1/21	33,200	-	One exceedance of NAL; not a COPC using EPA RSLs.
	7 SS	8,220	16,000	12,000	1/37	18,700	-	
	30 S	11,500	16,000	13,000	4/11	33,200	-	
	30 SS	9590	19,000	12,000	1/9	18,700	0.10	
Antimony	7 S	0.835	1.7	0.21	11/21	2.53	-	One exceedance of NAL; not a COPC using EPA RSLs.
	7 SS	n/a	n/a	0.21	0/37	2.7	-	
	30 S	1.15	3	0.21	8/13	2.53	0.12	
	30 SS	n/a	n/a	0.21	0/9	2.7	-	
Arsenic	7 S	5.58	16	12	1/21	15.9	0.10	Infrequent exceedances of background** and below NAL.
	7 SS	2.68	7.88	7.9	0/37	6.65	-	
	30 S	6.46	12	12	0/13	15.9	-	
	30 SS	2.75	4.03	7.9	0/9	6.65	-	
Beryllium	7 S	0.557	1.3	0.67	1/23	4.29	-	Below NAL.
	7 SS	n/a	n/a	0.69	0/37	5.32	-	
	30 S	0.677	1	0.67	4/11	4.29	-	
	30 SS	n/a	n/a	0.69	0/9	5.32	-	
Cadmium	30 S	0.982	2.8	0.21	3/13	3.16	-	Below NAL.
	30 SS	n/a	n/a	0.21	0/9	1.52	-	
Chromium	7 S	21.9	55.8	16	12/23	846	-	Below NAL.
	7 SS	11.8	20	43	0/37	1120	-	
	30 S	28.2	45.7	16	10/13	846	-	
	30 SS	20.3	49	43	1/9	1120	-	
Copper	30 SS	15.9	35	25	2/9	773	-	Below NAL.
Iron	7 S	14,000	30,000	28,000	1/21	25,100	0.12	Infrequent exceedances of background; not a COPC using EPA RSLs.
	7 SS	10,800	26,000	28,000	0/37	13,500	0.19	
	30 S	18,500	25,000	28,000	0/11	25,100	-	
	30 SS	14,100	29,000	28,000	1/9	13,500	0.21	
Manganese	7 S	377	1,120	1,500	0/21	2,580	-	Infrequent exceedances of background** and below NAL.
	7 SS	269	1,200	820	2/37	1,960	-	
	30 S	397	669	1,500	0/11	2,580	-	
	30 SS	209	740	820	0/9	1,960	-	
Nickel	7 SS	10.6	40	22	1/37	53.1	-	Infrequent exceedances of background, and below NAL.

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Table C.6. COCs Contributing to … r Hazards to Future Industrial and Outdoor Worker … and 30 (Continued)

Analysis	SWMU/Depth	Average (mg/kg)	Maximum (mg/kg)	Background[1] (mg/kg)	Frequency of Exceeding Background	NAL	HQ*	Comments
Uranium	7 S	310	1,270	4.9	13/23	107	1.19	Retained as a COC. Note: using current EPA RSLs, the maximum HQ would be below 1.
	7 SS	9.95	45	4.6	3/37	57.9	-	
	30 S	592	1,400	4.9	5/11	107	1.31	
	30 SS	1.25	1.72	4.6	0/9	57.9	-	
Vanadium	7 S	22.6	52	38	1/21	0.151	34	Infrequent exceedances of background. See additional discussion of vanadium, not a COPC using EPA RSLs.
	7 SS	16.4	34	37	0/37	0.187	-	
	30 S	27.7	43	38	1/11	0.151	28	
	30 SS	13.6	40	37	1/9	0.187	21	

[1] Background values are surface and subsurface concentrations taken from Table A.12 of the Risk Methods Document (DOE 2011).
*HQ = Hazard Quotient for the maximum concentration. "-" reflects maximum concentration is below the NAL.
**See Appendix B for further discussion.
S = Surface Soil SS = Subsurface Soil
COPC = contaminant of potential; EPA RSLs (EPA 2011)
surface soil = future industrial worker; subsurface soil = future outdoor worker
n/a = not available, all samples below detection limits.

The NALs for all of the inorganics, with the exception of arsenic and cadmium, assume a default dermal absorption of 5% or are set equivalent to the gastrointestinal (GI) absorption factor as reported in EPA RAGs Part E guidance (EPA 2004) if that GI absorption is less than 5%. The impact of these assumptions is that the intakes from the dermal pathway may be 100 times greater than for the oral dose. Currently, the EPA RSLs (EPA 2011) used by EPA Region 4 and recommended for use by the Commonwealth of Kentucky, Division of Waste Management Superfund Branch, (http://waste.ky.gov/SFB/Pages/default.aspx) follow the EPA RAGS Part E protocols and do not include default assumptions for dermal absorption of inorganics in calculating RSLs and recommend the contribution from this pathway be considered only qualitatively in a risk assessment.

The rationale for this is that though information is limited on the rate and extent of dermal absorption of metals in soil across the skin, this pathway is generally minor in comparison to the amount of exposure that occurs by the oral route. This view is based on the recognition that most metals tend to bind to soils, reducing the likelihood that they would dissociate from the soil and cross the skin, and ionic species such as metals have a relatively low tendency to cross the skin even when contact does occur. This is also found in toxicity profiles provided by Agency for Toxic Substances and Disease Registry supporting that these metals are not the primary route of exposure for these metals. Specifically, the intake from the dermal pathway is frequently minor and would not be higher than for the oral route of exposure. For these reasons, Table C.6 mentions these RSLs as a further consideration in refining the COC list.

Following these protocols (consistent with guidance recommended by both EPA and Kentucky), the maximum hazard quotients (HQs) for aluminum, antimony, and iron all would be below 0.1, further decreasing the potential contributions from other metals already below the NALs.

Vanadium infrequently exceeded background, a pattern consistent with that observed at several of the SWMUs and is eliminated on that basis. The potential hazard associated with the presence of vanadium also is likely overstated. First, 99% of the hazard for the industrial worker would be attributed to the dermal pathway and, following current guidance, would decrease that HQ by a factor of 100. In addition, background concentrations of vanadium based on the current NALs would correspond to an HQ of 20 or greater. The vanadium NALs were derived using a chronic reference dose of 0.00007 mg/kg/day, a Provisional Peer-Reviewed Toxicity Value for selected soluble inorganic forms of vanadium. EPA RSLs (EPA 2011) identified for "vanadium and compounds" are derived using the oral reference dose (RfD) of 0.005 mg/kg/day, derived from the Integrated Risk Information System (IRIS) toxicity value for vanadium pentoxide. Using the RfD of 0.005 mg/kg/day (which was used in the initial risk assessment), the maximum HQs would not be greater than 1; therefore, vanadium is eliminated based on infrequently exceeding background, but potential concerns related to the magnitude of the HQ were reviewed. Using current toxicity and dermal absorption factors for "vanadium and compounds," the HQ for vanadium would be below 0.1.

As part of the Soils Operable Unit, additional data were collected following the completion of the BGOU RI that provides additional information that may help to define the distribution of COCs. The current risk assessment suggested a HI > 1. A spatial risk evaluation (e.g., Ginevan and Splitstone 1997; Carlon et al. 2008) has been used at several sites, allowing the SWMU-wide hazard/risk defined by the upper confidence level (UCL) of the risk/HI, rather than tracking each potential chemical with a noncancer hazard separately. This more accurately provides a basis for risk estimates rather than independent UCL95 values for each chemical, particularly if not collocated. This tool was used to further support conclusions regarding potential noncancer hazards for the entire data set. The surface soil sample detected concentrations above background were compared to NALs. Of the 26 surface locations, 21 had 1 or more detected chemicals (above background) that pose a noncancer hazard and only 4 had an HI greater than 1 with a maximum HI of 1.4. Therefore, on a SWMU-wide basis, no noncancer hazard is identified for the industrial worker. Similarly, the subsurface soils were evaluated for the outdoor worker and of 48 samples, 26 had detected chemicals above background with 2 locations with an HI above 1 with a maximum HI of 3.4. Vanadium infrequently exceeded background and would pose unacceptable hazards at the maximum concentration of 50.2 mg/kg based on the NALs, but is below screening levels using current screening values as discussed previously. In several cases, XRF data show higher concentrations of selected constituents; however, only 6 surface soil locations would have an HI > 1, including these data, and this did not change the conclusions.

The following conclusions are drawn from the above discussion of noncarcinogenic COCs.

- No COCs were identified for noncancer hazards at SWMUs 2 and 3, and for SWMUs 7 and 30, the maximum HI was 5.4, with up to 97% of the hazard from dermal absorption of uranium and other naturally occurring metals.

- Uranium is retained as a COC in SWMUs 7 and 30 and an PRG developed to evaluate alternatives.

- Antimony, aluminum, beryllium, cadmium, chromium, copper, iron, manganese, vanadium and nickel are no longer considered target chemicals contributing to noncancer hazards at SWMUs 7 and 30 to be evaluated in this FS. Comparing results to NALs for chemicals posing potential noncancer hazards confirms SWMU-wide noncancer hazards.

- Arsenic is retained as a COC for SWMUs 2 and 7, primarily for its contribution to the cancer risk.

Uranium, a site-related compound of concern, was a COC at SWMUs 7 and 30, contributing to the noncancer hazards at these SWMUs. Several uranium radioisotopes are COCs at these SWMUs, contributing to the carcinogenic risk. Uranium, therefore, is retained as a COC for evaluating alternatives in this FS. Additional investigation of surface soils on the eastern portion of SWMU 7 included over 400 surface and subsurface soil samples (most analyzed by XRF) that provide additional information on the distribution of this COC for evaluating alternatives.

The screening process presented in this section provides data for the complete BGOU data set for SWMUs 7 and 30, including the data collected after the previous risk assessments. No additional chemicals were identified that would contribute to the noncancer hazard. In addition, no additional chemicals were identified at SWMU 3.

At SWMU 2, uranium was not identified as a COC in the previous risk assessment. The newer data showed only one location with uranium concentration that would correspond to an HI > 1, a location with a concentration of uranium-238 (a COC for this SWMU) at a risk level exceeding 1E-4. At all four locations with uranium detected, the PRGs derived in this section for U-238 would be exceeded; therefore, uranium does not change the actions to be considered in this FS.

C.1.3 EVALUATION OF CARCINOGENIC COCs

Carcinogenic compounds are the primary drivers for remedial action decisions at each of the SWMUs. As discussed in Appendix B, arsenic is retained as a COC for SWMUs 2 and 7.

At the time the WAG 22 RI reports were developed, beryllium was evaluated as a carcinogen through the oral route of exposure. Since the completion of those BHHRAs, the oral cancer slope factor for beryllium has been withdrawn from IRIS, and there has been an agreement not to use this withdrawn value for risk assessments performed in EPA Region 4. The maximum beryllium concentration at the BGOU SWMUs is below screening values for beryllium calculated consistent with current Risk Assessment Guidance for Superfund Part E guidance. In addition, as summarized in the RI (DOE 2010), although beryllium is a carcinogen by the inhalation route of exposure, it would be screened from evaluation as a COC because the highest risk at any SWMU was three orders of magnitude less than 1E-6. Beryllium, therefore, is not a target compound requiring further evaluation in this FS.

Several radionuclides were identified as COCs contributing to the ELCR for these four SWMUs. The data collected at SWMUs 7 and 30 subsequent to the risk assessment suggest there may be some higher maximum concentrations for selected COCs, but the range is not materially different and thus, it was concluded that the new data do not substantially impact the risk assessment. The subsurface soil samples collected beneath the waste at SWMU 3 also indicate no additional radionuclides to be addressed. At SWMU 2, additional radionuclides were identified at concentrations above the NALs in surface sample data collected after the risk assessment: these include: cesium-137, neptunium-237, plutonium-239, and thorium-230 present in two ditch samples that also were above PRGs for uranium-238, the primary COC for this SWMU (Figure A.1).

Total polychlorinated biphenyls (PCBs) were identified as COCs at SWMU 30 for the industrial worker. The newer data indicate these are not issues at SWMUs 2 and 3 in that no soil samples have concentrations above 10 mg/kg. PCBs were not identified as COCs for industrial or outdoor workers at SWMU 7. Additional data collected at SWMU 7 after the BHHRA and reviewed in the RI showed one value of Total PCBs above 10 (14.8 mg/kg). Data collected subsequent to the BGOU RI on the eastern portion of the site showed the frequency of detection of Total PCBs of 1/51 in surface soil samples and 1/117 in subsurface soil samples at concentrations of 0.078 and 0.02 mg/kg, respectively. This suggests impacts by PCBs are not widespread and not present at levels of concern at SWMU 7.

Total polycyclic aromatic hydrocarbons (PAHs) were identified as COCs at SWMUs 7 and 30. There is considerable uncertainty with respect to the source and impact of PAHs at PGDP sites. Given these uncertainties, the potential impact of PAHs on remedy selection is to be considered on a SWMU-specific basis. Carcinogenic PAHs were detected at concentrations above the industrial worker NAL in 13 of 43 samples collected at SWMUs 7 and 30. These were detected in surface soils within the SWMU boundaries, frequently collocated with other COCs.

A review of additional data collected after the BHHRA did not identify any additional carcinogenic chemicals to be addressed in this FS.

C.1.4 SUMMARY OF COCs FOR THE FS

Once the previous evaluations are considered, the COC list carried forward in the FS is as shown in Table C.7. These represent the target chemicals for which PRGs will be developed. As indicated previously, the COCs for SWMUs 2 and 3 are applicable to both the surface and subsurface soils.

Table C.7. Summary of Soil COCs identified for Future Industrial Worker and Outdoor Worker for the FS

	SWMU 2	**SWMU 3**	**SWMU 7**	**SWMU 30**
Carcinogenic COCs (ELCR > 1E-06)	Arsenic U-235 U-238	U-235 U-238	Arsenic Total PAHs Np-237 U-234 U-235 U-235/236 U-238 *Pu-239*	Total PCBs Total PAHs Np-237 U-234 U-235 U-235/236 U-238 *Pu-239*
Noncancer Hazard COCs (HQ > 0.1)	None	None	Uranium	Uranium

Note: Analytes in italics only identified as COCs for outdoor worker scenario.
Analytes not in italics are COCs for future industrial and outdoor worker scenarios.
At SWMUs 2 and 3, the industrial worker COCs were identified using both surface and subsurface soils.

These have been confirmed to be the primary COCs that will identify locations that may require actions. These are shown on figures for each SWMU in Appendix A. To address the uncertainties associated with data collected after the risk assessment was completed, the concentrations of the additional radionuclides detected in samples at SWMU 2 and Total PCB concentrations in SWMU 7 are included in these figures.

C.2. IDENTIFICATION OF SOIL PRGS THAT ENSURE PROTECTION OF INDUSTRIAL AND OUTDOOR WORKERS

The RAO for SWMUs 2, 3, 7, and 30 is "Prevent exposure to waste and contaminated soils that presents an unacceptable risk from direct contact." The COCs identified in the risk assessment to be addressed in this FS are contaminants in soils, recognizing that preventing exposure to waste also is necessary. Achieving the RAO for COCs in soils is based on meeting the following target cumulative ELCRs and cumulative noncancer HIs for the industrial and outdoor worker receptors:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an outdoor worker

In this section, soil PRGs are developed for the COCs identified above. These PRGs for contaminated surface and subsurface soils are used in Section 3 to identify those media-specific COCs that pose a threat that must be addressed by the remediation alternatives developed in this FS. PRGs protective of groundwater in the RGA beneath the SWMU from potential leaching of COCs from soil are identified in Appendix B. The COCs for the leaching pathway are identified based on unacceptable risks from residential use of groundwater at the SWMU boundary and, thus, focus on a range of more mobile analytes. With the exception of arsenic at SWMU 2, the COCs identified to pose a risk for the leaching pathway are not the same COCs that pose a significant risk for direct contact exposures, as shown below.

To guide the evaluation of alternatives, numeric criteria for each of the COCs are developed. These PRGs (Table C.8) provide "not-to-exceed" concentrations for surface and/or subsurface soils such that if these concentrations were met for the specified medium as a result of implementation of an alternative, the residual risk for these exposure units would meet the RAO.

Table C.8. PRGs for Direct Contact Exposures—Protection of Industrial and Outdoor Workers

SWMU	COC	Background		Direct Contact PRG	
		Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*	Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*
2	Arsenic	12	7.9	12[d]	20.8[b]
	Uranium-235+D	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
3	Uranium-235+D	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
7	Arsenic	12	7.9	12[d]	20.8[b]
	Total PAHs	NE	NE	0.296[b]	2.42[b]
	Neptunium-237+D	0.1	NE	1.36[b]	16.4[b]
	Plutonium-239+D	0.025	NE	N/A	81[b]
	Uranium-234+D	1.2	1.2	94.5[b]	141.5[b]
	Uranium-235/236	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
	Uranium (soluble salts)	4.9	4.6	535[a]	290[a]

Table C.8. PRGs for Direct Contact Exposures—Protection of Industrial and Outdoor Workers (Continued)

SWMU	COC	Background		Direct Contact PRG	
		Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*	Surface Soil (mg/kg) (pCi/g)*	Subsurface Soil (mg/kg) (pCi/g)*
30	Total PAHs	NE	NE	0.296[b]	2.42[b]
	Total PCBs	NE	NE	10[c]	10[c]
	Neptunium-237+D	0.1	NE	1.36[b]	16.4[b]
	Plutonium-239+D	0.025	NE	N/A	81[b]
	Uranium-234+D	1.2	1.2	94.5[b]	142[b]
	Uranium-235/236	0.06	0.06	1.98[b]	22.8[b]
	Uranium-238+D	1.2	1.2	8.5[b]	58.5[b]
	Uranium (soluble salts)	4.9	4.6	535[a]	290[a]

*mg/kg for chemicals; pCi/g for radionuclides
NAL values are given in Table A.4 of the 2011 Risk Methods Document (DOE 2011).
Background concentrations from the Risk Methods Document, Table A.12 (DOE 2011).
[a] The PRG for surface soil is 5 times the NAL for the industrial worker and for subsurface soils, 5 times the NAL for the outdoor worker. These correspond to a noncancer HQ of 0.5.
[b] The PRG for surface soil is 5 times the NAL for the industrial worker, corresponding to a cancer risk of 5E-6. For subsurface soils, the PRG is 50 times the NAL for the outdoor worker corresponding to a cancer risk of 5E-5.
[c] Risk management level for PCBs.
[d] The surface soil PRG for arsenic is the background concentration.
NE = no background concentration for the analyte.
N/A = not applicable, not a COC at this depth.

The following sections provide supporting information on the protectiveness of these PRGs for decision making and the derivation of these values.

C.2.1 CUMULATIVE RISK AND HAZARDS

In the risk assessment process, total risks (cumulative ELCR) and hazards (HI) are estimated for the exposure unit and receptors. For carcinogenic compounds, the chemical-specific risk for worker exposures to contaminants in soils represents the sum of the risks from ingestion, inhalation, and dermal absorption routes of exposure posed by that chemical at the defined soil concentration. The total or cumulative ELCR represents the sum of the risks posed by individual constituents. Similarly, for noncancer effects, the hazards posed by these routes of exposure for each constituent are summed to estimate the HI for the exposure unit.

Default assumptions for estimating soil contaminant intakes by industrial workers and outdoor workers are conservative in terms of protecting human health, for example assumptions of 250 days/year for 25 years for an industrial worker and 185 days/year for 25 years for an outdoor worker (DOE 2011). Therefore, an exposure point concentration is defined to represent an estimate of the average concentration over the exposure unit to which that worker may be exposed over the time period assumed for that exposure scenario.

Assuming the area within the SWMU boundaries are the appropriate exposure units for estimating residual risks for these potential future workers, an appropriate ELCR and HI would be calculated using the estimated average concentration remaining following any remedy implementation.

C.2.2 TARGET PRGs

The industrial and outdoor worker NALs from the 2011 Risk Management Document (DOE 2011) were derived using default assumptions for exposures to workers from all routes of exposure: (1) incidental ingestion, (2) inhalation, (3) dermal absorption, and (for radionuclides) external exposure to ionizing radiation. These numeric criteria are based on a target risk for carcinogens of 1E-06 and a HI of 0.1.

The PRGs, shown on Table C.8, for each COC (with the exception of arsenic in surface soil and Total PCBs) are set at one-half the target cumulative ELCR and HI as follows.

- **Surface soils.** PRG concentration is set at five times the industrial worker NAL. This corresponds to a risk of 5E-6 for carcinogenic COCs and a noncancer HQ of 0.5.

- **Subsurface soils**. PRG concentration is set at 50 times the outdoor worker NAL for carcinogens and 5 times the outdoor worker NAL for noncarcinogenic COCs (uranium). This corresponds to a risk of 5E-5 for carcinogenic COCs and a noncancer HQ of 0.5.

Arsenic at SWMUs 2 and 7 was retained as a COC because background concentrations were exceeded more frequently at these locations. The PRG for arsenic in surface soil was set at the background concentration. For subsurface soils, the PRG was set at 50 times the outdoor worker NAL, consistent with other carcinogenic COCs.

PCBs were identified as COCs for industrial and outdoor workers at SWMU 30. The 10 ppm value for Total PCBs in soil is the value jointly agreed upon by representatives of EPA Region 4, Kentucky Department for Environmental Protection, and DOE. This value was considered to be sufficiently protective of potential direct contact risk that could occur at the BGOU, when used to identify potential hot spots of PCBs. This is considered protective for cumulative risks for these exposure scenarios.

Uranium, a COC at SWMUs 7 and 30, is the only COC identified for noncancer hazards; therefore, using the PRG established at one-half the target HQ of 1 would be conservative for individual sample locations, would allow for potential uncertainties associated with contributions from other metals, and clearly would result in meeting the target HI for the overall SWMU.

In some cases, multiple carcinogenic COCs were identified. Any sample where even one of the COCs is present at concentrations above the PRGs would require further evaluation. Using the approach for setting the PRG at half the target risk has been used at PGDP and demonstrated to achieve RAOs.

There is a potential uncertainty associated with the case where multiple COCs are each present below the PRGs, but the cumulative ELCR still could exceed 1E-5 or 1E-4. To address this uncertainty, any SWMU medium that has identified multiple COCs, but does not exceed the target risk threshold, will be reevaluated to ensure that this has not occurred.

The attainment of cleanup objectives following a response action will be based on ELCR and HI calculations using concentrations measured in samples collected to verify that RAOs have been met at a SWMU. This will follow the same approach described in the Risk Methods Document (DOE 2011) and will be consistent with EPA (1991) guidance.

The analytical results for uranium-235 are reported in the WAG 3 risk assessment (DOE 2000) either as uranium-235 or uranium-235/236 in some soil samples from SWMUs 7 and 30. The identification of combined uranium-235/236 isotopes for some samples is due to the difficulty of differentiating between uranium-235 activity and uranium-236 activity. This uncertainty is expected to be minor because the same PRG value is calculated for uranium-235 and uranium-235/236 in the risk assessment (DOE 2000) and the same applicable PRG for soil was developed for both. The trace amounts of uranium-236 at PGDP originated from reactor recycled uranium; less than 10% of the material handled at PGDP was reactor recycled uranium; 0.002% of the reactor recycled uranium would be uranium-236. The important isotopes in assessing risk at PGDP are uranium-234, uranium-235, and uranium-238; therefore, these are the critical uranium isotopes that must be analyzed for in material at PGDP.

C.3. REFERENCES

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APPENDIX D

RISK ASSESSMENT EVALUATION FOR C-404 (SOLID WASTE MANAGEMENT UNIT 3) DISCHARGE DITCH

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CONTENTS

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FIGURES

TABLES

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ACRONYMS

BGOU	Burial Grounds Operable Unit
CDI	chronic daily intake
COC	contaminant of concern
COPC	chemical of potential concern
DAF	dilution attenuation factor
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
HI	hazard index
MCL	maximum contaminant level
MDA	minimum detectable activity
NAL	no action level
NCP	National Contingency Plan
NSDD	North-South Diversion Ditch
PRG	preliminary remediation goal
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RGA	Regional Gravel Aquifer
RMD	Risk Methods Document
RI	remedial investigation
SSL	soil screening level
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
UCL	upper confidence limit
WAG	waste area grouping

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D.1. INTRODUCTION

For Solid Waste Management Unit (SWMU) 3, the ditch adjacent to the C-404 impoundment formerly was used to discharge water and was identified as an area requiring further evaluation in this Burial Grounds Operable Unit (BGOU) Feasibility Study (FS). The SWMU 3 risk assessment as summarized in the Remedial Investigation (RI) report from Waste Area Grouping (WAG) 3 did not evaluate the samples collected from the ditch (DOE 2000). The BGOU RI determined that evaluation of these results were outside the scope of the BGOU RI, as defined in the approved work plan (DOE 2006); therefore, a quantitative risk assessment was not performed for soils in this ditch.

This risk assessment evaluates potential excess lifetime cancer risks (ELCRs) and noncancer hazard indices (HIs) for the future industrial worker and future outdoor worker scenarios, and conducts a screening analysis for future resident based on comparisons to no action levels (NALs) (DOE 2011). This evaluation also compares results with the removal action objectives identified for the Surface Water Operable Unit (SWOU).

The objective is to determine if ELCR/noncancer hazards are present that exceed target risk levels identified for the remedial action objectives (RAOs) for the BGOU FS and, if so, identify remediation goals (PRGs) to support evaluation of alternatives. The BGOU RAOs include the following.

RAO 1. Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination that will result in an exceedance of the maximum contaminant level (MCL) (or risk-based concentration for residential use of groundwater in the absence of an MCL in RGA groundwater).

RAO 2. Prevent exposure to waste or waste-related contaminated soils that exceed target cumulative ELCRs and cumulative noncancer HIs for the future industrial and future outdoor worker receptors. The acceptable cumulative levels for this RAO are defined as follows:

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

D.2. KEY FINDINGS FROM THIS RISK ASSESSMENT

The HI is less than 1 [no contaminants of concern (COCs) for noncancer] and the ELCR is less than 1E-5 for the future industrial worker and future outdoor worker using BGOU criteria and do not exceed the acceptable cumulative levels defined for the BGOU RAO.

Although residential scenarios are not a reasonable future use of this site, the potential ELCR risk and noncancer hazards for unrestricted use were screened based on comparison with child resident NALs to determine the baseline conditions and potential need for institutional controls. This screening suggests the potential for unacceptable hazards and risks (HI = 3, ELCR = 1.2E-5). As stated, this screening overstates the reasonable potential for exposure due to the area and configuration of the ditch. In addition, the HI would be less than 1 if the dermal pathway were excluded in a manner consistent with U.S. Environmental Protection Agency (EPA) Risk Assessment Guidance for Superfund (RAGS) Part E (EPA 2004).

The evaluation of potential migration of contaminants from soil to groundwater indicates no COCs that would limit future residential use of Regional Gravel Aquifer (RGA) groundwater based upon migration from the SWMU 3 ditch.

Although the potential for unacceptable risks is low based on this evaluation, the number of sample points are limited; thus, there is a potential uncertainty that should be addressed if this area is considered for release for unrestricted use. Its location within the secured area makes it unlikely that this will be an issue.

D.3. SWMU 3 DITCH BACKGROUND SUMMARY

The C-404 impoundment was designed with an overflow weir at its southwest corner. When the impoundment overflowed, the effluent flowed west in a ditch and eventually discharged through what is now Kentucky Pollutant Discharge Elimination System Outfall 015. When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. Leachate reportedly was pumped from the sump through an underground transfer line. The transfer line discharged into a northeast-southwest ditch (approximately 1,200-ft long, and 20-ft wide) just east of C-404. From this ditch, the leachate flowed into the North-South Diversion Ditch (NSDD). The duration of this practice is unknown, and there no longer is any discharge of leachate to the NSDD via this pipe.

Because there were no surface or subsurface soil historical data along the ditches around SWMU 3 and in the ditch leading to the NSDD, the BGOU RI Work Plan (DOE 2006) proposed collection of soil samples in this area. Soil samples were collected from 6 boring locations to a depth of 15 ft below ground surface (bgs) to evaluate impacts from the pipeline and ditch that once discharged leachate from SWMU 3 into the NSDD (Figure D.1). Samples from these borings were collected at the surface and from 1–5 ft, 5–10 ft, and 10–15 ft. In the time since the RI, this ditch mostly has been filled in and covered with a rail loading facility and a waste storage facility with surrounding gravel/paved areas.

The configuration of the ditch is not consistent with the large exposure used in a default worker (250 days/yr for 25 years) scenario nor chronic exposures to a resident. The current worker scenario used for the SWOU may be more applicable for addressing this area. Nevertheless, the soils data are evaluated for the default future scenarios.

D.4. CHEMICALS OF POTENTIAL CONCERN

The following summarizes the technical basis and criteria used to screen the data prior to its use in the risk and hazard calculations.

- **Units of measure.** All inorganic and organic chemicals were converted to mg/kg units and all radionuclides were converted to pCi/g prior to performing risk and hazard calculations.
- **Detect/nondetect status.** Each data point was assigned a detected or nondetected status. Any data with a “U” or “UJ” lab or validation flag was classified as nondetect; all other data points were

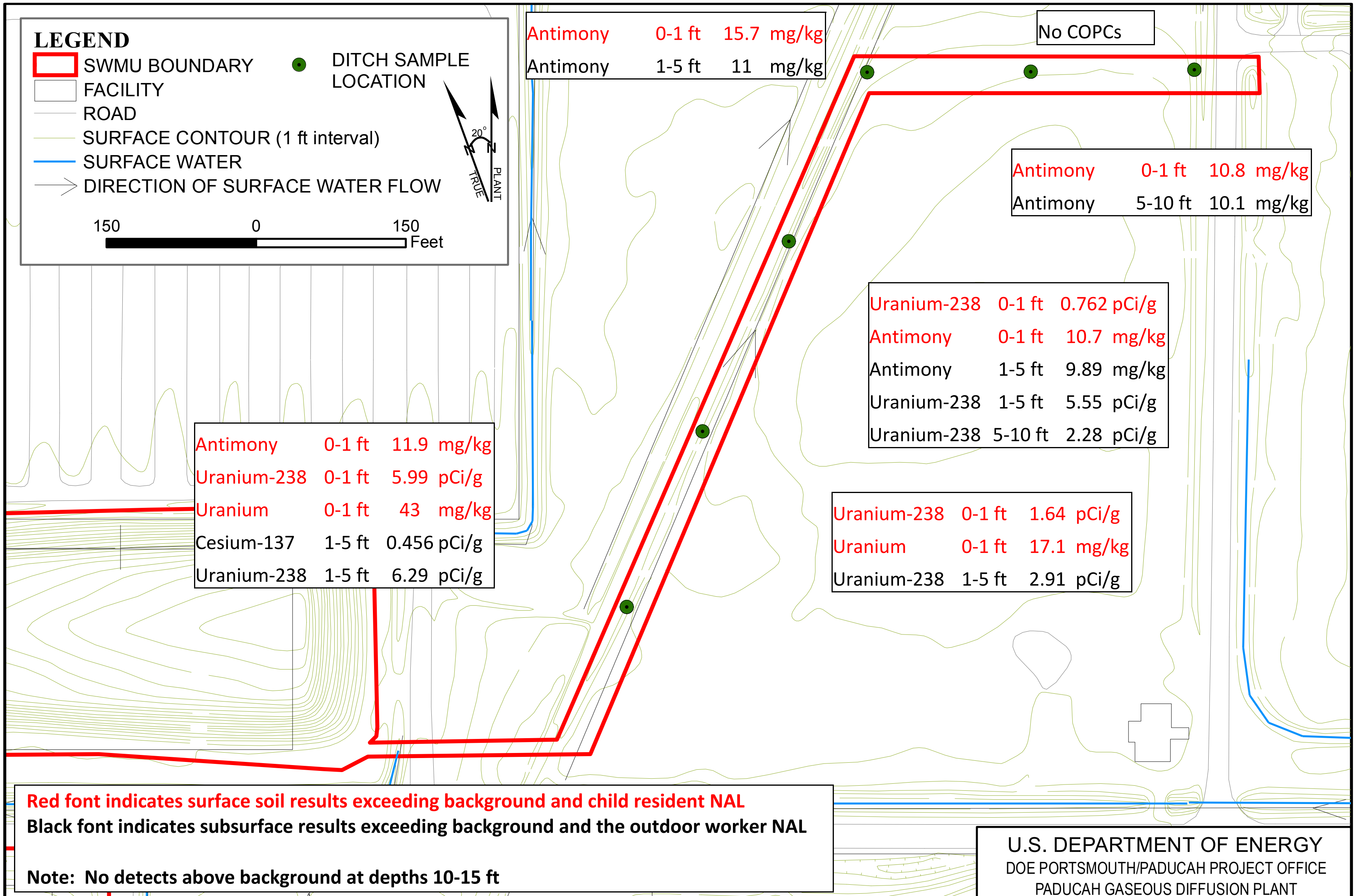

Figure D.1. Analytes Exceeding Background and No Action Limits within SWMU 3 Ditch

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Figure No. bgou\SWMU 3 Ditch Risk.mxd

classified as detects. For radionuclides, any analyte that was not reported above its minimum detectable activity (MDA) was removed from the data set.[1]

- **Essential nutrients.** The seven analytes listed in Section 3.3.3.2 of the 2011 Risk Methods Document (RMD) (DOE 2011) (calcium, chloride, iodine, magnesium, potassium, sodium, and phosphorous) were removed from the data set as they are essential nutrients.

- **Thorium-234.** Thorium-234, which has a 24.1 day half-life and is secular equilibrium with uranium-238, was removed from the data set based on previous comments from the regulatory agencies. Any remediation alternative for a SWMU containing uranium-238 incorporates thorium-234. Protactinium-234 and potassium-40 also would be removed, but were not included in the data set.

- **Nondetects.** Any chemical that was not detected in any surface sample (0–1 ft bgs) or subsurface sample (0–10 ft bgs) was removed from the data set.

- **Analyze duplicate samples.** Duplicate samples were available for some sample analyses. In cases where the value from the original sample and its duplicate both were detected values, the greater of the results from the original sample and its duplicate was retained in the data set. In cases where one value was a detected value and the other was a nondetect, the detected value was retained in the dataset. Finally, when both values were listed as nondetects, the lesser of the two detection limits was retained in the data set.

- **Background comparison.** The maximum concentration of each of the analytes exhibiting at least one detection was then compared to applicable background concentrations. Background concentrations for surface soils from Table A.12 of the RMD (DOE 2011) were used in this comparison.

Three metals (antimony, molybdenum, and uranium), one volatile organic compound [trichloroethene (TCE)] and four radionuclides [cesium-137, plutonium-239/240, technetium-99 (Tc-99), and uranium-238] were detected in one or more of the 24 (0–15 ft) soil samples above background concentrations. None of these chemicals were detected in the interval from 10–15 ft.

To identify chemicals of potential concern (COPCs) for the risk assessment calculations for the future industrial and future outdoor workers, the chemicals detected (and exceeding background) were screened against NALs for samples at the appropriate depths as follows:

Soil samples. Only surface samples (0–1 ft bgs) apply to the industrial worker scenario while both surface and subsurface samples (0–10 ft bgs) apply to the outdoor worker scenario, per the RMD (DOE 2011). The six samples from depths of 10–15 ft were not included in the risk calculations. None of the COPCs were detected in this interval.

Compare maximum detected concentrations to human health screening values to identify COPCs for direct contact exposures. The maximum detected result for each analyte was compared to NAL screening values for soil as part of the toxicity screen. Analytes with a maximum detected value less than the analyte's NAL were not retained as COPCs.

[1] This removal from the data set is not consistent with historical site practices; however, this approach was considered appropriate for this evaluation.

The values used to screen surface soil results were the direct contact residential child NAL values taken from Appendix A of the RMD (DOE 2011). These concentrations were lower than the future industrial worker NALs. This comparison also provides information on potential future residential use of this area even though not considered a reasonably foreseeable future land use in this area. For soils from depths from 0–10 ft bgs, the data were screened using the outdoor worker NAL.

Those analytes with at least one detection and which exceeded background and the NALs were retained as COPCs and carried through the risk and hazard calculations. The results of this screening are shown on Tables D.1 for surface soils and Table D.2 for the combined surface and subsurface results (0–10 ft) applicable for the evaluation for the future outdoor worker.

Table D.1. Surface Soil Summary SWMU 3 Ditch (0–1 ft) (Locations 003–005 through 003–010)

Analysis	Maximum Detection (mg/kg)* (pCi/g)	Background (mg/kg)* (pCi/g)	Frequency of Detection[a]	Frequency Detected above Background[b]	Child Resident NAL	COPC (Yes/No)
Antimony	15.7	0.21	4/6	4/6	0.552	Yes
Molybdenum	6.21	NA	4/6	NA	23	No
Uranium	43	4.9	4/6	3/6	13.8	Yes
TCE	0.00633	NA	1/5	NA	0.0234	No
Cesium-137	0.344	0.49	1/6	0/6	0.0267	No
Plutonium-239240	0.0562	0.025	1/6	1/6	3.15	No
Technetium-99	21.6	2.5	3/6	3/6	101	No**
Uranium-238	5.99	1.2	6/6	3/6	0.517	Yes

*mg/kg for chemicals or pCi/g for radionuclides.
**See discussion in text.
NA = not applicable
[a] Frequency of detection is the number of detection of an analyte per number of analyses (includes maximum of the regular and duplicate samples). For radionuclides, the frequency of detection reports the number of samples with values above the MDA.
[b] Background values are taken from DOE 2011. Results of samples collected 0–1 ft were compared to surface background values.

Table D.2. Subsurface Soil Summary SWMU 3 Ditch (0–10 ft) (Locations 003–005 through 003–010)

Analysis	Maximum Detection (mg/kg)* (pCi/g)	Background (mg/kg)* (pCi/g)	Frequency of Detection[a]	Frequency Detected above Background[b]	Outdoor Worker NAL	COPC (Yes/No)
Antimony	15.7	0.21	6/18	6/18	2.7	Yes
Molybdenum	6.21	NA	5/18	NA	96.6	No
Uranium	43	4.6	9/18	7/18	57.9	No
TCE	0.00633	NA	1/17	NA	0.0619	No
Cesium-137	0.456	0.28	2/18	1/18	0.115	Yes
Plutonium-239/240	0.0562	NA	2/18	2/18	1.61	No
Technetium-99	56.9	2.8	6/18	6/18	57.9	No**
Uranium-238	6.29	1.2	13/18	7/18	1.17	Yes

*mg/kg for chemicals or pCi/g for radionuclides.
**See discussion in text.
NA = not applicable
[a] Frequency of detection is the number of detection of an analyte per number of analyses (includes regular and duplicate samples). For radionuclides, the frequency of detection reports the number of samples with values above the MDA.
[b] These subsurface background values are taken from DOE 2011. Results of samples collected 0–1 ft were compared to surface background values shown on Table D.1. All other results were compared to these subsurface values. All results for plutonium-239/240 were compared to surface background values for plutonium-239.

D.5. RISK ESTIMATES FOR FUTURE WORKER SCENARIOS

Risk assessment calculations have been completed for a future industrial worker scenario and a future outdoor worker scenario using 2007 soil data collected from SWMU 3 ditch locations (D.1). Surface soil (0–1 ft) data collected from SWMU 3 ditch locations (003-005 through 003-010) were used to evaluate future industrial worker exposure while surface and subsurface soil data collected from these locations were used to evaluate the future outdoor worker.

The risk assessment was completed using guidance from the RMD (DOE 2011). Following the selection of COPCs, chronic daily intakes (CDIs) for the following exposure routes were calculated using the equations and default values shown in Appendix D of the RMD (DOE 2011) and shown in the attached risk calculation sheets. These evaluate intakes for the following routes of exposure as applicable:

- Incidental ingestion of soil,
- Inhalation of vapors and particulates from soil,
- Dermal contact with soil, and
- External exposure to ionizing radiation from soil.

The risk calculations were performed in a manner consistent with the RMD (DOE, 2011).

- Toxicity values used in the risk and hazard calculations were obtained from the RMD (DOE 2011).

- ELCRs and HIs were calculated using equations 10 through 15 in the RMD (DOE 2011), including use of the default dermal absorption values for inorganic chemicals.

The risk and hazard calculations for the future industrial worker and future outdoor worker are shown in tables included in Attachments D.1 and D.2. Supporting information on the derivation of the exposure point concentrations (EPCs) and summary of results are highlighted below.

D.5.1 FUTURE INDUSTRIAL WORKER SCENARIO (0–1 FT)

The COPCs for the SWMU 3 ditch surface soils for the future industrial worker include antimony, uranium, and uranium-238 (Table D.1). Because each COPC had a maximum of six data points, the 95% upper confidence limit (UCL) was not appropriate to compute. Instead, the maximum concentration for each COPC was used as the EPC.

Based on the maximum concentrations (Table D.1), the risk assessment calculations resulted in the ELCR of 3.5E-6, with uranium-238 the only COC. The total HI for the site was less than 1. Only the ELCR exceeded the *de minimis* risk levels for an industrial worker, and the level is within the EPA acceptable risk range. Calculations of the ELCR and HI for the future industrial worker are provided in Attachment D1.

D.5.2 FUTURE OUTDOOR WORKER SCENARIO (0–10 FT)

The COPCs for the SWMU 3 ditch surface and subsurface soils for the future outdoor worker include antimony, cesium-137, and uranium-238 (Table D.2). EPA's software program ProUCL was used to derive the 95% UCL used as the EPC for uranium-238, because there were a sufficient number of detections (13). The remaining COPCs each had 6 or fewer detections, making computation of the 95% UCL inappropriate. For these COPCs, the maximum concentration was used as the EPC.

Based on the EPCs calculated from the surface (Table D.1) and subsurface (Table D.2) soil data collected from SWMU 3, the total ELCR was 9.3E-6, with cesium-137 contributing a majority of the risk followed by uranium-238. The total HI for the site was less than 1. Only the ELCR exceeds *de minimis* risk levels for a future outdoor worker, but is within EPA's acceptable risk range (EPA 1999). Calculations of the ELCR and HI for the future outdoor worker are provided in Attachment D2.

D.5.3 FUTURE RESIDENTIAL SCENARIOS

The SWMU 3 ditch becoming a residential area is not considered a reasonably foreseeable land use, and baseline risk calculations were not completed. Residential scenarios are based, in part, on potential exposures to surface soils, and the three COPCs shown on Table D.1 would be those to consider for a future resident. Based on comparison with the NALs, the maximum concentration of antimony (15.7 mg/kg) equates to a hazard quotient of 2.84, and the contribution from uranium equates to a hazard quotient of 0.31, suggesting a maximum HI of 3.16 with 80 to 90% of the HI attributed to the dermal pathway. Even though information is limited on the rate and extent of dermal absorption of metals in soil across the skin, this pathway is generally minor in comparison to the amount of exposure that occurs by the oral route. This view is based on the recognition that most metals tend to bind to soils, reducing the likelihood that they would dissociate from the soil and cross the skin, and ionic species such as metals have a relatively low tendency to cross the skin even when contact does occur. Using assumptions from RAGS guidance and/or comparison with RSLs, the HI would be less than 1 for the child resident. The only carcinogenic COPC was uranium-238, and the maximum concentration in surface soil equates to an ELCR of 1.2E-5. Therefore, the risks would be above *de minimus* levels under this hypothetical scenario, but within EPA's acceptable risk range; using current assumptions for dermal absorption, the HI would be less than 1.

D.6. PROTECTION OF GROUNDWATER

Future residential use of groundwater in this area is not a likely scenario because this area is limited to a narrow ditch; however, these data were reviewed consistent with other screening protocols to determine the potential to impact RGA groundwater and limit future residential use. The default screening for protection of the RGA includes a dilution attenuation factor (DAF) of 58 applied to the applicable soil screening level (SSL).

Table D.3 compares the maximum detected concentration to the SSL protective of the RGA. For metals and TCE, the SSL with a DAF = 1 was obtained from Table A.7a of the RMD (DOE 2011) based on the groundwater target concentration of the MCL for antimony, uranium, and TCE. The maximum concentrations were at or below the RGA SSL for these three chemicals. No background concentration is identified for molybdenum. The maximum soil concentration slightly exceeds the RGA SSL (based on the child resident NAL at HI = 0.1). The remaining four detected concentrations ranged from 2.58 to 3.78 mg/kg, with no detections at depths below 5 ft bgs. Since this is the only constituent with a noncancer endpoint for groundwater that exceeds screening, evaluation with the target groundwater concentration at the HI = 1 would be appropriate, further indicating this metal is not a potential threat to groundwater.

Table D.3. Soil Summary SWMU 3 Ditch (0–15 ft) Soil to Groundwater Screening (Locations 003–005 through 003–010)

Analysis	Maximum Detection (mg/kg)* (pCi/g)	Frequency of Detection	Frequency Detected Above Background	Target Concentration (mg/L)* (pCi/L)	Target Reference	RGA SSL (DAF 58)
Antimony	15.7	7/24	7/24	0.006	MCL	15.7
Molybdenum	6.21	5/24	NA	0.00521	NAL	6.1
Uranium	43	9/24	7/24	0.03	MCL	783
TCE	0.00633	1/23	NA	0.005	MCL	0.103
Cesium-137	0.456	2/24	1/24	NA	NA	NA
Plutonium-239/240	0.0562	2/24	2/24	NA	NA	0.371
Technetium-99	56.9	6/24	6/24	900	MCL	21.2
Uranium-238	6.29	13/24	6/24	20	MCL	13.3

*mg/kg or mg/L for chemicals; pCi/g or pCi/L for radionuclides.
NA = not available or not applicable, not used in screening.
The MCL listed above for Tc-99 is based on 4 mrem/yr, using historical dosimetry assumptions.
Background screening compared surface soil results to surface background and subsurface to subsurface background levels; background concentrations from DOE 2011.
SSL (DAF = 1) values used for calculation of the RGA SSL were taken from the RMD (DOE 2011), Table A.7a for chemicals and A.7b for cesium-137 (no load in 10,000 years) and plutonium. Table A.7b also used in the derivation of an MCL based SSL for uranium.
The MCL-based SSL for Tc-99 for protection of RGA groundwater is taken from Table A.11 of RMD (DOE 2011) at the MCL of 4 mrem/yr.
DAF = dilution attenuation factor; MCL = maximum contaminant level; NAL = no action level for child resident; SSL = soil screening level; SWMU = solid waste management unit; TCE = trichloroethene

Four radionuclides were detected above background. None of these were identified as posing a potential threat to RGA groundwater.

No SSL for cesium-137 was identified in the RMD (DOE 2011, Table A.7b), because it does not reach groundwater within 10,000 years, precluding receptor uptake. In addition, EPA's Superfund radionuclide PRG Web site provides generic tables for screening the soil to groundwater pathway (http://epa-prgs.ornl.gov/radionuclides/download/outw_soil_rad_prg_august_2010.xls) based on a default DAF of 20. For cesium-137, the MCL-based SSL is 56.6 pCi/g. The maximum detected concentration was below this value. There was only one other detected value, and it was below background.

The maximum detected plutonium-239/240 concentration was below the RGA SSL based on the NAL in groundwater at 1E-6 for the adult resident RMD Table A.7b. It rarely was detected and is a low mobility radionuclide.

The maximum Tc-99 concentration exceeded the screening level of 21.2 pCi/g; however, the average was 4.2 pCi/g and there were no detections of Tc-99 at depths below 5 ft.

For uranium-238, the risk-based SSL for protection of RGA groundwater for a future resident was 0.718 pCi/g (DOE 2011, Table A.7b) based on the groundwater NAL (1E-6) of 1.08 pCi/g (DOE 2011, Table A.5). Because this screening protocol is based on MCLs where available, the risk-based SSL was converted to reflect 20 pCi/g target MCL concentration for uranium-238 (DOE 2011, Table A.14) resulting in an MCL-based SSL of 13.3 pCi/g. This value was not exceeded.

Based on this screening, there are no COCs that would limit future residential use of RGA groundwater.

D.7. SWMU 3 DITCH RISK ASSESSMENT UNCERTAINTIES

There is always a degree of uncertainty associated with all risk assessments. The following details elements of uncertainty associated with the assessment of potential human health risks and hazards associated with the future industrial and outdoor worker exposure scenarios.

D.7.1 USE OF MAXIMUM CONCENTRATIONS

As discussed above, maximum concentrations were used to compute human health ELCRs and hazard indices for most of the COPCs, rather than UCLs. UCLs were limited to uranium-238 for the outdoor worker scenario; however, for the industrial worker, UCLs were not employed due to the very limited number of data points available (six). This is standard industry practice, as small data sets can greatly increase the uncertainty in estimating the mean/UCL and consistent with the RMD.

The single risk calculation based on the maximum infers a level of risk/hazard throughout the area along the ditch. As illustrated in Figure D.2, risks are *de minimis* along much of the length of the ditch.

D.7.2 DERMAL ABSORPTION

Although HI for the worker scenarios was below the hazard level of 1.0, when considering other more conservative scenarios, the impact of the default dermal absorption factors for inorganics are a consideration. As much as 93% of the total HI is attributed to dermal absorption of metals (antimony and uranium) in this assessment. These were generated using the RMD (DOE 2011) default dermal absorption factor for metals of 5%.

EPA RAGS Part E (EPA 2004) identified a specific soil absorption factor for two inorganics (arsenic and cadmium), and they do not recommend the use of a default dermal absorption factor for inorganics. EPA follows this guidance when establishing regional screening levels (EPA 2011) and does not include the dermal pathway for metals including antimony and uranium. Following the recommendations of EPA RAGS Part E (EPA 2004), the HI for a hypothetical future child resident would be less than 1.

EPA Region 4 supplemental guidance (EPA 2000) (currently under revision) suggests a default dermal absorption factor for inorganics of 0.1% as compared to the 5% used in this risk assessment. Use of the Region 4 value would lower the dermally absorbed dose 50 fold from the current estimates; as a result, the HI still would be below the hazard level of 1.0 even for a future resident.

D.7.3 ANALYTICAL METHODS

The analytical method used by United States Enrichment Corporation, the on-site laboratory used by DOE, for determining uranium concentrations does not digest the uranium as fully as the method used to determine the uranium concentration for the Paducah Gaseous Diffusion Plant background study; therefore, comparisons of uranium concentrations that are less than 10 pCi/g to the background values may result in uranium isotopes being eliminated as below background when they actually are elevated slightly above background. uranium-234 was not retained as a COPC as the maximum detected activity was less than background; however, the risk contribution of uranium-234 under both worker scenarios does not change the total risk estimate. The effect of the difference in digestion recovery between the two methods is minimal; therefore, the uncertainty associated with the use of the two different methods is small.

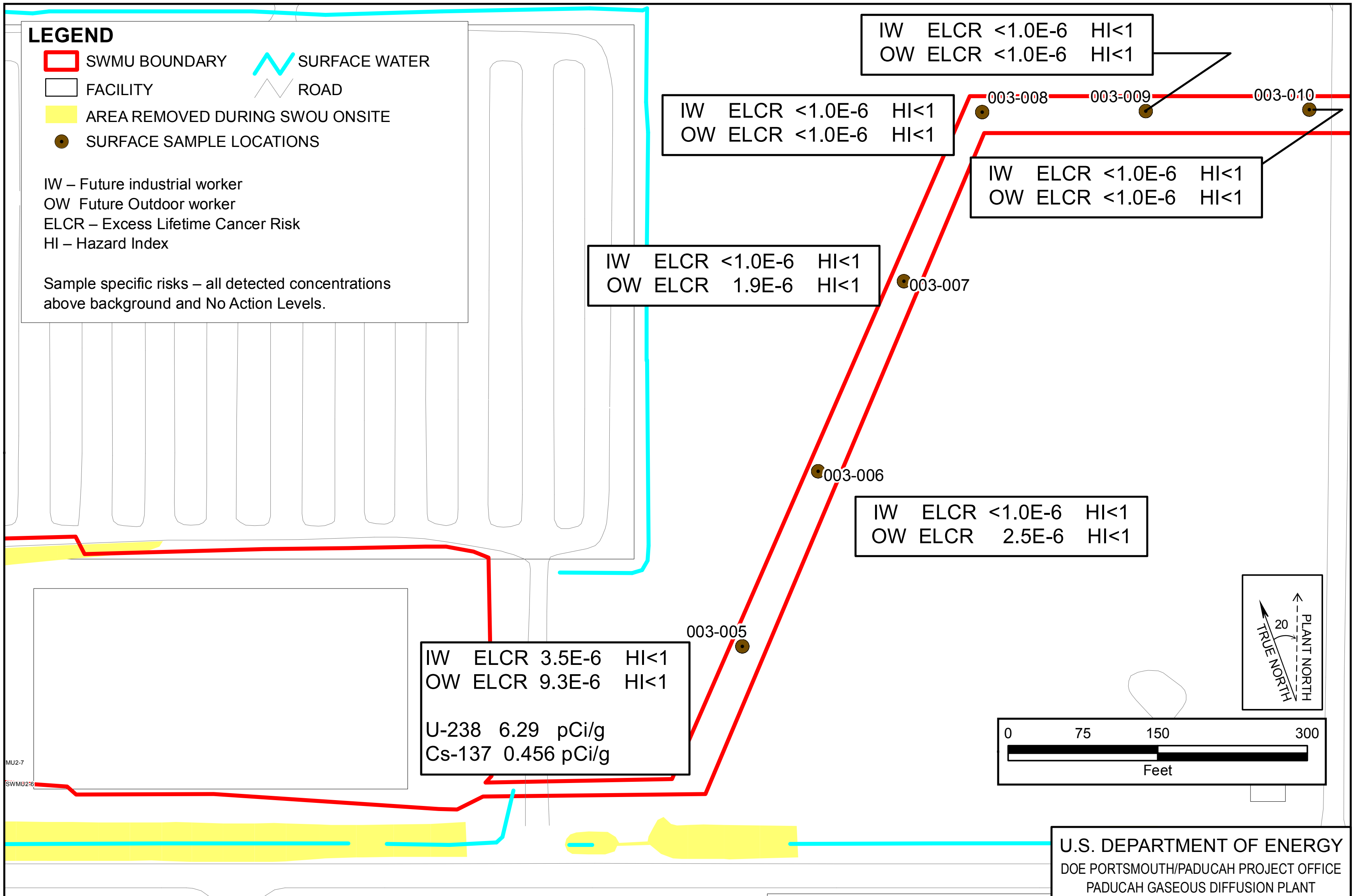

Figure D.2. SWMU 3 Ditch Risk Summary

3/15/2012 BGOU\FS\SWMU03_SURF_RISKR1.mxd

D.8. DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

The RAOs for the BGOU include the following:

- Contribute to the protection of groundwater by eliminating, reducing, or controlling sources of groundwater contamination.

- Prevent exposure to waste and contaminated soils that presents an unacceptable risk from direct contact.

D.8.1 PROTECTION OF GROUNDWATER

As discussed in D.5, no COCs were identified that pose a threat to groundwater and no PRGs are applicable.

D.8.2 PROTECTION OF FUTURE INDUSTRIAL AND OUTDOOR WORKERS

There are no wastes associated with the SWMU 3 ditch. Achieving the RAO to prevent exposure to contaminated soils that present an unacceptable risk from direct contact for this BGOU FS is based on meeting the following target cumulative ELCRs and cumulative HIs for the industrial and outdoor worker receptors.

- Surface Soil: Cumulative ELCR < 1E-05 and cumulative HI ≤ 1 for a future industrial worker
- Subsurface Soil: Cumulative ELCR < 1E-04 and cumulative HI ≤ 1 for an future outdoor worker

D.8.2.1 Future Industrial Worker Scenario

The risk assessment notes that ELCR to a future industrial worker at the SWMU 3 Ditch is above the *de minimis* risk level of 1E-06 due to uranium-238, which is within the acceptable ELCR range of 1E-06 to 1E-04 (EPA 1999) and below the target ELCR criterion stated for meeting the RAO for this FS. The noncancer HI estimated for industrial worker exposures to surface soil is below the acceptable value of 1 established in the NCP and the target HI criterion. Since the BGOU target cumulative ELCR and HI are met, no PRGs are derived.

D.8.2.2 Future Outdoor Worker Scenario

The risk assessment notes that the ELCR to a future outdoor worker exposed to subsurface soil at the SWMU 3 Ditch is above the *de minimis* risk level of 1E-06 due to cesium-137 contributing a majority of the risk followed by uranium-238. The total ELCR is within the acceptable range of 1E-06 to 1E-04 and below the target ELCR criterion for subsurface soil stated for meeting the RAO for this FS. The noncancer HI estimated for outdoor worker exposures to subsurface soil is estimated to be below the acceptable value of 1 established in the NCP and the target HI criterion. Because the BGOU target cumulative ELCR and HI are met, no PRGs are derived.

D.8.2.3 Potential Limits on Future Residential Use

Risk management decisions for remedial actions, as identified by the RAOs, recognize that residential use of this property is not a reasonable future use; however, clarification of the potential need to limit this future use was provided based on screening with the residential NALs. The detected chemicals above background suggest the ELCR at the maximum detected surface soil location would be 1.2E-5, within the acceptable range of 1E-06 to 1E-04 specified in the NCP. The HI would exceed 1, only if the dermal absorption pathway is retained for antimony and uranium; inconsistent with RAGS Part E (EPA 2004). It also is noted that the size and orientation of the ditch is not consistent with residential property use, so this type of screening is provided only to clarify the concentrations identified and provide insight into the baseline condition.

D.8.2.4 Exposure Scenarios Applicable to Drainageways/Surface Water

The conceptual models and exposure scenarios applicable to drainageways are evaluated in the SWOU. These better reflect the differences in exposure frequencies and duration that are relevant for possible maintenance in a drainageway area. The SWOU also considers issues like migration to downstream receptors—an evaluation not included in the scope of the BGOU. In addition, current plans are to conduct a sitewide baseline ecological risk assessment as part of future remedial investigation activities associated with the SWOU.

The SWOU target cleanup levels were based on the target cumulative ELCR of 1E-5 and HI $\leq$ 1 under current site conditions (14 days/year for 25 years), less frequent exposures than defined for the future industrial worker and/or outdoor worker than were evaluated in this assessment. Therefore, meeting the target ELCR and HI for the future workers would also meet the targets for the current worker scenario that is the basis for development of cleanup levels in the SWOU removal action work plan (DOE, 2009).

On that basis, the concentrations of the two carcinogenic chemicals making contributions above *de minimis* levels to future workers, cesium-137 and uranium-238, would not exceed PRGs developed for the SWOU of 8 pCi/g and 94 pCi/g respectively.

D.9. CONCLUSION

No PRGs need to be derived to meet the RAOs for either the BGOU or SWOU.

