Revised Proposed Plan for Solid Waste Management Units 1, 211A, 211B, and Part of 102 Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

February 2011

INTRODUCTION

The U.S. Department of Energy (DOE) is conducting cleanup activities at the Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky, to address contamination resulting from past waste-handling and disposal practices at the plant. As part of these cleanup activities, DOE, the U.S. Environmental Protection Agency (EPA), and the Commonwealth of Kentucky Energy and Environment Cabinet (KEEC) request public review and comment on this Proposed Plan (PP) for trichloroethene (TCE) sources to the Southwest Plume. DOE is the lead agency for conducting this action, and EPA and KEEC are supporting regulatory agencies providing oversight. This PP was developed consistent with the PGDP Federal Facility Agreement (FFA).

The Groundwater Operable Unit (OU) scope includes the Southwest Plume TCE sources in subsurface soil at both the Oil Landfarm and the C-720 Building areas.

The Southwest Plume consists of groundwater in the Regional Gravel Aquifer (RGA) contaminated primarily with TCE, a volatile organic compound (VOC), and is located within the DOE property, west of the C-400 Building and south of the larger groundwater contamination area identified as the Northwest Plume (Figure 1). This PP presents the Preferred Alternatives for remediation of VOCs in the Upper Continental Recharge System (UCRS) subsurface soils at Solid Waste Management Unit (SWMU) 1, Oil Landfarm, and the C-720 Building TCE Northeast Spill Site and Southeast Spill Site (SWMU 211A and 211B). These sites are sources of contamination to the Southwest Plume.

The basis for this decision is documented in the "Revised Focused Feasibility Study for Solid Waste Management Units 1, 211A, and 211B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky," DOE/LX/07-0362&D1, dated January 2011 (hereafter referred to as the Revised FFS) and the "Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky," DOE/OR/07-2180&D2/R1, dated June 2007 [hereafter referred to as the Site Investigation (SI) Report]. The SI Report also included a discussion of a storm sewer (part of SWMU 102) leading from the C-400 Building to Outfall 008 (Figure 2) thought to be a possible TCE source. The SI Report concluded that the storm sewer was not a source of TCE contamination; therefore, no further action is proposed for that area. This PP presents the Preferred Alternatives for SWMU 1 and for SWMUs 211A and 211B. ***Preferred Alternative 8—In Situ Source***

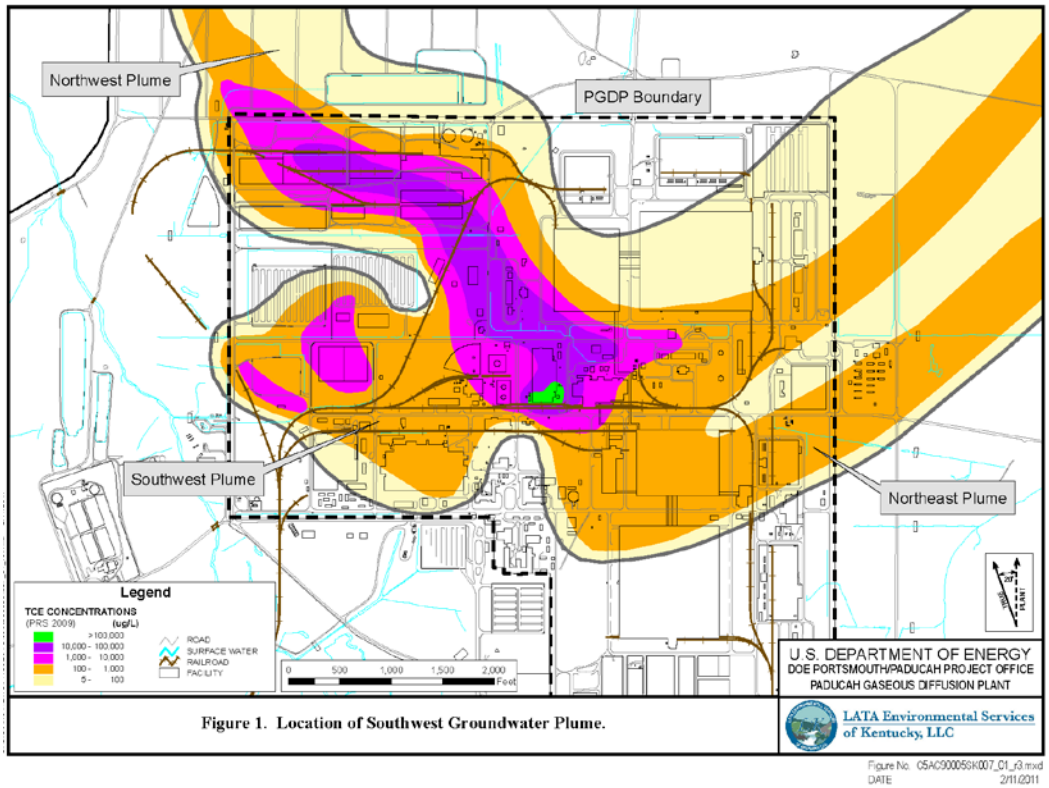

Figure 1. Location of Southwest Groundwater Plume

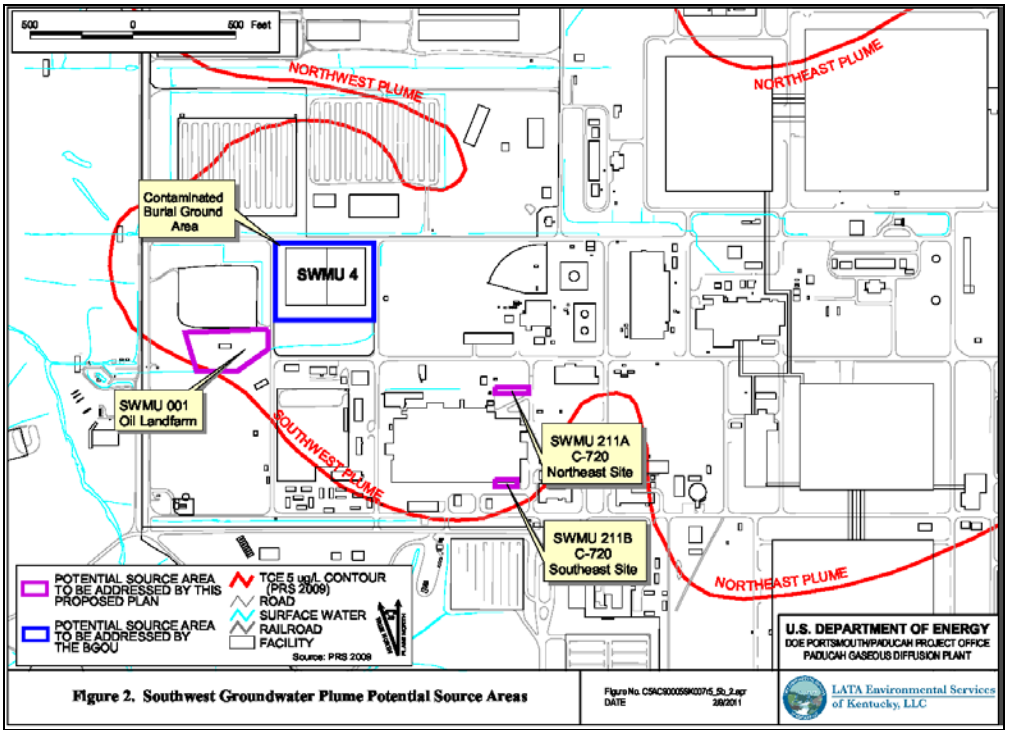

Figure 2. Southwest Plume Potential Source Areas

Treatment Using Enhanced In Situ Bioremediation with Interim Land Use Controls *(LUCs) is the preferred remedial action for the VOC sources at SWMU 1 (Oil Landfarm).* ***Preferred Alternative 2—Long-Term Monitoring with Interim LUCs*** *is the preferred remedial action for the Southwest Plume VOC sources at SWMUs 211A and 211B at the C-720 Building area.*

Preferred Alternative 8 consists of the following:

- *Remedial design support investigation (RDSI)*
- *Installation of gravity feed enhanced in situ bioremediation (EISB) system*
- *Introduction of bioamendment*
- *Confirmatory sampling*
- *Secondary waste management*
- *Site restoration*
- *Interim LUCs*
- *Groundwater monitoring*
- *Five-year reviews*

Preferred Alternative 2 consists of the following:

- *Interim LUCs*
- *Groundwater monitoring*
- *Five-year reviews*

This PP mitigates potential risk from exposure to VOC and non-VOC contamination found in source areas through interim LUCs during and after source treatment and removes TCE, identified as a principal threat waste (PTW) and other VOCs from the Oil Landfarm source area through treatment. Other sources to the Southwest Groundwater Plume, such as SWMU 4, will be evaluated as part of other OUs.

