DOE/LX/07-1254&D1

Update to the End State Vision for the Paducah Gaseous Diffusion Plant Paducah, Kentucky

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Update to the End State Vision for the Paducah Gaseous Diffusion Plant Paducah, Kentucky

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

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Paducah Gaseous Diffusion Plant
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PREFACE

This document, Draft *Update to the End State Vision for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1254&D1, revises DOE/LX/07-0013&D1, which superseded the document entitled, *Risk-Based End State Vision and Variance Report for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2119&D2/R3. The original document was prepared to meet requirements set forth in a memorandum from Jessie Roberson to Distribution dated September 22, 2003, as amended by clarification contained in a memorandum entitled "Risk Based End State Guidance Clarification," dated December 23, 2003 (DOE 2003a), and in the notes from the U.S. Department of Energy (DOE) Risk-Based End State (RBES) Next Steps Workshop, October 6 and 7, 2004. This revision reflects the interactions with stakeholders through December 2010.

The presentation of material in this document is consistent with DOE Policy, DOE P 455.1, entitled *Use of Risk-Based End States* (DOE 2003b), the standardized approach set forth in a guidance document entitled *Guidance for Developing a Site-Specific End State Vision* (dated September 11, 2003) (DOE 2003c), as amended by the "Risk Based End State Guidance Clarification," and the notes from the DOE RBES Next Steps Workshop, October 6 and 7, 2004. The document is a tool for communicating the Paducah Gaseous Diffusion Plant's (PGDP's) end state vision to stakeholders (i.e., DOE, the U.S. Environmental Protection Agency, the Commonwealth of Kentucky, and the general public). As discussed in the notes from the DOE Next Steps Workshop, this document will be updated as needed to reflect actual decisions from the ongoing Comprehensive Environmental Response, Compensation, and Liability Act process at the site.

Although this report presents potential actions to address hazards that could be used to reach the PGDP's end state, this report is not a decision document. Rather, discussions of potential specific mechanisms are included to provide an analytical framework that DOE will use to further evaluate the cleanup activities and the strategic approaches at PGDP to determine if it is appropriate to pursue changes in the PGDP baseline. Any decision to pursue changes to the baseline will include factors beyond those presented in this document, including input from stakeholders. If DOE ultimately decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, then those changes will be made in accordance with applicable requirements and procedures.

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CONTENTS

FIGURES

4.1b3. Hazard Area 1: Groundwater OU Treatment Train – End State 4-49

4.2a1. Hazard Area 2: SWOU – Current State 4-50

TABLES

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ACRONYMS

ACL	Alternate Concentration Limit
ACO	Administrative Consent Order
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
BaP	benzo(a)pyrene
BaPE	benzo(a)pyrene equivalent
BGOU	Burial Grounds Operable Unit
BRA	baseline risk assessment
BWMA	Ballard Wildlife Management Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
CSOU	Comprehensive Site Operable Unit
D&D	decontamination and decommissioning
DCE	dichloroethene
DMSA	DOE Material Storage Area
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DUF_6	uranium hexafluoride
ELCR	excess lifetime cancer risk
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GWOU	Groundwater Operable Unit
HI	hazard index
HQ	hazard quotient
HU	hydrogeologic unit
IDW	investigation-derived waste
KDWM	Kentucky Division of Waste Management
KPDES	Kentucky Pollutant Discharge Elimination System
MCL	maximum contaminant level
MNA	monitored natural attenuation
NCP	National Contingency Plan
NPL	National Priorities List
NSDD	North-South Diversion Ditch
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PRG	preliminary remediation goal
RAO	remedial action objective
RBES	risk-based end state
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RI	Remedial Investigation
RL	remediation level

ROD	Record of Decision
SI	Site Investigation
SMP	Site Management Plan
SOU	Soils Operable Unit
SRA	screening risk assessment
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
Tc-99	technetium-99
TCA	trichloroethane
TCE	trichloroethene
TI	technical impracticability
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
UF_6	uranium hexafluoride
USEC	United States Enrichment Corporation
USV	Upper Screening Value
VC	vinyl chloride
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area

DEFINITIONS

analyte–A constituent or parameter being analyzed.

aquifer–A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

biota–The animal and plant life of a particular region considered as a total ecological entity.

closure–Formal shutdown of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

compliance–Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

concentration–The amount of a substance contained in a unit volume or mass of a sample.

confluence–The point at which two or more streams meet; the point where a tributary joins the main stream.

contamination–Deposition of unwanted material on the surfaces of structures, areas, objects, or personnel.

curie (Ci)–A unit of radioactivity. One curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are used commonly.

picocurie (pCi)–10^{-12} Ci, one-trillionth of a curie; 3.7×10^{-2} disintegrations per second.

daughter–A nuclide formed by the radioactive decay of a parent nuclide.

decay, radioactive–The spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide or into a different energy state of the same radionuclide.

dense nonaqueous-phase liquid (DNAPL)–The liquid phase of chlorinated organic solvents. These liquids are denser than water and include commonly used industrial compounds such as tetrachloroethene and trichloroethene.

dose–The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

absorbed dose–The quantity of radiation energy absorbed by an organ divided by the organ’s mass. Absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 Gy).

dose equivalent–The product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 Sv).

downgradient–In the direction of decreasing hydrostatic head.

effluent–A liquid or gaseous waste discharge to the environment.

Environmental Restoration–A DOE program that directs the assessment and cleanup of its sites (remediation) and facilities (decontamination and decommissioning) contaminated with waste as a result of nuclear-related activities.

formation–A mappable unit of consolidated or unconsolidated geologic material of a characteristic lithology or assemblage of lithologies.

groundwater, unconfined–Water that is in direct contact with the atmosphere through open spaces in permeable material.

hydrogeology–Hydraulic aspects of site geology.

hydrology–The science dealing with the properties, distribution, and circulation of natural water systems.

in situ–In its original place; field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

isotopes–Forms of an element having the same number of protons but differing numbers of neutrons in the nuclei.

migration–The transfer or movement of a material through air, soil, or groundwater.

monitoring–Process whereby the quantity and quality of factors that can affect the environment or human health are measured periodically to regulate and control potential impacts.

mrem–The dose equivalent that is one-thousandth of a rem.

nuclide–An atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

outfall–The point of conveyance (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

part per billion (ppb)–A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or mg/mL.

part per million (ppm)–A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

polychlorinated biphenyl (PCB)–Any chemical substance that is limited to the biphenyl molecule and that has been chlorinated to varying degrees.

polynuclear aromatic hydrocarbon (PAH)–Any organic compound composed of more than one benzene ring.

process water–Water used within a system process.

rad–An acronym for Radiation Absorbed Dose. The rad is a basic unit of absorbed radiation dose. (This is being replaced by the "gray," which is equivalent to 100 rad.)

radioactivity–The spontaneous emission of radiation, generally alpha or beta particles or gamma rays, from the nucleus of an unstable isotope.

radioisotopes–Radioactive isotopes.

radionuclide–An unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

release–Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem–The unit of dose equivalent (absorbed dose in rads multiplied by the radiation quality factor). Dose equivalent is frequently reported in units of millirem (mrem), which is one-thousandth of a rem.

remediation–The correction of a problem. See Environmental Restoration.

Resource Conservation and Recovery Act (RCRA)–Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes.

sievert (Sv)–The SI (International System of Units) unit of dose equivalent; 1 Sv = 100 rem.

source–A point or object from which radiation or contamination emanates.

stable–Not radioactive or not easily decomposed or otherwise modified chemically.

surface water–All water on the surface of the earth, as distinguished from groundwater.

upgradient–In the direction of increasing hydrostatic head.

volatile organic compound (VOC)–Any organic compound that has a low boiling point and readily volatilizes into air (e.g., trichloroethane, tetrachloroethene, and trichloroethene).

watershed–The region draining into a river, river system, or body of water.

wetland–A lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted to life in saturated soils.

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EXECUTIVE SUMMARY

In 2002, the U.S. Department of Energy's (DOE's) Office of Environmental Management (EM) established a set of corporate projects to lead EM's response to the *Top to Bottom Review* (DOE 2002a). One of these projects resulted in the production of policy and guidance that directs DOE sites to submit a site-specific end state vision document. In accordance with that policy (DOE Policy 455.1, *Use of Risk--based End States)* and its implementing guidance *(Guidance for Developing a Site-specific Risk-based End State Vision)*, as amended, and the notes from the DOE Risk-Based End State (RBES) Next Steps Workshop, the Paducah Gaseous Diffusion Plant (PGDP) has prepared this End State Vision Document for the site. Similarly, consistent with the notes from the DOE RBES Next Steps Workshop, this report is a dynamic document that will be updated as needed to reflect actual decisions from the ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process at the site.

> This report presents potential actions to address hazards that could be used to reach the current planned end state and potential end state alternative. These presentations are not meant to be pre-decisional, but are meant to introduce examples of actions that may be completed. The selection of specific actions will be made in accordance with applicable law and agreements.

This report uses a standardized approach to meet the objectives contained in the guidance. This approach relies on the presentation of a series of maps and conceptual site models (CSMs) that depict the relationship between PGDP and its surroundings. The maps and CSMs are intended to present and allow comparisons between current and future land uses; depict hazards and risks to affected or potentially affected populations or receptors; serve as a planning tool for site management; facilitate communication of risks during discussions with stakeholders; allow tracking of expected and actual cleanup results; and serve as a communication tool for public meetings in regard to cleanup activities, current PGDP missions and requirements, and future land use. The maps follow a standardized hierarchical approach that depicts the end state vision in regional-, site-, and hazard-specific contexts. The CSMs are produced only in a hazard-specific context. In the CSMs and their associated text, various responses to achieve site cleanup are presented. These presentations are not meant to be pre-decisional, but are meant to introduce examples of actions that may be completed to reach the current planned end state or potential end state alternative. The selection of specific actions will be made in accordance with applicable law and agreements.

Using the information in this report, as well as information developed during implementation of cleanup and investigation activities at PGDP, DOE will continue to evaluate the cleanup activities and the strategic approaches at PGDP to determine if it is appropriate to pursue changes in the PGDP baseline. Any decision to pursue changes to the baseline will include factors beyond those presented in this report, including input from stakeholders. If DOE ultimately decides to seek changes to current compliance agreements, decisions, or statutory/regulatory requirements, then those changes will be made in accordance with applicable requirements and procedures.

Currently, PGDP, located in Paducah, Kentucky, is the nation's only operating uranium enrichment facility. Missions performed at PGDP are the enrichment mission, a uranium conversion mission, and an environmental cleanup mission. The enrichment mission began in the early 1950s and involves producing enriched uranium for commercial uses through a gaseous diffusion process. At present, the facilities and infrastructure used to produce enriched uranium are leased to the United States Enrichment Corporation (USEC). The uranium conversion mission, involves operation of a facility that converts depleted uranium hexafluoride (DUF_6) currently stored at PGDP to less reactive uranium forms and the subsequent disposal of the converted uranium. Finally, the environmental cleanup mission involves work performed under a Federal Facility Agreement (FFA) and other environmental compliance agreements. The current portion of the cleanup mission under the FFA is to investigate and address existing environmental contamination and to decontaminate and decommission (D&D) those facilities currently leased to USEC once the gaseous diffusion plant (GDP) ceases operation. Consistent with the end state visions guidance and the missions at PGDP, the following eight hazard areas were identified at PGDP. Please note that in the previous version of this document, nine hazard areas were identified. This update includes only eight because the work associated with the Legacy Waste and DOE Material Storage Areas (DMSAs) Hazard Area has been completed. (Please see Table ES.1 for summary information about each of these hazard areas.)

> Table ES.1 summarizes the following hazard areas discussed in the PGDP End State Vision Document:
>
> - A qualitative estimate of the extent of contamination included in the hazard area;
> - The sources of contamination (e.g. , media, waste, infrastructure) associated with the hazard area;
> - The main classes of contaminants found in the contaminant sources;
> - The environmental media that may be impacted by contaminants at or migrating from the contaminant sources;
> - The status of the investigations and cleanup of the sources in the hazard areas; and
> - A summary of the types of risk assessment information currently available for each hazard area.

- Hazard Area 1—Groundwater Operable Unit (GWOU): This hazard area encompasses both the sources of contamination to groundwater (i.e., spill areas) and contaminants migrating via groundwater from the industrialized area of PGDP to include three dissolved-phase plumes. [Two of these plumes (i.e., the Northwest and Northeast Plumes) extend off DOE-owned property.]

- Hazard Area 2—Surface Water Operable Unit (SWOU): This hazard area encompasses the potential sources of surface water contamination (i.e., waste, sediment, and soils) found within the industrialized portion of PGDP, including plant ditches. This hazard area also includes two creeks, Bayou and Little Bayou Creek, located outside of the industrialized portion of PGDP, which run both on and off DOE property.

- Hazard Area 3—Burial Grounds Operable Unit (BGOU) (Group 1). This hazard area includes two burial grounds that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination, but for which the current planned end state and potential end state alternatives differ.

- Hazard Area 4—Soils Operable Unit (SOU). This hazard area encompasses all areas containing contaminated soils that do not impact the GWOU or SWOU and that are not part of other hazard areas. This hazard area also encompasses the soil and rubble areas that have been identified both on and off DOE property that may contain contaminated soils or materials (DOE 2008a; 2010a; 2010b; 2010c).

- Hazard Area 5—Permitted Landfills. This hazard area includes two permitted, closed landfills, and the currently operating permitted landfill. Also, as a planning assumption, this hazard area includes under future conditions, a potential CERCLA Cell, that would be used to dispose of debris and other materials generated during GDP decontamination and decommissioning (D&D).

- Hazard Area 6—BGOU (Group 2). This hazard area includes four areas that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination and for which the current planned end state and potential end state alternatives do not differ.

Table ES.1. PGDP Summary Table of Hazard Areas in the End State Vision Document

Hazard Area[a]	Contaminant Extent	Source Media	Main Contaminants[b]	Media Potentially Impacted	Remediation Status	Status of Risk Information	
						Ecological Receptors	Health Risks
1 GWOU	Diffuse, includes plumes and sources	Soil, waste, DNAPL	Solvents, radionuclides	GW, SW, Sediment	FFS and PP submitted for Southwest Plume. Sampling of Little Bayou seeps is ongoing. RI complete for C-747 Burial Yard. C-404 Burial Ground closed under RCRA. Removal Action complete for C-747-C Oil Landfarm. Interim ROD for NW and NE Plumes. ROD for C-400 source area signed. C-400 remedy implementation is in progress. TCE degradation analysis initiated. Sitewide groundwater model has been revised. Property acquisition study has been completed.	SRAs complete	BRA complete
2 SWOU	Sources, drainage system, ditches, creeks	Soil, scrap, sediment	Metals, PCBs, PAHs, radionuclides	SW, Sediment	Limited SIs complete for Sewer System. Removal Action complete for scrap yards. ROD for NSDD in industrial area. SI completed for internal ditches and Bayou and Little Bayou Creeks. Removal action of "hot spot" on-site completed. Remedial Investigation Work Plan under development.	SRA for some Areas	SRA for some areas
3 BGOU (Group 1)	2 sites	Waste, soil	Metals, PAHs, radionuclides	Soil	RI complete for C-747-B Burial Ground. SI complete for Landfill Borrow Area. RI complete for BGOU. FS submitted for BGOU.	SRAs for 2 sites	BRAs for 2 sites
4 SOU	Dispersed	Soil	Metals, PAHs, PCB, radionuclides	Soil	SIs complete;, some soil piles added to SOU. Rubble piles removed. Removal action of C-218 Firing Range completed. RI completed. RI Report under development.	Not available	SRAs for some areas

Table ES.1. PGDP Summary Table of Hazard Areas in the End State Vision Document (Continued)

Hazard Area[a]	Contaminant Extent	Source Media	Main Contaminants[b]	Media Potentially Impacted	Remediation Status	Status of Risk Information	
						Ecological Receptors	Health Risks
5 Permitted Landfills	3 sites & potential CERCLA Cell	Waste, soil	Solvents, metals, asbestos, radionuclides	Soil, GW, SW, Sediment	SI completed for closed C-746-S and C-746-T Landfills. Groundwater Assessment completed for C-746-U. CERCLA evaluation for potential CERCLA Cell is underway.	SRA for 1 site	BRA for 1 site
6 BGOU (Group 2)	4 sites	Waste, soil	Metals, PAHs, radionuclides	Soil, GW, SW, Sediment	RI complete for BGOU. FS submitted for BGOU. ROD and Corrective Actions implemented for C-746-K Landfill.	SRAs complete	BRAs complete
7 Cylinder yard and conversion facility	"Hot spots"	Facility, cylinders, soil	Uranium hexafluoride	Soil, SW, Sediment	Construction of conversion facility completed. Operations activities are underway. Investigation of facilities and cylinder yards will occur when mission is complete.	Not applicable	Not applicable
8 Gaseous Diffusion Plant Facilities	"Hot spots," buildings	Facilities, soil	PCBs, metals, solvents, radionuclides, asbestos.	Soil, SW, sediment	Demolition and removal of the EES portion of the C-746-A North Warehouse was completed in FY 2010, with disposal of wastes completed in FY 2011 ARRA funds accelerated demolition of this facility. Completed regulatory documentation to allow the demolition of the EES located in the C-746-A North Warehouse and the C-340 Uranium Metals Reduction Complex. Completed demolition and removal of C-410-B Hydrogen Fluoride Neutralization Lagoon FY 2010.	Not available	SRAs for C-410/ C-420 and C-340

Table ES.1. PGDP Summary Table of Hazard Areas in the End State Vision Document (Continued)

Hazard Area[a]	Contaminant Extent	Source Media	Main Contaminants[b]	Media Potentially Impacted	Remediation Status	Status of Risk Information	
						Ecological Receptors	Health Risks
8 Gaseous Diffusion Plant Facilities (continued)					Completed a revision of the CERCLA Documentation for the C-410 Uranium Hexafluoride Feed Plant Complex to include structural demolition, as well as infrastructure removal. Completed demolition of the C-340-D Magnesium Storage Building and the C-340-E Emergency Power Building, which was an ARRA funded activity. Continued D&D of C-410 and C-340. Completed demolition of the C-410 Transformer Structure, approximately 1,200 ft^2. Making preparations to initiate demolition of C-411 and the eastern portion of the C-410 Building, a total of approximately 26,000 ft^2. D&D ongoing Investigation of operating facilities will occur after plant shutdown.		

ARRA = American Recovery and Reinvestment; BGOU = Burial Grounds Operable Unit; BRA = Baseline Risk Assessment; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; D&D = decontamination and decommissioning; DNAPL = dense nonaqueous-phase liquid; EES = East End Smelter; FFS = Focused Feasibility Study; FS = feasibility study; GW = Groundwater; GWOU = Groundwater Operable Unit; NE = Northeast; NSDD = North-South Diversion Ditch; NW = Northwest; PAH = polyaromatic hydrocarbon; PCB = polychlorinated biphenyl; PP = Proposed Plan; RA = Remedial Action; RAWP = Remedial Action Work Plan; RCRA = Resource Conservation and Recovery Act; RI = Remedial Investigation; ROD = Record of Decision; SI =Site Investigation; SOU =Soils Operable Unit; SRA =Screening Risk Assessment; SW = Surface Water; SWOU = Surface Water Operable Unit; TCE = trichloroethene

Notes:

[a] Please see Chapter 4 for additional information about the sites included in each hazard area.

[b] Primary solvent contaminants include trichloroethene; *cis*- and *trans*-1,2-dichloroethene; vinyl chloride; 1,1-dichloroethene; carbon tetrachloride; chloroform; ethylbenzene; benzene; tetrachloroethene; and xylenes.
Primary radionuclide contaminants include U-234, U-235, U-238, Tc-99, Cs-137, Th-230, Th-232, Am-241, Np-237, Pu-238, Pu-239, Pu-240, Ra-226, Sr-90, and Co-60.
Primary metal contaminants include antimony, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel selenium, silver, thallium, uranium, vanadium, and zinc.
Semivolatile organic compound contaminants in addition to PCBs and PAHs include dioxins, furans, and pyrene.
PAHs included as contaminants are benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, acenaphthene, acenaphthylene, anthracene, fluoranthene, naphthalene, and phenanthrene.
PCBs included as contaminants are Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

- Hazard Area 7—Cylinder Yards and uranium hexafluoride (DUF_6) Conversion Facility. This hazard area is composed of the cylinder yards that contain DUF_6 in cylinders and the operating conversion facility.

- Hazard Area 8—GDP Facilities. This hazard area is composed of the GDP facilities and infrastructure that will undergo D&D once the current uranium enrichment mission is ended. This hazard area also includes any sources to the GWOU and SWOU not addressed in the other hazard areas.

Each of these hazard areas, except for the portions of the dissolved-phase groundwater plumes and Bayou and Little Bayou Creeks located off DOE property, is in a location where current and future expected land uses are industrial or recreational. Some areas overlying the groundwater plumes or adjacent to the creeks in areas not on DOE property are evaluated against a future rural residential land use.

Under current conditions, risks at all hazard areas are at or below EPA's acceptable risk range for site-related exposures (bottom of the risk range is 10^{-6}) (EPA 1999). This level of risk, which is called a *de minimis* level of risk in this report, is attained under current conditions through access and institutional controls. However, unmitigated risks or risks that potentially could exist in the absence of these controls exceed the upper end of U.S. Environmental Protection Agency's (EPA's) acceptable risk range for site-related exposures (10^{-4}) at some locations (EPA 1999). These risks are driven by the presence of chlorinated solvents [primarily trichloroethene (TCE) and its breakdown products] in groundwater and by the presence of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, and radionuclides (primarily the uranium isotopes) in soil and sediment.

Under the potential end state alternative, risk at all hazard areas will be maintained at *de minimis* levels. These levels will be attained through the following actions:

- Continued access and institutional controls (e.g., covering/capping, excavation/penetration limitations, and controls on groundwater use);

- Continued operation of the groundwater pump-and-treat systems to remove TCE and its breakdown products from the groundwater and minimize the potential for additional migration of TCE off PGDP. The existing groundwater pump-and-treat systems may be supplemented by additional source-control treatment;

- Response actions at major source areas to reduce the concentration of TCE and other solvents in the subsurface that act as long-term sources of groundwater contamination;

- Monitored natural attenuation (MNA) of secondary sources of groundwater contamination (TCE source areas) and the dissolved-phase plumes with continued access and enhanced institutional controls;

- Natural attenuation to reduce TCE concentrations in groundwater discharged to surface water;

- Excavation and on and off-site disposal of contaminated surface soil and sediment to attain a target risk of 1E-04 to receptors consistent with current and future land use and average PCB concentrations within exposure units of 25 ppm in industrial areas and 1 ppm in recreational areas;

- Capping or covering of burial grounds for those areas not containing principal threat waste; and

- On- and off-site disposal of debris from D&D of facilities and infrastructure.

In order to identify variances between the potential end state alternative and the current PGDP baseline, a current planned end state also is presented for each of the hazard areas. Under the current planned end state, risk at all hazard areas also will be maintained at *de minimis* levels. These levels will be attained through the following actions:

· Continued access and institutional controls (e.g., covering/capping, excavation/penetration limitations, and controls on groundwater use);

· Continued operation of the groundwater pump-and-treat systems to remove TCE and its breakdown products from the groundwater and minimize the potential for additional migration of TCE off PGDP. The existing groundwater pump-and-treat systems may be supplemented by additional source-control treatment;

· Response actions at major and secondary source areas to reduce the concentration of TCE and other solvents in the subsurface that act as a long-term sources of groundwater contamination;

· Response actions to reduce TCE concentrations in the dissolved-phase plumes;

· MNA of sources of groundwater contamination (TCE source areas) and the dissolved-phase plumes following completion of response action to reduce TCE concentrations;

· Natural attenuation to reduce TCE concentrations in groundwater discharged to surface water;

· Capping or covering of burial grounds for those areas not containing principal threat waste;

· Excavation and on- and off-site disposal of surface and subsurface soil and sediment to attain a target risk of 1E-06 for hypothetical residents and an average PCB concentration of 1 ppm in recreational areas;

· Excavation and proper disposal of wastes from burial grounds; and

· On- and off-site disposal of debris from D&D of facilities and infrastructure.

Note that no final cleanup levels for soil or groundwater have been established at PGDP. The PGDP Federal Facility Agreement (FFA) does not establish specific cleanup targets. The cleanup levels discussed above are values projected to be used under either the potential end state alternative or current planned end state.

Using this information, the following seven variances were identified (potential end state alternative response action listed first):

(1) Enhanced institutional controls to limit groundwater use versus continuation of PGDP Water Policy to limit groundwater use—affects Hazard Areas 1, 5, 6, and 8;

(2) Active treatment of the primary groundwater source area and MNA with either enhanced institutional controls or continuation of the PGDP Water Policy, versus active treatment of multiple groundwater source areas with MNA and continuation of the PGDP Water Policy—affects Hazard Areas 1 and 8;

(3) MNA for groundwater source areas (e.g., burial grounds), with cover/capping and either enhanced institutional controls or continuation of the PGDP Water Policy, versus excavation of groundwater

source areas (burial grounds) and continued operation of the groundwater pump-and-treat systems with continuation of the PGDP Water Policy—affects Hazard Area 1;

(4) MNA for the dissolved-phase groundwater plumes, with either enhanced institutional controls or continuation of the PGDP Water Policy, versus continued operation of the groundwater pump-and-treat systems and active treatment for the dissolved-phase plume using oxidation technologies with MNA and continuation of the PGDP Water Policy—affects Hazard Area 1;

(5) Continued monitoring of discharges of groundwater to surface water versus actions to reduce contaminant levels in groundwater discharged to surface water—affects Hazard Area 1;

(6) Cleanup levels for soil and sediment in industrial areas set at targets of 1E-04 (under an industrial scenario) and PCBs of 25 ppm and cleanup levels for soil and sediment in recreational areas set at targets of 1E-04 (under a recreational scenario) and PCBs of 1 ppm versus cleanup levels for soil and sediment in industrial and recreational areas set at targets of 1E-06 (under a residential scenario) and PCBs of 1 ppm—affects Hazard Areas 2, 4, 7, and 8;

(7) Continued monitoring of contaminant levels in surface water at outfalls following "hot spot" removal versus "hot spot" removal and construction of sediment control basins to reduce contaminant migration in surface water and continued monitoring—affects Hazard Area 2; and

(8) Capping or covering certain burial grounds versus excavation of certain burial grounds—affects Hazard Area 3.

Subsequent to identifying the variances, the following challenges to achieving the potential end state alternative were identified:

- Public and regulator acceptance of the range of options included in enhanced institutional controls is uncertain.

- DOE policy may limit options that may be included in enhanced institutional controls.

- Current planned end state assumes that MNA for groundwater contamination will need to be augmented by source and plume actions to reduce contaminant concentrations within a "reasonable" period.

- Regulators' position is that a technical impractibility (TI) waiver for groundwater cleanup would be available only after a demonstrated, site-specific technology failure.

- Regulators' position is that the groundwater cleanup should have as a goal, restoration of groundwater throughout the contaminant plume, as opposed to using the DOE property boundary as the point of exposure for the purpose of developing cleanup levels.

- Regulators' position that capping/covering and institutional controls are inadequate to achieve protection of human health and environment. Their position, that these activities are inadequate to demonstrate compliance with the National Contingency Plan threshold criterion, indicates that the burial grounds should be excavated.

- Commonwealth of Kentucky's position is that all cleanup activities must attain cleanup levels established using a residential exposure scenario and a cancer risk and hazard target of 1E-06 and 1, respectively, rather than using an exposure scenario consistent with expected future uses (e.g., industrial, recreational) and a cancer risk and hazard target of 1E-04 and 1, respectively.

- Commonwealth of Kentucky's position is that all PCB cleanup activities in industrial areas must attain a 1 ppm cleanup level rather than a Toxic Substances Control Act (TSCA)-based 25 ppm cleanup level.

- The regulators' position is that additional data are needed for some hazard areas before a decision can be made.