D.10. REFERENCES

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ATTACHMENT D1

FUTURE INDUSTRIAL WORKER SCENARIO CALCULATIONS

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Attachment D1.1. Future Industrial Worker Scenario Hazard Calculations

Hazard Index Calculation for Industrial Worker

						Chronic Toxicity (RfD)				SWMU 3 Ditch										
COPC	**Ingestion Intake (II_{ing}) without Cs**	**ABS**	**Dermal Intake (DI) w/o ABS & Cs**	**Inhalation Intake (II_{inh}) without Cs**	**External exposure Intake (EI) w/o Cs**	**Ingestion**	**Dermal**	**Inhalation**	**External Exposure**	**EPC (C)**	**Ingestion Intake Hazard**	**Dermal Intake Hazard**	**Inhalation Intake Hazard**	**External Exposure Hazard**	**IngestionHQ**	**Dermal HQ**	**Inhalation HQ**	**External Exposure**	**Chemical HI**	**% Contribution**
Inorganic Chemicals (Metals)																				
Antimony	4.89E-07	5.00E-02	4.21E-05	6.10E-12	NA	4.00E-04	6.00E-05	NA	NA	1.57E+01	7.68E-06	3.30E-05	9.57E-11	NA	1.92E-02	5.50E-01	NA	NA	5.70E-01	72.8%
Uranium	4.89E-07	5.00E-02	4.21E-05	6.10E-12	NA	6.00E-04	5.10E-04	NA	NA	4.30E+01	2.10E-05	9.05E-05	2.62E-10	NA	3.51E-02	1.77E-01	NA	NA	2.12E-01	27.2%
Radionuclides																				
Uranium-238	3.13E+02	NA	NA	3.89E-03	4.57E+00	NA	NA	NA	NA	5.99E+00	1.87E+03	NA	2.33E-02	2.74E+01	NA	NA	NA	NA	0.00E+00	0.0%
														Cumulative Values:	5.43E-02	7.28E-01	0.00E+00	0.00E+00	**7.82E-01**	**100.0%**
														% Contribution:	6.9%	93.1%	0.0%	0.0%	100.0%	

Ingestion Calculation

Chemical Intake [mg/(kg x day)] = [C*CF*EF*FI*ED*IR/(BW*AT)]
Radionuclide Intake (pCi) = [A*CF_{rad}*EF*ED*IR*FI]

Industrial Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
CF =	1.00E-06	kg/mg
EF =	250	d/yr
FI =	1	
ED =	25	yr
IR =	50	mg/d
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
CF_{rad} =	1.00E-03	g/mg
$II_{ing-chemical}$ =	4.89E-07	
$II_{ing-rad}$ =	3.13E+02	
Radionuclide Intake $^{239/240}$Pu =	1.76E+01	

Dermal Contact Calculation

Absorbed Dose [mg/(kg x day)] = [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]

Industrial Worker

C =	1.57E+01	mg/kg as Antimony
CF_d =	1.00E-02	kg-cm^2/mg-m^2
SA =	0.43	m^2/d
AF =	1	mg/cm^2
ABS =	5.00E-02	for Antimony
EF =	250	d/yr
ED =	25	yr
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
DI w/o Cs & ABS =	4.21E-05	
Absorbed Dose Antimony =	3.30E-05	

Inhalation Calculation

Chemical Intake [mg/(kg x day)] = [C*EF*ED*ET*(1/VF+1/PEF)*IR_{air}] / (BW * AT)
Radionuclide Intake (pCi) = [A*EF*ED*ET*CF*(1/VF+1/PEF)*IR_{air}]

Industrial Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	250	d/yr
ED =	25	yr
ET =	8	hr/d
VF_{TCE}=	3.45E+03	m^3/kg
PEF =	3.21E+10	m^3/kg
IR_{air} =	2.5	m^3/hr
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
CF =	1.00E+03	g/kg
$II_{inh-TCE}$ =	5.67E-05	
$II_{inh-metals}$ =	6.10E-12	
$II_{inh-rad}$=	3.89E-03	
Radionuclide Intake $^{239/240}$Pu =	2.19E-04	

Absorbed Dose Calculation

Absorbed Dose = [A_s*ED*EF*(1-S_e)*T_e]

Industrial Worker

A_s =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	6.85E-01	d/d
ED =	25	yr
S_e =	0.2	
T_e	3.33E-01	hr/hr
EI =	4.57E+00	yr
Absorbed Dose $^{239/240}$Pu =	2.57E-01	

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Attachment D1.2. Future Industrial Worker Scenario Risk Calculations

Risk Calculation for Industrial Worker

						Cancer Toxicity (SF)				SWMU 3 Ditch										
COPC	Ingestion Intake (II_{ing}) without Cs	ABS	Dermal Intake (DI) w/o ABS & Cs	Inhalation Intake (II_{inh}) without Cs	External exposure Intake (EI) w/o Cs	Ingestion	Dermal	Inhalation	External Exposure	EPC (C)	Ingestion Intake Risk	Dermal Intake Risk	Inhalation Intake Risk	External Exposure Risk	IngestionELCR	Dermal ELCR	Inhalation ELCR	External Exposure	Chemical ELCR	% Contribution
Inorganic Chemicals (Metals)																				
Antimony	1.75E-07	5.00E-02	1.50E-05	2.18E-12	NA	NA	NA	NA	NA	1.57E+01	2.74E-06	1.18E-05	3.42E-11	NA	NA	NA	NA	NA	0.00E+00	0.0%
Uranium	1.75E-07	5.00E-02	1.50E-05	2.18E-12	NA	NA	NA	NA	NA	4.30E+01	7.51E-06	3.23E-05	9.36E-11	NA	NA	NA	NA	NA	0.00E+00	0.0%
Radionuclides																				
Uranium-238	3.13E+02	NA	NA	3.89E-03	4.57.E+00	2.10E-10	NA	9.35E-09	1.14E-07	5.99E+00	1.87E+03	NA	2.33E-02	2.74E+01	3.93E-07	NA	2.18E-10	3.12E-06	3.51E-06	100.0%
														Cumulative Values:	3.93E-07	0.00E+00	2.18E-10	3.12E-06	**3.51E-06**	**100.0%**
														% Contribution:	11.2%	0.0%	0.0%	88.8%	100.0%	

Ingestion Calculation

Chemical Intake [mg/(kg x day)] = [C*CF*EF*FI*ED*IR/(BW*AT)]
Radionuclide Intake (pCi) = [A*CF_{rad}*EF*ED*IR*FI]

Industrial Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
CF =	1.00E-06	kg/mg
EF =	250	d/yr
FI =	1	
ED =	25	yr
IR =	50	mg/d
BW =	70	kg
ATc = 70 x 365 =	25550	yr-day/yr
CF_{rad} =	1.00E-03	g/mg
$II_{ing\text{-}chemical}$ =	1.75E-07	
$II_{ing\text{-}rad}$ =	3.13E+02	
Radionuclide Intake $^{239/240}$Pu =	1.76E+01	

Dermal Contact Calculation

Absorbed Dose [mg/(kg x day)] = [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]

Industrial Worker

C =	1.57E+01	mg/kg as Antimony
CF_d =	1.00E-02	kg-cm^2/mg-m^2
SA =	0.43	m^2/d
AF =	1	mg/cm^2
ABS =	5.00E-02	for Antimony
EF =	250	d/yr
ED =	25	yr
BW =	70	kg
ATc = 70 x 365 =	25550	yr-day/yr
DI w/o Cs & ABS =	1.50E-05	
Absorbed Dose Antimony =	1.18E-05	

Inhalation Calculation

Chemical Intake [mg/(kg x day)] = [C*EF*ED*ET*(1/VF+1/PEF)*IR_{air}] / (BW * AT)
Radionuclide Intake (pCi) = [A*EF*ED*ET*CF*(1/VF+1/PEF)*IR_{air}]

Industrial Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	250	d/yr
ED =	25	yr
ET =	8	hr/d
VF_{TCE}=	3.45E+03	m^3/kg
PEF =	3.21E+10	m^3/kg
IR_{air} =	2.5	m^3/hr
BW =	70	kg
AT =	25550	yr-day/yr
CF =	1.00E+03	g/kg
$II_{inh\text{-}TCE}$ =	2.03E-05	
$II_{inh\text{-}metals}$ =	2.18E-12	
$II_{inh\text{-}rad}$=	3.89E-03	
Radionuclide Intake $^{239/240}$Pu =	2.19E-04	

Absorbed Dose Calculation

Absorbed Dose = [A_s*ED*EF*(1-S_e)*T_e]

Industrial Worker

A_s =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	6.85E-01	d/d
ED =	25	yr
S_e =	0.2	
T_e	3.33E-01	hr/hr
EI =	4.57E+00	yr
Absorbed Dose $^{239/240}$Pu =	2.57E-01	

ATTACHMENT D2

FUTURE OUTDOOR WORKER SCENARIO CALCULATIONS

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Attachment D2.1. Future Excavation Worker Scenario Hazard Calculations

Hazard Index Calculation for Outdoor Worker

						Chronic Toxicity (RfD)				SWMU 3 Ditch										
COPC	**Ingestion Intake (II_{ing}) without Cs**	**ABS**	**Dermal Intake (DI) w/o ABS & Cs**	**Inhalation Intake (II_{inh}) without Cs**	**External exposure Intake (EI) w/o Cs**	**Ingestion**	**Dermal**	**Inhalation**	**External Exposure**	**EPC (C)**	**Ingestion Intake Hazard**	**Dermal Intake Hazard**	**Inhalation Intake Hazard**	**External Exposure Hazard**	**IngestionHQ**	**Dermal HQ**	**Inhalation HQ**	**External Exposure**	**Chemical HI**	**% Contribution**
Inorganic Chemicals (Metals)																				
Antimony	3.48E-06	5.00E-02	3.11E-05	4.51E-12	NA	4.00E-04	6.00E-05	NA	NA	1.57E+01	5.46E-05	2.44E-05	7.08E-11	NA	1.36E-01	4.07E-01	NA	NA	5.44E-01	100.0%
Radionuclides																				
Cesium-137	2.22E+03	NA	NA	2.88E-03	3.38E+00	NA	NA	NA	NA	4.56E-01	1.01E+03	NA	1.31E-03	1.54E+00	NA	NA	NA	NA	0.00E+00	0.0%
Uranium-238	2.22E+03	NA	NA	2.88E-03	3.38E+00	NA	NA	NA	NA	3.21E+00	7.12E+03	NA	9.24E-03	1.08E+01	NA	NA	NA	NA	0.00E+00	0.0%
														Cumulative Values:	1.36E-01	4.07E-01	0.00E+00	0.00E+00	**5.44E-01**	**100.0%**
														% Contribution:	25.1%	74.9%	0.0%	0.0%	100.0%	

Ingestion Calculation

Chemical Intake [mg/(kg x day)] = [C*CF*EF*FI*ED*IR/(BW*AT)]
Radionuclide Intake (pCi) = [A*CF_{rad}*EF*ED*IR*FI]

Outdoor Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
CF =	1.00E-06	kg/mg
EF =	185	d/yr
FI =	1	
ED =	25	yr
IR =	480	mg/d
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
CF_{rad} =	1.00E-03	g/mg
$II_{ing\text{-}chemical}$ =	3.48E-06	
$II_{ing\text{-}rad}$ =	2.22E+03	
Radionuclide Intake $^{239/240}$Pu =	1.25E+02	

Dermal Contact Calculation

Absorbed Dose [mg/(kg x day)] = [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]

Outdoor Worker

C =	1.57E+01	mg/kg as Antimony
CF_d =	1.00E-02	kg-cm^2/mg-m^2
SA =	0.43	m^2/d
AF =	1	mg/cm^2
ABS =	5.00E-02	for Antimony
EF =	185	d/yr
ED =	25	yr
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
DI w/o Cs & ABS =	3.11E-05	
Absorbed Dose Antimony =	2.44E-05	

Inhalation Calculation

Chemical Intake [mg/(kg x day)] = [C*EF*ED*ET*(1/VF+1/PEF)*IR_{air}] / (BW * AT)
Radionuclide Intake (pCi) = [A*EF*ED*ET*CF*(1/VF+1/PEF)*IR_{air}]

Outdoor Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	185	d/yr
ED =	25	yr
ET =	8	hr/d
VF_{TCE}=	3.45E+03	m^3/kg
PEF =	3.21E+10	m^3/kg
IR_{air} =	2.5	m^3/hr
BW =	70	kg
ATnc = ED x 365 =	9125	yr-day/yr
CF =	1.00E+03	g/kg
$II_{inh\text{-}TCE}$ =	4.20E-05	
$II_{inh\text{-}metals}$ =	4.51E-12	
$II_{inh\text{-}rad}$=	2.88E-03	
Radionuclide Intake $^{239/240}$Pu =	1.62E-04	

Absorbed Dose Calculation

Absorbed Dose = [A_s*ED*EF*(1-S_e)*T_e]

Outdoor Worker

A_s =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	5.07E-01	d/d
ED =	25	yr
S_e =	0.2	
T_e	3.33E-01	hr/hr
EI =	3.38E+00	yr
Absorbed Dose $^{239/240}$Pu =	1.90E-01	

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Attachment D2.2. Future Excavation Worker Scenario Risk Calculations

Risk Calculation for Outdoor Worker

						Cancer Toxicity (SF)				SWMU 3 Ditch										
COPC	Ingestion Intake (II_{ing}) without Cs	ABS	Dermal Intake (DI) w/o ABS & Cs	Inhalation Intake (II_{inh}) without Cs	External exposure Intake (EI) w/o Cs	Ingestion	Dermal	Inhalation	External Exposure	EPC (C)	Ingestion Intake Risk	Dermal Intake Risk	Inhalation Intake Risk	External Exposure Risk	IngestionELCR	Dermal ELCR	Inhalation ELCR	External Exposure	Chemical ELCR	% Contribution
Inorganic Chemicals (Metals)																				
Antimony	1.24E-06	5.00E-02	1.11E-05	1.61E-12	NA	NA	NA	NA	NA	1.57E+01	1.95E-05	8.73E-06	2.53E-11	NA	NA	NA	NA	NA	0.00E+00	0.0%
Radionuclides																				
Cesium-137	2.22E+03	NA	NA	2.88E-03	3.38.E+00	4.33E-11	NA	1.19E-11	2.55E-06	4.56E-01	1.01E+03	NA	1.31E-03	1.54E+00	4.38E-08	NA	1.56E-14	3.93E-06	3.97E-06	42.6%
Uranium-238	2.22E+03	NA	NA	2.88E-03	3.38.E+00	2.10E-10	NA	9.35E-09	1.14E-07	6.29E+00	1.40E+04	NA	1.81E-02	2.13E+01	2.93E-06	NA	1.69E-10	2.42E-06	5.36E-06	57.4%
														Cumulative Values:	2.98E-06	0.00E+00	1.69E-10	6.35E-06	**9.33E-06**	**100.0%**
														% Contribution:	31.9%	0.0%	0.0%	68.1%	100.0%	

Ingestion Calculation

Chemical Intake [mg/(kg x day)] = [C*CF*EF*FI*ED*IR/(BW*AT)]
Radionuclide Intake (pCi) = [A*CF_{rad}*EF*ED*IR*FI]

Outdoor Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
CF =	1.00E-06	kg/mg
EF =	185	d/yr
FI =	1	
ED =	25	yr
IR =	480	mg/d
BW =	70	kg
ATc = 70 x 365 =	25550	yr-day/yr
CF_{rad} =	1.00E-03	g/mg
$II_{ing\text{-}chemical}$ =	1.24E-06	
$II_{ing\text{-}rad}$ =	2.22E+03	
Radionuclide Intake $^{239/240}$Pu =	1.25E+02	

Dermal Contact Calculation

Absorbed Dose [mg/(kg x day)] = [C*CF_d*SA*AF*ABS*EF*ED/(BW*AT)]

Outdoor Worker

C =	1.57E+01	mg/kg as Antimony
CF_d =	1.00E-02	kg-cm^2/mg-m^2
SA =	0.43	m^2/d
AF =	1	mg/cm^2
ABS =	5.00E-02	for Antimony
EF =	185	d/yr
ED =	25	yr
BW =	70	kg
ATc = 70 x 365 =	25550	yr-day/yr
DI w/o Cs & ABS =	1.11E-05	
Absorbed Dose Antimony =	8.73E-06	

Inhalation Calculation

Chemical Intake [mg/(kg x day)] = [C*EF*ED*ET*(1/VF+1/PEF)*IR_{air}] / (BW * AT)
Radionuclide Intake (pCi) = [A*EF*ED*ET*CF*(1/VF+1/PEF)*IR_{air}]

Outdoor Worker

A =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	185	d/yr
ED =	25	yr
ET =	8	hr/d
VF_{TCE}=	3.45E+03	m^3/kg
PEF =	3.21E+10	m^3/kg
IR_{air} =	2.5	m^3/hr
BW =	70	kg
AT =	25550	yr-day/yr
CF =	1.00E+03	g/kg
$II_{inh\text{-}TCE}$ =	1.50E-05	
$II_{inh\text{-}metals}$ =	1.61E-12	
$II_{inh\text{-}rad}$=	2.88E-03	
Radionuclide Intake $^{239/240}$Pu =	1.62E-04	

Absorbed Dose Calculation

Absorbed Dose = [A_s*ED*EF*(1-S_e)*T_e]

Outdoor Worker

A_s =	5.62E-02	pCi/g $^{239/240}$Pu
EF =	5.07E-01	d/d
ED =	25	yr
S_e =	0.2	
T_e	3.33E-01	hr/hr
EI =	3.38E+00	yr
Absorbed Dose $^{239/240}$Pu =	1.90E-01	

APPENDIX E

COST ESTIMATES

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COST ESTIMATES

This appendix contains cost estimates for the remedial alternatives for SWMUs 2, 3, 7, and 30 presented in this document. This appendix includes the following components:

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SWMU 2 COST ESTIMATES

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SWMU 2 Remedial Alternatives Cost Estimate Summary

				PRESENT WORTH [1]		ESCALATED	
Alternative	Description	Annual Time Period, yrs	Capital $ (2012 Constant Dollars)	Total Annual $	Total $ (Capital & Annual)	Total Annual $	Total $ (Capital & Annual)
Alt 1	No Action	30	$0	$0	$0	$0	$0
Alt 2	Limited Action: LUCs, Monitoring	30	$1,968,000	$1,333,000	$3,301,000	$2,820,996	$4,788,996
Alt 4.c.t1	Subtitle C Cap, ERH, LUCs, Monitoring	30	$20,862,000	$1,333,000	$22,195,000	$2,820,996	$23,682,996
Alt 4.c.t2	Subtitle C Cap, DPE, LUCs, Monitoring	30	$7,549,000	$9,460,000	$17,009,000	$21,029,136	$28,578,136
Alt 4.c.t3	Subtitle C Cap, ZVI, LUCs, Monitoring	30	$28,552,000	$1,333,000	$29,885,000	$2,820,996	$31,372,996
Alt 4.c.t4	Subtitle C Cap, Bio, LUCs, Monitoring	30	$7,949,000	$1,333,000	$9,282,000	$2,820,996	$10,769,996
Alt 5.CR	Excavation and Disposal, w/ Contingent Remedy	30	$179,233,000	$0	$179,233,000	$0	$179,233,000
Alt 5.CR.WDF	Excavation and Disposal, WDF, w/ Contingent Remedy	30	$172,609,000	$0	$172,609,000	$0	$172,609,000
Alt 6.c.CR	Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring, w/ Contingent Remedy	30	$37,774,000	$1,333,000	$39,107,000	$2,820,996	$40,594,996
Alt 7.c.t2.CR	Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, Monitoring, w/ Contingent Remedy	30	$40,506,000	$9,460,000	$49,966,000	$21,029,136	$61,535,136

Notes:
(1) Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 2 - Limited Action: Land use controls, monitoring

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		Approximate SWMU Surface Area	32,000	sf	Engr Est
		Recommended Buffer	5	feet	Engr Est
		SWMU Length	200	feet	Calc
		SWMU Normalized Width	160	feet	Calc
		SWMU Width plus Buffer (Cap)	210	feet	Calc
		SWMU Length plus Buffer (Cap)	200	feet	Calc
		Perimeter of Cap	820	feet	Calc
		Area of the Cap	42,000	sf	Calc
		Conversion	43,560	sf/acre	Calc
		Area of the Cap	0.96	acre	Calc

References:

Lindeburg, 1990, Engineering Unit Conversions

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COST ESTIMATE
BGOU SWMU 2
Alternative 2 - Limited Action: LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Cost									
1.0 Project Plans	1	ls	$726,000	$726,000					
2.0 Engineering Design	1	ls	$69,000	$69,000					
3.0 Work Package Prep./Readiness Review	1	ls	$29,000	$29,000					
4.0 Training	1	ls	$78,000	$78,000					
5.0 Well Installation	1	ls	$344,000	$344,000					
6.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$367,750	$368,000					Management = 10% (engineers estimate)
Fee	1	ls	$128,730	$129,000					Fee = 7%
			SUBTOTAL CAPITAL COST	**$1,968,000**					
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	LS	$28,000	$840,000					
Quarterly Groundwater LTM (Years 1 - 2)	2	LS	$93,000	$186,000					
Annual Groundwater LTM (Years 3 - 5)	3	LS	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	LS	$16,000	$400,000					
Five-Year Review Year 5	1	LS	$50,000	$50,000					
Five-Year Review Year 10	1	LS	$50,000	$50,000					
Five-Year Review Year 15	1	LS	$50,000	$50,000					
Five-Year Review Year 20	1	LS	$50,000	$50,000					
Five-Year Review Year 25	1	LS	$50,000	$50,000					
Five-Year Review Year 30	1	LS	$50,000	$50,000					
			SUBTOTAL ANNUAL COST	**$1,810,000**					
			TOTAL	**$3,778,000**					
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$1,968,000	$1,968,000				**$1,968,000**	
Annual Cover Maintenance (Years 1 - 30)	30	LS	$28,000	$840,000				**$601,986**	2.3% discount rate
Quarterly Groundwater LTM (Years 1 - 2)	2	LS	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	3	LS	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	LS	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	LS	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	LS	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	LS	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	LS	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	LS	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	LS	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital	**$1,968,000**	
						Present	**Annual**	**$1,333,000**	
						Worth	**Avg. Annual**	**$44,433**	
						Values	**Total**	**$3,301,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									

1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$211,000	$211,000					Engr Est.
Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$726,000**			**$0**	**$726,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$14,000	$14,000					Engr Est.
Design	1	LS	$55,062	$55,062					Engr Est.
TASK TOTAL				**$69,062**			**$0**	**$69,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$10,819	$10,819					Engr Est.
Training	1	LS	$847	$847					Engr Est.
USD/USQD	1	LS	$3,104	$3,104					Engr Est.
Lessons Learned	1	LS	$260	$260					Engr Est.
Procedures	1	LS	$1,445	$1,445					Engr Est.
AHA	1	LS	$846	$846					Engr Est.
Work Authorization	1	LS	$475	$475					Engr Est.
Excavation/Penetration Permits	1	LS	$2,185	$2,185					Engr Est.
Team Meeting Documentation	1	LS	$333	$333					Engr Est.
Emergency Response Plan	1	LS	$4,890	$4,890					Engr Est.
Transportation Plan	1	LS	$2,510	$2,510					Engr Est.
Project Org. Chart	1	LS	$950	$950					Engr Est.
TASK TOTALS				**$28,664**			**$0**	**$29,000**	
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. 100% Q-cleared local work crew.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	8	person	$800	$6,400					Includes cost of trainer and training module development.
Subcontractors	1	LS	$10,000	$10,000					Engr Est.
TASK TOTALS				**$16,400**			**$62,026**	**$78,000**	
5.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.

Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	**0**		**$194,029**	**$344,000**	
6.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$1,471,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					160		$10,560		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	1	acre	$400	$400					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$16,700**	**160**		**$10,560**	**$28,000**	ANNUAL COST

Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,300	$1,300					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,030	$46,642					
TASK TOTAL								**$93,000**	ANNUAL COST

Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 2
Alt 2
Limited Action: LUCs, Monitoring
Escalated Costs

Date	Yr	escalation	escalation factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012		1	1.000	$1,968,000						
2013	1	1.029	1.029		$28,812	$95,697				
2014	2	1.029	1.059		$29,648	$98,472				$128,120
2015	3	1.029	1.090		$30,507		$30,507			$61,015
2016	4	1.029	1.121		$31,392		$31,392			$62,784
2017	5	1.029	1.154		$32,302		$32,302		$57,683	$122,288
2018	6	1.029	1.187		$33,239			$37,988		$71,227
2019	7	1.029	1.222		$34,203					$34,203
2020	8	1.029	1.257		$35,195	$0		$40,223		$75,418
2021	9	1.029	1.293		$36,216	$0				$36,216
2022	10	1.029	1.331		$37,266	$0		$42,590	$66,546	$146,402
2023	11	1.029	1.370		$38,347	$0				$38,347
2024	12	1.029	1.409		$39,459	$0		$45,096		$84,554
2025	13	1.029	1.450		$40,603		$0			$40,603
2026	14	1.029	1.492		$41,780		$0	$47,749		$89,530
2027	15	1.029	1.535		$42,992		$0		$76,772	$119,764
2028	16	1.029	1.580		$44,239		$0	$50,559		$94,798
2029	17	1.029	1.626		$45,522		$0			$45,522
2030	18	1.029	1.673		$46,842		$0	$53,534		$100,376
2031	19	1.029	1.721		$48,200		$0			$48,200
2032	20	1.029	1.771		$49,598		$0	$56,684	$88,568	$194,850
2033	21	1.029	1.823		$51,037		$0			$51,037
2034	22	1.029	1.876		$52,517		$0	$60,019		$112,535
2035	23	1.029	1.930		$54,040		$0			$54,040
2036	24	1.029	1.986		$55,607		$0	$63,551		$119,157
2037	25	1.029	2.044		$57,219		$0		$102,177	$159,397
2038	26	1.029	2.103		$58,879		$0	$67,290		$126,169
2039	27	1.029	2.164		$60,586		$0			$60,586
2040	28	1.029	2.227		$62,343		$0	$71,249		$133,592
2041	29	1.029	2.291		$64,151		$0			$64,151
2042	30	1.029	2.358		$66,011		$0	$37,721	$117,878	$221,610
TOTAL				$1,968,000	$1,348,751	$194,169	$94,202	$674,250	$509,624	$4,788,996

BGOU SWMU 2
Alt 2
Limited Action: LUCs, Monitoring

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$1,968,000	$0	$0	$0	$0	$0	$1,968,000
2013	1	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2014	2	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2015	3	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2016	4	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2017	5	1	1.00	$0	$28,000	$0	$28,000	$0	$50,000	$106,000
2018	6	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2019	7	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2020	8	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2021	9	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2022	10	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2023	11	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2024	12	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2025	13	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2026	14	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2027	15	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2028	16	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2029	17	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2030	18	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2031	19	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2032	20	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2033	21	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2034	22	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2035	23	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2036	24	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2037	25	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2038	26	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2039	27	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2040	28	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2041	29	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2042	30	1	1.00	$0	$28,000	$0	$0	$16,000	$50,000	$94,000
TOTAL				$1,968,000	$840,000	$186,000	$84,000	$400,000	$300,000	$3,778,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 4s

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		Approximate SWMU Surface Area	32,000	sf	Engr Est
		Recommended Buffer	5	feet	Engr Est
		SWMU Length	200	feet	Calc
		SWMU Normalized Width	160	feet	Calc
		SWMU Width plus Buffer (Cap)	210	feet	Calc
		SWMU Length plus Buffer (Cap)	200	feet	Calc
		Perimeter of Cap	820	feet	Calc
		Area of the Cap	42,000	sf	Calc
		Conversion	43,560	sf/acre	Calc
		Area of the Cap	0.96	acre	Calc
	Groundwater Sumps				
		Assumed separation between perimeter sumps	100	ft	
		No. of perimeter sumps	8	sumps	
		Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
		Perimeter of Cap	11,304	sf/sump	calc
		No. of Sumps required for dewatering under Cap	4	sumps	calc
	Groundwater Pore Volume				
		Cap Area	42,000	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	588,000	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume beneath Cap	117,600	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume beneath Cap	880,000	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est
		Time to remove one pore volume	489	hours	calc
		Time to remove one pore volume	20	days	Calc
		Flowrate after removal of one pore volume	7	gpm	SWMU 2 IROD
		GW Rate after one pore volume removed	302,400	gal/month	Engr Est.
		GW Rate after one pore volume removed	3,628,800	gal/yr	Engr Est.
Electrical Requirements					
		Sump Pump Power Reqm	2	Hp	ww.grundfos.com, MPX-75
		Air Stripper Water Pump	2	Hp	Engr Est.
		Vapor Phase Carbon Blower	2	Hp	Engr Est.
		Air Stripper Blower	2	Hp	Engr Est.
		Effluent Pump	2	Hp	Engr Est.
		No. of Pumps/Blowers	9	pumps	Engr Est.
		Pump/Blower Horsepower	18	Hp	calc
		Conversion	0.7457	KW/Hp	Lindeburg, 1990
		Total Power Reqm.	13	KW	calc
		Annual Operation Time	8,760	hrs	calc
		Annual Power Consumption	200,000	KW-hrs/yr	calc
		Electricity Cost	0.050	$/KW-hrs	www.eia.doe.gov

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 4s

Parameter			Total	Units	Basis
Off Gas Operation					
		Assumed Air Stripper off gas flow rate	150	cfm	NEEP Systems
		Maximum Annual Offgas Processing, continuous operation	79,000,000	cf/yr	calc
Air Stripper Operation					
		Assumed Flowrate	8	gpm	SWMU 2 IROD
		Maximum Annual Flowrate	4,000,000	gal/yr	calc
t1 Calculations (Electrical Resistance Heating)					
SWMU Area					
		Source Treatment Width	20	feet	Engr Est.
		Source Treatment Length	60	feet	Engr. Est
		Source Treatment Area	1,200	sf	calc
Volume of Waste Requiring Treatment					
		Depth of Waste Requiring Treatment	39	feet	Engr Est.
		Conversion	27	cf/cy	Lindeburg, 1990
		Source Treatment Volume	1,733	bcy	calc
Single ERH Cell Makeup					
		Electrodes	6	electrodes/cell	FRTR, 2009
		Neutral	1	neutral/cell	Morgenstern, 2007
		Soil Venting Wells	6	wells/cell	Co-located with electrodes; Morgenstern, 2007
		Peizometers	4	wells/cell	Engr Est.
Electrical Resistance Heating Specifics					
		Assumed Diameter of Influence	40	ft	FRTR, 2009
		Assumed Area of Influence	1,256	sf	calc
		Total No. of Cells reqd for trmt	1	cells	calc
Total ERH Cell Specifics					
		Electrodes	6	electrodes	calc
		Neutral	1	neutral	calc
		Soil Venting Wells	6	SVE wells	Calc, Co-located with electrodes
		Peizometers	4	wells	Engr Est.
Soil Venting System, assuming standard temp and pressure					
		Approx. Carbon Vessels needed	1.00	vessels	calc
Groundwater Containment					
		Approximate Rate of Capture	7.90	gpm	DOE, 1995, pg 17
		Fraction of time pumping occurs after removal of initial pore vol	1.00	fraction	Engr Est
		GW Rate after one pore volume removed	340,000	gal/month	calc
		Est. ERH operation period	6	months	Engr Est
		Est. Volume of groundwater production	2,040,000	gallons	calc
Power Consumption					
		Soil Venting System Capacity	100	cfm	Engr Est
		Estimated No. of Systems	1	SVE Systems	Engr Est
		SVE Motor Size	8	Hp	Engr Est
		SVE Power Reqm	5	Hp	Engr Est
		Conversion	0.7457	KW/Hp	Lindeburg, 1990
		SVE Power Reqm	3	KW	calc
		Conversion	1,000	KW/M-KW	Lindeburg, 1990
		SVE Power Reqm	0.003	M-KW	calc
		SVE Power Consumption	1,000	M-KW-hr	calc
		Assumed Power Consumption per Electrode	3,000	M-KW-hr	Engr Est
		Total Consumption of Combined ERH Systems	3,000	M-KW-hr	calc
		Price of Electricity	0.05	$/KW-hr	www.eia.doe.gov

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 4s

Parameter			Total	Units	Basis
		Price of Electricity	50	$/M-KW-hr	www.eia.doe.gov

Calculations for t3 (Chemical Injection of a reductant)					
Well Installation (w/o excavation)					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	60	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	29,452	cf	calc
		weight of soil per well	3,092,505		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	61,850	lbs	calc
Well Installation (post excavation)					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	40	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	19,635	cf	calc
		weight of soil per well	2,061,670		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	41,233	lbs	calc

t4 Calculations (*In Situ* Enhanced Biological Treatment)					
SWMU Area					
		Source Treatment Width	75	feet	Engr Est.
		Source Treatment Length	75	feet	Engr. Est
		Source Treatment Area	5,625	sf	calc
Well Installation					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		# of wells (including 10% coverage adj.)	13	ea	Engr. Est
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	300	feet	
		Area	12,000	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	300	tons	calc
Volume of Waste Requiring Treatment					
		Depth of Waste Requiring Treatment	39	feet	Engr Est.
		Conversion	27	cf/cy	Lindeburg, 1990
		Source Treatment Volume	8,125	bcy	calc

References:

Lindeburg, 1990, Engineering Unit Conversions

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t1 - Subtitle C Cap, ERH, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,213,000	$1,213,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$53,000	$53,000					
4.0 Training	1	ls	$95,000	$95,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$222,000	$222,000					
7.0 ERH System Installation and Operation	1	ls	$9,866,000	$9,866,000					
8.0 Install Subtitle C cover	1	ls	$1,157,000	$1,157,000					
9.0 Monitoring Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$80,000	$80,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$2,708,000	$2,708,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,137,360	$1,137,000					fee = 7%.
Contingency	1	ls	$3,477,000	$3,477,000					20% contingency
		SUBTOTAL CAPITAL COST		**$20,862,000**					
Construction Schedule	**14.5**	**Months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000					
Quarterly Groundwater LTM (Years 1 - 2)	2	EA	$93,000	$186,000					
Annual Groundwater LTM (Years 3 - 5)	3	EA	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	EA	$16,000	$400,000					
Five-Year Review Year 5	1	LS	$50,000	$50,000					
Five-Year Review Year 10	1	LS	$50,000	$50,000					
Five-Year Review Year 15	1	LS	$50,000	$50,000					
Five-Year Review Year 20	1	LS	$50,000	$50,000					
Five-Year Review Year 25	1	LS	$50,000	$50,000					
Five-Year Review Year 30	1	LS	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$1,810,000**					
			TOTAL	**$22,672,000**					

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t1 - Subtitle C Cap, ERH, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$20,862,000	$20,862,000				**$20,862,000**	
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000				**$601,986**	2.3% discount rate
Quarterly Groundwater LTM (Years 1 - 2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital Costs	**$20,862,000**	
						Present Worth Values	**Annual**	**$1,333,000**	
							Avg. Annual	**$44,433**	
							Total	**$22,195,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,213,000**			0	**$1,213,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			0	**$105,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t1 - Subtitle C Cap, ERH, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$35,000	$35,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS				**$ 52,845**			**0**	**$53,000**	Engr Est.
4.0 Training									
Labor									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	16	person	$800	$12,800					Includes cost of trainer and training module development.
Subcontractors	1	LS	$20,000	$20,000					Engr Est.
TASK TOTALS				**$32,800**	**1,040**		**$62,026**	**$95,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 69,356**			**$153,015**	**$222,000**	
7.0 ERH System Installation and Operation									
Duration: Nine months total duration -installation will take approximately three months and operation will be for six months.									
Assumptions: Installation generated waste accepted by onsite Ulandfill and Industrial Waste Water Treatment Plant.									
Treatment of three 20' x 20' by 39' deep areas.									
Used 10 hour work-day; 22 work-days per month.									
Labor									
LATA Labor					14355		$731,610		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	1980	hr	$31	$61,380					Based on LATA Radcon allocation
Health & Safety Equipment									
Level D Modified PPE	2900	man-day	$4	$10,150					Engr Est

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Unit Pricing									
ERH Treatment	1,733	bcy	$350	$607,000					C-400
Infrastructure Removal	1	ls	$100,000	$100,000					Engr Est
Asphalt Cover	1	ls	$50,000	$50,000					C-400
Soil Venting System w/ Air Treatment	1,733	bcy	$722	$1,251,000					www.frtr.gov
Air Phase Carbon Replacement	1	vessel	$7,250	$7,250					www.tigg.com, 1,000 lb of carbon per vessel delivered
Power Installation	1	ls	$750,000	$750,000					C-400
Power Consumption	3,000	M-Kw-hr	$50	$150,000					www.eia.doe.gov, $0.05/KW-hr
Groundwater Trmt and Disposal	2,040,000	gal	$3	$6,120,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Fence, 8', barbed wire	540	lf	$35	$18,900					(3) 45' x 45' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	6	ea	$1,475	$8,850					RSMeans 0280-528-5070
TASK TOTAL				**$9,134,530**	**14355**		**$731,610**	**$9,866,000**	
8.0 Install Subtitle C cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of RCRA cap over the SWMU,									
Used 10 hour work-day; 22 work-days per month.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$459,045		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	42,000	sf							
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Two Portable Toilet	3	month	$300	$900					Engr Est.
TASK TOTAL				**$697,698**			**$459,045**	**$1,157,000**	
9.0 Monitoring Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
10.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	63	MSF	$50	$3,150					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,878**			**$70,785**	**$80,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$13,540,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					160		$10,560		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	1	acre	$400	$400					Engr Est, $100/acre, 4 times per year
Reporting									
Annual Report	1	ls	$10,000	$10,000					Engr Est., LATA Labor Rates
TASK TOTAL				**$16,700**	**160**		**$10,560**	**$28,000**	ANNUAL COST

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
				$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST

COST ESTIMATE
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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 2
Alt 4.c.t1
Subtitle C Cap, ERH, LUCs, Monitoring
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	20,862,000						20,862,000
2013	1	1.029	1.03		28,812	95,697				124,509
2014	2	1.029	1.06		29,648	98,472				128,120
2015	3	1.029	1.09		30,507		30,507			61,015
2016	4	1.029	1.12		31,392		31,392			62,784
2017	5	1.029	1.15		32,302		32,302		57,683	122,288
2018	6	1.029	1.19		33,239			37,988		71,227
2019	7	1.029	1.22		34,203					34,203
2020	8	1.029	1.26		35,195			40,223		75,418
2021	9	1.029	1.29		36,216					36,216
2022	10	1.029	1.33		37,266			42,590	66,546	146,402
2023	11	1.029	1.37		38,347					38,347
2024	12	1.029	1.41		39,459			45,096		84,554
2025	13	1.029	1.45		40,603					40,603
2026	14	1.029	1.49		41,780			47,749		89,530
2027	15	1.029	1.54		42,992				76,772	119,764
2028	16	1.029	1.58		44,239			50,559		94,798
2029	17	1.029	1.63		45,522					45,522
2030	18	1.029	1.67		46,842			53,534		100,376
2031	19	1.029	1.72		48,200					48,200
2032	20	1.029	1.77		49,598			56,684	88,568	194,850
2033	21	1.029	1.82		51,037					51,037
2034	22	1.029	1.88		52,517			60,019		112,535
2035	23	1.029	1.93		54,040					54,040
2036	24	1.029	1.99		55,607			63,551		119,157
2037	25	1.029	2.04		57,219				102,177	159,397
2038	26	1.029	2.10		58,879			67,290		126,169
2039	27	1.029	2.16		60,586					60,586
2040	28	1.029	2.23		62,343			71,249		133,592
2041	29	1.029	2.29		64,151					64,151
2042	30	1.029	2.36		66,011			37,721	117,878	221,610
TOTAL				$20,862,000	$1,348,751	$194,169	$94,202	$674,250	$509,624	$23,683,000

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Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$20,862,000	$0	$0	$0	$0	$0	$20,862,000
2013	1	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2014	2	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2015	3	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2016	4	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2017	5	1	1.00	$0	$28,000	$0	$28,000	$0	$50,000	$106,000
2018	6	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2019	7	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2020	8	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2021	9	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2022	10	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2023	11	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2024	12	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2025	13	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2026	14	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2027	15	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2028	16	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2029	17	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2030	18	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2031	19	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2032	20	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2033	21	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2034	22	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2035	23	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2036	24	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2037	25	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2038	26	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2039	27	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2040	28	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2041	29	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2042	30	1	1.00	$0	$28,000	$0	$0	$16,000	$50,000	$94,000
TOTAL				$20,862,000	$840,000	$186,000	$84,000	$400,000	$300,000	$22,672,000

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,213,000	$1,213,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$58,000	$58,000					
4.0 Training	1	ls	$105,000	$105,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$222,000	$222,000					
7.0 Subtitle C cover & DPE installation	1	ls	$2,930,000	$2,930,000					
8.0 Monitoring Well Installation	1	ls	$344,000	$344,000					
9.0 Baseline Sampling	1	ls	$182,000	$182,000					
10.0 Site Restoration	1	ls	$80,000	$80,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,411,000	$1,411,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$493,850	$494,000					Fee = 7%
		SUBTOTAL CAPITAL COST		**$7,549,000**					
Construction Schedule	**12**	**Months**							
Annual Cost									
Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	30	EA	$406,000	$12,180,000					
Quarterly Groundwater LTM (Years 1 - 2)	2	EA	$93,000	$186,000					
Annual Groundwater LTM (Years 3 - 5)	3	EA	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	EA	$16,000	$400,000					
Five-Year Review Year 5	1	LS	$50,000	$50,000					
Five-Year Review Year 10	1	LS	$50,000	$50,000					
Five-Year Review Year 15	1	LS	$50,000	$50,000					
Five-Year Review Year 20	1	LS	$50,000	$50,000					
Five-Year Review Year 25	1	LS	$50,000	$50,000					
Five-Year Review Year 30	1	LS	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$13,150,000**					
			TOTAL	**$20,699,000**					

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$7,549,000	$7,549,000				**$7,549,000**	
Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	30	EA	$406,000	$12,180,000				**$8,728,798**	2.3% discount rate
Quarterly Groundwater LTM (Years 1 - 2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital Costs	**$7,549,000**	
						Present Worth Values	**Annual**	**$9,460,000**	
							Avg. Annual	**$315,333**	
							Total	**$17,009,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,213,000**			0	**$1,213,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					20% of Construction Costs
TASK TOTAL				**$105,000**			0	**$105,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS				**$ 57,845**			**0**	**$58,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	16	person	$800	$12,800					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$42,800**	**1,040**		**$62,026**	**$105,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2,310.00		$153,015.00		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220.00	hr	31.00	6,820.00					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2.00	month	1,300.00	2,600.00					Hertz
Front End Loader	1.00	Month	4,150.00	4,150.00					Engr Est.
Dozer	1.00	Month	2,800.00	2,800.00					Engr Est.
Water Truck, 2000 gal	1.00	Month	1,850.00	1,850.00					Engr Est.
Compactor/12 ton/pad foot	1.00	Month	3,090.00	3,090.00					Engr Est.
Compactor/12 ton/smooth drum	1.00	Month	2,920.00	2,920.00					Engr Est.
Generator, 150 KW	1.00	Month	2,006.00	2,006.00					Engr Est.
Supply Trailer	1.00	Month	448.00	448.00					Engr Est.
TASK TOTALS				**$26,684**	**0**		**$153,015**	**$180,000**	

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 69,356**			**$153,015**	**$222,000**	
7.0 Subtitle C cover & DPE installation									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of 1) sumps through the cap, 2) RCRA cap over the SWMU,									
3) groundwater treatment system, and 4) offgas treatment.									
Each sump will be outfitted with pumps and controls.									
Piping will be buried in the cap. Collected groundwater (~8 gpm max) will be transferred									
to a groundwater treatment system consisting of filtration, air stripping, ion exchange, and liquid phase carbon.									
The air stripper off gas will be treated through vapor phase carbon before release to atmosphere.									
Treated water will be direct discharged. Used 10 hour work-day; 22 work-days per month.									
Schedule	**8**	**Month**							
Labor									
LATA Labor					18480		$1,224,120		Engr Est., LATA Labor Rate

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BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Unit Pricing									
Cap Construction	42,000	sf							www.frtr.gov
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Groundwater Pumps & Controls	4	ea	$6,000	$24,000					Grundfos
Equipment Building	400	sf	$100	$40,000					RS Means 33 43 0101
Oil/Water Separator	1	ea	$15,000	$15,000					RSMeans 19 04 0411
Low Profile Air Stripper	1	ea	$50,000	$50,000					www.frtr.gov. Assume 20 gpm, 5 tray, 150 cfm.
Vapor Recovery System	1	ea	$6,000	$6,000					160 cfm, RSMeans 33 13 2304
Vapor Phase Carbon	2	ls	$7,500	$15,000					Tigg, 1000 lbs, virgin coconut, delivered
Ion Exchange	1	ls	$80,000	$80,000					Remco Engineering
Liquid Phase Carbon	10	vessel	$5,000	$50,000					www.tigg.com, 850 lb of carbon per vessel
Discharge Pump	1	ea	$1,000	$1,000					RSMeans 33 29 0102
Miscellaneous Equipment	1	ls	$50,000	$50,000					Engr Est
Power Consumption	33,333	Kw-hr	$0.05	$1,667					www.eia.doe.gov, $0.05/KW-hr
Subcontractors									
Sumps	120	lf	$200	$24,000					30 ft deep, 12 inch dia, Sch 80 PVC, RSMeans 33 23 0117
Electrical Tie In	1	ls	$250,000	$250,000					Engr Est.
Electrician	1	ls	$100,000	$100,000					Engr Est.
Extraction Well Installation	4	ea	$16,096	$64,384					4 wells into the UCRS
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Laboratory Analytical									
Off Gas									
TO14	60	sample	$450	$27,000					Assume treated offgas and ground
Shipping	60	ea	$20	$1,200					water effluent samples taken daily
Treated GW Effluent									during startup.
Metals 6010	60	sample	$165	$9,900					
VOA 8260	60	sample	$165	$9,900					
SVOA 8270	60	sample	$352	$21,120					
RAD	60	sample	$1,047	$62,820					
Shipping	60	ls	$100	$6,000					

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BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

		Other Direct Costs			Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Equipment									
Pickup Truck, crew cab, F250	8	month	$1,300	$10,400					Hertz
Pickup Truck, crew cab, F250	8	month	$1,300	$10,400					Hertz
Front End Loader	8	month	$4,150	$33,200					Engr Est.
Dozer	8	month	$2,800	$22,400					Engr Est.
Compactor/12 ton/pad foot	8	month	$3,090	$24,720					Engr Est.
Compactor/12 ton/smooth drum	8	month	$2,920	$23,360					Engr Est.
Water Truck, 2000 gal	8	month	$1,850	$14,800					Engr Est.
Equipment Trailer	8	month	$300	$2,400					Engr Est.
Generator, 15KW	8	month	$2,006	$16,048					Engr Est.
Portable Toilet	8	month	$150	$1,200					Engr Est
TASK TOTAL				**$1,705,569**			**$1,224,120**	**$2,930,000**	
8.0 Monitoring Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	

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BGOU SWMU 2
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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
9.0 Baseline Sampling									
Duration: Assume two hour per sample.									
Assumptions: To be performed simultaneously with system installation.									
Collect soil samples during drilling of sumps and extraction wells; VOA soil sample from sump and extraction well depth interval with greatest PID reading.									
Soil composite sample from sumps every 5 ft depth interval. Collecting groundwater grab samples from sumps and wells after construction and development.									
Labor									
Lata Labor					288		$21,120		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Laboratory Analytical									
Soil									GW samples collected from
Metals 6010	48	sample	$165	$7,920					newly installed sumps and
PCB 8082	48	sample	$209	$10,032					MWs. VOA soil sample
VOA 8260	48	sample	$165	$7,920					collected from sumps and MWs
SVOA 8270	48	sample	$352	$16,896					for interval with highest PID
RAD	48	sample	$1,047	$50,256					reading; composite soil samples
Shipping	1	ls	$1,000	$1,000					collected at 5 ft intervals depth of
Groundwater									the sumps. Eight sumps 35' deep.
Metals 6010	8	sample	$165	$1,320					4 UCRS/RGA nested monitoring
VOA 8260	16	sample	$165	$2,640					well pairs. Analytical rates provided
SVOA 8270	8	sample	$352	$2,816					by LATA.
RAD	8	sample	$1,047	$8,376					
Shipping	1	ls	$1,000	$1,000					
Reporting									
Report of Findings	1	ls	$50,000	$50,000					Engr Est
TASK TOTAL				**$160,826**	**288**		**$21,120**	**$182,000**	
10.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	63	MSF	$50	$3,150					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,878**			**$70,785**	**$80,000**	

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$5,644,000**	
Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)									
Duration: Annual for thirty years.									
Assumptions: Includes O&M for groundwater recovery and treatment, offgas treatment, cap maintenance, and fence maintenance.									
All process waste accepted by onsite U Landfill.									
Assume 10 days per month labor on O&M with no overtime.									
10 hr/work day and 22 workdays/month.									
Labor									
LATA Labor					4320		$244,080		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Air Stripper	400	10000 gal	$20	$8,000					www.frtr.com
Ion Exchange	4,000	1000 gal	$0.50	$2,000					www.frtr.com
Materials									
Liquid Phase GAC	2	vessel	$6,000	$12,000					Tigg, 850 lb delivered
Vapor Phase GAC	2	vessel	$7,250.00	$14,500					Tigg, 1000 lbs, virgin coconut, delivered
Miscellaneous Supplies	1	ls	$10,000	$10,000					Engr Est.
Laboratory Analytical									
Off Gas									
TO14	52	sample	$450	$23,400					Collect weekly treated off-gas
Shipping	12	sample	$100	$1,200					sample and effluent sample
Treated Water									from groundwater treatment
Total Volatiles	12	sample	$165	$1,980					system.
Shipping	12	ls	$100	$1,200					
Subcontractor									
Electrician	1	ls	$10,000	$10,000					Engr Est.
Cap Maintenance	1	ls	$10,000	$10,000					Engr Est.
Site Maintenance	1	ls	$10,000	$10,000					Engr Est.
Reporting									
Annual Report	1	ls	$50,000	$50,000					
TASK TOTAL				**$162,080**			**$244,080**	**$406,000**	

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BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t2 -Subtitle C Cap, DPE, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 2
Alt 4.c.t2
Subtitle C Cap, DPE, LUCs, Monitoring
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$7,549,000						$7,549,000
2013	1	1.029	1.03		$417,774	$95,697				$513,471
2014	2	1.029	1.06		$429,889	$98,472				$528,362
2015	3	1.029	1.09		$442,356		$30,507			$472,864
2016	4	1.029	1.12		$455,185		$31,392			$486,577
2017	5	1.029	1.15		$468,385		$32,302		$57,683	$558,370
2018	6	1.029	1.19		$481,968			$37,988		$519,956
2019	7	1.029	1.22		$495,945					$495,945
2020	8	1.029	1.26		$510,328			$40,223		$550,550
2021	9	1.029	1.29		$525,127					$525,127
2022	10	1.029	1.33		$540,356			$42,590	$66,546	$649,492
2023	11	1.029	1.37		$556,026					$556,026
2024	12	1.029	1.41		$572,151			$45,096		$617,246
2025	13	1.029	1.45		$588,743					$588,743
2026	14	1.029	1.49		$605,817			$47,749		$653,566
2027	15	1.029	1.54		$623,385				$76,772	$700,157
2028	16	1.029	1.58		$641,464			$50,559		$692,022
2029	17	1.029	1.63		$660,066					$660,066
2030	18	1.029	1.67		$679,208			$53,534		$732,742
2031	19	1.029	1.72		$698,905					$698,905
2032	20	1.029	1.77		$719,173			$56,684	$88,568	$864,425
2033	21	1.029	1.82		$740,029					$740,029
2034	22	1.029	1.88		$761,490			$60,019		$821,509
2035	23	1.029	1.93		$783,573					$783,573
2036	24	1.029	1.99		$806,297			$63,551		$869,847
2037	25	1.029	2.04		$829,680				$102,177	$931,857
2038	26	1.029	2.10		$853,740			$67,290		$921,030
2039	27	1.029	2.16		$878,499					$878,499
2040	28	1.029	2.23		$903,975			$71,249		$975,225
2041	29	1.029	2.29		$930,191					$930,191
2042	30	1.029	2.36		$957,166			$37,721	$117,878	$1,112,764
TOTAL				$7,549,000	$19,556,891	$194,169	$94,202	$674,250	$509,624	$28,578,000

BGOU SWMU 2
Alt 4.c.t2
Subtitle C Cap, DPE, LUCs, Monitoring
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	Quarterly GW LTM (Yrs 1 - 5)	Semi-Annual GW LTM (Yrs 6 - 10)	Annual GW LTM (Yrs 11 - 30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$7,549,000	$0	$0	$0	$0	$0	$7,549,000
2013	1	1	1.00	$0	$406,000	$93,000	$0	$0	$0	$499,000
2014	2	1	1.00	$0	$406,000	$93,000	$0	$0	$0	$499,000
2015	3	1	1.00	$0	$406,000	$0	$28,000	$0	$0	$434,000
2016	4	1	1.00	$0	$406,000	$0	$28,000	$0	$0	$434,000
2017	5	1	1.00	$0	$406,000	$0	$28,000	$0	$50,000	$484,000
2018	6	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2019	7	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2020	8	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2021	9	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2022	10	1	1.00	$0	$406,000	$0	$0	$32,000	$50,000	$488,000
2023	11	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2024	12	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2025	13	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2026	14	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2027	15	1	1.00	$0	$406,000	$0	$0	$0	$50,000	$456,000
2028	16	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2029	17	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2030	18	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2031	19	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2032	20	1	1.00	$0	$406,000	$0	$0	$32,000	$50,000	$488,000
2033	21	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2034	22	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2035	23	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2036	24	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2037	25	1	1.00	$0	$406,000	$0	$0	$0	$50,000	$456,000
2038	26	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2039	27	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2040	28	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2041	29	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2042	30	1	1.00	$0	$406,000	$0	$0	$16,000	$50,000	$472,000
TOTAL				$7,549,000	$12,180,000	$186,000	$84,000	$400,000	$300,000	$20,699,000

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,213,000	$1,213,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$58,000	$58,000					
4.0 Training	1	ls	$105,000	$105,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$222,000	$222,000					
7.0 t3. - in situ high pressure chemical injection	1	ls	$14,841,000	$14,841,000					
8.0 Install Subtitle C cover	1	ls	$1,157,000	$1,157,000					
8.0 Monitoring Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$80,000	$80,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$3,706,000	$3,706,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,556,520	$1,557,000					fee = 7%.
Contingency	1	ls	$4,758,600	$4,759,000					20% contingency
			SUBTOTAL CAPITAL COST	**$28,552,000**					
Construction Schedule	**12.5**	**Months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000					
Quarterly Groundwater LTM (Years 1 - 2)	2	EA	$93,000	$186,000					
Annual Groundwater LTM (Years 3 - 5)	3	EA	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	EA	$16,000	$400,000					
Five-Year Review Year 5	1	LS	$50,000	$50,000					
Five-Year Review Year 10	1	LS	$50,000	$50,000					
Five-Year Review Year 15	1	LS	$50,000	$50,000					
Five-Year Review Year 20	1	LS	$50,000	$50,000					
Five-Year Review Year 25	1	LS	$50,000	$50,000					
Five-Year Review Year 30	1	LS	$50,000	$50,000					
			SUBTOTAL ANNUAL COST	**$1,810,000**					
			TOTAL	**$30,362,000**					

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$28,552,000	$28,552,000				**$28,552,000**	
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000				**$601,986**	2.3% discount rate
Quarterly Groundwater LTM (Years 1 - 2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital Costs	**$28,552,000**	
						Present Worth Values	**Annual**	**$1,333,000**	
							Avg. Annual	**$44,433**	
							Total	**$29,885,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,213,000**			0	**$1,213,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			0	**$105,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS				**$ 57,845**			**0**	**$58,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	16	person	$800	$12,800					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$42,800**	**1,040**		**$62,026**	**$105,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015.00		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 69,356**			**$153,015**	**$222,000**	
7.0 t3. - in situ high pressure chemical injection Well Installation									
Duration: seven months.									
Assumes installation of one well per disposal cell to a depth of 60 feet; 56 wells total (one for each cell)									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month. 8 Wells per month									
Cleared, local personnel.									
Schedule	**7**	**month**							
Number of wells	**56**	**ea**							
Labor									
LATA Labor					50050		$2,708,300		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	2200	hr	$31	$68,200					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	7	month	$1,300	$9,100					Hertz
Skid Steer Bobcat	7	month	$800	$5,600					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Injection Well Installation	56	ea	$46,000	$2,576,000					Vendor Quote
Surveyor	1	ls	$15,000	$15,000					Engr Est.

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COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Laboratory Analytical									
Metals 6010	560	sample	$165	$92,400					Analytical rates from LATA. 10 samples collected from 56 wells.
VOA 8260	560	sample	$165	$92,400					
Rad	560	sample	$1,041	$582,960					
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
Injected Reductanct									
Zero Valent Iron (ZVI)	3,463,606	lb	$2.50	$8,659,015					vendor quote
TASK TOTAL				**$12,132,075**			**$2,708,300**	**$14,841,000**	
8.0 Install Subtitle C cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of RCRA cap over the SWMU,									
Used 10 hour work-day; 22 work-days per month.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$459,045		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	42,000	sf							www.frtr.gov
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Hertz
Dozer	3	month	$2,800	$8,400					Hertz
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Hertz
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Hertz
Water Truck, 2000 gal	3	month	$1,850	$5,550					Hertz
Equipment Trailer	3	month	$300	$900					Hertz
Generator, 15KW	3	month	$2,006	$6,018					Hertz
Portable Toilet	3	month	$300	$900					Engr Est
TASK TOTAL				**$697,698**			**$459,045**	**$1,157,000**	
8.0 Monitoring Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	63	MSF	$50	$3,150					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,878**			**$70,785**	**$80,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$18,530,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					160		$10,560		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	1	acre	$400	$400					Engr Est, $100/acre, 4 times per year

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Reporting									
Annual Report	1	ls	$10,000	$10,000					Engr Est., LATA Labor Rates
TASK TOTAL				**$16,700**	**160**		**$10,560**	**$28,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST

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FORWARD

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t3 - Subtitle C Cap, ZVI, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 2
Alt 4.c.t3
Subtitle C Cap, ZVI, LUCs, Monitoring
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	28,552,000						$28,552,000
2013	1	1.029	1.03		28,812	95,697				$124,509
2014	2	1.029	1.06		29,648	98,472				$128,120
2015	3	1.029	1.09		30,507		30,507			$61,015
2016	4	1.029	1.12		31,392		31,392			$62,784
2017	5	1.029	1.15		32,302		32,302		57,683	$122,288
2018	6	1.029	1.19		33,239			37,988		$71,227
2019	7	1.029	1.22		34,203					$34,203
2020	8	1.029	1.26		35,195			40,223		$75,418
2021	9	1.029	1.29		36,216					$36,216
2022	10	1.029	1.33		37,266			42,590	66,546	$146,402
2023	11	1.029	1.37		38,347					$38,347
2024	12	1.029	1.41		39,459			45,096		$84,554
2025	13	1.029	1.45		40,603					$40,603
2026	14	1.029	1.49		41,780			47,749		$89,530
2027	15	1.029	1.54		42,992				76,772	$119,764
2028	16	1.029	1.58		44,239			50,559		$94,798
2029	17	1.029	1.63		45,522					$45,522
2030	18	1.029	1.67		46,842			53,534		$100,376
2031	19	1.029	1.72		48,200					$48,200
2032	20	1.029	1.77		49,598			56,684	88,568	$194,850
2033	21	1.029	1.82		51,037					$51,037
2034	22	1.029	1.88		52,517			60,019		$112,535
2035	23	1.029	1.93		54,040					$54,040
2036	24	1.029	1.99		55,607			63,551		$119,157
2037	25	1.029	2.04		57,219				102,177	$159,397
2038	26	1.029	2.10		58,879			67,290		$126,169
2039	27	1.029	2.16		60,586					$60,586
2040	28	1.029	2.23		62,343			71,249		$133,592
2041	29	1.029	2.29		64,151					$64,151
2042	30	1.029	2.36		66,011			37,721	117,878	$221,610
TOTAL				$28,552,000	$1,348,751	$194,169	$94,202	$674,250	$509,624	$31,373,000

BGOU SWMU 2
Alt 4.c.t3
Subtitle C Cap, ZVI, LUCs, Monitoring
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	28,552,000	0	0	0	0	0	$28,552,000
2013	1	1	1.00	0	28,000	93,000	0	0	0	$121,000
2014	2	1	1.00	0	28,000	93,000	0	0	0	$121,000
2015	3	1	1.00	0	28,000	0	28,000	0	0	$56,000
2016	4	1	1.00	0	28,000	0	28,000	0	0	$56,000
2017	5	1	1.00	0	28,000	0	28,000	0	50,000	$106,000
2018	6	1	1.00	0	28,000	0	0	32,000	0	$60,000
2019	7	1	1.00	0	28,000	0	0	0	0	$28,000
2020	8	1	1.00	0	28,000	0	0	32,000	0	$60,000
2021	9	1	1.00	0	28,000	0	0	0	0	$28,000
2022	10	1	1.00	0	28,000	0	0	32,000	50,000	$110,000
2023	11	1	1.00	0	28,000	0	0	0	0	$28,000
2024	12	1	1.00	0	28,000	0	0	32,000	0	$60,000
2025	13	1	1.00	0	28,000	0	0	0	0	$28,000
2026	14	1	1.00	0	28,000	0	0	32,000	0	$60,000
2027	15	1	1.00	0	28,000	0	0	0	50,000	$78,000
2028	16	1	1.00	0	28,000	0	0	32,000	0	$60,000
2029	17	1	1.00	0	28,000	0	0	0	0	$28,000
2030	18	1	1.00	0	28,000	0	0	32,000	0	$60,000
2031	19	1	1.00	0	28,000	0	0	0	0	$28,000
2032	20	1	1.00	0	28,000	0	0	32,000	50,000	$110,000
2033	21	1	1.00	0	28,000	0	0	0	0	$28,000
2034	22	1	1.00	0	28,000	0	0	32,000	0	$60,000
2035	23	1	1.00	0	28,000	0	0	0	0	$28,000
2036	24	1	1.00	0	28,000	0	0	32,000	0	$60,000
2037	25	1	1.00	0	28,000	0	0	0	50,000	$78,000
2038	26	1	1.00	0	28,000	0	0	32,000	0	$60,000
2039	27	1	1.00	0	28,000	0	0	0	0	$28,000
2040	28	1	1.00	0	28,000	0	0	32,000	0	$60,000
2041	29	1	1.00	0	28,000	0	0	0	0	$28,000
2042	30	1	1.00	0	28,000	0	0	16,000	50,000	$94,000
TOTAL				$28,552,000	$840,000	$186,000	$84,000	$400,000	$300,000	$30,362,000

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,213,000	$1,213,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$57,845	$58,000					
4.0 Training	1	ls	$105,000	$105,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$222,000	$222,000					
7.0 t4. - install enhanced bioremediation system	1	ls	$2,254,000	$2,254,000					
8.0 Install Subtitle C cover	1	ls	$1,157,000	$1,157,000					
9.0 Monitoring Well Installation	1	ls	$344,000	$344,000					
11.0 Site Restoration	1	ls	$80,000	$80,000					
12.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,485,750	$1,486,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$520,030	$520,000					Fee = 7%
		SUBTOTAL CAPITAL COST		**$7,949,000**					
Construction Schedule	**5.5**	**Months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000					
Quarterly Groundwater LTM (Years 1 - 2)	2	EA	$93,000	$186,000					
Annual Groundwater LTM (Years 3 - 5)	3	EA	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	EA	$16,000	$400,000					
Five-Year Review Year 5	1	LS	$50,000	$50,000					
Five-Year Review Year 10	1	LS	$50,000	$50,000					
Five-Year Review Year 15	1	LS	$50,000	$50,000					
Five-Year Review Year 20	1	LS	$50,000	$50,000					
Five-Year Review Year 25	1	LS	$50,000	$50,000					
Five-Year Review Year 30	1	LS	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$1,810,000**					
			TOTAL	**$9,759,000**					

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$7,949,000	$7,949,000				**$7,949,000**	
Annual Cover Maintenance (Years 1 - 30)	30	EA	$28,000	$840,000				**$601,986**	2.3% discount rate
Quarterly Groundwater LTM (Years 1 - 2)	2	EA	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	3	EA	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	EA	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital Costs	**$7,949,000**	
						Present Worth Values	**Annual**	**$1,333,000**	
							Avg. Annual	**$44,433**	
							Total	**$9,282,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,213,000**			**0**	**$1,213,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS				**$ 57,845**			**0**	**$57,845**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	16	person	$800	$12,800					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$42,800**	**1,040**		**$62,026**	**$105,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015.00		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 69,356**			**$153,015**	**$222,000**	
7.0 t4. - install enhanced bioremediation system									
Duration: Assume 4 months for mobilization, setup, well drilling, and injection.									
Assume 2 follow-on injections									
Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Schedule	**4**	**Month**							
Labor									
LATA Labor					9240		$560,000		Engr Est., LATA Labor Rate
Subcontractors									
Temporary decon pad and tear down	1	EA	$50,000	$50,000					Engr Est.
bio reagent	471,500	lb	$1.40	$660,100					Engr Est.
bio reagent (follow on)	22,500	lb	$1.40	$31,500					Engr Est.
bio delivery equipment	1	LS	$47,938.00	$47,938					Engr Est.
Well Mob/Demob	1	ea	$22,699.00	$22,699					Vendor Quote
Installation of 7 injection wells (deep)	7	ea	$46,000	$322,000					Vendor Quote
Well vaults	14	EA	$22,500	$315,000					Vendor Quote
Installation of 7 injection wells (shallow)	7	ea	$16,096	$112,672					Vendor Quote
Radcon Instruments									
RadCon Allocation	480	hr	$31	$14,880					Based on LATA Radcon allocation

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Equipment									
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Front End Loader, 3.5CY	4	month	$4,150	$16,600					
Dozer	4	month	$2,800	$11,200					
Equipment Trailer	4	month	$300	$1,200					
Generator, 150 KW	4	month	$2,006	$8,024					
Two Portable Toilets	4	month	$300	$1,200					
Laboratory Analytical									
Analytical Lab	1	ls	$68,451	$68,451					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
TASK TOTAL				**$1,693,864**	9240		**$560,000**	**$2,254,000**	
8.0 Install Subtitle C cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of RCRA cap over the SWMU,									
Used 10 hour work-day; 22 work-days per month.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$459,045		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	42,000	sf							www.frtr.gov
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Hertz
Dozer	3	month	$2,800	$8,400					Hertz
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Hertz
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Hertz
Water Truck, 2000 gal	3	month	$1,850	$5,550					Hertz
Equipment Trailer	3	month	$300	$900					Hertz
Generator, 15KW	3	month	$2,006	$6,018					Hertz
Portable Toilet	3	month	$300	$900					Engr Est
TASK TOTAL				**$697,698**	**0**		**$459,045**	**$1,157,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
9.0 Monitoring Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
11.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	63	MSF	$50	$3,150					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,878**			**$70,785**	**$80,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
12.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
						SUBTOTAL CAPITAL COST		**$5,943,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					160		$10,560		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	1	acre	$400	$400					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$16,700**	**160**		**$10,560**	**$28,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
				$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 2
Alternative 4.c.t4 - Subtitle C Cap, Bio, LUCs, Monitoring

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
				$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BACK

TABLE OF CONTENTS

FORWARD

BGOU SWMU 2
Alt 4.c.t4
Subtitle C Cap, Bio, LUCs, Monitoring
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$7,949,000						$7,949,000
2013	1	1.029	1.03		$28,812	$95,697				$124,509
2014	2	1.029	1.06		$29,648	$98,472				$128,120
2015	3	1.029	1.09		$30,507		$30,507			$61,015
2016	4	1.029	1.12		$31,392		$31,392			$62,784
2017	5	1.029	1.15		$32,302		$32,302		$57,683	$122,288
2018	6	1.029	1.19		$33,239			$37,988		$71,227
2019	7	1.029	1.22		$34,203					$34,203
2020	8	1.029	1.26		$35,195			$40,223		$75,418
2021	9	1.029	1.29		$36,216					$36,216
2022	10	1.029	1.33		$37,266			$42,590	$66,546	$146,402
2023	11	1.029	1.37		$38,347					$38,347
2024	12	1.029	1.41		$39,459			$45,096		$84,554
2025	13	1.029	1.45		$40,603					$40,603
2026	14	1.029	1.49		$41,780			$47,749		$89,530
2027	15	1.029	1.54		$42,992				$76,772	$119,764
2028	16	1.029	1.58		$44,239			$50,559		$94,798
2029	17	1.029	1.63		$45,522					$45,522
2030	18	1.029	1.67		$46,842			$53,534		$100,376
2031	19	1.029	1.72		$48,200					$48,200
2032	20	1.029	1.77		$49,598			$56,684	$88,568	$194,850
2033	21	1.029	1.82		$51,037					$51,037
2034	22	1.029	1.88		$52,517			$60,019		$112,535
2035	23	1.029	1.93		$54,040					$54,040
2036	24	1.029	1.99		$55,607			$63,551		$119,157
2037	25	1.029	2.04		$57,219				$102,177	$159,397
2038	26	1.029	2.10		$58,879			$67,290		$126,169
2039	27	1.029	2.16		$60,586					$60,586
2040	28	1.029	2.23		$62,343			$71,249		$133,592
2041	29	1.029	2.29		$64,151					$64,151
2042	30	1.029	2.36		$66,011			$37,721	$117,878	$221,610
TOTAL				$0	$1,348,751	$194,169	$94,202	$674,250	$509,624	$10,770,000