This plan fulfills the public participation requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980; the Resource Conservation and Recovery Act (RCRA) of 1976; and Kentucky Revised Statute 224.01-524 by summarizing the Revised FFS and SI Reports and requesting public comments on the Preferred Alternatives identified. This PP also serves as a "Statement of Basis" for the modification of the Kentucky Hazardous Waste Management Permit, KY8-890-008-982. The preferred alternative represents the recommendation by DOE, subject to public comment. The Administrative Record for this action is available for review at the DOE Environmental Information Center (see page 20).

DOE, EPA, and KEEC encourage public review and comment on these proposed Preferred Alternatives for addressing the TCE contamination in subsurface soil at the Oil Landfarm (SWMU 1) and the C-720 Building area (SWMUs 211A and 211B). The public comment period for this PP is scheduled from ***TBD****, 2011, through* ***TBD****, 2011. The "Responsiveness Summary" section of the Record of Decision (ROD) will address public comments received on this PP. Public comments also will become part of the record of modification for the Kentucky Hazardous Waste Management Permit, KY8-890-008-982. These Preferred Alternatives represent the recommendation by DOE, subject to public comment. The eventual remedial action selected in the ROD may be different from the Preferred Alternative presented in this document, depending upon public comments. Additional information regarding the public participation process can be found in the "Community Participation" section of this PP.*

SITE BACKGROUND

PGDP is located in McCracken County in western Kentucky, about 3.5 miles south of the Ohio River and approximately 10 miles west of the city of Paducah. It is an operating uranium enrichment facility owned by DOE. PGDP was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of CERCLA, DOE entered into an FFA with EPA and the Commonwealth of Kentucky on February 13, 1998. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with RCRA and CERCLA, including stakeholder involvement.

The Southwest Groundwater Plume was identified Remedial Investigation (RI) in 1998.[a] Subsequent work to characterize the plume was performed as part of the WAG 3 RI[b] and the Data Gaps Investigation[c] in 2000. In 2004, DOE conducted an SI of the Southwest Groundwater Plume and potential source areas.[d] As discussed in these reports, the primary contaminant defining the plume is TCE. A feasibility study initially was conducted for the Groundwater OU unit in 2001.[e] An FFS was conducted in 2009 as a component of the March 24, 2008, Dispute Resolution Agreement for the Southwest Plume SI.[f] The FFS subsequently was revised in 2010 to the Revised FFS[g] to include technical information made available from implementing the C-400 Interim Remedial Action and to add potential remedial alternatives for detailed analysis and consideration. The Dispute Resolution Agreement also required the development of this PP for conducting a remedial action for the Southwest Groundwater Plume sources.

SWMU 1 Oil Landfarm. SWMU 1 (C-747-C Oil Landfarm) is located in the southwest portion of the plant (Figure 2) and has a total area of approximately 8,947 m^2 (96,300 ft^2 or 2.2 acres). The Oil Landfarm was used from 1973 to 1979 for landfarming of waste oils contaminated with TCE; 1,1,1-trichloroethane; uranium; and polychlorinated biphenyls (PCBs). Soil contaminants remaining at the Oil Landfarm are residuals of the waste oils.

In 1991 and 1992, potential soil and groundwater contamination at the Oil Landfarm was investigated as part of the CERCLA SI, Phase II. Sampling performed in 1996 better defined the PCB and dioxin contamination in surface soils at the unit. In 1998, DOE excavated 23 yd^3 of contaminated surface soils as a non-time-critical removal action. Subsurface soil samples from the WAG 27 RI in 1998 identified a VOC source zone at the Oil Landfarm. The SI confirmed that TCE was the primary VOC present in the source zone and delimited the source area. No previous remedial actions have been taken to address groundwater or subsurface soils contamination at the Oil Landfarm.

SWMU 211A and 211B C-720 Building Area. The C-720 Building area is located in the southwest portion of PGDP (Figure 2) and occupies an area of approximately 82,962 m^2 (893,000 ft^2 or 20.5 acres). It has been used since the early 1950s (and still is active) for fabrication, assembly, cleaning, and repair of process equipment. Most areas adjacent to the C-720 Building are covered by concrete and asphalt pavement. Any areas not covered are small (less than 19 m^2 or 200 ft^2) and widely spaced. The C-720 Building area was identified as a possible source of TCE contamination during the Phase IV Groundwater Investigation.[h]

The WAG 27 RI identified five areas of subsurface soil contamination (primarily characterized by VOCs, with TCE being present at the highest concentrations) around the perimeter of the C-720 Building, including the area previously known as the C-720 TCE Spill Site—Northeast (SWMU 211A). The Southwest Groundwater Plume SI further investigated and confirmed the extent of the two primary areas of subsurface soil contamination located adjacent to the northeast (SWMU 211A) and southeast (SWMU 211B) corners of the building.

Subsurface soil contamination found to the northeast of the C-720 Building is believed to have been a result of routine equipment cleaning and rinsing with solvents. The source of VOC

[a] *Remedial Investigation Report for Waste Area Grouping 27 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1777&D2, June 1999.
[b] *Remedial Investigation Report for Waste Area Grouping 3 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1895&D1, July 2000.
[c] *Data Report for the Sitewide Remedial Evaluation for Source Areas Contributing to Off-Site Groundwater Contamination at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1845/D1, January 2000.
[d] *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2180&D2, June 2007.
[e] *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-1857/D2, August 2001.
[f] "Resolution of the Environmental Protection Agency Letter of Non-Concurrence for the Site Investigation Report for the Southwest Plume at the PGDP, Paducah, Kentucky (DOE/OR/07-2180&D2) and Notice of Informal Dispute Dated November 30, 2007, McCracken County, Kentucky," PPPO-02-392-08, March 2008.
[g] *Revised Focused Feasibility Study for Solid Waste Management Units 1, 211A, and 211B Volatile Organic Compound Sources for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-03627D1, January 2011.
[h] *Northeast Plume Preliminary Characterization Summary Report*, DOE/OR/07-1339&D2, July 1995.

contamination found to the southeast of the C-720 Building is uncertain, but may have originated from spills. Receiving and storage facilities are located in the southeast corner of the C-720 Building. No previous remedial actions have been taken to address soil and groundwater contamination at the C-720 Building area.

Storm Sewer Leading from C-400 to Outfall 008. Rainfall runoff at the south end of the C-400 Building drains through a storm water sewer line system to the Outfall 008 ditch on the west side of the plant (Figure 2). During the 1998 WAG 6 RI of the area around the C-400 Cleaning Building, VOC contamination of subsurface soils was identified near two of the lateral lines that feed into the main storm sewer. The TCE that leaked from the C-400 area to the surrounding soils has been identified as a source of groundwater contamination. Additionally, there was a possibility that some of the TCE was transported down the lateral lines to the main storm sewer (then west toward Outfall 008), encountered a breach in the storm sewer, and leaked to the surrounding soils to become a source of TCE to the Southwest Groundwater Plume. No remedial actions, except the 2010 C-400 Interim Remedial Action, have been taken in the area of the storm sewer extending from C-400 to the Outfall 008 ditch. The C-400 remedial action area is approximately 100 ft north of the storm sewer.

SITE CHARACTERISTICS

Each of the three areas has flat topography, with elevations ranging from approximately 112.8 to 115.5 m (370 to 379 ft) above mean sea level (amsl). The Oil Landfarm is grass covered and is bordered by drainage ditches on the north, south, and west sides. Storm water runoff from the Oil Landfarm flows to these perimeter ditches, which discharge via the Outfall 008 ditch to Bayou Creek. Most of the ground surface surrounding the C-720 Building area is covered by concrete, asphalt, or gravel. Drainage from the C-720 Building area is via a storm sewer that discharges through Outfalls 008 and 009 to Bayou Creek. Groundcover over the storm sewer extending from the C-400 Building to the Outfall 008 ditch varies from predominately gravel and pavement on the east half to mostly grass on the west half of this segment of the storm the three areas are similar. A sequence of silt and sewer. The subsurface geology and hydrogeology of clay layers, with interbedded sand and gravel lenses, occurs to an average depth of 16.8 to 18.3 m (55 to 60 ft) below ground surface. These units comprise the UCRS. At the Oil Landfarm, the depth to the water table in the UCRS averages approximately 4.26 m (14 ft), but can be as shallow as 2.13 m (7 ft) due to seasonal variability. In the C-720 Building Area, the depth to water in the UCRS ranges from 1.83 to 13.7 m (6 to 45 ft) below surface with an average of 8.8 m (29 ft).