Recommendations to address these challenges are as follows:

- Initiate further discussions with the regulators to determine willingness to consider enhanced institutional controls in conjunction with MNA in lieu of certain source and plume actions.

- Initiate further discussions with the regulators to discuss willingness to consider establishing points of compliance and exposure at property boundary based on enhanced institutional controls and monitoring.

- Revisit DOE policy concerning acquisition of property rights (including deed notices and permanent groundwater use restrictions). A property acquisition study determined that property purchase options were not cost effective when compared to the restrictive easement and a continuance of the PGDP Water Policy (KRCEE 2007a).

- Complete technical evaluations (e.g., BGOU FS, etc.) to support discussions with the regulators and public.

- Initiate discussions with regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the body of national performance data on dense nonaqueous-phase liquid (DNAPL) remediation, and (2) determine what would be required to decide whether a TI waiver should apply.

- Initiate further discussions with regulators to (1) seek agreement that cleanup standards for proposed actions will be set based upon current and future land uses; (2) gain agreement that cleanup standards will be set based on the CERCLA risk range (10^{-6} to 10^{-4}) (EPA 1999); and 3) seek agreement that national TSCA cleanup standards for PCBs for low occupancy (e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA standards for PCBs for high occupancy (e.g., 1 ppm) should be adopted for recreational areas.

The potential end state alternative, current planned end state, and the variances between the two end states that are presented in the report were developed based upon dialogue among stakeholders in 2004, 2005, and 2009. A summary of these activities is presented as an appendix to this report.

This 2010 update contains the following changes when compared to the previous report:

- Updated information for Hazard Area 2 to state that actions have been completed for Scrap Metal Removal and the Surface Water Operable Unit (SWOU) "Hot Spot" Removal. The updated information also states that the SWOU Remedial Investigation Work Plan currently is under development.

- Removed reference to Hazard Area associated with Legacy Waste and DMSAs. The work associated with this Hazard Area has been completed. Modified Hazard Area numbering to reflect this change.

- Updated information for Hazard Areas 4 and 8 to state that some actions have been completed for Inactive Facilities Removal.

- Completed soil piles investigations and added some soils piles to the SOU.

- Completed rubble pile removals as maintenance actions.

- Updated list of work completed since the last revision, including BGOU RI Report and Environmental Indicator results.

- Added information regarding PGDP cleanup strategy consistent with the FY 2011 Site Management Plan.

- Modified maps to be consistent with 2010 TCE Plume Map data.

- Updated maps and treatment trains based on current status of the various Hazard Areas.

- Updated variance tables to include the latest status of the Hazard Areas.

1. INTRODUCTION

This report delineates the end state vision for the Paducah Gaseous Diffusion Plant (PGDP) located in Paducah, Kentucky. It was prepared following the guidance contained in *Guidance for Developing Site-specific Risk-based End State Vision*, dated September 11, 2003 (DOE 2003c); U.S. Department of Energy (DOE) Policy, DOE P 455.1, *Use of Risk-based End States* (DOE 2003b), as amended by clarification contained in a memorandum entitled "Risk Based End State Guidance Clarification," dated December 23, 2003 (DOE 2003a); and notes from the DOE Risk-Based End State (RBES) Next Steps Workshop, October 2004. This report also incorporates changes made in response to input from various stakeholders, including members of the general public, Citizens Advisory Board, various local civic business organizations, and DOE headquarters. This report and subsequent revisions will provide information that can be used to establish clearly articulated and technically achievable cleanup goals that will focus the continuing cleanup at PGDP; serve as the primary tool for communicating the end state vision for PGDP to the involved parties [i.e., stakeholders from DOE, the U.S. Environmental Protection Agency (EPA), the Commonwealth of Kentucky, local and state-elected officials, and the public]; and, using maps and figures, summarize the PGDP end state vision so that any cleanup decisions can be compared to the end state vision so that the variances between the potential end state alternative and the current PGDP cleanup strategy can be identified. Using the document in this manner is consistent with the *Top to Bottom Review of the EM Program* (DOE 2002a), which recommended moving DOE's Environmental Management (EM) program to an accelerated, risk-based cleanup strategy and aligning the EM program so that its scope is consistent with an accelerated, risk--based cleanup and closure mission.

Objectives of the End of State Vision Document

- Provide information to be used to establish clearly articulated and technically achievable cleanup goals.
- Present maps and figures that can be used to ensure that cleanup decisions are consistent with the end state vision.
- Provide a tool for communicating the end state vision for PGDP to the involved parties.
- Summarize the potential end state alternative so that variance between it and the current cleanup strategy can be identified.

The end state vision presented here is driven by the current and expected future land use for areas at and around PGDP and the exposures that may occur to receptors in these areas. The future land use presented is consistent with that established in several meetings held among the involved parties since the beginning of site cleanup. These descriptions of current and future land use are consistent with those discussed in the fiscal year (FY) 2011 revision of *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (SMP) (DOE 2011a) and in other remedial investigation (RI) and feasibility study (FS) reports. It should be recognized that attainment of the end state vision will take longer than the 20 years commonly used as a planning horizon by local zoning boards for community changes due to the location and persistence of some contaminants and the uncertainty about the continued operation of the operating gaseous diffusion plant (GDP); therefore, it is possible that the land uses presented in this report will differ in the future, resulting in the need to modify the end state vision.

Definition of End States

As used in this document, end states are representations of site conditions and associated information that reflect the planned future use of the property and are appropriately protective of human health and the environment consistent with that use. They form the basis for the exposure scenarios developed in baseline risk assessments that help establish remediation levels (RLs) used to develop remedial alternatives in feasibility studies.

The exposures considered in formulating the end state vision were derived consistent with EPA's risk assessment guidance documents (e.g., EPA 1989: EPA 1996; EPA 2000) and PGDP's Risk Methods Document (DOE 2011b). These exposures, which are documented in a series of conceptual site models (CSMs) in Chapters 4 and 5 of this report, are based on realistic scenarios that consider reasonable pathways of exposure, rational time frames, and expected receptor populations.

The report contains two important comparisons. These are a comparison between the current state and the potential end state alternative and a comparison between the potential end state alternative and the current cleanup baseline end state. (The current cleanup baseline end state or current planned end state is the state the site would achieve upon executing the actions proposed in PGDP's current agreements and other planning documents.) The first of these comparisons is used to depict the risk reduction that would be achieved under the potential end state alternative. The second of these comparisons is used to identify variances between the potential end state alternative and current planned end state and to explore the risk balance between the potential end state alternative and the current planned end state during both response action implementation and at the two end states. (Please see Chapter 5 for a complete discussion of risk balancing between the two end states.)

Although potential actions to address site problems are identified in the report, this report is not a decision document. Once the end state vision is developed, DOE will evaluate further the cleanup activities and the strategic approaches at PGDP to determine if it is appropriate to pursue changes in the PGDP baseline. Any decision to pursue changes to the baseline will include factors beyond those presented in the report, including input from involved parties. If DOE ultimately decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, then those changes will be made in accordance with applicable requirements and procedures.

1.1 ORGANIZATION OF THE REPORT

This report is presented in six chapters and an appendix that summarizes the stakeholder input process. Figure 1.1 is a diagram taken from guidance material that depicts the process used when producing the initial revisions of the report. Chapter 1 presents some general information about the report, PGDP, and the status of cleanup at PGDP; Chapters 2 through 4 present descriptions of PGDP in regional, site-specific, and hazard-specific contexts. Chapter 5 includes the variance report and identifies differences between the current planned end state and the potential end state alternative. Chapter 6 includes the references used to prepare the report. The appendix presents a summary of the stakeholder input process undertaken in connection with production of the PGDP End State Vision Document.

The information presented in Chapters 2 through 4 consists primarily of a series of maps that depict the relationship between PGDP and its surroundings. These maps are intended to present and allow comparisons between current and future land use; depict hazards and risks to affected or potentially affected populations or receptors; serve as a planning tool for site management; facilitate communication of risks during discussions with stakeholders; allow tracking of expected and actual cleanup results; and serve as a communication tool for public meetings in regard to cleanup activities, current PGDP mission and requirements, and future land use. The maps follow a standardized hierarchical approach that depicts PGDP in regional, site, and hazard-specific contexts. The regional context maps are presented in Chapter 2. These maps show the relationship of PGDP to the surrounding region (i.e., surrounding counties) and include information about major watersheds (e.g., the Ohio River watershed), population centers, and other significant regional features. The site context maps are presented in Chapter 3. These maps depict the area immediately adjacent to PGDP, as well as the land inside the PGDP property boundaries. Finally, the potential end state alternative hazard-specific context maps are presented in Chapter 4. These maps contain the greatest detail and depict the hazard areas (e.g., disposal cells, landfills, underground plumes, and burial grounds) at PGDP that pose potential hazards to human health and the environment. These hazard-specific context maps are presented in concert with a series of CSMs that depict how receptors are or may be exposed to contamination both currently and when the potential end state alternative for PGDP is attained.

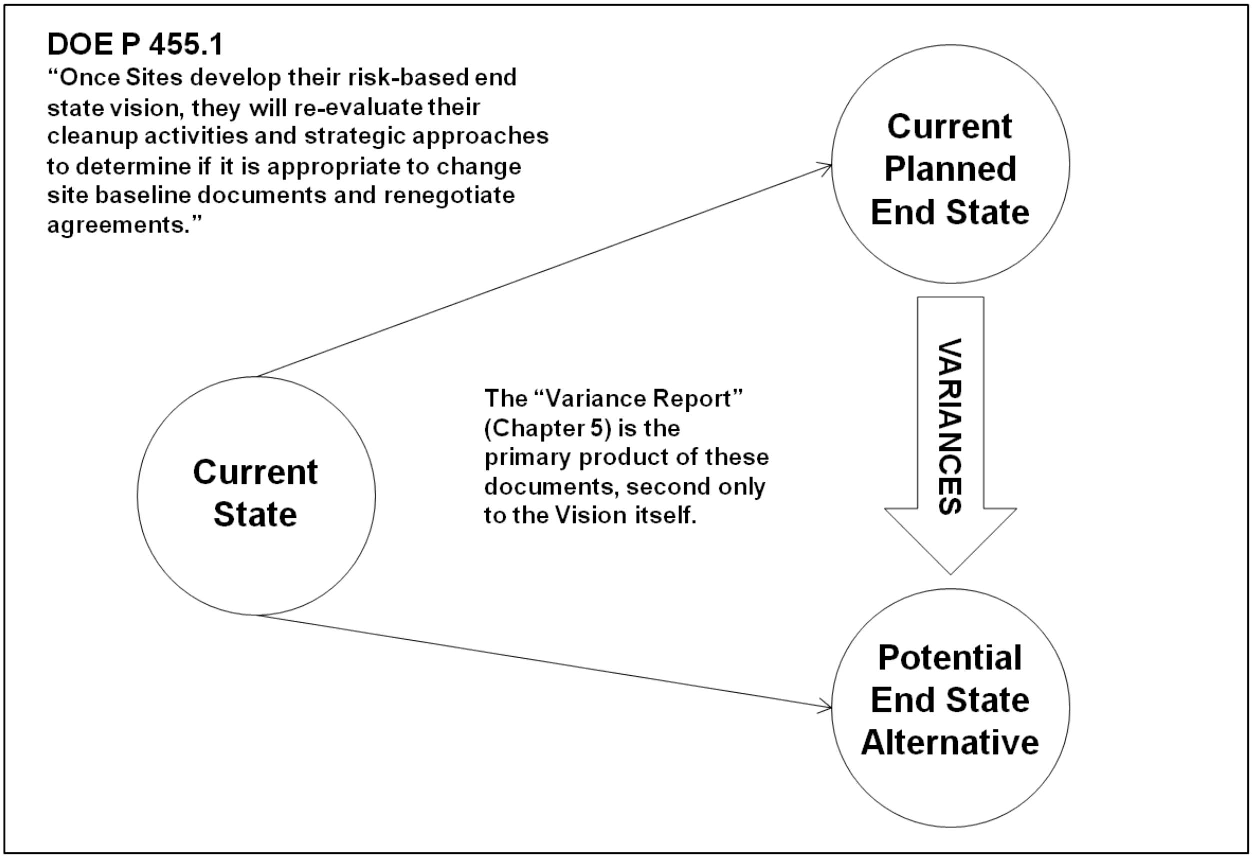

Figure 1.1. Conceptual Product Diagram for the End State Vision Document

Variances between the potential end state alternative and the current cleanup baseline end state (i.e., current planned end state) are presented in Chapter 5. These variances were identified through comparisons between the potential end state alternative maps, CSMs, and narrative presented in Chapter 4 and the current planned end state maps, CSMs, and narrative presented in Chapter 5. These variances were formulated through discussions with the involved parties. (The format of the maps and CSMs in Chapter 5matches that found in Chapter 4.) In addition to identifying the variances in Chapter 5, the potential impacts of the variances (including discussions of risk balancing), the challenges to achieving the potential end state alternative, and recommendations on how to resolve the challenges also are presented. This information is to be used by DOE to determine whether to pursue changes to the current baseline.

1.2 SITE MISSION

In October 2010, PGDP reached its 58th anniversary of operation. Although originally one of three uranium enrichment plants in the U.S., as of 2002, only PGDP was operating. Currently, the United States Enrichment Corporation (USEC) operates the uranium enrichment plant at PGDP. This corporation was established on October 24, 1992, when the President signed the Energy Policy Act of 1992. The charter of USEC under this act is to provide profitable and competitive uranium enrichment services. USEC has leased the gaseous diffusion uranium enrichment production facilities from DOE since July 1, 1993, but DOE has retained the nonleased facilities and is responsible for the decontamination and decommissioning (D&D) and cleanup for environmental conditions that existed before July 1, 1993. It currently is anticipated that USEC will continue to operate the gaseous diffusion uranium enrichment production facilities through at least 2012.

In addition to the enrichment mission, PGDP has both a uranium conversion mission and an environmental cleanup mission. The uranium conversion mission involves the operation of a facility that will convert depleted uranium hexafluoride (DUF_6) to less reactive uranium oxides. The facility began operation in 2011. Currently, it is anticipated that the conversion facility will operate for two or three decades.

The current DOE-EM cleanup mission at PGDP includes work under the Federal Facility Agreement (FFA) and other environmental compliance agreements. The current portion of the cleanup mission under the FFA is to investigate and address existing environmental contamination and to D&D those facilities currently leased to USEC, once the GDP ceases operation. The scope of these activities through 2019 is delineated in the FY 2011 SMP (DOE 2011a). This scope, which reflects investigation and cleanup of areas not impacted by the operating GDP, is to complete the following five strategic initiatives.

(1) Groundwater Operable Unit (OU) (GWOU) Strategic Initiative—This strategic initiative includes investigation, baseline risk assessment (BRA), evaluation of removal/remedial actions, and selection and implementation of actions necessary to achieve protection of human health from exposure to groundwater contamination that could result in unacceptable risk. The projects associated with implementation of this strategy are source actions at the C-400 Building and other major sources to the solvent plumes at PGDP (as identified) and the dissolved-phase plumes. This initiative is ongoing.

(2) Surface Water OU (SWOU) Strategic Initiative—This strategic initiative includes the investigation, BRA, evaluation of removal/remedial actions, and selection and implementation of actions necessary to achieve protection of human health and the environment from exposure to contamination" associated with internal plant ditches; outfall ditches; and Sections 3, 4, and 5 of the North-South Diversion Ditch (NSDD). In addition, the initiative includes evaluation of the need for additional sediment-control measures at PGDP and evaluation and potential implementation of actions to address legacy releases associated with the PGDP storm sewer system and potential contamination in Bayou and Little Bayou Creeks. The completion date for this initiative is 2017.

(3) Burial Grounds OU (BGOU) Strategic Initiative—This strategic initiative includes investigation, BRA, evaluation of remedial alternatives, and selection and implementation of actions necessary to protect human health and the environment from exposure to contamination found at eight burial grounds and additional disposal areas that might exist in other locations and beneath scrap yards. The completion date for this initiative is 2019.

(4) D&D OU Strategic Initiative—This strategic initiative includes a phased investigation and evaluation and implementation of removal actions for two major inactive process facilities. Fifteen smaller inactive facilities, also included as part of this initiative, have been addressed. The completion date for this initiative is 2017. This initiative does not include the D&D of the GDP facilities currently leased to USEC. Leased facilities will undergo D&D after the GDP ceases operation.

(5) Soils OU (SOU) Strategic Initiative—This strategic initiative includes the investigation, BRA, evaluation of removal alternatives, and selection and implementation of actions necessary to achieve protection of human health and the environment from exposure to contamination associated with the following:

- Soils underlying scrap yards,
- Soils outside DOE Material Storage Areas (DMSAs),
- Soil and rubble areas that have been identified that may contain contaminated soils or materials, both on and off DOE property, and
- Soils in plant areas not impacted by either the uranium enrichment or conversion missions.

The completion date for this initiative is 2016.

In addition to actions related to the five strategic initiatives discussed here, the FFA portion of the DOE-EM mission includes cleanup of areas impacted by the uranium enrichment and conversion missions. The scope of this cleanup will include D&D of the GDP followed by the Comprehensive Site OU (CSOU). The CSOU will include the investigation, BRA, evaluation of remedial alternatives, and selection and implementation of actions necessary to achieve protection of human health and the environment. While the planning associated with the scope of the CSOU will begin six months before GPD shutdown, the potential end state alternative and current planned end state to be achieved by the CSOU is discussed in this report. The completion date for the CSOU is uncertain due to the lease status of the GDP.

Another DOE-EM mission includes the continuation of waste management. The scope of the ongoing waste management activities is to characterize and properly disposition any newly generated waste and to operate the C-746-U Sanitary Landfill and other landfills, if any additional landfills are constructed during PGDP cleanup and GDP D&D. [The potential end state alternative does consider the potential construction of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Cell to be used for on-site disposal of materials derived from remedial and D&D activities.] Waste management's mission will continue until site cleanup is complete, including that portion of the cleanup that is managed under the CSOU.

1.3 STATUS OF CLEANUP PROGRAM

In response to the discovery of trichloroethene (TCE) and technetium-99 (Tc-99) in residential wells north of PGDP in 1988, DOE immediately provided a temporary alternative water supply to affected residences and sampled all surrounding residential wells. Following this initial response, DOE and EPA entered into an Administrative Consent Order (ACO) that required monitoring residential wells potentially affected by contamination, providing alternative drinking water to residents with contaminated wells, and investigating the nature and extent of off-site contamination.

The ACO activities delineated two off-site groundwater contamination plumes, referred to as the Northwest and Northeast Plumes; identified several potential on-site source areas requiring additional investigation; and resulted in several interim activities. Upon signature of the FFA in February 1998, the FFA parties declared the ACO requirements satisfied and terminated the ACO because the remaining cleanup would be continued under the authority of the FFA. A series of RI/FSs was conducted under the FFA, including completing the evaluation of all major contaminant sources impacting groundwater and surface water. In accordance with the ACO and FFA investigations, DOE implemented actions that focused on reducing potential risks associated with off-site contamination. Examples of significant actions initiated and completed to date include the following:

- Imposed institutional controls (fencing and posting) to restrict public access to contaminated areas in certain outfall ditches and surface water areas (1993).

- Extended municipal water lines as a permanent source of drinking water to affected residents to eliminate exposure to contaminated groundwater (1995).

- Constructed and implemented groundwater treatment systems for both the Northwest and Northeast Plumes to reduce contaminant migration (1995 and 1997, respectively).

- Constructed hard-piping to reroute surface runoff around highly contaminated portions of the NSDD to reduce potential migration of surface contamination (1995).

- Excavated soil with high concentrations of polychlorinated biphenyls (PCBs) in certain on-site areas to reduce off-site migration and potential direct-contact risks to plant workers (1998).

- Removed and disposed of "drum mountain," a contaminated scrap pile potentially contributing to surface water contamination to eliminate potential direct-contact risks to plant workers and reduce off-site migration (2000).

- Applied *in situ* treatment of TCE-contaminated soils at the cylinder drop test site using innovative technology (i.e., the LASAGNA™ technology) to eliminate a potential source of groundwater contamination (2002).

- Removed petroleum-contaminated soil from Solid Waste Management Unit (SWMU) 193 to eliminate a potential source of groundwater contamination (2002).

- Completed installation of a sediment control basin to control the potential migration of contamination during the scrap metal removal action and initiated removal and disposal of approximately 54,000 tons of scrap metal to eliminate potential direct contact risks to plant workers and a source of surface water contamination (2002).

- Completed hard-piping and installation of a detention basin and excavated the on-site portions of the NSDD, which removed a source of potential direct-contact risk to plant workers and surface water contamination (2004).

- Completed removal and disposal of approximately 54,000 tons of scrap metal to eliminate potential direct-contact risk to plant workers and a source of surface water contamination (2007).

- Initiated the remediation of TCE dense nonaqueous-phase liquid (DNAPL) in the vicinity of C-400 (2009).

- Completed removal of contaminants associated with sediments in Section 3, 4, and 5 of the NSDD and Kentucky Pollutant Discharge Elimination System (KPDES) Outfalls 001, 008, 010, 011 and 015, and associated internal ditches and areas of PGDP (2010).

- Completed removal of lead-contaminated soil at the C-218 Firing Range (SWMU 18) and removal within the boundaries of C-410-B (SWMU 19) (2010).

- Optimized the performance of the Northwest Plume pump-and-treat system (2010).

Appendix 1 of the FY 2011 SMP (DOE 2011a) contains a summary of the status of all actions taken to date that have been documented through a Record of Decision (ROD) or Action Memorandum. More detailed information on the status of each OU is available in the FFA Semiannual Progress Report (DOE 2010d). In addition to the completed actions, DOE has an ongoing integrated environmental monitoring program that assesses contaminant effects and depicts trends in effects over time. Results from this program are reported in the most recent Paducah Site *Annual Site Environmental Report* (DOE 2010e).

Figures 1.2 through 1.4 illustrate the overall strategy for the SWOU (On-Site), the GWOU, and the SOU. Not specifically illustrated is the BGOU, however, the BGOU is included within the GWOU strategy since the burial grounds are potential contributors to groundwater contamination.

The aforementioned response actions are steps in reducing site risks. While no known threats to human health or the environment currently exist, as verified by conclusions in the Agency for Toxic Substances and Disease Registry's Health Assessment (ATSDR 2002), and in the reports listed below from the Commonwealth of Kentucky, several major environmental challenges remain at PGDP.

- *Report of the Commonwealth of Kentucky's Task Force Examining State Regulatory Issues at the Paducah Gaseous Diffusion Plant* (KY 2000)

- *Assessment of Radiation in Surface Water at the Paducah Gaseous Diffusion Plant* (UK 2007)

These challenges, depicted in Figure 1.5 and discussed in more detail in Chapter 4, include, in summary, PCBs and radionuclides in creeks and soils, off-site solvent plumes, burial grounds, and on-site sources of groundwater contamination. Primary contaminants associated with these challenges are chlorinated solvents (primarily TCE and its breakdown products), PCBs, polycyclic aromatic hydrocarbon (PAHs) compounds, several metals (antimony, arsenic, cadmium, chromium, and lead), Tc-99, and uranium isotopes (U-234, U-235, and U-238). A complete list of the significant contaminants of potential concern at PGDP taken from completed BRAs is in Table 1.1. These residual contaminants have the potential to pose threats to human health or the environment under certain future use scenarios.

Table 1.1. Significant Contaminants of Potential Concern at PGDP[a]

Metals/Inorganic Chemicals	Organic Compounds	Radionuclides
Aluminum	Acenaphthene	Americium-241
Antimony	Acenaphthylene	Cesium-137+D
Arsenic	Acrylonitrile	Cobalt-60
Barium	Benzene	Neptunium-237+D
Beryllium	Carbazole	Plutonium-238
Boron	***Carbon tetrachloride***	Plutonium-239
Cadmium	***Chloroform***	Plutonium-240
Chromium III	***1,1-Dichloroethene***	***Technetium-99***
Chromium VI	***1,2-Dichloroethene (mixed)***	Thorium-230
Cobalt	***trans-1,2-Dichloroethene***	***Uranium-234***
Copper	***cis-1,2-Dichloroethene***	***Uranium-235+D***
Iron	Dieldrin	***Uranium-238+D***
Lead	Ethylbenzene	
Manganese	Fluoranthene	
Mercury	Fluorene	
Molybdenum	Hexachlorobenzene	
Nickel	Naphthalene	
Selenium	2-Nitroaniline	
Silver	N-Nitroso-di-n-propylamine	
Thallium	Pyrene	
Uranium	Tetrachloroethene	
Vanadium	***Trichloroethene***	
Zinc	Dioxins/Furans	
	Polycyclic aromatic hydrocarbons	
	Polychlorinated biphenyls	
	Vinyl chloride	
	Xylenes	

Table 1.1. Significant Contaminants of Potential Concern at PGDP (Continued)

Primary contaminants associated with site challenges are highlighted in bold, italic font.
+D indicates including daughter products.
[a] This list of chemicals, compounds, and radionuclides was compiled from chemicals of potential concern retained as contaminants of concern in baseline risk assessments performed at PGDP between 1990 and 2008 (i.e., DOE 1996a; DOE 1996b; DOE 1999a; DOE 1999b; DOE 2005a; and DOE 2008b).

1.4 GOAL OF PGDP CLEANUP STRATEGY

The goal of the PGDP cleanup strategy is to maximize the use of on- and off-site locations consistent with current and reasonably anticipated future use patterns. This end state goal was derived considering current and past land use, existing lease/licensing commitments, future missions at PGDP, the nature of site contamination, and input from involved parties.

To achieve the goal, specific site cleanup objectives were established. These objectives serve as the guiding principles used when developing more detailed remedial action objectives (RAOs) that focus on specific OU problems. The cleanup objectives were developed considering current and reasonably anticipated future land use, exposure pathways, and potentially affected receptors. These cleanup objectives are as follows:

- Ensure response actions are protective under both current and reasonably anticipated future land use.
- Implement a remediation approach with an emphasis on accelerated actions.
- Establish priorities that emphasize accelerated risk reduction while considering opportunities to implement activities intended to reduce long-term surveillance and maintenance costs.
- Ensure that enforceable milestones and funding requests are based on clearly defined work scope and objectives.

Under each of these objectives, protectiveness is defined either in terms of chemical-specific applicable or relevant and appropriate requirements (ARARs) or in terms of calculated risk-based concentrations consistent with the National Contingency Plan (NCP) (i.e., the implementing regulations of CERCLA). The ARARs are compiled as appropriate when response action decisions are made. The risk-based concentrations also are calculated when the response action decision is made and, for human health, are based on an exposure scenario and risk target agreed to by the regulatory agencies. (Please see Chapter 4 for additional information, as the scenario and targets vary by area.) For nonhuman receptors, the risk-based concentrations are estimates of concentrations of substances present in the environmental media that will protect ecological receptors at the site (DOE 2000a).