BGOU SWMU 2
Alt 4.c.t4
Subtitle C Cap, Bio, LUCs, Monitoring
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$7,949,000	$0	$0	$0	$0	$0	$7,949,000
2013	1	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2014	2	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2015	3	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2016	4	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2017	5	1	1.00	$0	$28,000	$0	$28,000	$0	$50,000	$106,000
2018	6	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2019	7	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2020	8	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2021	9	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2022	10	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2023	11	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2024	12	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2025	13	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2026	14	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2027	15	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2028	16	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2029	17	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2030	18	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2031	19	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2032	20	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2033	21	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2034	22	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2035	23	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2036	24	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2037	25	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2038	26	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2039	27	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2040	28	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2041	29	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2042	30	1	1.00	$0	$28,000	$0	$0	$16,000	$50,000	$94,000
TOTAL				$7,949,000	$840,000	$186,000	$84,000	$400,000	$300,000	$9,759,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
Calculations for Excavation and Disposal (Alternative 5)					
SWMU Dimensions					
		Total Area	32,000	SF	Engr Est.
		Fraction of Area to be Excavated	0.60		Engr Est.
		Area to be Excavated	19,200	SF	Calc
		Targeted Area to be Excavated	1,200	SF	Calc
		New Excavation Area	18,000	SF	Calc
		Average Excavation Depth	14	feet	Engr Est.
Waste Volume Calc					
		Waste Volume	9,333	BCY	calc
		Conversion	1.20	LCY/BCY	LATA Directive
		Excavated Waste Volume	11,200	LCY	calc
		U Landfill WAC Compliant Waste Fraction	0.429		Engr Est.
		Assumed MLLW/TSCA Fraction	0.571		Engr Est.
		MLLW Fraction (no treatment)	0.3997		Engr Est.
		TSCA Fraction	0.1713		Engr Est.
		U Landfill WAC Compliant Waste Volume	4,805	LCY	calc
		MLLW Waste Volume	4,477	LCY	calc
		TSCA Waste Volume	1,919	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est
		LLW Tonnage	6,727	ton	calc
		MLLW Tonnage	6,268	ton	calc
		TSCA Tonnage	2,687	ton	calc
Absorbents for Soil					
		Absorbent Rate	0.54	lb/CF	LATA Directive
		Total Excavated Soils	11,200	LCY	calc
		Total Absorbent needed	163,000	lbs	calc
Excavation Duration					
		Excavation Rate for U Landfill WAC Compliant Waste	4,400	bcy/month/ crew	Engr Est., 200 cy/day/crew, 22 wdays/mo
		Excavation Rate for TSCA & MLLW	2,200	bcy/ month/ crew	Engr Est., 100 cy/day/crew, 22 wdays/mo
		No. of Crews	1	crew	Engr Est.
		Time to Excavate U Landfill WAC Compliant Waste	1	month	calc
		Time to Excavate TSCA & MLLW	3	month	calc
		Total Excavation Time	4	month	calc
		Total Excavation Time	0.3	years	calc
		Work day	10	hrs/wday	Engr Est.
		Work week	5	wdays/wk	Engr Est.
		Work days per year	260	wdays/yr	calc
		Work hours per year	2,600	whour/yr	calc
		Work days per month	22	wdays/mo	calc
Groundwater Dewatering Production					
		Area	19,200	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	268,800	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume within Excavation	53,760	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume within Excavation	400,000	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est
		Time to remove one pore volume	222	hours	calc
		Time to remove one pore volume	9	days	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
		Flowrate after removal of one pore volume	7.9	gpm	DOE, 1995, pg 17
		Fraction of time pumping occurs after removal of initial pore vol	0.20	fraction	Engr Est
		GW Rate after one pore volume removed	70,000	gal/month	calc
		Total Dewatering Volume	680,000	gal	calc
		Rad Sludge produced from Groundwater Trmt	6,800	gal	calc
		Water produced from Groundwater Trmt	673,200	gal	calc
Sludge Production from GW Treatment					
		Assumed Dewatering Rate	7,846	gal/day	calc
		Number of days operating	87	days	calc
		Dewatering total	680,000	gallons	Engr Est
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	6,800	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1991
		Est. Sludge production	30	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	124	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	3	trips	calc
Transportation Boxes, Truck Liner					
	TSCA				
		B25 Box Volume	3.50	CY	Pactec
		B25 boxes required for TSCA	549	B25	calc
	MLLW				
		B25 Box Volume	3.50	CY	Pactec
		B25 boxes required for TSCA	1,280	B25	calc
	U Landfill WAC Compliant Waste				
		Truck Liner	14	CY	Engr Est.
		Trips/Liners required for U Landfill WAC Compliant Waste	343	Liners or trips	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant Waste+ 10 percent QA/QC	18	samples	Engr Est.
		Samples for LLW & MLLW + 10 percent QA/QC	16	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	700	feet	
		Area	28,000	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	600	tons	calc
Drum Volume					
		Drum Volume	7.4	CF	DOE 2007-198
		Drum Volume	0.27	CY	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	11,200	LCY	
		Conversion	1.41	CCY/LCY	US Army, 1994
		Volume of Backfill	15,792	CCY	
		Conversion	1.4	ton/CY	Lindeburg, 1990
		Backfill Tonnage	22,000	ton	
		Backfill Rate	1,500	cy/day	Engr Est.
		Est. Time to Backfill	7	days	calc
		Working days per month	22	days	calc
		Est. Months to Backfill	0.34	months	calc

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter	Total	Units	Basis
Compaction Testing			
Compaction Rate	20,000	SF/test	Engr Est
Compaction Area	19,200	SF	Engr Est.
Lift Thickness	2	feet	Engr Est.
Number of Lifts	7	lifts	calc
Number of Compactions Tests	10	tests	calc
Top Soil			
Area to be Excavated	19,200	sf	Engr Est.
Estimated Disturbed Area Factor	2		Engr Est.
Estimated Disturbed Area	38,400	sf	calc
Top Soil Thickness	0.5	feet	Engr Est.
Conversion	27	CF/CY	
Conversion	1.30	ton/CY	Engr Est.
Top Soil tonnage	1,000	ton	calc
Hydroseeding			
Area	38,400	sf	Engr Est
Area	38	MSF	calc
Trucking to Proposed On-Site Waste Disposal Facility			
Dump Capacity	14	ton	Engr Est
Dump Capacity	10	lcy	Engr Est
Dump Trips for LLW & MLLW	448	trips	calc
Truck Liners	448	liners	calc
PPE LLW Drums			
Drums filled per day with PPE Rad Waste	1	drum/day	Engr Est
No. of drums used during project	87	drums	calc
Drums per Truckload	60	drums/trucklo	Engr Est
Truck Trips	1	trips	calc
Drum Volume	55	gal/drum	Engr Est
Conversion	7.48	gal/cf	Lindeburg, 1990
Conversion	27	cf/cy	Lindeburg, 1990
Total Volume of PPE	24	cy	calc
Calculations for *In Situ* Source Treatment (Electrical Resistance Heating)			
(Alternative 1)			
SWMU Area			
Source Treatment Width	20	feet	Engr Est.
Source Treatment Length	60	feet	Engr. Est
Source Treatment Area	1,200	sf	calc
Volume of Waste Requiring Treatment			
Depth of Waste Requiring Treatment	39	feet	Engr Est.
Conversion	27	cf/cy	Lindeburg, 1990
Source Treatment Volume	1,733	bcy	calc
Single ERH Cell Makeup			
Electrodes	6	electrodes/cell	FRTR, 2009
Neutral	1	neutral/cell	Morgenstern, 2007
Soil Venting Wells	6	wells/cell	Co-located with electrodes; Morgenstern, 2007
Peizometers	4	wells/cell	Engr Est.
Electrical Resistance Heating Specifics			
Assumed Diameter of Influence	40	ft	FRTR, 2009
Assumed Area of Influence	1,256	sf	calc
Total No. of Cells reqd for trmt	1	cells	calc
Total ERH Cell Specifics			
Electrodes	6	electrodes	calc
Neutral	1	neutral	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
		Soil Venting Wells	6	SVE wells	Calc, Co-located with electrodes
		Peizometers	4	wells	Engr Est.
Soil Venting System, assuming standard temp and pressure					
		Assumed Avg Air Flowrate per Well	10	cfm	Engr Est.
		Assumed Avg Influent Conc for VOAs	0.7	mg/L	Engr Est.
		Assumed Treatment Duration	6	month	Engr Est.
		Total System Air Flowrate	60	cfm	calc
		Conversion	28.32	L/cf	Lindeburg, 1990
		Total System Air Flowrate	1,699	L/m	calc
		Carbon Adsorption Vessel Flow Capacity	20,000	cfm	www.tigg.com
		No. of Carbon Vessels Reqd	1	carbon unit	www.tigg.com
		Iodine Number	1,000	mg Iodine/gram carbon	Used to estimate carbon capacity of lower molecular wt compounds absorbing to carbon, www.tigg.com.
		Carbon Wt. per Vessel	1,000	lbs	www.tigg.com
		Conversion	454	gm/lb	Lindeburg, 1990
		Carbon Wt. per Vessel	454,000	gm	calc
		Conversion	1,000	mg/gm	Lindeburg, 1990
		VOA flow rate	1	gm/L	calc
		Total Air Volume through Carbon Vessel	4.466E+08	L	calc
		VOA mass removed during project	3.1709E+08	mg	calc
		Conversion	454,000	mg/lbs	Lindeburg, 1990
		VOA mass removed during project	698	lbs	calc
		Conversion	0.4540	kg/lbs	Lindeburg, 1990
		VOA mass removed during project	317	kg	calc
		VOA mass removed per ERH Cell	698	lbs/cell	calc
		VOA capacity of Carbon Vessel	3.171E+05	gram of carbon	calc
		Conversion	454	gm/lb	Lindeburg, 1990
		Carbon required for Project	698	lbs	calc
		Approx. Carbon Vessels needed	1.00	vessels	calc
Groundwater Containment					
		Approximate Rate of Capture	7.90	gpm	DOE, 1995, pg 17
		Fraction of time pumping occurs after removal of initial pore vol	1.00	fraction	Engr Est
		GW Rate after one pore volume removed	340,000	gal/month	calc
		Est. ERH operation period	6	months	Engr Est
		Est. Volume of groundwater production	2,040,000	gallons	calc
Power Consumption					
		Soil Venting System Capacity	100	cfm	Engr Est
		Estimated No. of Systems	1	SVE Systems	Engr Est
		SVE Motor Size	8	Hp	Engr Est
		SVE Power Reqm	5	Hp	Engr Est
		Conversion	0.7457	KW/Hp	Lindeburg, 1990
		SVE Power Reqm	3	KW	calc
		Conversion	1,000	KW/M-KW	Lindeburg, 1990
		SVE Power Reqm	0.003	M-KW	calc
		SVE Power Consumption	1,000	M-KW-hr	calc
		Assumed Power Consumption per Electrode	3,000	M-KW-hr	Engr Est
		Total Consumption of Combined ERH Systems	3,000	M-KW-hr	calc
		Price of Electricity	0.05	$/KW-hr	www.eia.doe.gov
		Price of Electricity	50	$/M-KW-hr	www.eia.doe.gov

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
Calculations for *In Situ* Source Treatment (Chemical Injection of a reductant)					
(Treatment t.3)					
Well Installation (w/o excavation)					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	60	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	29,452	cf	calc
		weight of soil per well	3,092,505		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	61,850	lbs	calc
Well Installation (post excavation)					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	40	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	19,635	cf	calc
		weight of soil per well	2,061,670		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	41,233	lbs	calc

Calculations for *In Situ* Source Treatment (Enhanced Biological Treatment)					
(Alternative 4)					
SWMU Area					
		Source Treatment Width	75	feet	Engr Est.
		Source Treatment Length	75	feet	Engr. Est
		Source Treatment Area	5,625	sf	calc
Well Installation					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		# of wells (including 10% coverage adj.)	13	ea	Engr. Est
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	300	feet	
		Area	12,000	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	300	tons	calc
Volume of Waste Requiring Treatment					
		Depth of Waste Requiring Treatment	39	feet	Engr Est.
		Conversion	27	cf/cy	Lindeburg, 1990
		Source Treatment Volume	8,125	bcy	calc

References:

DOE, 1995, Record of Decision for Interim Remedial Action at SWMUs 2 & 3 of WAG 22 at PGDP, KY, July.
DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.
DOE, 2010, BGOU Remedial Investigation Report.
FRTR 2009, Federal Remediation Technologies Roundtable (www.frtr.com)
Lindeburg, 1990, Engineering Unit Conversions, 2nd Ed.
Morgenstern, 2007, Electrical Resistance Heating of Soils at C-Reactor at the Savannah River Site, WSRC-STI-2007-00488, Michael R. Morgenstern, et al.
US Army, 1994, Field Manual No. 5-430-00-1, Planning and Design of Roads, Airfields, and Helioports in the Theater of Operations - Road Design. References:

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter	Total	Units	Basis

Assumptions-

Waste hauled to WDF in RO/RO boxes.

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,223,000	$1,223,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$108,000	$108,000					
5.0 Mobilization	1	ls	$245,000	$245,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$333,000	$333,000					
7.0 Excavation	1	ls	$3,893,000	$3,893,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$108,507,000	$108,507,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,344,000	$1,344,000					
10.0 Site Restoration	1	ls	$79,000	$79,000					
11.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$23,265,000	$23,265,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$9,771,300	$9,771,000					fee = 7%.
Contingency	1	ls	$29,872,200	$29,872,000					20% contingency
		SUBTOTAL CAPITAL COST		**$179,233,000**					
Construction Schedule	**8.5**	**Month**							
Annual Cost - Monitoring									
Quarterly Groundwater LTM (Years 1 - 2)	0	ls	$0	$0					
Annual Groundwater LTM (Years 3 - 5)	0	ls	$0	$0					
Biannual Groundwater LTM (Years 6-30)	0	ls	$0	$0					
		SUBTOTAL ANNUAL COST		**$0**					
			TOTAL	**$179,233,000**					
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$179,233,000	$179,233,000				**$179,233,000**	
Quarterly Groundwater LTM (Years 1 - 2)	0	ls	$0	$0				**$0**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	0	ls	$0	$0				**$0**	2.3% discount rate

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (Years 6-30)	0	ls	$0	$0				**$0**	2.3% discount rate
							Capital Costs	**$179,233,000**	
						Present	**Annual**	**$0**	
						Worth	**Avg. Annual**	**$0**	
						Values	**Total**	**$179,233,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$325,000	$325,000					Engr Est.
Remedial Action Work Plan	1	LS	$215,000	$215,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,223,000**			**0**	**$1,223,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS			$77,845	**$77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	20	person	$800	$16,000					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTALS				**$46,000**	**1,040**		**$62,026**	**$108,000**	
5.0 Mobilization									
Duration: Assume month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six workday/month overtime, totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$63,160**			**$181,575**	**$245,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Assume 100% cleared and local workers.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Fence, 8', barbed wire	820	lf	$39	$31,570					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
TASK TOTAL				**$151,430**			**$181,575**	**$333,000**	
7.0 Excavation									
Duration: Approximately 4 months for excavation, staging, and sampling based on excavating MLLW and TSCA waste at 100 bcy/day/crew,									
U Landfill WAC Compliant Waste at 200 bcy/day/crew. Using one crew.									
Assumption: Includes sheet piling the excavation perimeter.									
Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW/TSCA waste containerized into B-25 boxes and loaded on trucks for delivery to treatment facility.									
MLLW containerized in drums and loaded on trucks for delivery to treatment facility.									
U Landfill WAC Compliant Waste is transported from the stockpile to the onsite U Landfill.									
The excavation will require dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**4**	**Month**							
Labor									
LATA Labor					11440		$756,660		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	1100	man-day	$137	$150,700					Assumes 6 hours per day in Respirator
Equipment									
Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
All Terrain Forklift	4	month	$900	$3,600					Engr Est
Excavator 2 CY	4	month	$15,160	$60,640					Vendor quote
Crane	4	month	$1,600	$6,400					Engr Est
Dozer, JD, 99Hp	4	month	$2,800	$11,200					Engr Est
Front End Loader	4	month	$4,150	$16,600					Engr Est
Water Truck, 2000 gal	4	month	$1,850	$7,400					Engr Est
Tanker Truck, vacuum, 5000 gal	4	month	$4,000	$16,000					RSMeans 01590-400-7625
Dump Trailer, 16 cy	4	month	$1,248	$4,992					RSMeans 01590-200-5350
Dump Trailer, 16 cy	4	month	$1,248	$4,992					RSMeans 01590-200-5350
Equipment Trailer	4	month	$448	$1,792					Engr Est
Generator, 150 KW	4	month	$2,006	$8,024					Engr Est

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Two Portable Toilets	4	month	$300	$1,200					
Diaphragm Dewatering Pump & Hose	4	month	$500	$2,000					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	4	month	$2,006	$8,024					Hertz
Rad Screening System	4	month	$100,000	$400,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	4	month	$24,200	$96,800					RSMeans ECHOS 33 18 0405, $110/hr
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	600	tons	$2,125	$1,275,000					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	343	liners	$95	$32,605					Engr Est., ECHOS 33 19 0810
B25 Boxes	549	ea	$1,400	$768,600					DOE Engr Est.
55 gal Drums	1,490	ea	$64	$95,379					RSMeans 33 19 0402
Drum Liners	1,490	ea	$10	$14,903					Engr Est.
Confirmation Sampling									
Verification Samples	59	sample	$2,200	$129,306					Engr Est., 3 samples/ 1225 sf of excavation, 25% QA/QC samples, price includes Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$3,136,558**	**11,440**		**$756,660**	**$3,893,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. 100% cleared and local labor.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2860		$189,165		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	286	man-day	$137	$39,182					Assumes 6 hours per day in Respirator
Disposal/Waste Sampling									
Excavated Waste Sampling	41	sample	$2,200	$90,347					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	59	sample	$2,200	$129,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B25 box plus 10%QA.
PPE Waste	10	sample	$2,200	$22,000					Engr Est, 1 sample per 10 drums
Treated Waste Water	22	sample	$150	$3,300					One sample weekly for VOCs.
Sludge from Water Trmt	14	sample	$2,200	$30,800					Engr Est, 1 sample per 10 drums
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW - Thermal Treatment (Cells 6 & 8)	566	LCY	$27,277	$15,438,782					Energy Solutions
MLLW - Stabilization of Uranyl Fluoride (Cell 9)	288	LCY	$1,721	$495,648					Energy Solutions
TSCA/LLW Waste	549	B-25	$141,000	$77,409,000					Perma-Fix quote

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Transportation									
U Landfill WAC Compliant Waste	343	trips	$75	$25,741					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209
TSCA/LLW Waste	183	trips	$3,000	$549,000					Perma-Fix, 3 boxes per truck
MLLW to ES	427	trips	$7,053	$3,009,280					Envirocare, 3 boxes per truck
U Landfill WAC Compliant Waste (From Targeted Excavation Area)	213	trips	$75	$15,975					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209
MLLW (From Targeted Excavation Area)	53	trips	$7,053	$371,811					Enviocare, 60 drums per truckload
LLW PPE Waste	2	trips	$7,053	$14,106					Enviocare, 60 drums per truckload
LLW Sludge from Water Trmt	4	trips	$7,053	$28,212					Enviocare, 60 drums per truckload
Disposal									
U Landfill WAC Compliant Waste	4,805	LCY	$0	$0					Onsite U Landfill - Subtitle D
TSCA/LLW Waste	1,919	LCY	$1,135	$2,178,065					Envirocare, lined container by truck
MLLW	4,477	LCY	$1,135	$5,081,395					Envirocare, lined rail car
MLLW (From Targeted Excavation Area)	854	LCY	$1,135	$969,290					Engergy Solutions, Disposal cost per CY
LLW PPE Waste	24	LCY	$540	$12,745					Engergy Solutions, Disposal cost per CY
LLW Sludge from Water Trmt	30	LCY	$632	$18,960					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	673,200	gal	$3	$2,019,600					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	163,000	lbs	$2.13	$347,241					0.54lb/cf
Task Total				**$ 108,317,552**	2,860		**$189,165**	**$ 108,507,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 months									
Assumptions: Backfilling based on 1500 cy/day. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					1540		$102,440		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$3,050	$3,050					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR - Excavation and Disposal, w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value
Subcontractors									
Backfill Delivered	22,000	ton	$16	$352,000					Engr Est.
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	10	test	$54	$540					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$1,241,340**			**$102,440**	**$1,344,000**	
10.0 Site Restoration									
Duration: Approximately 2 weeks for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	58	MSF	$50	$2,880					Assume entire disturbed area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,608**			**$70,785**	**$79,000**	
11.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$116,325,000**	

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BGOU SWMU 2
Alt 5.CR
Excavation and Disposal, w/ Contingent Remedy
Escalated Costs

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1.00	$179,233,000				$179,233,000
2013	1	1.029	1.03		$0			$0
2014	2	1.029	1.06		$0			$0
2015	3	1.029	1.09			$0		$0
2016	4	1.029	1.12			$0		$0
2017	5	1.029	1.15			$0		$0
2018	6	1.029	1.19					$0
2019	7	1.029	1.22					$0
2020	8	1.029	1.26					$0
2021	9	1.029	1.29					$0
2022	10	1.029	1.33					$0
2023	11	1.029	1.37				$0	$0
2024	12	1.029	1.41				$0	$0
2025	13	1.029	1.45				$0	$0
2026	14	1.029	1.49				$0	$0
2027	15	1.029	1.54				$0	$0
2028	16	1.029	1.58				$0	$0
2029	17	1.029	1.63				$0	$0
2030	18	1.029	1.67				$0	$0
2031	19	1.029	1.72				$0	$0
2032	20	1.029	1.77				$0	$0
2033	21	1.029	1.82				$0	$0
2034	22	1.029	1.88				$0	$0
2035	23	1.029	1.93				$0	$0
2036	24	1.029	1.99				$0	$0
2037	25	1.029	2.04				$0	$0
2038	26	1.029	2.10				$0	$0
2039	27	1.029	2.16				$0	$0
2040	28	1.029	2.23				$0	$0
2041	29	1.029	2.29				$0	$0
2042	30	1.029	2.36				$0	$0
TOTAL				$179,233,000	$0	$0	$0	$179,233,000

BGOU SWMU 2
Alt 5.CR
Excavation and Disposal, w/ Contingent Remedy
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Semi-Annual Groundwater LTM (Years 3 - 10)	Bi-Annual Groundwater LTM (Years 11 - 30)	TOTALS
2012	0	1.00	1.00	$179,233,000				$179,233,000
2013	1	1.00	1.00		$0			$0
2014	2	1.00	1.00		$0			$0
2015	3	1.00	1.00			$0		$0
2016	4	1.00	1.00			$0		$0
2017	5	1.00	1.00			$0		$0
2018	6	1.00	1.00			$0		$0
2019	7	1.00	1.00			$0		$0
2020	8	1.00	1.00			$0		$0
2021	9	1.00	1.00			$0		$0
2022	10	1.00	1.00			$0		$0
2023	11	1.00	1.00				$0	$0
2024	12	1.00	1.00				$0	$0
2025	13	1.00	1.00				$0	$0
2026	14	1.00	1.00				$0	$0
2027	15	1.00	1.00				$0	$0
2028	16	1.00	1.00				$0	$0
2029	17	1.00	1.00				$0	$0
2030	18	1.00	1.00				$0	$0
2031	19	1.00	1.00				$0	$0
2032	20	1.00	1.00				$0	$0
2033	21	1.00	1.00				$0	$0
2034	22	1.00	1.00				$0	$0
2035	23	1.00	1.00				$0	$0
2036	24	1.00	1.00				$0	$0
2037	25	1.00	1.00				$0	$0
2038	26	1.00	1.00				$0	$0
2039	27	1.00	1.00				$0	$0
2040	28	1.00	1.00				$0	$0
2041	29	1.00	1.00				$0	$0
2042	30	1.00	1.00				$0	$0
TOTAL				$179,233,000	$0	$0	$0	$179,233,000

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,223,000	$1,223,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$108,000	$108,000					
5.0 Mobilization	1	ls	$245,000	$245,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$333,000	$333,000					
7.0 Excavation	1	ls	$3,893,000	$3,893,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$104,208,000	$104,208,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,344,000	$1,344,000					
10.0 Site Restoration	1	ls	$79,000	$79,000					
11.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$22,405,200	$22,405,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$9,410,170	$9,410,000					fee = 7%.
Contingency	1	ls	$28,768,200	$28,768,000					20% contingency
		SUBTOTAL CAPITAL COST		**$172,609,000**					
Construction Schedule	**8.5**	**Month**							
Annual Cost - Monitoring									
Quarterly Groundwater LTM (Years 1 - 2)	0	ls	$0	$0					
Annual Groundwater LTM (Years 3 - 5)	0	ls	$0	$0					
Biannual Groundwater LTM (Years 6-30)	0	ls	$0	$0					
		SUBTOTAL ANNUAL COST		**$0**					
			TOTAL	**$172,609,000**					

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$172,609,000	$172,609,000				**$172,609,000**	
Quarterly Groundwater LTM (Years 1 - 2)	0	ls	$0	$0				**$0**	2.3% discount rate
Annual Groundwater LTM (Years 3 - 5)	0	ls	$0	$0				**$0**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	0	ls	$0	$0				**$0**	2.3% discount rate
							Capital Costs	**$172,609,000**	
						Present Worth Values	**Annual**	**$0**	
							Avg. Annual	**$0**	
							Total	**$172,609,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$325,000	$325,000					Engr Est.
Remedial Action Work Plan	1	LS	$215,000	$215,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,223,000**			**0**	**$1,223,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS			$77,845	**$77,845**			**0**	**$78,000**	Engr Est.

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	20	person	$800	$16,000					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$46,000**	**1,040**		**$62,026**	**$108,000**	
5.0 Mobilization									
Duration: Assume month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six workday/month overtime, totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$63,160**	**0**		**$181,575**	**$245,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Assume 100% cleared and local workers.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Fence, 8', barbed wire	820	lf	$39	$31,570					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
TASK TOTAL				**$151,430**			**$181,575**	**$333,000**	

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
7.0 Excavation									
Duration: Approximately 4 months for excavation, staging, and sampling based on excavating MLLW and TSCA waste at 100 bcy/day/crew,									
U Landfill WAC Compliant Waste at 200 bcy/day/crew. Using one crew.									
Assumption: Includes sheet piling the excavation perimeter.									
Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW/TSCA waste containerized into B-25 boxes and loaded on trucks for delivery to treatment facility.									
MLLW containerized in drums and loaded on trucks for delivery to treatment facility.									
U Landfill WAC Compliant Waste is transported from the stockpile to the onsite U Landfill.									
The excavation will require dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**4**	**Month**							
Labor									
LATA Labor					11440		$756,660		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	1100	man-day	$137	$150,700					Assumes 6 hours per day in Respirator
Equipment									
Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
All Terrain Forklift	4	month	$900	$3,600					Engr Est
Crane	4	month	$1,600	$6,400					Engr Est
Excavator 2 CY	4	month	$15,160	$60,640					Vendor quote
Dozer, JD, 99Hp	4	month	$2,800	$11,200					Engr Est
Front End Loader	4	month	$4,150	$16,600					Engr Est
Water Truck, 2000 gal	4	month	$1,850	$7,400					Engr Est
Tanker Truck, vacuum, 5000 gal	4	month	$4,000	$16,000					RSMeans 01590-400-7625
Dump Trailer, 16 cy	4	month	$1,248	$4,992					RSMeans 01590-200-5350
Dump Trailer, 16 cy	4	month	$1,248	$4,992					RSMeans 01590-200-5350
Equipment Trailer	4	month	$448	$1,792					Engr Est
Generator, 150 KW	4	month	$2,006	$8,024					Engr Est
Two Portable Toilets	4	month	$300	$1,200					
Diaphragm Dewatering Pump & Hose	4	month	$500	$2,000					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	4	month	$2,006	$8,024					Engr Est
Rad Screening System	4	month	$100,000	$400,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	4	month	$24,200	$96,800					RSMeans ECHOS 33 18 0405, $110/hr
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	600	tons	$2,125	$1,275,000					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	343	liners	$95	$32,605					Engr Est., ECHOS 33 19 0810
B25 Boxes	549	ea	$1,400	$768,600					DOE Engr Est.
55 gal Drums	1,490	ea	$64	$95,379					RSMeans 33 19 0402
Drum Liners	1,490	ea	$10	$14,903					Engr Est.

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COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Confirmation Sampling									
Verification Samples	59	sample	$2,200	$129,306					Engr Est., 3 samples/ 1225 sf of excavation, 25% QA/QC samples, price includes Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$3,136,558**	**11,440**		**$756,660**	**$3,893,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. 100% cleared and local labor.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2860		$189,165		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	286	man-day	$137	$39,182					Assumes 6 hours per day in Respirator
Disposal/Waste Sampling									
Excavated Waste Sampling	41	sample	$2,200	$90,347					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	59	sample	$2,200	$129,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B25 box plus 10%QA.
PPE Waste	10	sample	$2,200	$22,000					Engr Est, 1 sample per 10 drums
Treated Waste Water	22	sample	$150	$3,300					One sample weekly for VOCs.
Sludge from Water Trmt	14	sample	$2,200	$30,800					Engr Est, 1 sample per 10 drums
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW - Thermal Treatment (Cells 6 & 8)	566	LCY	$27,277	$15,438,782					Energy Solutions
MLLW - Stabilization of Uranyl Fluoride (Cell 9)	288	LCY	$1,721	$495,648					Energy Solutions
TSCA/LLW Waste	549	B-25	$141,000	$77,409,000					Perma-Fix quote
Transportation									
U Landfill WAC Compliant Waste	343	trips	$75	$25,741					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209
TSCA/LLW Waste	366	trips	$3,000	$1,098,000					Perma-Fix, 3 boxes per truck
MLLW to ES	853	trips	$7,053	$6,018,560					Envirocare, 3 boxes per truck
U Landfill WAC Compliant Waste (From Targeted Excavation Area)	213	trips	$75	$15,975					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209
MLLW (From Targeted Excavation Area)	105	trips	$7,053	$743,621					Enviocare, 60 drums per truckload
LLW PPE Waste	2	trips	$7,053	$14,106					Enviocare, 60 drums per truckload
LLW Sludge from Water Trmt	4	trips	$7,053	$28,212					Enviocare, 60 drums per truckload

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

		Other Direct Costs			Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Disposal									
U Landfill WAC Compliant Waste	4,805	LCY	$0	$0					Onsite U Landfill - Subtitle D
TSCA/LLW Waste	1,919	LCY	$0	$0					Engergy Solutions, Disposal cost per CY
MLLW	4,477	LCY	$0	$0					Engergy Solutions, Disposal cost per CY
MLLW (From Targeted Excavation Area)	854	LCY	$0	$0					Engergy Solutions, Disposal cost per CY
LLW PPE Waste	24	LCY	$540	$12,745					Engergy Solutions, Disposal cost per CY
LLW Sludge from Water Trmt	30	LCY	$632	$18,960					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	673,200	gal	$3	$2,019,600					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	163,000	lbs	$2.13	$347,241					0.54lb/cf
Task Total				**$ 104,018,893**	2,860		**$189,165**	**$ 104,208,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 months									
Assumptions: Backfilling based on 1500 cy/day. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					1540		$102,440		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$3,050	$3,050					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value

COST ESTIMATE
BGOU SWMU 2
Alternative 5.CR.WDF - Excavation and Disposal, w/ WDF, Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Subcontractors									
Backfill Delivered	22,000	ton	$16	$352,000					Engr Est.
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	10	test	$54	$540					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$1,241,340**			**$102,440**	**$1,344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	58	MSF	$50	$2,880					Assume entire disturbed area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$8,608**			**$70,785**	**$79,000**	
11.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$112,026,000**	

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BGOU SWMU 2
Alt 5.CR.WDF
Excavation and Disposal, WDF, w/ Contingent Remedy
Escalated Costs

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1.00	$172,609,000				$172,609,000
2013	1	1.029	1.03		$0			$0
2014	2	1.029	1.06		$0			$0
2015	3	1.029	1.09			$0		$0
2016	4	1.029	1.12			$0		$0
2017	5	1.029	1.15			$0		$0
2018	6	1.029	1.19				$0	$0
2019	7	1.029	1.22					$0
2020	8	1.029	1.26				$0	$0
2021	9	1.029	1.29					$0
2022	10	1.029	1.33				$0	$0
2023	11	1.029	1.37					$0
2024	12	1.029	1.41				$0	$0
2025	13	1.029	1.45					$0
2026	14	1.029	1.49				$0	$0
2027	15	1.029	1.54					$0
2028	16	1.029	1.58				$0	$0
2029	17	1.029	1.63					$0
2030	18	1.029	1.67				$0	$0
2031	19	1.029	1.72					$0
2032	20	1.029	1.77				$0	$0
2033	21	1.029	1.82					$0
2034	22	1.029	1.88				$0	$0
2035	23	1.029	1.93					$0
2036	24	1.029	1.99				$0	$0
2037	25	1.029	2.04					$0
2038	26	1.029	2.10				$0	$0
2039	27	1.029	2.16					$0
2040	28	1.029	2.23				$0	$0
2041	29	1.029	2.29					$0
2042	30	1.029	2.36				$0	$0
TOTAL				$172,609,000	$0	$0	$0	$172,609,000

BGOU SWMU 2
Alt 5.CR.WDF
Excavation and Disposal, WDF, w/ Contingent Remedy
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1.00	1.00	$172,609,000	$0	$0	$0	$172,609,000
2013	1	1.00	1.00	$0	$0	$0	$0	$0
2014	2	1.00	1.00	$0	$0	$0	$0	$0
2015	3	1.00	1.00	$0	$0	$0	$0	$0
2016	4	1.00	1.00	$0	$0	$0	$0	$0
2017	5	1.00	1.00	$0	$0	$0	$0	$0
2018	6	1.00	1.00	$0	$0	$0	$0	$0
2019	7	1.00	1.00	$0	$0	$0	$0	$0
2020	8	1.00	1.00	$0	$0	$0	$0	$0
2021	9	1.00	1.00	$0	$0	$0	$0	$0
2022	10	1.00	1.00	$0	$0	$0	$0	$0
2023	11	1.00	1.00	$0	$0	$0	$0	$0
2024	12	1.00	1.00	$0	$0	$0	$0	$0
2025	13	1.00	1.00	$0	$0	$0	$0	$0
2026	14	1.00	1.00	$0	$0	$0	$0	$0
2027	15	1.00	1.00	$0	$0	$0	$0	$0
2028	16	1.00	1.00	$0	$0	$0	$0	$0
2029	17	1.00	1.00	$0	$0	$0	$0	$0
2030	18	1.00	1.00	$0	$0	$0	$0	$0
2031	19	1.00	1.00	$0	$0	$0	$0	$0
2032	20	1.00	1.00	$0	$0	$0	$0	$0
2033	21	1.00	1.00	$0	$0	$0	$0	$0
2034	22	1.00	1.00	$0	$0	$0	$0	$0
2035	23	1.00	1.00	$0	$0	$0	$0	$0
2036	24	1.00	1.00	$0	$0	$0	$0	$0
2037	25	1.00	1.00	$0	$0	$0	$0	$0
2038	26	1.00	1.00	$0	$0	$0	$0	$0
2039	27	1.00	1.00	$0	$0	$0	$0	$0
2040	28	1.00	1.00	$0	$0	$0	$0	$0
2041	29	1.00	1.00	$0	$0	$0	$0	$0
2042	30	1.00	1.00	$0	$0	$0	$0	$0
TOTAL				$172,609,000	$0	$0	$0	$172,609,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter	Total	Units	Basis
Calculations for Targeted Excavation and Disposal			
SWMU Dimensions			
Total Area	32,000	SF	Engr Est.
Fraction of Area to be Excavated	0.0375		Engr Est.
Area to be Excavated	1,200	SF	Calc
Excavation Depth	20	feet	Engr Est.
Waste Volume Calc			
Waste Volume	889	BCY	calc
TCE/DNAPL Source	13,500	BCY	Engr Est.
Conversion	1.20	LCY/BCY	LATA Directive
Excavated Waste Volume	1,067	LCY	calc
U Landfill WAC Compliant Waste Fraction	0.20		Engr Est.
Assumed MLLW Fraction	0.53		Engr Est.
Assumed MLLW/TSCA Fraction	0.27		Engr Est.
U Landfill WAC Compliant Waste Volume	213	LCY	calc
MLLW Volume	566	LCY	calc
MLLW/TSCA Volume	288	LCY	calc
Conversion	1.4	ton/LCY	Engr Est
LLW Tonnage	298	ton	calc
MLLW Tonnage	792	ton	calc
MLLW/TSCA Tonnage	403		
Absorbents for Soil			
Absorbent Rate	0.54	lb/CF	LATA Directive
Total Excavated Soils	1,067	LCY	calc
Total Absorbent needed	16,000	lbs	calc
Excavation Duration			
Excavation Rate for U Landfill WAC Compliant Waste	4,400	bcy/month/ crew	Engr Est., 200 cy/day/crew, 22 wdays/mo
Excavation Rate for LLW & MLLW	2,200	bcy/ month/ crew	Engr Est., 100 cy/day/crew, 22 wdays/mo
No. of Crews	1	crew	Engr Est.
Time to Excavate U Landfill WAC Compliant Waste	1	month	calc
Time to Excavate MLLW & MLLW/TSCA	1	month	calc
Total Excavation Time	2	month	calc
Total Excavation Time	0.2	years	calc
Work day	10	hrs/wday	Engr Est.
Work week	5	wdays/wk	Engr Est.
Work days per year	260	wdays/yr	calc
Work hours per year	2,600	whour/yr	calc
Work days per month	22	wdays/mo	calc
Groundwater Dewatering Production			
Area	1,200	sf	calc
Depth to Groundwater	6	ft	Engr Est
Depth to be dewatered	20	ft	Engr Est.
Volume to be dewatered	16,800	cf	calc
Landfill porosity	0.20		Engr Est.
Groundwater Pore Volume within Excavation	3,360	cf	calc
Conversion	7.48	gal/cf	Lindeburg, 1990
Groundwater Pore Volume within Excavation	0	gal	calc
Initial Dewatering Rate	30.0	gpm	Engr Est
Time to remove one pore volume	0	hours	calc
Time to remove one pore volume	0	days	calc
Flowrate after removal of one pore volume	7.9	gpm	DOE, 1995, pg 17

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter			Total	Units	Basis
		Fraction of time pumping occurs after removal of initial pore vol	0.20	fraction	Engr Est
		GW Rate after one pore volume removed	70,000	gal/month	calc
		Total Dewatering Volume	140,000	gal	calc
		Rad Sludge produced from Groundwater Trmt	1,400	gal	calc
		Water produced from Groundwater Trmt	138,600	gal	calc
Sludge Production from GW Treatment					
		Assumed Dewatering Rate	3,231	gal/day	calc
		Number of days operating	43	days	calc
		Dewatering total	140,000	gallons	Engr Est
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	1,400	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1991
		Est. Sludge production	10	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	25	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	1	trips	calc
Transportation Drums, Truck Liner					
	MLLW & MLLW/TSCA				
		Transportation Drum Volume	0.27	CY	Pactec
		Drums required	3,163	Drums	calc
	U Landfill WAC Compliant Waste				
		Truck Liner	14	CY	Engr Est.
		Trips/Liners required for U Landfill WAC Compliant Waste	15	Liners or trips	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant Waste+ 10 percent QA/QC	1	samples	Engr Est.
		Samples for LLW & MLLW + 10 percent QA/QC	2	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	120	feet	
		Area	4,800	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	100	tons	calc
Drum Volume					
		Drum Volume	7.4	CF	DOE 2007-198
		Drum Volume	0.27	CY	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	1,067	LCY	
		Conversion	1.41	CCY/LCY	US Army, 1994
		Volume of Backfill	1,504	CCY	
		Conversion	1.4	ton/CY	Lindeburg, 1990
		Backfill Tonnage	2,000	ton	
		Backfill Rate	1,500	cy/day	Engr Est.
		Est. Time to Backfill	1	days	calc
		Working days per month	22	days	calc
		Est. Months to Backfill	0.03	months	calc
Compaction Testing					
		Compaction Rate	20,000	SF/test	Engr Est
		Compaction Area	1,200	SF	Engr Est.

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter			Total	Units	Basis
		Lift Thickness	2	feet	Engr Est.
		Number of Lifts	10	lifts	calc
		Number of Compactions Tests	0	tests	calc
Top Soil					
		Area to be Excavated	1,200	sf	Engr Est.
		Estimated Disturbed Area Factor	2		Engr Est.
		Estimated Disturbed Area	2,400	sf	calc
		Top Soil Thickness	0.5	feet	Engr Est.
		Conversion	27	CF/CY	
		Conversion	1.30	ton/CY	Engr Est.
		Top Soil tonnage	100	ton	calc
Hydroseeding					
		Area	2,400	sf	Engr Est
		Area	2	MSF	calc
Trucking to Proposed On-Site Waste Disposal Facility					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	10	lcy	Engr Est
		Dump Trips for LLW & MLLW	57	trips	calc
		Truck Liners	57	liners	calc
PPE LLW Drums					
		Drums filled per day with PPE Rad Waste	1	drum/day	Engr Est
		No. of drums used during project	43	drums	calc
		Drums per Truckload	60	drums/trucklo	Engr Est
		Truck Trips	1	trips	calc
		Drum Volume	55	gal/drum	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Total Volume of PPE	12	cy	calc
Calculations for *In Situ* Source Treatment (Electrical Resistance Heating)					
(Alternative 1)					
SWMU Area					
		Source Treatment Width	20	feet	Engr Est.
		Source Treatment Length	60	feet	Engr. Est
		Source Treatment Area	1,200	sf	calc
Volume of Waste Requiring Treatment					
		Depth of Waste Requiring Treatment	39	feet	Engr Est.
		Conversion	27	cf/cy	Lindeburg, 1990
		Source Treatment Volume	1,733	bcy	calc
Single ERH Cell Makeup					
		Electrodes	6	electrodes/cell	FRTR, 2009
		Neutral	1	neutral/cell	Morgenstern, 2007
		Soil Venting Wells	6	wells/cell	Co-located with electrodes; Morgenstern, 2007
		Peizometers	4	wells/cell	Engr Est.
Electrical Resistance Heating Specifics					
		Assumed Diameter of Influence	40	ft	FRTR, 2009
		Assumed Area of Influence	1,256	sf	calc
		Total No. of Cells reqd for trmt	1	cells	calc
Total ERH Cell Specifics					
		Electrodes	6	electrodes	calc
		Neutral	1	neutral	calc
		Soil Venting Wells	6	SVE wells	Calc, Co-located with electrodes
		Peizometers	4	wells	Engr Est.

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter	Total	Units	Basis
Soil Venting System, assuming standard temp and pressure			
Assumed Avg Air Flowrate per Well	10	cfm	Engr Est.
Assumed Avg Influent Conc for VOAs	0.7	mg/L	Engr Est.
Assumed Treatment Duration	6	month	Engr Est.
Total System Air Flowrate	60	cfm	calc
Conversion	28.32	L/cf	Lindeburg, 1990
Total System Air Flowrate	1,699	L/m	calc
Carbon Adsorption Vessel Flow Capacity	20,000	cfm	www.tigg.com
No. of Carbon Vessels Reqd	1	carbon unit	www.tigg.com
Iodine Number	1,000	mg Iodine/gram carbon	Used to estimate carbon capacity of lower molecular wt compounds absorbing to carbon, www.tigg.com.
Carbon Wt. per Vessel	1,000	lbs	www.tigg.com
Conversion	454	gm/lb	Lindeburg, 1990
Carbon Wt. per Vessel	454,000	gm	calc
Conversion	1,000	mg/gm	Lindeburg, 1990
VOA flow rate	1	gm/L	calc
Total Air Volume through Carbon Vessel	4.466E+08	L	calc
VOA mass removed during project	3.1709E+08	mg	calc
Conversion	454,000	mg/lbs	Lindeburg, 1990
VOA mass removed during project	698	lbs	calc
Conversion	0.4540	kg/lbs	Lindeburg, 1990
VOA mass removed during project	317	kg	calc
VOA mass removed per ERH Cell	698	lbs/cell	calc
VOA capacity of Carbon Vessel	3.171E+05	gram of carbon	calc
Conversion	454	gm/lb	Lindeburg, 1990
Carbon required for Project	698	lbs	calc
Approx. Carbon Vessels needed	1.00	vessels	calc
Groundwater Containment			
Approximate Rate of Capture	7.90	gpm	DOE, 1995, pg 17
Fraction of time pumping occurs after removal of initial pore vol	1.00	fraction	Engr Est
GW Rate after one pore volume removed	340,000	gal/month	calc
Est. ERH operation period	6	months	Engr Est
Est. Volume of groundwater production	2,040,000	gallons	calc
Power Consumption			
Soil Venting System Capacity	100	cfm	Engr Est
Estimated No. of Systems	1	SVE Systems	Engr Est
SVE Motor Size	8	Hp	Engr Est
SVE Power Reqm	5	Hp	Engr Est
Conversion	0.7457	KW/Hp	Lindeburg, 1990
SVE Power Reqm	3	KW	calc
Conversion	1,000	KW/M-KW	Lindeburg, 1990
SVE Power Reqm	0.003	M-KW	calc
SVE Power Consumption	1,000	M-KW-hr	calc
Assumed Power Consumption per Electrode	3,000	M-KW-hr	Engr Est
Total Consumption of Combined ERH Systems	3,000	M-KW-hr	calc
Price of Electricity	0.05	$/KW-hr	www.eia.doe.gov
Price of Electricity	50	$/M-KW-hr	www.eia.doe.gov
Calculations for *In Situ* Source Treatment (Chemical Injection of a reductant)			
(Treatment t.3)			
Well Installation (w/o excavation)			

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter			Total	Units	Basis
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	60	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	29,452	cf	calc
		weight of soil per well	3,092,505		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	61,850	lbs	calc
Well Installation (post excavation)					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		Depth of Well	40	lf	Engr. Est
		Soil Density	105	lb/cf	Engr. Est
		Volume of Soil per well	19,635	cf	calc
		weight of soil per well	2,061,670		calc
		TCE Treatment Concentration (zv/soil)	0.020	lb/lb	Engr. Est
		micro ZVI required per well	41,233	lbs	calc
Calculations for *In Situ* Source Treatment (Enhanced Biological Treatment)					
(Alternative 4)					
SWMU Area					
		Source Treatment Width	75	feet	Engr Est.
		Source Treatment Length	75	feet	Engr. Est
		Source Treatment Area	5,625	sf	calc
Well Installation					
		Well effective diameter	25	ft	Engr. Est
		Well effective area	491	SF	calc
		# of wells (including 10% coverage adj.)	13	ea	Engr. Est
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	300	feet	
		Area	12,000	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	300	tons	calc
Volume of Waste Requiring Treatment					
		Depth of Waste Requiring Treatment	39	feet	Engr Est.
		Conversion	27	cf/cy	Lindeburg, 1990
		Source Treatment Volume	8,125	bcy	calc
Calculations for *Surface Cover (Subtitle C Cover)*					
(Alternative 5)					
SWMU Dimensions					
	Cap Dimensions				
		Recommended Buffer	5	feet	Engr Est
		SWMU Width plus Buffer (Cap)	210	feet	Calc
		SWMU Length plus Buffer (Cap)	200	feet	Calc
		Perimeter of Cap	820	feet	Calc
		Area of the Cap	42,000	sf	Calc
		Conversion	43,560	sf/acre	Calc
		Area of the Cap	0.96	acre	Calc
	Hydraulic Isolation Barrier				
		Depth of Barrier Wall	40	feet	Engr Est
		Barrier Wall Area	32,800	sf	Calc
	Groundwater Sumps				
		Assumed separation between perimeter sumps	100	ft	
		No. of perimeter sumps	8	sumps	

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 6c. - Targeted Excavation and Disposal, Subtitle C cover, Land Use Controls, Monitoring

Parameter			Total	Units	Basis
		Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
		Perimeter of Cap	11,304	sf/sump	calc
		No. of Sumps required for dewatering under Cap	4	sumps	calc
	Groundwater Pore Volume				
		Cap Area	42,000	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	588,000	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume beneath Cap	117,600	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume beneath Cap	880,000	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est
		Time to remove one pore volume	489	hours	calc
		Time to remove one pore volume	20	days	Calc
		Flowrate after removal of one pore volume	7	gpm	SWMU 2 IROD
		GW Rate after one pore volume removed	302,400	gal/month	Engr Est.
		GW Rate after one pore volume removed	3,628,800	gal/yr	Engr Est.

COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,223,000	$1,223,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$108,000	$108,000					
5.0 Mobilization	1	ls	$245,000	$245,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$333,000	$333,000					
6.1. Well Installation	1	ls	$344,000	$344,000					
7.0 Excavation	1	ls	$1,255,000	$1,255,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$18,172,000	$18,172,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,009,000	$1,009,000					
10.0 Subtitle C cover	1	ls	$1,157,000	$1,157,000					
11.0 Site Restoration	1	ls	$77,000	$77,000					
12.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$4,903,200	$4,903,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$2,059,330	$2,059,000					fee = 7%.
Contingency	1	ls	$6,295,600	$6,296,000					20% contingency
		SUBTOTAL CAPITAL COST		**$37,774,000**					
Construction Schedule	**10**	**Month**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	ls	$28,000	$840,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$1,810,000**					
			TOTAL	**$39,584,000**					

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COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$37,774,000	$37,774,000				**$37,774,000**	
Annual Cover Maintenance (Years 1 - 30)	30	ls	$28,000	$840,000				**$601,986**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital Costs	**$37,774,000**	
						Present	**Annual**	**$1,333,000**	
						Worth	**Avg. Annual**	**$44,433**	
						Values	**Total**	**$39,107,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA, 2009
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$325,000	$325,000					Engr Est.
Remedial Action Work Plan	1	LS	$215,000	$215,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,223,000**			**0**	**$1,223,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					

COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1	LS	$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	20	person	$800	$16,000					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$46,000**	**1,040**		**$62,026**	**$108,000**	
5.0 Mobilization									
Duration: Assume month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six workday/month overtime, totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$63,160**			**$181,575**	**$245,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									

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COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Schedule	**1**	**Month**							
Labor									
LATA Labor					2970		$181,575		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Fence, 8', barbed wire	820	lf	$39	$31,570					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
TASK TOTAL				**$151,430**			**$181,575**	**$333,000**	
6.1. Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote

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COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
7.0 Excavation									
Duration: Approximately 2 months for excavation, staging, and sampling based on excavating MLLW and TSCA waste at 100 bcy/day/crew,									
U Landfill WAC Compliant Waste at 200 bcy/day/crew. Using one crew.									
Assumption: Includes sheet piling the excavation perimeter.									
Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW/TSCA waste containerized into B-25 boxes and loaded on trucks for delivery to treatment facility.									
MLLW containerized in drums and loaded on trucks for delivery to treatment facility.									
U Landfill WAC Compliant Waste is transported from the stockpile to the onsite U Landfill.									
The excavation will require dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**2**	**Month**							
Labor									
LATA Labor					5720		$378,330		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	550	man-day	$137	$75,350					Assumes 6 hours per day in Respirator
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	2	month	$900	$1,800					Engr Est
Excavator 2 CY	2	month	$15,160	$30,320					Vendor quote
Crane	2	month	$1,600	$3,200					Engr Est
Dozer, JD, 99Hp	2	month	$2,800	$5,600					Engr Est
Front End Loader	2	month	$4,150	$8,300					Engr Est
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est
Tanker Truck, vacuum, 5000 gal	2	month	$4,000	$8,000					RSMeans 01590-400-7625
Dump Trailer, 16 cy	2	month	$1,248	$2,496					RSMeans 01590-200-5350
Dump Trailer, 16 cy	2	month	$1,248	$2,496					RSMeans 01590-200-5350
Equipment Trailer	2	month	$448	$896					Engr Est
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est
Two Portable Toilets	2	month	$300	$600					
Diaphragm Dewatering Pump & Hose	2	month	$500	$1,000					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est

COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Rad Screening System	2	month	$100,000	$200,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	2	month	$24,200	$48,400					RSMeans ECHOS 33 18 0405, $110/hr
Services	2								
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	100	tons	$2,125	$212,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	15	liners	$95	$1,445					Engr Est., ECHOS 33 19 0810
Soft Side Bags	0	bag	$350	$0					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)
B25 Boxes	0	ea	$1,400	$0					DOE Engr Est.
55 gal Drums	3,232	ea	$64	$206,834					Vendor quote
Drum Liners	3,232	ea	$10	$32,318					Engr Est.
Confirmation Sampling									
Verification Samples	4	sample	$2,200	$8,082					Engr Est., 3 samples/ 1225 sf of excavation, 25% QA/QC samples, price includes Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$876,561**	**5,720**		**$378,330**	**$1,255,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. 100% cleared and local labor.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2860		$189,165		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	286	man-day	$137	$39,182					Assumes 6 hours per day in Respirator
Disposal/Waste Sampling									
Excavated Waste	4	sample	$2,200	$8,607					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	59	sample	$2,200	$129,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B25 box plus 10%QA.
PPE Waste	5	sample	$2,200	$11,000					Engr Est, 1 sample per 10 drums
Treated Waste Water	14	sample	$150	$2,100					One sample weekly for VOCs.
Sludge from Water Trmt	3	sample	$2,200	$6,600					Engr Est, 1 sample per 10 drums
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW - Thermal Treatment (Cells 6 & 8)	566	LCY	$27,277	$15,438,782					Energy Solutions
MLLW - Stabilization of Uranyl Fluoride (Cell 9)	288	LCY	$1,721	$495,648					Energy Solutions
Transportation									
U Landfill WAC Compliant Waste	213	trips	$75	$15,975					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209

COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
MLLW	53	trips	$7,053	$371,811					Enviocare, 60 drums per truckload
LLW PPE Waste	1	trips	$7,053	$7,053					Enviocare, 60 drums per truckload
LLW Sludge from Water Trmt	1	trips	$7,053	$7,053					Enviocare, 60 drums per truckload
Disposal									
U Landfill WAC Compliant Waste	213	LCY	$0	$0					Onsite U Landfill - Subtitle D
MLLW	854	LCY	$1,135	$969,290					Engergy Solutions, Disposal cost per CY
LLW PPE Waste	12	LCY	$540	$6,373					Engergy Solutions, Disposal cost per CY
LLW Sludge from Water Trmt	10	LCY	$632	$6,320					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	138,600	gal	$3	$415,800					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	16,000	lbs	$2.13	$34,080					0.54lb/cf
Task Total				**$ 17,982,746**	2,860		**$189,165**	**$ 18,172,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 months									
Assumptions: Backfilling based on 1500 cy/day. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					1540		$102,440		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value
Subcontractors									
Backfill Delivered	2,000	ton	$16	$32,000					Engr Est.
Top Soil Delivered	100	ton	$16	$1,600					Engr Est.
Compaction Testing	0	test	$54	$0					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$906,150**			**$102,440**	**$1,009,000**	

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BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
10.0 Subtitle C cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of RCRA cap over the SWMU,									
Used 10 hour work-day; 22 work-days per month.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$459,045		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	42,000	sf							www.frtr.gov
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Hertz
Dozer	3	month	$2,800	$8,400					Hertz
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Hertz
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Hertz
Water Truck, 2000 gal	3	month	$1,850	$5,550					Hertz
Equipment Trailer	3	month	$300	$900					Hertz
Generator, 15KW	3	month	$2,006	$6,018					Hertz
Portable Toilet	3	month	$300	$900					Engr Est
TASK TOTAL				**$697,698**	**0**		**$459,045**	**$1,157,000**	
11.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	4	MSF	$50	$180					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$5,908**			**$70,785**	**$77,000**	
12.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$24,516,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					160		$10,560		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	1	acre	$400	$400					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$16,700**	**160**		**$10,560**	**$28,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									

COST ESTIMATE
BGOU SWMU 2
Alternative 6.c.CR - Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring w/ Contingent Remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Five-Year Review	1	LS	$50,198	$50,198					see detail report
TASK TOTAL								**$50,000**	

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Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring, w/ Contingent Remedy
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$37,774,000						$37,774,000
2013	1	1.029	1.03		$28,812	$95,697				$124,509
2014	2	1.029	1.06		$29,648	$98,472				$128,120
2015	3	1.029	1.09		$30,507		$30,507			$61,015
2016	4	1.029	1.12		$31,392		$31,392			$62,784
2017	5	1.029	1.15		$32,302		$32,302		$57,683	$122,288
2018	6	1.029	1.19		$33,239			$37,988		$71,227
2019	7	1.029	1.22		$34,203					$34,203
2020	8	1.029	1.26		$35,195			$40,223		$75,418
2021	9	1.029	1.29		$36,216					$36,216
2022	10	1.029	1.33		$37,266			$42,590	$66,546	$146,402
2023	11	1.029	1.37		$38,347					$38,347
2024	12	1.029	1.41		$39,459			$45,096		$84,554
2025	13	1.029	1.45		$40,603					$40,603
2026	14	1.029	1.49		$41,780			$47,749		$89,530
2027	15	1.029	1.54		$42,992				$76,772	$119,764
2028	16	1.029	1.58		$44,239			$50,559		$94,798
2029	17	1.029	1.63		$45,522					$45,522
2030	18	1.029	1.67		$46,842			$53,534		$100,376
2031	19	1.029	1.72		$48,200					$48,200
2032	20	1.029	1.77		$49,598			$56,684	$88,568	$194,850
2033	21	1.029	1.82		$51,037					$51,037
2034	22	1.029	1.88		$52,517			$60,019		$112,535
2035	23	1.029	1.93		$54,040					$54,040
2036	24	1.029	1.99		$55,607			$63,551		$119,157
2037	25	1.029	2.04		$57,219				$102,177	$159,397
2038	26	1.029	2.10		$58,879			$67,290		$126,169
2039	27	1.029	2.16		$60,586					$60,586
2040	28	1.029	2.23		$62,343			$71,249		$133,592
2041	29	1.029	2.29		$64,151					$64,151
2042	30	1.029	2.36		$66,011			$37,721	$117,878	$221,610
TOTAL				$0	$1,348,751	$194,169	$94,202	$674,250	$509,624	$40,595,000

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Alt 6.c.CR
Targeted Excavation and Disposal, Subtitle C Cap, LUCs, Monitoring, w/ Contingent Remedy
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$37,774,000	$0	$0	$0	$0	$0	$37,774,000
2013	1	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2014	2	1	1.00	$0	$28,000	$93,000	$0	$0	$0	$121,000
2015	3	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2016	4	1	1.00	$0	$28,000	$0	$28,000	$0	$0	$56,000
2017	5	1	1.00	$0	$28,000	$0	$28,000	$0	$50,000	$106,000
2018	6	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2019	7	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2020	8	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2021	9	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2022	10	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2023	11	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2024	12	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2025	13	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2026	14	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2027	15	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2028	16	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2029	17	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2030	18	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2031	19	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2032	20	1	1.00	$0	$28,000	$0	$0	$32,000	$50,000	$110,000
2033	21	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2034	22	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2035	23	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2036	24	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2037	25	1	1.00	$0	$28,000	$0	$0	$0	$50,000	$78,000
2038	26	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2039	27	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2040	28	1	1.00	$0	$28,000	$0	$0	$32,000	$0	$60,000
2041	29	1	1.00	$0	$28,000	$0	$0	$0	$0	$28,000
2042	30	1	1.00	$0	$28,000	$0	$0	$16,000	$50,000	$94,000
TOTAL				$37,774,000	$840,000	$186,000	$84,000	$400,000	$300,000	$39,584,000

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 7 - Targeted excavation and disposal, surface cover, land use controls, monitoring, in situ source treatment and contingent remedy

Parameter			Total	Units	Basis
Calculations for Excavation and Disposal (Alternative 7)					
SWMU Dimensions					
		Total Area	32,000	SF	Engr Est.
		Fraction of Area to be Excavated	0.0375		Engr Est.
		Area to be Excavated	1,200	SF	Calc
		Excavation Depth	20	feet	Engr Est.
Waste Volume Calc					
		Waste Volume	889	BCY	calc
		TCE/DNAPL Source	13,500	BCY	Engr Est.
		Conversion	1.20	LCY/BCY	LATA Directive
		Excavated Waste Volume	1,067	LCY	calc
		U Landfill WAC Compliant Waste Fraction	0.20		Engr Est.
		Assumed MLLW Fraction	0.53		Engr Est.
		Assumed MLLW/TSCA Fraction	0.27		Engr Est.
		U Landfill WAC Compliant Waste Volume	213	LCY	calc
		MLLW Volume	566	LCY	calc
		MLLW/TSCA Volume	288	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est
		LLW Tonnage	298	ton	calc
		MLLW Tonnage	792	ton	calc
		MLLW/TSCA Tonnage	403		
Absorbents for Soil					
		Absorbent Rate	0.54	lb/CF	LATA Directive
		Total Excavated Soils	1,067	LCY	calc
		Total Absorbent needed	16,000	lbs	calc
Excavation Duration					
		Excavation Rate for U Landfill WAC Compliant Waste	4,400	bcy/month/ crew	Engr Est., 200 cy/day/crew, 22 wdays/mo
		Excavation Rate for LLW & MLLW	2,200	bcy/ month/ crew	Engr Est., 100 cy/day/crew, 22 wdays/mo
		No. of Crews	1	crew	Engr Est.
		Time to Excavate U Landfill WAC Compliant Waste	1	month	calc
		Time to Excavate LLW & MLLW	1	month	calc
		Total Excavation Time	2	month	calc
		Total Excavation Time	0.2	years	calc
		Work day	10	hrs/wday	Engr Est.
		Work week	5	wdays/wk	Engr Est.
		Work days per year	260	wdays/yr	calc
		Work hours per year	2,600	whour/yr	calc
		Work days per month	22	wdays/mo	calc
Groundwater Dewatering Production					
		Area	1,200	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	16,800	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume within Excavation	3,360	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume within Excavation	0	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 7 - Targeted excavation and disposal, surface cover, land use controls, monitoring, in situ source treatment and contingent remedy

Parameter			Total	Units	Basis
		Time to remove one pore volume	0	hours	calc
		Time to remove one pore volume	0	days	calc
		Flowrate after removal of one pore volume	7.9	gpm	DOE, 1995, pg 17
		Fraction of time pumping occurs after removal of initial pore vol	0.20	fraction	Engr Est
		GW Rate after one pore volume removed	70,000	gal/month	calc
		Total Dewatering Volume	140,000	gal	calc
		Rad Sludge produced from Groundwater Trmt	1,400	gal	calc
		Water produced from Groundwater Trmt	138,600	gal	calc
Sludge Production from GW Treatment					
		Assumed Dewatering Rate	3,231	gal/day	calc
		Number of days operating	43	days	calc
		Dewatering total	140,000	gallons	Engr Est
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	1,400	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1991
		Est. Sludge production	10	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	25	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	1	trips	calc
Transportation Drums, Truck Liners					
	MLLW & MLLW/TSCA				
		Transportation Drum Volume	0.27	CY	Pactec
		Drums required	3,163	Drums	calc
	U Landfill WAC Compliant Waste				
		Truck Liner	14	CY	Engr Est.
		Trips/Liners required for U Landfill WAC Compliant Waste	15	Liners or trips	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant Waste+ 10 percent QA/QC	1	samples	Engr Est.
		Samples for LLW & MLLW + 10 percent QA/QC	2	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	120	feet	
		Area	4,800	SF	
		Sheet pile density	38	psf	left in place
		Tonnage	100	tons	calc
Drum Volume					
		Drum Volume	7.4	CF	DOE 2007-198
		Drum Volume	0.27	CY	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	1,067	LCY	
		Conversion	1.41	CCY/LCY	US Army, 1994
		Volume of Backfill	1,504	CCY	
		Conversion	1.4	ton/CY	Lindeburg, 1990
		Backfill Tonnage	2,000	ton	
		Backfill Rate	1,500	cy/day	Engr Est.
		Est. Time to Backfill	1	days	calc
		Working days per month	22	days	calc
		Est. Months to Backfill	0.03	months	calc

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CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 2

Alternative 7 - Targeted excavation and disposal, surface cover, land use controls, monitoring, in situ source treatment and contingent remedy

Parameter			Total	Units	Basis
Compaction Testing					
		Compaction Rate	20,000	SF/test	Engr Est
		Compaction Area	1,200	SF	Engr Est.
		Lift Thickness	2	feet	Engr Est.
		Number of Lifts	10	lifts	calc
		Number of Compactions Tests	0	tests	calc
Top Soil					
		Area to be Excavated	1,200	sf	Engr Est.
		Estimated Disturbed Area Factor	2		Engr Est.
		Estimated Disturbed Area	2,400	sf	calc
		Top Soil Thickness	0.5	feet	Engr Est.
		Conversion	27	CF/CY	
		Conversion	1.30	ton/CY	Engr Est.
		Top Soil tonnage	100	ton	calc
Hydroseeding					
		Area	2,400	sf	Engr Est
		Area	2	MSF	calc
Trucking to Proposed On-Site Waste Disposal Facility					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	10	lcy	Engr Est
		Dump Trips for LLW & MLLW	57	trips	calc
		Truck Liners	57	liners	calc
PPE LLW Drums					
		Drums filled per day with PPE Rad Waste	1	drum/day	Engr Est
		No. of drums used during project	43	drums	calc
		Drums per Truckload	60	drums/trucklo	Engr Est
		Truck Trips	1	trips	calc
		Drum Volume	55	gal/drum	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Total Volume of PPE	12	cy	calc

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COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,223,000	$1,223,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$108,000	$108,000					
5.0 Mobilization	1	ls	$245,000	$245,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$333,000	$333,000					
6.1 Well Installation	1	ls	$344,000	$344,000					
7.0 Excavation	1	ls	$1,255,000	$1,255,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$18,172,000	$18,172,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,009,000	$1,009,000					
10.0 Subtitle C cover & DPE installation	1	ls	$2,930,000	$2,930,000					
12.0 Site Restoration	1	ls	$77,000	$77,000					
13.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$5,257,800	$5,258,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$2,208,290	$2,208,000					fee = 7%.
Contingency	1	ls	$6,751,000	$6,751,000					20% contingency
			SUBTOTAL CAPITAL COST	**$40,506,000**					
Annual Cost									
Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	30	ls	$406,000	$12,180,000					
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
			SUBTOTAL ANNUAL COST	**$13,150,000**					
			TOTAL	**$53,656,000**					

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1	LS	$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Pyrophorics	20	person	$800	$16,000					Includes cost of trainer and training module development.
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$46,000**	**1,040**		**$62,026**	**$108,000**	
5.0 Mobilization									
Duration: Assume month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six workday/month overtime, totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$63,160**	**0**		**$181,575**	**$245,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Assume 100% cleared and local workers. Abandon three monitoring wells.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2750		$181,575		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Rad Screening System	2	mob	$1,500	$3,000					RSMeans ECHOS 33 18 0401, 500 miles
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Fence, 8', barbed wire	820	lf	$39	$31,570					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
TASK TOTAL				**$151,430**	**2750**		**$181,575**	**$333,000**	
6.1. Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
7.0 Excavation									
Duration: Approximately 2 months for excavation, staging, and sampling based on excavating MLLW and TSCA waste at 100 bcy/day/crew,									
U Landfill WAC Compliant Waste at 200 bcy/day/crew. Using one crew.									
Assumption: Includes sheet piling the excavation perimeter.									
Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW/TSCA waste containerized into B-25 boxes and loaded on trucks for delivery to treatment facility.									
MLLW containerized in drums and loaded on trucks for delivery to treatment facility.									
U Landfill WAC Compliant Waste is transported from the stockpile to the onsite U Landfill.									
The excavation will require dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**2**	**Month**							
Labor									
LATA Labor					5720		$378,330		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	550	man-day	$137	$75,350					Assumes 6 hours per day in Respirator
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
All Terrain Forklift	2	month	$900	$1,800					Engr Est
Excavator 2 CY	2	month	$15,160	$30,320					Vendor quote
Crane	2	month	$1,600	$3,200					Engr Est
Dozer, JD, 99Hp	2	month	$2,800	$5,600					Engr Est
Front End Loader	2	month	$4,150	$8,300					Engr Est
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est
Tanker Truck, vacuum, 5000 gal	2	month	$4,000	$8,000					RSMeans 01590-400-7625
Dump Trailer, 16 cy	2	month	$1,248	$2,496					RSMeans 01590-200-5350
Dump Trailer, 16 cy	2	month	$1,248	$2,496					RSMeans 01590-200-5350
Equipment Trailer	2	month	$448	$896					Engr Est
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est
Two Portable Toilets	2	month	$300	$600					
Diaphragm Dewatering Pump & Hose	2	month	$500	$1,000					RSMeans 01590-400-5200,3200 & 3250

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est
Rad Screening System	2	month	$100,000	$200,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	2	month	$24,200	$48,400					RSMeans ECHOS 33 18 0405, $110/hr
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	100	tons	$2,125	$212,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	15	liners	$95	$1,445					Engr Est., ECHOS 33 19 0810
Soft Side Bags	0	bag	$350	$0					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)
B25 Boxes	0	ea	$1,400	$0					DOE Engr Est.
55 gal Drums	3,232	ea	$64	$206,834					Vendor quote
Drum Liners	3,232	ea	$10	$32,318					Engr Est.
Confirmation Sampling									
Verification Samples	4	sample	$2,200	$8,082					Engr Est., 3 samples/ 1225 sf of excavation, 25% QA/QC samples, price includes Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$876,561**	**5,720**		**$378,330**	**$1,255,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. 100% cleared and local labor.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2860		$189,165		Engr Est., LATA Labor Rate
Health & Safety									
Level B PPE	286	man-day	$137	$39,182					Assumes 6 hours per day in Respirator
Disposal/Waste Sampling									
Excavated Waste	4	sample	$2,200	$8,607					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	59	sample	$2,200	$129,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B25 box plus 10%QA.
PPE Waste	5	sample	$2,200	$11,000					Engr Est, 1 sample per 10 drums
Treated Waste Water	14	sample	$150	$2,100					One sample weekly for VOCs.
Sludge from Water Trmt	3	sample	$2,200	$6,600					Engr Est, 1 sample per 10 drums
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW - Thermal Treatment (Cells 6 & 8)	566	LCY	$27,277	$15,438,782					Energy Solutions
MLLW - Stabilization of Uranyl Fluoride (Cell 9)	288	LCY	$1,721	$495,648					Energy Solutions
Transportation									

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COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
U Landfill WAC Compliant Waste	213	trips	$75	$15,975					Onsite U Landfill - Non Haz, round trip is 10 miles, 10 cy dumps, RS Means ECHOS 33 19 0209
MLLW	53	trips	$7,053	$371,811					Enviocare, 60 drums per truckload
LLW PPE Waste	1	trips	$7,053	$7,053					Enviocare, 60 drums per truckload
LLW Sludge from Water Trmt	1	trips	$7,053	$7,053					Enviocare, 60 drums per truckload
Disposal									
U Landfill WAC Compliant Waste	213	LCY	$0	$0					Onsite U Landfill - Subtitle D
MLLW	854	LCY	$1,135	$969,290					Engergy Solutions, Disposal cost per CY
LLW PPE Waste	12	LCY	$540	$6,373					Engergy Solutions, Disposal cost per CY
LLW Sludge from Water Trmt	10	LCY	$632	$6,320					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	138,600	gal	$3	$415,800					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	16,000	lbs	$2.13	$34,080					0.54lb/cf
Task Total				**$ 17,982,746**	2,860		**$189,165**	**$ 18,172,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 months									
Assumptions: Backfilling based on 1500 cy/day. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					1540		$102,440		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value
Subcontractors									
Backfill Delivered	2,000	ton	$16	$32,000					Engr Est.
Top Soil Delivered	100	ton	$16	$1,600					Engr Est.
Compaction Testing	0	test	$54	$0					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.