The RGA, a highly permeable layer of gravelly sand and chert gravel, typically extends from its top at approximately 16.8 to 18.3 m (55 to 60 ft) deep to a base as much as 32.0 m (105 ft) deep. In the area of the Oil Landfarm and the C-720 Building, the RGA is approximately 9.1-m (30-ft) thick. RGA water levels in the area of the Oil Landfarm and the C-720 sites are approximately 45–50 ft below ground surface.

Water within the UCRS tends to flow downward to the RGA. Groundwater flow in the RGA in the Southwest Groundwater Plume below PGDP generally is to the west-northwest. Information collected from all site investigations in the area of the downgradient Southwest Groundwater Plume indicates the Southwest Groundwater Plume has not migrated beyond the DOE property line, which is 914 m (3,000 ft) and 1,460 m (4,789 ft) along the groundwater model migration flow path from the source areas at the Oil Landfarm and the C-720 Building area, respectively. The investigations, however, do indicate that TCE and other VOCs are contaminants of concern (COCs). See text box, “What are the Contaminants of Concern?” on page 18. From the DOE property line, the distance within the Southwest Groundwater Plume flow path to the first point of discharge to surface water (near the Ohio River) is approximately 6.4 km (4 miles) along the groundwater flow path.

Nature and Extent of Contamination

The following section presents summaries of the investigation of the Oil Landfarm, the C-720 Building area, and the storm sewer leading from C-400 to the Outfall 008 ditch and the nature and extent of VOC soil contamination, primarily TCE, found in source areas at each location. More detailed information is in the SI Report.

SWMU 1 Oil Landfarm. TCE soil contamination

at the Oil Landfarm underlies an area of approximately 809 m^2 (8,700 ft^2/0.2 acres) throughout the thickness of the UCRS, to a depth of approximately 16.8 m (55 ft). Of the 108 soil analyses for the Oil Landfarm from the WAG 27 RI, 71 analyses report detected levels of TCE up to 439 mg/kg. The results of TCE soil analyses (having concentrations above 1 mg/kg), from the Oil Landfarm area were used to calculate an estimated average TCE concentration in the TCE source by depth. The average TCE concentrations within the source zone vary from 5.74 mg/kg at 15.2 to 16.8 m (50 to 55 ft) deep to 110.8 mg/kg at 3.0 to 6.1 m (10 to 20 ft) deep. The total TCE remaining in the soils of the Oil Landfarm source zone was approximately 187 L (49 gal). A complete discussion of the source term development is included in the SI.

SWMU 211-A and B C-720 Building Area. The primary area of TCE contamination in the soils around the perimeter of the C-720 Building is in the parking lot located southeast of the C-720 Building. These contaminated soils underlie an area of approximately 4,572 m^2 (15,000 ft^2/0.3 acres) to a depth of approximately 18.3 m (60 ft). Using TCE soil analyses from the C-720 source areas (having concentrations above 1 mg/kg), an estimated average TCE concentration in the TCE source by depth was calculated. The average TCE concentrations within the source zone vary from 0.10 mg/kg at 15.2 to 18.4 m (50 to 60 ft) deep to 11.9 mg/kg at 6.1 to 9.2 m (20 to 30 ft) deep. The total TCE remaining in the soils of the C-720 Building area source zone was estimated at approximately 76 L (20 gal). A complete discussion of the source term development is included in the SI.

Storm Sewer Leading from C-400 to Outfall 008. Both the camera inspection of 910 m (2,986 ft) of the storm sewer and the soil sample analyses for the storm sewer line leading from the C-400 Building to the Outfall 008 ditch confirm that the integrity of the storm sewer remains intact. TCE levels in the soil samples were nondetectable (less than 0.001 mg/kg) to 0.220 mg/kg. The SI concluded that the storm sewer is not a source of TCE to the Southwest Groundwater Plume.

The contaminant nature and extent assessments in the Southwest Groundwater Plume SI concluded that TCE is present at the Oil Landfarm and the C-720 Building area as isolated droplets dispersed in the soil of the UCRS. These zones of isolated droplets of TCE are in the upper 18.3 m (60 ft) of soils. Groundwater samples taken from the RGA beneath SWMU 1 and the C-720 area, as part of WAG 27 RI and the SI, also contained TCE as dissolved contamination; however, groundwater concentrations in the Southwest Plume are generally below levels that are considered indicative of nearby PTW as a source.

SCOPE AND ROLE OF THE RESPONSE ACTION

As described in the *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0305&D2, Annual Revision—FY 2010, June 2010, the Groundwater OU strategy includes a phased approach consisting of the following goals: (1) prevent human exposure to contaminated groundwater; (2) prevent or minimize further migration of contaminant plumes; (3) prevent, reduce, or control contaminant sources contributing to groundwater contamination; and (4) restore the groundwater to its beneficial uses wherever practicable.

The Groundwater OU is one of five media-specific OUs at PGDP being used to evaluate and implement remedial actions. For these OUs, DOE, EPA, and KEEC have agreed upon five strategic cleanup initiatives, as discussed in the Site Management Plan:

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

Multiple VOC source areas that have resulted in the development of three groundwater plumes in the RGA. The VOC source areas addressed in this proposed action (Oil Landfarm and C-720 Building Area) are assigned to the Groundwater OU at PGDP. The Groundwater OU is being implemented in a phased approach consisting of sequenced remedial and removal actions designed

to accomplish the strategy of the Site Management Plan.

Early Groundwater OU actions already have been implemented to prevent exposure and to reduce further off-site migration of contaminant plumes. These include the implementation of the DOE Water Policy and an ongoing operation of the groundwater treatment systems for the Northwest and Northeast Plumes. The operation of the Northeast and Northwest groundwater pump-and-treat activity is being conducted under an Interim Remedial Action (IRA) ROD. This groundwater IRA was enhanced in 2010 with the Northwest Plume Optimization. DOE currently is implementing a remedial action to remove source material from the subsurface near the C-400 Building area. The Water Policy, which is not part of the Preferred Alternative, prevents access and use of groundwater that results from the contaminant source areas at PGDP. It is expected that RGA groundwater use in the off-site area of PGDP, which currently is restricted under the Water Policy, will remain restricted.

The proposed remedial actions, upon implementation, will support goals 2, 3, and 4 of the Groundwater OU strategic remedial goals (RGs). These goals are supported by reducing source areas and removing PTW that results in groundwater contamination.

Remedial alternatives were developed in the Revised FFS in support of a final action for VOCs in the UCRS subsurface soils, which is to reduce the migration of VOCs, primarily TCE, from source areas at the Oil Landfarm and the C-720 Building; mitigate risk to potential receptors; and treat or remove PTW consistent with the National Contingency Plan (NCP). Risks posed by direct contact with contaminated surface soil or sediment at the Oil Landfarm and C-720 Building Area (211A and 211B) or remaining risks from potential use of contaminated groundwater will be addressed later as part of the decisions for the Surface Water, Soils, or Groundwater OUs. Non-VOC soil contamination at the source areas will be addressed by the Soils OU, as described in the 2011 Site Management Plan. Groundwater contamination will be addressed through the Dissolved-Phase Plumes Remedial Action. Interim LUCs consisting of the PGDP Excavation Penetration Permit (E/PP) Program (administrative control) and warning signs (physical control) will be implemented. These interim LUCs will be implemented to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not treated by this remedial action and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

Existing security/access controls, including fencing and security patrols that are established and maintained outside of CERCLA, are effective at preventing public access. Additionally, groundwater protection measures described in the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant*, which is an ongoing CERCLA action, protects residents from the risks associated with using contaminated groundwater. These controls are not LUC components of the Preferred Alternatives. They are effective at preventing public access and unwanted trespassers to contaminated areas of PGDP.

SUMMARY OF SITE RISKS

This section of the PP presents a summary of the baseline risk assessment. The Southwest Groundwater Plume SI includes a baseline risk assessment, which is consistent with the requirements of the NCP at 40 *CFR* § 300.430(d)(4) and Section XI of the PGDP FFA. The human health and ecological risk posed by the site determine whether a remedial action is warranted. This summary describes the risk to human health and the environment by the VOC contamination found at the Southwest Groundwater Plume source areas that will be addressed by the proposed action. This discussion is presented in two subsections: human health risks and ecological risks. Further information on risk is contained in the text box entitled, “What Is Risk and How Is It Calculated?” on page 18 of this PP.