FIGURES

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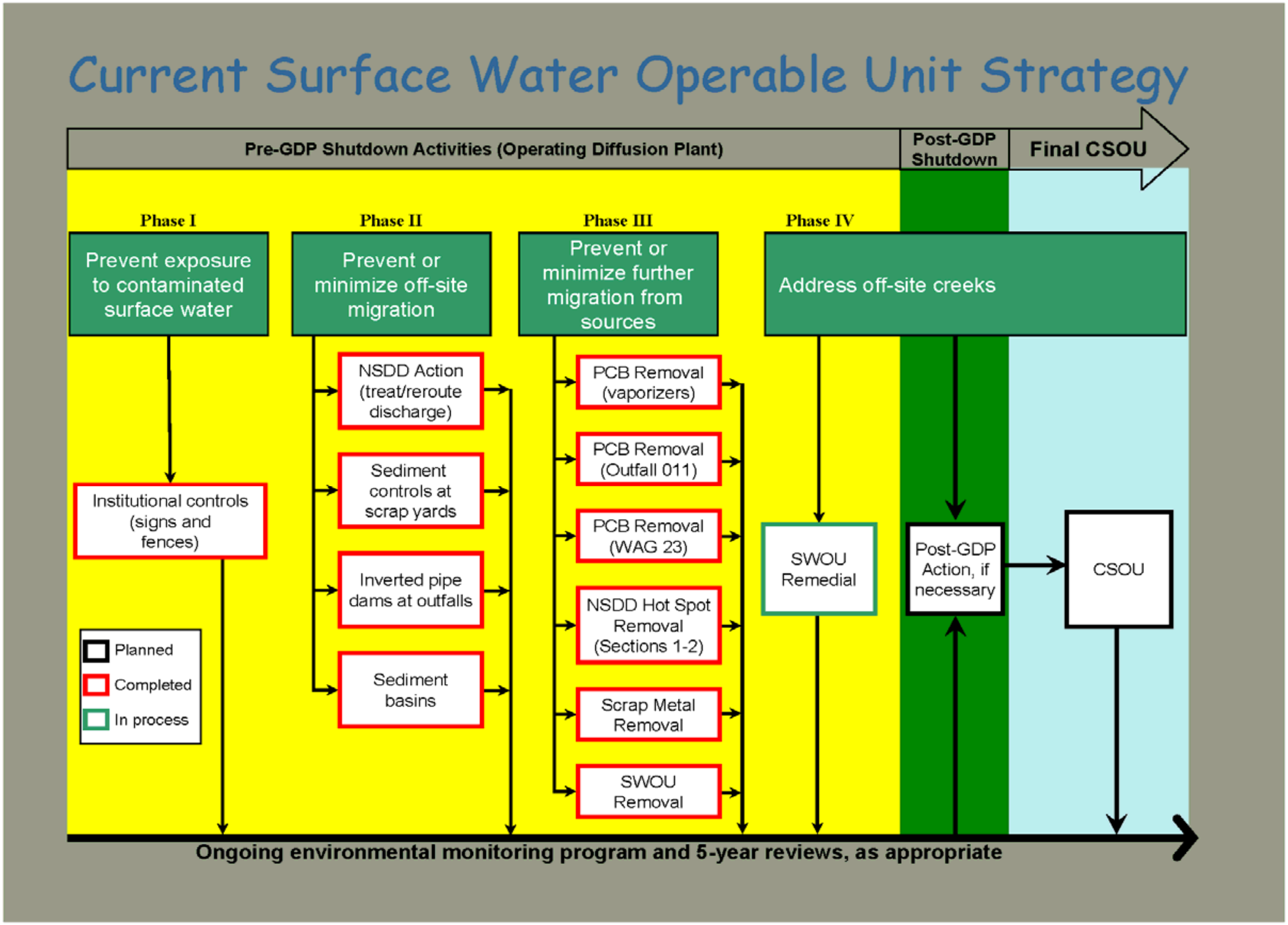

Figure 1.2. Current Surface Water Operable Unit Strategy

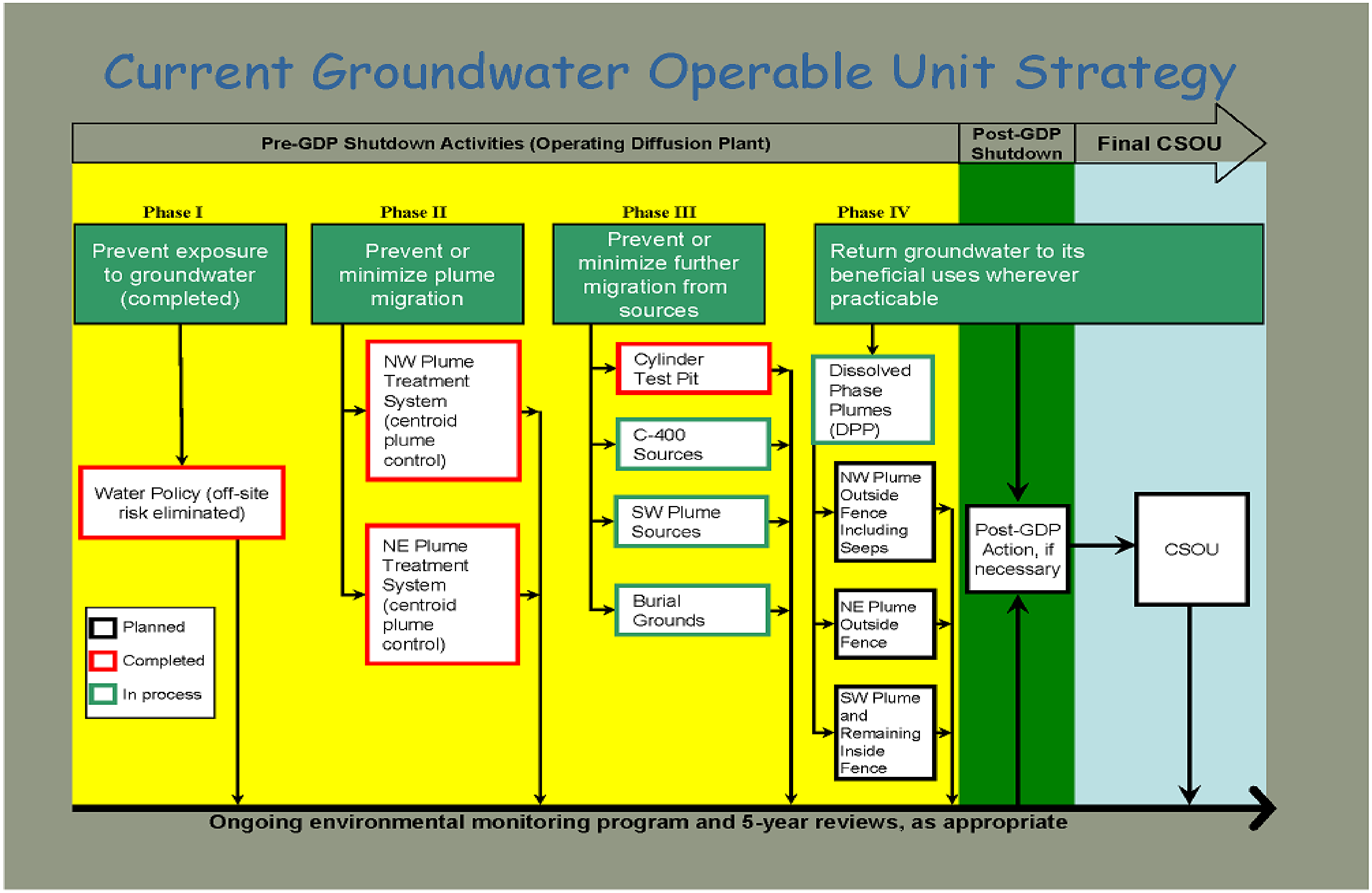

Figure 1.3. Current Groundwater Operable Unit Strategy

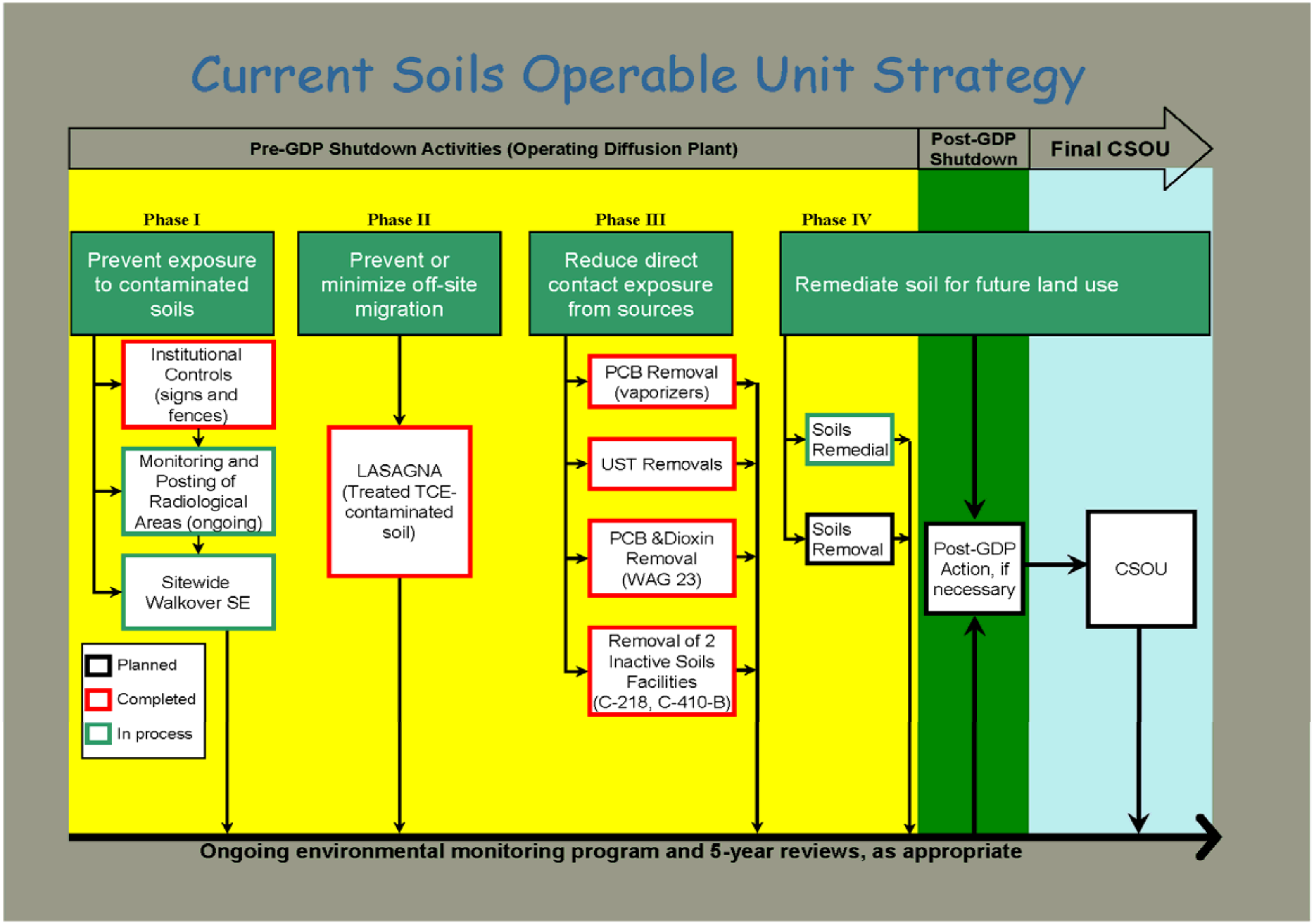

Figure 1.4. Current Soils Operable Unit Strategy

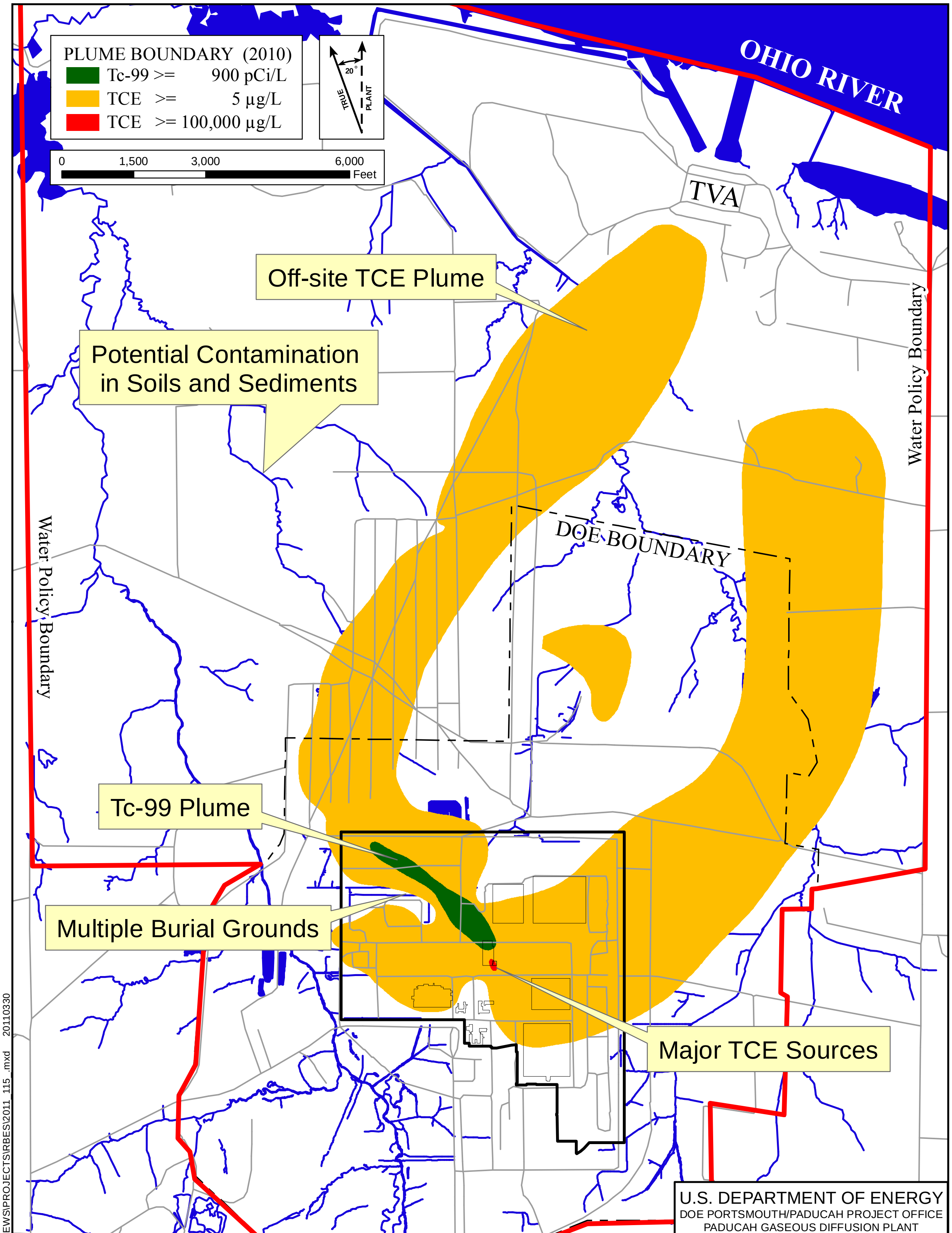

Figure 1.5. Major Site Challenges

2. REGIONAL CONTEXT DESCRIPTION

This chapter presents the regional context description. This description is intended to place PGDP within its larger contiguous regional area and depict its relationship to possible off-site pathways and ecological or human receptors of concern. The maps presented in this section depict the boundaries of all contiguous local and county governments and encompass all regional watersheds (e.g., the Ohio River), habitat and ecology areas, and other off-site areas that could be affected by contamination migrating from the site. Regional maps are presented for both the current state and potential end state alternative.

2.1 PHYSICAL AND SURFACE INTERFACE

This section discusses and depicts the regional administrative boundaries, major transportation and infrastructure features, major surface configuration features, and significant hazard areas at PGDP under both the current state and potential end state alternative. Administrative boundaries included are those for city, county, and state governments; federal and state properties, including the PGDP property boundary; and legal ownership (i.e., private versus governmental ownership). Transportation and infrastructure features included are major highways, roads, and railroads; dams and power plants; and major lakes, streams, and rivers.

2.1.1 Current State

Figure 2.1a depicts all physical and surface features under current conditions on a single map. The following narrative references this map.

Administrative Boundaries: As depicted in Figure 2.1a, PGDP is located in western McCracken County, Kentucky, approximately 3.5 miles south of the Ohio River and approximately 10 miles west of the city of Paducah. The DOE-owned property at PGDP encompasses approximately 3,556 acres. The industrial portion of PGDP is situated within a fenced security area consisting of approximately 650 acres. Within this area are the numerous buildings and offices, support facilities, equipment storage areas, and active and inactive waste management units that comprise the GDP. Outside the fenced security area are approximately 800 acres that are not surrounded by the main security fence, but are controlled for security purposes. The remaining 1,986 acres are licensed to the Commonwealth of Kentucky as part of the West Kentucky Wildlife Management Area (WKWMA). The entire WKWMA covers approximately 6,823 acres. A second wildlife management area, the Ballard Wildlife Management Area (BWMA) is in Ballard County, Kentucky, approximately 11 miles west of PGDP. The Shawnee Fossil Plant, a Tennessee Valley Authority-owned (TVA-owned) power plant, is immediately north of PGDP.

Another administrative boundary shown on Figure 2.1a is that for the PGDP Water Policy. The PGDP Water Policy was established as part of a removal action completed under the ACO (DOE 1994). Through this action, DOE offered municipal water to all existing private residences and businesses within the area affected by contaminated groundwater originating at PGDP. In return, the affected residences and businesses agreed not to drill new water supply wells or use existing water wells and to allow PGDP personnel property access to sample groundwater. (See Chapter 4 for additional discussion of the PGDP Water Policy.)

In addition to Paducah, cities and towns in Kentucky near PGDP are Barlow, La Center, and Kevil. Counties surrounding McCracken County are Ballard County (KY) to the west, Carlisle County (KY) to the southwest, Graves County (KY) to the south, Marshall County (KY) to the east, Livingston County

(KY) to the northeast, Massac County (IL) to the north, and Pulaski County (IL) to the northwest. Property surrounding the DOE-owned PGDP, Kentucky-owned WKWMA, and TVA-owned steam plant is privately owned. The nearest schools are Heath Elementary, Middle, and High Schools. These are 1.86 miles southeast of the plant in the unincorporated community in Heath, KY. The nearest hospitals are in Paducah.

Transportation and Infrastructure: As depicted in Figure 2.1a, PGDP is near the following major roads: U.S. Highway 60 and Kentucky Highways 358, 725, and 996. Additional major roads at greater distance are Interstate 24 and U.S. Highway 62. A rail spur services PGDP and connects to the Illinois Central Gulf Railroad. The nearest airport is Barkley Regional Airport, located approximately about 3.7 miles southeast of the site.

As noted, PGDP is approximately 3.5 miles south of the Ohio River. This river is navigable along its entire length and, near PGDP, has a downstream connection to the Mississippi River and an upstream connection to the Tennessee River. Dams (i.e., Lock and Dams No. 52 and 53) are located on the Ohio River both upstream and downstream from PGDP. In addition, the Kentucky Lock and Dam is located on the Tennessee River near its confluence with the Ohio River.

Surface Configuration: PGDP is located in the Jackson Purchase Region of western Kentucky, at the northern tip of the Mississippi Embayment portion of the Atlantic Coastal Plain physiographic province. The area is bounded on the north and east by the Highland Rim portion of the Interior Low Plateau physiographic province, an area of low plateaus. The Mississippi Embayment is a large sedimentary trough oriented north–south that received sediments from the middle of the North American continent. Major rivers running across this region are the Mississippi River to the west of PGDP, the Ohio River to the north of PGDP, and the Tennessee and Cumberland Rivers to the east of PGDP. Wetlands are found along the Ohio and Mississippi Rivers.

The region encompassing PGDP is characterized by low relief. Elevations vary 350 to 400 ft above mean sea level (amsl). Streams are common throughout the region, with many having eroded small valleys that are up to 20 ft below adjacent areas. Near PGDP, the two principal streams are Bayou Creek and Little Bayou Creek.

Hazard Areas of Concern: As depicted in Figure 2.1a, the hazard areas associated with PGDP include two major groundwater plumes that exist off DOE-owned property and four landfills located outside the main industrialized area of PGDP. Contamination also has been found in sediments along Bayou and Little Bayou Creeks in off-site areas.

The only active National Priorities List (NPL) sites near PGDP are found to the east in Calvert City, KY. These are the 2.75-acre Airco site and the 2-acre B.F. Goodrich site. These NPL sites are approximately 22 miles from PGDP. Please see the text box for information about these sites.

NPL Sites near PGDP

Airco site—An industrial landfill located approximately 2 miles northeast of Calvert City, Marshall County, KY, near the southern bank of the Tennessee River. From the mid-1950s until 1971, it is estimated that the landfill accepted 18,000 tons of caustics, acids, volatile organic compounds, zinc, mercuric acetate, and mercuric chloride. Disposals from 1971 to 1980 consisted of 14,000 tons of metal-contaminated coal ash, as well as polyvinyl chlorides, ferric hydroxide sludge, and construction wastes. The landfill was capped and closed in 1981. Groundwater, sediment, and soil are contaminated with PCBs, PAHs, and solvents from the former waste disposal practices.

The B.F. Goodrich site is a 2-acre industrial landfill that lies adjacent to the Airco site. Wastes disposed of from 1969 to 1972 consisted of 54,000 tons of construction waste and plant trash, 370 yd^3 of salt-brine sludge, and 2 million gal of liquid chlorinated organics (in several burn pits). From 1973 to 1980, the only waste disposed of at the site was excavation dirt. The landfill was closed under a state-approved closure plan in 1980. Groundwater, soil, and sediment are contaminated with solvents from the former waste disposal activities.

An additional, much larger NPL site previously was located in Mayfield, KY, approximately 15 miles from PGDP; however, this NPL site was determined to require no further action by the U.S. EPA in October 2000. This site is a 58-acre landfill located near a tire manufacturing plant. The landfill received approximately 152 tons of waste between 1970 and 1979. The investigation and risk assessment of the site was completed in the summer of 1993. Based on this study, EPA determined that no cleanup action was necessary because the site did not exhibit a threat to human health or the environment; however, the landfill continues to be monitored by the Commonwealth of Kentucky.

A closed municipal landfill is found to the east of PGDP. This landfill was used by McCracken County until it was closed; it now is a park containing soccer fields.

A coal-fired power plant, the Shawnee Fossil Plant, is located to the north of, and is contiguous to, PGDP. Another steam plant, Electric Energy, Inc., is located across the Ohio River in Joppa, IL. (See also Figure 2.1a.) The steam plants could be a potential source of some past or current air pollution at PGDP; however, there are no data that indicate any impacts currently exist or occurred in the past. A natural gas-fired power plant in east McCracken County began operation in 2010 (Electric Light & Power 2010). The new power plant is not expected to impact PGDP.

The water taken from the Ohio River for use in cooling at PGDP is a source of potential contamination. This water contains sediments contaminated with PCBs originating at upstream industrial sites. When these sediments are allowed to settle out at the PGDP water treatment plant, the concentrations of PCBs and metals in these sediments often are above PGDP-specific no action levels taken from DOE 2011b.

2.1.2 Potential End State Alternative

Figure 2.1b depicts all physical and surface features under potential end state alternative conditions on a single map. The following narrative references this figure.

Administrative Boundaries: As depicted in Figure 2.1b, DOE-owned property is not expected to increase under the potential end state alternative; however, the potential end state alternative includes enhanced institutional controls that would replace the existing PGDP Water Policy and be implemented on both DOE- and non-DOE-owned property. These controls could range from implementation of legal agreements with surrounding landowners to place enforceable restrictions on groundwater use to DOE's acquiring rights from surrounding property owners and directly implementing restrictions on groundwater and property use. A property acquisition study determined that property purchase options were not cost-effective when compared to the restrictive easement and a continuance of the PGDP Water Policy (KRCEE 2007a). Depending on the actions chosen to implement enhanced institutional controls, DOE-owned property could increase.

Transportation and Infrastructure: As depicted in Figure 2.1b, three significant changes in transportation and infrastructure are anticipated. These are construction of the Olmstead Dam on the Ohio River, the completion of I-69, and the construction of I-66. The Olmstead Dam will replace Ohio River Lock and Dams No. 52 and 53 and be located near Olmstead, IL. I-69 will cross north to south across western Kentucky, running from Fulton, KY, to Evansville, IN. Near PGDP, I-69 is planned to follow the current Purchase Parkway until the Parkway's end at I-24. I-66 is planned to run from east to west across all of Kentucky. Near PGDP, I-66 will follow a corridor that exits from I-24 near Paducah, KY, and crosses the Mississippi River south of its confluence with the Ohio River. In Missouri, I-66 will intersect with I-57.

Surface Configuration: As depicted in Figure 2.1b, no changes in surface configuration are expected by the end of the current planning horizon.

Hazard Areas of Concern: As depicted in Figure 2.1b, on a regional scale, the surface hazard areas found at PGDP will change significantly by the end of the current planning horizon under the potential end state alternative. By that time, all potentially contaminated sediments in Bayou and Little Bayou Creek will be addressed; all potentially contaminated surface soils and sediments in the secure area of PGDP will be addressed; and the GDP, including those facilities that currently are inactive and those that currently are operating, will undergo D&D. Hazard areas not at PGDP (i.e., NPL sites, Shawnee Fossil Plant, and Ohio River sediments) should change little in this time frame. The NPL sites are expected to change little because each of the NPL sites consists of a landfill that is not targeted for excavation.

Furthermore, the Shawnee Fossil Plant can be expected to be upgraded, as appropriate, and continue to operate. Finally, some improvements in the quality of Ohio River sediment can be expected if regional releases of contaminants to the river are maintained at low levels (compared to historical values); however, significant improvement in river sediment PCB concentrations is unlikely, given their current presence in Ohio River sediment and their persistence in the environment.

2.2 HUMAN AND ECOLOGICAL LAND USE

Material in this section discusses and depicts the human activities, land cover, and ecological activities at PGDP under both the current state and potential end state alternative. Human activities included are limited to a regional representation of population centers (i.e., locations of towns and cities) and density. Land cover depictions are based on area usage and include residential, commercial, industrial, agricultural, nonagricultural vegetated, and wetlands/water uses. Ecological activities included are conservation and ecological areas, watershed delineations, and biota habitats. Note that hazard areas of concern are discussed in Section 2.1 and are not discussed further here.

2.2.1 Current State

The figures in this section depicts the human and ecological land use information under current conditions.

Human Activities: As depicted in Figure 2.2a, and discussed earlier, cities and towns in Kentucky near PGDP are Paducah, Wickliffe, Barlow, La Center, and Kevil. Populations of these and other incorporated cities and towns in Ballard and McCracken Counties in the 2010 census (DOC 2011) are listed in Table 2.1. Population and density of McCracken County and surrounding counties is in Table 2.2.

Table 2.1. Population of Cities in Ballard and McCracken Counties, Kentucky (DOC 2011)

City/County	Population
Ballard County	8,249
Barlow	675
Blandville	90
Kevil	376
La Center	1,009
Wickliffe	688
McCracken County	65,565
Paducah	25,024

Table 2.2. Population Density and Total Population for Counties Near PGDP (DOC 2011)

County	Density	Population
Kentucky	108.5	4,339,367
Ballard	33.4	8,249
Carlisle	26.5	5,104
Graves	67.0	37,121
Livingston	30.2	9,519
McCracken	264.1	65,565
Marshall	98.8	31,448
Illinois	229.6	12,830,632
Massac	64.9	15,429
Pulaski	31.5	6,161

As depicted in Figure 2.2a and shown in Tables 2.1 and 2.2, population density and total population in areas near PGDP were low, relative to the average for the Commonwealth of Kentucky and the U.S. in the 2010 census. Except for McCracken County, which includes the city of Paducah, and Marshall County, including several small cities, population density is less than the Kentucky and U.S. average. For McCracken County, approximately 41% of the total population lives within the boundaries of Paducah.

The total population within a 10-mile radius of PGDP was estimated at 44,053 in 2010 (DOC 2011). The closest communities near PGDP are the unincorporated communities of Grahamville and Heath, located 1 to 2 miles east. The closest residences to the site are approximately 3,280 ft north and 3,609 ft east of PGDP.

Land Cover: As depicted in Figure 2.2a, land cover in the region near PGDP is dominated by agricultural and non-agricultural vegetated use. With the exception of PGDP and TVA's Shawnee Fossil Plant, little industrial land use occurs near PGDP. Several commercial properties are found in and near Paducah.

Within a 5-mile radius of the plant, approximately 90% of the area was identified as being agricultural or forested land in a PGDP environmental report (MMES 1993). This report also noted that urban and industrial lands comprise less than 4% of the surrounding area, and surface-water bodies cover approximately 5%. A public health assessment produced by the Agency for Toxic Substances Disease Registry (ATSDR 2002) for PGDP notes that there are approximately 400 active farms in McCracken County, Kentucky, with 45 to 50 operating in the area near PGDP.