COST ESTIMATE

BGOU SWMU 2

Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$906,150**			**$102,440**	**$1,009,000**	
10.0 Subtitle C cover & DPE installation									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of 1) sumps through the cap, 2) RCRA cap over the SWMU,									
3) groundwater treatment system, and 4) offgas treatment.									
Each sump will be outfitted with pumps and controls.									
Piping will be buried in the cap. Collected groundwater (~8 gpm max) will be transferred									
to a groundwater treatment system consisting of filtration, air stripping, ion exchange, and liquid phase carbon.									
The air stripper off gas will be treated through vapor phase carbon before release to atmosphere.									
Treated water will be direct discharged. Used 10 hour work-day; 22 work-days per month.									
Schedule	**8**	**Month**							
Labor									
LATA Labor					18480		$1,224,120		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	42,000	sf							www.frtr.gov
Riprap	3,733	LCY	$27	$101,000					Engr Est.
Cobbles/Soil Top Layer	3,733	LCY	$20	$75,000					Engr Est.
Biotic Barrier (Cobbles)	1,867	LCY	$45	$84,000					Engr Est.
Drainage Layer	1,867	LCY	$45	$84,000					Engr Est.
20 mil geomembrane	4,667	SY	$1	$5,000					Engr Est.
Low Hydraulic conductivity soil layer	3,733	LCY	$45	$168,000					Engr Est.
Geosynthetic Filter	4,667	SY	$1	$5,000					Engr Est.
Gas Vent Layer	1,867	LCY	$45	$84,000					Engr Est.
Groundwater Pumps & Controls	4	ea	$6,000	$24,000					Grundfos
Equipment Building	400	sf	$100	$40,000					RS Means 33 43 0101
Oil/Water Separator	1	ea	$15,000	$15,000					RSMeans 19 04 0411
Low Profile Air Stripper	1	ea	$50,000	$50,000					www.frtr.gov. Assume 20 gpm, 5 tray, 150 cfm.
Vapor Recovery System	1	ea	$6,000	$6,000					160 cfm, RSMeans 33 13 2304
Vapor Phase Carbon	2	ls	$7,500	$15,000					Tigg, 1000 lbs, virgin coconut, delivered
Ion Exchange	1	ls	$80,000	$80,000					Remco Engineering
Liquid Phase Carbon	10	vessel	$5,000	$50,000					www.tigg.com, 850 lb of carbon per vessel
Discharge Pump	1	ea	$1,000	$1,000					RSMeans 33 29 0102
Miscellaneous Equipment	1	ls	$50,000	$50,000					Engr Est
Power Consumption	33,333	Kw-hr	$0.05	$1,667					www.eia.doe.gov, $0.05/KW-hr
Subcontractors									
Sumps	120	lf	$200	$24,000					30 ft deep, 12 inch dia, Sch 80 PVC, RSMeans 33 23 0117
Electrical Tie In	1	ls	$250,000	$250,000					Engr Est.

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COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Electrician	1	ls	$100,000	$100,000					Engr Est.
Extraction Well Installation	4	ea	$16,096	$64,384					4 wells into the UCRS
Fence, 8', barbed wire	820	lf	$35	$28,700					210' x 200' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Laboratory Analytical									
Off Gas									
TO14	60	sample	$450	$27,000					Assume treated offgas and ground
Shipping	60	ea	$20	$1,200					water effluent samples taken daily
Treated GW Effluent									during startup.
Metals 6010	60	sample	$165	$9,900					
VOA 8260	60	sample	$165	$9,900					
SVOA 8270	60	sample	$352	$21,120					
RAD	60	sample	$1,047	$62,820					
Shipping	60	ls	$100	$6,000					
Equipment									
Pickup Truck, crew cab, F250	8	month	$1,300	$10,400					Hertz
Pickup Truck, crew cab, F250	8	month	$1,300	$10,400					Hertz
Front End Loader	8	month	$4,150	$33,200					Engr Est.
Dozer	8	month	$2,800	$22,400					Engr Est.
Compactor/12 ton/pad foot	8	month	$3,090	$24,720					Engr Est.
Compactor/12 ton/smooth drum	8	month	$2,920	$23,360					Engr Est.
Water Truck, 2000 gal	8	month	$1,850	$14,800					Engr Est.
Equipment Trailer	8	month	$300	$2,400					Engr Est.
Generator, 15KW	8	month	$2,006	$16,048					Engr Est.
Portable Toilet	8	month	$150	$1,200					Engr Est
TASK TOTAL				**$1,705,569**			**$1,224,120**	**$2,930,000**	
12.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1073		$70,785		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$2,000	$1,000					Engr Est.
Generator 150KW	0.5	month	$2,006	$1,003					Engr Est.
Portable Toilet	0.5	month	$150	$75					Engr Est.
Subcontractors									
Hydroseed Bluegrass	4	MSF	$50	$180					Assume entire capped area plus 50%; RSMeans 02920-320-1000

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$5,908**			**$70,785**	**$77,000**	
13.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$26,289,000**	
Long-Term Monitoring									
Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)									
Duration: Annual for thirty years.									
Assumptions: Includes O&M for groundwater recovery and treatment, offgas treatment, cap maintenance, and fence maintenance.									
All process waste accepted by onsite U Landfill.									
Assume 10 days per month labor on O&M with no overtime.									
10 hr/work day and 22 workdays/month.									
Labor									
LATA Labor					4320		$244,080		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Air Stripper	400	10000 gal	$20	$8,000					www.frtr.com
Ion Exchange	4,000	1000 gal	$0.50	$2,000					www.frtr.com
Materials									
Liquid Phase GAC	2	vessel	$6,000	$12,000					Tigg, 850 lb delivered
Vapor Phase GAC	2	vessel	$7,250.00	$14,500					Tigg, 1000 lbs, virgin coconut, delivered
Miscellaneous Supplies	1	ls	$10,000	$10,000					Engr Est.
Laboratory Analytical									
Off Gas									
TO14	52	sample	$450	$23,400					Collect weekly treated off-gas
Shipping	12	sample	$100	$1,200					sample and effluent sample
Treated Water									from groundwater treatment
Total Volatiles	12	sample	$165	$1,980					system.
Shipping	12	ls	$100	$1,200					
Subcontractor									
Electrician	1	ls	$10,000	$10,000					Engr Est.
Cap Maintenance	1	ls	$10,000	$10,000					Engr Est.
Site Maintenance	1	ls	$10,000	$10,000					Engr Est.
Reporting									
Annual Report	1	ls	$50,000	$50,000					
TASK TOTAL				**$162,080**	**0**		**$244,080**	**$406,000**	
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									

COST ESTIMATE
BGOU SWMU 2
Alternative 7.c.t2.CR - Targeted excavation and disposal, Subtitle C cap, land use controls, monitoring, in situ source treatment and contingent remedy

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					see detail report
TASK TOTAL								**$50,000**	

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BGOU SWMU 2
Alt 7.c.t2.CR
Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, Monitoring, w/ Contingent Remedy
Escalated Costs

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$40,506,000						$40,506,000
2013	1	1.029	1.03		$417,774	$95,697				$513,471
2014	2	1.029	1.06		$429,889	$98,472				$528,362
2015	3	1.029	1.09		$442,356		$30,507			$472,864
2016	4	1.029	1.12		$455,185		$31,392			$486,577
2017	5	1.029	1.15		$468,385		$32,302		$57,683	$558,370
2018	6	1.029	1.19		$481,968			$37,988		$519,956
2019	7	1.029	1.22		$495,945					$495,945
2020	8	1.029	1.26		$510,328			$40,223		$550,550
2021	9	1.029	1.29		$525,127					$525,127
2022	10	1.029	1.33		$540,356			$42,590	$66,546	$649,492
2023	11	1.029	1.37		$556,026					$556,026
2024	12	1.029	1.41		$572,151			$45,096		$617,246
2025	13	1.029	1.45		$588,743					$588,743
2026	14	1.029	1.49		$605,817			$47,749		$653,566
2027	15	1.029	1.54		$623,385				$76,772	$700,157
2028	16	1.029	1.58		$641,464			$50,559		$692,022
2029	17	1.029	1.63		$660,066					$660,066
2030	18	1.029	1.67		$679,208			$53,534		$732,742
2031	19	1.029	1.72		$698,905					$698,905
2032	20	1.029	1.77		$719,173			$56,684	$88,568	$864,425
2033	21	1.029	1.82		$740,029					$740,029
2034	22	1.029	1.88		$761,490			$60,019		$821,509
2035	23	1.029	1.93		$783,573					$783,573
2036	24	1.029	1.99		$806,297			$63,551		$869,847
2037	25	1.029	2.04		$829,680				$102,177	$931,857
2038	26	1.029	2.10		$853,740			$67,290		$921,030
2039	27	1.029	2.16		$878,499					$878,499
2040	28	1.029	2.23		$903,975			$71,249		$975,225
2041	29	1.029	2.29		$930,191					$930,191
2042	30	1.029	2.36		$957,166			$37,721	$117,878	$1,112,764
TOTAL				$40,506,000	$19,556,891	$194,169	$94,202	$674,250	$509,624	$61,535,000

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BGOU SWMU 2
Alt 7.c.t2.CR
Targeted Excavation and Disposal, Subtitle C Cap, DPE, LUCs, Monitoring, w/ Contingent Remedy
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual GW Treatment System and RCRA Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$40,506,000	$0	$0	$0	$0	$0	$40,506,000
2013	1	1	1.00	$0	$406,000	$93,000	$0	$0	$0	$499,000
2014	2	1	1.00	$0	$406,000	$93,000	$0	$0	$0	$499,000
2015	3	1	1.00	$0	$406,000	$0	$28,000	$0	$0	$434,000
2016	4	1	1.00	$0	$406,000	$0	$28,000	$0	$0	$434,000
2017	5	1	1.00	$0	$406,000	$0	$28,000	$0	$50,000	$484,000
2018	6	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2019	7	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2020	8	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2021	9	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2022	10	1	1.00	$0	$406,000	$0	$0	$32,000	$50,000	$488,000
2023	11	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2024	12	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2025	13	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2026	14	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2027	15	1	1.00	$0	$406,000	$0	$0	$0	$50,000	$456,000
2028	16	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2029	17	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2030	18	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2031	19	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2032	20	1	1.00	$0	$406,000	$0	$0	$32,000	$50,000	$488,000
2033	21	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2034	22	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2035	23	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2036	24	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2037	25	1	1.00	$0	$406,000	$0	$0	$0	$50,000	$456,000
2038	26	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2039	27	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2040	28	1	1.00	$0	$406,000	$0	$0	$32,000	$0	$438,000
2041	29	1	1.00	$0	$406,000	$0	$0	$0	$0	$406,000
2042	30	1	1.00	$0	$406,000	$0	$0	$16,000	$50,000	$472,000
TOTAL				$40,506,000	$12,180,000	$186,000	$84,000	$400,000	$300,000	$53,656,000

SWMU 3 COST ESTIMATES

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SWMU 3 Remedial Alternatives Cost Estimate Summary

Alternative	Description	Annual Time Period, yrs	Capital $ (2012 Constant Dollars)	PRESENT WORTH [1] Total Annual $	PRESENT WORTH [1] Total $ (Capital & Annual)	ESCALATED Total Annual $	ESCALATED Total $ (Capital & Annual)
Alt. 1	No Action	0	$0	$0	$0	$0	$0
Alt. 2.t5	Limited Action	30	$1,968,000	$1,570,000	$3,538,000	$3,351,000	$5,318,863
Alt. 3.a.t5	Soil Cover, L, M, E	30	$2,642,000	$1,570,000	$4,212,000	$3,351,000	$5,992,863
Alt. 5.t5	Excavation & Disposal	0	$138,694,000	$0	$138,694,000	$0	$138,694,000
Alt 5.WDF	Excavation and Disposal at WDF	0	$43,018,000	$0	$43,018,000	$0	$43,018,000

Notes:
(1) Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.

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

A. Given SWMU Dimensions
Originally constructed as an above ground holding pond, with and on-grade tamped earth floor
and 6-ft high clay dike walls. Later the site was used for waste disposal; the site covered with a RCRA multilayered cap.
The SWMU dimensions are reported as 387ft x 137 ft.
Reference: DOE, 2010

Description	Length, ft	Width, ft	Area, sf
SWMU 3	387	137	53,000

B. Quantifiable Items Disposed of in SWMU

Item	Quantity	Units
Uranium-contaminated Waste	6,615,000	lb
Precipitation Filter Cake (end projects from the gold dissolver process)	645	drums
Total Waste Disposal	260,000 9,600	cf cy

Reference: DOE, 1999

C. Unquantifiable Disposal Items

Primary disposal area for Tc99 and uranium-contaminated effluent, which was removed prior to disposing of uranium -contaminated bulk wastes.
Contains bulk solid waste.
Upper portion used for the disposal of bulk and containerized uranium-contaminated solid waste.
Contains drummed waste similar to that collected in the impoundment plus smelter furnace liners and drums of hazardous waste (cadmium, lead, selenium).
Waste uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, degreasing sludge, and radioactively contaminated trash.
Fluoride, TCE, PCBs, neptunium, technetium-99, and uranium-238 found in leachate.
33 percent of the surface area is covered with drums ((DOE, 1978).

D. Excavation
Assumptions:
5 feet of soil/clay cover (Fig 2-30, DOE 1998 FS) above storage area.
5-10 ft bgs contains drummed waste
10-16 ft bgs consists of former waste burial ground area.
Excavated soil volumes derived from LATA GIS:
Original Cover Area volume = 28,000 LCY
Buried Drum Area volume = 10,000 LCY
Area Under Drum Area volume = 10,000 LCY
Remaining SWMU Area volume = 10,000 LCY
Excavation increases soil volume by a factor of 20 percent during handling (bank to loose).
Soil density is 100 pounds per cubic foot.
All excavated soil will require addition of sorbent to reduce moisture content.
Density of sorbent will increase soil volume by 0.54 percent. Assume 0.54 lbs sorbent added to 100 lbs soil (or each cubic foot of soil).
Assume no treatment for VOCs required before disposal.
Assume Drum Area and Area Under Drum will need stabilization prior to disposal.

F. References
DOE, 2010, BGOU Remedial Investigation Report
DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Cost									
1.0 Project Plans	1	ls	$726,000	$726,000					
2.0 Engineering Design	1	ls	$75,000	$75,000					
3.0 Work Package Prep./Readiness Review	1	ls	$29,000	$29,000					
4.0 Training	1	ls	$72,000	$72,000					
5.0 Well Installation	1	ls	$344,000	$344,000					
6.0 O&M Manual and Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$367,750	$368,000					Management = 10% (engineers estimate)
Fee	1	ls	$128,730	$129,000					fee = 7%.
		SUBTOTAL CAPITAL COST		**$1,968,000**					
Annual Cost									
Annual Cover Maintenance (Years 1-30)	30	ls	$39,000	$1,170,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Year 5	1	ls	$50,000	$50,000					
Five-Year Review Year 10	1	ls	$50,000	$50,000					
Five-Year Review Year 15	1	ls	$50,000	$50,000					
Five-Year Review Year 20	1	ls	$50,000	$50,000					
Five-Year Review Year 25	1	ls	$50,000	$50,000					
Five-Year Review Year 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,140,000**					
			TOTAL	**$4,108,000**					

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$1,968,000	$1,968,000				**$1,968,000**	
Annual Cover Maintenance (Years 1-30)	30	ls	$39,000	$1,170,000				**$838,481**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital	**$1,968,000**	
					Present		**Annual**	**$1,570,000**	
					Worth		**Avg. Annual**	**$52,333**	
					Values		**Total Cost**	**$3,538,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$211,000	$211,000					Engr Est.
Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$726,000**			**0**	**$726,000**	

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

			Other Direct Costs		Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
2.0 Engineering Design									
Civil Surveying	1	LS	$20,000	$20,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$75,000**			**0**	**$75,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$10,819	$10,819					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$28,664	**$ 28,664**			**0**	**$29,000**	Engr Est.
4.0 Training									
Assumptions: Cleared and local labor.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$10,000	$10,000					Engr Est.
TASK TOTALS				**$10,000**	**1,040**		**$62,026**	**$72,000**	
5.0 Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
6.0 O&M Manual and Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**				**$225,000**	
					SUBTOTAL CAPITAL COST			**$1,471,000**	
Annual Cover Maintenance (Years 1-30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					320		$21,054		Engr Est., LATA Labor Rate

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	2	acre	$400	$800					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,100**			**$21,054**	**$39,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,300	$1,300					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,030	$46,642					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.

COST ESTIMATE
BGOU SWMU 3
Alternative 2.t6 - Limited Action

			Other Direct Costs		Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BACK

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FORWARD

BGOU SWMU 3
Alternative 2.t6 - Limited Action

Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1-30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012		1	1.000	$ 1,968,000						
2013	1	1.029	1.029		$40,131	$95,697				$ 135,828
2014	2	1.029	1.059		$41,295	$98,472				$ 139,767
2015	3	1.029	1.090		$42,492		$30,507			$73,000
2016	4	1.029	1.121		$43,725		$31,392			$75,117
2017	5	1.029	1.154		$44,993		$32,302		$57,683	$134,978
2018	6	1.029	1.187		$46,297			$37,988		$84,285
2019	7	1.029	1.222		$47,640					$47,640
2020	8	1.029	1.257		$49,022			$40,223		$89,244
2021	9	1.029	1.293		$50,443					$50,443
2022	10	1.029	1.331		$51,906			$42,590	$66,546	$161,042
2023	11	1.029	1.370		$53,411					$53,411
2024	12	1.029	1.409		$54,960			$45,096		$100,056
2025	13	1.029	1.450		$56,554					$56,554
2026	14	1.029	1.492		$58,194			$47,749		$105,943
2027	15	1.029	1.535		$59,882				$76,772	$136,653
2028	16	1.029	1.580		$61,618			$50,559		$112,177
2029	17	1.029	1.626		$63,405					$63,405
2030	18	1.029	1.673		$65,244			$53,534		$118,778
2031	19	1.029	1.721		$67,136					$67,136
2032	20	1.029	1.771		$69,083			$56,684	$88,568	$214,335
2033	21	1.029	1.823		$71,087					$71,087
2034	22	1.029	1.876		$73,148			$60,019		$133,167
2035	23	1.029	1.930		$75,269					$75,269
2036	24	1.029	1.986		$77,452			$63,551		$141,003
2037	25	1.029	2.044		$79,698				$102,177	$181,876
2038	26	1.029	2.103		$82,010			$67,290		$149,299
2039	27	1.029	2.164		$84,388					$84,388
2040	28	1.029	2.227		$86,835			$71,249		$158,084
2041	29	1.029	2.291		$89,353					$89,353
2042	30	1.029	2.358		$91,945			$37,721	$117,878	$247,543
TOTAL				$ 1,968,000	$ 1,878,618	$ 194,169	$ 94,202	$ 674,250	$ 509,624	$ 5,318,863

BGOU SWMU 3
Alternative 2.t6 - Limited Action

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1-30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$ 1,968,000	$0					
2013	1	1	1.00		$39,000	$93,000				
2014	2	1	1.00		$39,000	$93,000				$ 132,000
2015	3	1	1.00		$39,000		$28,000			$67,000
2016	4	1	1.00		$39,000		$28,000			$67,000
2017	5	1	1.00		$39,000		$28,000		$50,000	$117,000
2018	6	1	1.00		$39,000			$32,000		$71,000
2019	7	1	1.00		$39,000					$39,000
2020	8	1	1.00		$39,000			$32,000		$71,000
2021	9	1	1.00		$39,000					$39,000
2022	10	1	1.00		$39,000			$32,000	$50,000	$121,000
2023	11	1	1.00		$39,000					$39,000
2024	12	1	1.00		$39,000			$32,000		$71,000
2025	13	1	1.00		$39,000					$39,000
2026	14	1	1.00		$39,000			$32,000		$71,000
2027	15	1	1.00		$39,000				$50,000	$89,000
2028	16	1	1.00		$39,000			$32,000		$71,000
2029	17	1	1.00		$39,000					$39,000
2030	18	1	1.00		$39,000			$32,000		$71,000
2031	19	1	1.00		$39,000					$39,000
2032	20	1	1.00		$39,000			$32,000	$50,000	$121,000
2033	21	1	1.00		$39,000					$39,000
2034	22	1	1.00		$39,000			$32,000		$71,000
2035	23	1	1.00		$39,000					$39,000
2036	24	1	1.00		$39,000			$32,000		$71,000
2037	25	1	1.00		$39,000				$50,000	$89,000
2038	26	1	1.00		$39,000			$32,000		$71,000
2039	27	1	1.00		$39,000					$39,000
2040	28	1	1.00		$39,000			$32,000		$71,000
2041	29	1	1.00		$39,000					$39,000
2042	30	1	1.00		$39,000			$16,000	$50,000	$105,000
TOTAL				$1,968,000	$1,170,000	$186,000	$84,000	$400,000	$300,000	$4,108,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 3 (C404)

Alternative 3a - Limited Action with 1 foot soil cover

Asssume that cover is topsoil

Cost and calculations for this cover are from the previous estimate for excavation for topsoil placement following backfill:

Subcontractors						
Top Soil Delivered		2,100	ton	$16	$33,600	Vendor quote, local.
Compaction Testing		3	test	$54	$162	Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source		2	ls	$420	$840	Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
Hydroseed Bluegrass		87	MSF	$50	$4,356	150% of SWMU 5 area, RSMeans 02920-320-1000

Top Soil					
		Disturbed Area	2	acres	Engr Est.
		Conversion	43,560	SF/acre	
		Top Soil Thickness	1	feet	Engr Est.
		Conversion	27	CF/CY	
		Conversion	1	ton/CY	Engr Est.
		Top Soil tonnage	2,100	ton	calc
Hydroseeding					
		Area	87,120	sf	Engr Est
		Area	87	MSF	calc

COST ESTIMATE
BGOU SWMU 3
Alternative 3.a.t6 - Soil Cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Cost									
1.0 Project Plans	1	ls	$765,000	$765,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$38,000	$38,000					
4.0 Training	1	ls	$82,000	$82,000					
5.0 Mobilization	1	ls	$90,000	$90,000					
6.0 Site Preparation/Construct	1	ls	$139,000	$139,000					
7.0 One foot topsoil cover Installation	1	ls	$187,000	$187,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
9.0 O&M Manual and Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$493,750	$494,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$172,830	$173,000					fee = 7%.
		SUBTOTAL CAPITAL COST		**$2,642,000**					
Annual Cost									
Annual Cover Maintenance (Years 1-30)	30	ls	$39,000	$1,170,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Year 5	1	ls	$50,000	$50,000					

Five-Year Review Year 10	1	ls	$50,000	$50,000					
Five-Year Review Year 15	1	ls	$50,000	$50,000					
Five-Year Review Year 20	1	ls	$50,000	$50,000					
Five-Year Review Year 25	1	ls	$50,000	$50,000					
Five-Year Review Year 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,140,000**					
			TOTAL	**$4,782,000**					
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$2,642,000	$2,642,000				**$2,642,000**	
Annual Cover Maintenance (Years 1-30)	30	ls	$39,000	$1,170,000				**$838,481**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital	**$2,642,000**	
					Present Worth Values		**Annual**	**$1,570,000**	
							Avg. Annual	**$52,333**	
							Total Cost	**$4,212,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									

1.0 Project Plans										
	Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
	Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
	Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
	Remdial Design Report	1	LS	$250,000	$250,000					Engr Est.
	Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
	QA Plan	1	LS	$50,000	$50,000					Engr Est.
	Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
	Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
	TASK TOTAL				**$765,000**			**0**	**$765,000**	
2.0 Engineering Design										
	Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
	Design	1	LS	$55,000	$55,000					Engr Est.
	TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review										
	Work Instructions	1	LS	$20,000	$20,000					
	Training	1	LS	$847	$847					
	USD/USQD	1	LS	$3,104	$3,104					
	Lessons Learned	1	LS	$260	$260					
	Procedures	1	LS	$1,445	$1,445					
	AHA	1	LS	$846	$846					
	Work Authorization	1	LS	$475	$475					
	Excavation/Penetration Permits	1	LS	$2,185	$2,185					
	Team Meeting Documentation	1	LS	$333	$333					
	Emergency Response Plan	1	LS	$4,890	$4,890					
	Transportation Plan	1	LS	$2,510	$2,510					
	Project Org. Chart	1	LS	$950	$950					
	TASK TOTALS	1		$37,845	**$ 37,845**			**0**	**$38,000**	Engr Est.
4.0 Training										
Assumptions: Cleared and local labor.										
Labor										
	LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
	Subcontractors	1	LS	$20,000	$20,000					Engr Est.
	TASK TOTALS				**$20,000**	**1,040**		**$62,026**	**$82,000**	

5.0 Mobilization									
Duration: Assume two weeks for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**0.5**	**Month**							
Labor									
LATA Labor					1155		$76,508		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	110	hr	$31	$3,410					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	0.5	Month	$4,150	$2,075					Engr Est.
Dozer	0.5	Month	$2,800	$1,400					Engr Est.
Water Truck, 2000 gal	0.5	Month	$1,850	$925					Engr Est.
Compactor/12 ton/pad foot	0.5	Month	$3,090	$1,545					Engr Est.
Compactor/12 ton/smooth drum	0.5	Month	$2,920	$1,460					Engr Est.
Generator, 150 KW	0.5	Month	$2,006	$1,003					Engr Est.
Supply Trailer	0.5	Month	$448	$224					Engr Est.
TASK TOTALS				**$13,342**			**$76,508**	**$90,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two weeks for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**0.5**	**Month**							
LATA Labor					1155		$76,508		Engr Est., LATA Labor Rate

Equipment									
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Pickup Truck, crew cab, F250	0.5	month	$1,300	$650					Hertz
Front End Loader, 3.5CY	0.5	month	$4,150	$2,075					Engr Est.
Dozer	0.5	month	$2,800	$1,400					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Equipment Trailer	0.5	month	$300	$150					Engr Est.
Generator, 150 KW	0.5	month	$2,006	$1,003					Engr Est.
Two Portable Toilets	0.5	month	$300	$150					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 62,353**	**1155**		**$76,508**	**$139,000**	
7.0 One foot topsoil cover Installation									
Duration: Assume 0.5 month									
Assumptions: Backfilling based on 1500 cy/day. 10 hrs/wday and 22 wdays/month.									
Labor 100% cleared and local.									
Schedule	**0.5**	**month**							
Labor									
LATA Labor					1870		$131,010		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, 4x4	0.5	month	$1,300	$650					Hertz
Pickup Truck, crew cab, 4x4	0.5	month	$1,300	$650					Hertz
Dozer, JD, 99Hp	0.5	month	$2,800	$1,400					Engr Est.
Front End Loader	0.5	month	$4,150	$2,075					Engr Est.
Compactor/12 ton/pad foot	0.5	month	$3,090	$1,545					Engr Est.
Compactor/12 ton/smooth drum	0.5	month	$2,920	$1,460					Engr Est.
Water Truck, 2000 gal	0.5	month	$1,850	$925					Engr Est.
Two Portable Toilets	0.5	month	$300	$150					

Subcontractors									
Top Soil Delivered	2,100	ton	$16	$33,600					Vendor quote, local
Compaction Testing	162	test	$54	$8,748					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
Hydroseed Bluegrass	87	MSF	$50	$4,356					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$56,399**	**1870**		**$131,010**	**$187,000**	
8.0 Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									Envirocare, 60 drums per truckload
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.

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Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
9.0 O&M Manual and Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**				**$225,000**	
							SUBTOTAL CAPITAL COST	**$1,975,000**	
Annual Cover Maintenance (Years 1-30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					320		$21,054		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	2	acre	$400	$800					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,100**			**$21,054**	**$39,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,300	$1,300					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.

Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,030	$46,642					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		

Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 3
Alternative 3.a.t6 - Soil Cover, L, M, E

Escalated

Date	Yr	Esca- lation	Esca- lation Factor	Capital	Annual Cover Maintenance (Years 1-30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012		1	1.000	$2,642,000						
2013	1	1.029	1.029		$40,131	$95,697				$ 135,828
2014	2	1.029	1.059		$41,295	$98,472				$ 139,767
2015	3	1.029	1.090		$42,492		$30,507			$73,000
2016	4	1.029	1.121		$43,725		$31,392			$75,117
2017	5	1.029	1.154		$44,993		$32,302		$57,683	$134,978
2018	6	1.029	1.187		$46,297			$37,988		$84,285
2019	7	1.029	1.222		$47,640					$47,640
2020	8	1.029	1.257		$49,022			$40,223		$89,244
2021	9	1.029	1.293		$50,443					$50,443
2022	10	1.029	1.331		$51,906			$42,590	$66,546	$161,042
2023	11	1.029	1.370		$53,411					$53,411
2024	12	1.029	1.409		$54,960			$45,096		$100,056
2025	13	1.029	1.450		$56,554					$56,554
2026	14	1.029	1.492		$58,194			$47,749		$105,943
2027	15	1.029	1.535		$59,882				$76,772	$136,653
2028	16	1.029	1.580		$61,618			$50,559		$112,177
2029	17	1.029	1.626		$63,405					$63,405
2030	18	1.029	1.673		$65,244			$53,534		$118,778
2031	19	1.029	1.721		$67,136					$67,136
2032	20	1.029	1.771		$69,083			$56,684	$88,568	$214,335
2033	21	1.029	1.823		$71,087					$71,087
2034	22	1.029	1.876		$73,148			$60,019		$133,167
2035	23	1.029	1.930		$75,269					$75,269
2036	24	1.029	1.986		$77,452			$63,551		$141,003
2037	25	1.029	2.044		$79,698				$102,177	$181,876
2038	26	1.029	2.103		$82,010			$67,290		$149,299
2039	27	1.029	2.164		$84,388					$84,388
2040	28	1.029	2.227		$86,835			$71,249		$158,084
2041	29	1.029	2.291		$89,353					$89,353
2042	30	1.029	2.358		$91,945			$37,721	$117,878	$247,543
TOTAL				$2,642,000	$1,878,618	$194,169	$94,202	$674,250	$509,624	$5,992,863

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1-30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$ 2,642,000	$0					
2013	1	1	1.00		$39,000	$93,000				
2014	2	1	1.00		$39,000	$93,000				$ 132,000
2015	3	1	1.00		$39,000		$28,000			$67,000
2016	4	1	1.00		$39,000		$28,000			$67,000
2017	5	1	1.00		$39,000		$28,000		$50,000	$117,000
2018	6	1	1.00		$39,000			$32,000		$71,000
2019	7	1	1.00		$39,000					$39,000
2020	8	1	1.00		$39,000			$32,000		$71,000
2021	9	1	1.00		$39,000					$39,000
2022	10	1	1.00		$39,000			$32,000	$50,000	$121,000
2023	11	1	1.00		$39,000					$39,000
2024	12	1	1.00		$39,000			$32,000		$71,000
2025	13	1	1.00		$39,000					$39,000
2026	14	1	1.00		$39,000			$32,000		$71,000
2027	15	1	1.00		$39,000				$50,000	$89,000
2028	16	1	1.00		$39,000			$32,000		$71,000
2029	17	1	1.00		$39,000					$39,000
2030	18	1	1.00		$39,000			$32,000		$71,000
2031	19	1	1.00		$39,000					$39,000
2032	20	1	1.00		$39,000			$32,000	$50,000	$121,000
2033	21	1	1.00		$39,000					$39,000
2034	22	1	1.00		$39,000			$32,000		$71,000
2035	23	1	1.00		$39,000					$39,000
2036	24	1	1.00		$39,000			$32,000		$71,000
2037	25	1	1.00		$39,000				$50,000	$89,000
2038	26	1	1.00		$39,000			$32,000		$71,000
2039	27	1	1.00		$39,000					$39,000
2040	28	1	1.00		$39,000			$32,000		$71,000
2041	29	1	1.00		$39,000					$39,000
2042	30	1	1.00		$39,000			$16,000	$50,000	$105,000
TOTAL				$ 2,642,000	$ 1,170,000	$ 186,000	$ 84,000	$ 400,000	$ 300,000	$ 4,782,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 3 (C404)

Alternative 5 - Excavation and Disposal

Parameter			Total	Units	Basis
SWMU Dimensions					
		SWMU Width	137	feet	DOE, 2010
		SWMU Length	387	feet	DOE, 2010
		SWMU Area	53,000	SF	Engr Est
		Area of RCRA Cap	2	acres	DOE, 2007
		Depth of RCRA Cap	5	feet	Engr Est
Waste Volume Calc					
		Waste Volume (based on GIS)	48,437	BCY	calc
		Conversion	1.20	LCY/BCY	LATA Directive
		Excavated Waste Volume	58,124	LCY	calc
		Assumed Original Cover Area	0.48		Engr Est
		Assumed Buried Drum Area	0.17		Engr Est
		Assumed Area Under Drums	0.17		Engr Est
		Assumed Remaining SWMU Areas	0.17		Engr Est
		Original Cover Area Volume	28,000	LCY	calc
		Buried Drum Area Volume	10,000	LCY	calc
		Area Under Drum Area Volume	10,000	LCY	calc
		Remaining SWMU Area Volume	10,000	LCY	calc
		Clean Soil Volume (Original Cover Area + Remaining SWMU Area	38,000	LCY	calc
		Treated Waste Volume (Buried Drum Area + Under Drum Area	20,000	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est
		Clean Soil Tonnage	53,200	ton	calc
		Treated Waste Tonnage	28,000	ton	calc
Waste Volume Below Original Grade					
		Length of Lagoon	390	feet	Engr Est
		Width of Lagoon	140	feet	Engr Est
		Excavation Area	54,600	SF	calc
		Excavation Depth	4	feet	Engr Est
		Excavation Volume	218,400	CF	calc
		Conversion	27	CF/CY	calc
		Excavation Volume (BCY)	8,089	BCY	calc
		Conversion	1.20	LCY/BCY	LATA Directive
		Excavated Waste Volume (asssumed mixed waste - no treatement	9,707	LCY	calc
Absorbents for Soil					
		Absorbent Rate	0.54	lb/cf	LATA Directive
		Conversion	27.00	cf/cy	Lindeburg, 1990
		Absorbent Rate	14.58	lb/cy	calc
		Total Excavated Soils	58,124	LCY	calc
		Total Absorbent needed	847,000	lbs	calc
Excavation Duration					
		Excavation Rate for U Landfill WAC Compliant Waste	4,400	bcy/month/ crew	Engr Est., 200 cy/day/crew, 22 wdays/mo
		Excavation Rate for LLW / MLLW	2,200	bcy/month/ crew	Engr Est., 100 cy/day/crew, 22 wdays/mo
		No. of Crews	2	crew	Engr Est.
		Time to Excavate Clean Soil	4	month	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 3 (C404)

Alternative 5 - Excavation and Disposal

Parameter			Total	Units	Basis
		Time to Excavate Treated Waste	4	month	calc
		Total Excavation Time	7	month	calc
		Total Excavation Time	0.6	years	calc
		Work day	10	hrs/wday	Engr Est.
		Work week	5	wdays/wk	Engr Est.
		Work days per year	260	wdays/yr	calc
		Work hours per year	2,600	whour/yr	calc
		Work days per month	22	wdays/mo	calc
Groundwater Dewatering Production					
		Area	53,000	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	742,000	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume within Excavation	148,400	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume within Excavation	1,100,000	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est
		Time to remove one pore volume	611	hours	calc
		Time to remove one pore volume	25	days	calc
		Flowrate after removal of one pore volume	7.9	gpm	DOE, 1995, pg 17
		Fraction of time pumping occurs after removal of initial pore vol	0.20	fraction	Engr Est
		GW Rate after one pore volume removed	70,000	gal/month	calc
		Total Dewatering Volume	1,590,000	gal	calc
		Rad Sludge produced from Groundwater Trmt	22,000	gal	calc
		Water produced from Groundwater Trmt	1,568,000	gal	calc
Sludge Production from GW Treatment					
		Assumed Dewatering Rate	10,484	gal/day	calc
		Number of days operating	152	days	calc
		Dewatering total	1,590,000	gallons	Engr Est
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	15,900	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1991
		Est. Sludge production	80	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	289	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	5	trips	calc
Transportation Bags & Truck Liner					
		Transportation Bag Volume	8.96	CY	Pactec

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 3 (C404)

Alternative 5 - Excavation and Disposal

Parameter			Total	Units	Basis
		Bags required for LLW /MLLW	1,117	Bags	calc
		Truck Liner	16	CY	Engr Est.
		Liners required for U Landfill WAC Compliant Waste	1,750	Liners	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant Waste + 10 percent QA/QC	103	samples	Engr Est.
		Samples for LLW / MLLW + 10 percent QA/QC	37	samples	Engr Est.
Compaction Testing					
		Compaction Rate	20,000	SF/test	Engr Est
		Compaction Area	53,000	SF	DOE 2009
		Lift Thickness	2	feet	Engr Est.
		Number of Lifts	10	lifts	calc
		Number of Compactions Tests	30	tests	calc
Top Soil					
		Disturbed Area	2	acres	Engr Est.
		Conversion	43,560	SF/acre	
		Top Soil Thickness	1	feet	Engr Est.
		Conversion	27	CF/CY	
		Conversion	1	ton/CY	Engr Est.
		Top Soil tonnage	2,100	ton	calc
Fencing					
		Perimeter	921	feet	calc
		Fence Perimeter	2,000	feet	calc
Hydroseeding					
		Area	87,120	sf	Engr Est
		Area	87	MSF	calc
Trucking to existing U Landfill at PDGP					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	15	lcy	Engr Est
		Dump Trips for U Landfill WAC Compliant Waste	2,533	trips	calc
Trucking to Proposed On-Site Waste Disposal Facility					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	15	lcy	Engr Est
		Dump Trips for LLW / MLLW	3,180	trips	calc
PPE Rad Drums					
		Drums filled per day with PPE Rad Waste	1	drum/day	Engr Est
		No. of drums used during project	152	drums	calc
		Drums per Truckload	60	drums/trucklo	Engr Est
		Truck Trips	3	trips	calc
		Drum Volume	55	gal	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Total Volume of PPE	50	cy	calc

References:
DOE, 2009, BGOU Remedial Investigation Report.
Lindeburg, 1990, Engineering Unit Conversions.
US Army, 1994, Field Manual No. 5-430-00-1, Planning and Design of Roads, Airfields, and Helioports in the Theater of Operations - Road Design.

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COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Costs									
1.0 Project Plans	1	ls	$1,299,000	$1,299,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Procurement	1	ls	$135,000	$135,000					
4.0 Training	1	ls	$86,000	$86,000					
5.0 Mobilization/Demobilization	1	ls	$275,000	$275,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$338,000	$338,000					
7.0 Excavation	1	ls	$1,389,000	$1,389,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$85,899,000	$85,899,000					
9.0 Backfill, Site Restoration, and Equipment	1	ls	$313,000	$313,000					
10.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$18,002,800	$18,003,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$7,561,190	$7,561,000					fee = 7%.
Contingency	1	ls	$23,115,600	$23,116,000					20% contingency
	SUBTOTAL CAPITAL COST			**$138,694,000**					
Construction Schedule	**17**	**month**							
Annual Cost									
Quarterly Groundwater LTM (Years 1 - 2)	1	ls	$0	$0					
Annual Groundwater LTM (Years 3 - 5)	1	ls	$0	$0					
Biannual Groundwater LTM (Years 6-30)	1	ls	$0	$0					
Five-Year Review Yr 5	1	ls	$0	$0					
Five-Year Review Yr 10	1	ls	$0	$0					
Five-Year Review Yr 15	1	ls	$0	$0					
Five-Year Review Yr 20	1	ls	$0	$0					
Five-Year Review Yr 25	1	ls	$0	$0					
Five-Year Review Yr 30	1	ls	$0	$0					
	SUBTOTAL ANNUAL COST			**$0**					
			TOTAL	**$138,694,000**					

Present Worth Value Cost									
	Quantity	Unit	Unit Cost	Total				Present Worth	
Total Capital Cost	1	ls	$138,694,000	$138,694,000				**$138,694,000**	
							Capital	**$138,694,000**	
						Present	**Annual**	**$0**	
						Worth	**Avg. Annual**	**$0**	
						Values	**Total**	**$138,694,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA,
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					LATA
Remedial Design Report	1	LS	$410,000	$410,000					LATA
Remedial Action Work Plan	1	LS	$211,000	$211,000					LATA
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,299,000**			**0**	**$1,299,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Procurement									
Subcontractor Procurement	1	LS	$75,000	$75,000					
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
UCD/USQD	1	LS	$4,000	$4,000					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$2,500	$2,500					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$135,395	**$ 135,395**			**0**	**$135,000**	Engr Est.

4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor 100% cleared and local.									
Labor									
LATA Personnel					1120		$66,000		Engr Est., LATA Labor Rates
Subcontractors	1	LS			1	$20,000	$20,000		Engr Est.
TASK TOTALS				**$0**			**$86,000**	**$86,000**	
5.0 Mobilization/Demobilization									
Duration: Assume one month for mobilization and demobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six 1.5xOT workday/month totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
(4)Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
(2) Excavator	2	month	$16,000	$32,000					Vendor quote
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Fork Lift 25 Ton	1	month	$2,920	$2,920					Vendor quote
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Crane, 65 ton	1	month	$10,000	$10,000					Vendor quote
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Supply Trailer	1	month	$448	$448					Engr Est.
Generator	1	month	$2,006	$2,006					Engr Est.
(7) 15cy Dump Truck	7	month	$3,714	$25,998					Vendor quote
Pinlock Trailer	1	month	$1,045	$1,045					Vendor quote
Tractor Trailer	1	month	$6,500	$6,500					Vendor quote
TASK TOTALS				**$114,567**	**2,750**		**$160,000**	**$275,000**	

6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning & lining ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor cleared and local.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	0	month	$6,000	$0					Liftech
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Crane	1	month	$1,600	$1,600					Vendor quote
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Geophysical Survey	1.00	ls	50,000.00	50,000.00					Engr Est
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$178,254**	**0**		**$160,000**	**$338,000**	
7.0 Excavation									
Duration: Approximately 7 months for excavation, staging, and sampling,									
based on excavating MLLW & LLW at 100 bcy/day/crew, U Landfill WAC Compliant Waste at 200 bcy/day/crew, Using two crews.									
Labor cleared and local. Includes transportation of excavated soil, waste, and debris to the staging area.									
The excavation will require some dewatering.									
The resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**7**	**month**							

Labor									
LATA Personnel					13000		$839,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	7	month	$1,300	$9,100					Hertz
Pickup Truck, crew cab, 4x4	7	month	$1,300	$9,100					Hertz
Excavator 2 CY	7	month	$15,160	$106,120					Vendor quote
Excavator 1 CY	7	month	$6,560	$45,920					Vendor quote
Dozer, JD, 99Hp	7	month	$3,050	$21,350					Vendor quote
Front End Loader	7	month	$4,150	$29,050					Engr Est.
Water Truck, 6000 gal	7	month	$11,000	$77,000					Engr Est.
Equipment Trailer	7	month	$150	$1,050					Engr Est.
Generator, 150 KW	7	month	$2,006	$14,042					Engr Est.
Two Portable Toilets	7	month	$300	$2,100					
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Materials									
Rad Allocation	2,110	hr	$31	$64,967					LATA RAD Allocation
Laundry	11,100	hr	$4	$38,850					LATA calculation
PPE	10,500	hr	$2	$24,885					LATA calculation
Confirmation Sampling									
Verification Samples	44	sample	$2,200	$96,800					Engr Est., 4 samples/ boring of excavation floor, 10% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$550,334**	**13,000**		**$839,000**	**$1,389,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation.									
Assumptions: Includes transportation from staging area to OSWDF.									
U Landfill WAC compliant waste will be transported to the U Landfill									
MLLW will be transported by rail to Energy Solutions for treatment and disposal									
MLLW from below the original grade will be excavated to 4 feet and transported to Energy Solutions for disposal.									
Uranium waste/Rad Material over packed for truck transport to NNSS.									
Labor 100% cleared and local.									
Schedule	**7**	**month**							
Labor									
LATA Personnel					18600		$1,200,000		Engr Est., LATA Labor Rates

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Equipment									
Crane, 65 ton	7	month	$10,000	$70,000					Vendor quote
15cy Dump Truck (7 each)	7	month	$26,000	$182,000					Vendor quote
Fork Lift 25 Ton	7	month	$10,200	$71,400					Vendor quote
Front End Loader	7	month	$1,700	$11,900					Vendor quote
Pinlock Trailer	7	month	$1,045	$7,315					Vendor quote
Tractor Trailer	7	month	$6,500	$45,500					Vendor quote
Disposal/Waste Sampling									
Cover Sampling	20	sample	$2,200	$44,000					Engr Est, 2 sample per boring plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Drum Sampling	325	sample	$2,200	$715,000					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per drum.
Confirmation Sampling	1800	sample	$400	$720,000					Engr Est, Metals, One sample per stabilized container plus QA/QC.
Sludge from Water Trmt	32	sample	$2,200	$70,400					Engr Est, 1 sample per 10 drums
Treated Waste Water	30	sample	$150	$4,500					One sample weekly for VOCs.
Transportation									
RM/Sources	1	trip	$11,000	$11,000					NNSS, one trip.
Untreated Waste	2,533	trips	$75	$190,000					U Landfill - , round trip is 10 miles,RS Means ECHOS 33 19 0209
Mixed Waste (no treatment)	136	gons	$19,400	$2,638,400					Energy Solutions by Rail, Eight bags per gondola, Includes fees
Treated Waste	278	gons	$19,400	$5,393,200					Energy Solutions by Rail, Eight bags per gondola, Includes fees
Sludge from Water Trmt	5	trips	$7,053	$35,265					Envirocare, 60 drums per truckload
Treatment									
Stabilization	20,005	CY	$1,721	$34,428,605					Energy Solutions
Disposal									
RM/Sources	1	B25 Box	$1,400	$1,400					NNSS, one B-25 Box
LLW	20,005	CY	$1,135	$22,705,675					Energy Solutions
Mixed Waste (no treatment)	9,707	CY	$1,135	$11,017,445					Energy Solutions
Sludge from Water Trmt	80	LCY	$632	$50,560					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	1,568,000	gal	$3	$4,704,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day

Materials									
Rad Allocation	3,010	hr	$31	$92,678					LATA RAD Allocation
Lift Bags	3,307	ea	$335.00	$1,107,845					Vendor Quote, 9 CY per bag
Loading Frame for bags	5	ea	$5,135.00	$25,675					Vendor Quote
Lifting Frame for bags	5	ea	$4,485.00	$22,425					Vendor Quote
Dump Truck Liners	2,533	ea	$95.00	$240,667					Vendor Quote
Laundry	14,290	hr	$3.50	$50,015					LATA calculation
PPE/Respirator	8,500	hr	$5.00	$42,500					LATA calculation
Task Total				**$84,699,370**			**$1,200,000**	**$85,899,000**	
9.0 Backfill, Site Restoration, and Equipment Decontamination.									
Duration: Assume 2 months									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Labor 100% cleared and local.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					3850		$254,218		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$3,050	$3,050					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					
Subcontractors									
Top Soil Delivered	2,100	ton	$16	$33,600					Engr Est.
Compaction Testing	30	test	$54	$1,620					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
Hydroseed Bluegrass	87	MSF	$50	$4,356					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$58,376**	**3850**		**$254,218**	**$313,000**	

10.0 Remedial Action Completion Report									Engr Est.
Reports									
As-Builts	1	ls	$15,000	$15,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$90,014,000**	

BGOU SWMU 3
Alternative 5.t5 - Excavation and Disposal

Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1	$138,694,000				
2013	1	1.029	1.029		$0			
2014	2	1.029	1.059		$0			
2015	3	1.029	1.090			$0		
2016	4	1.029	1.121			$0		
2017	5	1.029	1.154			$0		
2018	6	1.029	1.187				$0	
2019	7	1.029	1.222					
2020	8	1.029	1.257				$0	
2021	9	1.029	1.293					
2022	10	1.029	1.331				$0	
2023	11	1.029	1.370					
2024	12	1.029	1.409				$0	
2025	13	1.029	1.450					
2026	14	1.029	1.492				$0	
2027	15	1.029	1.535					
2028	16	1.029	1.580				$0	
2029	17	1.029	1.626					
2030	18	1.029	1.673				$0	
2031	19	1.029	1.721					
2032	20	1.029	1.771				$0	
2033	21	1.029	1.823					
2034	22	1.029	1.876				$0	
2035	23	1.029	1.930					
2036	24	1.029	1.986				$0	
2037	25	1.029	2.044					
2038	26	1.029	2.103				$0	
2039	27	1.029	2.164					
2040	28	1.029	2.227				$0	
2041	29	1.029	2.291					
2042	30	1.029	2.358				0	
TOTAL				$138,694,000				$138,694,000

BGOU SWMU 3
Alternative 5.t5 - Excavation and Disposal

Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1	$138,694,000				
2013	1	1.00	1.00		$0			
2014	2	1.00	1.00		$0			
2015	3	1.00	1.00			$0		
2016	4	1.00	1.00			$0		
2017	5	1.00	1.00			$0		
2018	6	1.00	1.00				$0	
2019	7	1.00	1.00					
2020	8	1.00	1.00				$0	
2021	9	1.00	1.00					
2022	10	1.00	1.00				$0	
2023	11	1.00	1.00					
2024	12	1.00	1.00				$0	
2025	13	1.00	1.00					
2026	14	1.00	1.00				$0	
2027	15	1.00	1.00					
2028	16	1.00	1.00				$0	
2029	17	1.00	1.00					
2030	18	1.00	1.00				$0	
2031	19	1.00	1.00					
2032	20	1.00	1.00				$0	
2033	21	1.00	1.00					
2034	22	1.00	1.00				$0	
2035	23	1.00	1.00					
2036	24	1.00	1.00				$0	
2037	25	1.00	1.00					
2038	26	1.00	1.00				$0	
2039	27	1.00	1.00					
2040	28	1.00	1.00				0	
2041	29	1.00	1.00					
2042	30	1.00	1.00				0	
TOTAL				$138,694,000				$138,694,000

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COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Costs									
1.0 Project Plans	1	ls	$1,299,000	$1,299,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Procurement	1	ls	$135,000	$135,000					
4.0 Training	1	ls	$86,000	$86,000					
5.0 Mobilization/Demobilization	1	ls	$275,000	$275,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$338,000	$338,000					
7.0 Excavation	1	ls	$1,389,000	$1,389,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$23,804,000	$23,804,000					
9.0 Backfill, Site Restoration, and Equipment	1	ls	$313,000	$313,000					
10.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$5,583,800	$5,584,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$2,345,210	$2,345,000					fee = 7%.
Contingency	1	ls	$7,169,600	$7,170,000					20% contingency
		SUBTOTAL CAPITAL COST		**$43,018,000**					
Annual Cost									
Quarterly Groundwater LTM (Years 1 - 2)	1	ls	$0	$0					
Annual Groundwater LTM (Years 3 - 5)	1	ls	$0	$0					
Biannual Groundwater LTM (Years 6-30)	1	ls	$0	$0					
Five-Year Review Yr 5	1	ls	$0	$0					
Five-Year Review Yr 10	1	ls	$0	$0					
Five-Year Review Yr 15	1	ls	$0	$0					
Five-Year Review Yr 20	1	ls	$0	$0					
Five-Year Review Yr 25	1	ls	$0	$0					
Five-Year Review Yr 30	1	ls	$0	$0					
		SUBTOTAL ANNUAL COST		**$0**					
			TOTAL	**$43,018,000**					

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value Cost									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$43,018,000	$43,018,000				**$43,018,000**	
							Capital	**$43,018,000**	
						Present	**Annual**	**$0**	
						Worth	**Avg. Annual**	**$0**	
						Values	**Total**	**$43,018,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA,
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					LATA
Remedial Design Report	1	LS	$410,000	$410,000					LATA
Remedial Action Work Plan	1	LS	$211,000	$211,000					LATA
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,299,000**			**0**	**$1,299,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Procurement									
Subcontractor Procurement	1	LS	$75,000	$75,000					
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
UCD/USQD	1	LS	$4,000	$4,000					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$2,500	$2,500					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$135,395	**$ 135,395**			**0**	**$135,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor 100% cleared and local.									
Labor									
LATA Personnel					1120		$66,000		Engr Est., LATA Labor Rates
Subcontractors	1	LS			1	$20,000	$20,000		Engr Est.
TASK TOTALS				**$0**			**$86,000**	**$86,000**	
5.0 Mobilization/Demobilization									
Duration: Assume one month for mobilization and demobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and six 1.5xOT workday/month totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Instruments									
RadCon Allocation	440	hr	$31	$13,640					Based on LATA Radcon allocation
Equipment									
(4)Pickup Truck, crew cab, 4x4	4	month	$1,300	$5,200					Hertz
(2) Excavator	2	month	$16,000	$32,000					Vendor quote
All Terrain Forklift	0		$900	$0					Hertz
Crane	0		$1,600	$0					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Fork Lift 25 Ton	1	month	$2,920	$2,920					Vendor quote
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Crane, 65 ton	1	month	$10,000	$10,000					Vendor quote
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Supply Trailer	1	month	$448	$448					Engr Est.

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Generator	1	month	$2,006	$2,006					Engr Est.
(7) 15cy Dump Truck	7	month	$3,714	$25,998					Vendor quote
Pinlock Trailer	1	month	$1,045	$1,045					Vendor quote
Tractor Trailer	1	month	$6,500	$6,500					Vendor quote
Loading Frame for bags	0	frame	$5,750	$0					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	0	frame	$3,600	$0					Pactec, 8'L x 5.5'W
TASK TOTALS				**$114,567**	**2,750**		**$160,000**	**$275,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation and construction laydown and staging areas.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning & lining ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor cleared and local.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	0	month	$6,000	$0					Liftech
Crane	0	month							
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Crane	1	month	$1,600	$1,600					Vendor quote
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$178,254**	**0**		**$160,000**	**$338,000**	
7.0 Excavation									
Duration: Approximately 7 months for excavation, staging, and sampling,									
based on excavating MLLW & LLW at 100 bcy/day/crew, U Landfill WAC Compliant Waste at 200 bcy/day/crew, Using two crews.									
Labor cleared and local. Includes transportation of excavated soil, waste, and debris to the staging area.									
The excavation will require some dewatering.									
The resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Schedule	**7**	**month**							
Labor									
LATA Personnel					13000		$839,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	7	month	$1,300	$9,100					Hertz
Pickup Truck, crew cab, 4x4	7	month	$1,300	$9,100					Hertz
Excavator 2 CY	7	month	$15,160	$106,120					Vendor quote
Excavator 1 CY	7	month	$6,560	$45,920					Vendor quote
Dozer, JD, 99Hp	7	month	$3,050	$21,350					Vendor quote
Front End Loader	7	month	$4,150	$29,050					Engr Est.
Water Truck, 6000 gal	7	month	$11,000	$77,000					Engr Est.
Equipment Trailer	7	month	$150	$1,050					Engr Est.
Generator, 150 KW	7	month	$2,006	$14,042					Engr Est.
Two Portable Toilets	7	month	$300	$2,100					
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Materials									
Rad Allocation	2,110	hr	$31	$64,967					LATA RAD Allocation
Laundry	11,100	hr	$4	$38,850					LATA calculation
PPE	10,500	hr	$2	$24,885					LATA calculation
Confirmation Sampling									
Verification Samples	44	sample	$2,200	$96,800					Engr Est., 4 samples/ boring of excavation floor, 10% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$550,334**	**13,000**		**$839,000**	**$1,389,000**	

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation.									
Assumptions: Includes transportation from staging area to OSWDF.									
LLW will be trucked to the proposed onsite Waste Disposal Facility.									
MLLW will be treated with grout and transported to the proposed onsite Waste Disposal Facility.									
MLLW from below the original grade will be excavated to 4 feet and transported to the onsite Waste Disposal Facility.									
Uranium waste/Rad Material over packed for truck transport to NNSS.									
Labor 100% cleared and local.									
Schedule	**7**	**month**							
Labor									
LATA Personnel					18600		$1,200,000		Engr Est., LATA Labor Rates
Equipment									
Crane, 65 ton	7	month	$10,000	$70,000					Vendor quote
15cy Dump Truck (7 each)	7	month	$26,000	$182,000					Vendor quote
Fork Lift 25 Ton	7	month	$10,200	$71,400					Vendor quote
Front End Loader	7	month	$1,700	$11,900					Vendor quote
Pinlock Trailer	7	month	$1,045	$7,315					Vendor quote
Tractor Trailer	7	month	$6,500	$45,500					Vendor quote
Disposal/Waste Sampling									
Cover Sampling	20	sample	$2,200	$44,000					Engr Est, 2 sample per boring plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Drum Sampling	325	sample	$2,200	$715,000					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per drum.
Confirmation Sampling	1800	sample	$400	$720,000					Engr Est, Metals, One sample per stabilized container plus QA/QC.
Sludge from Water Trmt	32	sample	$2,200	$70,400					Engr Est, 1 sample per 10 drums
Treated Waste Water	30	sample	$150	$4,500					One sample weekly for VOCs.
Transportation									
RM/Sources	1	trip	$11,000	$11,000					NNSS, one trip.
Untreated Waste	3,180	trips	$75	$238,535					Envirocare, 60 drums per truckload
Treated Waste	1,540	trips	$75	$115,500					OSWDF, round trip is 10 miles, RS Means ECHOS 33 19 0209

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COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Disposal									
RM/Sources	1	B25 Box	$1,400	$1,400					NNSS, one B-25 Box
Dewater/Wastewater Trmt	1,568,000	gal	$3	$4,704,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Rad Allocation	3,010	hr	$31	$92,678					LATA RAD Allocation
1/2 High Containers	1,540	ea	$8,850.00	$13,629,000					Vendor Quote
Plastic Liners	2,260	ea	$65.00	$146,900					Vendor Quote
Grout	16,000	CY	$83.00	$1,328,000					Vendor Quote, 10 CY grout to 13 CY of waste - total of 23 CY per half-high container.
Dump Truck Liners	3,180	ea	$95.00	$302,144					Vendor Quote
Laundry	14,290	hr	$3.50	$50,015					LATA calculation
PPE/Respirator	8,500	hr	$5.00	$42,500					LATA calculation
Task Total				**$22,603,687**			**$1,200,000**	**$23,804,000**	
9.0 Backfill, Site Restoration, and Equipment Decontamination.									
Duration: Assume 2 months									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Labor 100% cleared and local.									
Schedule	**1**	**month**							
Labor									
Travel									USGSA
Labor Travel Expenses	0	days	$109	$0					
LATA Personnel					3850		$254,218		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$3,050	$3,050					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Two Portable Toilets	1	month	$300	$300					

COST ESTIMATE
BGOU SWMU 3
Alternative 5.t5 WDF - Excavation & Disposal at WDF

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Subcontractors									
Top Soil Delivered	2,100	ton	$16	$33,600					Engr Est.
Compaction Testing	30	test	$54	$1,620					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
Hydroseed Bluegrass	87	MSF	$50	$4,356					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$58,376**	**3850**		**$254,218**	**$313,000**	
10.0 Remedial Action Completion Report									Engr Est.
Reports									
As-Builts	1	ls	$15,000	$15,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$27,919,000**	

BGOU SWMU 3
Alternative 5.t5 WDF - Excavation and Disposal (On-Site WDF)

Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1	$43,018,000				
2013	1	1.029	1.03		$0			
2014	2	1.029	1.06		$0			
2015	3	1.029	1.09			$0		
2016	4	1.029	1.12			$0		
2017	5	1.029	1.15			$0		
2018	6	1.029	1.19				$0	
2019	7	1.029	1.22					
2020	8	1.029	1.26				$0	
2021	9	1.029	1.29					
2022	10	1.029	1.33				$0	
2023	11	1.029	1.37					
2024	12	1.029	1.41				$0	
2025	13	1.029	1.45					
2026	14	1.029	1.49				$0	
2027	15	1.029	1.54					
2028	16	1.029	1.58				$0	
2029	17	1.029	1.63					
2030	18	1.029	1.67				$0	
2031	19	1.029	1.72					
2032	20	1.029	1.77				$0	
2033	21	1.029	1.82					
2034	22	1.029	1.88				$0	
2035	23	1.029	1.93					
2036	24	1.029	1.99				$0	
2037	25	1.029	2.04					
2038	26	1.029	2.10				$0	
2039	27	1.029	2.16					
2040	28	1.029	2.23				$0	
2041	29	1.029	2.29					
2042	30	1.029	2.36				$0	
TOTAL				$43,018,000				$43,018,000

BGOU SWMU 3
Alternative 5.t5 WDF - Excavation and Disposal (On-Site WDF)
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1 - 2)	Annual Groundwater LTM (Years 3 - 5)	Biannual Groundwater LTM (Years 6-30)	TOTALS
2012	0	1	1	$43,018,000				
2013	1	1.00	1.00		$0			
2014	2	1.00	1.00		$0			
2015	3	1.00	1.00			$0		
2016	4	1.00	1.00			$0		
2017	5	1.00	1.00			$0		
2018	6	1.00	1.00				$0	
2019	7	1.00	1.00					
2020	8	1.00	1.00				$0	
2021	9	1.00	1.00					
2022	10	1.00	1.00				$0	
2023	11	1.00	1.00					
2024	12	1.00	1.00				$0	
2025	13	1.00	1.00					
2026	14	1.00	1.00				$0	
2027	15	1.00	1.00					
2028	16	1.00	1.00				$0	
2029	17	1.00	1.00					
2030	18	1.00	1.00				$0	
2031	19	1.00	1.00					
2032	20	1.00	1.00				$0	
2033	21	1.00	1.00					
2034	22	1.00	1.00				$0	
2035	23	1.00	1.00					
2036	24	1.00	1.00				$0	
2037	25	1.00	1.00					
2038	26	1.00	1.00				$0	
2039	27	1.00	1.00					
2040	28	1.00	1.00				$0	
2041	29	1.00	1.00					
2042	30	1.00	1.00				0	
TOTAL				$43,018,000				$43,018,000

SWMU 7 COST ESTIMATES

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SWMU 7 Remedial Alternatives Cost Estimate Summary

Alternative	Description	Annual Time Period, yrs	Capital $ (2012 Constant Dollars)	PRESENT WORTH [1] Total Annual $	PRESENT WORTH [1] Total $ (Capital & Annual)	ESCALATED Total Annual $	ESCALATED Total $ (Capital & Annual)
1	No Action	0	$0	$0	$0	$0	$0
2.t6	Limited Action: LUCs, Monitoring, Existing Features	30	$2,001,000	$1,699,000	$3,700,000	$3,639,881	$5,640,881
3.b.t6	18/6 Cover, LUCs, Monitoring, Existing features	30	$4,204,000	$1,699,000	$5,903,000	$3,639,881	$7,843,881
3.d.t6	Subtitle D Cap, LUCs, Monitoring, Existing Features	30	$6,491,000	$1,699,000	$8,190,000	$3,639,881	$10,130,881
4.b.t1.t6	18/6 Cover, ERH, L, M, E	30	$31,580,000	$1,699,000	$33,279,000	$3,639,881	$35,219,881
4.d.t1.t6	Subtitle D Cap, ERH, LUCs, Monitoring, Existing Features	30	$34,122,000	$1,699,000	$35,821,000	$3,639,881	$37,761,881
4.b.t3.t6	18/6 Cover, ZVI, LUCs, Monitoring, Existing Features	30	$8,219,000	$1,699,000	$9,918,000	$3,639,881	$11,858,881
4.d.t3.t6	Subtitle D Cap, ZVI, LUCs, Monitoring, Existing Features	30	$10,426,000	$1,699,000	$12,125,000	$3,639,881	$14,065,881
4.b.t4.t6	18/6 Cover, Bio, LUCs, Monitoring, Existing Features	30	$7,461,000	$1,699,000	$9,160,000	$3,639,881	$11,100,881
4.d.t4.t6	Subtitle D Cap, Bio, LUCs, Monitoring, Existing Features	30	$9,667,000	$1,699,000	$11,366,000	$3,639,881	$13,306,881
5.t6.CR	Excavation and Disposal, Existing Features, Contingent Remedy	30	$73,306,000	$0	$73,306,000	$0	$73,306,000
5.t6.CR+WDF	Exc. and Disposal, Existing Features, Potential WDF Use, Contingent Remedy	30	$31,016,000	$0	$31,016,000	$0	$31,016,000
6.b.t6.CR	Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features	30	$17,544,000	$1,699,000	$19,243,000	$3,639,881	$21,183,881
6.d.t6.CR	Targeted Exc. and Disposal, Subtitle D Cap, LUCs, Monitoring, Existing Features	30	$20,056,000	$1,699,000	$21,755,000	$3,639,881	$23,695,881

Notes:
(1) Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.