Human Health Risks

The baseline human health risk assessment considered both the current and potential future uses of the Oil Landfarm and C-720 Southeast and

Northeast areas and the areas to which contaminants from the site may migrate. Currently, all three areas lie within the industrialized areas of PGDP. Under current plans, these areas are expected to remain industrial, with use restrictions in the future. It is not reasonable, therefore, to expect there would be exposure to site contaminants or that groundwater would be drawn from the sites and used for any purpose other than monitoring.

Risks calculated for consumption of groundwater drawn from the RGA at the source areas by a hypothetical resident exceeded the lower limit of EPA's acceptable cancer risk range (10^{-6}=Lower) and/or the noncancer hazard index (HI) value (HI=1). The SWMU boundary for SWMU 1 is assumed to be 56 ft from the center of the source area, and for C-720, it is 122 ft from the center of the C-720 source areas. The Storm Sewer was determined not to be a source of TCE contamination to the Southwest Groundwater Plume.

For groundwater use by the adult resident at the Oil Landfarm, VOC COCs include TCE; *cis*-1,2-dichloroethene (DCE); chloroform; and 1,1-DCE, all of which are Priority COCs, except for 1,1-DCE. At the C-720 Building Area, the VOC COCs for groundwater use by the adult resident include TCE; *cis*-1,2-DCE; VC; and 1,1-DCE. All except VC are Priority COCs. An HI greater than 1 or an estimated lifetime cancer risk above the upper limit of EPA's acceptable cancer risk range (10^{-4}) is a "priority COC." The C-720 Building does not have any "priority COCs." The SWMU boundary for SWMU 1 is assumed to be 56 ft from the center of the source area, and for C-720, it is 122 ft from the center of the C-720 source areas. Based on the previous and current modeling results, neither metals nor radionuclides are COCs for contaminant migration from the sources at the C-720 area or Oil Landfarm.

Risks to the Future Excavation Worker exceeded the lower limit of EPA's acceptable cancer risk range (10^{-6}=Lower) and/or the noncancer HI value (HI=1) for the Oil Landfarm. The risks to the Future Excavation Worker at the C-720 sites also exceeded the acceptable cancer risk range, but did not exceed the noncancer HI.

Risks to a hypothetical resident from the inhalation of volatiles as a result of vapor intrusion into home basements exceeded the lower limit of EPA's acceptable cancer risk range and/or the noncancer HI value from the source at the C-720 area and the Oil Landfarm.

Ecological Risks

A screening ecological risk assessment indicated that no ecological impacts were likely to occur from exposure to the VOC sources areas addressed by this PP. This was based upon the location of the contamination being addressed (i.e., in the subsurface and for the C-720 source areas below significant cover such as a building or cement pad), the relatively small size of the contaminant source areas, and the industrial nature of the units. Additionally, groundwater flow modeling predicted the first location that TCE in groundwater from the Oil Landfarm and the C-720 Building area could discharge is approximately 6.4 km (4 miles) away near the Ohio River. No organic compounds were identified as chemicals of potential ecological concern at the sites.

It is DOE's judgment that the Preferred Alternatives identified in this PP or one of the other active measures considered is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. Furthermore, it is DOE's judgment that remedial action of the VOC source areas is critical to protecting and restoring groundwater to its beneficial use(s).

REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) describe what the proposed site cleanup is expected to accomplish. The RAOs for the Oil Landfarm and the C-720 Building (SWMUs 211A and 211B) that were used to screen the remedial alternatives in the FFS are the following:

(1) Treat and/or remove the PTW consistent with the NCP.

(2a) Prevent exposure to VOC contamination in the source areas that will cause an unacceptable risk to excavation workers (< 10 ft).

(2b) Prevent exposure to non-VOC contamination and residual VOC contamination through

interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211A, and SWMU 211B) pending remedy selection as part of the Soils OU and the Groundwater OU.

(3) Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 Northeast and Southeast Sites so that contaminants migrating from the treatment areas do not result in the exceedance of maximum contaminant levels (MCLs) in underlying RGA groundwater.

Two types of RGs were developed to support the RAOs. Worker protection RGs are VOC concentrations in soils present at depths of 0-10 ft that would meet RAO 2a. The RG for TCE for worker protection is 0.0585 mg/kg. Groundwater protection RGs are VOC concentrations in subsurface soils that would meet RAO 3. These values for TCE were calculated to be 0.080 mg/kg and 0.083 mg/kg for the Oil Landfarm and C-720 Northeast and Southeast sites, respectively. Alternatives were evaluated with respect to their effectiveness at attaining RGs and meeting the RAOs based on previous source removal demonstrations at PGDP; literature reports of previous actions at other sites; modeling of VOCs to determine exceedances of MCLs; and engineering judgment. A discussion of RG development and application is contained in Section 2.2 and Appendix C of the D1 Revised FFS.

SUMMARY OF ALTERNATIVES

Eight remedial alternatives were assessed for application to the Southwest Groundwater Plume source areas at the Oil Landfarm (SWMU 1) and the C-720 Building (SWMUs 211A and 211B) area. The SI determined that the storm sewer is not a source of TCE to the Southwest Groundwater Plume; therefore, no alternatives were developed to address the soil surrounding the storm sewer.

Several common elements are included in all alternatives except Alternative 1—No Further Action. These common elements include groundwater monitoring, interim LUCs and five-year reviews. Groundwater monitoring is included as a component of the alternatives and will continue until the UCRS soil RGs are attained. The length of time for required monitoring is alternative dependent. Contamination above levels that would prevent unrestricted use would remain on-site during and for a specific time period after active implementation of each alternative and would require CERCLA mandated five-year reviews.

The interim LUCs are controls in the form of physical and administrative restrictions. Specifically, they are the PGDP E/PP program and posting of warning signs for the Southwest Groundwater Plume source areas. These interim LUCs would be implemented to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not addressed by this remedial action and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

A screening evaluation of all eight alternatives was conducted in the Revised FFS, which resulted in the elimination of some of the alternatives being considered. Alternatives 6 and 7 were screened out for further evaluation at the Oil Landfarm due to the high relative cost and difficulty in implementation due to the low permeable soils. Alternatives 3, 4, and 8 were screened out of further evaluation at the C-720 Northeast (SWMU 211A) and Southeast (SWMU 211B) due to low implementability because of interfering infrastructure such as buried utilities.

Of the eight alternatives, the preferred alternative for the Oil Landfarm (SWMU 1) is Alternative 8; Alternative 2 is the preferred alternative for the C-720 Northeast (SWMU 211A) and Southeast (SWMU 211B). Table ES.3 in the Revised FFS contains a comparative ranking of the alternatives. On balance, these alternatives best meet the NCP criteria. These are the specific components of the alternatives developed for evaluation.

- **Alternative 1: No Further Action**.

- **Alternative 2: Long-term Monitoring with Interim LUCs**. This alternative consists of monitoring, five-year reviews, and interim LUCs. It would not include an RDSI,

treatment, or removal of VOC contamination. Alternative 2 would prevent the completion of exposure pathways when combined with the existing groundwater use restrictions provided by the Water Policy, which is not part of Alternative 2. Alternative 2 would be applicable to all three source areas and would have a total escalated project cost of $6.6M and a present worth cost of $5.1M. The estimated time to attain RGs at SWMU 1 and C-720 is estimated at 150 and 97 years, respectively.

- **Alternative 3: *In Situ* Source Treatment Using Deep Soil Mixing with Interim LUCs**. This alternative consists of an RDSI to refine the extent of VOC contamination and quantify parameters for selecting and applying treatment reagents. The VOC contamination would be treated utilizing large diameter augers to mix the soil with a chemical reagent to destroy the VOC contamination. Also included in the alternative would be waste management, confirmation sampling, and site restoration activities. Alternative 3 is applicable only to SWMU 1 (Oil Landfarm) and would have a total escalated project cost of $9.7M and a present worth cost of $9.1M. The estimated time to attain RGs is 68 years.

- **Alternative 4: Source Removal and *In Situ* Chemical Source Treatment with Interim LUCs**. This alternative consists of an RDSI for source area refinement, excavation of the sources utilizing large diameter augers, and treating the bottom 10 ft to 13 ft *in situ* with reagents for VOC destruction. The excavated soils would be managed and disposed of according to applicable or relevant and appropriate requirements (ARARs). Also included in the alternative would be confirmation sampling and site restoration activities. Alternative 4 is applicable only to SWMU 1 (Oil Landfarm) and would have a total escalated project cost of $12.1M and a present worth cost of $11.4M. The estimated time to attain RGs is 38 years.