Ecological Activities: As depicted in Figure 2.2a, ecological activities near PGDP are dominated by agricultural use, nonagricultural vegetated use, and wetlands. As discussed above, approximately 90% of the area is agricultural land or forested. Wetlands of significant size are found along the Ohio, Mississippi, and Tennessee Rivers.

Hazard Areas of Concern: Please see Section 2.1 for a depiction and discussion of hazard areas of concern under current conditions.

2.2.2 Potential End State Alternative

The figure in this section depicts the human and ecological land use information under the potential end state alternative.

Human Activities: As depicted in Figure 2.2b, the location of cities and towns and population density are expected to change little within the planning horizon used. This projection is consistent with the past population counts for Ballard and McCracken Counties shown in Table 2.3, which presents total population from 1960 to 2010 and with population changes between 1980 and 2010 for Paducah, shown in Table 2.4. ATSDR reports (ATSDR 2002) that information obtained from the Census Bureau and McCracken County Seat suggests that McCracken County's population is expected to keep growing, with the addition of new housing subdivisions west of Paducah toward Ballard County providing the bulk of the growth. ATSDR also notes that there is an ongoing initiative to bring new industries into the area. These changes undoubtedly will affect the make-up of the population near PGDP, but the rate of change is uncertain given the lack of previous population changes.

Land Cover: As depicted in Figure 2.2b, little change is expected in the land use in the region near PGDP within the period considered. As discussed in ATSDR 2002, however, a gradual transition from agricultural use to low-density housing (i.e., residences on lots averaging from 1 to 5 acres) and recreational use is possible. In that report, ATSDR states that this transition is indicated by the increasing subdivision of farmland for residential development along U.S. 60, west of Paducah, and the expansion of that road into a four-lane highway.

Table 2.3. Historical Total Population of Ballard and McCracken Counties, Kentucky (DOC 2011)

County	1960	1970	1980	1990	2000	2010
Ballard	8,618	8,276	8,798	7,902	8,286	8,249
McCracken	57,306	58,281	61,310	62,839	65,514	65,565

Table 2.4. Historical Total Population of Paducah, Kentucky (ATSDR 2002; DOC 2011)

City	1980	1990	2000	2010
Paducah	29,315	27,256	26,307	25,024
% Change		-7%	-3%	-5%

Ecological Activities: As depicted in Figure 2.2b, little change is expected in ecological activities. As noted above, the only changes expected in the long-term are a decrease in the agricultural use of land and an increase in low-density housing.

Hazard Areas of Concern: Please see Section 2.1 for a depiction and discussion of hazard areas of concern under end-state conditions.

2.3 CUSTOM CONFIGURATION—SEISMIC ISSUES AT PGDP

Three seismic sources have the potential to affect PGDP (Figure 2.3): the New Madrid Seismic Zone (centered near the juncture of Kentucky, Missouri, and Tennessee); the Wabash Valley Seismic Zone (in southeast Illinois and southwest Indiana); and background seismicity (KRCEE 2007b).[1] Of these, the New Madrid Seismic Zone presents the most prominent seismic hazard to PGDP. Additional information regarding seismic issues at PGDP is presented in *Final Report: Seismic Hazard Assessment at the PGDP* (KRCEE 2007b).

[1] Background seismicity is seismic activity not associated with any known seismic zone.

FIGURES

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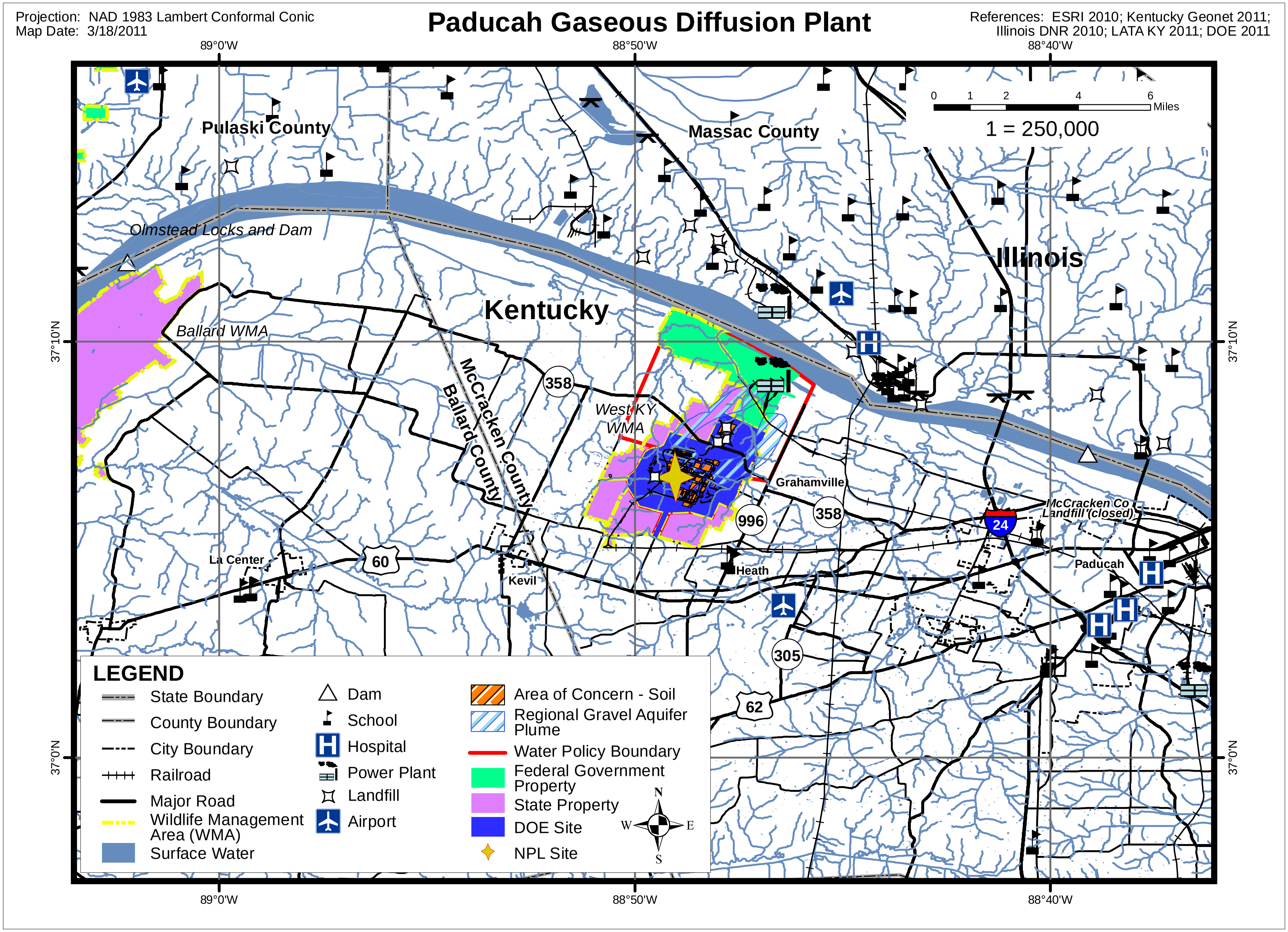


Figure 2.1a. Regional Physical and Surface Interface - Current State

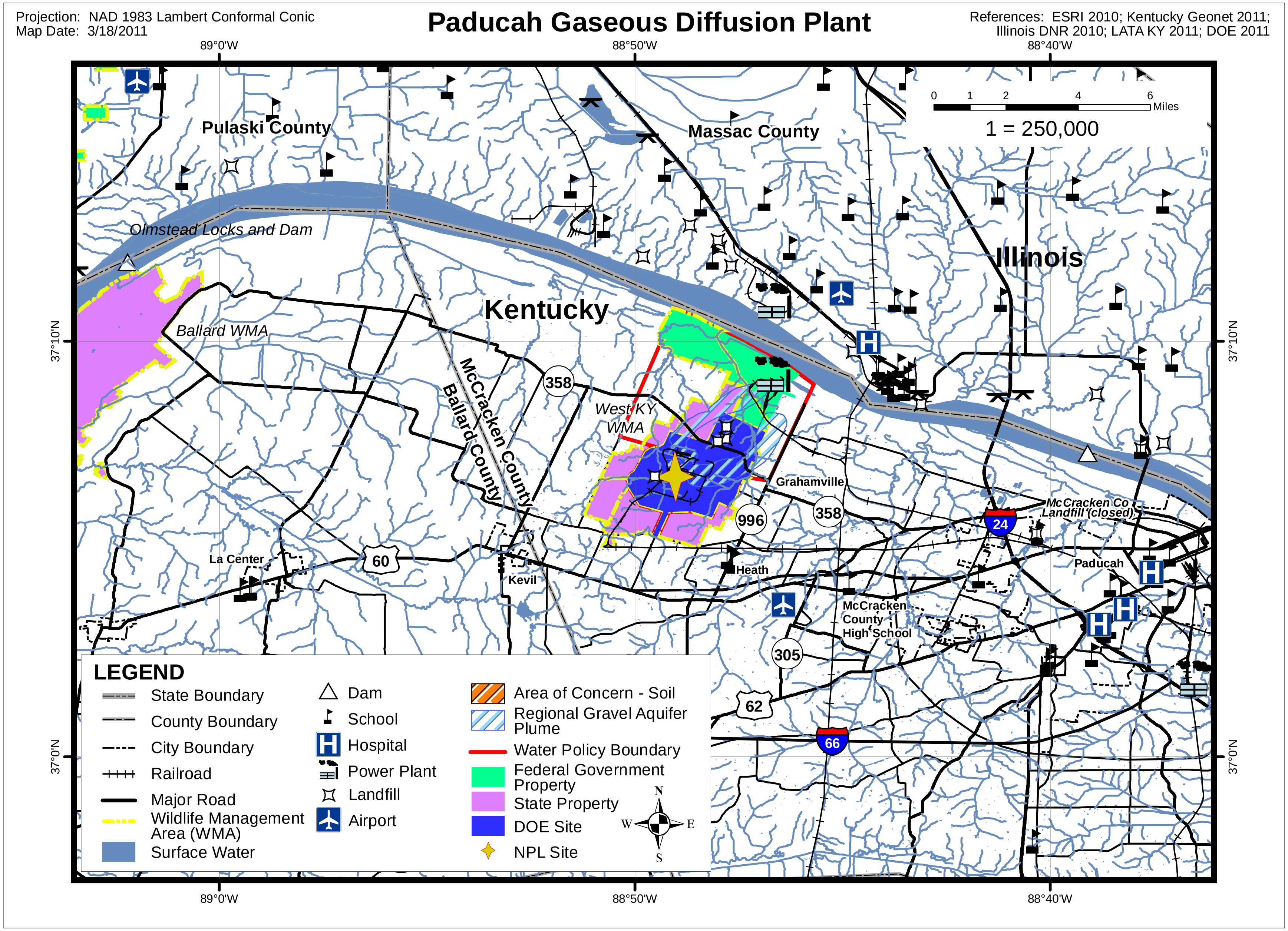


Figure 2.1b. Regional Physical and Surface Interface - Potential End State Alternative

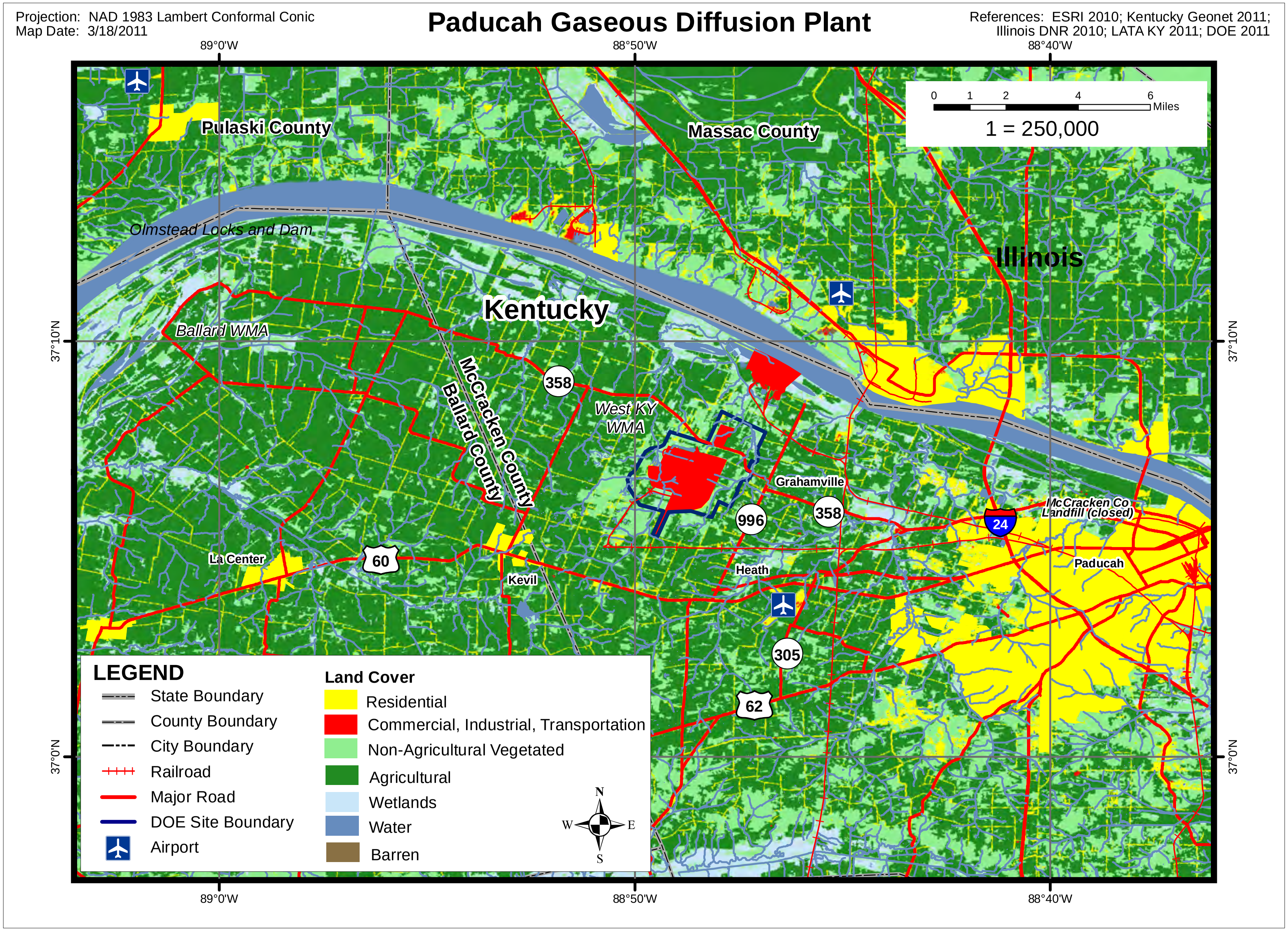


Figure 2.2a. Regional Human and Ecological Land Use - Current State

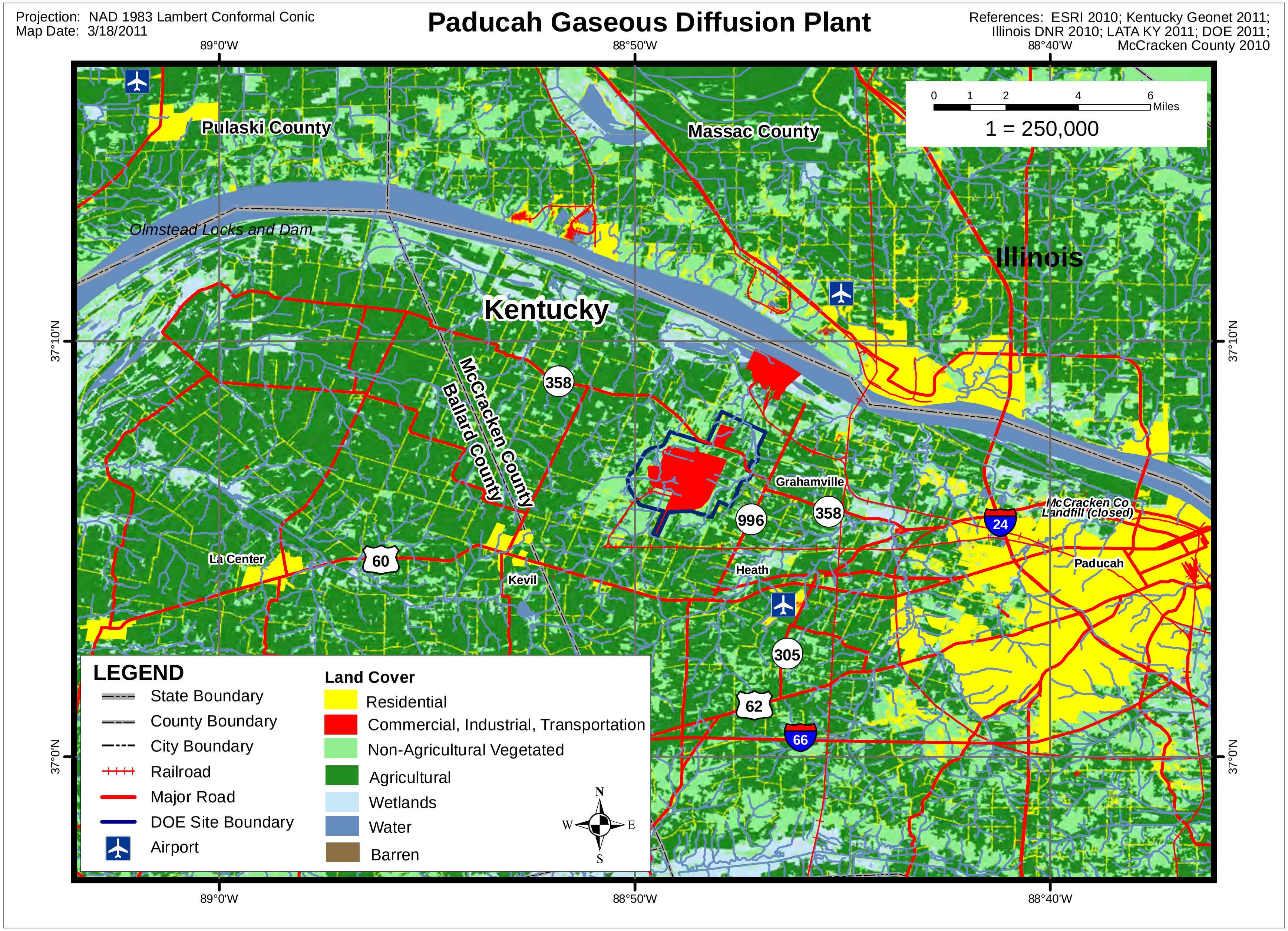
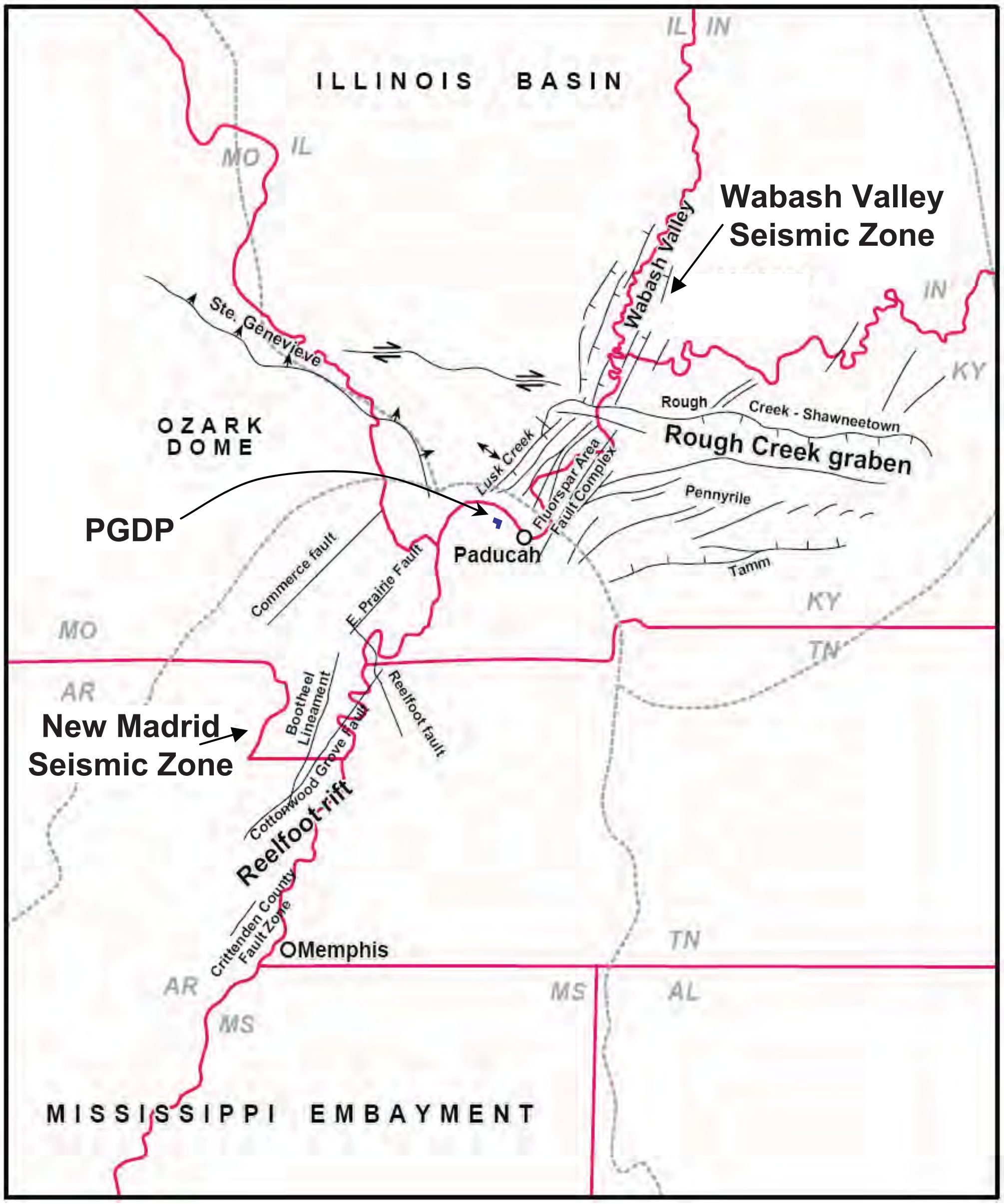


Figure 2.2b. Regional Human and Ecological Land Use - Potential End State Alternative



LEGEND

.........Faults

.........Physiographic boundary

0 — 50 mi

0 — 50 km

(scale is approximate)

N

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

LATA Environmental Services of Kentucky, LLC

Figure 2.3. Regional Custom Configuration - Regional Tectonic Map

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3. SITE-SPECIFIC DESCRIPTION

This chapter presents the site-specific description. This description presents information similar to that in Chapter 2, except at a greater level of detail. Generally, the maps presented here are similar to the sitewide maps that have appeared in the various RI documents (e.g., DOE 1996a, 1996b, 1997, 1998a, 1999a, 1999b, 2000a, 2000b) and FS reports (e.g., DOE 2001a) prepared for PGDP.

The maps presented in this chapter are intended to show all areas and human and ecological receptors of concern near PGDP that might be affected by contamination originating on the site. The maps presented in this section depict the boundaries of all contiguous local and county governments and encompass site watersheds (i.e., Bayou and Little Bayou Creek), habitat and ecology areas, and other areas that could be affected by contamination migrating from the site. Site maps are presented for both current and potential end state alternative land use.

Additionally, Section 3.5 of this chapter presents information that has been collected to date concerning the hydrogeology and contaminant plumes at the PGDP. Custom configuration figures in this section are a geological cross-section and a map that shows the contaminant levels currently found in groundwater in source areas and within the plumes.

3.1 PHYSICAL AND SURFACE INTERFACE

Material in this section discusses and depicts the local administrative boundaries, transportation and infrastructure features, surface configuration features, and their relationship with hazard areas of concern at PGDP under both the current state and potential end state alternatives. Administrative boundaries included are those for local governments; federal and state properties, including the PGDP property boundary and fence lines; and legal ownership (i.e., private versus federal ownership). Transportation and infrastructure features included are highways, roads, and railroads; utility lines; and power plants. Surface configuration features included are Bayou Creek and Little Bayou Creek watersheds and major drainages leading from PGDP. Information presented about hazard areas of concern includes locations of contaminated surface water, sediment, and soil; waste cells (i.e., burial grounds); groundwater plumes; and contaminated buildings. Other information includes locations of monitoring wells, drinking water wells, and relevant institutional controls.

3.1.1 Current State

Figure 3.1a depicts all physical and surface features under current conditions on a single map. The following narrative references this map.

Administrative Boundaries: As depicted in Figure 3.1a, the DOE-owned PGDP is surrounded by the state-owned WKWMA, the TVA-owned steam plant, and private property. As noted in Chapter 2, PGDP encompasses approximately 3,556 acres, with the industrial portion of PGDP situated within a fenced security area that consists of approximately 650 acres. Within this area are the numerous buildings and offices, support facilities, equipment storage areas, and active and inactive waste management units that comprise PGDP. Outside the fenced security area are approximately 800 acres that are not surrounded by the main security fence, but are controlled for security purposes. The remaining 1,986 acres are licensed to the Commonwealth of Kentucky as part of the WKWMA. The entire WKWMA covers approximately 6,823 acres. Another administrative boundary shown on Figure 3.1a is that for the PGDP Water Policy.

As discussed in Section 2.1, the PGDP Water Policy Area was established as part of a removal action completed under the ACO (DOE 1994), through which DOE offered municipal water to all existing private residences and businesses within the area affected by contaminated groundwater originating at PGDP. In return, the affected residences and businesses agreed not to drill new water supply wells or use existing water wells and to allow PGDP personnel property access to sample groundwater. (Please see Chapter 4 for additional discussion of the PGDP Water Policy.)

No incorporated towns or cities are visible on the site-context map; however, the unincorporated community of Heath borders the eastern and southeastern sides of PGDP. The nearest schools are Heath Elementary, Middle, and High Schools located about 1.86 miles southeast of PGDP in Heath.

Transportation and Infrastructure: As depicted in Figure 3.1a, several state and county roads run near PGDP, with the main entrance road running from U.S. Highway 60 northeast into the plant. About 17.5 miles of paved roadway (concrete or asphalt) are in the industrialized portion of PGDP, and additional patrol roads and paved access roads branch to the plant's periphery. In addition, a railroad spur services PGDP and there are slightly more than 17 miles of track within the industrialized area. The spurs connect to the Illinois Central Gulf Railroad. No airports are visible on the site-context map. (The nearest airport is Barkley Regional Airport located approximately about 3.7 miles southeast of PGDP.)

Surface Configuration: The PGDP region is characterized by low relief. Elevations vary from 290 ft amsl at the Ohio River, located approximately 3.5 miles to the north, to 380 ft amsl on the plant site. Two main topographic features dominate the landscape: a loess-covered terrace, at 350-380 ft amsl elevation, and the Ohio River floodplain zone, dominated by alluvial sediments, at 300-320 ft amsl.

The terrain of the PGDP area is modified slightly by the branching drainage systems associated with Bayou Creek and Little Bayou Creek. These northerly flowing streams, which meet 3.5 miles north of the site and discharge into the Ohio River, have eroded small valleys that are approximately 20 ft below the adjacent plain and ultimately discharge to the Ohio River. Bayou Creek is a perennial stream, and its drainage extends from approximately 2.5 miles south of PGDP to the Ohio River. Drainage flows toward the river along a 9-mile course that passes along the western boundary of the industrialized area of the plant. Little Bayou Creek, an intermittent stream south of PGDP, originates in the WKWMA and flows north toward the Ohio River along a 6.5-mile course that includes parts of the eastern boundary of the industrialized area of plant. Effluents from PGDP operations constitute ~85% of the normal flow in Bayou Creek and nearly 100% of the normal flow in Little Bayou Creek (Kornegay et al. 1991).