ESTIMATE BASIS
SWMU 7 (C-747-A Burial Ground)

A. SWMU Dimensions

SWMU comprised of ten waste cells (Pits B, C, D, E, F1-F5, and G).
Pits reportedly filled with wastes and covered with 3 ft of earth.

Boundary of site extended to the north and south to include the area between the current boundary and the ditches.

Geophysical investigation identified another anomaly in the shape of a rough circular area (15 ft diameter) west of the F-4 and F-5 Pits between SWMU 30 and SWMU 7.

Approximate depths of Pits is 7 ft.

Waste cell fraction of SWMU area based on quantity take off (DOE, 2010).

SWMU dimensions estimated at 200 ft x 850 ft.

SWMU Width =	200	ft
SWMU Length =	850	ft
SWMU Area =	170,000	sf
Est. Fraction of the SWMU area comprised of burial cells =	0.40	
Estimated Area containing Burial Cells =	68,000	sf

Reference: DOE, 2010

B. Unquantifiable Disposal Items

DNAPL source may exist between SWMUs 7 and 30.

Radiologically contaminated scrap drums reportedly filled the area between the F Pits and Pit G, corroborated by geophysical evidence.

Contaminated drums (Drum Mountain) formerly located on southeast corner of surface covering Pit G.

A PGDP scrap metal project covered the west half of SWMU 7 with 1 to 2 ft of gravel as a working base for traffic.

Burial Pit	Description of Buried Waste
Pit B	Buried material includes noncombustible trash and contaminated and noncombustible material and equipment. No specific disposal records exist.
Pit C	same as Pit B
Pit D	Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases from C-410 used during the fluorination process of uranium tetrafluoride to uranium hexafluoride.
Pit E	Documented buried material consists of uranium-contaminated concrete pieces of reactor tray bases.
Pits F1-F5	Documented buried material consists of uranium-contaminated scrap metal and equipment and empty uranium and magnesium power drums. Drawings indicate a sixth F Pit that was not numbered.
Pit G	Documented buried material consists of noncombustible trash and contaminated and noncombustible material and equipment.

Reference: DOE, 2010

ESTIMATE BASIS
SWMU 7 (C-747-A Burial Ground)

C. Excavation and Disposal

Assumptions:

Burial cells encompass 60% of SWMU area.

Excavate to a maximum depth of 20 feet bgs.

Burial pits reportedly 7 ft; however, geophysics indicated depths of 8-15 ft. Assume average depth of 10 ft to bottom of waste.

Excavation increases soil volume by a factor of 20 percent during handling (bank to loose).

Soil density is 100 pounds per cubic foot.

All excavated soil will require addition of sorbent to reduce moisture content.
Density of sorbent will increase soil volume by 0.54 percent. Assume 0.54 lbs sorbent added to 100 lbs soil (or each cubic foot of soil).

Excavated Soil Volume Calculation

Area (SF)	Beginning Depth (feet bgs)	End Depth (feet bgs)	Quantity (BCY)	Quantity (LCY)	**Quantity (LCY) w/sorbent**	% Off-Site Disposal	**Off-Site (CY)**	**On-Site (CY)**
68,000	0	2	5,037	6,044	6,077	0	0	6,077
68,000	2	5	7,556	9,067	9,116	0	0	9,116
68,000	5	11	15,111	18,133	18,231	100	18,231	0
68,000	11	20	22,667	27,200	27,347	75	20,510	6,837
						Total	**39,000**	**22,000**
							64%	36%

Material excavated from 0-5 ft will be primarily nonhazardous LLW (gravel and fill).

D. Dewatering Estimate for Excavation

Sheet pile installed around perimeter of excavation =	1000	lf
Assumed depth to groundwater (DOE, 2010) =	5	ft
Assumed bottom of Excavation below grade =	20	ft
Groundwater Thickness =	15	ft
Assumed Average Site Soil Porosity =	0.2	
Area to be Dewatered =	68,000	sf

Initial Pore Volume = Area x Groundwater Thickness x Porosity

Estimate of Initial Pore Volume to Dewater

area (sf)	thickness (ft)	porosity	Volume (cubic ft)	Volume (gallon)
68,000	15	0.2	204,000	1,500,000

Assumed removal rate achieved for dewatering initial pore volume =	30	gpm
Dewatering rate after removal of initial pore volume (DOE, 1998, pg 17) =	7.9	gpm

ESTIMATE BASIS
SWMU 7 (C-747-A Burial Ground)

E. Cap or Cover

For a cap or cover, extend SWMU by 5 ft to edge of north south drainage ditches.

feet	feet	Area (SF)
210	860	180,600

Perimeter of cap
2140 feet

F. Source Area Excavation and Thermal Treatment

Disposal cell areas will be subjected to in situ thermal treatment for removal of volatile organic compounds.
Source area perimeter will be sheet piled, then excavated down to 20 ft.
Excavation to be backfilled, then sheet pile removed.

G. References

DOE, 2010, BGOU Remedial Investigation Report

DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 2 - Limited Action: Land use controls, monitoring, existing features

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		SWMU Area	170,000	SF	Engr Est
		Buffer	5	feet	Engr Est
		Soil Cover Area	180,600	SF	Calc
		Soil Cover Perimeter	1,670	feet	Calc

References:
Lindeburg, 1990, Engineering Unit Conversions

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$726,000	$726,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$29,000	$29,000					
4.0 Training	1	ls	$72,000	$72,000					
5.0 Well Installation	1	ls	$344,000	$344,000					
6.0 Remedial Action Completion Reporting	1	ls	$220,000	$220,000					
Management reserve, Subproject Management	1	ls	$374,000	$374,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$130,900	$131,000					Fee = 7%
		SUBTOTAL CAPITAL COST		**$2,001,000**					
Construction Schedule	**1**	**Months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	ls	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
Annual Cost - Monitoring									
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$4,321,000**					

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COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$2,001,000	$2,001,000				**$2,001,000**	
Annual Cover Maintenance (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$2,001,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$3,700,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$211,000	$211,000					Engr Est.
Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$726,000**			**0**	**$726,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,062	$55,062					Engr Est.
TASK TOTAL				**$105,062**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$10,819	$10,819					Engr Est.
Training	1	LS	$847	$847					Engr Est.
USD/USQD	1	LS	$3,104	$3,104					Engr Est.
Lessons Learned	1	LS	$260	$260					Engr Est.
Procedures	1	LS	$1,445	$1,445					Engr Est.
AHA	1	LS	$846	$846					Engr Est.
Work Authorization	1	LS	$475	$475					Engr Est.
Excavation/Penetration Permits	1	LS	$2,185	$2,185					Engr Est.
Team Meeting Documentation	1	LS	$333	$333					Engr Est.
Emergency Response Plan	1	LS	$4,890	$4,890					Engr Est.
Transportation Plan	1	LS	$2,510	$2,510					Engr Est.
Project Org. Chart	1	LS	$950	$950					Engr Est.
TASK TOTALS	1		$28,664	**$ 28,664**			**0**	**$29,000**	
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$10,000	$10,000					Engr Est.
TASK TOTALS				**$10,000**			**$62,026**	**$72,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
5.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
6.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$10,000	$10,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$220,000**			**$0**	**$220,000**	
							SUBTOTAL CAPITAL COST	**$1,496,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

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COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Bi-Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
2.t6
Limited Action: LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$2,001,000						$2,001,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$2,001,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$5,641,000

BGOU SWMU 7
2.t6
Limited Action: LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$2,001,000	$0	$0	$0	$0	$0	$2,001,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$2,001,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$4,321,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 3 - Surface cover, land use controls and monitoring.

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		SWMU Area	170,000	SF	Engr Est
		Buffer	5	feet	Engr Est
		Soil Cover Area	180,600	SF	Calc
		Soil Cover Perimeter	1,670	feet	Calc
	Hydraulic Isolation Barrier				
		Depth of Barrier Wall	40	feet	Engr Est
		Barrier Wall Area	66,800	sf	Calc
	Groundwater Sumps				
		Assumed separation between perimeter sumps	100	ft	
		No. of perimeter sumps	1,700	sumps	
		Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
		Perimeter of Cap	11,304	sf/sump	calc
		No. of Sumps required for dewatering under Cap	15	sumps	calc
Soil Volume Calc					
	Cover Soil Volume				
		Cover Soil Thickness; 10-5 cm/s hydraulic conductivity	1.5	feet	Engr Est
		Cover Soil Volume - Compacted	10,033	CCY	calc
		Conversion	1.41	CCY/LCY	US Army, 1994
		Cover Soil Volume - Loose	14,150	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Cover Soil Tonnage	20,000	ton	calc
	Top Soil Volume				
		Top Soil Thickness	0.5	feet	Engr. Est.
		Top Soil Volume - compacted	3,340	CCY	calc
		Conversion	1.39	CCY/LCY	US Army, 1994
		Top Soil Volume - Loose	4,700	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Top Soil Tonnage	6,600	ton	Engr Est.
Cap Construction Duration					
		Cap Construction Rate	1000	LCY/day/ crew	Engr Est.
		Cap Construction Duration	19	wdays	calc
		Conversion	10	hrs/wday	Engr Est.
		Conversion	5	wday/wks	Engr Est.
		Cap Construction Duration	190	hrs	calc
		Cap Construction Duration	4	wks	calc
		Cap Construction Duration	2	months	Engr Est.
Compaction Testing					
		Compaction Rate	10,000	SF/test	Engr Est
		Compaction Area	180,600	SF	calc
		Lift Thickness	1	feet	Engr Est.
		Number of Lifts	2	lifts	calc
		Number of Compactions Tests	40	tests	calc
Fence Dimensions					
		Area	170,000	sf	DOE, 2009
		Buffer Length	60	feet	Engr Est.
		SWMU Perimeter/Fence Length	1,890	feet	calc
		Fenced Area plus 10 ft path outside perimeter of fence (mowing area)	190,000	sf	calc
Drums Reqd for Post Holes					
		Distance between posts	8	feet	Engr Est
		Number of post holes	236	post holes	Engr Est
		Post hole depth	3	feet	Engr Est
		Post hole diameter	1	feet	Engr Est

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 3 - Surface cover, land use controls and monitoring.

Parameter			Total	Units	Basis
		Post hole volume	0.79	cf/post hole	calc
		Total volume of post hole soil	1,737	cf	calc
		Drum volume	55	gal	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Drum volume	7	cf/drum	calc
		No. of Drums	240	drums	calc

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COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$740,000	$740,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$42,000	$42,000					
4.0 Training	1	ls	$82,000	$82,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 Install 18" Clay/ 6" soil cover	1	ls	$879,000	$879,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$785,750	$786,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$275,030	$275,000					Fee = 7%
		SUBTOTAL CAPITAL COST		**$4,204,000**					
Construction Schedule	**8**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Bi-annual Groundwater LTM (Years 6 - 30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$6,524,000**					

COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$4,204,000	$4,204,000				**$4,204,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Bi-annual Groundwater LTM (Years 6 - 30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$4,204,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$5,903,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$225,000	$225,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$740,000**			0	**$740,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			0	**$105,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$24,000	$24,000					Engr Est.
Training	1	LS	$847	$847					Engr Est.
USD/USQD	1	LS	$3,104	$3,104					Engr Est.
Lessons Learned	1	LS	$260	$260					Engr Est.
Procedures	1	LS	$1,445	$1,445					Engr Est.
AHA	1	LS	$846	$846					Engr Est.
Work Authorization	1	LS	$475	$475					Engr Est.
Excavation/Penetration Permits	1	LS	$2,185	$2,185					Engr Est.
Team Meeting Documentation	1	LS	$333	$333					Engr Est.
Emergency Response Plan	1	LS	$4,890	$4,890					Engr Est.
Transportation Plan	1	LS	$2,510	$2,510					Engr Est.
Project Org. Chart	1	LS	$950	$950					Engr Est.
TASK TOTALS	1		$41,845	**$ 41,845**			**0**	**$42,000**	
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$20,000	$20,000					Engr Est.
TASK TOTALS				**$20,000**	**1,040**		**$62,026**	**$82,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Travel									
Labor Travel Expenses	0	days	$109	$0					
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**	**4620**		**$279,190**	**$363,000**	
7.0 Install 18" Clay/ 6" soil cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of installation of 18" clay/6" soil cover over the SWMU.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$457,380		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
18" Clay	12,040	LCY	$21	$253,000					Engr Est.
6" Soil cover	4,013	LCY	$23	$92,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz

COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Portable Toilet	3	month	$150	$450					Engr Est.
TASK TOTAL				**$421,548**	**6930**		**$457,380**	**$879,000**	
8.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz

COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$3,143,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST

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COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,300	$1,300					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,030	$46,642					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST

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COST ESTIMATE
BGOU SWMU 7
Alternative 3.b.t6 - 18/6 cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
3.b.t6
18/6 Cover, LUCs, Monitoring, Existing features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Bi-annual Groundwater LTM (Years 6 - 30)	Five-Year Reviews	TOTALS
2012	0	1	1	$4,204,000						$4,204,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$4,204,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$7,843,881

BGOU SWMU 7
3.b.t6
18/6 Cover, LUCs, Monitoring, Existing features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly GW LTM (Yrs 1 - 5)	Semi-Annual GW LTM (Yrs 6 - 10)	Annual GW LTM (Yrs 11 - 30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$4,204,000	$0	$0	$0	$0	$0	$4,204,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$4,204,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$6,524,000

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BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$816,000	$816,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$46,000	$46,000					
4.0 Training	1	ls	$82,000	$82,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 - Subtitle D Cover Installation	1	ls	$2,509,000	$2,509,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,213,250	$1,213,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$424,620	$425,000					Fee = 7%
		SUBTOTAL CAPITAL COST		**$6,491,000**					
Construction Schedule	**11**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Bi-annual Groundwater LTM (Years 6 - 30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$8,811,000**					

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Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$6,491,000	$6,491,000				**$6,491,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Bi-annual Groundwater LTM (Years 6 - 30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$6,491,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$8,190,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$240,000	$240,000					Engr Est.
Remedial Action Work Plan	1	LS	$211,000	$211,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$816,000**				**$816,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**				**$105,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$28,000	$28,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$45,845	**$ 45,845**				**$46,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$20,000	$20,000					Engr Est.
TASK TOTALS				**$20,000**	**1,040**		**$62,026**	**$82,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**	**0**		**$279,190**	**$363,000**	
7.0 - Subtitle D Cover Installation									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Schedule	**6**	**Month**							
Labor									
LATA Labor					13860		$914,760		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
Vegetative Soil Layer	20,067	LCY	$23	$461,533					Vendor Quote
Drainage Layer with a min perm 1E-03 cm/sec	6,689	LCY	$21	$140,467					Vendor Quote
Clay Layer with a min perm of 1E-07 cm/sec	10,033	LCY	$21	$210,700					Vendor Quote
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Sand Gas Venting System with a min perm 1E-03 cm/sec	6,689	LCY	$45	$301,000					Engr Est.
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz

COST ESTIMATE
BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Front End Loader	6	month	$4,150	$24,900					Engr Est.
Dozer	6	month	$2,800	$16,800					Engr Est.
Compactor/12 ton/pad foot	6	month	$3,090	$18,540					Engr Est.
Compactor/12 ton/smooth drum	6	month	$2,920	$17,520					Engr Est.
Water Truck, 2000 gal	6	month	$1,850	$11,100					Engr Est.
Equipment Trailer	6	month	$300	$1,800					Engr Est.
Generator, 15KW	6	month	$2,006	$12,036					Engr Est.
Portable Toilet	6	month	$150	$900					Engr Est.
TASK TOTAL				**$1,594,096**			**$914,760**	**$2,509,000**	
8.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									

COST ESTIMATE
BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$4,853,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.

COST ESTIMATE
BGOU SWMU 7
Alternative 3.d.t6 - Subtitle D cover, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
3.d.t6
Subtitle D Cap, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Bi-annual Groundwater LTM (Years 6 - 30)	Five-Year Reviews	TOTALS
2012	0	1	1	$6,491,000						$6,491,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$6,491,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$10,131,000

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BGOU SWMU 7
3.d.t6
Subtitle D Cap, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Bi-annual Groundwater LTM (Years 6 - 30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$6,491,000	$0	$0	$0	$0	$0	$6,491,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$6,491,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$8,811,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 4 - Surface cover, source treatment, land use controls and monitoring

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		Approximate SWMU Surface Area	170,000	sf	Engr Est
		Recommended Buffer	5	feet	Engr Est
		Perimeter of Cap	2,100	feet	Calc
		Area of the Cap	180,600	sf	Calc
		Conversion	43,560	sf/acre	Calc
		Area of the Cap	4.15	acre	Calc
	Hydraulic Isolation Barrier				
		Depth of Barrier Wall	40	feet	Engr Est
		Barrier Wall Area	84,000	sf	Calc
	Groundwater Sumps				
		Assumed separation between perimeter sumps	100	ft	
		No. of perimeter sumps	21	sumps	
		Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
		Perimeter of Cap	11,304	sf/sump	calc
		No. of Sumps required for dewatering under Cap	16	sumps	calc
	Groundwater Pore Volume				
		Cap Area	180,600	sf	calc
		Depth to Groundwater	6	ft	Engr Est
		Depth to be dewatered	20	ft	Engr Est.
		Volume to be dewatered	2,528,400	cf	calc
		Landfill porosity	0.20		Engr Est.
		Groundwater Pore Volume beneath Cap	505,680	cf	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Groundwater Pore Volume beneath Cap	3,782,000	gal	calc
		Initial Dewatering Rate	30.0	gpm	Engr Est
		Time to remove one pore volume	2,101	hours	calc
		Time to remove one pore volume	88	days	Calc
		Flowrate after removal of one pore volume	7	gpm	SWMU 2 IROD
		GW Rate after one pore volume removed	302,400	gal/month	Engr Est.
		GW Rate after one pore volume removed	3,628,800	gal/yr	Engr Est.
Electrical Requirements					
		Sump Pump Power Reqm	2	Hp	ww.grundfos.com, MPX-75
		Air Stripper Water Pump	2	Hp	Engr Est.
		Vapor Phase Carbon Blower	2	Hp	Engr Est.
		Air Stripper Blower	2	Hp	Engr Est.
		Effluent Pump	2	Hp	Engr Est.
		No. of Pumps/Blowers	21	pumps	Engr Est.
		Pump/Blower Horsepower	42	Hp	calc
		Conversion	0.7457	KW/Hp	Lindeburg, 1990
		Total Power Reqm.	31	KW	calc
		Annual Operation Time	8,760	hrs	calc
		Annual Power Consumption	300,000	KW-hrs/yr	calc
		Electricity Cost	0.050	$/KW-hrs	www.eia.doe.gov

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 4 - Surface cover, source treatment, land use controls and monitoring

Parameter			Total	Units	Basis
Off Gas Operation					
		Assumed Air Stripper off gas flow rate	150	cfm	NEEP Systems
		Maximum Annual Offgas Processing, continuous operation	79,000,000	cf/yr	calc
Air Stripper Operation					
		Assumed Flowrate	8	gpm	SWMU 2 IROD
		Maximum Annual Flowrate	4,000,000	gal/yr	calc
Calculations for *In Situ* Source Treatment (Electrical Resistance Heating)					
(Alternative 1)					
SWMU Area					
		Treatment area length	75	feet	Engr Est.
		Treatment area width	75	feet	Engr Est.
		Source Treatment Area	5,625	sf	calc
Volume of Waste Requiring Treatment					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$900,000	$900,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$53,000	$53,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 ERH System Installation and Operation	1	ls	$17,172,000	$17,172,000					
8.0 Install 18" Clay/ 6" soil cover	1	ls	$879,000	$879,000					
9.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$4,099,200	$4,099,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,721,650	$1,722,000					fee = 7%.
Contingency	1	ls	$5,263,400	$5,263,000					20% contingency
		SUBTOTAL CAPITAL COST		**$31,580,000**					
Construction Schedule	**17**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$33,900,000**					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$31,580,000	$31,580,000				**$31,580,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$31,580,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$33,279,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$900,000**			**0**	**$900,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$35,000	$35,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$52,845	**$ 52,845**			**0**	**$53,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**			**$279,190**	**$363,000**	
7.0 ERH System Installation and Operation									
Duration: Nine months total duration -installation will take approximately three months and operation will be for six months.									
Assumptions: Installation generated waste accepted by onsite Ulandfill and Industrial Waste Water Treatment Plant.									
Treatment area will be 75' x 75' by 39' deep.									
Used 10 hour work-day; 22 work-days per month.									
Labor									
LATA Labor					14355		$731,610		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	1980	hr	$31	$61,380					Based on LATA Radcon allocation
Health & Safety Equipment									
Level D Modified PPE	2900	man-day	$4	$10,150					Engr Est
Unit Pricing									
ERH Treatment	8,125	bcy	$350	$2,844,000					C-400
Infrastructure Removal	1	ls	$100,000	$100,000					Engr Est
Asphalt Cover	1	ls	$50,000	$50,000					C-400
Soil Venting System w/ Air Treatment	8,125	bcy	$722	$5,866,000					www.frtr.gov
Air Phase Carbon Replacement	3	vessel	$7,250	$21,750					www.tigg.com, 1,000 lb of carbon per vessel delivered
Power Installation	1	ls	$750,000	$750,000					C-400
Power Consumption	12,000	M-Kw-hr	$50	$600,000					www.eia.doe.gov, $0.05/KW-hr
Groundwater Trmt and Disposal	2,040,000	gal	$3	$6,120,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
TASK TOTAL				**$16,440,230**	**14355**		**$731,610**	**$17,172,000**	
8.0 Install 18" Clay/ 6" soil cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of installation of 18" clay/6" soil cover over the SWMU.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$457,380		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
18" Clay	12,040	LCY	$21	$253,000					Engr Est.
6" Soil cover	4,013	LCY	$23	$92,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Portable Toilet	3	month	$150	$450					Engr Est.
TASK TOTAL				**$421,548**			**$457,380**	**$879,000**	
9.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$20,496,000**	

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t1.t6 - 18/6 cover, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.b.t1.t6
18/6 Cover, ERH, L, M, E
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$31,580,000						$31,580,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$31,580,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$35,220,000

BGOU SWMU 7
4.b.t1.t6
18/6 Cover, ERH, L, M, E
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$31,580,000	$0	$0	$0	$0	$0	$31,580,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$31,580,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$33,900,000

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$915,000	$915,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$58,000	$58,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 ERH System Installation and Operation	1	ls	$17,172,000	$17,172,000					
8.0. - Install Subtitle D Cover	1	ls	$2,509,000	$2,509,000					
9.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$4,429,200	$4,429,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,860,250	$1,860,000					fee = 7%.
Contingency	1	ls	$5,687,000	$5,687,000					20% contingency
		SUBTOTAL CAPITAL COST		**$34,122,000**					
Construction Schedule	**20**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$36,442,000**					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$34,122,000	$34,122,000				**$34,122,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$34,122,000**	
						Present	**Annual**	**$1,699,000**	
						Worth	**Avg. Annual**	**$56,633**	
						Values	**Total**	**$35,821,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$315,000	$315,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$915,000**			**0**	**$915,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					20% of Construction Costs
TASK TOTAL				**$105,000**			**0**	**$105,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$57,845	**$ 57,845**			**0**	**$58,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**	**0**		**$279,190**	**$363,000**	
7.0 ERH System Installation and Operation									
Duration: Nine months total duriation -installation will take approximately three months and operation will be for six months.									
Assumptions: Installation generated waste accepted by onsite Ulandfill and Industrial Waste Water Treatment Plant.									
Treatment area will be 75' x 75' by 39' deep.									
Used 10 hour work-day; 22 work-days per month.									
Labor									
LATA Labor					14355		$731,610		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	1980	hr	$31	$61,380					Based on LATA Radcon allocation
Health & Safety Equipment									
Level D Modified PPE	2900	man-day	$4	$10,150					Engr Est
Unit Pricing									
ERH Treatment	8,125	bcy	$350	$2,844,000					C-400
Infrastructure Removal	1	ls	$100,000	$100,000					Engr Est
Asphalt Cover	1	ls	$50,000	$50,000					C-400
Soil Venting System w/ Air Treatment	8,125	bcy	$722	$5,866,000					www.frtr.gov
Air Phase Carbon Replacement	3	vessel	$7,250	$21,750					www.tigg.com, 1,000 lb of carbon per vessel delivered
Power Installation	1	ls	$750,000	$750,000					C-400
Power Consumption	12,000	M-Kw-hr	$50	$600,000					www.eia.doe.gov, $0.05/KW-hr
Groundwater Trmt and Disposal	2,040,000	gal	$3	$6,120,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
TASK TOTAL				**$16,440,230**	**14355**		**$731,610**	**$17,172,000**	
8.0. - Install Subtitle D Cover									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Schedule	**6**	**Month**							
Labor									
LATA Labor					13860		$914,760		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
Vegetative Soil Layer	20,067	LCY	$23	$461,533					Vendor Quote
Drainage Layer with a min perm 1E-03 cm/sec	6,689	LCY	$21	$140,467					Vendor Quote
Clay Layer with a min perm of 1E-07 cm/sec	10,033	LCY	$21	$210,700					Vendor Quote
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Sand Gas Venting System with a min perm 1E-03 cm/sec	6,689	LCY	$45	$301,000					Engr Est.
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Front End Loader	6	month	$4,150	$24,900					Engr Est.
Dozer	6	month	$2,800	$16,800					Engr Est.
Compactor/12 ton/pad foot	6	month	$3,090	$18,540					Engr Est.
Compactor/12 ton/smooth drum	6	month	$2,920	$17,520					Engr Est.
Water Truck, 2000 gal	6	month	$1,850	$11,100					Engr Est.
Equipment Trailer	6	month	$300	$1,800					Engr Est.
Generator, 15KW	6	month	$2,006	$12,036					Engr Est.
Portable Toilet	6	month	$150	$900					Engr Est.
TASK TOTAL				**$1,594,096**			**$914,760**	**$2,509,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
9.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
						SUBTOTAL CAPITAL COST		**$22,146,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t1.t6 - Subtitle D Cap, ERH, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.d.t1.t6
Subtitle D Cap, ERH, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$34,122,000						$34,122,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$34,122,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$37,762,000

BGOU SWMU 7
4.d.t1.t6
Subtitle D Cap, ERH, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$34,122,000	$0	$0	$0	$0	$0	$34,122,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$34,122,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$36,442,000

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$900,000	$900,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$53,000	$53,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 In situ high pressure chemical injection	1	ls	$2,821,000	$2,821,000					
8.0 Install 18" Clay/ 6" soil cover	1	ls	$879,000	$879,000					
9.0 Well Installation	1	ls	$344,000	$344,000					
11.0 Site Restoration	1	ls	$183,000	$183,000					
12.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,536,250	$1,536,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$537,670	$538,000					fee = 7%.
	SUBTOTAL CAPITAL COST			**$8,219,000**					
Construction Schedule	**8**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					

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Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$10,539,000**					
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$8,219,000	$8,219,000				**$8,219,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$8,219,000**	
						Present	**Annual**	**$1,699,000**	
						Worth	**Avg. Annual**	**$56,633**	
						Values	**Total**	**$9,918,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$900,000**			**0**	**$900,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$35,000	$35,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$52,845	**$ 52,845**			**0**	**$53,000**	Engr Est.
4.0 Training									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTALS				**$26,684**			**$153,015**	**$180,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Travel									
Labor Travel Expenses	0	days	$109	$0					
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**			**$279,190**	**$363,000**	
7.0 In situ high pressure chemical injection									
Well Installation									
Duration: two months.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month. 8 Wells per month									
Cleared, local personnel.									
Schedule	**2**	**month**							
Number of wells	**13**	**ea**							
Labor									
LATA Labor					14300		$773,800		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	2200	hr	$31	$68,200					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Skid Steer Bobcat	2	month	$800	$1,600					Hertz
Drums	100	drum	$64	$6,400					Vendor quote

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Subcontractors									
Injection Well Installation	13	ea	$46,000	$598,000					Vendor Quote
Surveyor	1	ls	$15,000	$15,000					Engr Est.
Laboratory Analytical									
Metals 6010	130	sample	$165	$21,450					Analytical rates from LATA. 10 samples collected from 13 wells.
VOA 8260	130	sample	$165	$21,450					
Rad	130	sample	$1,041	$135,330					
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
Injected Reductanct									
Zero Valent Iron (ZVI)	460,688	lb	$2.50	$1,151,719					vendor quote
TASK TOTAL				**$2,046,749**			**$773,800**	**$2,821,000**	
8.0 Install 18" Clay/ 6" soil cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of installation of 18" clay/6" soil cover over the SWMU.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$457,380		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
18" Clay	12,040	LCY	$21	$253,000					Engr Est.
6" Soil cover	4,013	LCY	$23	$92,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Portable Toilet	3	month	$150	$450					Engr Est.

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$421,548**			**$457,380**	**$879,000**	
9.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
11.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
12.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$6,145,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

			Other Direct Costs		Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					

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BGOU SWMU 7
Alternative 4.b.t3.t6 - 18/6 cover, ZVI, L, M, E

		Other Direct Costs				Labor				
	Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
	TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)										
	Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
	TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.b.t3.t6
Subtitle D Cap, ZVI, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$8,219,000						$8,219,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$8,219,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$11,859,000

BGOU SWMU 7
4.b.t3.t6
Subtitle D Cap, ZVI, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$8,219,000	$0	$0	$0	$0	$0	$8,219,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$8,219,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$10,539,000

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$915,000	$915,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$58,000	$58,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 In situ high pressure chemical injection	1	ls	$2,821,000	$2,821,000					
8.0 Install Subtitle D Cover	1	ls	$2,509,000	$2,509,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,948,750	$1,949,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$682,080	$682,000					fee = 7%.
	SUBTOTAL CAPITAL COST			**$10,426,000**					
Construction Schedule	**13**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
	SUBTOTAL ANNUAL COST			**$2,320,000**					
			TOTAL	**$12,746,000**					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$10,426,000	$10,426,000				**$10,426,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$10,426,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$12,125,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$315,000	$315,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$915,000**			**0**	**$915,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$57,845	**$ 57,845**			**0**	**$58,000**	Engr Est.
4.0 Training									
Labor									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**	**0**		**$153,015**	**$180,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**			**$279,190**	**$363,000**	
7.0 In situ high pressure chemical injection									
Well Installation									
Duration: two months.									
Assumptions: IDW is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month. 8 Wells per month									
Cleared, local personnel.									
Schedule	**2**	**month**							
Number of wells	**13**	**ea**							
Labor									
LATA Labor					14300		$773,800		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	2200	hr	$31	$68,200					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Skid Steer Bobcat	2	month	$800	$1,600					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Injection Well Installation	13	ea	$46,000	$598,000					Vendor Quote
Surveyor	1	ls	$15,000	$15,000					Engr Est.
Laboratory Analytical									
Metals 6010	130	sample	$165	$21,450					Analytical rates from LATA. 10 samples collected from 13 wells.
VOA 8260	130	sample	$165	$21,450					
Rad	130	sample	$1,041	$135,330					
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
Injected Reductant									
Zero Valent Iron (ZVI)	460,688	lb	$2.50	$1,151,719					vendor quote
TASK TOTAL				**$2,046,749**			**$773,800**	**$2,821,000**	

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
8.0 Install Subtitle D Cover									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Schedule	**6**	**Month**							
Labor									
LATA Labor					13860		$914,760		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
Vegetative Soil Layer	20,067	LCY	$23	$461,533					Vendor Quote
Drainage Layer with a min perm 1E-03 cm/sec	6,689	LCY	$21	$140,467					Vendor Quote
Clay Layer with a min perm of 1E-07 cm/sec	10,033	LCY	$21	$210,700					Vendor Quote
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Sand Gas Venting System with a min perm 1E-03 cm/sec	6,689	LCY	$45	$301,000					Engr Est.
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Front End Loader	6	month	$4,150	$24,900					Engr Est.
Dozer	6	month	$2,800	$16,800					Engr Est.
Compactor/12 ton/pad foot	6	month	$3,090	$18,540					Engr Est.
Compactor/12 ton/smooth drum	6	month	$2,920	$17,520					Engr Est.
Water Truck, 2000 gal	6	month	$1,850	$11,100					Engr Est.
Equipment Trailer	6	month	$300	$1,800					Engr Est.
Generator, 15KW	6	month	$2,006	$12,036					Engr Est.
Portable Toilet	6	month	$150	$900					Engr Est.
TASK TOTAL				**$1,594,096**	**0**		**$914,760**	**$2,509,000**	

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
8.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
						SUBTOTAL CAPITAL COST		**$7,795,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years; assume 80 crew hours per year labor.									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t3.t6 - Subtitle D, ZVI, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.d.t3.t6
Subtitle D Cap, ZVI, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$10,426,000						$10,426,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$10,426,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$14,066,000

BGOU SWMU 7
4.d.t3.t6
Subtitle D Cap, ZVI, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$10,426,000	$0	$0	$0	$0	$0	$10,426,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$10,426,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$12,746,000

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$900,000	$900,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$53,000	$53,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 t4. - install enhanced bioremediation system	1	ls	$2,254,000	$2,254,000					
8.0 Install 18" Clay/ 6" soil cover	1	ls	$879,000	$879,000					
9.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,394,500	$1,395,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$488,110	$488,000					fee = 7%.
		SUBTOTAL CAPITAL COST		**$7,461,000**					
Construction Schedule	**9**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$9,781,000**					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$7,461,000	$7,461,000				**$7,461,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$7,461,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$9,160,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$900,000**			**0**	**$900,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$35,000	$35,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$52,845	**$ 52,845**			**0**	**$53,000**	Engr Est.
4.0 Training									
Labor									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**	**0**		**$153,015**	**$180,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**			**$279,190**	**$363,000**	
7.0 t4. - install enhanced bioremediation system									
Duration: Assume 4 months for mobilization, setup, well drilling, and injection.									
Assume 2 follow-on injections									
Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Schedule	**4**	**Month**							
Labor									
LATA Labor					9240		$560,000		Engr Est., LATA Labor Rate
Subcontractors									
Temporary decon pad and tear d	1	EA	$50,000	$50,000					Engr Est.
bio reagent	471,500	lb	$1.40	$660,100					Engr Est.
bio reagent (follow on)	22,500	lb	$1.40	$31,500					Engr Est.
bio delivery equipment	1	LS	$47,938.00	$47,938					Engr Est.
Well Mob/Demob	1	ea	$22,699.00	$22,699					Vendor Quote
Installation of 7 injection wells (deep)	7	ea	$46,000	$322,000					Vendor Quote
Well vaults	14	EA	$22,500	$315,000					Vendor Quote
Installation of 7 injection wells (shallow)	7	ea	$16,096	$112,672					Vendor Quote
Radcon Instruments									
RadCon Allocation	480	hr	$31	$14,880					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Front End Loader, 3.5CY	4	month	$4,150	$16,600					
Dozer	4	month	$2,800	$11,200					
Equipment Trailer	4	month	$300	$1,200					
Generator, 150 KW	4	month	$2,006	$8,024					
Two Portable Toilets	4	month	$300	$1,200					
Laboratory Analytical									
Analytical Lab	1	ls	$68,451	$68,451					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
TASK TOTAL				**$1,693,864**			**$560,000**	**$2,254,000**	
8.0 Install 18" Clay/ 6" soil cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									

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BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Construction will consist of installation of installation of 18" clay/6" soil cover over the SWMU.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$457,380		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
18" Clay	12,040	LCY	$21	$253,000					Engr Est.
6" Soil cover	4,013	LCY	$23	$92,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Portable Toilet	3	month	$150	$450					Engr Est.
TASK TOTAL				**$421,548**			**$457,380**	**$879,000**	
9.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$5,578,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 7
Alternative 4.b.t4.t6 - 18/6 cover, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.b.t4.t6
18/6 Cover, Bio, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$7,461,000						$7,461,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$7,461,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$11,101,000

BGOU SWMU 7
4.b.t4.t6
18/6 Cover, Bio, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$7,461,000	$0	$0	$0	$0	$0	$7,461,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$7,461,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$9,781,000

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$915,000	$915,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$58,000	$58,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$363,000	$363,000					
7.0 t4. - install enhanced bioremediation system	1	ls	$2,254,000	$2,254,000					
8.0 Install Subtitle D Cover	1	ls	$2,509,000	$2,509,000					
9.0 Well Installation	1	ls	$344,000	$344,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Reporting	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,807,000	$1,807,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$632,450	$632,000					fee = 7%.
			SUBTOTAL CAPITAL COST	**$9,667,000**					
Construction Schedule	**15**	**Months**							
Annual Cost									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
			SUBTOTAL ANNUAL COST	**$2,320,000**					
			TOTAL	**$11,987,000**					

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$9,667,000	$9,667,000				**$9,667,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$9,667,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$11,366,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
Remedial Design Work Plan	1	LS	$150,000	$150,000					Engr Est.
Remdial Design Report	1	LS	$315,000	$315,000					Engr Est.
Remedial Action Work Plan	1	LS	$230,000	$230,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$915,000**			**0**	**$915,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$40,000	$40,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$57,845	**$ 57,845**			**0**	**$58,000**	Engr Est.
4.0 Training									
Labor									
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: For Non-Union personnel assume 10 hrs/workday, 22 workday/month straight time.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
100% cleared workers, no travel.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2310		153015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**	**0**		**$153,015**	**$180,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume two months for site preparation and construction laydown and staging areas.									
Assumptions: 100% cleared, no travel.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the treatment area.									
Includes geophysical survey of areas where ground penetration is planned.									
Schedule	**2**	**Month**							
LATA Labor					4620		$279,190		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader, 3.5CY	2	month	$4,150	$8,300					Engr Est.
Dozer	2	month	$2,800	$5,600					Engr Est.
Water Truck, 2000 gal	2	month	$1,850	$3,700					Engr Est.
Equipment Trailer	2	month	$300	$600					Engr Est.
Generator, 150 KW	2	month	$2,006	$4,012					Engr Est.
Two Portable Toilets	2	month	$300	$600					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$ 83,362**			**$279,190**	**$363,000**	
7.0 t4. - install enhanced bioremediation system									
Estimated installation time	2	months							
Duration: Assume 4 months for mobilization, setup, well drilling, and injection.									
Assume 2 follow-on injections									
Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Schedule	**4**	**Month**							
Labor									
LATA Labor					9240		$560,000		Engr Est., LATA Labor Rate
Subcontractors									
Temporary decon pad and tear do	1	EA	$50,000	$50,000					Engr Est.
bio reagent	471,500	lb	$1.40	$660,100					Engr Est.
bio reagent (follow on)	22,500	lb	$1.40	$31,500					Engr Est.
bio delivery equipment	1	LS	$47,938.00	$47,938					Engr Est.
Well Mob/Demob	1	ea	$22,699.00	$22,699					Vendor Quote
Installation of 7 injection wells (deep)	7	ea	$46,000	$322,000					Vendor Quote
Well vaults	14	EA	$22,500	$315,000					Vendor Quote
Installation of 7 injection wells (shallow)	7	ea	$16,096	$112,672					Vendor Quote
Radcon Instruments									
RadCon Allocation	480	hr	$31	$14,880					Based on LATA Radcon allocation
Equipment									

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Pickup Truck, crew cab, F250	4	month	$1,300	$5,200					Hertz
Front End Loader, 3.5CY	4	month	$4,150	$16,600					
Dozer	4	month	$2,800	$11,200					
Equipment Trailer	4	month	$300	$1,200					
Generator, 150 KW	4	month	$2,006	$8,024					
Two Portable Toilets	4	month	$300	$1,200					
Laboratory Analytical									
Analytical Lab	1	ls	$68,451	$68,451					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
TASK TOTAL				**$1,693,864**	9240		**$560,000**	**$2,254,000**	
8.0 Install Subtitle D Cover									
Duration: Six months construction and two months of startup.									
Assumptions: Construction Labor included in Unit Pricing.									
Assumptions: Construction Labor included in Unit Pricing.									
Schedule	**6**	**Month**							
Labor									
LATA Labor					13860		$914,760		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
Vegetative Soil Layer	20,067	LCY	$23	$461,533					Vendor Quote
Drainage Layer with a min perm 1E-03 cm/sec	6,689	LCY	$21	$140,467					Vendor Quote
Clay Layer with a min perm of 1E-07 cm/sec	10,033	LCY	$21	$210,700					Vendor Quote
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Sand Gas Venting System with a min perm 1E-03 cm/sec	6,689	LCY	$45	$301,000					Engr Est.
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Front End Loader	6	month	$4,150	$24,900					Engr Est.
Dozer	6	month	$2,800	$16,800					Engr Est.
Compactor/12 ton/pad foot	6	month	$3,090	$18,540					Engr Est.
Compactor/12 ton/smooth drum	6	month	$2,920	$17,520					Engr Est.
Water Truck, 2000 gal	6	month	$1,850	$11,100					Engr Est.
Equipment Trailer	6	month	$300	$1,800					Engr Est.

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COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

		Other Direct Costs				Labor				
Task Description	Qty	Unit	Unit Price	Total	Hours	Rate	Total	Total Cost	Basis of Estimate
Generator, 15KW	6	month	$2,006	$12,036					Engr Est.
Portable Toilet	6	month	$150	$900					Engr Est.
TASK TOTAL				**$1,594,096**	**0**		**$914,760**	**$2,509,000**	
9.0 Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
11.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					PRS, 2009
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
						SUBTOTAL CAPITAL COST		**$7,228,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST

COST ESTIMATE
BGOU SWMU 7
Alternative 4.d.t4.t6 - Subtitle D, Bio, L, M, E

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Groundwater LTM (years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 7
4.d.t4.t6
Subtitle D Cap, Bio, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1	$9,667,000						$9,667,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$9,667,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$13,307,000

BGOU SWMU 7
4.d.t4.t6
Subtitle D Cap, Bio, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (years 1-2)	Annual Groundwater LTM (years 3-5)	Biannual Groundwater LTM (years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$9,667,000	$0	$0	$0	$0	$0	$9,667,000
2013	1	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$9,667,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$11,987,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
SWMU Dimensions					
	Cap Dimensions				
		SWMU Area	170,000	SF	Engr Est
		Buffer	5	feet	Engr Est
		Soil Cover Area	180,600	SF	Calc
		Soil Cover Perimeter	1,670	feet	Calc
	Hydraulic Isolation Barrier				
		Depth of Barrier Wall	40	feet	Engr Est
		Barrier Wall Area	66,800	sf	Calc
	Groundwater Sumps				
		Assumed separation between perimeter sumps	100	ft	
		No. of perimeter sumps	1,700	sumps	
		Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
		Perimeter of Cap	11,304	sf/sump	calc
		No. of Sumps required for dewatering under Cap	15	sumps	calc
Soil Volume Calc					
	Cover Soil Volume				
		Cover Soil Thickness; 10-5 cm/s hydraulic conductivity	1.5	feet	Engr Est
		Cover Soil Volume - Compacted	10,033	CCY	calc
		Conversion	1.41	CCY/LCY	US Army, 1994
		Cover Soil Volume - Loose	14,150	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Cover Soil Tonnage	20,000	ton	calc
	Top Soil Volume				
		Top Soil Thickness	0.5	feet	Engr. Est.
		Top Soil Volume - compacted	3,340	CCY	calc
		Conversion	1.39	CCY/LCY	US Army, 1994
		Top Soil Volume - Loose	4,700	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Top Soil Tonnage	6,600	ton	Engr Est.
Cap Construction Duration					
		Cap Construction Rate	1000	LCY/day/ crew	Engr Est.
		Cap Construction Duration	19	wdays	calc
		Conversion	10	hrs/wday	Engr Est.
		Conversion	5	wday/wks	Engr Est.
		Cap Construction Duration	190	hrs	calc
		Cap Construction Duration	4	wks	calc
		Cap Construction Duration	2	months	Engr Est.
Compaction Testing					
		Compaction Rate	10,000	SF/test	Engr Est
		Compaction Area	180,600	SF	calc
		Lift Thickness	1	feet	Engr Est.
		Number of Lifts	2	lifts	calc
		Number of Compactions Tests	40	tests	calc
Fence Dimensions					
		Area	170,000	sf	DOE, 2009
		Buffer Length	60	feet	Engr Est.
		SWMU Perimeter/Fence Length	1,890	feet	calc
		Fenced Area plus 10 ft path outside perimeter of fence (mowing area)	190,000	sf	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
Drums Reqd for Post Holes					
		Distance between posts	8	feet	Engr Est
		Number of post holes	236	post holes	Engr Est
		Post hole depth	3	feet	Engr Est
		Post hole diameter	1	feet	Engr Est
		Post hole volume	0.79	cf/post hole	calc
		Total volume of post hole soil	1,737	cf	calc
		Drum volume	55	gal	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Drum volume	7	cf/drum	calc
		No. of Drums	240	drums	calc
2. Excavation & Disposal Calculations					
Source Area Dimensions					
		Area to be Excavated	72,225	SF	Engr Est.
		Excavation Depth	20	feet	Engr Est.
Waste Volume Calc					
		Waste Volume	53,500	BCY	calc
		Conversion	1.20	LCY/BCY	PRS Directive
		Waste Volume	64,200	LCY	calc
		Assumed Nearly Nondetectable Radioactive Material (U Landfill WAC Compliant) Fraction	0.4		Engr Est
		Assumed LLW & MLLW Fraction	0.6		Engr Est
		U Landfill WAC Compliant Volume	23,200	LCY	calc
		LLW & MLLW Volume	41,000	LCY	calc
		Assumed LLW Fraction of LLW & MLLW Vol	0.5		Engr Est
		Assumed MLLW Fraction of LLW & MLLW Vol	0.5		Engr Est
		LLW Volume	20,500	LCY	calc
		MLLW Volume	20,500	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est
		LLW & MLLW Tonnage	32,480	ton	calc
Absorbents for Soil					
		Absorbent Rate	0.54	lb/CF	Engr. Est
		Total Excavated Soils	64,200	LCY	calc
		Total Absorbent needed	936,036	lbs	calc
Excavation Duration					
		Excavation Rate for U Landfill WAC Compliant	4,400	bcy/month/ crew	Engr Est., 200 bcy/day/crew 22 wdays/mo
		Excavation Rate for LLW & MLLW	2,200	bcy/month/ crew	Engr Est., 100 bcy/day/crew, 22 wdays/mo
		No. of Crews	1	crew	Engr Est
		Time to Excavate U Landfill WAC Compliant	8	month	calc
		Time to Excavate LLW & MLLW	9	month	calc
		Work week	5	wdays/wk	Engr Est.
		Work days per year	260	wdays/yr	calc
		Work hours per year	2,600	whour/yr	calc
		Work days per month	22	wdays/mo	calc
Dewatering Calc					
		Initial Pore Volume	1,620,729	gal	calc from Est. Basis
		Dewatering Rate for Initial Pore Vol	30	gpm	Assumed
		Days to dewater initial pore volume	38	days	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
		Dewatering Rate after removing initial pore vol.	7.9	gpm	DOE, 1998, pg 17
		Total Excavation Time	17	months	calc
		Fraction of time pumping occurs after removal of initial pore volume	0.1	fraction	Engr Est
		Dewater Volume during excavation	419,016	gal	calc
		Total Water for Trmt/Disposal during excavation	2,039,745	gal	calc
MLLW Sludge Production from GW Treatment					
		Assumed Dewatering Rate	5,538	gal/day	calc
		Number of days operating	368	days	calc
		Dewatering total	2,039,745	gallons	calc
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	20,397	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Est. Sludge production	101	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	371	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	7	trips	calc
Transportation Bags, Truck Liner, and Rail Cars					
		Transportation Bag Volume	8.96	CY	Pactec
		Bags required for U Landfill WAC Compliant	2,590	Bags	calc
		Truck Liner	16	CY	Engr Est.
		Liners required for LLW & MLLW	2,563	Liners	calc
		Bags per Rail Car	11.5	bags/rail car	Energy Solutions
		No. of Rail Cars	230	rail cars	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant + 10 percent QA/QC	160	samples	Engr Est.
		Samples for LLW & MLLW + 10 percent QA/QC	90	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	1,075	feet	calc
		Fence Perimeter	2,000	feet	calc
		Area	43,000	SF	calc
		Sheet pile density	38	psf	left in place
		Tonnage	900	tons	calc
Drum Volume					
		Drum Volume	7.4	CF	DOE 2007-198
		Drum Volume	0.27	CY	calc
Fence Dimensions					
		SWMU Perimeter/Fence Length	1,100	feet	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	64,200	LCY	
		Conversion	1.41	CCY/LCY	US Army, 1994
		Volume of Backfill	90,522	CCY	calc
		Conversion	1.4	ton/CY	Lindeburg, 1990
		Backfill Tonnage	127,000	ton	calc
		Backfill Rate	3,000	cy/day/crew	Engr Est.
		Est. Time to Backfill	21	days	calc
		Working days per month	22	days	calc
		Est. Months to Backfill	1	months	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 5 - Excavation and Disposal, Land Use Controls

Parameter			Total	Units	Basis
Compaction Testing					
		Compaction Rate	20,000	SF/test	Engr Est
		Compaction Area	72,225	SF	DOE 2010
		Lift Thickness	2	feet	Engr Est.
		Number of Lifts	10	lifts	calc
		Number of Compactions Tests	36	tests	calc
Top Soil & Hydroseeding					
		Disturbed Area	4	acres	Engr Est.
		Conversion	43,560	SF/acre	Lindeburg, 1990
		Disturbed Area	174,240	SF	calc
		Conversion	1,000	SF/MSF	
		Disturbed Area	180	MSF	calc
		Top Soil Thickness	1	feet	Engr Est.
		Conversion	27	CF/CY	Lindeburg, 1990
		Conversion	1.3	ton/CY	Engr Est.
		Top Soil tonnage	4,200	ton	calc
Trucking to existing U Landfill at PGDP					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	10	lcy	Engr Est
		Dump Trips for U Landfill WAC Compliant	4,100	trips	calc
Trucking to future On-Site Disposal Cell at PGDP					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	10	lcy	Engr Est
		Dump Trips for LLW & MLLW	2,320	trips	calc
PPE LLW Drums					
		Drums filled per day with PPE LLW Waste	1	drum/day	Engr Est
		No. of drums used during project	368	drums	calc
		Drums per Truckload	60	drums/trucklo	Engr Est
		Truck Trips	7	trips	calc
		Drum Volume	55	gal/drum	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Total Volume of PPE	100	cy	calc

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Michael R. Morgenstern, et al.

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FORWARD

COST ESTIMATE
BGOU SWMU 7
5.t6.CR
Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,189,000	$1,189,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$266,000	$266,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$391,000	$391,000					
7.0 Excavation	1	ls	$6,878,000	$6,878,000					
8.0 Waste Transportation & Disposal	1	ls	$34,831,000	$34,831,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$3,154,000	$3,154,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$9,515,400	$9,515,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$3,996,440	$3,996,000					fee = 7%.
Contingency	1	ls	$12,217,600	$12,218,000					20% contingency
		SUBTOTAL CAPITAL COST		**$73,306,000**					
Construction Schedule	**14**	**Month**							
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$73,306,000	$73,306,000				**$73,306,000**	
							Capital Costs	**$73,306,000**	
						Present Worth Values	**Annual**	**$0**	
							Avg. Annual	**$0**	
							Total	**$73,306,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$211,000	$211,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.

COST ESTIMATE
BGOU SWMU 7
5.t6.CR
Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$1,189,000**			**0**	**$1,189,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor is cleared and local; using two work crews for this remedial action.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. One work crew.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	420	hr	$31	$13,020					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est

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Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$98,440**	**2,673**		**$167,558**	**$266,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crewsof Q cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor is cleared and local									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	267	man day	$24	$6,328					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Two Portable Toilets	1	month	$300	$300					Engr Est
Rad Screening System	1	setup	$40,000	$40,000					RSMeans ECHOS 33 18 0402
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$17	$13,600					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$223,082**	**2673**		**$167,558**	**$391,000**	

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BGOU SWMU 7
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Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
7.0 Excavation									
Duration: Using one crew, approximately 9 months for excavation, staging, and sampling based on excavating MLLW at 100 bcy/day/crew,									
U Landfill WAC Compliant waste at 200 bcy/day/crew, and lag time between excavation and transporting offsite.									
Assumption: Install sheet piling along excavation perimeter. Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW & LLW stockpiles containerized into soft side bags loaded on trucks for delivery to the rail spur.									
At the rail spur the soft side bags are lifted on rail cars for delivery to the offsite disposal facility.									
U Landfill WAC Compliant & Non Haz Waste is transported from the stockpile to the onsite U Landfill.									
Uranium waste/Rad Material over packed for truck transport to NTS.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharge.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									
Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**9**	**months**							
Labor									
LATA Labor					23684		$1,485,820		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	2,360	man-day	$24	$55,932					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	9	month	$1,300	$11,424					Hertz
Pickup Truck, crew cab, 4x4	9	month	$1,300	$11,424					Hertz
All Terrain Forklift	9	month	$900	$7,909					Engr Est
Excavator 2 CY	9	month	$15,160	$136,440					Vendor quote
Crane	9	month	$1,600	$14,061					Engr Est
Dozer, JD, 99Hp	9	month	$2,800	$24,606					Engr Est
Front End Loader	9	month	$4,150	$36,470					Engr Est
Water Truck, 2000 gal	9	month	$1,850	$16,258					Engr Est
Tanker Truck, vacuum, 5000 gal	9	month	$4,000	$35,152					Engr Est
Dump Trailer, 16 cy	9	month	$1,248	$10,967					Engr Est
Dump Trailer, 16 cy	9	month	$1,248	$10,967					Engr Est
Tractor Trailer, 6x4, 45 ton, 240HP	9	month	$6,500	$57,121					Engr Est
Equipment Trailer	9	month	$448	$4,032					Engr Est
Generator, 150 KW	9	month	$2,006	$18,054					Engr Est
Two Portable Toilets	9	month	$300	$2,700					Engr Est
Diaphragm Dewatering Pump & Hose	9	month	$500	$4,500					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	9	month	$2,006	$18,054					Engr Est
Crane for HEPA Filtration	9	month	$2,350	$21,150					Engr Est
Rad Screening System	9	month	$100,000	$900,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	9	month	$24,200	$217,800					RSMeans ECHOS 33 18 0405, $110/hr
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	900	tons	$2,125	$1,912,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	2,563	liners	$95	$243,438					Engr Est., ECHOS 33 19 0810
Soft Side Bags	2,590	bag	$350	$906,500					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)

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BGOU SWMU 7
5.t6.CR
Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
B25 Boxes	4	ea	$1,400	$5,600					DOE Engr Est.
55 gal Drums	979	ea	$64	$62,669					Vendor quote
Drum Liners	979	ea	$10	$9,792					Engr Est.
Drum Overpacks	100	ea	$150	$15,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									
Verification Samples	221	sample	$2,200	$486,413					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$5,391,932**	**23,684**		**$1,485,820**	**$6,878,000**	
8.0 Waste Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with two work crews.									
Assumptions: Includes transportation from staging area to final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5390		$338,152		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	539	man-day	$24	$12,774					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.

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Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Disposal/Waste Sampling									
Excavated Waste	214	sample	$2,200	$470,800					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	4	sample	$2,200	$8,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
PPE Waste	41	sample	$2,200	$89,137					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	42	sample	$150	$6,300					One sample weekly for VOCs.
Sludge from Water Trmt	41	sample	$2,200	$89,749					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Transportation									
RM/Sources	2	truck load	$11,000	$22,000					NTS, three B25 Boxes per truckload
U Landfill WAC Compliant	4,100	truck load	$75	$307,500					Onsite existing U Landfill -Subtitle D, assume 15 cy dump trucks, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW & MLLW	230	rail car	$14,750	$3,392,500					Energy Solns, 10-12 bags/gondola railcar, 100 tons per gondola car.
LLW PPE Waste	7	truck load	$7,053	$49,371					Energy Solns, 60 drums per truckload
LLW Sludge from Water Trmt	7	truck load	$7,053	$49,371					Energy Solns, 60 drums per truckload
Disposal									
RM/Sources	1	truckload	$0	$0					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	23,200	LCY	$0	$0					Onsite U Landfill
LLW	20,500	LCY	$184	$3,772,000					Envirocare
MLLW	20,500	LCY	$864	$17,712,000					Envirocare
LLW PPE Waste	100	LCY	$215	$21,500					Envirocare
LLW Sludge from Water Trmt	101	LCY	$632	$63,830					Envirocare
Dewater/Wastewater Trmt	2,039,745	gal	$3	$6,119,235					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	936,036	lbs	$2.13	$1,993,757					0.54lb/cf
Task Total				**$ 34,493,070**	5,390		**$338,152**	**$ 34,831,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 month with two work crews.									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									

COST ESTIMATE
BGOU SWMU 7
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Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Schedule	**1**	**months**							
Labor									
LATA Labor					2464		$143,176		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	246	man-day	$24	$5,830					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$3,948					Engr Est.
Loader, crawler	1	month	$1,800	$2,538					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$4,357					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$4,117					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$2,609					Engr Est.
Generator 150 KW	1	month	$2,006	$2,828					Engr Est.
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$3,948					Engr Est.
Loader, crawler	1	month	$1,800	$2,538					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$4,357					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$4,117					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$2,609					Engr Est.
Generator 150 KW	1	month	$2,006	$2,828					Engr Est.
Two Portable Toilets	1	month	$300	$423					Engr Est.
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value in SWMU 2 FS
Subcontractors									
Backfill Delivered	127,000	ton	$16	$2,032,000					Engr Est.
Top Soil Delivered	4,200	ton	$16	$67,200					Engr Est.
Compaction Testing	36	test	$54	$1,944					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$3,010,363**	2464		**$143,176**	**$3,154,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.

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Alternative 5 - Excavation and Disposal, Existing Features, Contingent Remedies

		Other Direct Costs				Labor				
Task Description		**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
	Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
	Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
	Generator 150KW	1	month	$2,006	$2,006					Engr Est.
	Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors										
	Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire SWMU + 50%; RSMeans 02920-320-1000
	TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Report										
Reports										
	As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
	Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
	TASK TOTAL				**$175,000**			**$0**	**$175,000**	
								SUBTOTAL CAPITAL COST	**$47,577,000**	

BGOU SWMU 7
5.t6.CR
Excavation and Disposal, Existing Features, Contingent Remedy
Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Five-Year Reviews	TOTALS
2012	0	1	1.00	$73,306,000		$73,306,000
2013	1	1.029	1.03			$0
2014	2	1.029	1.06			$0
2015	3	1.029	1.09			$0
2016	4	1.029	1.12			$0
2017	5	1.029	1.15		$0	$0
2018	6	1.029	1.19			$0
2019	7	1.029	1.22			$0
2020	8	1.029	1.26			$0
2021	9	1.029	1.29			$0
2022	10	1.029	1.33		$0	$0
2023	11	1.029	1.37			$0
2024	12	1.029	1.41			$0
2025	13	1.029	1.45			$0
2026	14	1.029	1.49			$0
2027	15	1.029	1.54		$0	$0
2028	16	1.029	1.58			$0
2029	17	1.029	1.63			$0
2030	18	1.029	1.67			$0
2031	19	1.029	1.72			$0
2032	20	1.029	1.77		$0	$0
2033	21	1.029	1.82			$0
2034	22	1.029	1.88			$0
2035	23	1.029	1.93			$0
2036	24	1.029	1.99			$0
2037	25	1.029	2.04		$0	$0
2038	26	1.029	2.10			$0
2039	27	1.029	2.16			$0
2040	28	1.029	2.23			$0
2041	29	1.029	2.29			$0
2042	30	1.029	2.36		$0	$0
TOTAL				$73,306,000	$0	$73,306,000

BGOU SWMU 7
5.t6.CR
Excavation and Disposal, Existing Features, Contingent Remedy
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Five-Year Reviews	TOTALS
2012	0	1.00	1.00	$73,306,000	$0	$73,306,000
2013	1	1.00	1.00	$0	$0	$0
2014	2	1.00	1.00	$0	$0	$0
2015	3	1.00	1.00	$0	$0	$0
2016	4	1.00	1.00	$0	$0	$0
2017	5	1.00	1.00	$0	$0	$0
2018	6	1.00	1.00	$0	$0	$0
2019	7	1.00	1.00	$0	$0	$0
2020	8	1.00	1.00	$0	$0	$0
2021	9	1.00	1.00	$0	$0	$0
2022	10	1.00	1.00	$0	$0	$0
2023	11	1.00	1.00	$0	$0	$0
2024	12	1.00	1.00	$0	$0	$0
2025	13	1.00	1.00	$0	$0	$0
2026	14	1.00	1.00	$0	$0	$0
2027	15	1.00	1.00	$0	$0	$0
2028	16	1.00	1.00	$0	$0	$0
2029	17	1.00	1.00	$0	$0	$0
2030	18	1.00	1.00	$0	$0	$0
2031	19	1.00	1.00	$0	$0	$0
2032	20	1.00	1.00	$0	$0	$0
2033	21	1.00	1.00	$0	$0	$0
2034	22	1.00	1.00	$0	$0	$0
2035	23	1.00	1.00	$0	$0	$0
2036	24	1.00	1.00	$0	$0	$0
2037	25	1.00	1.00	$0	$0	$0
2038	26	1.00	1.00	$0	$0	$0
2039	27	1.00	1.00	$0	$0	$0
2040	28	1.00	1.00	$0	$0	$0
2041	29	1.00	1.00	$0	$0	$0
2042	30	1.00	1.00	$0	$0	$0
TOTAL				$73,306,000	$0	$73,306,000

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,189,000	$1,189,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$266,000	$266,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$391,000	$391,000					
7.0 Excavation	1	ls	$6,333,000	$6,333,000					
8.0 Transportation & Disposal	1	ls	$7,929,000	$7,929,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$3,154,000	$3,154,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$4,026,000	$4,026,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,690,920	$1,691,000					fee = 7%.
Contingency	1	ls	$5,169,400	$5,169,000					20% contingency
		SUBTOTAL CAPITAL COST		**$31,016,000**					
Construction Schedule	**14**	**Month**							
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$31,016,000	$31,016,000				**$31,016,000**	
							Capital Costs	**$31,016,000**	
						Present Worth Values	**Annual**	**$0**	
							Avg. Annual	**$0**	
							Total	**$31,016,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA, 2009
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$211,000	$211,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,189,000**			**0**	**$1,189,000**	Engr Est.

COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					5% of Construction Cost
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor is cleared and local; using two work crews for this remedial action.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. One work crew.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	420	hr	$31	$13,020					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$98,440**	**2,673**		**$167,558**	**$266,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crew of Q cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor is cleared and local									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	267	man day	$24	$6,328					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Two Portable Toilets	1	month	$300	$300					Engr Est
Rad Screening System	1	setup	$40,000	$40,000					RSMeans ECHOS 33 18 0402
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$17	$13,600					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$223,082**	**2673**		**$167,558**	**$391,000**	

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
7.0 Excavation									
Duration: Using one crew, approximately 9 months for excavation, staging, and sampling based on excavating MLLW at 100 bcy/day/crew,									
LLW at 200 bcy/day/crew, and lag time between excavation and transporting.									
Assumption: Install sheet piling along excavation perimeter. Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW & LLW stockpiles loaded on trucks for delivery to the OSWDF.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharge.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									
Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**9**	**months**							
Labor									
LATA Labor					23684		$1,485,820		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	2,360	man-day	$24	$55,932					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	9	month	$1,300	$11,424					Hertz
Pickup Truck, crew cab, 4x4	9	month	$1,300	$11,424					Hertz
All Terrain Forklift	9	month	$900	$7,909					Engr Est
Excavator 2 CY	9	month	$15,160	$136,440					Vendor quote
Crane	9	month	$1,600	$14,061					Engr Est
Dozer, JD, 99Hp	9	month	$2,800	$24,606					Engr Est
Front End Loader	9	month	$4,150	$36,470					Engr Est
Water Truck, 2000 gal	9	month	$1,850	$16,258					Engr Est
Tanker Truck, vacuum, 5000 gal	9	month	$4,000	$35,152					Engr Est
Dump Trailer, 16 cy	9	month	$1,248	$10,967					Engr Est
Dump Trailer, 16 cy	9	month	$1,248	$10,967					Engr Est
Tractor Trailer, 6x4, 45 ton, 240HP	9	month	$6,500	$57,121					Engr Est
Equipment Trailer	9	month	$448	$4,032					Engr Est
Generator, 150 KW	9	month	$2,006	$18,054					Engr Est
Two Portable Toilets	9	month	$300	$2,700					Engr Est
Diaphragm Dewatering Pump & Hose	9	month	$500	$4,500					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	9	month	$2,006	$18,054					Engr Est
Crane for HEPA Filtration	9	month	$2,350	$21,150					Engr Est
Rad Screening System	9	month	$100,000	$900,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	9	month	$24,200	$217,800					RSMeans ECHOS 33 18 0405, $110/hr
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	900	tons	$2,125	$1,912,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	6,427	liners	$95	$610,565					Engr Est., ECHOS 33 19 0810
55 gal Drums	979	ea	$64	$62,669					Vendor quote
Drum Liners	979	ea	$10	$9,792					Engr Est.
Drum Overpacks	100	ea	$150	$15,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

Task Description	Qty	Unit	Unit Price	Total	Hours	Rate	Total	Total Cost	Basis of Estimate
	Other Direct Costs				Labor				
Task Description	Qty	Unit	Unit Price	Total	Hours	Rate	Total	Total Cost	Basis of Estimate
Verification Samples	221	sample	$2,200	$486,413					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$4,846,960**	**23,684**		**$1,485,820**	**$6,333,000**	
8.0 Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with two work crews.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5390		$338,152		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	539	man-day	$24	$12,774					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250

COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Disposal/Waste Sampling									
Excavated Waste	214	sample	$2,200	$470,800					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	4	sample	$2,200	$8,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
PPE Waste	41	sample	$2,200	$89,137					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	42	sample	$150	$6,300					One sample weekly for VOCs.
Sludge from Water Trmt	41	sample	$2,200	$89,749					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Disposal									
Dewater/Wastewater Trmt	2,039,745	gal	$3	$6,119,235					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Transportation									
OSWDF WAC Compliant	6,420	truck load	$75	$481,500					OSWDF, assume 15 cy dump trucks, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW PPE Waste	7	truck load	$75	$525					OSWDF, assume 15 cy dump trucks, round trip is 10 miles, RS Means ECHOS 33 19 0209
Task Total				**$ 7,591,266**	5,390		**$338,152**	**$ 7,929,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 month with two work crews.									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2464		$143,176		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	246	man-day	$24	$5,830					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$3,948					Engr Est.
Loader, crawler	1	month	$1,800	$2,538					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$4,357					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$4,117					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$2,609					Engr Est.
Generator 150 KW	1	month	$2,006	$2,828					Engr Est.
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,833					Hertz

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Dozer, JD, 99Hp	1	month	$2,800	$3,948					Engr Est.
Loader, crawler	1	month	$1,800	$2,538					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$4,357					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$4,117					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$2,609					Engr Est.
Generator 150 KW	1	month	$2,006	$2,828					Engr Est.
Two Portable Toilets	1	month	$300	$423					Engr Est.
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value in SWMU 2 FS
Subcontractors									
Backfill Delivered	127,000	ton	$16	$2,032,000					Engr Est.
Top Soil Delivered	4,200	ton	$16	$67,200					Engr Est.
Compaction Testing	36	test	$54	$1,944					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$3,010,363**	2464		**$143,176**	**$3,154,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire SWMU + 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	

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COST ESTIMATE
BGOU SWMU 7
5.t6.CR+WDF
Alternative 5 - Excavation and Disposal, Existing Features, Potential WDF Use, Contingent Remedies

		Other Direct Costs				Labor				
Task Description		Qty	Unit	Unit Price	Total	Hours	Rate	Total	Total Cost	Basis of Estimate
11.0 Remedial Action Completion Report										
Reports										
	As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
	Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
	TASK TOTAL				**$175,000**			**$0**	**$175,000**	
								SUBTOTAL CAPITAL COST	**$20,130,000**	

BGOU SWMU 7
5.t6.CR+WDF
Exc. and Disposal, Existing Features, Potential WDF Use, Contingent Remed
Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Five-Year Reviews	TOTALS
2012	0	1	1.00	$31,016,000		$31,016,000
2013	1	1.029	1.03			$0
2014	2	1.029	1.06			$0
2015	3	1.029	1.09			$0
2016	4	1.029	1.12			$0
2017	5	1.029	1.15		$0	$0
2018	6	1.029	1.19			$0
2019	7	1.029	1.22			$0
2020	8	1.029	1.26			$0
2021	9	1.029	1.29			$0
2022	10	1.029	1.33		$0	$0
2023	11	1.029	1.37			$0
2024	12	1.029	1.41			$0
2025	13	1.029	1.45			$0
2026	14	1.029	1.49			$0
2027	15	1.029	1.54		$0	$0
2028	16	1.029	1.58			$0
2029	17	1.029	1.63			$0
2030	18	1.029	1.67			$0
2031	19	1.029	1.72			$0
2032	20	1.029	1.77		$0	$0
2033	21	1.029	1.82			$0
2034	22	1.029	1.88			$0
2035	23	1.029	1.93			$0
2036	24	1.029	1.99			$0
2037	25	1.029	2.04		$0	$0
2038	26	1.029	2.10			$0
2039	27	1.029	2.16			$0
2040	28	1.029	2.23			$0
2041	29	1.029	2.29			$0
2042	30	1.029	2.36		$0	$0
TOTAL				$31,016,000	$0	$31,016,000

BGOU SWMU 7
5.t6.CR+WDF
Exc. and Disposal, Existing Features, Potential WDF Use, Contingent Remed
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Five-Year Reviews	TOTALS
2012	0	1.00	1.00	$31,016,000	$0	$31,016,000
2013	1	1.00	1.00	$0	$0	$0
2014	2	1.00	1.00	$0	$0	$0
2015	3	1.00	1.00	$0	$0	$0
2016	4	1.00	1.00	$0	$0	$0
2017	5	1.00	1.00	$0	$0	$0
2018	6	1.00	1.00	$0	$0	$0
2019	7	1.00	1.00	$0	$0	$0
2020	8	1.00	1.00	$0	$0	$0
2021	9	1.00	1.00	$0	$0	$0
2022	10	1.00	1.00	$0	$0	$0
2023	11	1.00	1.00	$0	$0	$0
2024	12	1.00	1.00	$0	$0	$0
2025	13	1.00	1.00	$0	$0	$0
2026	14	1.00	1.00	$0	$0	$0
2027	15	1.00	1.00	$0	$0	$0
2028	16	1.00	1.00	$0	$0	$0
2029	17	1.00	1.00	$0	$0	$0
2030	18	1.00	1.00	$0	$0	$0
2031	19	1.00	1.00	$0	$0	$0
2032	20	1.00	1.00	$0	$0	$0
2033	21	1.00	1.00	$0	$0	$0
2034	22	1.00	1.00	$0	$0	$0
2035	23	1.00	1.00	$0	$0	$0
2036	24	1.00	1.00	$0	$0	$0
2037	25	1.00	1.00	$0	$0	$0
2038	26	1.00	1.00	$0	$0	$0
2039	27	1.00	1.00	$0	$0	$0
2040	28	1.00	1.00	$0	$0	$0
2041	29	1.00	1.00	$0	$0	$0
2042	30	1.00	1.00	$0	$0	$0
TOTAL				$31,016,000	$0	$31,016,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 6 - Targeted excavation and disposal, cover, land use controls, monitoring w/contingent post excavation treatment

Parameter	Total	Units	Basis
SWMU Dimensions			
Cap Dimensions			
SWMU Area	170,000	SF	Engr Est
Buffer	5	feet	Engr Est
Soil Cover Area	180,600	SF	Calc
Soil Cover Perimeter	1,670	feet	Calc
Hydraulic Isolation Barrier			
Depth of Barrier Wall	40	feet	Engr Est
Barrier Wall Area	66,800	sf	Calc
Groundwater Sumps			
Assumed separation between perimeter sumps	100	ft	
No. of perimeter sumps	1,700	sumps	
Assumed ROI for sumps around landfill cap	60	ft	Engr Est.
Perimeter of Cap	11,304	sf/sump	calc
No. of Sumps required for dewatering under Cap	15	sumps	calc
Soil Volume Calc			
Cover Soil Volume			
Cover Soil Thickness; 10-5 cm/s hydraulic conductivity	1.5	feet	Engr Est
Cover Soil Volume - Compacted	10,033	CCY	calc
Conversion	1.41	CCY/LCY	US Army, 1994
Cover Soil Volume - Loose	14,150	LCY	calc
Conversion	1.4	ton/LCY	Engr Est.
Cover Soil Tonnage	20,000	ton	calc
Top Soil Volume			
Top Soil Thickness	0.5	feet	Engr. Est.
Top Soil Volume - compacted	3,340	CCY	calc
Conversion	1.39	CCY/LCY	US Army, 1994
Top Soil Volume - Loose	4,700	LCY	calc
Conversion	1.4	ton/LCY	Engr Est.
Top Soil Tonnage	6,600	ton	Engr Est.
Cap Construction Duration			
Cap Construction Rate	1000	LCY/day/ crew	Engr Est.
Cap Construction Duration	19	wdays	calc
Conversion	10	hrs/wday	Engr Est.
Conversion	5	wday/wks	Engr Est.
Cap Construction Duration	190	hrs	calc
Cap Construction Duration	4	wks	calc
Cap Construction Duration	2	months	Engr Est.
Compaction Testing			
Compaction Rate	10,000	SF/test	Engr Est
Compaction Area	180,600	SF	calc
Lift Thickness	1	feet	Engr Est.
Number of Lifts	2	lifts	calc
Number of Compactions Tests	40	tests	calc
Fence Dimensions			
Area	170,000	sf	DOE, 2009
Buffer Length	60	feet	Engr Est.
SWMU Perimeter/Fence Length	1,890	feet	calc
Fenced Area plus 10 ft path outside perimeter of fence (mowing area)	190,000	sf	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 6 - Targeted excavation and disposal, cover, land use controls, monitoring w/contingent post excavation treatment

Parameter	Total	Units	Basis
Drums Reqd for Post Holes			
Distance between posts	8	feet	Engr Est
Number of post holes	236	post holes	Engr Est
Post hole depth	3	feet	Engr Est
Post hole diameter	1	feet	Engr Est
Post hole volume	0.79	cf/post hole	calc
Total volume of post hole soil	1,737	cf	calc
Drum volume	55	gal	Engr Est
Conversion	7.48	gal/cf	Lindeburg, 1990
Drum volume	7	cf/drum	calc
No. of Drums	240	drums	calc
2. Excavation & Disposal Calculations			
Source Area Dimensions			
Excavation area lenth	75	feet	
Excavation area width	75	feet	
Area to be Excavated	5,625	SF	Engr Est.
Excavation Depth	20	feet	Engr Est.
Waste Volume Calc			
Waste Volume	4,167	BCY	calc
Conversion	1.20	LCY/BCY	PRS Directive
Waste Volume	5,000	LCY	calc
Assumed Nearly Nondetectable Radioactive Material (U Landfill WAC Compliant) Fraction	0.4		Engr Est
Assumed LLW & MLLW Fraction	0.6		Engr Est
U Landfill WAC Compliant Volume	1,800	LCY	calc
LLW & MLLW Volume	3,200	LCY	calc
Assumed LLW Fraction of LLW & MLLW Vol	0.5		Engr Est
Assumed MLLW Fraction of LLW & MLLW Vol	0.5		Engr Est
LLW Volume	1,600	LCY	calc
MLLW Volume	1,600	LCY	calc
Conversion	1.4	ton/LCY	Engr Est
LLW & MLLW Tonnage	2,520	ton	calc
Absorbents for Soil			
Absorbent Rate	0.54	lb/CF	Engr. Est
Total Excavated Soils	5,000	LCY	calc
Total Absorbent needed	72,900	lbs	calc
Excavation Duration			
Excavation Rate for U Landfill WAC Compliant	4,400	bcy/month/ crew	Engr Est., 200 bcy/day/crew 22 wdays/mo
Excavation Rate for LLW & MLLW	2,200	bcy/month/ crew	Engr Est., 100 bcy/day/crew, 22 wdays/mo
No. of Crews	1	crew	Engr Est
Time to Excavate U Landfill WAC Compliant	1	month	calc
Time to Excavate LLW & MLLW	1	month	calc
Work week	5	wdays/wk	Engr Est.
Work days per year	260	wdays/yr	calc
Work hours per year	2,600	whour/yr	calc
Work days per month	22	wdays/mo	calc
Dewatering Calc			
Initial Pore Volume	126,225	gal	calc from Est. Basis

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 6 - Targeted excavation and disposal, cover, land use controls, monitoring w/contingent post excavation treatment

Parameter			Total	Units	Basis
		Dewatering Rate for Initial Pore Vol	30	gpm	Assumed
		Days to dewater initial pore volume	3	days	calc
		Dewatering Rate after removing initial pore vol.	7.9	gpm	DOE, 1998, pg 17
		Total Excavation Time	1	months	calc
		Fraction of time pumping occurs after removal of initial pore volume	0.1	fraction	Engr Est
		Dewater Volume during excavation	24,648	gal	calc
		Total Water for Trmt/Disposal during excavation	150,873	gal	calc
MLLW Sludge Production from GW Treatment					
		Assumed Dewatering Rate	6,963	gal/day	calc
		Number of days operating	22	days	calc
		Dewatering total	150,873	gallons	calc
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	1,509	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Est. Sludge production	7	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	27	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	1	trips	calc
Transportation Bags, Truck Liner, and Rail Cars					
		Transportation Bag Volume	8.96	CY	Pactec
		Bags required for LLW & MLLW	358	Bags	calc
		Truck Liner	15	CY	Engr Est.
		Liners required for U Landfill	120	Liners	calc
		Bags per Rail Car	8.0	bags/rail car	Energy Solutions
		No. of Rail Cars	50	rail cars	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant + 10 percent QA/QC	20	samples	Engr Est.
		Samples for LLW & MLLW + 10 percent QA/QC	10	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	300	feet	calc
		Fence Perimeter	1,000	feet	calc
		Area	12,000	SF	calc
		Sheet pile density	38	psf	left in place
		Tonnage	300	tons	calc
Up to Date Cost Factor					
		Escalation Rate 2003-2006	0.0737	fraction	DOE 2007
		Escalation Rate 2003-2009	0.1474	fraction	calc
		ODC & OH	0.0231	fraction	DOE 2007
		Escalation Rate 2003-2009/ODC & OH Factor	1.171		calc
Drum Volume					
		Drum Volume	7.4	CF	DOE 2007-198
		Drum Volume	0.27	CY	calc
Fence Dimensions					
		SWMU Perimeter/Fence Length	300	feet	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	5,000	LCY	
		Conversion	1.41	CCY/LCY	US Army, 1994

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 7

Alternative 6 - Targeted excavation and disposal, cover, land use controls, monitoring w/contingent post excavation treatment

Parameter	Total	Units	Basis
Volume of Backfill	7,050	CCY	calc
Conversion	1.4	ton/CY	Lindeburg, 1990
Backfill Tonnage	10,000	ton	calc
Backfill Rate	3,000	cy/day/crew	Engr Est.
Est. Time to Backfill	2	days	calc
Working days per month	22	days	calc
Est. Months to Backfill	0	months	calc
Compaction Testing			
Compaction Rate	20,000	SF/test	Engr Est
Compaction Area	5,625	SF	DOE 2010
Lift Thickness	2	feet	Engr Est.
Number of Lifts	10	lifts	calc
Number of Compactions Tests	3	tests	calc
Top Soil & Hydroseeding			
Disturbed Area	1	acres	Engr Est.
Conversion	43,560	SF/acre	Lindeburg, 1990
Disturbed Area	43,560	SF	calc
Conversion	1,000	SF/MSF	
Disturbed Area	50	MSF	calc
Top Soil Thickness	1	feet	Engr Est.
Conversion	27	CF/CY	Lindeburg, 1990
Conversion	1.3	ton/CY	Engr Est.
Top Soil tonnage	1,000	ton	calc
Trucking to existing U Landfill at PGDP			
Dump Capacity	14	ton	Engr Est
Dump Capacity	15	lcy	Engr Est
Dump Trips for U Landfill WAC Compliant	120	trips	calc
Trucking to future On-Site Disposal Cell at PGDP			
Dump Capacity	14	ton	Engr Est
Dump Capacity	15	lcy	Engr Est
Dump Trips for LLW & MLLW	120	trips	calc
PPE LLW Drums			
Drums filled per day with PPE LLW Waste	1	drum/day	Engr Est
No. of drums used during project	22	drums	calc
Drums per Truckload	60	drums/trucklo	Engr Est
Truck Trips	1	trips	calc
Drum Volume	55	gal/drum	Engr Est
Conversion	7.48	gal/cf	Lindeburg, 1990
Conversion	27	cf/cy	Lindeburg, 1990
Total Volume of PPE	10	cy	calc

References:

DOE, 1995, Record of Decision for Interim Remedial Action at SWMUs 2 & 3 of WAG 22 at PGDP, KY, July.
DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.
DOE, 2010, BGOU Remedial Investigation Report.
FRTR 2009, Federal Remediation Technologies Roundtable (www.frtr.com)
Lindeburg, 1990, Engineering Unit Conversions, 2nd Ed.
Morgenstern, 2007, Electrical Resistance Heating of Soils at C-Reactor at the Savannah River Site, WSRC-STI-2007-00488, Michael R. Morgenstern, et al.
US Army, 1994, Field Manual No. 5-430-00-1, Planning and Design of Roads, Airfields, and Helioports in the Theater of Operations - Road Design.

COST ESTIMATE
BGOU SWMU 7
6.b.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,189,000	$1,189,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$268,000	$268,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$391,000	$391,000					
6.1. Well Installation	1	ls	$344,000	$344,000					
7.0 Excavation	1	ls	$1,511,000	$1,511,000					
8.0 Waste Transportation & Disposal	1	ls	$4,723,000	$4,723,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,214,000	$1,214,000					
b. - 18" Clay/ 6" soil cover	1	ls	$879,000	$879,000					
10.0 Site Restoration	1	ls	$183,000	$183,000					
11.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$2,277,400	$2,277,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$956,480	$956,000					fee = 7%.
Contingency	1	ls	$2,924,000	$2,924,000					20% contingency
		SUBTOTAL CAPITAL COST		**$17,544,000**					
Construction Schedule	**6**	**Month**							
Annual Cost - Monitoring									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (Years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$19,864,000**					

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COST ESTIMATE
BGOU SWMU 7
6.b.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$17,544,000	$17,544,000				**$17,544,000**	
Annual Cap O&M (Years 1 - 30)	30	ls	$45,000	$1,350,000				**$967,478**	2.3% discount rate
Quarterly Groundwater LTM (Years 1-2)	2	ea	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3-5)	3	ea	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ea	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$17,544,000**	
						Present	**Annual**	**$1,699,000**	
						Worth	**Avg. Annual**	**$56,633**	
						Values	**Total**	**$19,243,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA, 2009
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$211,000	$211,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,189,000**			**0**	**$1,189,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					5% of Construction Cost
TASK TOTAL				**$340,000**			**0**	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor is cleared and local; using two work crews for this remedial action.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. Labor is 100% un-cleared.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	480	hr	$31	$14,880					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$100,300**	**2,673**		**$167,558**	**$268,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crew of Q cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor is cleared and local;									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	267	man day	$24	$6,328					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Two Portable Toilets	1	month	$300	$300					Engr Est
Rad Screening System	1	setup	$40,000	$40,000					RSMeans ECHOS 33 18 0402
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$17	$13,600					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$223,082**	**2673**		**$167,558**	**$391,000**	
6.1. Well Installation									
Duration: One month.									
Assumptions: Drilling derived Waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	LS	$22,699	$22,699					Vendor Quote
Well Installation	4	LS	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
7.0 Excavation									
Duration: Using one crew approximately 1 months for excavation, staging, and sampling based on excavating MLLW at 100 bcy/day/crew,									
U Landfill WAC Compliant waste at 200 bcy/day/crew, and lag time between excavation and transporting offsite.									
Assumption: Install sheet piling along excavation perimeter. Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW & LLW stockpiles containerized into soft side bags loaded on trucks for delivery to the rail spur.									
At the rail spur the soft side bags are lifted on rail cars for delivery to the offsite disposal facility.									
U Landfill WAC Compliant & Non Haz Waste is transported from the stockpile to the onsite U Landfill.									
Uranium waste/Rad Material over packed for truck transport to NTS.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharge.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									
Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5564		$349,040		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	556	man-day	$24	$13,177					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$886					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$886					Hertz
All Terrain Forklift	1	month	$900	$614					Engr Est
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
Crane	1	month	$1,600	$1,091					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$1,909					Engr Est
Front End Loader	1	month	$4,150	$2,830					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,261					Engr Est
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$2,727					Engr Est
Dump Trailer, 16 cy	1	month	$1,248	$851					Engr Est
Dump Trailer, 16 cy	1	month	$1,248	$851					Engr Est
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$4,432					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Two Portable Toilets	1	month	$300	$300					Engr Est
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hı
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	300	tons	$2,125	$637,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	120	liners	$95	$11,400					Engr Est., ECHOS 33 19 0810
Soft Side Bags	358	bag	$350	$125,300					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)
B25 Boxes	4	ea	$1,400	$5,600					DOE Engr Est.
55 gal Drums	289	ea	$64	$18,502					Vendor quote
Drum Liners	289	ea	$10	$2,891					Engr Est.
Drum Overpacks	60	ea	$150	$9,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Verification Samples	17	sample	$2,200	$37,883					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$1,161,561**	**5,564**		**$349,040**	**$1,511,000**	
8.0 Waste Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with two work crews.									
Assumptions: Includes transportation from staging area to final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5390		$338,152		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	539	man-day	$24	$12,774					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hı
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hı

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Disposal/Waste Sampling									
Excavated Waste	17	sample	$2,200	$36,667					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	4	sample	$2,200	$8,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
PPE Waste	2	sample	$2,200	$5,243					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	9	sample	$150	$1,350					One sample weekly for VOCs.
Sludge from Water Trmt	3	sample	$2,200	$6,638					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Transportation									
RM/Sources	2	truck load	$11,000	$22,000					NTS, three B25 Boxes per truckload
U Landfill WAC Compliant	120	truck load	$75	$9,000					Onsite existing U Landfill -Subtitle D, assume 15 cy dump trucks, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW & MLLW	50	gons	$19,400	$970,000					Energy Solutions by Rail, Eight bags per gondola, Includes fees
LLW PPE Waste	1	truck load	$7,053	$7,053					Energy Solns, 60 drums per truckload
LLW Sludge from Water Trmt	1	truck load	$7,053	$7,053					Energy Solns, 60 drums per truckload
Disposal									
RM/Sources	2	truckload	$0	$0					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	1,800	LCY	$0	$0					Onsite U Landfill
LLW	1,600	LCY	$347	$555,200					Envirocare, soil & Debris disposal avg $347/cy
MLLW	1,600	LCY	$1,135	$1,816,000					Energy Solutions
LLW PPE Waste	10	LCY	$215	$2,150					Envirocare
LLW Sludge from Water Trmt	7	LCY	$632	$4,721					Envirocare
Dewater/Wastewater Trmt	150,873	gal	$3	$452,619					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	72,900	lbs	$2.13	$155,277					0.54lb/cf
Task Total				**$4,384,992**	5,390		**$338,152**	**$ 4,723,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 month with two work crews.									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2464		$143,176		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	246	man-day	$24	$5,830					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Loader, crawler	1	month	$1,800	$1,800					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Generator 150 KW	1	month	$2,006	$2,006					Engr Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Loader, crawler	1	month	$1,800	$1,800					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Generator 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value in SWMU 2 FS
Subcontractors									
Backfill Delivered	10,000	ton	$16	$160,000					Engr Est.
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	3	test	$54	$162					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$1,071,264**	2464		**$143,176**	**$1,214,000**	
b. - 18" Clay/ 6" soil cover									
Duration: Three months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Construction will consist of installation of installation of 18" clay/6" soil cover over the SWMU.									
Schedule	**3**	**Month**							
Labor									
LATA Labor					6930		$457,380		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
18" Clay	12,040	LCY	$21	$253,000					Engr Est.
6" Soil cover	4,013	LCY	$23	$92,000					Engr Est.
Subcontractors									
Fence, 8', barbed wire	400	lf	$35	$14,000					100' x 100' fence, 8' tall with barb wire, RSMeans 02820-528-0920
Double Swing Gate, 8'	2	ea	$1,475	$2,950					RSMeans 0280-528-5070
Equipment									
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Pickup Truck, crew cab, F250	3	month	$1,300	$3,900					Hertz
Front End Loader	3	month	$4,150	$12,450					Engr Est.
Dozer	3	month	$2,800	$8,400					Engr Est.
Compactor/12 ton/pad foot	3	month	$3,090	$9,270					Engr Est.
Compactor/12 ton/smooth drum	3	month	$2,920	$8,760					Engr Est.
Water Truck, 2000 gal	3	month	$1,850	$5,550					Engr Est.
Equipment Trailer	3	month	$300	$900					Engr Est.
Generator, 15KW	3	month	$2,006	$6,018					Engr Est.
Portable Toilet	3	month	$150	$450					Engr Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
TASK TOTAL				**$421,548**	**0**		**$457,380**	**$879,000**	
10.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire SWMU + 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
11.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$11,387,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (Years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote

COST ESTIMATE
BGOU SWMU 7
6.b.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (Years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (Years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
TASK TOTAL								**$50,000**	

SWMU 7
6.b.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$17,544,000						$17,544,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$17,544,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$21,184,000

SWMU 7
6.b.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.00	1.00	$17,544,000	$0	$0	$0	$0	$0	$17,544,000
2013	1	1.00	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1.00	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1.00	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1.00	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1.00	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1.00	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1.00	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1.00	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1.00	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1.00	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$17,544,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$19,864,000

COST ESTIMATE
BGOU SWMU 7
6.d.t6.CR
Targeted Exc. and Disposal, Subtitle D Cap, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$1,189,000	$1,189,000					
2.0 Engineering Design	1	ls	$340,000	$340,000					
3.0 Work Package Prep./Readiness Review	1	ls	$78,000	$78,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$268,000	$268,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$391,000	$391,000					
6.1. Well Installation	1	ls	$344,000	$344,000					
7.0 Excavation	1	ls	$1,511,000	$1,511,000					
8.0 Waste Transportation & Disposal	1	ls	$4,723,000	$4,723,000					
9.0 Backfill and Equipment Decontamination.	1	ls	$1,214,000	$1,214,000					
10.0 Install Subtitle D Cover	1	ls	$2,509,000	$2,509,000					
11.0 Site Restoration	1	ls	$183,000	$183,000					
12.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$2,603,400	$2,603,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$1,093,400	$1,093,000					fee = 7%.
Contingency	1	ls	$3,342,600	$3,343,000					20% contingency
		SUBTOTAL CAPITAL COST		**$20,056,000**					
Construction Schedule	**6**	**Month**							
Annual Cost - Monitoring									
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000					
Quarterly Groundwater LTM (Years 1-2)	2	ea	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ea	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ea	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,320,000**					
			TOTAL	**$22,376,000**					

COST ESTIMATE
BGOU SWMU 7
6.d.t6.CR
Targeted Exc. and Disposal, Subtitle D Cap, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$20,056,000	$20,056,000				**$20,056,000**	
Annual Cap O&M (Years 1 - 30)	30	ea	$45,000	$1,350,000				**$967,478**	
Quarterly Groundwater LTM (Years 1-2)	2	ea	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3-5)	3	ea	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ea	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,857**	2.3% discount rate
							Capital Costs	**$20,056,000**	
						Present Worth Values	**Annual**	**$1,699,000**	
							Avg. Annual	**$56,633**	
							Total	**$21,755,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Documented Safety Analysis	1	LS	$333,000	$333,000					LATA, 2009
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$211,000	$211,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,189,000**			0	**$1,189,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$35,000	$35,000					Engr Est.
Remedial Design Investigation	1	LS	$250,000	$250,000					Engr Est.
Land Use Controls	1	LS	$0	$0					Engr Est.
Design	1	LS	$55,000	$55,000					5% of Construction Cost
TASK TOTAL				**$340,000**			0	**$340,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$60,000	$60,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					

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COST ESTIMATE
BGOU SWMU 7
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Targeted Exc. and Disposal, Subtitle D Cap, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$77,845	**$ 77,845**			**0**	**$78,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding. Labor is cleared and local; using two work crews for this remedial action.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**	**1,040**		**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. Labor is 100% un-cleared									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	480	hr	$31	$14,880					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	2	month	$1,248	$2,496					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$100,300**	**2,673**		**$167,558**	**$268,000**	

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COST ESTIMATE
BGOU SWMU 7
6.d.t6.CR
Targeted Exc. and Disposal, Subtitle D Cap, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crew of Q cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill. Labor is cleared and local									
Schedule	**1**	**months**							
Labor									
LATA Labor					2673		$167,558		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	267	man day	$24	$6,328					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Two Portable Toilets	1	month	$300	$300					Engr Est
Rad Screening System	1	setup	$40,000	$40,000					RSMeans ECHOS 33 18 0402
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$17	$13,600					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	2,000	lf	$39	$77,000					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$223,082**	**2673**		**$167,558**	**$391,000**	
6.1. Well Installation									
Duration: One month.									
Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	LS	$22,699	$22,699					Vendor Quote
Well Installation	4	LS	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from eight wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
7.0 Excavation									
Duration: Using one crew, approximately 1 month for excavation, staging, and sampling based on excavating MLLW at 100 bcy/day/crew,									
U Landfill WAC Compliant waste at 200 bcy/day/crew, and lag time between excavation and transporting offsite.									
Assumption: Install sheet piling along excavation perimeter. Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
MLLW & LLW stockpiles containerized into soft side bags loaded on trucks for delivery to the rail spur.									
At the rail spur the soft side bags are lifted on rail cars for delivery to the offsite disposal facility.									
U Landfill WAC Compliant & Non Haz Waste is transported from the stockpile to the onsite U Landfill.									
Uranium waste/Rad Material over packed for truck transport to NTS.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharge.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									
Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5564		$349,040		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	556	man-day	$24	$13,177					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$886					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$886					Hertz
All Terrain Forklift	1	month	$900	$614					Engr Est
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
Crane	1	month	$1,600	$1,091					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$1,909					Engr Est
Front End Loader	1	month	$4,150	$2,830					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,261					Engr Est
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$2,727					Engr Est
Dump Trailer, 16 cy	1	month	$1,248	$851					Engr Est
Dump Trailer, 16 cy	1	month	$1,248	$851					Engr Est
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$4,432					Engr Est
Equipment Trailer	1	month	$448	$448					Engr Est
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Two Portable Toilets	1	month	$300	$300					Engr Est

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	300	tons	$2,125	$637,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	120	liners	$95	$11,400					Engr Est., ECHOS 33 19 0810
Soft Side Bags	358	bag	$350	$125,300					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)
B25 Boxes	4	ea	$1,400	$5,600					DOE Engr Est.
55 gal Drums	289	ea	$64	$18,502					Vendor quote
Drum Liners	289	ea	$10	$2,891					Engr Est.
Drum Overpacks	60	ea	$150	$9,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									
Verification Samples	17	sample	$2,200	$37,883					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$1,161,561**	**5,564**		**$349,040**	**$1,511,000**	
8.0 Waste Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with two work crews.									
Assumptions: Includes transportation from staging area to final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared and local; using two work crews. Level D Modified PPE.									
Schedule	**1**	**months**							
Labor									
LATA Labor					5390		$338,152		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	539	man-day	$24	$12,774					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$900	$900					Engr Est.
Crane	1	month	$2,350	$2,350					Engr Est.
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Tanker Truck, vacuum, 5000 gal	1	month	$4,000	$4,000					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Dump Trailer, 16 cy	1	month	$1,248	$1,248					Engr Est.
Tractor Trailer, 6x4, 45 ton, 240HP	1	month	$6,500	$6,500					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Crane for HEPA Filtration	1	month	$2,350	$2,350					Engr Est.
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Disposal/Waste Sampling									
Excavated Waste	17	sample	$2,200	$36,667					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	4	sample	$2,200	$8,800					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
PPE Waste	2	sample	$2,200	$5,243					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	9	sample	$150	$1,350					One sample weekly for VOCs.
Sludge from Water Trmt	3	sample	$2,200	$6,638					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Transportation									
RM/Sources	2	truck load	$11,000	$22,000					NTS, three B25 Boxes per truckload
U Landfill WAC Compliant	120	truck load	$75	$9,000					Onsite existing U Landfill -Subtitle D, assume 15 cy dump trucks, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW & MLLW	50	gons	$19,400	$970,000					Energy Solutions by Rail, Eight bags per gondola, Includes fees
LLW PPE Waste	1	truck load	$7,053	$7,053					Energy Solns, 60 drums per truckload

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
LLW Sludge from Water Trmt	1	truck load	$7,053	$7,053					Energy Solns, 60 drums per truckload
Disposal									
RM/Sources	1	truckload	$0	$0					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	1,800	LCY	$0	$0					Onsite U Landfill
LLW	1,600	LCY	$347	$555,200					Envirocare, soil & Debris disposal avg $347/cy
MLLW	1,600	LCY	$1,135	$1,816,000					Energy Solutions
LLW PPE Waste	10	LCY	$215	$2,150					Envirocare
LLW Sludge from Water Trmt	7	LCY	$632	$4,721					Envirocare
Dewater/Wastewater Trmt	150,873	gal	$3	$452,619					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	72,900	lbs	$2.13	$155,277					0.54lb/cf
Task Total				**$4,384,992**	5,390		**$338,152**	**$ 4,723,000**	
9.0 Backfill and Equipment Decontamination.									
Duration: Assume 1 month with two work crews.									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2464		$143,176		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	246	man-day	$24	$5,830					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Loader, crawler	1	month	$1,800	$1,800					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Generator 150 KW	1	month	$2,006	$2,006					Engr Est.
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Loader, crawler	1	month	$1,800	$1,800					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Generator 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Rad Screening System	1	Demob	$100,000	$100,000					RSMeans ECHOS 33 18 0403
Unit Pricing									
Decontamination	1	ls	$754,000	$754,000					DOE, 1998; doubled original value in SWMU 2 FS
Subcontractors									
Backfill Delivered	10,000	ton	$16	$160,000					Engr Est.

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	3	test	$54	$162					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
TASK TOTAL				**$1,071,264**	2464		**$143,176**	**$1,214,000**	
10.0 Install Subtitle D Cover									
Duration: Six months. Estimated a maximum of 25 truckloads per day and a production rate of 300 CY per day.									
Assumptions: Construction Labor included in Unit Pricing.									
Schedule	**6**	**Month**							
Labor									
LATA Labor					13860		$914,760		Engr Est., LATA Labor Rate
Unit Pricing									
Cap Construction	180,600	sf							
Vegetative Soil Layer	20,067	LCY	$23	$461,533					Vendor Quote
Drainage Layer with a min perm 1E-03 cm/sec	6,689	LCY	$21	$140,467					Vendor Quote
Clay Layer with a min perm of 1E-07 cm/sec	10,033	LCY	$21	$210,700					Vendor Quote
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Sand Gas Venting System with a min perm 1E-03 cm/sec	6,689	LCY	$45	$301,000					Engr Est.
Filter Fabric	180,600	sf	$1	$180,600					Engr Est.
Equipment									
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Pickup Truck, crew cab, F250	6	month	$1,300	$7,800					Hertz
Front End Loader	6	month	$4,150	$24,900					Engr Est.
Dozer	6	month	$2,800	$16,800					Engr Est.
Compactor/12 ton/pad foot	6	month	$3,090	$18,540					Engr Est.
Compactor/12 ton/smooth drum	6	month	$2,920	$17,520					Engr Est.
Water Truck, 2000 gal	6	month	$1,850	$11,100					Engr Est.
Equipment Trailer	6	month	$300	$1,800					Engr Est.
Generator, 15KW	6	month	$2,006	$12,036					Engr Est.
Portable Toilet	6	month	$150	$900					Engr Est.
TASK TOTAL				**$1,594,096**	**0**		**$914,760**	**$2,509,000**	
11.0 Site Restoration									
Duration: Approximately one month for site restoration.									
Assumptions: 10 hrs/workday and 22 workdays/month. Radcon not needed.									
Schedule	**1**	**Month**							
Labor									

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	271	MSF	$50	$13,545					Assume entire SWMU + 50%; RSMeans 02920-320-1000
TASK TOTAL				**$25,001**			**$157,513**	**$183,000**	
12.0 Remedial Action Completion Report									
Reports									
As-Built Drawings	1	ls	$15,000	$15,000					Engr Est
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$13,017,000**	
Annual Cap O&M (Years 1 - 30)									
Duration: First year through thirty years.									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					460		$26,460		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	4	acre	$400	$1,600					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,900**	**460**		**$26,460**	**$45,000**	ANNUAL COST
Quarterly Groundwater LTM (Years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote

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	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (Years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (Years 6-30)									
Duration: years six through thirty									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									

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		Other Direct Costs				Labor				
Task Description		Qty	Unit	Unit Price	Total	Hours	Rate	Total	Total Cost	Basis of Estimate
	Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
	TASK TOTAL								$50,000	

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Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features
Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$20,056,000						$20,056,000
2013	1	1.029	1.03		$46,305	$95,697				$142,002
2014	2	1.029	1.06		$47,648	$98,472				$146,120
2015	3	1.029	1.09		$49,030		$30,507			$79,537
2016	4	1.029	1.12		$50,451		$31,392			$81,844
2017	5	1.029	1.15		$51,915		$32,302		$57,683	$141,900
2018	6	1.029	1.19		$53,420			$37,988		$91,408
2019	7	1.029	1.22		$54,969					$54,969
2020	8	1.029	1.26		$56,563			$40,223		$96,786
2021	9	1.029	1.29		$58,204					$58,204
2022	10	1.029	1.33		$59,892			$42,590	$66,546	$169,028
2023	11	1.029	1.37		$61,629					$61,629
2024	12	1.029	1.41		$63,416			$45,096		$108,511
2025	13	1.029	1.45		$65,255					$65,255
2026	14	1.029	1.49		$67,147			$47,749		$114,896
2027	15	1.029	1.54		$69,094				$76,772	$145,866
2028	16	1.029	1.58		$71,098			$50,559		$121,657
2029	17	1.029	1.63		$73,160					$73,160
2030	18	1.029	1.67		$75,282			$53,534		$128,815
2031	19	1.029	1.72		$77,465					$77,465
2032	20	1.029	1.77		$79,711			$56,684	$88,568	$224,963
2033	21	1.029	1.82		$82,023					$82,023
2034	22	1.029	1.88		$84,402			$60,019		$144,421
2035	23	1.029	1.93		$86,849					$86,849
2036	24	1.029	1.99		$89,368			$63,551		$152,918
2037	25	1.029	2.04		$91,960				$102,177	$194,137
2038	26	1.029	2.10		$94,626			$67,290		$161,916
2039	27	1.029	2.16		$97,371					$97,371
2040	28	1.029	2.23		$100,194			$71,249		$171,444
2041	29	1.029	2.29		$103,100					$103,100
2042	30	1.029	2.36		$106,090			$37,721	$117,878	$261,688
TOTAL				$20,056,000	$2,167,636	$194,169	$94,202	$674,250	$509,624	$23,696,000

SWMU 7
6.d.t6.CR
Targeted Excavation and Disposal, 18/6 Cover, LUCs, Monitoring, Existing Features
Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Annual Cap O&M (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.00	1.00	$20,056,000	$0	$0	$0	$0	$0	$20,056,000
2013	1	1.00	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2014	2	1.00	1.00	$0	$45,000	$93,000	$0	$0	$0	$138,000
2015	3	1.00	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2016	4	1.00	1.00	$0	$45,000	$0	$28,000	$0	$0	$73,000
2017	5	1.00	1.00	$0	$45,000	$0	$28,000	$0	$50,000	$123,000
2018	6	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2019	7	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2020	8	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2021	9	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2022	10	1.00	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2023	11	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2024	12	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2025	13	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2026	14	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2027	15	1.00	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2028	16	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2029	17	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2030	18	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2031	19	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2032	20	1.00	1.00	$0	$45,000	$0	$0	$32,000	$50,000	$127,000
2033	21	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2034	22	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2035	23	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2036	24	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2037	25	1.00	1.00	$0	$45,000	$0	$0	$0	$50,000	$95,000
2038	26	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2039	27	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2040	28	1.00	1.00	$0	$45,000	$0	$0	$32,000	$0	$77,000
2041	29	1.00	1.00	$0	$45,000	$0	$0	$0	$0	$45,000
2042	30	1.00	1.00	$0	$45,000	$0	$0	$16,000	$50,000	$111,000
TOTAL				$20,056,000	$1,350,000	$186,000	$84,000	$400,000	$300,000	$22,376,000

SWMU 30 COST ESTIMATES

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SWMU 30 Remedial Alternatives Cost Estimate Summary

Alternative	Description	Annual Time Period, yrs	Capital $ (2012 Constant Dollars)	PRESENT WORTH [1] Total Annual $	PRESENT WORTH [1] Total $ (Capital & Annual)	ESCALATED Total Annual $	ESCALATED Total $ (Capital & Annual)
1	No Action	0	$0	$0	$0	$0	$0
2.t6	Limited Action: LUCs, Monitoring, Existing Features	30	$2,001,000	$1,548,000	$3,549,000	$3,302,250	$5,303,250
3.a.t6	Soil Cover, LUCs, Monitoring, Existing Features	30	$3,452,000	$1,548,000	$5,000,000	$3,302,250	$6,754,250
3.d.t6	Subtitle D Cap, LUCs, Monitoring, Existing Features	30	$5,774,000	$1,548,000	$7,322,000	$3,302,250	$9,076,250
5.t6	Excavation and Disposal	30	$38,164,000	$0	$38,164,000	$0	$38,164,000
5.t6.WDF	Excavation and Disposal, WDF	30	$17,629,000	$0	$17,629,000	$0	$17,629,000

Notes:
(1) Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.

ESTIMATE BASIS
SWMU 30 (C-747-A Burn Area)

A. SWMU Description
Burn and burial pit (Burial Pit A) and location of a former incinerator.
Pit reportedly excavated to a depth of 12 feet and covered with 4 feet of earth.
Drainage ditches on the north an south side of the site.
Deeper soil borings encountered surficial fill materials to depths of 2 to 12 ft.

Geophysics identified an anomaly in the shape of a rough circle approx. 43 feet in diameter. The RI confirmed that anomaly is likely the metal reinforcement within the footer and retaining walls of the former incinerator and/or parts of the buried former incinerator.
Burial Pit A dimensions estimated at 50 ft x 250 ft, or 12,500 sf (DOE, 2010).
SWMU covers an area of approximately 128,000 sf (DOE, 2010)
Reference: DOE, 2010

From Fig. 4.7 (DOE, 2010) quantity takeoff, SWMU area = 110,110 sf and Waste Cell area = 18,225 sf.

For calculations, use Waste Cell Area = 20,000 sf (rounded up, conservative value) and 120,000 sf (rounded up average of quantity takeoff from Fig 4.7 and value presented in RI (DOE, 2010).

Assumed SWMU Area =	120,000	sf
Assumed Waste Cell Area=	20,000	sf
Est. Fraction of the SWMU area comprised of burial cells =	0.17	

B. Unquantifiable Disposal Items
Incinerator used to burn combustible trash, which may have contained uranium contamination.
Contaminated and uncontaminated trash, ash, and debris were buried in Burial Pit A.
Assumed ash from the incinerator was buried onsite and may have contained uranium contamination.

C. Excavation and Disposal
Assumptions:
Burial cells are expected to encompass 25 percent of SWMU area.
Excavate to a maximum depth of 20 feet bgs.
Entire Burial Area will require excavation
Excavation increases soil volume by a factor of 20 percent during handling (bank to loose).
Soil density is 100 pounds per cubic foot.
All excavated soil will require addition of sorbent to reduce moisture content.
Density of sorbent will increase soil volume by 0.54 percent. Assume 0.54 lbs sorbent added to 100 lbs

Excavated Soil Volume Calculation

Area (SF)	Beginning Depth (feet bgs)	End Depth (feet bgs)	Quantity (BCY)	Quantity (LCY)	**Quantity (LCY) w/sorbent**	Percentage for Off-Site Disposal	**Off-Site (CY)**	**On-Site (CY)**
20,000	0	4	2,963	3,556	3,575	10	357	3,217
20,000	4	12	5,926	7,111	7,150	70	5,005	2,145
20,000	12	20	5,926	7,111	7,150	30	2,145	5,005
						Total	**7,500**	**10,300**
							42%	58%

-
Material excavated from 0-4 ft will be primarily nonhazardous LLW.

ESTIMATE BASIS
SWMU 30 (C-747-A Burn Area)

D. Dewatering Estimate for Excavation

Sheet pile installed around perimeter of excavation =	600	lf
Assumed depth to groundwater (DOE, 2010) =	5	ft
Assumed bottom of Excavation below grade =	20	ft
Groundwater Thickness =	15	ft
Assumed Average Site Soil Porosity =	0.2	
Area to be Dewatered =	20,000	sf

Initial Pore Volume = Area x Groundwater Thickness x Porosity

Estimate of Initial Pore Volume to Dewater				
area (sf)	thickness (ft)	porosity	Volume (cubic ft)	Volume (gallon)
20,000	15	0.2	60,000	400,000

Assumed removal rate achieved for dewatering initial pore volume =	30	gpm
Dewatering rate after removal of initial pore volume (DOE, 1998, pg 17) =	7.9	gpm

-

E. Cap or Cover

Use 5 ft buffer around cap.

feet	feet	Area (SF)
350	350	122,500

Perimeter of cap
1400 feet

F. References

DOE, 2010, BGOU Remedial Investigation Report.
DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 2 - Limited Action: Land Use Controls, Monitoring, Existing Features

Parameter			Total	Units	Basis
SWMU Dimensions					
		SWMU Area	122,500	SF	Est Basis

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Other Direct Costs				Labor				
Task Description	**Qty**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Cost Estimate Summary									
Capital Cost									
1.0 Project Plans	1	ls	$726,000	$726,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$29,000	$29,000					
4.0 Training	1	ls	$72,000	$72,000					
5.0 Well Installation	1	ls	$344,000	$344,000					
6.0 Remedial Action Completion Reporting	1	ls	$220,000	$220,000					
Management reserve, Subproject Management	1	ls	$374,000	$374,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$130,900	$131,000					fee = 7%.
		SUBTOTAL CAPITAL COST		**$2,001,000**					
Construction Schedule	**1**	**Months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000					
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Yr 5	1	ls	$50,000	$50,000					
Five-Year Review Yr 10	1	ls	$50,000	$50,000					
Five-Year Review Yr 15	1	ls	$50,000	$50,000					
Five-Year Review Yr 20	1	ls	$50,000	$50,000					
Five-Year Review Yr 25	1	ls	$50,000	$50,000					
Five-Year Review Yr 30	1	ls	$50,000	$50,000					
Annual Cost - Monitoring									
		SUBTOTAL ANNUAL COST		**$2,110,000**					
			TOTAL	**$4,111,000**					
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$2,001,000	$2,001,000				**$2,001,000**	
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000				**$816,981**	2.3% discount rate
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Yr 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Yr 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Yr 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate

COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	Five-Year Review Yr 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
	Five-Year Review Yr 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
	Five-Year Review Yr 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
								Capital Costs	**$2,001,000**	
							Present	**Annual**	**$1,548,000**	
							Worth	**Avg. Annual**	**$51,600**	
							Values	**Total**	**$3,549,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.										
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.										
1.0 Project Plans										
	Prelim. Hazard Screening	1	LS	$20,000	$20,000					Engr Est.
	Remedial Design Work Plan	1	LS	$145,000	$145,000					Engr Est.
	Remdial Design Report	1	LS	$211,000	$211,000					Engr Est.
	Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
	Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
	QA Plan	1	LS	$50,000	$50,000					Engr Est.
	Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
	Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
	TASK TOTAL				**$726,000**			**0**	**$726,000**	
2.0 Engineering Design										
	Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
	Land Use Controls	1	LS	$0	$0					Engr Est.
	Design	1	LS	$55,000	$55,000					Engr Est.
	TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review										
	Work Instructions	1	LS	$10,819	$10,819					Engr Est.
	Training	1	LS	$847	$847					Engr Est.
	USD/USQD	1	LS	$3,104	$3,104					Engr Est.
	Lessons Learned	1	LS	$260	$260					Engr Est.
	Procedures	1	LS	$1,445	$1,445					Engr Est.
	AHA	1	LS	$846	$846					Engr Est.
	Work Authorization	1	LS	$475	$475					Engr Est.
	Excavation/Penetration Permits	1	LS	$2,185	$2,185					Engr Est.
	Team Meeting Documentation	1	LS	$333	$333					Engr Est.
	Emergency Response Plan	1	LS	$4,890	$4,890					Engr Est.
	Transportation Plan	1	LS	$2,510	$2,510					Engr Est.
	Project Org. Chart	1	LS	$950	$950					Engr Est.
	TASK TOTALS	1		$28,664	**$ 28,664**			**0**	**$29,000**	
4.0 Training										
Assumptions: Assume 10 hrs/workday, 16 workday/month. 100% cleared workers, no travel.										
Labor										
	LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
	Subcontractors	1	LS	$10,000	$10,000					Engr Est.
	TASK TOTALS				**$10,000**			**$62,026**	**$72,000**	
5.0 Well Installation										
Duration: One month.										

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COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

Assumptions: Drilling derived waste is non hazardous and accepted by onsite disposal facilities. 10 hours/workday and 22 workdays/month.									
Cleared, local personnel.									
Schedule	**1**	**month**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Hertz
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
6.0 Remedial Action Completion Reporting									Engr Est.
Reports									
As-Built Drawings	1	ls	$10,000	$10,000					Engr Est.
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$220,000**			**$0**	**$220,000**	
						SUBTOTAL CAPITAL COST		**$1,496,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					345		$19,845		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	3	acre	$400	$1,200					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,500**	**345**		**$19,845**	**$38,000**	ANNUAL COST
Quarterly Groundwater LTM (Years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									

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COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor										
	Monitoring					480		$31,123		Engr Est., LATA Labor Rate
	Reporting					170		$15,641		Engr Est., LATA Labor Rate
						650		$46,764		
Equipment										
	pickup	1	LS	$1,291	$1,291					Hertz
	generator	1	LS	$459	$459					Vendor Quote
	sampling trailer	1	LS	$53	$53					Engr. Est.
Materials										
	55 gal drums	10	ea	$68	$680					Vendor Quote
	misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors										
	Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
				$46,021	$46,633					
	TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (Years 3-5)										
Duration: years three through five										
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year										
	IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor										
	Monitoring					120		$7,780		Engr Est., LATA Labor Rate
	Reporting					90		$8,175		Engr Est., LATA Labor Rate
						210		$15,955		
Equipment										
	pickup	1	LS	$323	$323					Hertz
	generator	1	LS	$115	$115					Vendor Quote
	sampling trailer	1	LS	$13	$13					Engr. Est.
Materials										
	55 gal drums	10	ea	$68	$680					Vendor Quote
	misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors										
	Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
				$11,557	$12,169					
	TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (Years 6-30)										
Duration: years six through thirty										
Assumptions: Bi-Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years										
	IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor										
	Monitoring					60		$3,890		Engr Est., LATA Labor Rate
	Reporting					70		$6,428		Engr Est., LATA Labor Rate
						130		$10,318		
Equipment										
	pickup	1	LS	$161	$161					Hertz
	generator	1	LS	$57	$57					Vendor Quote

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COST ESTIMATE
BGOU SWMU 7
Alternative 2.t6- Limited Action: Land use controls, monitoring, existing features

	sampling trailer	1	LS	$7	$7					Engr. Est.
Materials										
	55 gal drums	10	ea	$68	$680					Vendor Quote
	misc materials	1	LS	$910	$910					Engr. Est.
Contractors										
	Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
				$5,154	$5,766					
	TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)										
	Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
	TASK TOTAL								**$50,000**	

BGOU SWMU 30
Alternative 2 - Limited Action: Land Use Controls, Monitoring, Existing Features

Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.000	1.000	$2,001,000						$ 2,001,000
2013	1	1.029	1.029		$39,102	$95,697				$134,799
2014	2	1.029	1.059		$40,236	$98,472				$138,708
2015	3	1.029	1.090		$41,403		$30,507			$71,910
2016	4	1.029	1.121		$42,603		$31,392			$73,996
2017	5	1.029	1.154		$43,839		$32,302		$57,683	$133,824
2018	6	1.029	1.187		$45,110			$37,988		$83,098
2019	7	1.029	1.222		$46,419					$46,419
2020	8	1.029	1.257		$47,765			$40,223		$87,988
2021	9	1.029	1.293		$49,150					$49,150
2022	10	1.029	1.331		$50,575			$42,590	$66,546	$159,711
2023	11	1.029	1.370		$52,042					$52,042
2024	12	1.029	1.409		$53,551			$45,096		$98,647
2025	13	1.029	1.450		$55,104					$55,104
2026	14	1.029	1.492		$56,702			$47,749		$104,451
2027	15	1.029	1.535		$58,346				$76,772	$135,118
2028	16	1.029	1.580		$60,038			$50,559		$110,597
2029	17	1.029	1.626		$61,780					$61,780
2030	18	1.029	1.673		$63,571			$53,534		$117,105
2031	19	1.029	1.721		$65,415					$65,415
2032	20	1.029	1.771		$67,312			$56,684	$88,568	$212,564
2033	21	1.029	1.823		$69,264					$69,264
2034	22	1.029	1.876		$71,272			$60,019		$131,291
2035	23	1.029	1.930		$73,339					$73,339
2036	24	1.029	1.986		$75,466			$63,551		$139,017
2037	25	1.029	2.044		$77,655				$102,177	$179,832
2038	26	1.029	2.103		$79,907			$67,290		$147,197
2039	27	1.029	2.164		$82,224					$82,224
2040	28	1.029	2.227		$84,609			$71,249		$155,858
2041	29	1.029	2.291		$87,062					$87,062
2042	30	1.029	2.358		$89,587			$37,721	$117,878	$245,185
TOTAL				$2,001,000	$ 1,830,000	$ 194,000	$ 94,000	$674,250	$ 510,000	$ 5,303,690

BGOU SWMU 30
Alternative 2 - Limited Action: Land Use Controls, Monitoring, Existing Features

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$2,001,000	$0	$0	$0	$0	$0	$ 2,001,000
2013	1	1	1.00	$0	$38,000	$93,000	$0	$0	$0	$131,000
2014	2	1	1.00	$0	$38,000	$93,000	$0	$0	$0	$131,000
2015	3	1	1.00	$0	$38,000	$0	$28,000	$0	$0	$66,000
2016	4	1	1.00	$0	$38,000	$0	$28,000	$0	$0	$66,000
2017	5	1	1.00	$0	$38,000	$0	$28,000	$0	$50,000	$116,000
2018	6	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2019	7	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2020	8	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2021	9	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2022	10	1	1.00	$0	$38,000	$0	$0	$32,000	$50,000	$120,000
2023	11	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2024	12	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2025	13	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2026	14	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2027	15	1	1.00	$0	$38,000	$0	$0	$0	$50,000	$88,000
2028	16	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2029	17	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2030	18	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2031	19	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2032	20	1	1.00	$0	$38,000	$0	$0	$32,000	$50,000	$120,000
2033	21	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2034	22	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2035	23	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2036	24	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2037	25	1	1.00	$0	$38,000	$0	$0	$0	$50,000	$88,000
2038	26	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2039	27	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2040	28	1	1.00	$0	$38,000	$0	$0	$32,000	$0	$70,000
2041	29	1	1.00	$0	$38,000	$0	$0	$0	$0	$38,000
2042	30	1	1.00	$0	$38,000	$0	$0	$16,000	$50,000	$104,000
TOTAL				$2,001,000	$ 1,140,000	$ 186,000	$ 84,000	$ 400,000	$ 300,000	$ 4,111,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 3a - Soil Cover and Long-Term Monitoring

Parameter			Total	Units	Basis
SWMU Dimensions					
		SW MU Area	122,500	SF	Est Basis
		Buffer	5	feet	Engr Est.
		Soil Cover Perimeter	1,420	feet	calc
		Soil Cover Area	130,000	SF	calc
Soil Volume Calc					
	Cover Soil Volume				
		Cover Soil Thickness; 10-5 cm/s hydraulic conductivity	0	feet	Engr Est
		Cover Soil Volume - Compacted	0	CCY	calc
		Conversion	1.41	CCY/LCY	US Army, 1994
		Cover Soil Volume - Loose	0	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Cover Soil Tonnage	0	ton	calc
	Top Soil Volume				
		Top Soil Thickness	1	feet	Engr. Est.
		Top Soil Volume - compacted	4,815	CCY	calc
		Conversion	1.39	CCY/LCY	US Army, 1994
		Top Soil Volume - Loose	6,700	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est.
		Top Soil Tonnage	9,380	ton	calc
Cap Construction Duration					
		Cap Construction Rate	300	LCY/day	Engr Est.
		Cap Construction Duration	22	wdays	calc
		Conversion	10	hrs/wday	Engr Est.
		Conversion	5	wday/wks	Engr Est.
		Cap Construction Duration	230	hrs	calc
		Cap Construction Duration	5	wks	calc
		Cap Construction Duration	1.25	months	Engr Est.
Compaction Testing					
		Compaction Rate	10,000	SF/test	Engr Est
		Compaction Area	130,000	SF	calc
		Lift Thickness	1	feet	Engr Est.
		Number of Lifts	1	lifts	calc
		Number of Compactions Tests	10	tests	calc

References:

DOE, 2010, BGOU Remedial Investigation Report.
Lindeburg, 1990, Engineering Unit Conversions
US Army, 1994, Field Manual No. 5-430-00-1, Planning and Design of Roads, Airfields, and Helioports in the Theater of Operations - Road Design.

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FORWARD

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

		Other Direct Costs			Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Cost									
1.0 Project Plans	1	ls	$870,000	$870,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$42,000	$42,000					
4.0 Training	1	ls	$82,000	$82,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation	1	ls	$222,000	$222,000					
7.0 Cover Construction	1	ls	$332,000	$332,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
9.0 Site Restoration	1	ls	$179,000	$179,000					
10.0 O&M Manual and Remedial Action Completion Report	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$645,250	$645,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$225,820	$226,000					fee = 7%.
		SUBTOTAL CAPITAL COST		**$3,452,000**					
Construction Schedule	**5**	**months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000					
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Year 5	1	ls	$50,000	$50,000					
Five-Year Review Year 10	1	ls	$50,000	$50,000					
Five-Year Review Year 15	1	ls	$50,000	$50,000					
Five-Year Review Year 20	1	ls	$50,000	$50,000					
Five-Year Review Year 25	1	ls	$50,000	$50,000					
Five-Year Review Year 30	1	ls	$50,000	$50,000					
		SUBTOTAL ANNUAL COST		**$2,110,000**					
			TOTAL	**$5,562,000**					
Present Worth Value Cost									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$3,452,000	$3,452,000				**$3,452,000**	
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000				**$816,981**	2.3% discount rate
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				**Labor**				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
							Capital	**$3,452,000**	
					Present		**Annual**	**$1,548,000**	
					Worth		**Avg. Annual**	**$51,600**	
					Values		**Total Cost**	**$5,000,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Hazard Analysis Document	1	LS	$100,000	$100,000					LATA
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$145,000	$145,000					DOE
Remdial Design Report	1	LS	$225,000	$225,000					Engr Est.
Remedial Action Work Plan	1	LS	$150,000	$150,000					Engr Est.
Security Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$870,000**			**0**	**$870,000**	
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$24,000	$24,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTAL	1		$41,845	**$ 41,845**			**0**	**$42,000**	Engr Est.
4.0 Training									
Assumptions: 100% cleared and local personnel.									