- **Alternative 5: *In Situ* Thermal Treatment with Interim LUCs**. This alternative consists of an RDSI for source refinement, treatment using *in situ* thermal technology with vapor extraction, treatment of recovered vapor and groundwater, process monitoring, confirmation sampling, groundwater discharge to an outfall, waste management, and site restoration. Alternative 5 is applicable to all three source areas and would have a total escalated project cost of $31.4M and a present worth cost of $29.3M. The estimated time to attain RGs is 39 and 20 years for SWMU 1 and C-720, respectively.

- **Alternative 6: *In Situ* Source Treatment Using Liquid Atomized Injection with Interim LUCs**. This alternative consists of an RDSI for source refinement and to quantify soil parameters for selecting and applying treatment reagents. Treatment would occur by applying the reagent mixture in the subsurface in an atomized/aerosol form by high pressure injection. Alternative 6 would include confirmation sampling, waste management, and site restoration. Alternative 6 is applicable only to the C-720 Building Northeast (SWMU 211A) and Southeast (SWMU 211B) source areas. The total escalated project cost and present worth cost for Alternative 6 are $7.6M and $6.6M, respectively. The estimated time to attain RGs is 52 years.

- **Alternative 7: *In Situ* Soil Flushing and Source Treatment Using Multiphase Extraction with Interim LUCs**. This alternative consists of an RDSI for source refinement and to quantify soil and source parameters for surfactant selection and vapor extraction. Multiphase extraction would be utilized to remove the source material from the subsurface. Surfactant soil flushing will be utilized to enhance the removal and recovery of vapors and water with entrained VOC contamination. Vapor and liquid phases will be treated and surfactant microemulsions recovered and reutilized. Alternative 7 would include confirmation sampling, waste management, and site restoration. Alternative 7 is applicable only to the C-720 Building Northeast (SWMU 211A) and Southeast (SWMU 211B) source areas. The total escalated project cost and present worth cost for Alternative 7 are $8.8M and $7.8M, respectively. The estimated time to attain RGs is 39 years.

- **Alternative 8: *In Situ* Source Treatment Using EISB with Interim LUCs**. Alternative 8 will consist of an RDSI for source

refinement and quantification of soil parameters for bioremedial action. Enhanced bioremediation will be implemented and facilitated by multilevel injection points. The placement of amendments will utilize shallow gravity-feed injection wells and deep gravity-feed UCRS injectors. Included in Alternative 8 are activities for waste management, confirmation sampling, and site restoration. Alternative 8 has a total escalated project cost of $6.1M and present worth cost of $5.5M. Alternative 8 is applicable only to the Oil Landfarm (SWMU 1). The estimated time to attain RGs is 93 years.

EVALUATION OF ALTERNATIVES

The Preferred Alternatives are as follows:

- C-720 Northeast (SWMU 211A) and Southeast (SWMU 211B) Sites**—Alternative 2—Long-Term Monitoring and Interim LUCs**.

- Oil Landfarm (SWMU 1)**—Alternative 8—*In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation and Interim LUCs.**

Alternative 2 consists of the following:

- Groundwater monitoring

- Interim LUCs (i.e., warning signs and E/PP program)

- Five-year reviews

This alternative would result in reduction of toxicity, mobility, and volume through dispersion, source depletion, and degradation. The source would be monitored to insure that major changes to the contaminant characteristics and concentration are monitored during alternative implementation. Alternative 2 is expected to attain RGs in approximately 150 years for SWMU 1 and 97 years for C-720. Alternative 2 also would institute interim LUCs, which are restrictions associated with the E/PP program, and physical controls in the form of warning signs. These interim LUCs would prevent the completion of the worker exposure pathways. RGA groundwater monitoring wells would be installed at the source areas to monitor TCE concentrations attributed to contamination leaching from the UCRS into the RGA.

Attenuation processes (e.g., degradation, migration, and dispersion) are expected to have limited impact on VOC contamination in the UCRS. Both aerobic and anaerobic conditions most likely are present in the UCRS; however, these processes were not accounted for in the model-based analysis of time required to meet RGs. This microbiology is confirmed by the presence of TCE degradation products, which are largely a result of natural biodegradation.

Alternative 2 also would include the development of the Five-Year Reviews for the source areas during the period of time the RGs are being attained. Secondary wastes would be generated from monitoring well installation and monitoring activities over time. The estimated cost of implementing Alternative 2 at the two C-720 sites, 211A and 211B, is $4.4M.

Alternative 8—An RDSI would be performed to further characterize the Oil Landfarm source area in support of the treatment system design. The RDSI would perform soil and groundwater testing of parameters specific to application of EISB. EISB amendments, as determined from the RDSI, will be introduced to the UCRS via shallow and deep gravity-feed infiltration galleries and wells. The quantity and sequence of amendment injections would be determined during the remedial design development. Groundwater monitoring will be performed to determine the effects on the contaminant concentrations in the water. Confirmation sampling, site restoration, and waste management activities will be performed during the alternative's implementation. The E/PP program and warning signs, the interim LUCs, will be implemented to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not treated by this remedial action and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media. The total escalated project cost and present worth cost for Alternative 8 at SWMU 1 and $6.1M and $5.1M, respectively.

The following discussion summarizes the comparison of alternatives in the context of the

threshold and balancing criteria. A more extensive evaluation is located in the Revised FFS. A brief description of the evaluation criteria is shown on Page 19.

Overall Protection of Human Health and the Environment

Protection of human health and the environment would be afforded by implementation of interim LUCs for all alternatives (2-8) at applicable source areas except Alternative 1. Alternative 1 (No Further Action) would not meet this threshold criterion because no action would be implemented.

Compliance with ARARs

Alternatives 2 through 8 are compliant with location- and action-specific ARARs and meet this threshold criterion. There are no chemical-specific ARARs. The MCL for TCE was utilized to determine how much TCE could be left in the UCRS soils and not exceed the MCL in the RGA groundwater. This value of TCE in the UCRS is the RG for this source control action. Although Alternative 1 would be compliant with ARARs, it would not meet both threshold criteria. A complete listing of ARARs is contained in Section 4 of the Revised FFS.

Long-Term Effectiveness and Permanence

The overall ranking, highest to lowest, of the alternatives with respect to Long-Term Effectiveness and Permanence is 4, 5, 3, 8, 2, and 1 for the Oil Landfarm, and 5, 7, 6, 2, and 1 for the C-720 Northeast and Southeast sites. For the Oil Landfarm, Alternatives 4 and 5 provide the best Long-Term Effectiveness and Permanence because they would attain the RAOs in the shortest time frame, approximately 38–39 years. For the C-720 sites, the RAOs are estimated to be attained in 20 years with Alternative 5 and 39 years with Alternative 7. Alternative 8 attains the RAOs within 93 years and, as such, is moderately effective when time to attain RGs is a primary consideration. Alternative 2, without active treatment, is expected to attain RGs in approximately 150 years for SWMU 1 and 97 years for C-720; this is similar to active treatment remedies included in Alternatives 3 to 8.

Reduction of Toxicity, Mobility, or Volume through Treatment

The overall ranking, of highest to lowest, of alternatives applicable to the Oil Landfarm is 4, 5, 3, 8, 2, and 1. Alternative 4's reduction in volume is expected to be the highest, estimated at 100% for the excavated areas in the Oil Landfarm; while Alternative 5 is expected to destroy 98% of the contaminant mass in the Oil Landfarm. Alternatives 3 and 8 would achieve less reduction. Although Alternative 3 would accomplish less contaminant removal, it would facilitate the destruction of contaminants or a reduction of mobility based upon the amendment utilized. Alternatives 1 and 2 would achieve no reductions through treatment and would rely upon degradation, dispersion, and source depletion.

The C-720 Building alternative ranking (highest to lowest) is 5, 7, 6, 2, and 1. Similar reductions in volume from Alternative 5 are expected at C-720 as at the Oil Landfarm. Alternative 7 would achieve an estimated 95% volume reduction. Alternative 6's reduction is estimated at approximately 90%. As at the Oil Landfarm, Alternatives 1 and 2 would achieve no reductions through treatment and would rely upon degradation, dispersion, and source depletion.