The average elevation at PGDP is 380 ft amsl, or about 80 ft above the average water level of the Ohio River near the plant. Storm water and effluent from the plant flow into a series of man-made ditches and storm sewers that direct flow off of plant property through outfall ditches. These outfall ditches, which contain a specific point that is monitored for compliance with regulatory discharge limits, carry storm water and/or effluent into Bayou and Little Bayou Creeks.

Hazard Areas of Concern: Several hazard areas are visible in Figure 3.1a. These consist of the process buildings, landfills, and contaminated soils and sediments found on DOE-owned property and two major dissolved-phase solvent plumes found off DOE-owned property. In addition, contaminated sediments are found along Bayou and Little Bayou Creeks both on and off DOE property. Two groundwater pump-and-treat systems also are visible in Figure 3.1a. These systems are located near the centers of the Northeast and Northwest Plumes and are used to control the migration of the high-concentration centroids of these plumes. (Note that these pump-and-treat systems do not completely contain the plumes hydraulically and are not intended to completely "remediate" the dissolved-phase plumes.) The plumes also are monitored by several wells located within the plumes and along their peripheries. (Please see Section 3.5 for additional information on groundwater flow and the contaminant plumes at the PGDP.)

3.1.2 Potential End State Alternative

Figure 3.1b depicts all physical and surface features under the potential end state alternative on a single map. The following narrative references this figure.

Administrative Boundaries: As depicted in Figure 3.1b, DOE-owned property is not expected to increase under the potential end state alternative; however, the potential end state alternative does include enhanced institutional controls that would replace the existing PGDP Water Policy and be implemented on both DOE- and non-DOE-owned property. These controls could range from implementation of legal agreements with surrounding landowners to place enforceable restrictions on groundwater use to DOE's acquiring rights from surrounding property owners and directly implementing restrictions on groundwater and property use. Depending on the actions chosen to implement enhanced institutional controls, DOE-owned property could increase, though a property acquisition study determined that property purchase options were not cost effective when compared to the restrictive easement and a continuance of the PGDP Water Policy (KRCEE 2007a).

Transportation and Infrastructure: No significant transportation or infrastructure changes are visible on the site-context map. The changes in roads, railroads, and other infrastructure (e.g., utility lines) that may occur after GDP D&D are unknown, but these are expected to remain if PGDP is reindustrialized.

Surface Configuration: As depicted in Figure 3.1b, no changes in surface configuration are expected by the end of the current planning horizon; however, Little Bayou Creek may become an intermittent stream if PGDP ceases discharging effluent to it.

Hazard Areas of Concern: As depicted in Figure 3.1b, on a site-specific scale, the surface hazard areas found at PGDP will change significantly by the end of the current planning horizon under the potential end state alternative. As noted in Chapter 2, when the end state is attained, potentially contaminated sediments in Bayou and Little Bayou Creeks will be addressed; potentially contaminated surface soils and sediments in the industrialized area of PGDP will be addressed; and the GDP, including those facilities that currently are inactive and those that currently are operating, will undergo D&D. Hazard areas expected to remain are the permitted landfills (potentially including a newly constructed CERCLA Cell, which is assumed to be used for on-site disposal of materials from the D&D of the GDP), the subsurface sources of the groundwater plumes and the dissolved-phase plumes, and the capped burial grounds. (Please see Section 3.5 for additional information on groundwater flow and the contaminant plumes at the PGDP.)

3.2 HUMAN AND ECOLOGICAL LAND USE

Material in this section discusses and depicts the human activities, land cover, and ecological activities and their relationship to hazard areas of concern at PGDP under both the current state and potential end state alternative. Human activities included are land use and water supply information. Ecological activities included are conservation and ecological areas, watersheds, wetlands and floodplains, and biota habitat. Information presented about hazard areas of concern matches that in Section 3.1.

3.2.1 Current State

Human Activities:

Several small communities are located within 5 miles of PGDP. The closest communities, both unincorporated, are Grahamville, located 1 mile to the east, and Heath, located approximately 2 miles to the southeast. These areas support multiple private houses and lots, with the nearest residing approximately 3,000 ft from the industrial area. Areas south of PGDP are mainly rural. West of PGDP, the population density is low, and the setting is rural.

Land Cover:

Current human activities at and around PGDP are depicted on Figure 3.2a1, and include the following land uses:

- Residential
- Manufacturing/Industrial
- Agricultural
- Ecological/Preservation

The immediate area of PGDP is identified as a manufacturing and industrial area and is surrounded by the WKWMA for a minimum of approximately 1 mile in all directions. The WKWMA is an ecological preservation zone that is bordered on the west, east, and south by areas currently used for agricultural purposes. Residential areas are shown on the figure to the southeast of PGDP and across the Ohio River to the north.

Ecological Activities:

The area surrounding PGDP supports a variety of ecological resources including the following:

- Vegetation
- Wildlife
- Aquatic regions
- Wetlands
- Threatened and endangered species

Each of these categories is discussed in the following section (DOE 2001a; DOE 2003d).

The upland habitats in the PGDP area support a variety of plant and wildlife species. Because much of the DOE-owned property and WKWMA terrestrial habitat is managed for multiple uses, the diversity of habitat is excellent. Forest and shrub tracts alternate with fencerows and transitional edge habitats along roads and transmission-line corridors. Fencerow communities are dominated by elm, locust, oak, and maple, with an often thick understory of sumac, honeysuckle, blackberry, and grape. Herbaceous growth in these areas includes clover, plantain, and numerous grasses.

The terrestrial community is described by the dominant vegetation-sites that characterize the community. The communities range from oak-hickory forest, in areas that have been relatively undisturbed, to managed fencerows and agricultural lands. Significant areas of the DOE-owned property and WKWMA include vegetation managed for consumption by wildlife, especially northern bobwhite quail.

Most of the area within WKWMA has been cleared of vegetation at some time. Approximately 2,000 acres in WKWMA consist of old field grasslands. Approximately 800 acres within WKWMA are in scrub or shrub habitat. The Kentucky Department of Fish and Wildlife Resources staff mows 600 to 700 acres; control burns 200 to 400 acres; plants 150 acres of food plots (for wildlife); and sprays, stripdiscs, or otherwise actively manages an additional 100 to 500 acres annually on WKWMA.

Wildlife commonly found in the PGDP area consists of species indigenous to open grassland, thickets, and forest habitats. Observations by ecologists and WKWMA staff have provided a qualitative description of wildlife communities likely to inhabit the vegetation communities in the WKWMA. Open herbaceous areas are frequented by rabbits, mice, and a variety of other small mammals. Birds include red-winged blackbirds, quail, sparrows, and predators such as hawks and owls. In areas that include fencerows, low shrub, and young forests, a variety of wildlife is present including opossum, vole, mole, raccoon, and deer. Birds typically present include red-winged blackbird, loggerhead shrike, mourning dove, northern bobwhite quail, wild turkey, northern cardinal, and western meadowlark. Several groups of coyotes also reside near PGDP. In mature forests, squirrel, various songbirds, and great horned owls may be present. The primary game species hunted for food in the area are deer, wild turkey, northern bobwhite, rabbit, and squirrel. Opossums and raccoons are hunted for dog training and pelts.

Both Bayou and Little Bayou Creeks and tributaries support a variety of aquatic life including several species of sunfish, as well as spotted and largemouth bass, bullheads, and creek chub. Inhabitants of shallow streams, characteristic of the two main area creeks, are dominantly bluegill, green and longear sunfish, and central stonerollers.

In addition to stream habitats, approximately 13 fishing ponds are located near PGDP, primarily in the WKWMA. Most of the ponds north of PGDP are used for public fishing. Ponds to the south of PGDP have been posted with consumption warnings, due to contamination from operations of an ordnance works that operated during World War II. Pond areas generally are dominated by largemouth bass, bluegill, and to a lesser extent, green sunfish.

Aquatic habitats are used by muskrat and beaver. Many species of water birds, including wood duck, geese, heron, and species of migratory birds, also use these areas. Numerous other smaller ponds and abandoned gravel pits usually contain water and may have functioning ecosystems.

Habitats that have soil and hydrology capable of supporting vegetation adapted for hydric environments are considered wetlands. These habitats include marshes (wetlands dominated by herbaceous species) and swamps (wetlands dominated by woody species), as well as variations between terrestrial and aquatic habitats. Near PGDP, there are numerous areas where these conditions prevail, particularly in the region adjacent to the Ohio River. Within the WKWMA, approximately 4,000 acres have been identified as having hydric soil capable of supporting wetlands (Figure 3.2a2). Some of these systems include a special-status species, the water hickory. Approximately 400 acres of this area are Tupelo Swamp, and another 600 acres are bottomland hardwood. The Tupelo Swamp, which is located near the Ohio River, is considered very unusual by state and federal land managers and is thought to be only one of three similar systems left in the United States. Most of the remainder of the wetlands in the PGDP vicinity is in agricultural use or is in some stage of succession to wetland scrub. Other wetland habitats are found associated with the shorelines of ditches and creeks (riparian vegetation), although many of these are incised and have only marginal areas of wetlands.

Eleven federally listed, proposed, or candidate species have been identified as potentially occurring at or near PGDP. None of the species has been reported as sighted on the DOE-owned property; however, potential summer habitat and suitable forage habitat exist on DOE-owned property for one listed species, the Indiana bat (Figure 3.2a3), and Indiana bats have been captured in the PGDP vicinity.

Hazard Areas of Concern: Please see Section 3.1 for a depiction and discussion of hazard areas of concern under current conditions.

3.2.2 Potential End State Alternative

Human Activities:

Figures 3.2b1 and 3.2b2 present the expected future land use and future zoning in the area, respectively. As shown in Figure 3.2b2, the areas south of PGDP are anticipated to remain urban and rural residential. As discussed in Section 2.2.2, a gradual transition from agricultural use to low-density housing (i.e., residences on lots averaging from 1 to 5 acres) and recreational use is possible. Note that the change from agriculture use to low-density housing is not reflected in Figure 3.2b1 because the area where the transition from agricultural use to low-density housing may occur is unknown. This transition is consistent with the increasing subdivision of farmland for residential development along U.S. 60, west of Paducah, and the expansion of that road into a four-lane highway.

The variance between the future land-use map (Figure 3.2b1) and the zoning map (Figure 3.2b2) is notable for the area encompassed by the WKWMA. As shown in Figure 3.2b1, the planned future use of the WKWMA, for purposes of cleanup decisions and the potential end state alternative, is ecological/preservation; however, as shown in Figure 3.2b2, the WKWMA currently is zoned manufacturing and industrial. This variance, while notable on the map, is of little practical significance because zoning for manufacturing and industrial does not preclude the anticipated ecological/preservation future land-use. (Note that if future land-use were changed to manufacturing and industrial from ecological/preservation, then the cleanup levels for the affected areas would be greater.)

Land Cover:

Land uses for the potential end state alternative are presented on Figure 3.2b1 and include the following:

- Residential
- Commercial
- Manufacturing/Industrial
- Agricultural
- Ecological/Preservation

The potential end state alternative land use is almost identical to the current state land uses, with the manufacturing/industrial PGDP area surrounded by the ecological/preservation area of WKWMA, which subsequently is bordered by agricultural areas. Residential areas under the potential end state alternative are to the southeast of PGDP and across the Ohio River to the north. Additionally, a commercial area that is identified on the zoning map is found to the southeast of the plant.

The most significant differences between Figures 3.2a1 and 3.2b1 are the removal of several hazard areas and the absence of the current extraction well system.

Ecological Activities:

Ecological resources in the PGDP area for the potential end state alternative will be consistent with the current state. Changes in the size of the WKWMA in the future may result in changes to the areas inhabited by terrestrial and aquatic species.

Hazard Areas of Concern:

Please see Section 3.2 for a depiction and discussion of hazard areas of concern under potential end state alternative conditions.

3.3 LEGAL OWNERSHIP

Material in this section discusses and depicts the legal ownership of areas at and around PGDP under the current state and potential end state alternative. The ownership (surface and subsurface) classes considered are private and government (i.e., state, federal, and local).

3.3.1 Current State

As depicted in Figure 3.3a state government-owned property (i.e., the state-owned portion of the WKWMA) borders PGDP on the south, west, and north sides; federal, government-owned property (i.e., the TVA Shawnee Fossil Plant) borders the PGDP north side; and private property borders PGDP on the east and south sides. Private property, in turn, surrounds the portion of the WKWMA bordering PGDP.

No incorporated communities are near enough to PGDP to appear on the site-context maps; however, the privately owned property to the east of PGDP does consist of homes located on relatively small lots (approximately 1 acre or less). This area is the unincorporated community of Heath.

The nearest schools also are located in Heath and are to the southeast of PGDP. These schools (i.e., Heath elementary, middle, and high schools) are approximately 1.86 miles from the boundary of DOE-owned property.

As noted earlier, portions of PGDP containing infrastructure needed for uranium enrichment are leased to USEC. Infrastructure leased to USEC includes the process buildings, electrical switchyards, an administration building, and several maintenance and support buildings. In total, USEC leases 421 acres of the approximately 650 acres within the secure area of PGDP.

An additional facility at PGDP is the depleted uranium hexafluoride conversion facility (DUF_6 Conversion Facility). This facility is located in the southeast corner of the DOE-owned property and covers 9 acres.

3.3.2 Potential End State Alternative

As depicted in Figure 3.3b, DOE-owned property is not expected to increase under the potential end state alternative. The potential end state alternative includes enhanced institutional controls that would replace the existing PGDP Water Policy and be implemented on both DOE- and non-DOE-owned property. These controls could range from implementation of legal agreements with surrounding landowners to place enforceable restrictions on groundwater use to DOE’s acquiring rights from surrounding property owners and directly implementing restrictions on groundwater and property use. Depending on the actions chosen to implement enhanced institutional controls, DOE-owned property could increase, though a property acquisition study determined that property purchase options were not cost effective when compared to the restrictive easement and a continuance of the PGDP Water Policy (KRCEE 2007a).

3.4 DEMOGRAPHICS

Information presented in this section discusses and depicts the population density and other pertinent demographic information for the area near PGDP under the current state and potential end state alternative. Demographic data presented include population data and housing and socioeconomic data.

3.4.1 Current State

As depicted in Figure 3.4a, the population density immediately around PGDP under current conditions is between 151 and 500 individuals per square mile. Specific demographic information from the 1980, 1990, and 2000 censuses about census tract 0315, block group 2, which is the block group for the area containing PGDP, is presented in Table 3.1.

As shown in Table 3.1, the area immediately around PGDP had a small net population gain from 1980 to 2000. The block group was over 90% white in the censuses and the percentage white has increased between censuses. There were slightly more elderly persons than children under age 10 in 1990, as the percentage of children declined, and the percentage of elderly people increased during that time.

For the 1990 census, there were 2.57 individuals per household, and nearly 90% of all households were owner-occupied, which is typical of rural areas. Over 71% of persons age 25 and older had at least a high school education, and median income was $27,560. Fewer than 13% lived below the poverty level, which is relatively low for western Kentucky. Over three-quarters of the housing units in the area had water from sources other than a private well (ATSDR 2002).

For the 2000 census, there were 2.48 individuals per household (a –3.5% change) and an 87% rate of home ownership (a –2.2% change). Over 71% of persons age 25 and older had at least a high school education, and the median household income was $37,308 (a 35% change). Fewer than 8% lived below the poverty level (a change of –39%) compared to a statewide average of 12.7%. The rate of private well use was similar to the 1990 census at 24%.

For the 2010 census, there remained 2.48 individuals per household (no change from 2000) and an 85.5% rate of home ownership (a –0.8% change). Additional 2010 information for the area has not been reported by the census bureau at this time.

3.4.2 Potential End State Alternative

By the end of the period considered, demographics are not expected to change markedly in areas near PGDP. As discussed in Chapter 2, the population size and the rate at which the population increases can be expected to become greater as the area around PGDP changes from agricultural use to low-density housing; however, the overall population density can be expected to remain below 500 individuals per square mile (Figure 3.4b). Additionally, the socioeconomic status can be expected to remain stable as industry is recruited to replace any jobs lost as the PGDP mission changes. Note that there is a chance that the inflation-adjusted median household income could fall if the PGDP mission changes abruptly, because PGDP is a major regional employer that pays relatively high wages.

Table 3.1. Demographic Information for the Area Near PGDP Under Current State (ATSDR 2002 and DOC 2011)[a]

Information	1980	1990	2000	2010
Population				
Total population	1,383	1,366	1,442	1,394
Percent change[b]		-1.2%	+5.6%	-3.4%
Density per square mile	46	45	45.3	43.8
Percent change		-2.2%	+5.3%	-3.4%
Race				
% Caucasian	91.4%	92.9%	94.4%	97.7%
Percent change		+1.6%	+1.6%	+3.4%
Age				
Under Age 10	16.1%	12.4%	10.9%	NA
Percent change		-23%	-12%	
Age 65 and Over	11.5%	13.0%	14.7%	15.2%
Percent change		+13%	+13%	+3.3%
Socioeconomic Information				
Total households	NA	531	581	581
Percent change			+9.4%	0%
Individuals per household	NA	2.57	2.48	2.48
Percent change			-3.5%	0%
% households owned	NA	88.5%	86.3%	85.5%
Percent change			-2.5%	-0.8%
Individuals age 25 and older	NA	927	974	NA
Percent change			+5.1%	
% with at least high school diploma	NA	71.4%	71.4%	NA
Percent change			None	
Median income, $	NA	$27,560	$37,308	NA
Percent change			+35%	
% below poverty level	NA	12.7%	7.7%	NA
Percent change			-39%	
Employed age 16 and older	NA	673	603	NA
Percent change			-10%	
% in blue collar job	NA	38.6%		NA
Percent change				
% in white collar job	NA	61.4%		NA
Percent change				
Water Source				
Housing units	NA	580	631	NA
Percent change			+8.8%	
% with water from well	NA	24.3%	24.1%	NA
Percent change			-0.8%	
% with other water supply	NA	75.7%	75.9%	NA
Percent change			+0.3%	

"NA" indicates that the information was not available at the time this draft of the report was prepared.
[a] Information presented is for census tract 0315, block group 2.
[b] Percent change is relative to the previous census in all cases.

3.5 CUSTOM CONFIGURATION—HYDROGEOLOGY AND CONTAMINANT PLUMES AT PGDP

This section includes a brief discussion of the hydrogeology and the contaminant plumes at PGDP. This information is pertinent to understanding the current state, potential end state alternative, and current planned end state at the PGDP because the major off-site hazard issue to be addressed at the PGDP concerns contamination found in groundwater. Additional information regarding the hydrogeology at the

PGDP may be found in the *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001a).

The flow system near PGDP exists primarily within the unconsolidated sediments that overlie the bedrock. Specific components for the regional groundwater flow system, shown in Figure 3.5a1, have been identified and are defined in the following subsections.

3.5.1 Bedrock Aquifer

The top of the limestone bedrock appears beneath PGDP at 335 to 350 ft bgs. Groundwater production from the bedrock aquifer comes from fissures and fractures and from the weathered rubble zone near the top of the bedrock. The bottom of a 5- to 20-ft thick rubble zone that overlies the bedrock generally marks the base of the active groundwater flow system beneath PGDP. Through 2003, no contamination associated with PGDP has been found in the bedrock aquifer or overlying rubble zone.

3.5.2 McNairy Flow System

This component consists of intermingled lenses of sand, silt, and clay. The sand in the McNairy Formation is an excellent aquifer in the southeastern part of the Jackson Purchase Region; however, near PGDP, the McNairy Formation contains significant amounts of silt and clay making it less useful as an aquifer. Regionally, the groundwater in the McNairy Formation flows north and northwest.

The McNairy Formation appears beneath the PGDP at depths ranging from approximately 100 to 350 ft. Near the PGDP, the upper to middle portions of the McNairy Formation are predominately silty and clayey fine sands, and the lower 40 to 50% is composed of sands. In some portions of the McNairy Formation, where coarser-grained sediments are in contact with the overlying Regional Gravel Aquifer (RGA), the groundwater flow mimics the flow of the RGA. Some contamination associated with the PGDP (primarily TCE) has been found in the upper portions of the McNairy Formation near source areas at the C-400 Building. (See Chapter 4 for a discussion of contaminant sources at PGDP.)

3.5.3 Terrace Gravel and Eocene Sands

A thick clay terrace exists in the southern part of the DOE-owned property. The Terrace Gravel and Eocene sands overlie the clay terrace. South and west of the PGDP, the groundwater in this system discharges to Bayou Creek, but closer to the northern limit of the terrace the groundwater discharges directly into the RGA. Low concentrations of contamination associated with the PGDP have been found in the terrace gravels and Eocene sands in the industrialized portions of PGDP. (See Chapter 4 for a discussion of contaminant sources at PGDP.)

3.5.4 Regional Gravel Aquifer

This aquifer consists primarily of the coarse sand and gravel and overlies the McNairy Formation. Sands in the overlying deposits and the underlying McNairy Formation, where they occur in contact with the lower continental deposits, are included in the RGA. The RGA is found throughout the plant area and to the north, but pinches out to the south along the Porters Creek Clay terrace. Regionally, the RGA includes the sediments deposited in the distant past by the ancestral Ohio River.

The RGA is the primary aquifer beneath PGDP and, with relatively high hydraulic conductivities,[2] is the dominant groundwater flow system in the area extending from PGDP to the Ohio River (DOE 1997). Regional groundwater flow within the RGA trends north–northeast toward the Ohio River, but east-west trends in the local geology and leaks from PGDP utilities cause groundwater flow to be directed locally to the northeast and northwest of the plant.

The RGA is the dominant pathway by which groundwater contamination migrates off-site. The Northeast Plume, the Northwest Plume, and the Southwest Plume exist in the RGA. Figures 3.5a2 and 3.5a3 display the most recent mapping of TCE and Tc-99 plumes in the RGA, respectively. Since the flow in the RGA is affected by leakage from PGDP utilities, the areas affected by the plumes may change in the future when this leakage ceases. However, the rate of leakage is unknown, so the anticipated effects on the plumes has not been quantified or modeled.

3.5.5 Upper Continental Recharge System

The Upper Continental Recharge System (UCRS) consists of the upper continental deposits and the thick, overlying, shallow deposits. The predominant groundwater flow in the UCRS is vertically downward into the RGA, hence the term "recharge system." The presence of steep, but undetermined, vertical gradients for most areas of PGDP has limited the ability to map a water table at PGDP (DOE 1997).[3] Regionally, the thickness of the saturated UCRS ranges from 0 to 50 ft. Contamination associated with the PGDP is found in the UCRS at many areas within the industrialized areas at the PGDP; however, no contamination associated with the PGDP has been found in the UCRS outside of these industrialized areas because of the essentially vertical flow through the unit.

[2] Hydraulic conductivities from the pumping tests within the RGA have been reported as ranging from 1.87E-02 to 2.01E+00 cm/s.
[3] Vertical hydraulic gradients generally range from 0.5 to 1 m/m.

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FIGURES

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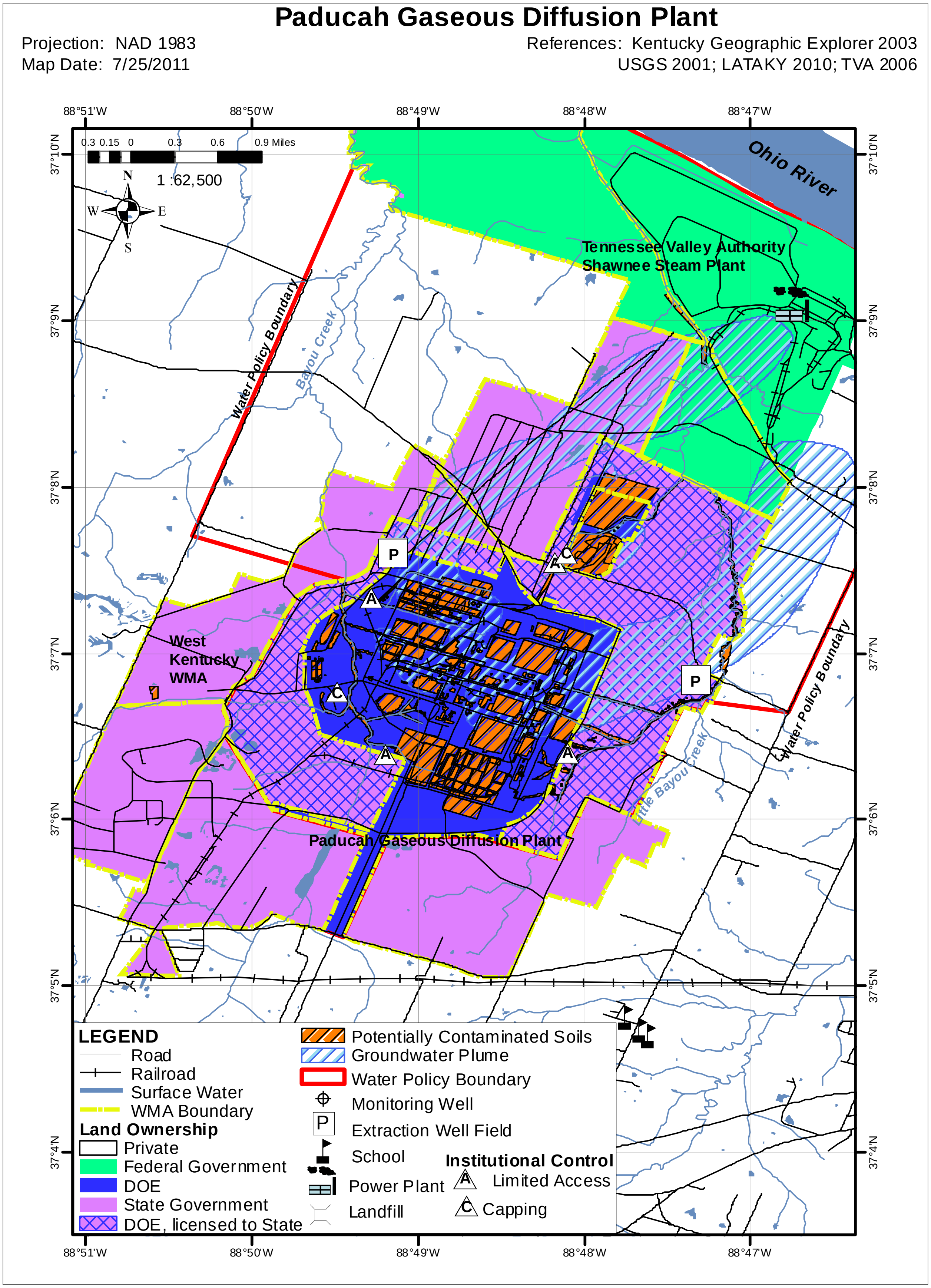