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				**Labor**				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$20,000	$20,000					Engr Est.
TASK TOTALS				**$20,000**	**1,040**		**$62,026**	**$82,000**	
5.0 Mobilization									
Duration: One month.									
Assumptions: 10 hours per workday and 22 workdays per month. Cleared and local labor.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**	**2310**		**$153,015**	**$180,000**	
6.0 Site Preparation									
Duration: One months.									
Assumptions: 10 hrs per workday, 22 workdays per month. Cleared local personnel.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
TASK TOTAL				**$69,356**	**2310**		**$153,015**	**$222,000**	
7.0 Cover Construction									
Duration: One month.									
Assumptions: 10 hrs per workday, 22 workdays per month.									
Install 12 inches of borrow soil to be compacted to 1 x 10-5 cm/sec									
100% cleared local personnel.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F251	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Loader	1	month	$1,800	$1,800					Engr Est.
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth	1	month	$2,920	$2,920					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator 150 KW	1	month	$2,006	$2,006					Engr Est.
Materials									
Subcontractors									
Cover Soil Delivered	0	cy	$23	$0					RSMeans 02060 150 0200
Top Soil Delivered	6,700	cy	$23	$154,100					RSMeans 02060 150 0800
Soil Density, Nuclear Method	10	ea	$50	$500					RSMeans 01450 500 4735
TASK TOTAL				**$178,786**	**2310**		**$153,015**	**$332,000**	
8.0 Well Installation									
Duration: One month.									
Assumptions: IDW is non hazardous and accepted by U Landfill. 10 hours/workday and 22 workdays/month. 100% cleared local personnel									
Schedule	**1**	**months**							
Labor									
Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate
Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Engr Est.
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
9.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1.0	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	195	MSF	$50	$9,750					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$21,206**			**$157,513**	**$179,000**	
10.0 O&M Manual and Remedial Action Completion Report									
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
As Builts	1	ls	$15,000	$15,000					Engr Est.
Remedial Action Completion Report	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
							SUBTOTAL CAPITAL COST	**$2,581,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									
Labor									
LATA Labor					345		$19,845		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	3	acre	$400	$1,200					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,500**	**345**		**$19,845**	**$38,000**	ANNUAL COST
Quarterly Groundwater LTM (Years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (Years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									
Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
			$11,557	$12,169					
TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (Years 6-30)									
Duration: years six through thirty									
Assumptions: Bi-Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years									
IDW is non-hazardous and acceptable to onsite disposal facilities									

COST ESTIMATE
BGOU SWMU 30
Alternative 3.a.t6 - Soil Cover, LUCs, Monitoring, Existing Features

	Other Direct Costs				**Labor**				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Labor									
Monitoring					60		$3,890		Engr Est., LATA Labor Rate
Reporting					70		$6,428		Engr Est., LATA Labor Rate
					130		$10,318		
Equipment									
pickup	1	LS	$161	$161					Hertz
generator	1	LS	$57	$57					Vendor Quote
sampling trailer	1	LS	$7	$7					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$910	$910					Engr. Est.
Contractors									
Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
			$5,154	$5,766					
TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)									
Five-Year Review	1	LS	$50,198	$50,198					Engr Est.
TASK TOTAL								**$50,000**	

BGOU SWMU 30
Alternative 3.a.t6 - Subitle D Cap, LUCs, Monitoring, Existing Features

Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.029	1.000	$ 3,452,000						$ 3,452,000
2013	1	1.029	1.029		$39,102	$95,697				$134,799
2014	2	1.029	1.059		$40,236	$98,472				$138,708
2015	3	1.029	1.090		$41,403		$30,507			$71,910
2016	4	1.029	1.121		$42,603		$31,392			$73,996
2017	5	1.029	1.154		$43,839		$32,302		$57,683	$133,824
2018	6	1.029	1.187		$45,110			$37,988		$83,098
2019	7	1.029	1.222		$46,419					$46,419
2020	8	1.029	1.257		$47,765			$40,223		$87,988
2021	9	1.029	1.293		$49,150					$49,150
2022	10	1.029	1.331		$50,575			$42,590	$66,546	$159,711
2023	11	1.029	1.370		$52,042					$52,042
2024	12	1.029	1.409		$53,551			$45,096		$98,647
2025	13	1.029	1.450		$55,104					$55,104
2026	14	1.029	1.492		$56,702			$47,749		$104,451
2027	15	1.029	1.535		$58,346				$76,772	$135,118
2028	16	1.029	1.580		$60,038			$50,559		$110,597
2029	17	1.029	1.626		$61,780					$61,780
2030	18	1.029	1.673		$63,571			$53,534		$117,105
2031	19	1.029	1.721		$65,415					$65,415
2032	20	1.029	1.771		$67,312			$56,684	$88,568	$212,564
2033	21	1.029	1.823		$69,264					$69,264
2034	22	1.029	1.876		$71,272			$60,019		$131,291
2035	23	1.029	1.930		$73,339					$73,339
2036	24	1.029	1.986		$75,466			$63,551		$139,017
2037	25	1.029	2.044		$77,655				$102,177	$179,832
2038	26	1.029	2.103		$79,907			$67,290		$147,197
2039	27	1.029	2.164		$82,224					$82,224
2040	28	1.029	2.227		$84,609			$71,249		$155,858
2041	29	1.029	2.291		$87,062					$87,062
2042	30	1.029	2.358		$89,587			$37,721	$117,878	$245,185
TOTAL				$ 3,452,000	$ 1,830,000	$ 194,000	$ 94,000	$ 674,250	#######	$ 6,754,690

BGOU SWMU 30
Alternative 3.a.t6 - Subitle D Cap, LUCs, Monitoring, Existing Features

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$ 3,452,000	$ -	$ -	$ -	$ -	$ -	$ 3,452,000
2013	1	1	1.00	$ -	$ 38,000	$ 93,000	$ -	$ -	$ -	$131,000
2014	2	1	1.00	$ -	$ 38,000	$ 93,000	$ -	$ -	$ -	$131,000
2015	3	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ -	$66,000
2016	4	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ -	$66,000
2017	5	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ 50,000	$116,000
2018	6	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2019	7	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2020	8	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2021	9	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2022	10	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ 50,000	$120,000
2023	11	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2024	12	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2025	13	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2026	14	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2027	15	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ 50,000	$88,000
2028	16	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2029	17	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2030	18	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2031	19	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2032	20	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ 50,000	$120,000
2033	21	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2034	22	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2035	23	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2036	24	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2037	25	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ 50,000	$88,000
2038	26	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2039	27	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2040	28	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2041	29	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2042	30	1	1.00	$ -	$ 38,000	$ -	$ -	$ 16,000	$ 50,000	$104,000
TOTAL				$ 3,452,000	$ 1,140,000	$ 186,000	$ 84,000	$ 400,000	#######	$ 5,562,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 3d - Subtitle D Cover and Long-Term Monitoring

Parameter			Total	Units	Basis
SWMU Dimensions					
		SW MU Area	122,500	SF	Est Basis
		Buffer	5	feet	Engr Est.
		Soil Cover Perimeter	1,420	feet	calc
		Soil Cover Area	130,000	SF	calc
Cap Construction Calc					
		Riprap	11,556	LCY	calc
		Cobbles/Soil Top Layer	11,556	LCY	calc
		Biotic Barrier (Cobbles)	5,778	LCY	calc
		Drainage Layer	5,778	LCY	calc
		20 mil geomembrane	14,444	SY	calc
		Low Hydraulic conductivity soil layer	5,778	LCY	calc
		Geosynthetic Filter	14,444	SY	calc
		Gas Vent Layer	5,778	LCY	calc
Cap Construction Duration					
		Cap Construction Rate	300	LCY/day	Engr Est.
		Cap Construction Duration	212	wdays	calc
		Conversion	10	hrs/wday	Engr Est.
		Conversion	5	wday/wks	Engr Est.
		Cap Construction Duration	2120	hrs	calc
		Cap Construction Duration	43	wks	calc
		Cap Construction Duration	10.75	months	Engr Est.
Compaction Testing					
		Compaction Rate	10,000	SF/test	Engr Est
		Compaction Area	130,000	SF	calc
		Lift Thickness	1	feet	Engr Est.
		Number of Lifts	8	lifts	calc
		Number of Compactions Tests	100	tests	calc
Fence Dimensions					
		Area	122,500	sf	DOE, 2009
		Buffer Length	60	feet	Engr Est.
		SWMU Perimeter/Fence Length	1,640	feet	calc
		Fenced Area plus 10 ft path outside perimeter of fence (mowing area)	140,000	sf	calc
Drums Reqd for Post Holes					

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Cost									
1.0 Project Plans	1	ls	$885,000	$885,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$48,000	$48,000					
4.0 Training	1	ls	$87,000	$87,000					
5.0 Mobilization	1	ls	$180,000	$180,000					
6.0 Site Preparation	1	ls	$222,000	$222,000					
7.0 Cap Construction	1	ls	$2,042,000	$2,042,000					
8.0 Well Installation	1	ls	$344,000	$344,000					
9.0 Site Restoration	1	ls	$179,000	$179,000					
10.0 O&M Manual and Remedial Action Completion Report	1	ls	$225,000	$225,000					
Management reserve, Subproject Management	1	ls	$1,079,250	$1,079,000					mgt reserve = 15%, and Subproject Management = 10% (engineers estimate)
Fee	1	ls	$377,720	$378,000					fee = 7%.
			SUBTOTAL CAPITAL COST	**$5,774,000**					
Construction Schedule	**8**	**months**							
Annual Cost									
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000					
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000					
Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000					
Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000					
Five-Year Review Year 5	1	ls	$50,000	$50,000					
Five-Year Review Year 10	1	ls	$50,000	$50,000					
Five-Year Review Year 15	1	ls	$50,000	$50,000					
Five-Year Review Year 20	1	ls	$50,000	$50,000					
Five-Year Review Year 25	1	ls	$50,000	$50,000					
Five-Year Review Year 30	1	ls	$50,000	$50,000					
			SUBTOTAL ANNUAL COST	**$2,110,000**					
			TOTAL	**$7,884,000**					
Present Worth Value Cost									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$5,774,000	$5,774,000				**$5,774,000**	
Annual Cover Maintenance (Years 1 - 30)	30	ls	$38,000	$1,140,000				**$816,981**	2.3% discount rate
Quarterly Groundwater LTM (Years 1-2)	2	ls	$93,000	$186,000				**$179,774**	2.3% discount rate

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

	Annual Groundwater LTM (Years 3-5)	3	ls	$28,000	$84,000				**$76,710**	2.3% discount rate
	Biannual Groundwater LTM (Years 6-30)	25	ls	$16,000	$400,000				**$269,229**	2.3% discount rate
	Five-Year Review Year 5	1	ls	$50,000	$50,000				**$44,626**	2.3% discount rate
	Five-Year Review Year 10	1	ls	$50,000	$50,000				**$39,830**	2.3% discount rate
	Five-Year Review Year 15	1	ls	$50,000	$50,000				**$35,550**	2.3% discount rate
	Five-Year Review Year 20	1	ls	$50,000	$50,000				**$31,729**	2.3% discount rate
	Five-Year Review Year 25	1	ls	$50,000	$50,000				**$28,319**	2.3% discount rate
	Five-Year Review Year 30	1	ls	$50,000	$50,000				**$25,276**	2.3% discount rate
								Capital	**$5,774,000**	
						Present		**Annual**	**$1,548,000**	
						Worth		**Avg. Annual**	**$51,600**	
						Values		**Total Cost**	**$7,322,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.										
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.										
1.0 Project Plans										
	Hazard Analysis Document	1	LS	$100,000	$100,000					LATA
	Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
	Remedial Design Work Plan	1	LS	$150,000	$150,000					DOE
	Remdial Design Report	1	LS	$225,000	$225,000					Engr Est.
	Remedial Action Work Plan	1	LS	$160,000	$160,000					Engr Est.
	Security Plan	1	LS	$50,000	$50,000					Engr Est.
	QA Plan	1	LS	$50,000	$50,000					Engr Est.
	Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
	Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
	TASK TOTAL				**$885,000**			**0**	**$885,000**	
2.0 Engineering Design										
	Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
	Design	1	LS	$55,000	$55,000					Engr Est.
	TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review										
	Work Instructions	1	LS	$30,000	$30,000					
	Training	1	LS	$847	$847					
	USD/USQD	1	LS	$3,104	$3,104					
	Lessons Learned	1	LS	$260	$260					
	Procedures	1	LS	$1,445	$1,445					
	AHA	1	LS	$846	$846					
	Work Authorization	1	LS	$475	$475					
	Excavation/Penetration Permits	1	LS	$2,185	$2,185					
	Team Meeting Documentation	1	LS	$333	$333					
	Emergency Response Plan	1	LS	$4,890	$4,890					
	Transportation Plan	1	LS	$2,510	$2,510					
	Project Org. Chart	1	LS	$950	$950					
	TASK TOTAL	1		$47,845	**$ 47,845**			**0**	**$48,000**	Engr Est.
4.0 Training										

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

Assumptions: 100% cleared and local personnel.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$25,000	$25,000					Engr Est.
TASK TOTALS				**$25,000**	**1,040**		**$62,026**	**$87,000**	
5.0 Mobilization									
Duration: One month.									
Assumptions: 10 hours per workday and 22 workdays per month. Cleared and local labor.									
For Union personnel assume 10 hrs/workday, 16 workday/month straight time and 6 workday/month overtime totaling 22 workdays/month.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Radcon Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	2	month	$1,300	$2,600					Hertz
Front End Loader	1	Month	$4,150	$4,150					Engr Est.
Dozer	1	Month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	Month	$1,850	$1,850					Engr Est.
Compactor/12 ton/pad foot	1	Month	$3,090	$3,090					Engr Est.
Compactor/12 ton/smooth drum	1	Month	$2,920	$2,920					Engr Est.
Generator, 150 KW	1	Month	$2,006	$2,006					Engr Est.
Supply Trailer	1	Month	$448	$448					Engr Est.
TASK TOTALS				**$26,684**	**2310**		**$153,015**	**$180,000**	
6.0 Site Preparation									
Duration: One months.									
Assumptions: 10 hrs per workday, 22 workdays per month. Cleared local personnel.									
Schedule	**1**	**months**							
Labor									
LATA Labor					2310		$153,015		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader, 3.5CY	1	month	$4,150	$4,150					Engr Est.
Dozer	1	month	$2,800	$2,800					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$300	$300					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Subcontractor									
Geophysics Survey	1	ls	$50,000	$50,000					Engr Est.
Materials									
Rip Rap delivered	200	ton	$17	$3,400					Carver Sand & Gravel
Geotextile delivered	2	roll	$600	$1,200					AH Harris, 500cy roll

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

	Silt Fence	15	roll	$50	$750					AH Harris, 100 ft roll
	TASK TOTAL				**$69,356**	**2310**		**$153,015**	**$222,000**	
7.0 Cap Construction										
Duration: Seven months.										
Assumptions: 10 hrs per workday, 22 workdays per month. Assume 300 CY per day production rate.										
RCRA cap over the SWMU										
100% cleared local personnel.										
	Schedule	**5**	**months**							
Labor										
	LATA Labor					11550		$762,300		
Instruments										
	RadCon Allocation	1540	hr	$31	$47,740					Based on LATA Radcon allocation
Equipment										
	Pickup Truck, crew cab, F250	7	month	$1,300	$9,100					Hertz
	Pickup Truck, crew cab, F250	7	month	$1,300	$9,100					Hertz
	Front End Loader	7	month	$4,150	$29,050					Engr Est.
	Dozer	7	month	$2,800	$19,600					Engr Est.
	Compactor/12 ton/pad foot	7	month	$3,090	$21,630					Engr Est.
	Compactor/12 ton/smooth drum	7	month	$2,920	$20,440					Engr Est.
	Water Truck, 2000 gal	7	month	$1,850	$12,950					Engr Est.
	Equipment Trailer	7	month	$300	$2,100					Engr Est.
	Generator, 15KW	7	month	$2,006	$14,042					Engr Est.
	Portable Toilet	7	month	$150	$1,050					Engr Est.
Materials										
	Level D Equipment	1125	man-day	$24	$26,663					Engr Est
Unit Pricing										
	Cap Construction	130,000	sf							
	Vegetative Soil Layer	14,444	LCY	$23	$332,222					Vendor Quote
	Drainage Layer with a min perm 1E-03 cm/sec	4,815	LCY	$21	$101,111					Vendor Quote
	Clay Layer with a min perm of 1E-07 cm/sec	7,222	LCY	$21	$151,667					Vendor Quote
	Filter Fabric	130,000	sf	$1	$130,000					Engr Est.
	Sand Gas Venting System with a min perm 1E-03 cm/sec	4,815	LCY	$45	$216,667					Engr Est.
	Filter Fabric	130,000	sf	$1	$130,000					Engr Est.
	Soil Density, Nuclear Method	100	ea	$50	$5,000					RSMeans 01450 500 4735
	TASK TOTAL				**$1,280,131**	**11550**		**$762,300**	**$2,042,000**	
8.0 Well Installation										
Duration: One month.										
Assumptions: IDW is non hazardous and accepted by U Landfill. 10 hours/workday and 22 workdays/month. 100% cleared local personnel										
	Schedule	**1**	**months**							
Labor										
	Well installation & restoration					2280		$167,016		Engr Est., LATA Labor Rate

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

Data Reporting					295		$27,013		Engr Est., LATA Labor Rate
Instruments									
RadCon Allocation	280	hr	$31	$8,680					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Skid Steer Bobcat	1	month	$800	$800					Engr Est.
Drums	100	drum	$64	$6,400					Vendor quote
Subcontractors									
Mob/Demob	1	ea	$22,699	$22,699					Vendor Quote
Well Installation	4	ea	$16,100	$64,400					Vendor Quote
Hydroseeding	1	LS	$762	$762					Engr Est.
Laboratory Analytical									
Analytical Lab	1	ls	$19,511	$19,511					Analytical rates from LATA. Samples collected from four wells. QA/QC 10%. Engr Est.
Reporting									
Well Construction Report	1	ls	$25,000	$25,000					Engr Est.
TASK TOTAL				**$149,552**	2575		**$194,029**	**$344,000**	
9.0 Site Restoration									
Duration: Approximately two weeks for site restoration.									
Assumptions: Used 10 hour work-day; 22 work-days per month.									
Schedule	**1**	**Month**							
Labor									
LATA Labor					2145		$157,513		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$2,000	$2,000					Engr Est.
Generator 150KW	1	month	$2,006	$2,006					Engr Est.
Portable Toilet	1.0	month	$150	$150					Engr Est.
Subcontractors									
Hydroseed Bluegrass	195	MSF	$50	$9,750					Assume entire capped area plus 50%; RSMeans 02920-320-1000
TASK TOTAL				**$21,206**			**$157,513**	**$179,000**	
10.0 O&M Manual and Remedial Action Completion Report									
O&M Plan	1	ls	$50,000	$50,000					Engr Est.
As Builts	1	ls	$15,000	$15,000					Engr Est.
Remedial Action Completion Report	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$225,000**			**$0**	**$225,000**	
						SUBTOTAL CAPITAL COST		**$4,317,000**	
Annual Cover Maintenance (Years 1 - 30)									
Duration: First year through thirty years									
Assumptions: Annual Inspection of cap and cap maintenance. Cleared and local labor.									

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COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

Labor									
LATA Labor					345		$19,845		Engr Est., LATA Labor Rate
Equipment									
Pickup Truck, crew cab, F250	1	month	$1,300	$1,300					Hertz
Contractors									
Cap Maintenance	1	ls	$5,000	$5,000					Engr Est.
Mowing	3	acre	$400	$1,200					Engr Est, $100/acre, 4 times per year
Reporting									Engr Est., LATA Labor Rates
Annual Report	1	ls	$10,000	$10,000					
TASK TOTAL				**$17,500**	**345**		**$19,845**	**$38,000**	ANNUAL COST
Quarterly Groundwater LTM (Years 1-2)									
Duration: first two years									
Assumptions: Quarterly monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 4 times per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					480		$31,123		Engr Est., LATA Labor Rate
Reporting					170		$15,641		Engr Est., LATA Labor Rate
					650		$46,764		
Equipment									
pickup	1	LS	$1,291	$1,291					Hertz
generator	1	LS	$459	$459					Vendor Quote
sampling trailer	1	LS	$53	$53					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$7,274	$7,274					Engr. Est.
Contractors									
Analytical Lab	1	LS	$36,876	$36,876					Analytical Rates from LATA
			$46,021	$46,633					
TASK TOTAL								**$93,000**	ANNUAL COST
Annual Groundwater LTM (Years 3-5)									
Duration: years three through five									
Assumptions: Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, 1 time per year									
IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor									
Monitoring					120		$7,780		Engr Est., LATA Labor Rate
Reporting					90		$8,175		Engr Est., LATA Labor Rate
					210		$15,955		
Equipment									
pickup	1	LS	$323	$323					Hertz
generator	1	LS	$115	$115					Vendor Quote
sampling trailer	1	LS	$13	$13					Engr. Est.
Materials									
55 gal drums	10	ea	$68	$680					Vendor Quote
misc materials	1	LS	$1,819	$1,819					Engr. Est.
Contractors									

COST ESTIMATE
BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

	Analytical Lab	1	LS	$9,219	$9,219					Analytical Rates from LATA
				$11,557	$12,169					
	TASK TOTAL								**$28,000**	ANNUAL COST
Biannual Groundwater LTM (Years 6-30)										
Duration: years six through thirty										
Assumptions: Bi-Annual monitoring well sampling. Sample time is 5 hours per well, 4 wells total, once every 2 years										
	IDW is non-hazardous and acceptable to onsite disposal facilities									
Labor										
	Monitoring					60		$3,890		Engr Est., LATA Labor Rate
	Reporting					70		$6,428		Engr Est., LATA Labor Rate
						130		$10,318		
Equipment										
	pickup	1	LS	$161	$161					Hertz
	generator	1	LS	$57	$57					Vendor Quote
	sampling trailer	1	LS	$7	$7					Engr. Est.
Materials										
	55 gal drums	10	ea	$68	$680					Vendor Quote
	misc materials	1	LS	$910	$910					Engr. Est.
Contractors										
	Analytical Lab	1	LS	$3,951	$3,951					Analytical Rates from LATA
				$5,154	$5,766					
	TASK TOTAL								**$16,000**	ANNUAL COST
Five-Year Review (Yrs 5, 10, 15, 20, 25, 30)										
	Five-Year Review	1	LS	$50,198	$50,198					Engr. Est.
	TASK TOTAL								**$50,000**	

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Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

Escalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.029	1.000	$5,774,000						$ 5,774,000
2013	1	1.029	1.029		$39,102	$95,697				$134,799
2014	2	1.029	1.059		$40,236	$98,472				$138,708
2015	3	1.029	1.090		$41,403		$30,507			$71,910
2016	4	1.029	1.121		$42,603		$31,392			$73,996
2017	5	1.029	1.154		$43,839		$32,302		$57,683	$133,824
2018	6	1.029	1.187		$45,110			$37,988		$83,098
2019	7	1.029	1.222		$46,419					$46,419
2020	8	1.029	1.257		$47,765			$40,223		$87,988
2021	9	1.029	1.293		$49,150					$49,150
2022	10	1.029	1.331		$50,575			$42,590	$66,546	$159,711
2023	11	1.029	1.370		$52,042					$52,042
2024	12	1.029	1.409		$53,551			$45,096		$98,647
2025	13	1.029	1.450		$55,104					$55,104
2026	14	1.029	1.492		$56,702			$47,749		$104,451
2027	15	1.029	1.535		$58,346				$76,772	$135,118
2028	16	1.029	1.580		$60,038			$50,559		$110,597
2029	17	1.029	1.626		$61,780					$61,780
2030	18	1.029	1.673		$63,571			$53,534		$117,105
2031	19	1.029	1.721		$65,415					$65,415
2032	20	1.029	1.771		$67,312			$56,684	$88,568	$212,564
2033	21	1.029	1.823		$69,264					$69,264
2034	22	1.029	1.876		$71,272			$60,019		$131,291
2035	23	1.029	1.930		$73,339					$73,339
2036	24	1.029	1.986		$75,466			$63,551		$139,017
2037	25	1.029	2.044		$77,655				$102,177	$179,832
2038	26	1.029	2.103		$79,907			$67,290		$147,197
2039	27	1.029	2.164		$82,224					$82,224
2040	28	1.029	2.227		$84,609			$71,249		$155,858
2041	29	1.029	2.291		$87,062					$87,062
2042	30	1.029	2.358		$89,587			$37,721	$117,878	$245,185
TOTAL				$ 5,774,000	$ 1,830,000	$ 194,000	$ 94,000	$ 674,250	$ 510,000	$ 9,076,690

BGOU SWMU 30
Alternative 3.d.t6 - Subtitle D Cap, LUCs, Monitoring, Existing Features

Unescalated

Date	Yr	Esca-lation	Esca-lation Factor	Capital	Annual Cover Maintenance (Years 1 - 30)	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$5,774,000	$ -	$ -	$ -	$ -	$ -	$ 5,774,000
2013	1	1	1.00	$ -	$ 38,000	$ 93,000	$ -	$ -	$ -	$131,000
2014	2	1	1.00	$ -	$ 38,000	$ 93,000	$ -	$ -	$ -	$131,000
2015	3	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ -	$66,000
2016	4	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ -	$66,000
2017	5	1	1.00	$ -	$ 38,000	$ -	$ 28,000	$ -	$ 50,000	$116,000
2018	6	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2019	7	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2020	8	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2021	9	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2022	10	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ 50,000	$120,000
2023	11	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2024	12	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2025	13	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2026	14	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2027	15	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ 50,000	$88,000
2028	16	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2029	17	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2030	18	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2031	19	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2032	20	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ 50,000	$120,000
2033	21	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2034	22	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2035	23	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2036	24	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2037	25	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ 50,000	$88,000
2038	26	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2039	27	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2040	28	1	1.00	$ -	$ 38,000	$ -	$ -	$ 32,000	$ -	$70,000
2041	29	1	1.00	$ -	$ 38,000	$ -	$ -	$ -	$ -	$38,000
2042	30	1	1.00	$ -	$ 38,000	$ -	$ -	$ 16,000	$ 50,000	$104,000
TOTAL				$ 5,774,000	$ 1,140,000	$ 186,000	$ 84,000	$ 400,000	$ 300,000	$ 7,884,000

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 6 - Excavation and Disposal

Parameter			Total	Units	Basis
SWMU Dimensions					
		Total Area	120,000	SF	Est Basis
		Fraction of Area to be Excavated	0.2		Est Basis
		Area to be Excavated	20,000	SF	Calc
		Excavation Depth	20	feet	Engr Est.
Waste Volume Calc					
		Waste Volume	14,815	BCY	calc
		Conversion	1.20	LCY/BCY	PRS Directive
		Excavated Waste Volume	17,778	LCY	calc
		Assumed U Landfill WAC Compliant Fraction	0.58		Engr Est
		Assumed LLW / MLLW Fraction	0.42		Engr Est
		U Landfill WAC Compliant Volume	10,300	LCY	calc
		LLW / MLLW Volume	7,500	LCY	calc
		LLW fraction of LLW / MLLW Volume	0.75		Engr Est
		MLLW fraction of LLW / MLLW Volume	0.25		Engr Est
		LLW Volume	5,625	LCY	calc
		MLLW Volume	1,875	LCY	calc
		Conversion	1.4	ton/LCY	Engr Est
		U Landfill WAC Compliant Tonnage	7,875	ton	calc
		MLLW Tonnage	2,625	ton	calc
Absorbents for Soil					
		Absorbent Rate	0.54	lb/CF	Engr Est
		Total Excavated Soils	17,800	LCY	calc
		Total Absorbent needed	300,000	lbs	calc
Excavation Duration					
		Excavation Rate for U Landfill WAC Compliant	4,400	bcy/month/ crew	Engr Est., 200 bcy/day/crew 22 wdays/mo
		Excavation Rate for LLW / MLLW	2,200	bcy/month/ crew	Engr Est., 100 bcy/day, 22 wdays/mo
		No. of Crews	1	crew	Engr Est
		Time to Excavate U Landfill WAC Compliant	2	month	calc
		Time to Excavate LLW /MLLW	3	month	calc
		Total Excavation Time	5	month	calc
		Total Excavation Time	0.4	years	calc
		Work day	10	hrs/wday	Engr Est.
		Work week	5	wdays/wk	Engr Est.
		Work days per year	260	wdays/yr	calc
		Work hours per year	2,600	whour/yr	calc
		Work days per month	22	wdays/mo	calc
Dewatering Calc					
		Initial Pore Volume	400,000	gal	calc from Est. Basis
		Dewatering Rate for Initial Pore Vol	30	gpm	Assumed
		Days to dewater initial pore volume	9	days	calc
		Dewatering Rate after removing initial pore vol.	7.9	gpm	DOE, 1998, pg 17
		Total Excavation Time	5	months	calc
		Fraction of time pumping occurs after removal of initial pore volume	0.2		Engr Est
		Dewater Volume during excavation	246,000	gal	calc
		Total Water for Trmt/Disposal during excavation	646,000	gal	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 6 - Excavation and Disposal

Parameter			Total	Units	Basis
Rad Sludge Production from GW Treatment					
		Dewatering total	646,000	gallons	calc
		Number of days operating	108	days	calc
		Assumed Dewatering Rate	5,963	gal/day	calc
		Est. Sludge fraction	0.01		Engr Est
		Est. Sludge production	6,460	gallons	calc
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Est. Sludge production	32	cy	calc
		Drum Volume	55	gal/drum	
		Sludge Drum Total	117	drums	calc
		Sludge Drums per truckload	60	drums/trucklo	Engr Est
		Sludge Truck trips	2	trips	calc
Transportation Bags, Truck Liner, and Rail Cars					
		Transportation Bag Volume	8.96	CY	Pactec
		Bags required for LLW / MLLW	838	Bags	calc
		Bags per Rail Car	8.0	bags/rail car	Energy Solutions
		No. of Rail Cars	105	rail cars	calc
		Truck Liner	15	CY	Engr Est.
		Liners required for U Landfill WAC Compliant	687	Liners	calc
Disposal Samples					
		Sample Rate	300	LCY	Engr Est.
		Samples for U Landfill WAC Compliant + 10 percent QA/QC	40	samples	Engr Est.
		Samples for LLW / MLLW + 10 percent QA/QC	30	samples	Engr Est.
Sheet Pile Installation					
		Depth of installation	40	feet	DOE, 1998
		Perimeter	566	feet	calc
		Fence Perimeter	1,000	feet	calc
		Area	22,627	SF	calc
		Sheet pile density	38	psf	left in place
		Tonnage	500	tons	calc
Backfill					
		Volume of Excavated Soil, Debris, Waste	17,800	CCY	
		Conversion	1.41	LCY/CCY	US Army, 1994
		Volume of Backfill	25,098	LCY	calc
		Conversion	1.4	ton/CY	Lindeburg, 1990
		Backfill Tonnage	35,000	ton	
		Backfill Rate	1,500	cy/day	Engr Est.
		No. of Crews	1	crew	Engr Est.
		Est. Time to Backfill	12	days	calc
		Working days per month	22	days	calc
		Est. Months to Backfill	1	months	calc
Compaction Testing					
		Compaction Rate	20,000	SF/test	Engr Est
		Compaction Area	120,000	SF	DOE 2009
		Lift Thickness	2	feet	Engr Est.
		Number of Lifts	10	lifts	calc
		Number of Compactions Tests	60	tests	calc

CONCEPTUAL DESIGN CALCULATIONS

BGOU SWMU 30

Alternative 6 - Excavation and Disposal

Parameter			Total	Units	Basis
Top Soil & Hydroseeding					
		Excavated Area	20,000	sf	Engr Est.
		Estimated Disturbed Area Factor	2		Engr Est.
		Estimated Disturbed Area	40,000	sf	calc
		Disturbed Area	40	MSF	calc
		Top Soil Thickness	0.5	feet	Engr Est.
		Conversion	27	CF/CY	Lindeburg, 1990
		Conversion	1.3	ton/CY	Engr Est.
		Top Soil tonnage	1,000	ton	calc
Trucking to existing U Landfill at PDGP					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	15	lcy	Engr Est
		Dump Trips for U Landfill WAC Compliant	687	trips	calc
Trucking to onsite future On-Site PGDP Disposal Cell					
		Dump Capacity	14	ton	Engr Est
		Dump Capacity	15	lcy	Engr Est
		Dump Trips for LLW /MLLW	500	trips	calc
PPE LLW Drums					
		Drums filled per day with PPE LLW Waste	1	drum/day	Engr Est
		No. of drums used during project	108	drums	calc
		Drums per Truckload	60	drums/trucklo	Engr Est
		Truck Trips	2	trips	calc
		Drum Volume	55	gal/drum	Engr Est
		Conversion	7.48	gal/cf	Lindeburg, 1990
		Conversion	27	cf/cy	Lindeburg, 1990
		Total Volume of PPE	30	cy	calc

References:
DOE, 1998, Feasibility Study for Final Action at SWMU 2 of WAG 22 at the Paducah GDP, KY, Sept.
Lindeburg, 1990, Engineering Unit Conversions
US Army, 1994, Field Manual No. 5-430-00-1, Planning and Design of Roads, Airfields, and Helioports in the Theater of Operations - Road Design.

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COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Costs									
1.0 Project Plans	1	ls	$1,050,000	$1,050,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$68,000	$68,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$251,000	$251,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$298,000	$298,000					
7.0 Excavation	1	ls	$3,705,000	$3,705,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$18,020,000	$18,020,000					
9.0 Backfill & Site Restoration.	1	ls	$1,004,000	$1,004,000					
10.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$4,953,600	$4,954,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$2,080,540	$2,081,000					fee = 7%.
Contingency	1	ls	$6,360,600	$6,361,000					20% contingency
		SUBTOTAL CAPITAL COST		**$38,164,000**					
Construction Schedule	**9**	**months**							
Annual Costs									
		SUBTOTAL ANNUAL COST		**$0**					
			TOTAL COST	**$38,164,000**					
Present Worth Value									
	Quantity	Unit	Unit Cost	Total				**Present Worth**	
Total Capital Cost	1	ls	$38,164,000	$38,164,000				**$38,164,000**	
							Capital	**$38,164,000**	
						Present	**Annual**	**$0**	
						Worth	**Avg. Annual**	**$0**	
						Values	**Total**	**$38,164,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Hazard Analysis Document	1	LS	$100,000	$100,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$175,000	$175,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$225,000	$225,000					Engr Est.
Security Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.

COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

			Other Direct Costs		Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,050,000**			**0**	**$1,050,000**	Engr Est.
2.0 Engineering Design									
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$50,000	$50,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$67,845	**$ 67,845**			**0**	**$68,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**			**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. Labor is cleared and local.									
Schedule	**1**	**month**							
Labor									
LATA Labor					2750		$160,000		Engr Est., LATA Labor Rates
Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est

COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	1	month	$1,248	$1,248					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$90,992**	**0**		**$160,000**	**$251,000**	
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crew of cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	1,000	lf	$39	$38,500					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$138,154**	2750		**$160,000**	**$298,000**	
7.0 Excavation									
Duration: Approximately 5 months for excavation, staging, and sampling based on excavating MLLW & LLW at 100 bcy/day/crew,									
U Landfill WAC Compliant at 200 bcy/day/crew, and one month lag time between excavation and transporting offsite.									
Assumption: Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
LLW & MLLW stockpiles containerized into soft side bags loaded on trucks for delivery to the rail spur.									
At the rail spur the soft side bags are lifted on rail cars for delivery to the offsite disposal facility.									
U Landfill WAC Compliant transported from the stockpile to the onsite U Landfill.									
Uranium waste/Rad Material over packed for truck transport to NTSs.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									

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COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Includes sheet piling the excavation perimeter. Labor is cleared and local,									
Schedule	**5**	**month**							
Labor									
LATA Labor					17600		$1,149,475		Engr Est., LATA Labor Rates
Health & Safety Equipment									
Level D Modified PPE	1,700	man-day	$24	$40,290					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	5	month	$1,300	$6,500					Hertz
Pickup Truck, crew cab, 4x4	5	month	$1,300	$6,500					Hertz
Excavator 2 CY	5	month	$15,160	$75,800					Vendor quote
All Terrain Forklift	5	month	$6,000	$30,000					Liftech
Dozer, JD, 99Hp	5	month	$2,800	$14,000					Engr Est.
Front End Loader	5	month	$1,800	$9,000					Engr Est.
Water Truck, 2000 gal	5	month	$858	$4,290					Engr Est.
Dump Trailer, 16 cy	5	month	$1,100	$5,500					RSMeans 01590-200-5350
Equipment Trailer	5	month	$150	$750					Engr Est.
Generator, 150 KW	5	month	$2,006	$10,030					Engr Est.
Two Portable Toilets	5	month	$300	$1,500					
Diaphragm Dewatering Pump & Hose	5	month	$500	$2,500					RSMeans 01590-400-5200,3200 & 3250
Rad Screening System	5	month	$100,000	$500,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	5	month	$24,200	$121,000					RSMeans ECHOS 33 18 0405, $110/hr
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	500	tons	$2,125	$1,062,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	687	liners	$95	$65,233					Engr Est., ECHOS 33 19 0810
Soft Side Bags	838	bag	$350	$293,300					Pactec, 8'L x 5.5'W x 5.5'H x IP1 (8.96 cy)
B25 Boxes	4	ea	$1,400	$5,600					DOE Engr Est.
55 gal Drums	226	ea	$64	$14,450					Vendor quote
Drum Liners	226	ea	$10	$2,258					Engr Est.
Drum Overpacks	100	ea	$150	$15,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									
Verification Samples	61	sample	$2,200	$134,694					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$2,555,696**	**35,200**		**$1,149,475**	**$3,705,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with one work crew.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared, local, and divided into two work crews. Level D Modified PPE.									
Schedule	**1**	**month**							

COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Labor									
LATA Labor					3520		$229,895		Engr Est., LATA Labor Rate
Health & Safety Equipment									
Level D Modified PPE	320	man-day	$24	$7,584					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$6,000	$6,000					Liftech
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$1,800	$1,800					Engr Est.
Water Truck, 2000 gal	1	month	$858	$858					Engr Est.
Dump Trailer, 16 cy	1	month	$1,100	$1,100					RSMeans 01590-200-5350
Equipment Trailer	1	month	$150	$150					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Disposal/Waste Sampling									
Excavated Waste	66	sample	$2,200	$145,200					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	5	sample	$2,200	$11,000					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
PPE Waste	12	sample	$2,200	$26,400					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	26	sample	$150	$3,900					One sample weekly for VOCs.
Rad Sludge from Water Trmt	13	sample	$2,200	$28,424					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW	3,750	LCY	$1,721	$6,453,750					Energy Solutions
Transportation									
RM/Sources	2	truck load	$11,000	$22,000					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	687	truck load	$75	$51,525					Onsite existing U Landfill-Subtitle D, assume 10 cy dumps, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW & MLLW	105	gons	$19,400	$2,037,000					Energy Solutions by Rail, Eight bags per gondola, Includes fees
LLW PPE Waste	2	truck load	$7,053	$14,106					Energy Solns, 60 drums per truckload

COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Rad Sludge from Water Trmt	2	trips	$7,053	$13,807					Enviocare, 60 drums per truckload
Disposal									
RM/Sources	4	B25	$0	$0					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	10,300	LCY	$0	$0					Onsite U Landfill - Subtitle D
LLW	5,625	LCY	$347	$1,951,875					Envirocare, soil & Debris disposal avg $347/cy
Treated MLLW	3,750	LCY	$1,135	$4,256,250					Energy Solutions
LLW PPE Waste	30	LCY	$347	$10,410					Envirocare
Rad Sludge from Water Trmt	32	LCY	$632	$20,215					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	646,000	gal	$3	$1,938,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	300,000	lbs	$2.13	$639,000					0.54lb/cf
Task Total				**$ 17,790,033**	3,520		**$229,895**	**$ 18,020,000**	
9.0 Backfill & Site Restoration.									
Duration: Assume 1 month with one work crew.									
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**month**							
Labor									
LATA Labor					3080		$197,115		
Health & Safety Equipment									
Level D Modified PPE	300	man-day	$24	$7,110					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Hertz
Loader, crawler	1	month	$1,800	$1,800					Hertz
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Hertz
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Hertz
Water Truck, 2000 gal	1	month	$858	$858					USGSA
Equipment Trailer	1	month	$300	$300					Hertz
Generator 150 KW	1	month	$2,006	$2,006					Hertz
Rad Screening System	2	Demob	$100,000	$200,000					RSMeans ECHOS 33 18 0403
Subcontractors									
Backfill Delivered	35,000	ton	$16	$560,000					Engr Est.
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	60	test	$54	$3,240					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.

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COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Hydroseed Bluegrass	60	MSF	$50	$3,000					Disturbed Area = 50%, RSMeans 02920-320-1000
TASK TOTAL				**$806,564**			**$197,115**	**$1,004,000**	
10.0 Remedial Action Completion Report									Engr Est.
Reports									
As-Builts	1	ls	$15,000	$15,000					
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
					SUBTOTAL CAPITAL COST			**$24,768,000**	

BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$ 38,164,000					$ 38,164,000
2013	1	1.03	1.03		$0				$0
2014	2	1.03	1.06		$0				$0
2015	3	1.03	1.09			$0			$0
2016	4	1.03	1.13			$0			$0
2017	5	1.03	1.16			$0		$0	$0
2018	6	1.03	1.19				$0		$0
2019	7	1.03	1.23						$0
2020	8	1.03	1.27				$0		$0
2021	9	1.03	1.30						$0
2022	10	1.03	1.34				$0	$0	$0
2023	11	1.03	1.38						$0
2024	12	1.03	1.43				$0		$0
2025	13	1.03	1.47						$0
2026	14	1.03	1.51				$0		$0
2027	15	1.03	1.56					$0	$0
2028	16	1.03	1.60				$0		$0
2029	17	1.03	1.65						$0
2030	18	1.03	1.70				$0		$0
2031	19	1.03	1.75						$0
2032	20	1.03	1.81				$0	$0	$0
2033	21	1.03	1.86						$0
2034	22	1.03	1.92				$0		$0
2035	23	1.03	1.97						$0
2036	24	1.03	2.03				$0		$0
2037	25	1.03	2.09					$0	$0
2038	26	1.03	2.16				$0		$0
2039	27	1.03	2.22						$0
2040	28	1.03	2.29				$0		$0
2041	29	1.03	2.36						$0
2042	30	1.03	2.43				$0	$0	$0
TOTAL				$ 38,164,000	$ -	$ -	$ -	$ -	$ 38,164,000

BGOU SWMU 30
Alternative 5.t6 - Excavation & Disposal

Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$ 38,164,000					$ 38,164,000
2013	1	1	1.00		$0				$0
2014	2	1	1.00		$0				$0
2015	3	1	1.00			$0			$0
2016	4	1	1.00			$0			$0
2017	5	1	1.00			$0		$0	$0
2018	6	1	1.00				$0		$0
2019	7	1	1.00						$0
2020	8	1	1.00				$0		$0
2021	9	1	1.00						$0
2022	10	1	1.00				$0	$0	$0
2023	11	1	1.00						$0
2024	12	1	1.00				$0		$0
2025	13	1	1.00						$0
2026	14	1	1.00				$0		$0
2027	15	1	1.00					$0	$0
2028	16	1	1.00				$0		$0
2029	17	1	1.00						$0
2030	18	1	1.00				$0		$0
2031	19	1	1.00						$0
2032	20	1	1.00				$0	$0	$0
2033	21	1	1.00						$0
2034	22	1	1.00				$0		$0
2035	23	1	1.00						$0
2036	24	1	1.00				$0		$0
2037	25	1	1.00					$0	$0
2038	26	1	1.00				$0		$0
2039	27	1	1.00						$0
2040	28	1	1.00				$0		$0
2041	29	1	1.00						$0
2042	30	1	1.00				$0	$0	$0
TOTAL				$ 38,164,000	$ -	$ -	$ -	$ -	$ 38,164,000

COST ESTIMATE
BGOU SWMU 30
Alternative 5.t6.WDF - Excavation & Disposal, WDF

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		Other Direct Costs			Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
COST ESTIMATE SUMMARY									
Capital Costs									
1.0 Project Plans	1	ls	$1,050,000	$1,050,000					
2.0 Engineering Design	1	ls	$105,000	$105,000					
3.0 Work Package Prep./Readiness Review	1	ls	$68,000	$68,000					
4.0 Training	1	ls	$92,000	$92,000					
5.0 Mobilization	1	ls	$251,000	$251,000					
6.0 Site Preparation/Construct Laydown & Staging Areas	1	ls	$298,000	$298,000					
7.0 Excavation	1	ls	$3,459,000	$3,459,000					
8.0 Waste Treatment, Transportation & Disposal	1	ls	$4,940,000	$4,940,000					
9.0 Backfill & Site Restoration	1	ls	$1,004,000	$1,004,000					
10.0 Remedial Action Completion Report	1	ls	$175,000	$175,000					
Management reserve, Subproject Management	1	ls	$2,288,400	$2,288,000					mgt reserve = 15%, and Subproject Management = 5% (engineers estimate)
Fee	1	ls	$961,100	$961,000					fee = 7%.
Contingency	1	ls	$2,938,200	$2,938,000					20% contingency
		SUBTOTAL CAPITAL COST		**$17,629,000**					
Schedule	**9**	**month**							
Annual Costs									
		SUBTOTAL ANNUAL COST		**$0**					
			TOTAL COST	**$17,629,000**					
Present Worth Value									
	Quantity	**Unit**	**Unit Cost**	**Total**				**Present Worth**	
Total Capital Cost	1	ls	$17,629,000	$17,629,000				**$17,629,000**	
							Capital	**$17,629,000**	
						Present	**Annual**	**$0**	
						Worth	**Avg. Annual**	**$0**	
						Values	**Total**	**$17,629,000**	
This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.									
Not used for budgeting or planning purposes because value is based on investing funds for out year expenditures.									
1.0 Project Plans									
Hazard Analysis Document	1	LS	$100,000	$100,000					Engr Est.
Health & Safety Plan	1	LS	$50,000	$50,000					Engr Est.
Remedial Design Work Plan	1	LS	$175,000	$175,000					Engr Est.
Remdial Design Report	1	LS	$300,000	$300,000					Engr Est.
Remedial Action Work Plan	1	LS	$225,000	$225,000					Engr Est.
Security Plan	1	LS	$50,000	$50,000					Engr Est.
QA Plan	1	LS	$50,000	$50,000					Engr Est.
Sampling & Analysis Plan	1	LS	$50,000	$50,000					Engr Est.
Waste Management Plan	1	LS	$50,000	$50,000					Engr Est.
TASK TOTAL				**$1,050,000**			**0**	**$1,050,000**	Engr Est.
2.0 Engineering Design									

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Alternative 5.t6.WDF - Excavation & Disposal, WDF

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	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Civil Surveying	1	LS	$50,000	$50,000					Engr Est.
Design	1	LS	$55,000	$55,000					Engr Est.
TASK TOTAL				**$105,000**			**0**	**$105,000**	
3.0 Work Package Prep./Readiness Review									
Work Instructions	1	LS	$50,000	$50,000					
Training	1	LS	$847	$847					
USD/USQD	1	LS	$3,104	$3,104					
Lessons Learned	1	LS	$260	$260					
Procedures	1	LS	$1,445	$1,445					
AHA	1	LS	$846	$846					
Work Authorization	1	LS	$475	$475					
Excavation/Penetration Permits	1	LS	$2,185	$2,185					
Team Meeting Documentation	1	LS	$333	$333					
Emergency Response Plan	1	LS	$4,890	$4,890					
Transportation Plan	1	LS	$2,510	$2,510					
Project Org. Chart	1	LS	$950	$950					
TASK TOTALS	1		$67,845	**$ 67,845**			**0**	**$68,000**	Engr Est.
4.0 Training									
Assumptions: Training Specialist and training courses funded through other funding.									
All have 40 hr HAZWOPER training.									
Labor									
LATA Labor					1040		$62,026		Engr Est., LATA Labor Rate
Subcontractors	1	LS	$30,000	$30,000					Engr Est.
TASK TOTALS				**$30,000**			**$62,026**	**$92,000**	
5.0 Mobilization									
Duration: Assume one month for mobilization.									
Assumptions: Assume 10 hrs/workday, 22 workday/month. Labor is cleared and local,									
Schedule	**1**	**month**							
Labor									
LATA Labor					2750		$160,000		Engr Est., LATA Labor Rates
Instruments									
RadCon Allocation	220	hr	$31	$6,820					Based on LATA Radcon allocation
Equipment									
Pickup Truck, crew cab, 4x4	2	month	$1,300	$2,600					Hertz
Excavator 2 CY	1	month	$15,160	$15,160					Vendor quote
All Terrain Forklift	1	month	$900	$900					Engr Est
Crane	1	month	$1,600	$1,600					Engr Est
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est
Front End Loader	1	month	$4,150	$4,150					Engr Est
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Engr Est
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Engr Est
Water Truck, 2000 gal	1	month	$1,850	$1,850					Engr Est
Supply Trailer	1	month	$448	$448					Engr Est
16cy Dump Trailer	1	month	$1,248	$1,248					Engr Est
Tractor Trailer	1	month	$6,500	$6,500					Engr Est
Generator	1	month	$2,006	$2,006					Engr Est
Loading Frame for bags	4	frame	$5,750	$23,000					Pactec, 8'L x 5.5'W x 5.5'H
Lifting Frame for bags	4	frame	$3,600	$14,400					Pactec, 8'L x 5.5'W
Rad Screening System	1	mob	$1,500	$1,500					RSMeans ECHOS 33 18 0401, 500 miles
TASK TOTALS				**$90,992**	**0**		**$160,000**	**$251,000**	

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	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
6.0 Site Preparation/Construct Laydown & Staging Areas									
Duration: Assume one month for site preparation, construction laydown and staging areas using one crew of cleared, local workers.									
Assumptions: Assume 10 hrs/workday, 22 workday/month.									
Also install stormwater control measures including cleaning ditches, repairing culverts and drains, and diverting water from the project areas.									
Includes geophysical survey of the landfill.									
Schedule	**1**	**month**							
Labor									
LATA Personnel					2750		$160,000		Engr Est., LATA Labor Rates
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Vendor quote
Front End Loader	1	month	$4,150	$4,150					Engr Est.
Water Truck, 6000 gal	1	month	$1,850	$1,850					Engr Est.
Equipment Trailer	1	month	$448	$448					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Materials									
Geotextile Fabric	2500	SY	$1	$2,500					Engr Est.
Crushed Stone Delivered	450	ton	$20	$9,000					Engr Est.
Silt Fence	1000	LF	$0.35	$350					Engr Est.
Hay Bales	600	ea	$4	$2,400					Engr Est.
Rip Rap delivered	800	ton	$20	$16,000					Engr Est.
Contractors									
Geophysical Survey	1	ls	$50,000	$50,000					Engr Est
Fence, 8', barbed wire	1,000	lf	$39	$38,500					RSMeans 3231-13.20.5090
Double Swing Gate, 8'	2	ea	$2,625	$5,250					RSMeans 3231-13.20.0920
TASK TOTAL				**$138,154**	2750		**$160,000**	**$298,000**	
7.0 Excavation									
Duration: Approximately 5 months for excavation, staging, and sampling based on excavating MLLW and LLW at 100 bcy/day/crew,									
U Landfill WAC Compliant at 200 bcy/day, and one month lag time between excavation and transporting offsite.									
Assumption: Soil, debris, waste excavated to 300 cy stockpiles for waste profile sampling;									
All waste delivered to the proposed On-Site Waste Disposal Facility.									
Uranium waste and rad material over packed for truck transport to NTSs.									
The excavation will require some dewatering ; the resulting wastewater will be treated with a skid mounted treatment unit and direct discharged.									
Labor for one month of lag time between excavation and transport offsite is accounted for in the next task estimate.									
Includes sheet piling the excavation perimeter. Labor is cleared and local,									
Schedule	**5**	**month**							
Labor									
LATA Labor					17600		$1,149,475		Engr Est., LATA Labor Rates
Health & Safety Equipment									
Level D Modified PPE	1,700	man-day	$24	$40,290					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	5	month	$1,300	$6,500					Hertz
Pickup Truck, crew cab, 4x4	5	month	$1,300	$6,500					Hertz
Excavator 2 CY	5	month	$15,160	$75,800					Vendor quote
All Terrain Forklift	5	month	$6,000	$30,000					Liftech
Dozer, JD, 99Hp	5	month	$2,800	$14,000					Engr Est.
Front End Loader	5	month	$1,800	$9,000					Engr Est.
Water Truck, 2000 gal	5	month	$858	$4,290					Engr Est.
Dump Trailer, 16 cy	5	month	$1,100	$5,500					RSMeans 01590-200-5350
Equipment Trailer	5	month	$150	$750					Engr Est.

COST ESTIMATE
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Alternative 5.t6.WDF - Excavation & Disposal, WDF

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	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Generator, 150 KW	5	month	$2,006	$10,030					Engr Est.
Two Portable Toilets	5	month	$300	$1,500					
Diaphragm Dewatering Pump & Hose	5	month	$500	$2,500					RSMeans 01590-400-5200,3200 & 3250
Rad Screening System	5	month	$100,000	$500,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	5	month	$24,200	$121,000					RSMeans ECHOS 33 18 0405, $110/hr
Portable HEPA Filtration Unit	1	ls	$125,000	$125,000					Vendor Quote for Similar work, 2500 cfm
Services									
Land Surveying	1	ls	$10,000	$10,000					Document excavation limits, Engr Est.
Sheet Piling, left in place	500	tons	$2,125	$1,062,500					RSMeans 31 41 16.10.0600
Materials									
Dump Truck Liners	1,187	liners	$95	$112,733					Engr Est., ECHOS 33 19 0810
B25 Boxes	4	ea	$1,400	$5,600					DOE Engr Est.
55 gal Drums	226	ea	$64	$14,450					vendor quote
Drum Liners	226	ea	$10	$2,258					Engr Est.
Drum Overpacks	100	ea	$150	$15,000					RSMeans ECHOS 33 19 0975
Confirmation Sampling									
Verification Samples	61	sample	$2,200	$134,694					Engr Est., 3 samples/ 1225 sf, 25% QA/QC samples, Metals, PCBs, VOAs, SVOAs, & RAD
TASK TOTAL				**$2,309,896**	**35,200**		**$1,149,475**	**$3,459,000**	
8.0 Waste Treatment, Transportation & Disposal									
Duration: Assume performed concurrent with excavation at a 1 month lag time with one work crew.									
Assumptions: Includes transportation from staging area to final destination and treatment at final destination.									
Labor cost included under Excavation & Backfill section. Labor is cleared, local, and divided into two work crews. Level D Modified PPE.									
Schedule	**1**	**month**							
Labor									
LATA Labor					3520		$229,895		
Health & Safety Equipment									
Level D Modified PPE	320	man-day	$24	$7,584					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
All Terrain Forklift	1	month	$6,000	$6,000					Liftech
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Engr Est.
Front End Loader	1	month	$1,800	$1,800					Engr Est.
Water Truck, 2000 gal	1	month	$858	$858					Engr Est.
Dump Trailer, 16 cy	1	month	$1,100	$1,100					RSMeans 01590-200-5350
Equipment Trailer	1	month	$150	$150					Engr Est.
Generator, 150 KW	1	month	$2,006	$2,006					Engr Est.
Two Portable Toilets	1	month	$300	$300					Engr Est.
Diaphragm Dewatering Pump & Hose	1	month	$500	$500					RSMeans 01590-400-5200,3200 & 3250
Rad Screening System	1	month	$100,000	$100,000					RSMeans ECHOS 33 18 0404
Rad Screening System Labor	1	month	$24,200	$24,200					RSMeans ECHOS 33 18 0405, $110/hr
Disposal/Waste Sampling									

COST ESTIMATE
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	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Excavated Waste	66	sample	$2,200	$145,200					Engr Est, 300 cy/sample plus 10% QA/QC, Metals, PCBs, VOAs, SVOAs, & RAD
Rad Material	5	sample	$2,200	$11,000					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per B-25 boxes plus 10% QA.
MLLW PPE Waste	12	sample	$2,200	$26,400					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treated Waste Water	26	sample	$150	$3,900					One sample weekly for VOCs.
Rad Sludge from Water Trmt	13	sample	$2,200	$28,424					Engr Est, Metals, PCBs, VOAs, SVOAs, & RAD. One sample per 10 drums plus 10% QA.
Treatment									
Treatability Study	1	ls	$17,273	$17,273					Energy Solutions
MLLW	1,875	LCY	$867	$1,625,625					Energy Solns; avg soil and debris stabilization = $64/cf trmt &D and $32.cf trmt. Assume 100% MLLW requires trmt.
Transportation									
RM/Sources	2	truck load	$11,000	$22,000					NTS, three B25 boxes per truckload
U Landfill WAC Compliant	687	truck load	$75	$51,525					Onsite existing U Landfill - Subtitle D, assume 15 cy dumps, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW & MLLW	500	truck load	$75	$37,500					Proposed On-Site Waste Disposal Facility, assume 15 cy dumps, round trip is 10 miles, RS Means ECHOS 33 19 0209
LLW PPE Waste	2	truck load	$75	$150					Proposed On-Site Waste Disposal Facility, assume 15 cy dumps, round trip is 10 miles, RS Means ECHOS 33 19 0209
Rad Sludge from Water Trmt	2	trips	$7,053	$13,807					Enviocare, 60 drums per truckload
Disposal									
RM/Sources	4	B25	$0	$0					NTS
U Landfill WAC Compliant	10,300	LCY	$0	$0					Onsite U Landfill - Subtitle D
LLW	5,625	LCY	$0	$0					Proposed Onsite Waste Disposal Facility
Treated MLLW	1,875	LCY	$0	$0					Proposed Onsite Waste Disposal Facility
LLW PPE Waste	30	LCY	$0	$0					Proposed Onsite Waste Disposal Facility
Rad Sludge from Water Trmt	32	LCY	$0	$0					Engergy Solutions, Disposal cost per CY
Dewater/Wastewater Trmt	646,000	gal	$3	$1,938,000					RSMeans ECHOS 33 19 7104, Rad water, 10,000 gal/day
Materials									
Absorbent	300,000	lbs	$2.13	$639,000					0.54lb/cf
Task Total				**$ 4,709,702**	0		**$229,895**	**$ 4,940,000**	
9.0 Backfill & Site Restoration									
Duration: Assume 1 month with one work crew.									

COST ESTIMATE
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Alternative 5.t6.WDF - Excavation & Disposal, WDF

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	Other Direct Costs				Labor				
Task Description	**Quantity**	**Unit**	**Unit Price**	**Total**	**Hours**	**Rate**	**Total**	**Total Cost**	**Basis of Estimate**
Assumptions: Backfilling based on 1500 cy/day/crew. 10 hrs/wday and 22 wdays/month.									
Schedule	**1**	**month**							
Labor									
LATA Labor					3080		$197,115		
Health & Safety Equipment									
Level D Modified PPE	300	man-day	$24	$7,110					Engr Est
Equipment									
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Pickup Truck, crew cab, 4x4	1	month	$1,300	$1,300					Hertz
Dozer, JD, 99Hp	1	month	$2,800	$2,800					Hertz
Loader, crawler	1	month	$1,800	$1,800					Hertz
Compactor/12 ton/pad foot	1	month	$3,090	$3,090					Hertz
Compactor/12 ton/smooth drum	1	month	$2,920	$2,920					Hertz
Water Truck, 2000 gal	1	month	$858	$858					USGSA
Equipment Trailer	1	month	$300	$300					Hertz
Generator 150 KW	1	month	$2,006	$2,006					Hertz
Rad Screening System	2	Demob	$100,000	$200,000					RSMeans ECHOS 33 18 0403
Subcontractors									
Backfill Delivered	35,000	ton	$16	$560,000					Engr Est.
Top Soil Delivered	1,000	ton	$16	$16,000					Engr Est.
Compaction Testing	60	test	$54	$3,240					Vendor Quote, Nuclear Densitometer with Technician, $54/hr, assume avg. 1 hour per test.
Geotech Testing of Backfill Source	2	ls	$420	$840					Vendor Quote, includes Technician 2 hrs collection time. Testing -Std Proctor, Atterberg, Sieve Hydrometer, Soil Class.
Hydroseed Bluegrass	60	MSF	$50	$3,000					Disturbed Area + 50%, RSMeans 02920-320-1000
TASK TOTAL				**$806,564**			**$197,115**	**$1,004,000**	
10.0 Remedial Action Completion Report									Engr Est.
Reports									
As Builts	1	ls	$15,000	$15,000					Engr Est.
Remedial Action Completion Report and Reviews	1	ls	$160,000	$160,000					Engr Est.
TASK TOTAL				**$175,000**			**$0**	**$175,000**	
							SUBTOTAL CAPITAL COST	**$11,442,000**	

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Alternative 5.t6.WDF - Excavation & Disposal, WDF

Escalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1.03	1.00	$17,629,000					$ 17,629,000
2013	1	1.03	1.03		$0				$0
2014	2	1.03	1.06		$0				$0
2015	3	1.03	1.09			$0			$0
2016	4	1.03	1.13			$0			$0
2017	5	1.03	1.16			$0		$0	$0
2018	6	1.03	1.19				$0		$0
2019	7	1.03	1.23						$0
2020	8	1.03	1.27				$0		$0
2021	9	1.03	1.30						$0
2022	10	1.03	1.34				$0	$0	$0
2023	11	1.03	1.38						$0
2024	12	1.03	1.43				$0		$0
2025	13	1.03	1.47						$0
2026	14	1.03	1.51				$0		$0
2027	15	1.03	1.56					$0	$0
2028	16	1.03	1.60				$0		$0
2029	17	1.03	1.65						$0
2030	18	1.03	1.70				$0		$0
2031	19	1.03	1.75						$0
2032	20	1.03	1.81				$0	$0	$0
2033	21	1.03	1.86						$0
2034	22	1.03	1.92				$0		$0
2035	23	1.03	1.97						$0
2036	24	1.03	2.03				$0		$0
2037	25	1.03	2.09					$0	$0
2038	26	1.03	2.16				$0		$0
2039	27	1.03	2.22						$0
2040	28	1.03	2.29				$0		$0
2041	29	1.03	2.36						$0
2042	30	1.03	2.43				$0	$0	$0
TOTAL				$17,629,000	$ -	$ -	$ -	$ -	$ 17,629,000

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Alternative 5.t6.WDF - Excavation & Disposal, WDF

Unescalated

Date	Yr	Escalation	Escalation Factor	Capital	Quarterly Groundwater LTM (Years 1-2)	Annual Groundwater LTM (Years 3-5)	Biannual Groundwater LTM (Years 6-30)	Five-Year Reviews	TOTALS
2012	0	1	1.00	$17,629,000					$ 17,629,000
2013	1	1	1.00		$ -				$0
2014	2	1	1.00		$ -				$0
2015	3	1	1.00			$ -			$0
2016	4	1	1.00			$ -			$0
2017	5	1	1.00			$ -		$ -	$0
2018	6	1	1.00				$ -		$0
2019	7	1	1.00						$0
2020	8	1	1.00				$ -		$0
2021	9	1	1.00						$0
2022	10	1	1.00				$ -	$ -	$0
2023	11	1	1.00						$0
2024	12	1	1.00				$ -		$0
2025	13	1	1.00						$0
2026	14	1	1.00				$ -		$0
2027	15	1	1.00					$ -	$0
2028	16	1	1.00				$ -		$0
2029	17	1	1.00						$0
2030	18	1	1.00				$ -		$0
2031	19	1	1.00						$0
2032	20	1	1.00				$ -	$ -	$0
2033	21	1	1.00						$0
2034	22	1	1.00				$ -		$0
2035	23	1	1.00						$0
2036	24	1	1.00				$ -		$0
2037	25	1	1.00					$ -	$0
2038	26	1	1.00				$ -		$0
2039	27	1	1.00						$0
2040	28	1	1.00				$ -		$0
2041	29	1	1.00						$0
2042	30	1	1.00				$ -	$ -	$0
TOTAL				$17,629,000	$ -	$ -	$ -	$ -	$ 17,629,000

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APPENDIX F

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED GUIDANCE

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TABLES

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F.1. INTRODUCTION

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and 40 *CFR* § 300.430(f)(1)(ii)(B) of the National Contingency Plan require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate requirements (ARARs) or provide grounds for invoking a CERCLA waiver. ARARs include the substantive requirements of federal or more stringent state environmental or facility siting laws/regulations. Additionally, per 40 *CFR* § 300.400(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [to be considered (TBC) category]. CERCLA § 121(d)(4) provides several ARAR waiver options that may be invoked, provided that human health and the environment are protected. ARARs do not include occupational safety or worker protection requirements. On-site activities must comply with the substantive, but not administrative requirements. Administrative requirements include applying for permits, recordkeeping, consultation, and reporting. Activities conducted off-site must comply with both the substantive and administrative requirements of applicable laws.

ARARs typically are divided into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific. "Chemical-specific ARARs usually are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values" [53 *FR* 51394, 51437 (December 21, 1988)]. (In the absence of chemical-specific ARARs, cleanup criteria are based upon risk calculations.) Location-specific ARARs generally are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations [53 *FR* 51394, 51437 (December 21, 1988)]. Action-specific ARARs usually are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes or requirements to conduct certain actions to address particular circumstances at a site [53 *FR* 51394, 51437 (December 21, 1988)]. ARARs and TBC guidance for the Burial Grounds Operable Unit (BGOU) Feasibility Study for Solid Waste Management Units (SWMUs) 2, 3, 7 and 30 are identified in Tables F.1 and F.2.

F.2. CHEMICAL-SPECIFIC ARARs/TBC

Chemical-specific ARARs provide health or risk-based concentration limits or discharge limitations in environmental media (i.e., surface water, groundwater, soil, or air) for specific hazardous substances, pollutants, or contaminants. There are no chemical-specific ARARs for remediation of the contaminated soils at the SWMUs 2, 3, 7 and 30 source areas.

F.3. LOCATION-SPECIFIC ARARs/TBC

Location-specific requirements establish restrictions on activities conducted within protected or environmentally sensitive areas. In addition, these requirements establish restrictions on permissible concentrations of hazardous substances within these areas.

F.3.1 WETLANDS

A wetlands assessment would be performed prior to remedy implementation. Although it is not anticipated, if an action should involve discharge of dredge or fill material into waters of the United States, including jurisdictional wetlands, compliance with the substantive requirements of Nationwide Permit 38, General Conditions, would be complied with, as appropriate.

F.4. ACTION-SPECIFIC ARARs/TBCs

Action-specific ARARs include operation, performance, and design requirements or limitations based on waste type, media, and remedial activities. Component actions include groundwater monitoring, institutional controls, waste management, and transportation.

F.4.1 GENERAL CONSTRUCTION ACTIVITIES

Requirements for storm water runoff and fugitive dust emission control measures potentially provide ARARs for construction and site preparation activities. ARARs for these common activities are discussed here.

F.4.2 STORM-WATER RUNOFF

Storm-water discharges from activities involving construction operations that result in the disturbance of land equal to or greater than one acre and less than five acres require implementation of good site planning and best management practices.

F.4.3 FUGITIVE EMISSIONS

Emission of airborne particulate concentrations may result from construction activities. Fugitive emissions are regulated by Kentucky through administrative rules at 401 *KAR* 63:010. Reasonable precautions must be taken to prevent particulate matter from becoming airborne.

Radionuclide emissions, excluding radon-220 and radon-222, from the U.S. Department of Energy (DOE) facilities are addressed in 40 *CFR* § 61, Subpart H. These regulations apply to airborne emissions during construction and operation activities. National Emissions Standards for Hazardous Air Pollutants limit ambient air radionuclide emissions from DOE facilities to levels that would prevent any individual from receiving an effective dose equivalent (EDE) of 10 millirem per year (mrem/year) or more (40 *CFR* § 61.92). Nonpoint-source fugitive radionuclide emissions are estimated by plant monitoring stations.

F.4.4 COLLECTION/TREATMENT OF VOLATILE ORGANIC CONSTITUENTS

Alternatives 4 and 7 involve *in situ* heating of soils using an electrical resistance heating process. This will result in the collection and recovery of contaminants from the aquifer and vadose zone. Prior to emission of collection vapor/gases, contaminants must be removed to comply with 401 *KAR* 63:020. An off-gas treatment system shall be employed to ensure contaminant emissions do not exceed allowable levels. This system may include such equipment as condensers and/or filters to accomplish the required contaminant removal.

F.4.5 WASTE-WATER TREATMENT

Contaminated water, including decontamination fluid, collected storm water, and groundwater, shall be treated before discharge. Under alternatives that include electrical resistance heating, dual-phase extraction, or excavation, a waste water treatment facility may be constructed and designed to meet the ARARs.

F.4.6 WASTE MANAGEMENT

All primary waste (i.e., groundwater and contaminated soils) and secondary waste (i.e., contaminated personal protective equipment, treatment residuals, and decontamination wastewaters) generated during remedial activities will be characterized as Resource Conservation and Recovery Act (RCRA) wastes (solid or hazardous), Toxic Substances Control Act (TSCA) waste, low-level radioactive waste(s), and/or mixed waste(s), as appropriate, and each must be managed in accordance with appropriate RCRA, TSCA, or DOE Order/Manual requirements. Waste managed on-site must comply with the substantive requirements of the aforementioned ARARs.

F.4.7 TRANSPORTATION

Any remediation waste transferred off-site or transported in commerce along public rights-of-way must be conducted in compliance with all applicable laws and regulations. These transportation requirements include provisions for proper packaging, labeling, marking, manifesting, record keeping, licensing, and placarding that must be fully complied with for shipment. Before shipment of CERCLA waste to any off-site facility, DOE must ensure the acceptance of the receiving site under the CERCLA Off-site Rule (40 *CFR* § 300.440 *et seq.*).