Short-Term Effectiveness

Short-term effectiveness for all but the remediation workers is similar for Alternatives 2 through 8 due to the use of interim LUCs. The short-term risks associated with groundwater use off-site are removed for all of the alternatives by the continued application of the DOE Water Policy, which is not part of this remedial action. The combination of these would maintain protectiveness of the public and the environment from exposure to the site; therefore, only worker risks, risks to the public from remedy implementation, and time required to attain RAOs are considered in this Short-Term Effectiveness analysis. The overall ranking of the alternatives from highest effectiveness to lowest for the Oil Landfarm applicable alternatives is 3, 5, 4, 8, 2, and 1. Alternative 1 does not meet the short-term effectiveness criterion because it does not achieve short-term protectiveness through interim LUCs. Alternative 3 has reduced short-term risk due to its being an *in situ* technology; its overall duration of treatment is approximately four months.

Alternative 5 has a faster field implementation schedule than Alternative 3; however, there are increased risks to workers from drilling, construction of electrodes, and the presence of electrical and thermal hazards. Alternative 4 has increased worker risk due its *ex situ* handling, treatment, hauling, and disposal of the contaminated soils. Alternative 4 may pose some risks to the public should contaminated soils be conveyed to an off-site disposal location. Alternatives 8 and 2 have the least short-term efficiency and therefore increased short-term risk because of the extensive time period of 93 years to attain the RAOs. These risks from lengthy implementation are minor and manageable.

The alternatives applicable to the C-720 Northeast and Southeast sites have relative Short-Term Effectiveness rankings (highest to lowest) of 5, 7, 6, 2, and 1. Although Alternatives 5 and 7 do present risks associated with implementation, these are mitigated somewhat by the shorter implementation time and RAO attainment time when compared to the other alternatives. For Alternative 6, although it is implemented quickly, RAOs are not attained for 52 years, which results in increased monitoring risks. Alternatives 1 and 2 have the most short-term risk due to the extended time (exceeds 97 years) to attain RAOs. With Alternative 2, short-term risks, however, are reduced as compared to Alternative 1 because interim LUCs are implemented.

Implementability

All alternatives are implementable as evaluated for the sites. Some alternatives have increased implementability due to use of standard construction techniques and reduced waste generation. The alternatives applicable to the Oil Landfarm rank (from highest to lowest) 1, 2, 8, 3, 5, and 4 in implementability. Alternatives 1 and 2 are the most implementable since, respectively, one has no action at all, and the other has no active treatment. Alternative 8 follows Alternatives 1 and 2 because it has reduced intrusive activities and utilizes readily available services and industrial techniques. The implementability of Alternative 3 ranks lower than 8, because it will generate more waste and has increased need for coordination of more complex fieldwork. Alternative 4 has reduced implementability due to health and safety issues and waste generation quantities. Alternative 5 is the least implementable at the Oil Landfarm due to the reduced number of vendors who offer this technology, the technical complexity of the technology, and worker protection issues.

The C-720 Northeast and Southeast applicable alternatives rank in implementability (from highest to lowest) at 1, 2, 6, 7, and 5. Again, Alternatives 1 and 2 have the highest implementability due to the same reasons as for the Oil Landfarm. Alternative 6 has the highest implementability for alternatives with active treatment for the C-720 sites. The implementability is high because it utilizes high pressure jetting and injection, which use standard equipment and technology. It does have some reduced implementability due to limited availability of vendors. Alternative 7 has reduced implementability due to the need for application of the technology for an extended period of time to reach the RAOs. Alternative 5's implementability issues are the same as discussed for application at the Oil Landfarm.

Cost

The estimated lifecycle costs were calculated and are presented as escalated values in fiscal year 2010 dollars for capital, operating and maintenance, and periodic costs for each alternative. The overall ranking of costs, lowest to highest, for the alternatives associated with the Oil Landfarm is 1, 2, 8, 3, 4, and 5. The similar ranking of C-720 sites alternatives is 1, 2, 6, 7, and 5. Table 1 provides a breakdown of the cost for each alternative with respect to the three source areas. Alternative 5 is the most expensive of the 8 alternatives at $31.4M; Alternative 1 is the least, at no cost as expected for a no further action alternative. The combination of Alternatives 6 and 8 is the least expensive, at $13.7M for the alternatives that implement active source reduction operations. The combination of Alternatives 7 and 8 has a slightly higher cost at $14.9M. Alternative combination 2 and 8 at $10.5M is the least expensive of the alternatives that implement some portion of the remedial actions.

Cost Effectiveness

An alternative is cost effective, according to the NCP, 40 *CFR* § 300.430(f)(1)(ii)(D), if its costs are proportional to the overall effectiveness. A proportional analysis of cost was performed. In this analysis, time and cost to reach RGs for active treatment Alternatives 6 and 8 for C-720 Northeast

and Southeast cost 2 times as much as Alternative 2, but result in only a 46% reduction in estimated time required to attain RGs. Alternative 5, which is the most expensive alternative, costs 3 times as much as Alternative 2 and results in approximately an 80% reduction in the estimated time required to attain RGs. The benefits of reducing the time to reach RGs are not proportional to the higher cost associated with alternatives, other than Alternative 2 and 8. Groundwater at PGDP will continue to be impacted by other site sources well beyond the time required to reach RGs under Alternative 2. Except for Alternative 1, all alternatives contain interim LUCs that provide protection as discussed in the Evaluation of Alternatives section. The proportionality to overall effectiveness becomes diminished when the overall time frame for return of the RGA to beneficial use is considered. Existing groundwater contamination at PGDP from other contributing sources is expected to persist above MCLs beyond the time required for all alternatives considered in the Revised FFS. These other long-term source areas have resulted in contamination in the RGA both on- and off-site and, therefore, will prevent the beneficial use of RGA groundwater in the foreseeable future. To that end, the time for remediation, which is a component of the analysis of long- and short-term effectiveness becomes less critical. The following considerations support this conclusion:

- Drinking water and industrial process water at PGDP is obtained from the Ohio River; RGA groundwater will not be needed.

- A Water Policy has been established to provide the surrounding community water for drinking and agricultural use through the West McCracken Water District. This is expected to continue in the foreseeable future.

- PGDP's current land use within the security fence is industrial and is expected to remain industrial for the foreseeable future.

- The estimated time frames required to attain RGs for Alternatives 2 and 8 at C-720 Northeast and Southeast and SWMU 1 are considered to be consistent with the goal of returning groundwater to beneficial use.

Thus, there is no practical benefit to accelerating the Southwest source remediation. Acceleration results in the unnecessary expenditure of financial resources that could be utilized to fund other priority risk reduction projects that would provide more benefit to site risk reduction.

Table 1. Alternative Escalated Cost by Site, M$

Alternative	C-720-Norhteast (211A)	C-720-Southeast (211B)	Oil Land-farm	Total
1	0	0	0	0
2	2.2	2.2	2.2	6.6
3	n/a	n/a	9.7	9.7*
4	n/a	n/a	12.1	12.1*
5	7.1	7.1	17.2	31.4
6	3.8	3.8	n/a	7.6*
7	4.4	4.4	n/a	8.8*
8	n/a	n/a	6.1	6.1*

- Costs are in millions of dollars, M$.
- n/a indicates alternative not applicable to the specific source area.
- Discussion of present value and unescalated costs is contained in the FFS.
- Estimate accuracy is -30% to +50%.
- *Total costs do not apply a remedy to all three source areas.

SUMMARY OF PREFERRED ALTERNATIVES

These are the Preferred Alternatives.

Alternative 2—Long-Term Monitoring with Interim LUCs for SWMUs 211A and 211B, C-720 Building, northeast and southeast areas.

Alternative 8—*In Situ* Source Treatment Using Enhanced *In Situ* Bioremediation with Interim Land Use Controls for SWMU 1, Oil Landfarm.

Alternative 2 is composed of the following major components.

- **Groundwater monitoring—**Groundwater sampling and testing will be performed prior to, during, and following the remediation to determine if groundwater contaminant levels are changing and if attenuation is having an impact on the concentrations in the RGA.

- **Interim LUCs—**Interim LUCs, as described in the Evaluation of Alternatives Section, will consist of the E/PP program and placement of warning signs to provide notice and warning of environmental contamination. They are necessary for any VOC and non-VOC

contamination at the sites and where concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

- **Five-year reviews—**Five-year reviews will be used to evaluate the remedial action consistent with CERCLA requirements for as long as soil contaminant concentrations remain above the RGs.