Figure 3.1a. Site Physical and Surface Interface - Current State

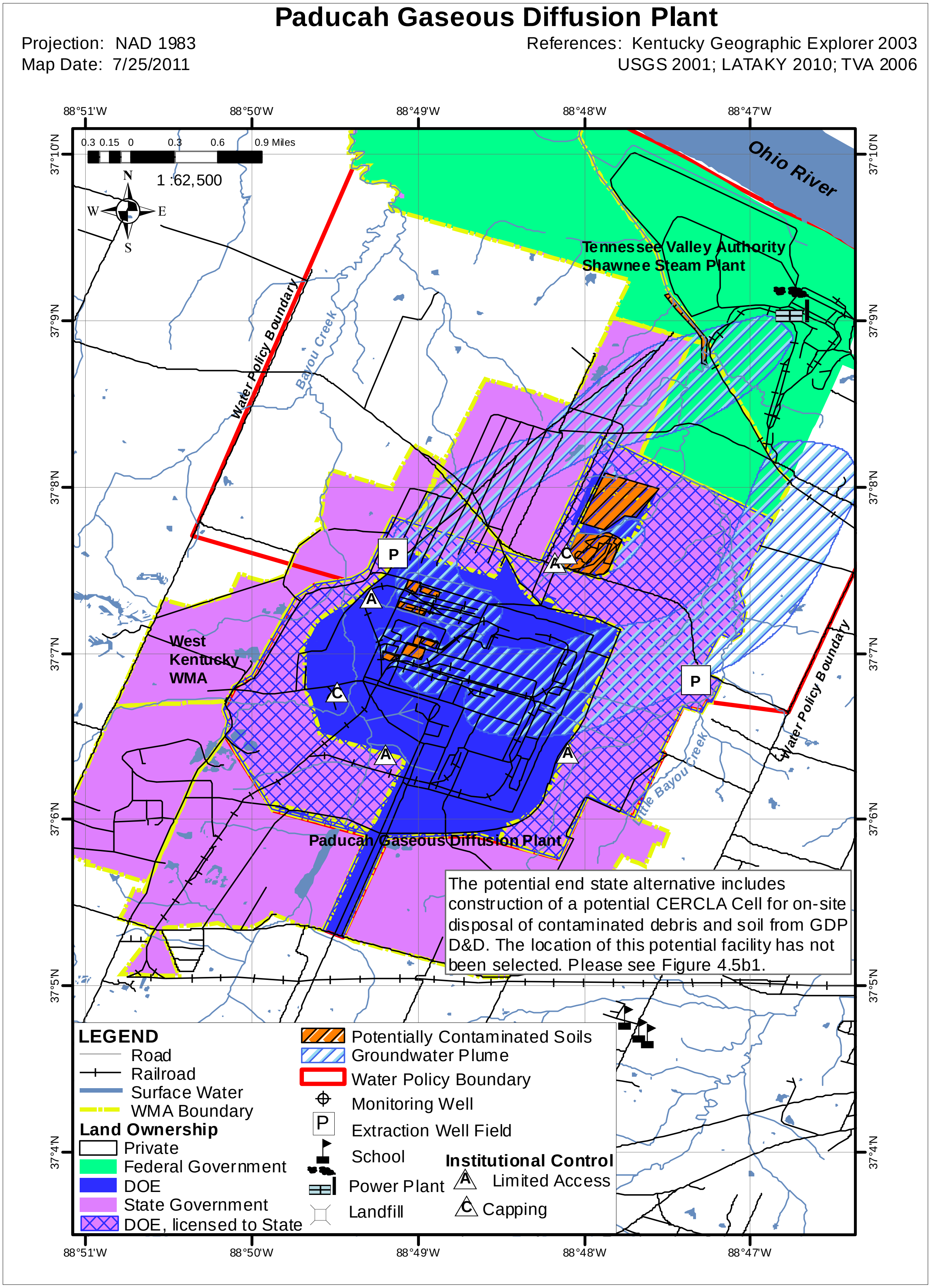


Figure 3.1b. Site Physical and Surface Interface - Potential End State Alternative

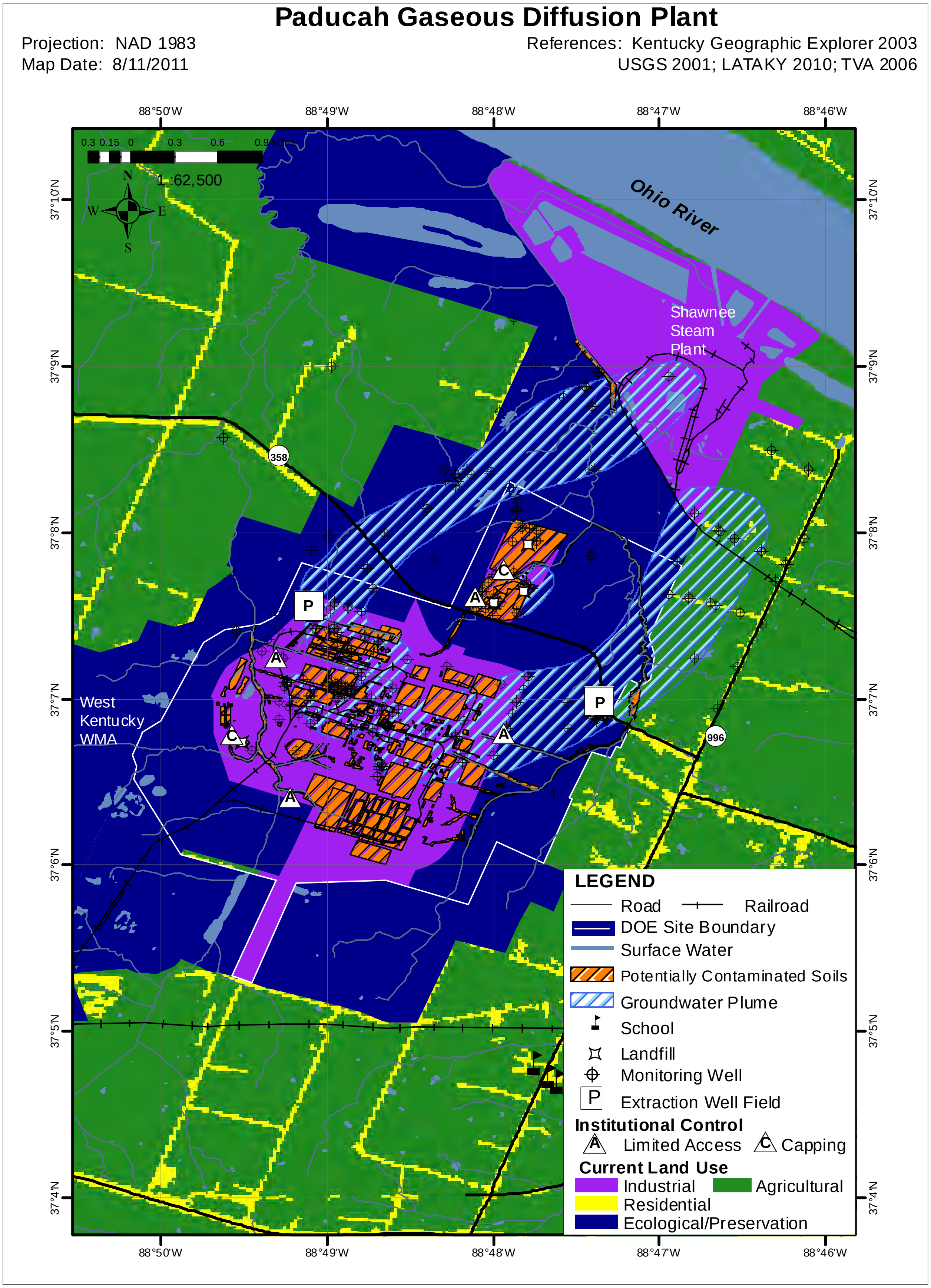


Figure 3.2a1. Site Human and Ecological Land Use - Current State

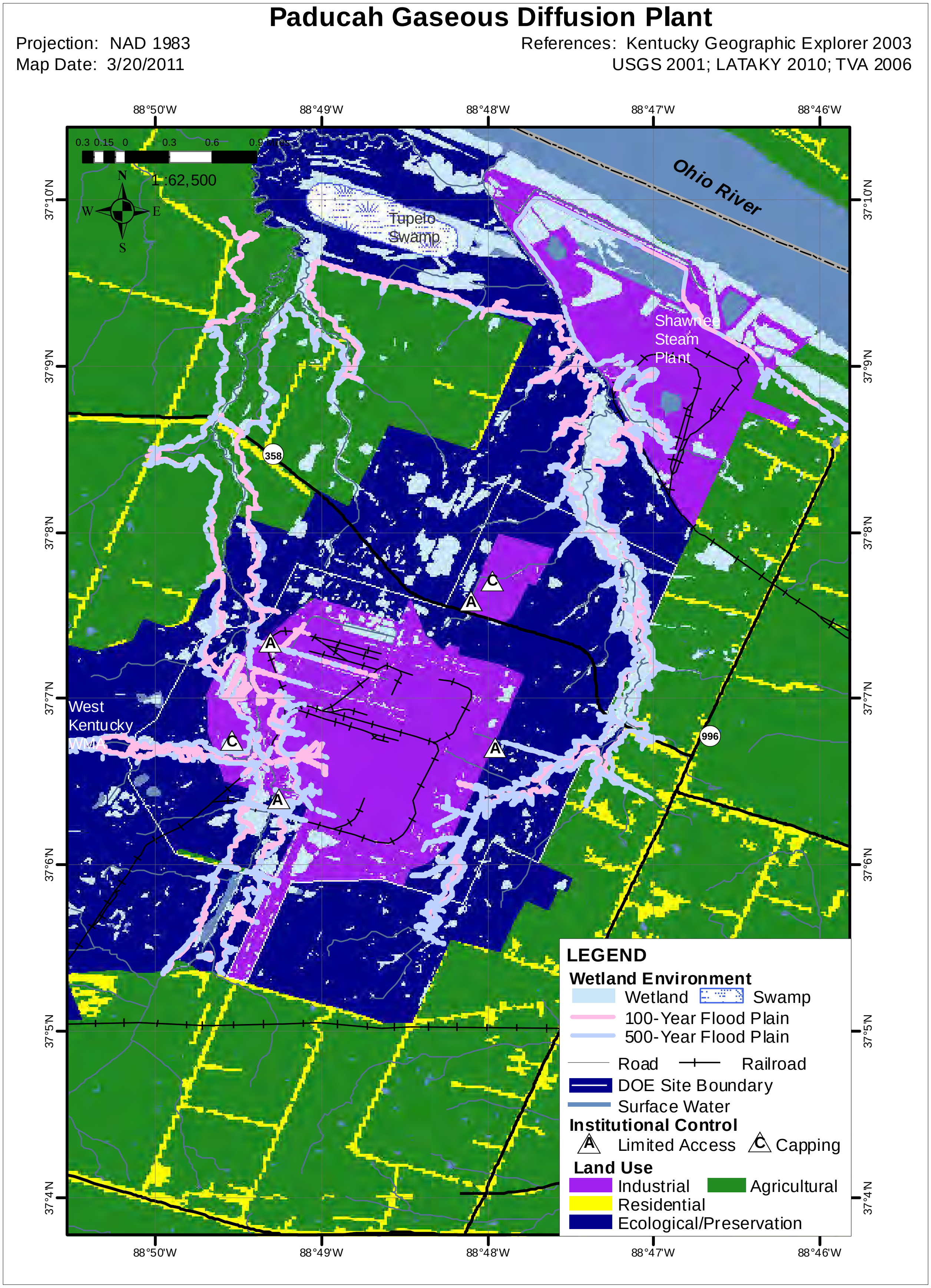


Figure 3.2a2. Site Human and Ecological Land Use, Wetlands - Current State

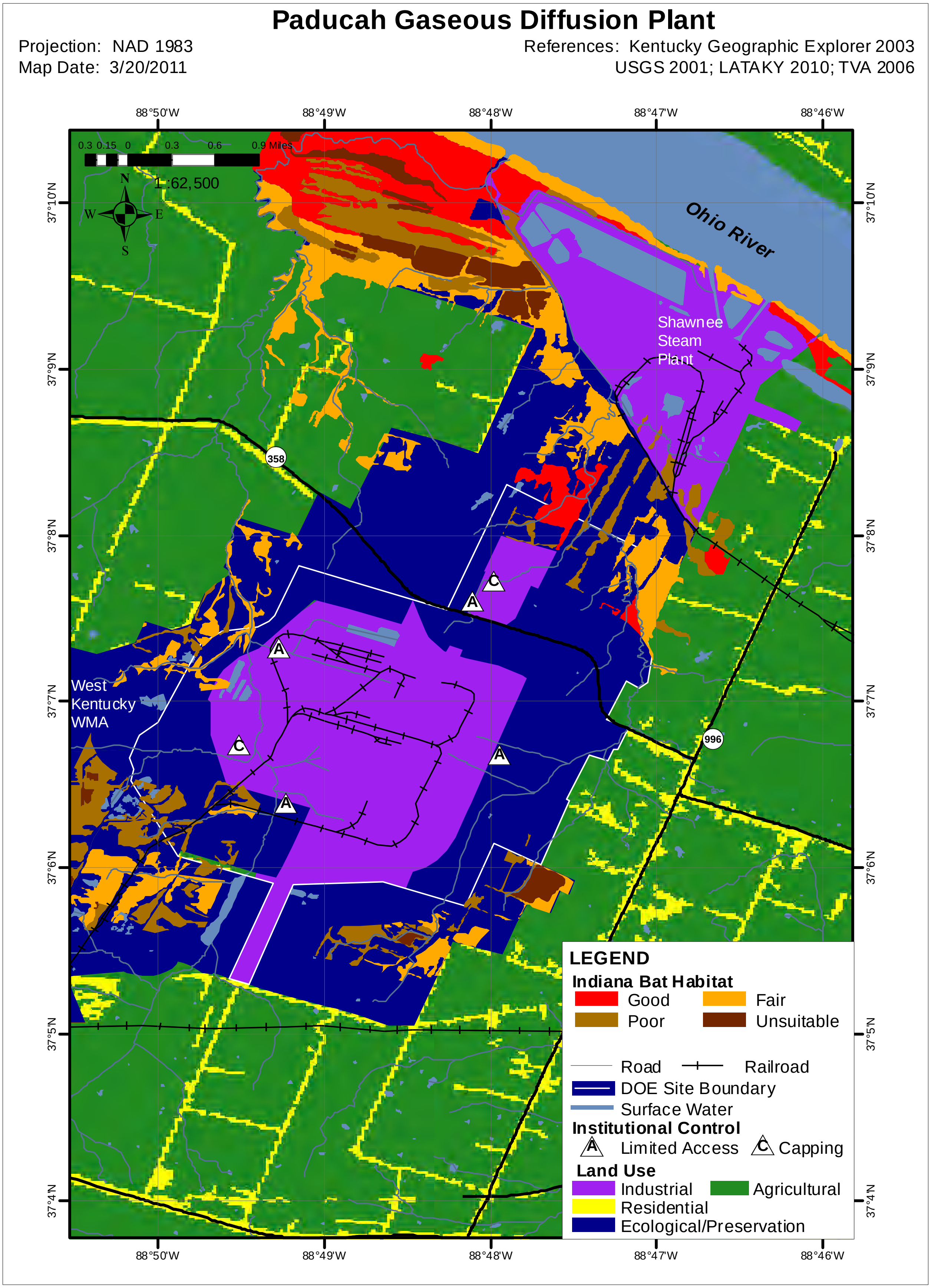


Figure 3.2a3. Site Human and Ecological Land Use, Indiana Bat Habitat - Current State

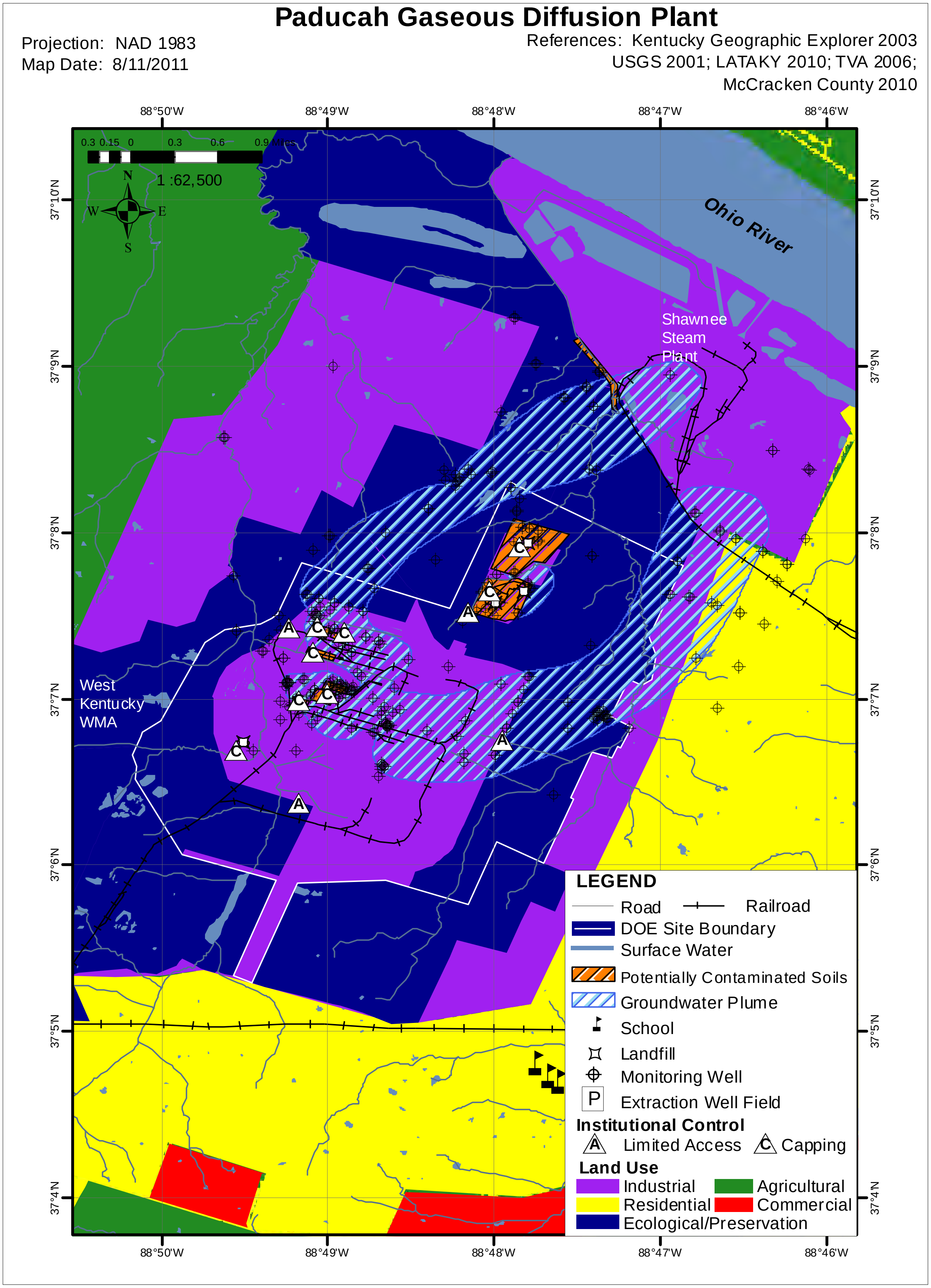


Figure 3.2b1. Site Human and Ecological Land Use - Potential End State Alternative