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Table F.1. Location-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30

Location	Requirement	Prerequisite	Citation	SWMU 2	SWMU 3	SWMU 7	SWMU 30
Presence of wetlands as defined in 10 *CFR* § 1022.4	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands.	DOE actions that involve potential impacts to, or take place within, wetlands—**applicable**.	10 *CFR* § 1022.3(a)	✓	✓	✓	✓
	Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.		10 *CFR* § 1022.3(a) (7) and (8)	✓	✓	✓	✓
	Undertake a careful evaluation of the potential effects of any new construction in wetlands. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands.		10 *CFR* § 1022.3(b) and (d)	✓	✓	✓	✓
	Measures that mitigate the adverse effects of actions in a wetland including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-sensitive areas.		10 *CFR* § 1022.13(a)(3)	✓	✓	✓	✓
	If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in E.O. 11990.		10 *CFR* § 1022.14(a)	✓	✓	✓	✓

Table F.1. Location-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Location	Requirement	Prerequisite	Citation	SWMU 2	SWMU 3	SWMU 7	SWMU 30
Location encompassing aquatic ecosystem as defined in 40 *CFR* § 230.3(c)	Except as provided under section 404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**relevant and appropriate**.	40 *CFR* § 230.10(a) and (c)	✓	✓	✓	✓
	Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 *CFR* § 230.70 *et seq.* identifies such possible steps.		40 *CFR* § 230.10(d)	✓	✓	✓	✓
Nationwide Permit Program	Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate.	Discharge of dredged or fill material into *waters of the United States*, including jurisdictional wetlands—**relevant and appropriate**.	Nation Wide Permit (38) Cleanup of Hazardous and Toxic Waste 33 *CFR* § 323.3(b)	✓	✓	✓	✓

CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
E.O. = Executive Order
NWP = Nationwide Permit

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Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Site Preparation, Construction, and Excavation																						
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)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	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 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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air Emissions																						
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 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. Shall not 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				✓			✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Activities heating nonhazardous material	Emission limit and work practice standards.	Roasting and desorption without hazardous waste constituents—**applicable**.	40 *CFR* § 63.7500 (a)(1)														✓	✓				
Emission standards for stationary emergency engines (e.g., generators)	Must comply with the emission standards in table 1 Subpart IIII of Part 60.	Operation of pre-2007 model year emergency stationary compression ignition internal combustion engines as defined in 40 *CFR* § 60.4219 with a displacement of less than 10 liters per cylinder that are not fire pump engines—**applicable.**	40 *CFR* § 60.4205(a)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Gu… GOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	Must comply with the emission standards for new nonroad compression ignition engines in 40 *CFR* § 60.4202, for all pollutants, for the same model year and maximum engine power for their 2007 model year and later emergency stationary compression ignition internal combustion engines.	Operation of 2007 model year and later emergency stationary compression ignition internal combustion engines with a displacement of less than 30 liters per cylinder that are not fire pump engines—**applicable**.	40 *CFR* § 60.4205(b)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
	Must meet the following • Reduce NO_X emissions by 90 percent or more, or limit the emissions of NO_X in the stationary CI internal combustion engine exhaust to 1.6 grams per KW-hour (1.2 grams per HP-hour). • Reduce PM emissions by 60 percent or more, or limit the emissions of PM in the stationary CI internal combustion engine exhaust to 0.15 g/KW-hr (0.11 g/HP-hr).	Operation of emergency stationary compression ignition internal combustion engines with a displacement of greater than or equal to 30 liters per cylinder—**applicable**.	40 *CFR* § 60.4205(d)				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Emission standards for new hazardous waste combustors (i.e., hazardous waste incinerators)	Must not discharge or cause combustion gases to be emitted into the atmosphere that contain: • Dioxins and furans in excess of 0.11 ng TEQ/dscm corrected to 7 percent oxygen for incinerators equipped with either a waste heat boiler or dry air pollution control system; or Dioxins and furans in excess of 0.20 ng TEQ/dscm corrected to 7 percent oxygen for sources not equipped with either a waste heat boiler or dry air pollution control system;	Thermal desorber that meets the definition of a hazardous waste incinerator in 40 *CFR* § 260.10 that burn hazardous waste at any time, including all associated firing systems and air pollution control devices, as well as the combustion chamber equipment, except as otherwise exempt in Table 1 of 40 *CFR* § 63.1200—**applicable**.	40 *CFR* § 63.1219(b) (1)														✓	✓				
	Mercury in excess of 8.1 µgm/dscm, corrected to 7 percent oxygen;		40 *CFR* § 63.1219(b) (2)														✓	✓				
	Cadmium and lead in excess of 10 µgm/dscm, combined emissions, corrected to 7 percent oxygen;		40 *CFR* § 63.1219(b) (3)														✓	✓				
	Arsenic, beryllium, and chromium in excess of 23 µgm/dscm, combined emissions, corrected to 7 percent oxygen;		40 *CFR* § 63.1219(b) (4)														✓	✓				
	For carbon monoxide and hydrocarbons, either: • Carbon monoxide in excess of 100 parts per million by volume, over an hourly rolling average (monitored continuously with a continuous emissions monitoring system), dry basis and corrected to		40 *CFR* § 63.1219 (b)(5)														✓	✓				

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	7 percent oxygen. If you elect to comply with this carbon monoxide standard rather than the hydrocarbon standard under 40 *CFR* § 63.1219(b)(5)(ii), must also document that, during the destruction and removal efficiency (DRE) test runs or their equivalent as provided by §63.1206(b)(7), hydrocarbons do not exceed 10 parts per million by volume during those runs, over an hourly rolling average (monitored continuously with a continuous emissions monitoring system), dry basis, corrected to 7 percent oxygen, and reported as propane; or Hydrocarbons in excess of 10 parts per million by volume, over an hourly rolling average (monitored continuously with a continuous emissions monitoring system), dry basis, corrected to 7 percent oxygen, and reported as propane;																					
	Hydrogen chloride and chlorine gas in excess of 21 parts per million by volume, combined emissions, expressed as a chloride (Cl(−)) equivalent, dry basis and corrected to 7 percent oxygen; and		40 *CFR* § 63.1219(b)(6)														✓	✓				
	Except as provided by 40 *CFR* § 63.1219(e), particulate matter emissions in excess of 0.0016 gr/dscf corrected to 7 percent oxygen.		40 *CFR* § 63.1219(b)(7)														✓	✓				
	Except as provided in 40 *CFR* § 63.1219(c)(2), must achieve a destruction and removal efficiency (DRE) of 99.99% for each principle organic hazardous constituent (POHC) designated under 40 *CFR* § 63.1219(c)(3). Must calculate DRE for each POHC from the following equation: $DRE = [1 - (W_{out}/W_{in})] \times 100\%$ Where: W_{in}= mass feedrate of one POHC in a waste feedstream; and W_{out}= mass emission rate of the same POHC present in exhaust emissions prior to release to the atmosphere.		40 *CFR* § 63.1219(c)(1)														✓	✓				
	Must treat each POHC in the waste feed that you specify under 40 *CFR* § 63.1219(c)(3)(ii) to the extent required by 40 *CFR* § 63.1219(c)(1).		40 *CFR* § 63.1219(c)(3)														✓	✓				

Table F.2. Action-Specific ARARs and TBC Gui[illegible]SOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	Must specify one or more POHCs that are representative of the most difficult to destroy organic compounds in your hazardous waste feedstream. Must base this specification on the degree of difficulty of incineration of the organic constituents in the hazardous waste and on their concentration or mass in the hazardous waste feed, considering the results of hazardous waste analyses or other data and information.																					
	The emission limits provided by 40 *CFR* § 63.1219 (b) are presented with two significant figures. Although intermediate calculations must be performed using at least three significant figures, may round the resultant emission levels to two significant figures to document compliance.		40 *CFR* § 63.1219(d)														✓	✓				
Alternative metal emission control requirements to the particulate matter standard	In lieu of complying with the particulate matter standards of this section, you may elect to comply with the following alternative metal emission control requirement:		40 *CFR* § 63.1219(e) (1)														✓	✓				
	• Must not discharge or cause combustion gases to be emitted into the atmosphere that contain cadmium, lead, and selenium in excess of 10 µgm/dscm, combined emissions, corrected to 7 percent oxygen; and, Must not discharge or cause combustion gases to be emitted into the atmosphere that contain antimony, arsenic, beryllium, chromium, cobalt, manganese, and nickel in excess of 23 µgm/dscm, combined emissions, corrected to 7 percent oxygen.		40 *CFR* § 63.1219(e) (3)														✓	✓				
	Semivolatile and low volatile metal operating parameter limits must be established to ensure compliance with the alternative emission limitations described in 40 *CFR* § 63.1219 (e)(3) pursuant to § 63.1209(n), except that semivolatile metal feedrate limits apply to lead, cadmium, and selenium, combined, and low volatile metal feed rate limits apply to arsenic, beryllium, chromium, antimony, cobalt, manganese, and nickel, combined.		40 *CFR* § 63.1219(e) (4)														✓	✓				

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Hazardous waste incinerators meeting MACT standards	Except as provided by 40 *CFR* § 264.340 (b)(2) through (b)(3), the standards of 40 *CFR* Part 264 do not apply to a new hazardous waste incineration unit that demonstrates compliance with the maximum achievable control technology (MACT) requirements of part 63, Subpart EEE, of this chapter by conducting a comprehensive performance test and documenting compliance with the requirements of part 63, Subpart EEE, of chapter 1.	Thermal desorption in units meeting definition of hazardous waste incinerator in 40 *CFR* § 260.10—**applicable**.	40 *CFR* § 264.340(b)(1) 401 *KAR* 34:240 § 1														✓	✓				
	The MACT standards do not replace the closure requirements of 40 *CFR* § 264.351 or the applicable requirements of Subparts A through G, BB and CC that are identified as ARARS in Table F.2.		40 *CFR* § 264.340(b)(2) 401 *KAR* 34:240 § 1														✓	✓				
	The particulate matter standard of 40 *CFR* § 264.343(c) remains in effect for incinerators that elect to comply with the alternative to the particulate matter standard under 40 *CFR* §§ 63.1206(b)(14) and 63.1219(e).		40 *CFR* § 264.340(b)(3) 401 *KAR* 34:240 § 1														✓	✓				
General standards for process vents used in treatment of VOCs	Select and meet the requirements under one of the options specified below: • Control hazardous air pollutants (HAP) emissions from the affected process vents according to the applicable standards specified in §§ 63.7890 through 63.7893. • Determine for the remediation material treated or managed by the process vented through the affected process vents that the average total volatile organic hazardous air pollutant (VOHAP) concentration, as defined in § 63.7957, of this material is less than 10 (ppm). Determination of VOHAP concentration will be made using procedures specified in § 63.7943. • Control HAP emissions from affected process vents subject to another subpart under 40 *CFR* part 61 or 40 *CFR* part 63 in compliance with the standards specified in the applicable subpart.	Process vents as defined in 40 *CFR* § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *CFR* § 63.7885(c)(1)—**relevant and appropriate**.	40 *CFR* § 63:7885(b) 401 *KAR* 63:002, §§ 1 and 2, except for 40 *CFR* § 63.72 as incorporated in § 2(3)				✓			✓	✓			✓				✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Emission limitations for process vents used in treatment of VOCs	Meet the requirements under one of the options specified below: • Reduce from all affected process vents the total emissions of the HAP to a level less than 1.4 kilograms per hour (kg/hr) and 2.8 Mg/yr (3.0 pounds per hour (lb/hr) and 3.1 tpy); or • Reduce from all affected process vents the emissions of total organic compounds (TOC) (minus methane and ethane) to a level below 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr and 3.1 tpy); or • Reduce from all affected process vents the total emissions of the HAP by 95 percent by weight or more; or • Reduce from all affected process vents the emissions of TOC (minus methane and ethane) by 95 percent by weight or more.	Process vents as defined in 40 *CFR* § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit hazardous air pollutants (HAP) listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 *CFR* § 63.7885(c)(1)—**relevant and appropriate**.	40 *CFR* § 63.7890(b)(1)-(4) 401 *KAR* 63:002, §§ 1 and 2, except for 40 *CFR* § 63.72 as incorporated in § 2(3)				✓			✓	✓			✓				✓	✓	✓	✓	✓
Standards for closed vent systems and control devices used in treatment of VOCs	For each closed vent system and control device you use to comply with the requirements above, you must meet the operating limit requirements and work practice standards in Sec. 63.7925(d) through (j) that apply to the closed vent system and control device. *NOTE:* EPA approval to use alternate work practices under paragraph (j) in 40 *CFR* § 63.7925 will be obtained in FFA CERCLA document (e.g., Remedial Design).	Closed vent system and control devices as defined in 40 *CFR* § 63.7957 that are used to comply with § 63.7890(b)—**relevant and appropriate**.	40 *CFR* § 63.7890(c)				✓			✓	✓			✓				✓	✓	✓	✓	✓
Monitoring of closed vent systems and control devices used in treatment of VOCs	Must monitor and inspect the closed vent system and control device according to the requirements in 40 *CFR* § 63.7927 that apply to the affected source. *NOTE:* Monitoring program will be developed as part of the CERCLA process and included in a Remedial Design or other appropriate FFA CERCLA document.	Closed vent system and control devices as defined in 40 *CFR* § 63.7957 that are used to comply with § 63.7890(b)—**relevant and appropriate**.	40 *CFR* § 63.7892				✓			✓	✓			✓				✓	✓	✓	✓	✓
Disposal of residual PCBs on metal surfaces in a scrap metal recovery oven	Onsite disposal of residual PCBs associated with metal surfaces in PCB remediation waste regulated under 40 *CFR* § 761.61, or metal surfaces in PCB bulk product waste regulated under 40 *CFR* § 761.62(a)(6) and 40 *CFR* § 761.79(c)(6), from which all free-flowing liquids have been removed**—applicable**.	The oven shall have at least two enclosed interconnected chambers)—**relevant and appropriate.**	40 *CFR* § 761.72(a)(1)														✓	✓				

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
		The equipment with all free flowing liquid removed shall first be placed in the primary chamber at room temperature—**relevant and appropriate**.	40 *CFR* § 761.72(a)(2)														✓	✓				
		The primary chamber shall operate at a temperature between 537°C and 650°C for a minimum of 2½ hours and reach a minimum temperature of 650°C once during each heating cycle or batch treatment of unheated, liquid-free equipment—**relevant and appropriate**.	40 *CFR* § 761.72(a)(3)														✓	✓				
		Heated gases from the primary chamber must feed directly into the secondary chamber (i.e., afterburner) which must operate at a minimum temperature of 1,200 °C (2,192 °F) with at least a 3 percent excess oxygen and a retention time of 2.0 seconds with a minimum combustion efficiency of 99.9 percent according to the definition in §761.70(a)(2)—**relevant and appropriate**.	40 *CFR* § 761.72(a)(4)														✓	✓				
		Heating of the primary chamber shall not commence until the secondary chamber has reached a temperature of 1,200 ±100 °C—**relevant and appropriate**.	40 *CFR* § 761.72(a)(5)														✓	✓				
Monitoring, Extraction, and Injection 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 remedial action—**applicable**.	401 *KAR* 6:350 § 1(2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
	All permanent monitoring wells (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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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 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.		401 *KAR* 6:350 § 6 (a)(6) and (7)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
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 remedial 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 remedial 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; an (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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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 remedial 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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Extraction well installation	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 extraction well for remedial action—**relevant and appropriate**.	401 *KAR* 6:350 § 1 (2)				✓			✓	✓			✓				✓	✓	✓	✓	✓
Reinjection of treated contaminated groundwater	No owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 *CFR* Part 142 or may otherwise adversely affect the health of persons.	Underground injection into an underground source of drinking water—**relevant and appropriate**.	40 *CFR* § 144.12(a)				✓			✓	✓			✓				✓	✓	✓	✓	✓
	Wells are not prohibited if injection is approved by EPA or a State pursuant to provisions for cleanup of releases under CERCLA or RCRA *as provided in the FFA CERCLA document*.	Class IV wells [as defined in 40 *CFR* § 144.6(d)] used to reinject treated contaminated groundwater into the same formation from which it was drawn—**relevant and appropriate**.	40 *CFR* § 144.13(c) RCRA § 3020(b)				✓			✓	✓			✓				✓	✓	✓	✓	✓
	Prior to abandonment any Class IV well, the owner or operator shall plug or otherwise close the well in a manner *as provided in the FFA CERCLA document*.	Class IV wells [as defined in 40 *CFR* § 144.6(d)] used to reinject of treated contaminated groundwater into the same formation from which it was drawn—**relevant and appropriate**.	40 *CFR* § 144.23(b)(1)				✓			✓	✓			✓				✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Plugging and abandonment of Class IV injection wells	Prior to abandoning the well, the owner or operator shall close the well in accordance with 40 *CFR* § 144.23(b).	Operation of a Class IV injection well [as defined in 40 *CFR* § 144.6(d)]—**relevant and appropriate**.	40 *CFR* § 146.10(b)				✓			✓	✓			✓				✓	✓	✓	✓	✓
Groundwater monitoring requirements																						
Groundwater monitoring requirements for RCRA hazardous waste landfills	All or part of the requirements for releases from solid waste management units of 40 *CFR* §§ 264.91 through 264.100 may be replaced with alternative requirements for groundwater monitoring and corrective action for releases to groundwater set out in the enforceable CERCLA document where it has been determined that: (1) The regulated unit is situated among solid waste management units (or areas of concern), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or areas of concern) are likely to have contributed to the release; and (2) It is not necessary to apply the groundwater monitoring and corrective action requirements of 40 *CFR* §§ 264.91 through 264.100 because alternative requirements will protect human health and the environment.	Conducting monitoring for responding to releases from landfills under 40 *CFR* § 264.90—**applicable to SWMU 3**.	40 *CFR* § 264.90(f)(1) and (2) 401 *KAR* 34:060 § 1	✓	✓	✓																
Capping Waste in Place—Landfill Closure and Post-Closure																						
Installation of low-permeability cover	Must install cover designed and constructed to: • provide long-term minimization of migration of liquids through the closed landfill; • function with minimum maintenance; • promote drainage and minimize erosion or abrasion of the cover; • accommodate settling and subsidence so that the cover's integrity is maintained; and • have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.	Design and construction of cover—**relevant and appropriate**.	40 *CFR* § 264.310(a) 401 *KAR* 34:230 § 7							✓	✓	✓	✓							✓		✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	EPA guidance provides technical recommendations on the design parameters for a multi-layer low permeability cover including a two component low permeability layer, a soil drainage layer, and a two component top layer. The guidance acknowledges that other final cover designs may be acceptable,	Design and construction of cover—**TBC**.	Sections 1.4.1, 2, 3, and 4 of the EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impound-ments, EPA OSWER 530-SW-89-047, (July 1989)							✓	✓	✓	✓							✓		✓
Maintenance of low-permeability cover	Must maintain the integrity and effectiveness of the cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events; and	Installation of cover—**relevant and appropriate**.	40 *CFR* § 264.310(b)(1) 401 *KAR* 34:230 § 7							✓	✓	✓	✓							✓		✓
	Must prevent run-on and run-off from eroding or otherwise damaging the cover.		40 *CFR* § 264.310(b)(5) 401 *KAR* 34:230 § 7							✓	✓	✓	✓							✓		✓
	Must continue maintenance of the cover for 30 years.		40 *CFR* § 264.117(a)(1) 401 *KAR* 34:070 § 8							✓	✓	✓	✓							✓		
Disturbance of integrity of low-permeability cover	Must never allow disturbance of the integrity of the cover, or any other components of the containment system, or the function of the facility's monitoring systems, unless the disturbance: • Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or • Is necessary to reduce a threat to human health or the environment.		40 *CFR* § 264.117(c) 401 *KAR* 34:070 § 8							✓	✓	✓	✓							✓		✓
Installation of a solid waste landfill cover system	The cover system must be designed and constructed to • Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than $1{\times}10^{-5}$cm/sec, whichever is less, and • Minimize infiltration by the use of an infiltration layer that contains a	Design and construction of a solid waste landfill cover system to minimize infiltration and erosion—**relevant and appropriate**.	40 *CFR* § 258.60 (a)			✓								✓	✓	✓					✓	

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	minimum 18-inches of earthen material, and • Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6-inches of earthen material that is capable of sustaining native plant growth.																					
	At a minimum the final cap shall consist of a layered system. Each layer shall have the same slope of between five (5) and twenty-five (25) percent. The components, listed from bottom to top, are: (1) A filter fabric or other material approved by the cabinet; (2) A twelve (12) inch sand gas venting system with a minimum hydraulic permeability of 1×10^{-3}; (3) A filter fabric or other material approved by the cabinet; (4) An eighteen (18) inch clay layer with a maximum permeability of 1×10^{-7} centimeters per second; (5) For areas of the final cap with a slope of less than fifteen (15) percent, a twelve (12) inch drainage layer with a minimum permeability of 1×10^{-3} centimeters per second; and (6) A thirty-six (36) inch vegetative soil layer. Specifications for these required layers are provided in 401 *KAR* 48:080 § 9.		401 *KAR* 48:080 §8 401 *KAR* 48:080 §9			✓								✓	✓	✓					✓	
	Alternative final cover design may be used that include: (1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in 40 *CFR* § 258.60 (a)(1) and 40 *CFR* § 258.60 (a)(2), and (2) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in 40 *CFR* § 258.60 (a)(3).		40 *CFR* § 258.60 (b)			✓								✓	✓	✓					✓	
	Alternative specifications may be used that result in performance with regard to safety, stability, and environmental protection equal to or better than that resulting from designs complying with the specifications of this administrative regulation. **NOTE:** Approval to use alternate specifications under 401 *KAR* 48:080, Section 11 will be obtained in an FFA CERCLA document (e.g., Remedial Design).		401 *KAR* 48:080 § 11			✓								✓	✓	✓					✓	

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Maintenance of a solid waste landfill cover	Must continue maintenance for 30 years, except as provided under 40 *CFR* § 258.61(b), and consist of at least the following: • Maintaining the integrity and effectiveness of any cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover.	Installation of a solid waste landfill cover—**relevant and appropriate**.	40 *CFR* § 258.61 (a)(1)			✓								✓	✓	✓					✓	
	The operator of a contained solid waste landfill shall close each landfill unit and phase in a manner that minimizes the need for further maintenance and minimizes the closure care formation and release of leachate to the groundwater, or surface water to the extent necessary to protect human health and the environment.		401 *KAR* 48:070 § 15(1)			✓								✓	✓	✓					✓	
	A contained solid waste landfill site shall be maintained as necessary to prevent erosion or washing of the fill, and grade as necessary to drain rainwater from the fill area and to prevent standing water.		401 *KAR* 48:090 § 7(1)			✓								✓	✓	✓					✓	
	The integrity and effectiveness of any cap shall be maintained the integrity and effectiveness of any final cap, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cap.		401 *KAR* 48:090 § 13(1)(a)(1)			✓								✓	✓	✓					✓	
	Closure care use of the property shall not be allowed to disturb the integrity of the final cap, or any other components of the containment system, unless the activities shall not increase the potential threat to human health or the environment or the disturbance is necessary to reduce a threat to human health or the environment.		401 *KAR* 48:090 § 13(2)(c)			✓								✓	✓	✓					✓	
General post-closure care	Owner or operator must:	Post-closure of a RCRA landfill—**applicable to SWMU 3 only**.	40 *CFR* § 264.310(b) 401 *KAR* 34:230 § 7	✓	✓	✓													✓			✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	• maintain the effectiveness and integrity of the final cover including making repairs to the cap as necessary to correct effects of settling, erosion, or other events.;		40 *CFR* § 264.310(b)(1) 401 *KAR* 34:230 § 7	✓	✓	✓													✓			✓
	• prevent run-on and run-off from eroding or otherwise damaging final cover		40 *CFR* § 264.310(b)(5) 401 *KAR* 34:230 § 7	✓	✓	✓													✓			✓
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)														✓	✓	✓	✓	✓	✓
Management of PCB remediation waste	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 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).	Generation of PCB/radioactive waste with ≥50 ppm PCBs for storage—**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 PCB properties in the waste (and not the radioactive properties of the waste), the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or nonmunicipal nonhazardous waste landfill [e.g., PCB bulk-product waste under 40 *CFR* § 761.62(b)(1)], then the person may dispose of PCB/radioactive waste, without regard to the PCBs, based on its radioactive properties in accordance with applicable requirements for the radioactive 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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	Must determine whether the waste is characteristic waste (identified in Subpart C of 40 *CFR* Part 261) by using prescribed testing methods or 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 *CFR* §§ 264 and 268.	Generation of RCRA-hazardous waste for storage, treatment or disposal—**applicable**.	40 *CFR* § 264.13(a)(1) 401 *KAR* 34:020 § 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Characterization of industrial wastewater	Industrial wastewater discharges that are point source discharges subject to regulation under § 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 groundwater will be considered equivalent to a wastewater treatment unit and the point source discharges subject to regulation under CWA § 402, provided the effluent meets all identified CWA ARARs.*	Generation of industrial wastewater 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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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* 37:020 § 7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Characterization of PCB Waste	Any person land disposing of non-liquid PCBs may avoid otherwise-applicable sampling requirements by presuming that the PCBs disposed of are ≥ 500 ppm (or ≥100 µg/100 cm2 if no free-flowing liquids are present).	Generation of PCB waste—**applicable.**	40 *CFR* § 761.50(a)(5)														✓	✓	✓	✓	✓	✓
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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste: • physical and chemical characteristics; • volume, including the waste and any stabilization or absorbent media; • weight of the container and contents; • identities, activities, and concentration of major radionuclides; • characterization date; • generating source; and • 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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Waste Storage and Staging																						
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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	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) 401 *KAR* 34:180 § 6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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) 401 *KAR* 34:180 § 6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Temporary tanks and container storage areas used to treat or store hazardous remediation wastes	EPA may replace the design, operating, or closure standards with alternate requirements that protect human health and the environment. A temporary unit must be located within the contiguous property under the control of the owner/operator where the wastes to be managed in the temporary unit originated. *NOTE:* EPA approval of alternate design, operating, or closure requirements for a temporary unit will be obtained by approval of a FFA CERCLA document	Use of temporary tanks and container storage areas to treat or store hazardous remediation wastes during remedial activities—**applicable**.	40 *CFR* § 264.553(a) and (b) 401 *KAR* 34:287				✓			✓	✓			✓			✓	✓	✓	✓	✓	✓
	In establishing standards to be applied to a temporary unit, the following factors shall be considered: • Length of time such unit will be in operation; • Type of unit; • Volumes of wastes to be managed; • Physical and chemical characteristics of the wastes to be managed in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility which may influence the migration of any potential releases; and • Potential for exposure of humans and environmental receptors if releases were to occur from the unit.		40 *CFR* § 264.553(c) 401 *KAR* 34:287				✓			✓	✓			✓			✓	✓	✓	✓	✓	✓
Temporary on-site storage of remediation waste in staging piles (e.g., excavated soils/sediments, sludge)	May be temporarily stored, (including mixing, sizing, blending, or other similar physical operations intended to prepare the wastes for subsequent management or treatment) at a facility if used only during remedial operations provided that the staging pile will be	Accumulation of non-flowing hazardous remediation waste in staging pile (or remediation waste otherwise subject to land disposal restrictions)—**applicable**.	40 *CFR* § 264.554(a)(1) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	• located within the contiguous property under the control of the owner/operator where the wastes to be managed in the staging pile originated.		40 *CFR* § 264.554(a) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	• designed to facilitate a reliable, effective, and protective remedy;		40 *CFR* § 264.554(d)(1)(i) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	• designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer as necessary to protect human health and the environment (e.g., use of liners, covers, run-off/run-on controls, as appropriate).		40 *CFR* § 264.554(d)(1)(ii) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	In determining the design, the following factors must be considered: (i) Length of time the pile will be in operation; (ii) Volumes of wastes intended to be stored in the pile; (iii) Physical and chemical characteristics of the wastes to be stored in the unit; (iv) Potential for releases from the unit; (v) Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and (vi) Potential for human and environmental exposure to potential releases from the unit		40 *CFR* § 264.554(d)(2) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must not place ignitable or reactive remediation waste in a staging pile unless the remediation waste has been treated, rendered, or mixed before placed in the staging pile so that	Storage of ignitable or reactive remediation waste in staging piles in—**applicable**.	40 *CFR* § 264.554(e) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	• The remediation waste no longer meets the definition of ignitable or reactive under 40 *CFR* § 261.21 and §261.23; and		40 *CFR* § 264.554(e)(1)(i) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	• You have complied with 40 *CFR* § 264.17(b), General Requirements for Ignitable, Reactive, or Incompatible Wastes.		40 *CFR* § 264.554(e)(1)(ii) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	Alternatively, instead of meeting the above requirements in 40 *CFR* 264.554(e)(1), the remediation waste may be managed to protect it from exposure to any material or condition that may cause it to ignite or react.		40 *CFR* § 264.554(e)(2) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must not place in the same staging pile unless you have complied with 40 *CFR* § 264.17(b).	Storage of incompatible remediation waste in staging piles in—**applicable**.	40 *CFR* § 264.554(f)(1) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must not pile remediation waste on the same base where incompatible wastes or materials were previously piled, unless the base has been decontaminated sufficiently to comply with 40 *CFR* § 264.17(b).		40 *CFR* § 264.554(f)(3) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must separate the incompatible materials or protect them from one another by using a dike, berm, wall, or other device.	Storage of remediation waste in a staging pile that is incompatible with any waste or material stored nearby in containers, other piles, open tanks or land disposal units (for example, surface impoundments)—**applicable**.	40 *CFR* § 264.554(f)(2) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
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 the 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.		40 *CFR* § 761.65(b)(2)(iii)														✓	✓	✓	✓	✓	✓
	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.																✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Storage of PCB waste and/or PCB/radioactive waste in non-RCRA regulated unit	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 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).	Storage of PCBs and PCB Items at concentrations ≥ 50ppm designated for disposal—**applicable**.	40 *CFR* § 761.65(b)														✓	✓	✓	✓	✓	✓
	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)														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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 ≥ 50ppm 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)														✓	✓	✓	✓	✓	✓
	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)														✓	✓	✓	✓	✓	✓
Storage of PCB/radioactive waste in containers	For liquid wastes, containers must be nonleaking.	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performance standards—**applicable**.	40 *CFR* § 761.65(c)(6) (i)(A)														✓	✓	✓	✓	✓	✓
	For nonliquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 *CFR* § 761.65(b)(1)(ii).		40 *CFR* § 761.65(c)(6) (i)(B)														✓	✓	✓	✓	✓	✓
	For both liquid and nonliquid wastes, containers must meet all substantive requirements pertaining to nuclear criticality safety. Acceptable container materials include polyethylene and stainless steel provided that the container material is chemically compatible with the waste being stored. Other containers may be used if the use of such containers is protective of health and the environment as well as public health and safety.		40 *CFR* § 761.65(c)(6) (i)(C)														✓	✓	✓	✓	✓	✓
Temporary storage of bulk PCB remediation waste or PCB bulk product waste in a waste pile	May be stored at the clean-up site or site of generation subject to the following conditions: • waste must be placed in a pile designed and operated to control dispersal by wind, where necessary, by means other than wetting; • waste must not generate leachate through decomposition or other reactions.	Storage of PCB remediation waste or PCB bulk product waste in a waste pile—**applicable**.	40 *CFR* § 761.65(c)(9) (i) 40 *CFR* § 761.65(c)(9) (ii)														✓	✓	✓	✓	✓	✓
	Storage site must have a liner designed, constructed, and installed to prevent any migration of wastes off or through liner into adjacent subsurface		40 *CFR* § 761.65(c)(9) (iii)(A)														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	soil, groundwater or surface water at any time during the active life (including closure period) of the storage site.																					
	Liner must be: • constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure because of pressure gradients, physical contact with waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;		40 *CFR* § 761.65(c)(9) (iii)(A)(*1*)														✓	✓	✓	✓	✓	✓
	• placed on foundation or base capable of providing support to liner and resistance to pressure gradients above and below the liner to present failure because of settlement compression or uplift;		40 *CFR* § 761.65(c)(9) (iii)(A)(*2*)														✓	✓	✓	✓	✓	✓
	• installed to cover all surrounding earth likely to be in contact with waste.		40 *CFR* § 761.65(c)(9) (iii)(A)(*3*)														✓	✓	✓	✓	✓	✓
	Waste pile must have a cover that meets the above requirements and installed to cover all of the stored waste likely to be contacted by precipitation, and is secured so as not to be functionally disabled by winds expected under normal weather conditions at the storage site; and	Storage of PCB remediation waste or PCB bulk product waste in a waste pile—**applicable**.	40 *CFR* § 761.65(c)(9) (iii)(B)														✓	✓	✓	✓	✓	✓
	Waste pile must have a run-on control system designed, constructed, operated and maintained such that: • It prevents flow on the stored waste during peak discharge from at least a 25-year storm; • It collects and controls at least the water volume resulting from a 24-hour, 25-year storm. Collection and holding facilities (e.g., tanks or basins) must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.		40 *CFR* § 761.65(c)(9) (iii)(C) 40 *CFR* § 761.65(c)(9) (iii)(C)(*1*) 40 *CFR* § 761.65(c)(9) (iii)(C)(*2*)														✓	✓	✓	✓	✓	✓
	Requirements of 40 *CFR* § 761.65(c)(9) may be modified under the risk-based disposal option of 40 *CFR* § 761.61(c).		40 *CFR* § 761.65(c)(9) (iv)														✓	✓	✓	✓	✓	✓
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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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 and noncorrosive liquid as is reasonably achievable. The liquid shall not exceed one (1) percent of the volume.	Preparation of solid LLW containing liquid 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)(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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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																						
Transport or conveyance of collected RCRA wastewater to a WWTU 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 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 unit (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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Release of property with residual radioactive material	Residual Radioactive Material. Property potentially containing residual radioactive material must not be cleared from DOE control unless either: A. The property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or B. The property is evaluated and appropriately monitored or surveyed to determine: 1. The types and quantities of residual radioactive material within the property; 2. The quantities of removable and total residual radioactive material on property surfaces (including residual radioactive material present on and under any coating); 3. That for property with potentially contaminated surfaces that are difficult to access for radiological monitoring or surveys, an evaluation of residual radioactive material on such surfaces is performed which is: a. Based on process and historical knowledge meeting the requirements of paragraph 4.k.(5) of this Order and monitoring and or surveys, to the extent feasible and b. Sufficient to demonstrate that applicable specific or pre-approved DOE Authorized Limits will not be exceeded; and 4. That any residual radioactive material within or on the property is in compliance with applicable specific or pre-approved DOE Authorized Limits.	Generation of DOE materials and equipment with residual radioactive contamination—**TBC**.	DOE O 458.1 § 4.k(3)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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)				✓										✓		✓			✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Disposal of a restricted RCRA hazardous waste soil in a land based unit	Prior to land disposal, all "constituents subject to treatment" as defined in 40 *CFR* § 268.49(d) must be treated as follows.	Land disposal, as defined in 40 CFR 268.2 of restricted hazardous waste soils—**applicable**.	40 *CFR* § 268.49(c)(1) 401 *KAR* 37:040 § 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	For non-metals (except carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations, except as provided in 40 *CFR* § 268.49(c)(1)(C).		40 *CFR* § 268.49(c)(1)(A) 401 *KAR* 37:040 § 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	For metals and carbon disulfide, cyclohexanone, and methanol), treatment must achieve a 90 percent reduction in total constituent concentrations as measured in leachate from the treated media (tested according to TCLP) <u>or</u> 90 percent reduction in total constituent concentrations (when a metal removal technology is used), except as provided in 40 *CFR* § 268.49(c)(1)(C).		40 *CFR* § 268.49(c)(1)(B) 401 *KAR* 37:040 § 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	When treatment of any constituent subject to treatment to a 90 percent reduction standard would result in a concentration less than 10 times the Universal Treatment Standard for that constituent, treatment to achieve constituent concentrations less than 10 times the universal treatment standard is not required. [Universal Treatment Standards (UTS) are identified in 40 *CFR* § 268.48 Table UTS].		40 *CFR* § 268.49(c)(1)(C) 401 *KAR* 37:040 § 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	In addition to the treatment requirement required by paragraph (c)(1) of 40 *CFR* § 268.49, soils must be treated to eliminate these characteristics.	Land disposal, as defined in 40 *CFR* § 268.2 of soils that exhibit the hazardous characteristic of ignitability, corrosivity, or reactivity—**applicable**.	40 *CFR* § 268.49(c)(2) 401 *KAR* 37:040 § 10	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Disposal of RCRA hazardous waste soil in a land-based unit	Must be treated according to the alternative treatment standards of 40 *CFR* § 268.49(c) <u>or</u> 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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Disposal of RCRA characteristic wastewaters in an NPDES permitted wastewater treatment unit	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 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 <u>or</u> 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 treated hazardous debris	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 *CFR* § 268.45 and which no longer exhibits a characteristic is not a hazardous waste and need not be managed in RCRA Subtitle C facility. Hazardous debris contaminated with listed waste that is treated by immobilization technology must be managed in a RCRA Subtitle C facility.	Treated debris contaminated with RCRA-listed or characteristic waste—**applicable**.	40 *CFR* § 268.45(c) 401 *KAR* 37:040 § 7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Disposal of hazardous debris treatment residues	Except as provided in 268.45(d)(2) and (d)(4), must be separated from debris by simple physical or mechanical means, and such residues are subject to the waste-specific treatment standards for the waste contaminating the debris.	Residue from treatment of hazardous debris —**applicable**.	40 *CFR* § 268.45(d)(1) 401 *KAR* 37:040 § 7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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; • in a hazardous waste landfill permitted by a State authorized under §3006 of RCRA; or • in a PCB disposal facility approved under 40 *CFR* § 761.60.	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)*														✓	✓	✓	✓	✓	✓
Disposal of PCB-contaminated nonporous surfaces on-site	• Decontamination procedures under 40 *CFR* § 761.79, • Technologies approved under 40 *CFR* § 761.60(e), or • Risk-based procedures/technologies under 40 *CFR* § 761.61(c).	PCB remediation waste porous surfaces as defined in 40 *CFR* § 761.3 for on-site disposal—**applicable**.	40 *CFR* § 761.61(a)(5) (ii)(A)														✓	✓	✓	✓	✓	✓
Disposal of PCB-contaminated nonporous surfaces off-site	Shall be disposed of in accordance with 40 *CFR* § 761.61(a)(5)(i)(B)(3)(ii) [sic] 40 *CFR* § 761.61(a)(5)(i)(B)(2)(ii). Metal surfaces may be thermally decontaminated in accordance with 40 *CFR* § 761.79(c)(6)(i).	PCB remediation waste nonporous surfaces as defined in 40 *CFR* § 761.3 having surface concentrations < 100 µg/100 cm^2 for off-site disposal—**applicable**.	40 *CFR* § 761.61(a)(5) (ii)(B)(1)														✓	✓	✓	✓	✓	✓
	Shall be disposed of in accordance with 40 *CFR* § 761.61(a)(5)(i)(B)(3)(iii) [sic] [40 *CFR* § 761.61(a)(5)(i)(B)(2)(iii)]. Metal surfaces may be thermally decontaminated in accordance with 40 *CFR* § 761.79(c)(6)(ii).	PCB remediation waste nonporous surfaces having surface concentrations ≥ 100 µg/100 cm^2 for off-site disposal—**applicable**.	40 *CFR* § 761.61 (a)(5)(ii)(B) (2)														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Disposal of PCB-contaminated porous surfaces	Shall be disposed on-site or off-site as bulk PCB-remediation waste according to 40 *CFR* § 761.61(a)(5)(i) or decontaminated for use according to 40 *CFR* § 761.79(b)(4).	PCB remediation waste porous surfaces (as defined in 40 *CFR* § 761.3)—**applicable**.	40 *CFR* § 761.61(a)(5)(iii)														✓	✓	✓	✓	✓	✓
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)—**applicable**.	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)														✓	✓	✓	✓	✓	✓
Disposal of PCB cleanup wastes (e.g., PPE, rags, non-liquid cleaning materials) (self-implementing)	Shall be either decontaminated in accordance with 40 *CFR* § 761.79((b) or (c), or disposed of in one of the following facilities: • a facility permitted, licensed or registered by a State to manage municipal solid waste under 40 *CFR* § 258; • a facility permitted, licensed, or registered by a State to manage non-municipal non-hazardous waste subject to 40 *CFR* § 257.5 thru 257.30, as applicable; or • a hazardous waste landfill RCRA permitted by EPA under Section 3004 of RCRA, or a state authorized under Section 3006 of RCRA; or • in a PCB disposal facility approved under 40 *CFR* § 761; or *NOTE*: or otherwise authorized under CERCLA	Generation of non-liquid cleaning materials at any PCB concentration resulting from the cleanup of PCB remediation waste—**applicable**.	40 *CFR* § 761.61(a)(5)(v)(A)														✓	✓	✓	✓	✓	✓
Reuse of PCB cleaning solvents, abrasives and equipment	May be reused after decontamination under 40 *CFR* § 761.79.	Generation of PCB wastes from the cleanup of PCB remediation waste—**applicable**.	40 *CFR* § 761.61(a)(5)(v)(B)														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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); • 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	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)														✓	✓	✓	✓	✓	✓
	• • through decontamination in accordance with 40 *CFR* § 761.79.		40 *CFR* § 761.61(b)(2)(ii)														✓	✓	✓	✓	✓	✓
	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 decontamination waste and residues	Such waste shall be disposed of at their existing PCB concentration unless otherwise specified in 40 *CFR* § 761.79(g)(1-6).	PCB decontamination waste and residues—**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 DOE facility—**TBC**.	DOE M 435.1-1(IV)(J)(2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discharge of Treated Water to Surface Water																						
General duty to mitigate for discharge of wastewater from groundwater treatment system	Take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of effluent standards which has a reasonable likelihood of adversely affecting human health or the environment.	Discharge of pollutants to surface waters—**applicable**.	401 *KAR* 5:065 § 2(1) 40 *CFR* §122.41(d)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Operation and maintenance of treatment system	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 adequate laboratory controls and appropriate quality assurance procedures.	Discharge of pollutants to surface waters—**relevant and appropriate**.	401 *KAR* 5:065 § 2(1) 40 *CFR* § 122.41(e)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Technology-based treatment requirements for wastewater discharge	To the extent that EPA promulgated effluent limitations are inapplicable, shall develop on a case-by-case Best Professional Judgment (BPJ) basis under § 402(a)(1)(B) of the CWA, technology based effluent limitations by applying the factors listed in 40 *CFR* § 125.3(d) and shall consider: • The appropriate technology for this category or class of point sources, based upon all available information; and • Any unique factors relating to the discharger.	Discharge of pollutants to surface waters from other than a POTW—**applicable**.	40 *CFR* § 125.3(c)(2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quality-based effluent limits for wastewater discharge	Must develop water quality based effluent limits that ensure that: • The level of water quality to be achieved by limits on point source(s) established under this paragraph is derived from, and complies with all applicable water quality standards; and • Effluent limits developed to protect narrative or numeric water quality criteria are consistent with the assumptions and any available waste load allocation for the discharge prepared by the State and approved by EPA pursuant to 40 *CFR* § 130.7.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard established under § 303 of the CWA—**applicable**.	40 *CFR* § 122.44(d)(1)(vii) 401 *KAR* 5:065 § 2(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Must attain or maintain a specified water quality through water quality related effluent limits established under § 302 of the CWA.	Discharge of pollutants to surface waters that causes, or has reasonable potential to cause, or contributes to an instream excursion above a narrative or numeric criteria within a State water quality standard—**applicable**.	40 *CFR* § 122.44(d)(2) 401 *KAR* 5:065 § 2(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	If a discharge causes, has the reasonable potential to cause, or contribute to an in-stream excursion above the numeric criterion for whole effluent toxicity using the procedures in paragraph (d)(1)(ii), must develop effluent limits for whole effluent toxicity.	Discharge of wastewater that causes, has the reasonable potential to cause, or contributes to an in-stream excursion above the numeric criterion for whole effluent toxicity**—applicable**.	40 *CFR* § 122.44(d)(1)(iv) 401 *KAR* § 5:065 2(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monitoring requirements for groundwater treatment system discharges	In addition to 40 *CFR* §122.48(a) and (b) and to assure compliance with effluent limitations, one must monitor, as provided in subsections (i) thru (iv) of 122.44(i)(1). *NOTE:* Monitoring parameters, including frequency of sampling, will be developed as part of the CERCLA process and included in a Remedial Design, RAWP, or other appropriate FFA CERCLA document.	Discharge of pollutants to surface waters—**applicable**.	40 *CFR* § 122.44(i)(1) 401 *KAR* § 5:065 2(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR.WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	All effluent limitations, standards, and prohibitions shall be established for each outfall or discharge point, except as provided under § 122.44(k).		40 *CFR* § 122.45(a) 401 *KAR* § 5:065 2(5)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	All effluent limitations, standards and prohibitions, including those necessary to achieve water quality standards, shall unless impracticable be stated as: • Maximum daily and average monthly discharge limitations for all discharges.	Continuous discharge of pollutants to surface waters—**applicable**.	40 *CFR* § 122.45(d)(1) 401 *KAR* § 5:065 2(5)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mixing zone requirements for discharge of pollutants to surface water	The relevant requirements provided in 401 *KAR* 10:029 § 4 shall apply to a mixing zone for a discharge of pollutants. *NOTE*: Determination of the appropriate mixing zone will, if necessary, involve consultation with KDEP and will be documented in the CERCLA Remedial Design or other appropriate FFA CERCLA document.	Discharge of pollutants to surface waters of the Commonwealth [*Bayou Creek*]—**applicable**.	401 *KAR* 10:029 § 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Surface Water Standards	Table 1 of 401 *KAR* 10:031 § 6(1) provides allowable instream concentrations of pollutants that may be found in surface waters or discharged into surface waters.	Discharge of pollutants to surface waters of the Commonwealth designated as *Warm Water Aquatic Life Habitat*—**applicable**.	401 *KAR* 10:031 § 6(1)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Effluent limits for radionuclides in wastewater	Shall not exceed the limits for radionuclides listed on Table II – Effluent Limitations.	Discharge of wastewater with radionuclides from an NRC. Agreement State licensed facility into surface waters—**relevant and appropriate**.	902 *KAR* 100:019 § 44 (7)(a)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Conduct activities to ensure that liquid discharges containing radionuclides from DOE activities do not exceed an annual average (at the point of discharge) of either of the following: (a) 5 pCi (0.2 Bq) per gram above background of settleable solids for alpha-emitting radionuclides. (b) 50 pCi (2 Bq) per gram above background of settleable solids for beta-emitting radionuclides.	Discharge of radioactive concentrations in sediments to surface water from a DOE facility—**TBC**.	DOE O 458.1 §4.g(4)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Decontamination/Cleanup																						
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)														✓	✓	✓	✓	✓	✓
	For unrestricted use, meet standard of 0.5 ppb PCBs.		40 *CFR* § 761.79(b)(1)(iii)														✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Decontamination of PCB-contaminated liquids	Meet standard of < 2 ppm PCBs.	Organic liquids and nonaqueous inorganic liquids containing PCBs—**applicable**.	40 *CFR* § 761.79(b)(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.	Decontaminating a PCB Container as defined in 40 *CFR* § 761.3—**applicable**.	40 *CFR* § 761.79(c)(1)														✓	✓	✓	✓	✓	✓
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.	Decontaminating movable equipment contaminated by PCB, tools and sampling equipment—**applicable**.	40 *CFR* § 761.79(c)(2)														✓	✓	✓	✓	✓	✓
Decontamination of metal surfaces in contact with PCBs	For surfaces in contact with liquid or non-liquid PCBs < 500 ppm, may be decontaminated in an industrial furnace for purposes of disposal in accordance with 40 *CFR* § 761.72.	Use of thermal processes to decontaminate metal surfaces, as required by 40 *CFR* § 761.61 (a)(6)—**applicable**.	40 *CFR* § 761.79 (c)(6)(i)														✓	✓	✓	✓	✓	✓
	For surfaces in contact with liquid or non-liquid PCBs ≥ 500 ppm, may be smelted in an industrial furnace operating in accordance with 40 *CFR* § 761.72(b), but must first be decontaminated in accordance with 40 *CFR* § 761.72(a) or to a surface concentration of < 100 µg/100 cm^2.		40 *CFR* § 761.79 (c)(6)(ii)														✓	✓	✓	✓	✓	✓
Unit Closure																						
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • Minimizes the need for further maintenance; • Controls minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • Complies with the closure requirements of part G, but not limited to, the requirements of 40 *CFR* § 264.178 for containers.	Storage of RCRA hazardous waste in containers—**applicable**.	40 *CFR* § 264.111 401 *KAR* 34:070 § 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 *CFR* § 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit with a containment system—**applicable**.	40 *CFR* § 264.178 401 *KAR* 34:180 § 9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Closure of staging piles of remediation waste	Must be closed by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate.	Storage of remediation waste in staging pile located in previously contaminated area—**relevant and appropriate**.	40 *CFR* § 264.554(j)(1) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must decontaminate contaminated sub-soils in a manner that will protect human and the environment.		40 *CFR* § 264.554(j)(2) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
	Must be closed according to substantive requirements in 40 *CFR* § 264.258(a) and 264.111.	Storage of remediation waste in staging pile located in uncontaminated area—**relevant and appropriate**.	40 *CFR* § 264.554(k) 401 *KAR* 34:287 § 5														✓	✓	✓	✓	✓	✓
Clean closure of TSCA storage facility	A TSCA/RCRA storage facility closed under RCRA is exempt from the TSCA closure requirements of 40 *CFR* § 761.65(e).	Closure of TSCA/RCRA storage facility—**relevant and appropriate**.	40 *CFR* § 761.65(e)(3)														✓	✓	✓	✓	✓	✓
Waste Transportation																						
Transportation of samples (i.e., contaminated soils and wastewaters)	Are not subject to any requirements of 40 *CFR* Parts 261 through 268 or 270 when: • The sample is being transported to a laboratory for the purpose of testing; or • The sample is being transported back to the sample collector after testing.	Samples of solid waste <u>or</u> a sample of water, soil for purpose of conducting testing to determine its characteristics or composition—**applicable**.	40 *CFR* § 261.4(d)(1)(i) and (ii) 401 *KAR* 31:010 § 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements. • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 *CFR* § 261.4(d)(2)(i) 401 *KAR* 31:010 § 4 40 *CFR* § 261.4(d)(2)(i)(A) 401 *KAR* 31:010 § 4 40 *CFR* § 261.4(d)(2)(i)(B) 401 *KAR* 31:010 § 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table F.2. Action-Specific ARARs and TBC Guidance for BGOU FS—SWMUs 2, 3, 7, and 30 (Continued)

Action	Requirement	Prerequisite	Citation	Alt 2	Alt 3.a or 3.b	Alt 3.d	Alt 4.b.t1	Alt 4.b.t3	Alt 4.b.t4	Alt 4.c.t1	Alt 4.c.t2	Alt 4.c.t3	Alt 4.c.t4	Alt 4.d.t1	Alt 4.d.t3	Alt 4.d.t4	Alt 5 or 5.WDF	Alt 5.CR or 5.CR. WDF	Alt 6.b.CR	Alt 6.c.CR	Alt 6.d.CR	Alt 7.c.t2.CR
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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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 HMR [i.e., *Transportation Safety Document for On-Site Transport within the Paducah Gaseous Diffusion Plant*, PRS-WSD-0661 (PRS 2007b)].	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)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
BAT = best available technology
BMP = Best Management Practices
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR = *Code of Federal Regulations*
CR = contingent remedy includes LUCs and monitoring
CWA = Clean Water Act
DCG = Derived Concentration Guide
DOE = U.S. Department of Energy
DOE M = DOE Manual
DOE O = DOE Order
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
E.O. = Executive Order
EPA = U.S. Environmental Protection Agency
FFA = federal facility agreement
HAP = hazardous air pollutant
HMR = Hazardous Material Regulations
KAR = *Kentucky Administrative Regulations*
KPDES = Kentucky Pollutant Discharge Elimination System
LDR = land disposal restrictions
LLW = low-level (radioactive) waste
mrem = millirem
NAAQS = National Ambient Air Quality Standards
NESHAP = National Emissions Standards for Hazardous Air Pollutant
NRC = Nuclear Regulatory Commission
NSPR = New Source Performance Standards
NSR = new source review
NWP = Nationwide Permits
PCB = polychlorinated biphenyl
PGDP = Paducah Gaseous Diffusion Plant
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act
SWMU = solid waste management unit
TBC = to be considered
TCLP = Toxicity Characteristic Leaching Procedure
TOC = total organic compound
TSCA = Toxic Substances Control Act
UTS = Universal Treatment Standards
VOC = Volatile organic compound
VOHAP = volatile organic hazardous air pollutant
WAC = waste acceptance criteria
WDF= potential on-Site Waste Disposal Facility
WWTU = wastewater treatment unit

Surface Cover
a. 1-ft soil cover, configured to drain
b. 18-inch local clay/6-inch soil
c. Subtitle C equivalent
d. Subtitle D equivalent

** Treatment Options [also CR except t2]
t1. ERH
t2. DPE
t3. ZVI injection
t4. bio

*** Existing Features
t5. Subtitle C cap and leachate collection and treatment system (SWMU 3)
t6. Northwest Plume Pump-and-Treat System (SWMUs 7 and 30)

APPENDIX G

SWMU 3 RCRA POST-CLOSURE PERMIT CONDITIONS SUMMARY

(The following is a historical document reprinted in its original format. Pagination and formatting from original document retained.)

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APPENDIX I-2

C-404 LANDFILL POST CLOSURE PLAN

1. POSTCLOSURE CARE PLAN C-404 LANDFILL

This plan identifies all steps that will be necessary for the U.S. Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP) to perform postclosure care meeting requirements of 401 *KAR* 34:070, Section 8 (incorporating 40 *CFR* § 264.117) at the C-404 Landfill. The C-404 Landfill began postclosure care under the permit issued in 1992 and will continue for a minimum of 30 years after landfill closure.

The C-404 Low-Level Radioactive Burial Ground is located in the west-central portion of the security-fenced area of PGDP. The C-404 unit originally was constructed in the early 1950s as a rectangular aboveground surface impoundment with a floor area of approximately 53,000 ft^2 (387 ft by 137 ft). The floor of the surface impoundment was constructed of well-tamped earth, and clay dikes provide liquid containment to an operating depth of 6 ft. From 1952 through 1957, the surface impoundment was operated as a neutralization/sedimentation treatment facility for uranium-contaminated waste water generated at the C-400 decontamination facility. From 1957 through 1976, the impoundment was used for the bulk disposal of uranium-contaminated solid waste. The surface impoundment thus was filled with bulk solid wastes to within 1–2 ft of the top of the original dikes. The facility then was covered with compacted earth to the top of the original dikes and sloped to facilitate runoff. The exit weir was converted to an enclosed concrete basin for use as a leachate collection sump.

In 1977, bulk and containerized uranium-contaminated solid wastes were placed on top of the previously filled area. These wastes were then covered with earth. In 1983, the eastern quarter of the site was covered with a clay cap that extends over the out-slope of the dike. One of the types of containerized solid wastes disposed of in the upper portion of the facility was gold dissolver precipitate, a solid waste containing no free liquid. During a routine testing program, the gold dissolver precipitate disposed of in early 1986 was found to be hazardous based upon the Extraction Procedure Toxicity. The C-404 Landfill subsequently was closed by placement of a final cover over the facility.

Postclosure use of the C-404 Landfill never will be allowed to disturb the integrity of the final cover, liner(s), or any other component of the containment system or the function of the facility's monitoring systems, unless the disturbance is necessary and 1) will not increase the potential hazard to human health or the environment or 2) is necessary to reduce a threat to human health or the environment. Access to the landfill will be restricted and maintained through existing security measures including checkpoints, fences, and postings.

1.1 GENERAL FACILITY INSPECTION AND MAINTENANCE

The primary objective of routine inspection is to identify potential problems at an early stage prior to the need for significant maintenance. General facility inspections will be performed on security fences, gates, locks, and HWFP required warning signs quarterly, as applicable. Possible problems may include deterioration, erosion, frost heaves of fence post anchors, normal wear, or vandalism. Maintenance activities may include erosion or sediment control and the repair or replacement of damaged fences, locks, or warning signs.

1.1.1 Landfill Cover

As described in the C-404 Closure Plan, the synthetic liner and vegetative cover installed on the C-404 Landfill is designed to minimize maintenance requirements. The cover shall be inspected quarterly and following any major precipitation event approaching or exceeding a 24-hour, 25-year storm (5.8 inches within 24-hours). The cover will be inspected for surface cracks, erosion, depressions or subsidence, damage to cover by burrowing animals, vegetative stress, or any other factors that might adversely affect proper functioning of the vegetative and landfill cover.

The vegetative cover shall be mowed regularly during the active growing season to discourage the growth of weeds, competitive species, or deep-rooted vegetation. Since C-404 has been designated a radiological contaminated area, mowing will be conducted in such a way as to prevent airborne contaminants.

Damage to the cover by erosion greater than 6-inches deep will be repaired by restoring the cover to its original grade with soil and reseeding. Differential settlement or subsidence will be repaired by restoring the site to its original grade with soil and reseeding. Other repairs, such as eradicating burrowing animals, will be performed as necessary.

1.1.2 Cover Drainage System

The synthetic liner is anchored using a French-type drainage system. Construction details are described in the C-404 Closure Plan. The area surrounding the C-404 Landfill will be inspected quarterly and following any precipitation event approaching or exceeding a 24-hour, 25-year storm (5.8 inches within 24-hours). The area will be inspected for washouts or depressions, which could indicate that the system is plugged or that the drainage pipe has ruptured or collapsed. Drainage pipe failures shall be repaired by removing the failed piece, installing a new section, and replacing the fill material as necessary.

The drain exits shall be monitored following one rainfall event each quarter to check for unusual flow or lack of discharge.

1.2 OPERATION OF THE LEACHATE COLLECTION SYSTEM

The leachate collection system shall be maintained until leachate no longer is generated by the landfill. The quantity of liquid in the leachate collection system shall be monitored at least monthly. Preparation to remove the leachate shall begin when the depth of leachate in the sump exceeds 3 ft. The removed leachate shall be sampled and analyzed for the parameters in Table 1. The results of the leachate analysis will be reviewed prior to proper disposal. Sampling and analytical procedures shall be conducted according to Part C, Waste Analysis Plan, of the HWFP application.

Table 1. List of C-404 Leachate Characterization Analytes

Mercury	Fluoride
Arsenic	Ammonia Nitrate
Selenium	pH
Silver	Trichloroethylene
Barium	Neptunium 237
Cadmium	Technetium 99
Chromium	Thorium 230
Copper	Uranium 234
Iron	Uranium 235
Nickel	Uranium 238
Lead	Plutonium 239
Zinc	

The leachate shall be pumped to a portable tank(s) and stored awaiting appropriate treatment and/or disposition. The leachate collection pit will be inspected quarterly including when the leachate is removed for any major structural deterioration. Cracks and other damage will be repaired as necessary. A leachate sump integrity test will be conducted annually.

1.3 MAINTENANCE OF THE LEAK DETECTION SYSTEM

The C-404 Landfill does not have a leak detection system.

1.4 MAINTAIN AND OPERATE THE GROUNDWATER MONITORING SYSTEM

All groundwater monitoring wells at C-404 will be inspected annually during the third quarter of the calendar year. The wells will be inspected for the condition of the AKGWA identification, the outer casing, the concrete pad, the bumper posts, painting, the well cap, the lettering and numbers, lock and hasp, well access, vegetation control, and well fittings and tubing. Items will be repaired as necessary.

The wells will be inspected annually for excessive sedimentation by performing a depth sounding at each monitoring well.

1.5 RUN ON AND RUNOFF CONTROL SYSTEM

Run on and runoff control is provided by a series of ditches surrounding the C-404 Landfill. This system is discussed in detail in the C-404 Closure Plan. These ditches shall be inspected quarterly and following any major precipitation event approaching or exceeding a 24-hour, 25-year storm (5.8-inches in 24-hours) for obstructions such as debris, excessive sediment, erosion, or any deterioration that might adversely affect the drainage from the landfill cover. Repairs or maintenance may include removal of accumulated debris, sediment, and restoration of the ditch to the original grade. Ditches will be reseeded or additional gravel placed as needed.

1.6 PROTECT AND MAINTAIN SURVEY BENCHMARKS

Benchmarks have been permanently installed at the groundwater monitoring wells. Benchmarks will be inspected annually with the groundwater monitoring wells, and new benchmarks will be installed if necessary.

1.7 RECORDKEEPING AND REPORTING

Inspection records will be recorded on an inspection log or summary. The records will include the date and time of inspection, the name of the inspector, a notation of the observation, and the date and nature of any repairs. Inspection records will be maintained for three years from the date of inspection. Records concerning the operation of the leachate system, including inspection, leachate removal volumes, damage assessment, and repairs undertaken, will be maintained at the facility during the postclosure care period and available for inspection by Kentucky Division of Waste Management (KDWM.)

The annual groundwater flow rate and direction shall be submitted by November 30 of each year of the postclosure period. Analytical results of leachate sampling will be submitted to the KDWM along with semiannual groundwater sampling results. Copies of these groundwater reports, containing analytical data, will be maintained for inspection at the facility.

All Resource Conservation and Recovery Act permitted treatment and storage facilities at the PGDP are owned by DOE. The DOE point of contact during the postclosure care period is as follows.

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

1.8 EXAMPLE INSPECTION FORMS

Attached are examples of the inspection forms that will be used for C-404 inspections.

C-404 Monthly Inspection Summary[1]

Period of Inspection: ______________________________

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination			
Second monthly leachate level determination			
Third monthly leachate level determination			

* If the leachate level in the sump is at **3 feet (36 inches)**, then contact the appropriate personnel to initial removal and sampling of leachate AND when leachate is removed, complete the "**C-404 Inspection Checklist for Leachate Removal**."

Notes:

1. If any item is found to be unacceptable and cannot be explained in the space available, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.

C-404 Quarterly Inspection Checklist[1]

Item No.	Inspection Item	Item Description	Inspection Results A	Inspection Results U	Comments/Observations
A	Warning Signs	Four signs around landfill			
B	Vegetative Cover	Gully erosion depth > 6 inches			
		Vegetative die-off			
		Varmint intrusion/burrowing from animals			
		Overgrowth			
		Depressions			
C	Ditches	Debris in ditches			
		Excessive sediment			
		Drainage			
		Erosion			
D	Anchor Trench	Washouts or depressions			
		Lack of discharge			
		Unusual volume or color			
		Drainage (4 drains from landfill)			
E	Leachate System	Level			
		Cracks or damage			

Inspector: ______________________ (Printed Name)	Signature: ______________________ Date:______________Time:__________

A=Acceptable
U=Unacceptable

Notes:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.

C-404 Annual Inspection Checklist[1,2,3]

Item No.	Inspection Item	Item Description	Inspection Results		Comments
			A	U	
A	Wells	Attach well inspection form			
B	Leachate Pit	Interior malformations			
		Exterior malformations			
		Integrity test (attach data)			

Inspector: ______________________________
(Printed Name)

Signature: ______________________

Date: ______________ Time: __________

A=Acceptable
U=Unacceptable

Notes:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. Annual inspection performed during the third quarter of the calendar year.
3. For the integrity test of the leachate pit during the annual inspection, data from the datalogger is downloaded electronically and printed annually, and the attached to the annual inspection checklist for maintaining in the file.

C-404 Inspection Checklist for a 24-Hour Rain Event[1]

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Vegetative Cover	Gully erosion depth > 6 inches			
		Vegetative die-off			
		Varmint intrusion/burrowing from animals			
		Overgrowth			
		Depressions			
B	Ditches	Debris in ditches			
		Excessive sediment			
		Drainage			
		Erosion			
C	Anchor Trench	Washouts or depressions			
		Lack of discharge			
		Unusual volume or color			
		Drainage (4 drains from landfill)			
Inspector:________________ (Printed Name)			Signature: ________________ Date:__________ Time:__________		

A=Acceptable
U=Unacceptable

Notes:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.

C-404 Inspection Checklist for Leachate Removal[1,2]

Leachate Removal Inspection	YES	NO	N/A	Date (M/D/YY)	Volume (gallons)
Was any removal necessary during the quarter?					
Has any leachate removed during the quarter been sampled?					
Date of superficial inspection upon removal of leachate.					
Date of sampling of leachate after removal.					

Item No.	Inspection Item	Item Description	Inspection Results		Comments
			A	U	
A	Leachate Pit	Interior malformations			
		Exterior malformations			

Inspector: ______________________ (Printed Name)	Signature: ______________________ Date:______________Time:____________

A=Acceptable
U=Unacceptable

Notes:

1. This form is completed if the leachate level in the sump is at **3 feet (36 inches)** and is being removed.

2. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.

C-404 Inspection Addendum

Date	Item No.	Observation	Repairs Completed

INSPECTIONS FORM

Inside

SAMPLE POINT :
Location: C-404 Landfill
AKGWA Number:

	Accept	Reject	N/A
AKGWA Number Tag	☐	☐	☐
Stamped AKGWA Number	☐	☐	☐
Outer Casing	☐	☐	☐
Concrete Pad	☐	☐	☐
Bumper Post	☐	☐	☐
Painting	☐	☐	☐
Cap	☐	☐	☐
Road Access	☐	☐	☐
Brush/Weed eating/Mowing	☐	☐	☐
Fittings/Tubing/Pump Repair	☐	☐	☐
Lettering/Numbers	☐	☐	☐
Lock and Hasp	☐	☐	☐

Comments:

Signature: ______________________ Time: __________ Date: ______________