Alternative 2 meets the RAOs consistent with the NCP. In 40 *CFR* § 300.430(a)(1)(iii)(A), an expectation is established to use treatment to address PTW wherever practicable. The analysis of cost-effectiveness concluded that it would not be beneficial to utilize treatment and additional funds to accelerate the remediation of the SWMU 1 and C-720 source areas. The implementation of active treatment beyond Alternatives 8 and 2 was shown not to result in acceleration of returning sitewide RGA groundwater to beneficial use, but results in unnecessary expenditure of funds. RAO 2a and 2b would be met by the placement of the interim LUCs. RAO 3 would be met in the time frame discussed earlier.

The range of time in years (half-life) utilized to assess TCE attenuation is intended to bracket the expected rate of natural reduction in TCE concentrations in the UCRS due to attenuation (see Table 2).

Table 2. Alternative 2 TCE Attenuation Rate in UCRS

TCE Half-Life in UCRS, Years	Time to Reach MCL in RGA after Alternative 2 Implementation, Years	
	Oil Landfarm	C-720
5	35	41
25	>100	97
50	>100	>100

Alternative 2 applied to the two C-720 source areas meets the threshold criteria (overall protection of human health and the environment and compliance with ARARs) by utilizing interim LUCs. Alternative 2 provides the best balance of trade-offs among the alternatives with respect to the balancing and modifying criteria for remedy selection. It provides for acceptable long-term effectiveness and permanence because it achieves RAOs, to the extent practicable, prior to the remaining PGDP groundwater source areas reaching long-term cleanup goals.

The cost of Alternative 2 is a combined $4.4M, compared to the next more expensive action (Alternative 6) at $7.6M. This results in a $3.2M cost avoidance for Alternative 2. Alternative 2's short-term effectiveness is established through interim LUCs. Some short-term risk exists to workers associated with the sampling work during the extended monitoring period. Risks to workers will be managed throughout the extended implementation period via health and safety plans. Alternative 2 has the best rank in the area of implementability and cost for any of the alternatives, other than Alternative 1. Specific parameters and values will be defined for completion criteria by the FFA parties and will be stated in the ROD and quantified in the Remedial Action Work Plan.

Specific parameters and values will be defined for completion criteria by the FFA parties and will be stated in the ROD and quantified in the Remedial Action Work Plan.

Alternative 8 is composed of the following major components.

- **RDSI—**Results from the investigation will be used to refine the source areas to be treated and to quantify soil, groundwater, and contaminant parameters to be utilized in the design of the bioremediation treatment.

- **Enhanced *In Situ* Bioremediation System**—Deep gravity feed wells will be installed along with a shallow infiltration gallery for the system. A bioamendment composed of microbes, nutrients, and/or reductants, as necessary, will be injected or placed in the wells and gallery to allow the amendment to enter the subsurface either by gravity or under pressure. Periodically, additional bioamendment will be added to the system. The amendment will enhance subsurface biological activity, which will result in the destruction of the TCE contaminant by the microbes. Testing and monitoring will include measuring of bioamendment concentrations

and soil and groundwater parameters during the *in situ* operation.

- **Groundwater monitoring—**Groundwater sampling and testing will be performed prior to, during, and following the remediation to determine how groundwater contaminant levels are changing and if the treatment is having an impact on the RGA groundwater concentration.

- **Confirmatory sampling for VOCs—**Results from soil sampling will be used to determine if the remedial action has met the RGs.

- **Secondary waste management—**The remedial action will generate waste materials that will require disposition including contaminated water, drill cuttings, soils, bioamendment, and general construction debris. These materials will require management and disposal.

- **Site restoration**—Following completion of the remedial action (active treatment), injection wells and infiltration galleries will be abandoned and treatment systems will be removed. The areas will be returned to original contours and seeded. Groundwater monitoring wells will remain in place until RAOs are attained.

- **Interim LUCs—**Interim LUCs, as described in the Evaluation of Alternatives Section, will consist of the E/PP program and placement of warning signs to provide notice and warning of environmental contamination and are necessary for any residual or remaining VOC and non-VOC contamination that is not treated by this remedial action and whose concentrations prevent unrestricted use/unlimited exposure in the Southwest Groundwater Plume source areas. The interim LUCs will remain in place pending final remedy selection as part of a subsequent OU that addresses the relevant media.

- **Five-year reviews—**Five-year reviews will be used to evaluate the remedial action consistent with CERCLA requirements for as long as soil contaminant concentrations remain above the RGs.

Alternative 8 meets the RAOs. RAO #1 would be met by removal of the PTW via *in situ* destruction by bacteria. RAO 2a would be met by removing VOCs to levels within EPA's generally acceptable cancer risk range for site-related exposures of E-04 to E-06, and reducing the VOCs lowers the noncancer HI for VOCs to less than 1. The attainment of RAO 2a also is supported by interim LUCs. RAO 2b would be met by implementing interim LUCs. RAO 3 would be met by reducing VOC soil concentrations to groundwater protection RGs through a combination of active remediation of enhanced bioremediation and attenuation. Groundwater modeling results indicate that, after completion of the active remedial treatment, residual VOC mass still will leach to groundwater in the RGA and result in TCE concentrations above the MCL at both sites. The time necessary to reach the UCRS soil remediation goal for TCE is dependent on the TCE attenuation rate in the UCRS (TCE half-life in UCRS years) and is shown in the Table 3.

The range of time in years (half-life) utilized to assess TCE attenuation is intended to bracket the expected rate of natural reduction in TCE concentrations in the UCRS due to natural attenuation. After 93 years of continued attenuation, TCE concentrations in the RGA groundwater will be below MCL levels at the Oil Landfarm (SWMU 1).

Table 3. Alternative 8 TCE Attenuation Rate in the UCRS

TCE Half-Life in UCRS, Years	Time to Reach MCL in RGA after Alternative 8 Treatment, Years
	SWMU 1
5	35
25	93
50	>100

Alternative 8 applied to the Oil Landfarm site meets the threshold criteria (overall protection of human health and the environment and compliance with ARARs) and provides the best balance of trade-offs among the alternatives with respect to the balancing and modifying criteria for remedy selection. Alternative 8 would provide for good long-term effectiveness and permanence because it removes a significant amount of TCE from affected media. The time frame for attenuation,

although long, is expected to be shorter than the expected time frame for remediation of other groundwater resources at PGDP. To that end, the extended period of time in meeting RAOs is not a detriment to returning the groundwater to beneficial use. The cost of Alternative 8 is lower than Alternative 3 by $3.6M, which results in a cost savings without the loss of use of the groundwater. Alternative 8's short-term effectiveness is established through interim LUCs, but the risk also is limited due to the slow rate of remediation associated with bioremediation. Risks to workers can be managed throughout the extended implementation period. Alternative 8 has the best rank in the area of implementability for any of the alternatives that have active treatment. The cost of Alternative 8 is estimated at $6.1M, which is the lowest of all of the active treatment alternatives.

Completion criteria for discontinuing enhanced *in situ* bioremediation are a complex issue due to the extended period of time required to attain the RAOs. Two parameters available for determining completion are groundwater concentrations and confirmation soil sampling. Specific parameters and values will be defined for completion criteria by the FFA parties and will be stated in the ROD and quantified in the Remedial Action Work Plan.

The No Further Action alternative is appropriate for the storm sewer leading from the C-400 Building area to the Outfall 008 ditch because it is not contributing TCE to the Southwest Groundwater Plume.

KEEC and EPA concur with the proposed remedial actions selected in this PP. Consistent with the NCP at 40 *CFR* § 300.430(f)(4), EPA jointly selects these proposed remedial alternatives with DOE at PGDP, a federal facility. This document also serves as a Statement of Basis, as discussed in the Introduction section, where the requirements fulfilled by the PP are discussed. The Preferred Alternatives can change in response to public comment or new information.

Based on information currently available, DOE believes that the Preferred Alternatives meet the threshold criteria and provide the best balance of trade-offs among the other alternatives with respect to the balancing criteria. DOE expects each Preferred Alternative to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; and (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The Preferred Alternatives represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable and cost-effective manner at the site, consistent with the NCP.

During active treatment and during the period of attenuation, hazardous substances will remain on-site above levels that allow for unlimited use and unrestricted exposure. DOE will review the final remedial action no less than every five years after initiation of the remedial action per CERCLA Section 121(c) and the NCP at 40 *CFR* § 300.430(f)(4)(ii). If results of the five-year reviews reveal that the remedy's integrity is compromised and protection of human health is insufficient, then additional remedial actions would be evaluated by the parties and implemented by DOE.