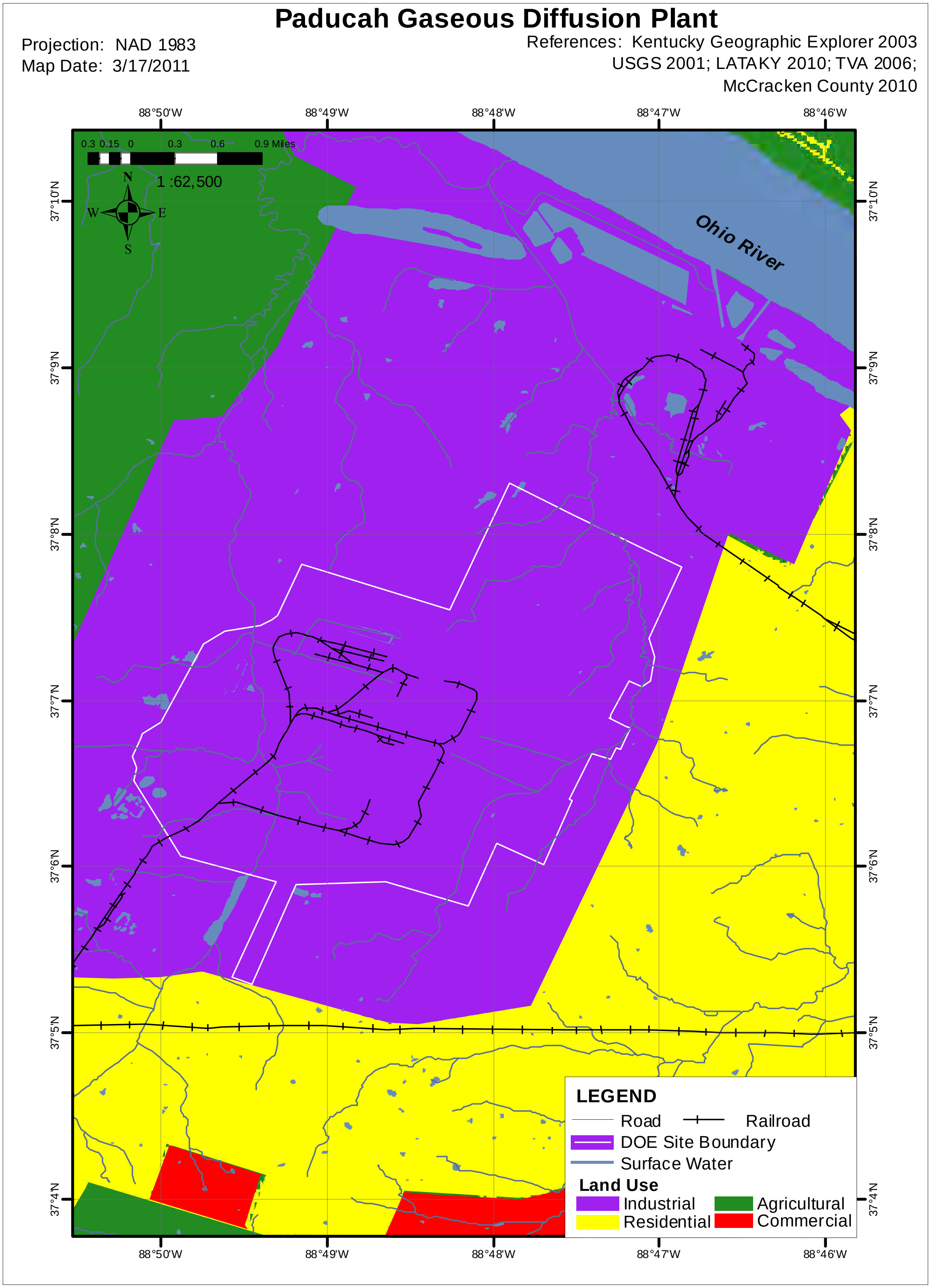


Figure 3.2b2. Site Custom Configuration - Future Zoning

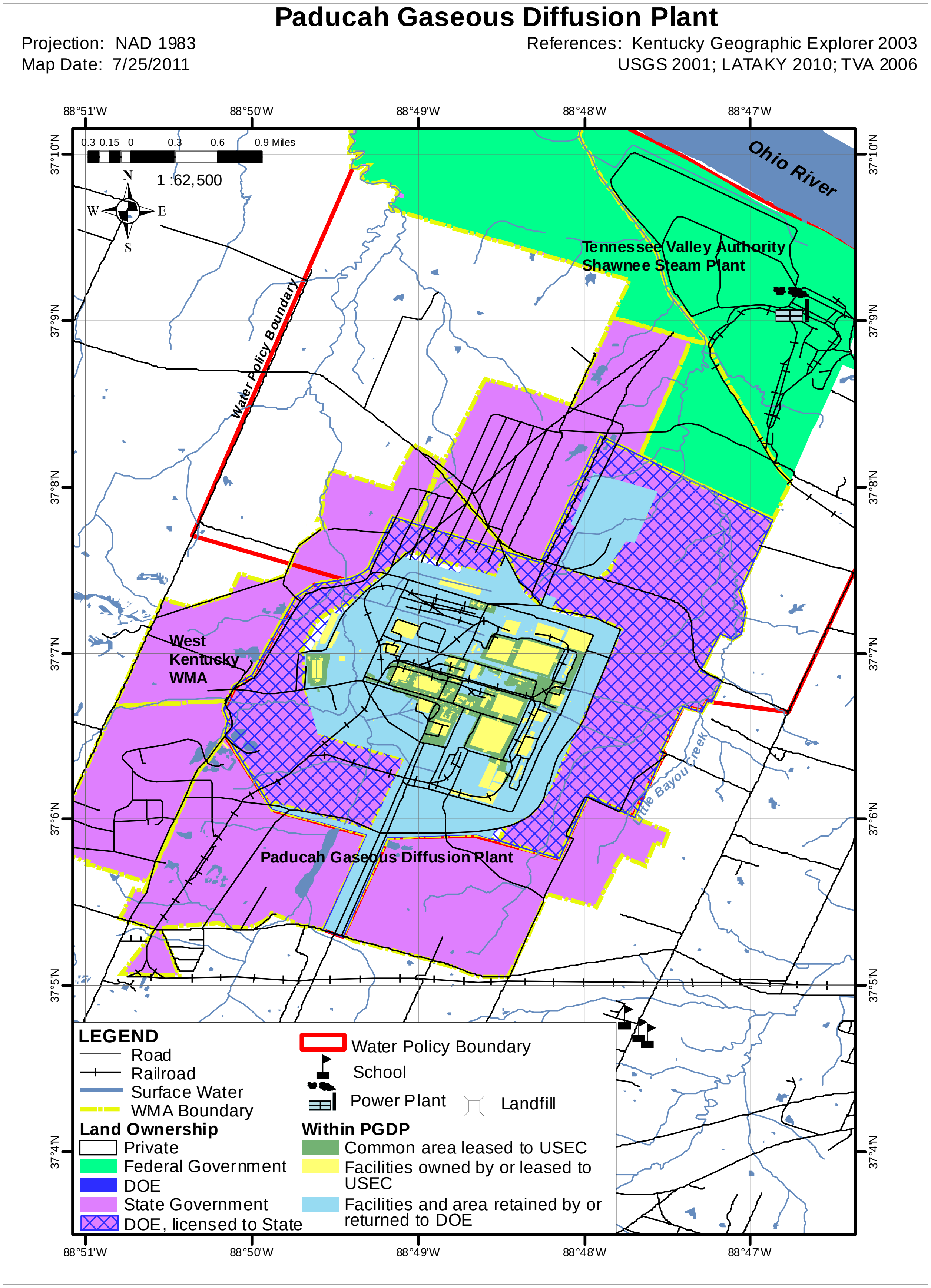


Figure 3.3a. Site Legal Ownership - Current State

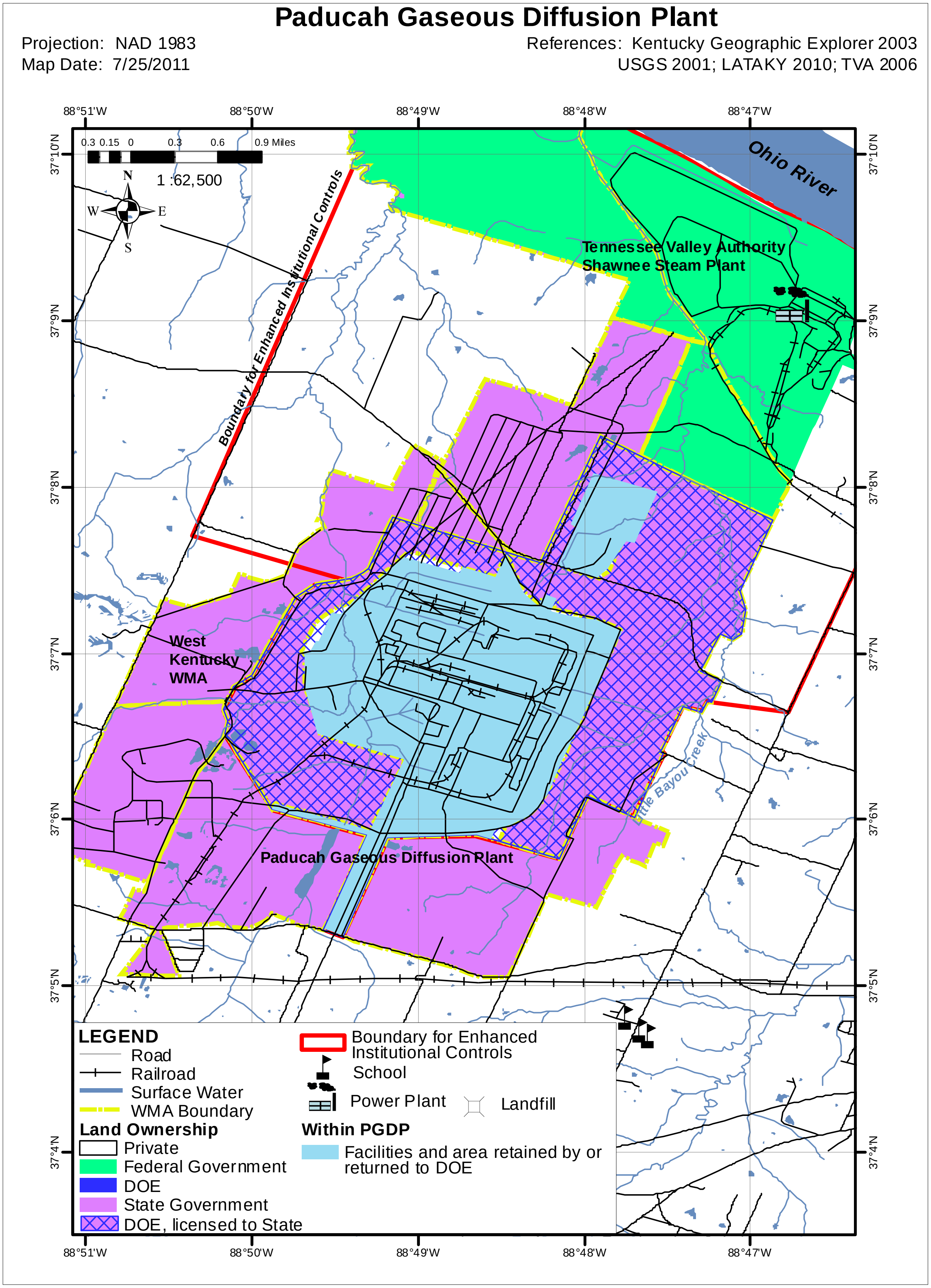


Figure 3.3b. Site Legal Ownership - Potential End State Alternative

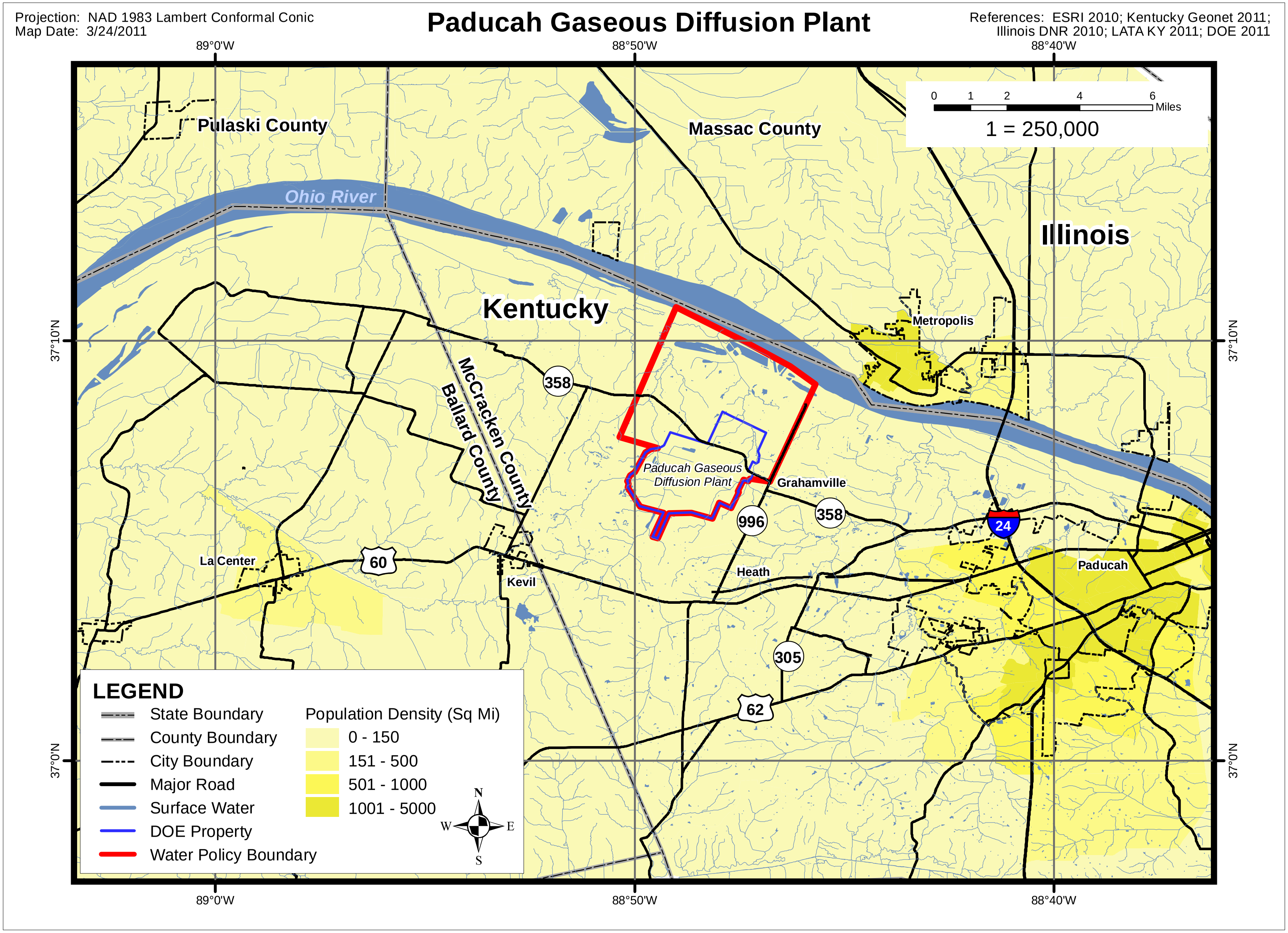


Figure 3.4a. Site Population Density - Current State

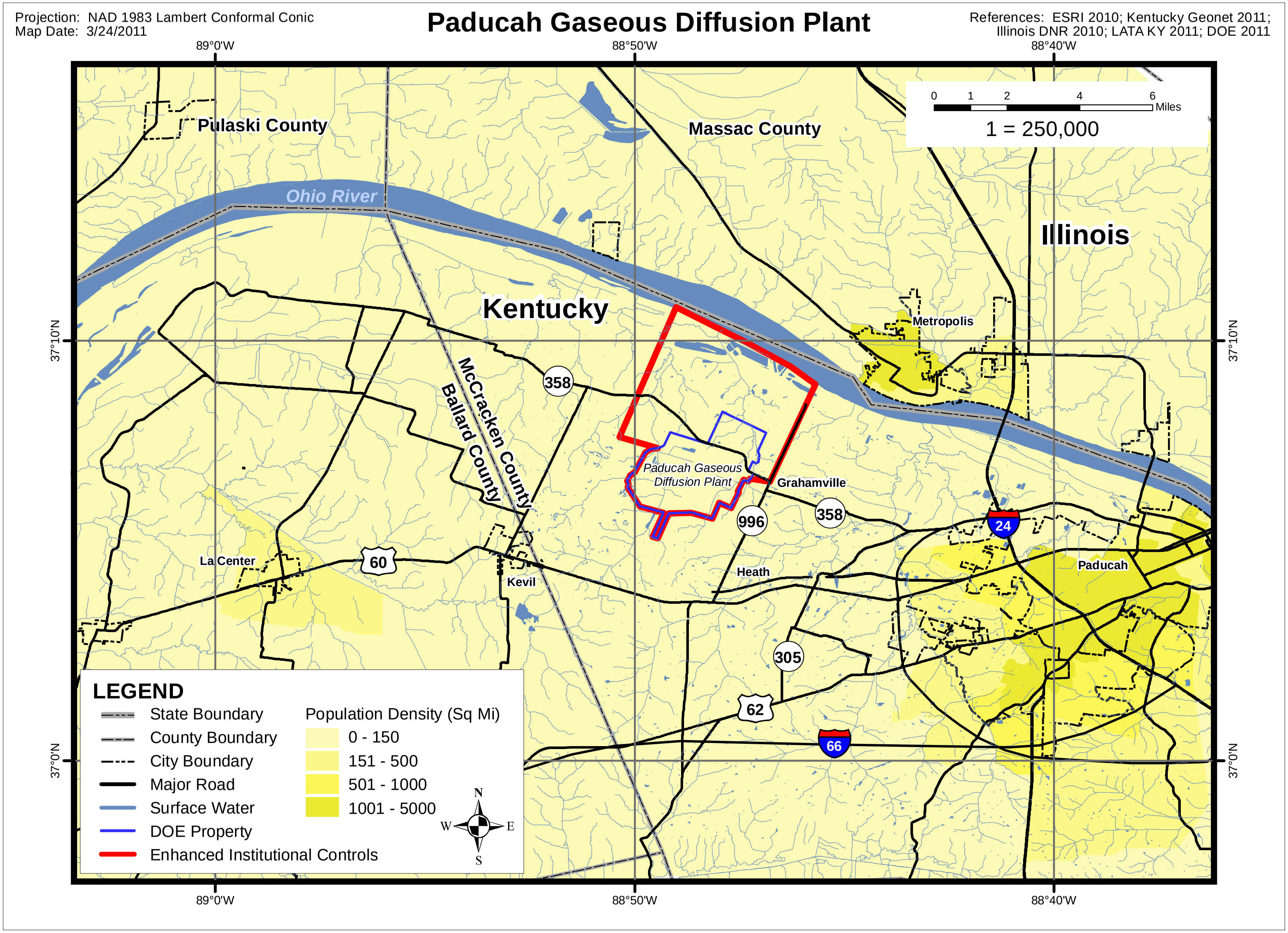


Figure 3.4b. Site Population Density - Potential End State Alternative

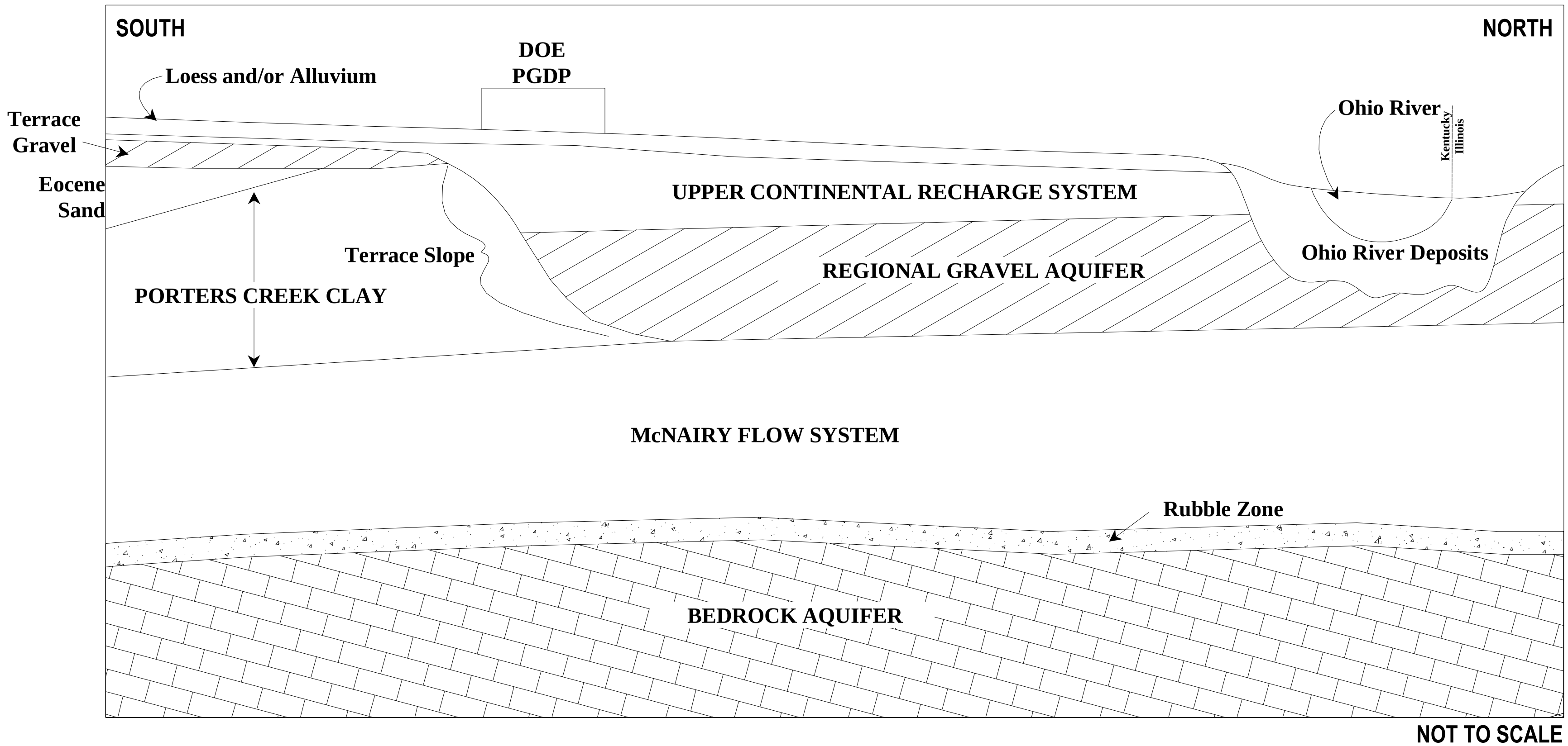


Figure 3.5a1. Schematic of Hydrgeologic Relationships Near the PGDP

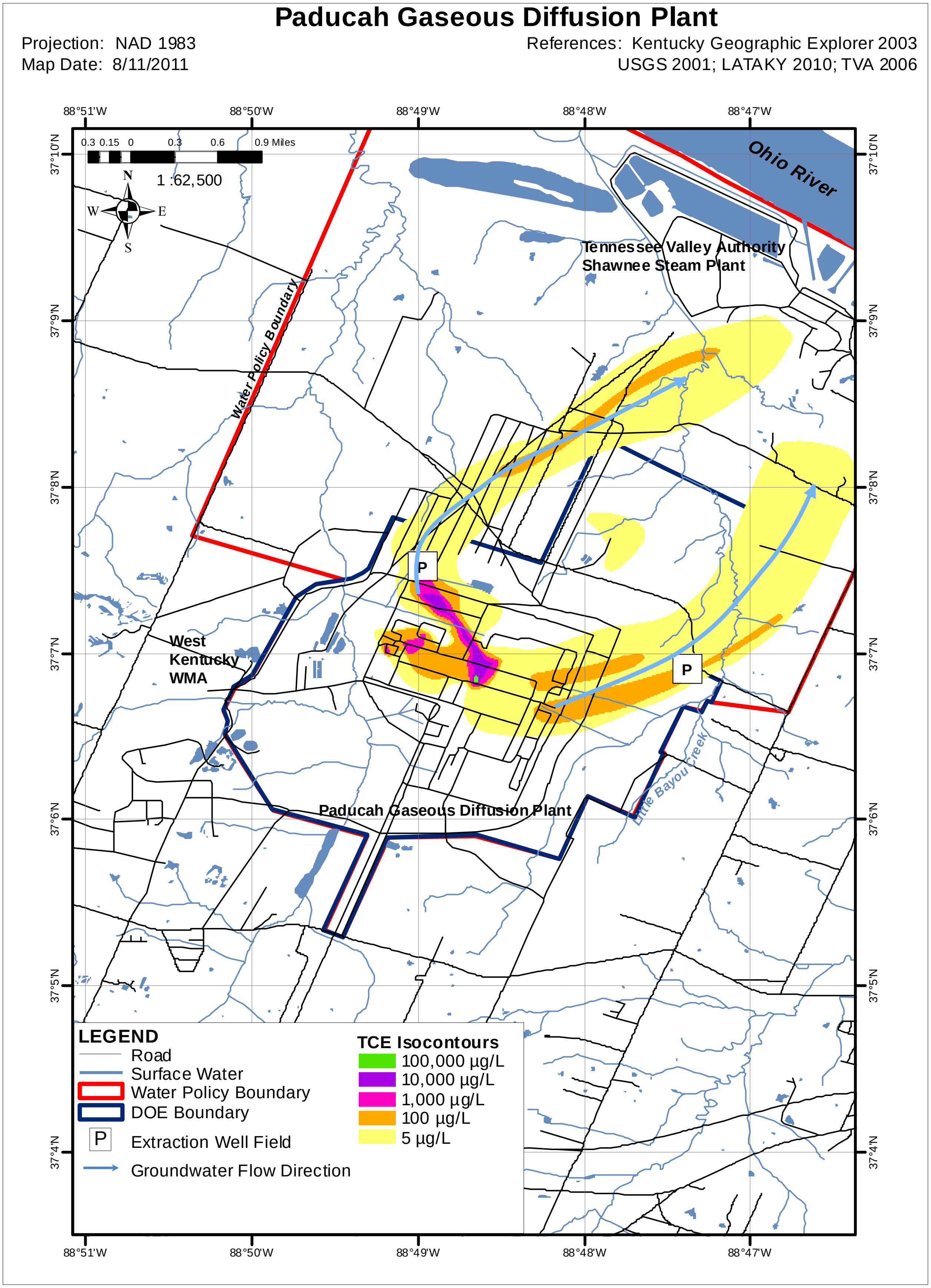


Figure 3.5a2. PGDP Trichloroethene Plume - Current State

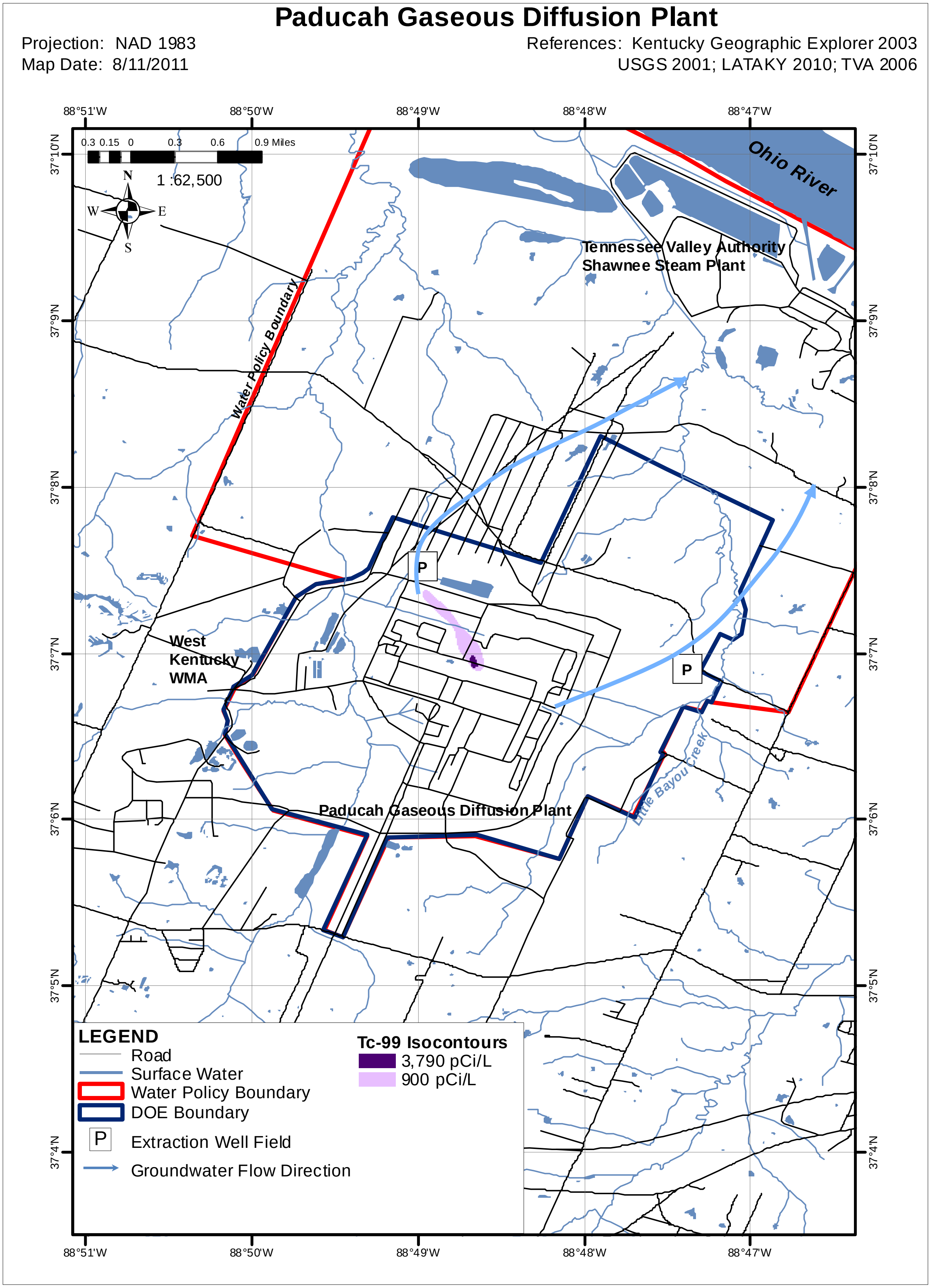


Figure 3.5a3. PGDP Technetium-99 Plume - Current State

4. HAZARD-SPECIFIC CONTEXT DESCRIPTION FOR THE POTENTIAL END STATE ALTERNATIVE

> This chapter presents potential actions to address hazards that could be used to reach the potential end state alternative. These presentations are not meant to be pre-decisional, but are meant to introduce examples of actions that may be completed to reach end state. The selection of specific actions will be made in accordance with applicable law and agreements.

This chapter presents the hazard-specific context description for the potential end state alternative. This description provides the greatest detail for the key hazard areas of concern at PGDP that were developed with a focus on reduction of risks to human health and the environment to *de minimis* levels. The information presented is that necessary to qualify or quantify the nature of the hazard present, the potential of the hazard to have an impact (and degree of impact) on human health and the environment, and any mitigation of the hazard identified. Hazard-specific maps and CSMs are presented for both current and potential end state alternative land use. Note that hazard-specific maps for the current planned end state are presented in Chapter 5. Both the potential end state alternative maps and CSMs in this chapter and the current planned end state maps and CSMs in Chapter 5 are used to support the forthcoming variance discussion.

The CSMs presented are intended to communicate risk information to DOE managers, the regulatory community, and the general public. They provide summary level information regarding the hazard, pathways, receptors, and barriers (if applicable) between hazards and the receptors. The five major elements of the CSMs are as follows:

(1) A description of the hazard area of concern being depicted in the map;

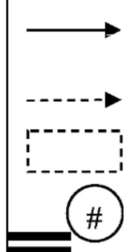
(2) Identification of the primary and secondary sources of contamination;

(3) Identification of the current and potential future release, transport, and exposure mechanisms;

(4) Identification of the current and potential future receptors believed to be at risk; and

(5) Identification of current and planned barriers or mechanisms that will prevent or limit potential exposure to at-risk receptors.

<u>KEY to CSM Diagrams</u>



Active transport, uptake, or exposure pathway

Blocked transport, uptake, or exposure pathway

Source contaminant removed

Engineered barrier or administrative control – sequentially numbered

<u>Barriers to Exposure</u>

On the CSMs, barriers to exposure are numbered sequentially starting with those present under current conditions and continuing through the potential barriers under the potential end state alternative and current planned end state. In the narrative discussing the CSMs, the numbers attached to the barriers (e.g., c, d, e) are included for illustration.

The CSMs were developed following guidance presented in American Society for Testing and Materials (ASTM) Standard E 1689-95, *Standard Guide for Developing Conceptual Site Models for Contaminated Sites,* as extended by the DOE guidance material concerning development of the earlier revisions of this report (DOE 2003c) and the guidance materials' associated clarification memorandum (DOE 2003a).

As noted earlier, the CSMs are presented for both the current state and potential end state alternative for each hazard area. The goal of this presentation is to highlight the current protective barriers and mechanisms in place at each hazard site (if any) and the barriers and mechanisms that are anticipated to be included when the end state is attained. The purpose of the CSMs, therefore, is to clarify what already has been done at each hazard site and what DOE would do to manage potential and actual risks to attain the end state.

The narrative that accompanies the CSMs includes a description of the mechanisms envisioned to be in place when the end state is attained. Discussion of potential specific mechanisms is necessary to provide an analytical framework and is not meant to be predecisional. As noted in Chapter 1, the selection of specific actions will be made in the appropriate decision documents after receipt of stakeholder and public input, as required in accordance with applicable law and agreements.

Each of the mechanisms or barriers discussed later as examples that may be used to reach the potential end state alternative may fail to permanently mitigate risk. For example, institutional controls (which include the PGDP Water Policy, enhanced institutional controls, and property and excavation restrictions at PGDP) rely both on the cooperation of potential receptors and continued enforcement to be effective in mitigating risk over the long- and short-term. Similarly, engineered barriers (such as soil cover and caps) require maintenance to continue to function as designed and mitigate risk over the long-and short-term; therefore, both institutional controls and engineered controls may be less sustainable in mitigating risk than some other actions. For example, removal of source material through a source action, such as resistance heating for solvents in soil and groundwater or excavation and off-site disposal of buried materials from burial grounds, is sustainable and mitigates risks permanently because the contaminated material is removed from the environment. Similarly, natural attenuation, which also results in the permanent removal of contaminated material from the environment, is an effective mechanism that can reduce risk over the long-term when used in combination with access controls.

Nine hazard areas are considered in this chapter. These hazard areas are depicted under the current state and potential end state alternative in Figures 4.0a1 and 4.0b1, respectively. These areas, developed to be consistent with the PGDP site mission and cleanup strategy presented in Chapter 1, are as follows.

- Hazard Area 1: This hazard area is composed of the GWOU. It encompasses both the sources of contamination to groundwater and the dissolved-phase plumes. Sources considered are those below the C-400 Cleaning Building located in the center of the industrialized area of PGDP, two burial grounds located in the west-central portion of the industrialized area of PGDP, the C-720 Building located in the southern part of PGDP, and an oil landfarm.

- Hazard Area 2: This hazard area is composed of the SWOU. It encompasses the sources of surface water contamination found within the industrialized portion of PGDP; the plant ditches and outfalls found inside the industrialized portion of PGDP; the NSDD, a portion of which is located outside the industrialized portion of PGDP; and Bayou and Little Bayou Creeks, which are found outside the industrialized area and run both on and off DOE property.

- Hazard Area 3: This hazard area is composed of two areas included in the BGOU that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination, but for which the current planned end state and potential end state alternatives differ. One of these areas is burial grounds located in the northwestern part of the industrialized area of PGDP. The other area is located in the north-central part of the PGDP, outside of the industrialized area.

- Hazard Area 4: This hazard area is composed of units that make up the SOU. It encompasses all areas containing contamination that do not impact the GWOU or SWOU. This hazard area also encompasses the soil and rubble areas that may contain contaminated soils or materials that have been identified both on and off DOE property. As depicted later in this chapter, this hazard area includes all areas inside the industrialized portion of PGDP that are not part of other hazard areas, including those that are part of Hazard Area 9.

- Hazard Area 5: This hazard area is composed of two permitted, closed landfills; the currently operating permitted landfill; and, under future conditions, a potential CERCLA Cell that would be used to dispose of debris and other materials generated during GDP D&D. The two closed landfills and the operating landfills are located in the north-central portion of PGDP, outside the industrialized area. The site of the potential CERCLA Cell has not been determined at this time.

- Hazard Area 6: This hazard area is composed of four areas included in the BGOU that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination, but for which the current planned end state and potential end state alternatives do not differ. These include a landfill located to the southwest of the industrialized portion of PGDP, adjacent to Bayou Creek, and three burial grounds located in the northwestern part of the industrialized area of PGDP.

- Hazard Area 7: This hazard area is composed of the cylinder yards that contain DUF_6 and a facility being used to convert the DUF_6 to more stable uranium oxides before off-site shipment. The cylinder yards are located throughout the site, and the largest yard is in the southeast corner of the industrialized area of PGDP. The planned conversion facility will be located adjacent to this yard.