COMMUNITY PARTICIPATION

Community involvement is a critical aspect of the cleanup process at PGDP. DOE, EPA, and KEEC encourage the public to read and comment on this PP. The Preferred Alternatives discussed in this document represent a preliminary decision that is subject to public comment. A Notice of Availability will be published in *The Paducah Sun* announcing the 45-day public review period for this document. The public comment period for this PP is scheduled from **TBD** through **TBD**, 2011.

A public meeting will be conducted if requested in writing. All public comments at the meeting will be recorded. The Kentucky Department for Environmental Protection, Division of Waste Management, will conduct a public hearing following the public meeting, if requested. A hearing is a formal gathering during which public comments are recorded officially by a hearing officer (to be designated by KEEC), as required by RCRA and Kentucky hazardous waste regulations. Written requests for a public hearing should state the issues to be discussed.

If either a meeting or a hearing is requested, a notice will appear in *The Paducah Sun*. To request a public meeting and/or submit comments on this

PP, please contact the Paducah DOE Site Office, P.O. Box 1410, Paducah, KY 42001, phone (270) 441-6800. To request a public hearing and/or submit comments on this "Statement of Basis," please contact Tony Hatton, Kentucky Department for Environmental Protection, Division of Waste Management, 200 Fair Oaks Lane, 2nd Floor, Frankfort, KY 40601, phone (502) 564-6716.

WHAT IS RISK AND HOW IS IT CALCULATED?

A CERCLA human health risk assessment estimates "baseline risk." This is an estimate of the likelihood of health problems occurring under current and expected future use if no cleanup action is taken at a site. To estimate the baseline risk at a CERCLA site, a four-step process is followed.

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, the risk assessor looks at the concentrations of contaminants found at a site, as well as at past scientific studies on the effects these contaminants have had on people (or animals, when human health studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies enable the risk assessor to determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, the risk assessor considers the different ways that people might be exposed to the contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency and duration of exposure. Using this information, the risk assessor calculates dose from a "reasonable maximum exposure" (RME) scenario, which represents an estimate of the highest level of human exposure that reasonably could be expected to occur within a given time period.

In Step 3, the risk assessor uses the information from Step 2, combined with the information of the toxicity of each chemical, to assess potential health risks. Two types of risk are considered: cancer risk and noncancer risk. The likelihood of any kind of cancer resulting from a CERCLA site generally is expressed as an upper bound probability: for example, a "1 in 10,000 chance." In other words, for every 10,000 people exposed under the RME scenario, one extra cancer *may* occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than normally would be expected from all other causes. For noncancer health effects, the risk assessor calculates a "hazard index." The key concept for noncancer health effects is that a "threshold level" (measured as a hazard index of 1) exists; below this level, noncancer health effects are not expected.

In Step 4, the risk assessor determines whether the site risks are great enough to cause unacceptable health problems for people exposed at or near a site. To do this, the risk assessor combines and summarizes the risk results for the individual chemicals and routes of exposure within the RME scenario and compares the resulting scenario risk estimates to the generally acceptable risk range for site-related exposures.

WHAT ARE THE CONTAMINANTS OF CONCERN?

DOE has identified several contaminants of concern (COCs) in subsurface soil and groundwater at the three locations. However, fate and transport modeling, combined with sampling of groundwater in the Southwest Plume, confirmed that TCE is the primary groundwater COC for potential exposure by receptors. Discussions of the fate and transport modeling and the other COCs are in Appendices F and G, respectively, of the Southwest Plume Site Investigation Report, DOE/OR/07-2180&D2.

TCE is a halogenated organic compound used in the past at PGDP for a variety of purposes. Exposure to this compound has been associated with deleterious health effects in humans, including anemia, skin rashes, liver conditions, and urinary tract disorders. Based on laboratory studies, TCE is considered a probable human carcinogen. Over time, TCE naturally degrades to other organic compounds, including 1,2-dichloroethene and vinyl chloride. TCE currently is not used at the PGDP.

CRITERIA FOR REMEDIAL ALTERNATIVES EVALUATION

Nine criteria developed by the EPA are used to compare alternatives and select a cleanup plan or remedy that meets the statutory goals of protecting human health and the environment, maintaining protection over time, and minimizing contamination. These nine criteria make up the assessment process regulated under CERCLA Section 121 and regulations promulgated in the NCP and are the standard criteria used for all Superfund sites. The following list highlights these nine criteria and some questions that must considered in selecting a final cleanup plan. More detailed definitions are contained in Section 4 of the FFS.

Threshold Criteria

1. **Overall protection of human health and the environment:** Will the alternative protect human health and plant and animal life on and near the area? The chosen cleanup plan must meet this criterion.
2. **Compliance with applicable or relevant and appropriate requirements (ARARs):** Does the alternative meet all pertinent federal and state environmental statutes, regulations, and requirements? The chosen cleanup plan must meet this criterion.

Balancing Criteria

3. **Long-term effectiveness and permanence:** How reliable will the alternative be at long-term protection of human health and the environment? Is contamination likely to present a potential risk again?
4. **Reduction of toxicity, mobility, or volume through treatment:** Does the alternative incorporate treatment to reduce the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present?
5. **Short-term effectiveness:** How soon will risks be adequately reduced? Are there short-term hazards to workers, the community, or the environment that could occur during the cleanup process?
6. **Implementability:** Is the alternative technically and administratively feasible? Are the goods and services needed to implement the alternative (e.g., treatment machinery, space at an approved disposal facility) readily available?
7. **Cost:** What is the total cost of constructing and operating the alternative? Costs presented in this document represent the present worth costs of construction, operations, and monitoring for the anticipated lifetime of the alternative.

Modifying Criteria

8. **State acceptance:** Do state environmental agencies agree with the recommendations? What are their preferences and concerns?
9. **Community acceptance:** What suggestions or modifications do residents of the community offer during the comment period? What are their preferences and concerns?

Of these nine criteria, the two threshold criteria (protection of human health and the environment and compliance with ARARs) must be met for a candidate cleanup alternative to be selected. The five balancing criteria are used to evaluate and compare the elements of the alternatives that meet the threshold criteria. This comparison evaluates which alternative provides the best balance of trade-offs with respect to the balancing criteria outlined above (3-7). State and community acceptance are considered modifying criteria and are factored into a final evaluation of all criteria to select a remedy. Consideration of state and community comments may prompt aspects of the preferred alternative to change or that another alternative provides a more appropriate balance.

This document serves both as a Proposed Plan and as a Statement of Basis.

To send written comments or obtain further information about this Proposed Plan, contact:
Dave Dollins
U.S. Department of Energy
Paducah Site Office
P.O. Box 1410
Paducah, KY 42001
(270) 441-6800

To send written comments about this Statement of Basis, contact:
Tony Hatton
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, KY 40601
(502) 564-6716

Administrative Record Availability

Information about this site considered during the response action determinations for this project, including the Proposed Plan, is available for review at the DOE Environmental Information Center, 115 Memorial Drive, Barkley Centre, Paducah, KY 42001 (270) 554-6979

Hours: 8:00 A.M. to 12:00 P.M. Monday through Friday

The Proposed Plan also is available at the
McCracken County Public Library
555 Washington Street, Paducah, KY 42001
(270) 442-2510

Hours: 9:00 A.M. to 9:00 P.M. Monday through Thursday
9:00 A.M. to 6:00 P.M. Friday and Saturday
1:00 to 6:00 P.M. Sunday

or contact:
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks, 2nd Floor
Frankfort, KY 40601-1190
Attention: Edward Winner
(502) 564-6716

(Record reviews at the Kentucky Department for Environmental Protection are by appointment only.)

U. S. Environmental Protection Agency
61 Forsyth Street, S.W.
Atlanta, GA 30303-8960
Attention: Turpin Ballard (4 WD-FFB)
ballard.turpin@epa.gov
(404) 562-8550

The ROD and the proposed modification to the Kentucky Hazardous Waste Management Permit will be made available at the Environmental Information Center and at the Paducah Public Library after they have been signed by the United States Department of Energy and the United States Environmental Protection Agency and concurred with by the Kentucky Department for Environmental Protection.

The United States Department of Energy, the United States Environmental Protection Agency, and the Kentucky Energy and Environment Cabinet do not discriminate upon the basis of race, color, national origin, sex, age, religion, or disability in the provision of services. Upon request, reasonable accommodations will be provided. These accommodations include auxiliary aids and services necessary to afford an individual with a disability an equal opportunity to participate in all services, programs, and activities. To request appropriate accommodations for a public hearing or meeting (such as an interpreter) or alternate formats for printed information, contact Matthew Hackathorn at (502) 564-6716 or the LATA Environmental Services of Kentucky, LLC, Public Information Officer at (270) 441-5000.