- Hazard Area 8: This hazard area is composed of the GDP facilities and infrastructure that will undergo D&D as part of either the D&D OU strategic initiative (see Chapter 1) or the final GDP D&D. This hazard area also encompasses any sources to groundwater and surface water not addressed in other hazard areas.

4.1 HAZARD AREA 1—GWOU

This hazard area is composed of the facilities and SWMUs listed below. This hazard area is depicted in Figure 4.1a1. A description of each facility and SWMU is provided in the following section.

- C-720 Maintenance and Storage Building
- C-400 Cleaning Facility
- SWMU 1: C-747-C Oil Land Farm
- SWMU 2: C-749 Uranium Burial Ground
- SWMU 3: C-404 Low-level Radioactive Waste Burial Ground
- SWMU 4: C-747 Contaminated Burial Ground
- SWMU 201: Northwest Groundwater Plume
- SWMU 202: Northeast Groundwater Plume
- SWMU 210: Southwest Groundwater Plume
- Little Bayou Creek Groundwater Plume Seeps

4.1.1 Current State

<u>Sources</u>

The *C-720 Maintenance and Storage Building* was built in 1950 and is located in the southern part of the industrialized area of PGDP. The building is composed of structural steel and corrugated transite siding, occupies about 6.5 acres, and contains several repair and machine shops as well as other support operations. From the early 1950s to present, the C-720 Building has been used for the fabrication, assembling, cleaning, and repairing of process equipment. Various shops housed within the C-720 Building include the compressor shop, machine shop, paint shop, instrument shop, vacuum pump shop, welding shop, and valve shop. Based on past and current activities in these shops, the potential contaminants associated with the C-720 Building include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, PCBs, and radionuclides.

What is DNAPL?

DNAPLs are liquid chemicals that do not readily dissolve in water and are denser than water. Once in the ground, DNAPLs can migrate downward through the subsurface, with a portion being trapped in the pore spaces in the soil and the remaining portion continuing to migrate downward.

In the subsurface, DNAPL serves as a continuing source of groundwater contamination as it slowly goes into solution with water. Because DNAPL is difficult to locate in the subsurface and oftentimes exists in the pore spaces in the soil, achieving cleanup has been shown to be very difficult.

During RIs (DOE 1999b), three areas were identified as potential sources of contamination at the C-720 Building. These were SWMU 209 (the Compressor Shop Pit Sump), AOC 211 (the spill site located to the northeast of the building), and the floor drain system in the C-720 Building. Subsequently, TCE and its breakdown products were identified in subsurface soil around the building. The highest concentrations [i.e., 68, 450, and 0.4 ppm of TCE, *trans*-1,2-dichloroethene (*trans*-1,2-DCE), and vinyl chloride (VC), respectively] were found in shallow (<35 ft bgs) subsurface soil near the southeast corner of the building. The found concentrations of VOCs are not high enough to suggest the presence of DNAPLs. A Site Investigation (SI) was conducted in 2005 to further determine the extent to which the C-720 Building is a contributing source to the Southwest Plume (DOE 2006a). Sampling indicates that the extent of contamination at the two source areas at the east end of the C-720 Building is similar in size to that defined in the earlier RI. Average TCE concentrations within this source varied from 0.1 ppm at 50 to 60 ft bgs to 11.9 ppm at 20 to 30 ft bgs. Concentrations of all other VOCs are smaller and are confined to the upper portions of the UCRS.

The *C-400 Cleaning Building* was built in the early 1950s, is located near the center of the industrialized section of PGDP, and covers about 4 acres. Primary activities taking place in the C-400 Building are cleaning machinery parts, disassembling and testing of cascade components, and laundering plant clothes.

Suspected sources of leaks and spills at the C-400 Building include degreaser and cleaning tank pits, drains and sewers, the east side plenum/fan room basement, tanks and sumps outside the building, and various other processes. These sources have resulted in contamination of soil and groundwater by VOCs (primarily TCE and its breakdown products), SVOCs, and various metals and radionuclides.

Both the C-400 RI (DOE 1999a) and the Remedial Design Support Investigation (July through August 2006) of the C-400 Interim Remedial Action identified TCE leak and spill sites near the south end of the C-400 Building. The southeast C-400 Building spill sites include SWMU 11 (which is where a drain line from the degreaser sump was connected to a storm sewer) and SWMU 533 (which is where transfer pumps and piping moved solvents to and from a storage area associated with the building). The highest concentrations of solvents in the soil and groundwater were found southeast and southwest of the C-400 Building. As noted above, the area to the southeast contains SWMUs 11 and 533. The area of soil contamination to the southwest of the building has not been linked to a particular C-400 process.

Elevated concentrations of TCE and its breakdown products suggest that DNAPL source areas exist within the subsurface soils to the southeast and southwest of the C-400 Building. In the southeast C-400 area, the C-400 RI documented soil contamination as high as 11,055 ppm TCE, 102 ppm *trans*-1,2-DCE, and 29 ppm vinyl chloride. The maximum TCE concentration detected in the underlying aquifer (i.e., the RGA) was 701 ppm. (64% of the maximum solubility of TCE in water), suggesting that the DNAPL has penetrated the RGA and is acting as a secondary source of groundwater contamination (DOE 2005b). For the area of soil contamination to the southwest of the C-400 Building, the RI reported soil contamination ranging up to 168 ppm TCE.

A Membrane Interface Probe survey was used to measure the amount of VOCs in subsurface soils to the south and southeast of the C-400 Building. This was performed as part of the Remedial Design Support

Investigation to help characterize the extent of the DNAPL zones. The largest DNAPL zone of the spill sites is associated with SWMU 533. DNAPL may extend from near land surface down to the base of the RGA, where it forms a DNAPL pool at depths of 90 to 100 ft. Most of the DNAPL associated with the other leak sites is retained in the soils above the RGA.

The *C-747-C Oil Landfarm* (SWMU 1) is located in the western part of the industrialized portion of PGDP. It was used for landfarming of waste oils contaminated with TCE, uranium, PCBs, and 1,1,1-TCA. These waste oils are believed to have been derived from a variety of plant processes. When in operation, the landfarm consisted of two 1,125 ft^2 (0.026 acre) plots that were plowed to a 1 to 2 ft depth. (The entire SWMU covers about 2.4 acres.) Waste oils were spread on the surface every 3 to 4 months, then the surface was limed and fertilized. Several investigations collected data on SWMU 1, with the most recent being the Southwest Plume SI (DOE 2006a). These investigations identified solvents (TCE and its breakdown products), PCBs, dioxins, SVOCs, heavy metals, and radionuclides as potential contaminants in soil and groundwater.

After use of the landfarm was discontinued in 1979, a cover (<12 inches) of soil was placed over the two disposal plots. As part of a subsequent removal action, approximately 23 yd^3 of dioxin-contaminated soil was excavated from SWMU 1.

The *C-749 Uranium Burial Ground* (SWMU 2) was used for the disposal of containerized and uncontainerized uranium and uranium-contaminated wastes, is located in the west-central portion of the industrialized portion of PGDP, and covers about 1.4 acres. The wastes were buried in 16- to 17-ft deep pits and then covered with 2 to 4 ft of soil. These wastes included uranium shavings in oils and solvents (i.e., TCE). Four major investigations have been conducted at SWMU 2, with the most recent being an RI (DOE 2010f). The main contaminants at SWMU 2 are pyrophoric uranium and other radionuclides, heavy metals, solvents, and, to a lesser extent degree, PCBs.

Pyrophoric Uranium

Pyrophoric uranium consists of small pieces of uranium metal. When exposed to air, the small pieces of metal spontaneously combust creating uranium oxides, that become air-borne. Because combustion occurs spontaneously, the control of emissions during cleanup of pyrophoric uranium may be difficult.

In 1982, a 6-inch clay cap was installed over the burial pits. In 1984, a pit was excavated, resulting in the recovery of 40 drums. The liquids found in four of the drums were transferred to new drums. All the drums were placed in overpack drums, reburied, and recapped with 6 inches of clay and 18 inches of soil.

The *C-404 Low-level Radioactive Waste Burial Ground* (SWMU 3) is located in the west-central portion of the industrialized portion of PGDP, covers approximately 2.9 acres, and originally was constructed as an aboveground holding pond with a tamped floor and clay dike walls. Liquid uranium-bearing wastes were treated in the pond in the 1950s. This activity was discontinued in 1957, when all free liquids were removed from the unit. From 1957 to 1977, solid contaminated scrap was placed in the site. At that time, burial of containerized and bulk wastes on top of the filled-in pond area was begun. The unit was closed as a Resource Conservation and Recovery Act (RCRA)-hazardous waste landfill in 1987. This closure included construction of a multilayer cap consisting of 2 ft of compacted clay, a 36-mil Hypalon liner, 1 ft of granular fill, geotextile fabric, and 2 ft of vegetative cover.

In the holding pond area, the waste consists of uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, and contaminated trash. The upper tier of waste contains the same type of wastes as well as smelter furnace liners and approximately 450 drums of extraction procedure toxic hazardous wastes. The main contaminants at SWMU 3 consist of radionuclides, metals, solvents, and PCBs. An RI for the BGOU, including this SWMU, was completed in 2007. The results from this RI have been used to prepare an FS that is currently under review.

The *C-747 Contaminated Burial Yard* (SWMU 4) operated from 1951 through 1958 and is located on about 7.4 acres in the west-central portion of the industrialized area of PGDP, south of SWMU 2. It was used for disposal of contaminated and uncontaminated trash, some of which was burned. The site consists of several pits excavated to about 15 ft. The waste was placed in the pits and covered with 2 to 3 ft of soil. This waste consists of scrap equipment with surface contamination and other materials. A 6-inch clay cap was installed in 1982, and, in 2000, a fence was placed around the SWMU, preventing access by the general plant population. An RI occurred in 1999 (DOE 2000a). The contaminants found included radionuclides, heavy metals, solvents, SVOCs, and PCBs. A follow-up SI focused on identifying the sources of the Southwest Plume and included additional sampling near the C-747 Burial Yard. This investigation concluded that SWMU 4 is a source of TCE and its breakdown products and Tc-99 found in the Southwest Plume. An SI was conducted in 2005 to further determine the extent to which SWMU 4 is a contributing source to the Southwest Plume (DOE 2006a). This information was used to prepare an FS that includes this unit. A non-time-critical removal action of the wastes from this unit was contemplated by an Engineering Evaluation/Cost Analysis that subsequently has been withdrawn.

Groundwater Contamination at the PGDP

As noted in Section 3.5, the primary aquifer affected by contamination at PGDP is called the RGA. This aquifer consists primarily of course sand and gravel and extends in various locations from ~45 to ~100 ft bgs. Regionally, the RGA is a very productive aquifer and is a major source of drinking water.

Primary contaminants from PGDP found in off-site locations in this aquifer are TCE and its breakdown products and Tc-99. Contaminants found in groundwater above background levels below the industrialized portion of PGDP and not in off-site locations include several metals, volatile organic compounds (e.g., carbon tetrachloride and tetrachloroethene), and radionuclides (primarily uranium isotopes) (DOE 2001b).

The *Northwest Dissolved-Phase Plume* originates at the C-400 Building and extends to near the TVA Shawnee Fossil Plant, which is off DOE-owned property. The plume covers over 1,100 acres, and the overall size of the plume has changed little since it was identified in 1989. Near the steam plant, some discharges to the surface occur at seeps along Little Bayou Creek. (Please see text below for additional discussion concerning the seeps). The principal contaminant in the plume is TCE. Other contaminants found near source areas are TCE breakdown products and Tc-99. SWMU 2 is another potential source of TCE that is found in the Northwest Dissolved-Phase Plume.

Currently, a pump-and-treat system is used to control the migration of the high concentration areas of the plume. This system was installed under an interim ROD that was signed in 1993 (DOE 1993). This system has removed more than 2,450 gal of TCE from the dissolved-phase. Current concentrations in both the source areas and in the distal area of the plumes are somewhat lower than historical concentrations.

The *Northeast Dissolved-Phase Plume* also originates at the C-400 Building and extends toward the Ohio River into areas off DOE-owned property. The plume covers over 1,000 acres, and the size of the plume has changed little since it was identified in 1989. No surface discharges are known to occur within the Northeast Dissolved-Phase Plume. The principal plume contaminant is TCE. Other contaminants found near source areas are TCE breakdown products. The maximum concentration currently seen in an area off DOE property to the northeast of PGDP is 95 ppb (LATA Kentucky 2011a).

Currently, a pump-and-treat system is used to control migration of the high concentration area of the Northeast plume. This system was installed under an interim ROD that was signed in 1995 (DOE 1995).

The *Southwest Plume* is thought to originate in the vicinity of the C-720 Building, SWMU 1, and SWMU 4, and extends west toward the DOE property line. The plume covers over 180 acres. The Southwest Plume does not currently extend to areas off DOE-owned property, and its migration is not expected to extend to areas off DOE property, based on results of potentiometric surface mapping and groundwater flow modeling (DOE 2011c). The primary contaminants associated with the Southwest Plume are solvents (primarily TCE and its breakdown products) and radionuclides (Tc-99).

The *Little Bayou Creek Groundwater Plume Seeps* are located near the TVA Shawnee Fossil Plant to the north of PGDP. These seeps lie approximately 6,700 to 11,500 ft from the industrialized portion of PGDP and cover an area of about 10 acres. As noted above, these seeps contain TCE and other solvents that are discharging from the Northwest Dissolved-Phase RGA Groundwater Plume. The concentrations of TCE in samples of surface water collected at one seep location ranges from 150 to 240 ppb, based on 2010 sampling events (LATA Kentucky 2011b).

<u>Pathways</u>

In the current CSM for the GWOU (see Figure 4.1a2), solvents existing as DNAPLs in subsurface soil and in groundwater are the primary sources of contamination. [As noted earlier, metals and radionuclides also are found in groundwater below PGDP at concentrations above maximum contaminant levels (MCLs) and health-based limits; however, except for Tc-99, no plumes of these contaminants have been defined in on-site and off-site areas PGDP. The Tc-99 plume is not discussed in the CSM because this contaminant is not found at concentrations greater than its MCL (4 mrem/yr) in areas off DOE property, and the Tc-99 plume has changed little since it was first identified in 1989. Groundwater modeling for the C-400 Building does indicate that concentrations of Tc-99 in the plume may exceed its MCL at locations within the DOE property boundary in the future. The maximum modeled activities for Tc-99 at the DOE property boundary are in the range of 3E-06 pCi/L (DOE 1999a). Empirical evidence suggests Tc-99 concentrations of Tc-99 in groundwater do not exceed its MCL outside the DOE property boundary. Please see Figure 3.5a3 for information about the Tc-99 plume.] The solvent plumes extend to areas off DOE property, and a portion of the plume discharges to surface water seeps. Once in surface water, contaminants could affect ecological receptors or enter the food chain; however, within a short distance from where the seep waters enter the creek, the concentrations have decreased to below the respective surface water ecological screening values.

Using this CSM, the media of concern for Hazard Area 1 are subsurface soil, groundwater, and surface water. Receptors potentially exposed to subsurface soil are workers. Receptors potentially exposed to groundwater are workers and residents. Receptors potentially exposed to surface water are workers, visitors, and ecological receptors. In addition, the resident, visitor, and ecological receptor potentially are exposed through the food chain. (Please see the CSM for a definition of all receptors.)

Under current conditions, the barriers to exposure are access controls to prevent exposure to subsurface soil • and the PGDP Water Policy , . (Please see the text box for additional information concerning the PGDP Water Policy.) The impacts of discharges to surface water are minimized through natural attenuation „ , which includes biodegradation, chemical degradation, and other natural processes. Finally, a “hot spot” pump-and-treat ƒ , which consists of extraction wells within the high TCE concentration areas of the Northwest and Northeast Dissolved-Phase Plumes, is used to control the spread of high TCE concentration areas.

PGDP Water Policy

The PGDP Water Policy was implemented through an Action Memorandum in 1994 (DOE 1994). Under the water policy

- DOE provides municipal water to all existing residences and businesses within the area affected by groundwater contamination from the PGDP;
- DOE has paid to connect affected residences and businesses to a public water supply, if these were not already connected; and
- DOE pays water bills of affected residences.

In return for the replacement water supply, the affected residences and businesses agree neither to drill any new water supply wells within the affected area nor use water from existing wells. (Existing wells were locked to prevent unauthorized use.) In addition, the residences and businesses agree to permit PGDP personnel property access to sample groundwater from existing wells.

The PGDP Water Policy is implemented through license agreements that are renewed every 5 years. Currently, there are no plans to terminate the PGDP Water Policy.

Risk Levels

As shown in Figure 4.1a2, no exposure pathways currently are complete for the GWOU due to the presence of barriers to exposure; however, baseline or unmitigated risks that could be present if the barriers did not exist have been assessed. Tables 4.1a, 4.2a, and 4.2b summarize these results for a resident potentially exposed to groundwater in off-site areas near the PGDP property boundary, both under current conditions and assuming continued migration of contaminants from source areas to the point of exposure. Additionally, the unmitigated risk potentially posed to a recreational user exposed to groundwater discharged to the surface along Little Bayou Creek is presented. Note that these results show that the primary contaminants posing risks at off-site locations are solvents, with TCE and its breakdown products being most prominent.

Table 4.1b summarizes the results for ecological receptors exposed to contamination at locations along Little Bayou Creek near the seeps. These results show that unacceptable impacts to ecological receptors from the contaminants associated with the Northwest Dissolved-Phase Plume that are released from the seep (i.e., TCE and its degradation products and Tc-99) are not expected under the current state.

Enhanced Institutional Controls

Enhanced institutional controls under the potential end state alternative would be implemented on what is currently both DOE and non-DOE-owned property. These controls would replace the PGDP Water Policy and be implemented to prevent the use of contaminated groundwater by residents and recreational users. (The PGDP Water Policy would continue until the enhanced controls are in place.) Enhanced institutional controls implemented could range from legal agreements with the surrounding landowners to place enforceable restrictions on groundwater use to property purchase, which would allow DOE to directly implement restrictions on groundwater and property use. A property acquisition study determined that property purchase options were not cost effective when compared to the restrictive easement and a continuance of the PGDP Water Policy (KRCEE 2007). As with other response actions, the selection of the specific institutional control will be made in the appropriate decision documents after receipt of stakeholder and public inputs, as required in accordance with applicable law and agreements.

4.1.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.1.1 for a discussion of sources and pathways of exposure.

Barriers and Actions

Barriers to exposure at the end state (see Figures 4.1b1 and 4.1b2) are continued access controls to prevent exposure to subsurface soil • and implementation of enhanced institutional controls to limit access to and use of contaminated groundwater…. (Please see the text box for a discussion of the enhanced institutional controls.) Discharges to surface water are addressed under the potential end state alternative through natural attenuation „ . Contaminants in source zones and in the plumes not addressed by source actions are addressed through monitored natural attenuation (MNA) † . The burial grounds are capped ‡ to mitigate potential contaminant migration and limit exposure. Finally, a source action is planned at the C-400 area to reduce DNAPL concentrations in subsurface soil and the RGA ˆ . (Note that the source action planned under the potential end state alternative is resistance heating and would address solvents only. Because this action would not reduce concentrations of metals and radionuclide to MCLs and would not reduce solvent concentrations in the plumes, long-term monitoring would be required after this source action is completed.)

Table 4.1a. Risk Assessment Summary[a] for Residential Exposure to Groundwater Drawn from the RGA at a Point within the Off-site Northwest and Northeast Plumes and for Recreational Exposure to Groundwater Discharged to the Surface at Seeps Along Little Bayou Creek

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/L)	Baseline Risk Level[e]	PRG[f] (mg/L)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration[h]
NW Plume Off-site	Residential	Y	Residential	TCE	1.39	ELCR = 1E-03 HI=120	0.005	MCL	NA
				Cadmium	0.0161	ELCR = 6E-04 HI = 2	0.005	MCL	NA
NE Plume Off-site	Residential	Y	Residential	TCE	0.754	ECLR = 5E-04 HI = 64	0.005	MCL	NA
				1,1-DCE	0.006	ELCR = 6E-04 HI = NA	0.007	MCL	NA
Seeps (1997 data)	Recreational	N	Recreational	TCE	0.051 (maximum)	18 of 88 results (1 location) exceeded no action level	0.0218	Risk-Based	NA
				Cadmium	0.026 (maximum)	1 of 39 results exceeded no action level	0.00457	Risk-Based	NA
Seeps (2000 data)	Recreational	N	Recreational	TCE	0.44 (maximum)	49 of 71 results (12 locations) exceeded no action level	0.0127	Risk-Based	NA
				Antimony	0.0035 (maximum)	1 of 15 results exceeded no action level	0.00312	Risk-Based	NA

NA = not applicable

[a] Results for Northwest and Northeast Plumes are taken from DOE 2001a. Results for seeps are from an unnumbered information sheet entitled, *Seeps Along Little Bayou Creek, Northwest Groundwater Plume,* dated July 2001. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.

[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all groundwater results collected from wells in the off-site areas of the Northwest and Northeast Plumes.

[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.

[d] Residential scenario considered lifetime (40 year) exposure by a resident to groundwater used in the home as drinking water, while showering, and for general household uses. Recreational scenario considered direct exposure to water while wading.

[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.

[f] "PRG" is the preliminary remediation goal used when considering potential response actions.

[g] "MCL" is maximum contaminant level. "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard).

[h] "MNA" is monitored natural attenuation. Under potential end state alternative, the potential action is MNA; therefore, no values are available at this time.

Table 4.1b. Risk Assessment Summary for Ecological Exposures to Soil Associated with Seeps Along Little Bayou Creek[a]

Location	Land Use	Risk[b]	Risk Scenario	Contaminant Description	Representative Concentration[c] (mg/kg or mg/L)	Frequency above USV Level[d]	USV[e] (mg/kg or mg/L)	Basis for USV	Actual or Expected Post Cleanup Concentration or Risk Level
Little Bayou Seeps—Sediment	Industrial	N	Ecological	Chromium	196	2/8	90	Abiotic value	NA
				PCBs	0.6	15/42	0.3	Abiotic value	NA
				Benzo(a)anthracene	1	3/3	0.4	Abiotic value	NA
				Benzo(a)pyrene	0.8	1/3	0.8	Abiotic value	NA
				Chrysene	1.1	1/3	0.9	Abiotic value	NA
				Fluoranthene	3	1/3	2.3	Abiotic value	NA
				Phenanthrene	2.3	1/3	0.5	Abiotic value	NA
Little Bayou Seeps—Surface Water	Ecological	N	Ecological	Aluminum	4.9	18/30	0.8	Abiotic value	NA
				Cadmium	0.05	19/39	0.002	Abiotic value	NA
				Copper	0.1	30/39	0.007	Abiotic value	NA
				Lead	0.3	19/39	0.04	Abiotic value	NA
				Silver	0.03	4/11	0.001	Abiotic value	NA
				Zinc	0.2	28/39	0.07	Abiotic value	NA

NA = not applicable

[a] Results for seeps are from an unnumbered information sheet entitled, Seeps Along Little Bayou Creek, Northwest Groundwater Plume, dated July 2001. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.

[b] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.

[c] Contaminant concentrations used for the assessment were the maximum detected concentration.

[d] Values exceeding upper screening values (USVs) indicate that a deleterious health effect is possible. Consistent with the results, screening values are from DOE 2001b.

[e] "USVs" are chemical concentrations in sediment and surface water (i.e., abiotic media) that pose a high probability of causing adverse effects to ecological receptors.

Table 4.2a. Risk Assessment Summary for Residential Exposure to Groundwater at Off-site Location Impacted by Sources at the C-400 Building (Northwest and Northeast Dissolved-Phase Plume)[a]

Contaminant	Max Modeled Concentration over 1,000 years (mg/L or pCi/L)[b]	Cancer Risk[c]	Hazard[d]	Dose (mrem/yr)[e]
Results for the Northwest and Northeast Dissolved-Phase Plumes				
		NA		
Copper	1.19E+01	NA	2E+01	NA
Benzene	6.16E-03	2E-05	1E+00	NA
Chloroform	1.37E-03	6E-06	4E+00	NA
Dichloroethene, 1,1-	2.36E-01	5E-03	2E+00	NA
Dichloroethene, *cis*-1,2-	1.98E+01	NA	7E+02	NA
Naphthalene	3.96E-01	NA	1E+02	NA
Trichloroethene	8.08E+00	5E-03	5E+02	NA
Vinyl chloride	6.29E-02	2E-03	2E+00	NA
Technetium-99	1.70E+04	1E-03	NA	1.7E+01

NA = not applicable to this pathway Max = maximum

[a] Values in the table are from a draft sitewide risk assessment completed for the PGDP (DOE 2003e). The risks reported are baseline or unmitigated risks that assume no barriers to exposure. The points of exposure considered are within the Northwest and Northeast Plume at the DOE property boundary.

[b] Contaminant concentrations reported are the maximum expected over the next 1,000 years at the point of exposure, if no source actions are implemented at the C-400 Building source areas.

[c] Cancer risk to a resident that uses groundwater in the home as drinking water, while showering, and for other purposes. A lifetime exposure (40 years) is assumed.

[d] Hazard index for a child resident exposed as discussed above. Hazard index for an adult would be less.

[e] Dose to an adult resident exposure as discussed above. The dose to a child would be less.

Table 4.2b. Risk Assessment Summary for Residential Exposure to Southwest Plume Sources[a]

Contaminant	Exposure Point Concentration (mg/L or pCi/L)	Cancer Risk[b]	Hazard[c]	Dose (mrem/yr)
Results for the Southwest Plume (C-720 Building)				
Arsenic	4.26E-03	1.22E-04	9.42E-01	NA
Barium	4.22E-01	NA	4.07E-01	NA
Chromium	3.80E-01	NA	2.16E-02	NA
Cobalt	2.86E-02	NA	3.16E-02	NA
Copper	5.50E-02	NA	9.88E-02	NA
Iron	3.12E+01	NA	6.94E+00	NA
Manganese	4.25E+00	NA	1.21E+01	NA
Nickel	7.01E-01	NA	2.33E+00	NA
Dichloroethene, 1,1-	5.40E-02	1.15E-03	2.19E+00	NA
Trichloroethene	7.38E-01	4.28E-04	4.62E+01	NA
Vinyl chloride	2.10E-03	6.01E-05	6.87E-02	NA
Dichloroethene, *cis*-1,2-	1.40E-02	NA	1.13E-00	NA
Dichloroethene, *trans*-1,2-	5.40E-02	NA	2.55E-01	NA
Technetium-99	9.34E+01	6.65E-06	NA	NA
Results for the Southwest Plume (SWMU 1)				
Arsenic	4.36E-03	1.25E-04	9.64E-01	NA
Barium	4.62E-01	NA	4.45E-01	NA
Chromium	2.97E-02	NA	1.69E-03	NA
Cobalt	2.11E-01	NA	2.33E-01	NA
Iron	5.57E+00	NA	1.24E+00	NA
Manganese	3.97E+00	NA	1.13E+01	NA
Nickel	1.47E-01	NA	4.89E-01	NA
Zinc	3.15E-02	NA	6.99E-03	NA
Dichloroethene, 1,1-	7.00E-04	1.49E-05	2.84E-02	NA
Chloroform	3.20E-03	1.47E-05	1.11E+01	NA
Trichloroethene	7.80E-01	4.52E-04	7.05E+01	NA
Dichloroethene, *cis*-1,2-	6.70E-02	NA	2.73E+00	NA
Technetium-99	2.39E+01	1.70E-06	NA	NA
Results for the Southwest Plume (SWMU 4)				
Barium	3.14E-01	NA	3.03E-01	NA
Chromium	2.51E-01	NA	1.42E-02	NA
Cobalt	2.95E-03	NA	3.26E-03	NA
Iron	6.02E+00	NA	1.34E+00	NA
Manganese	1.40E+00	NA	4.00E+00	NA
Nickel	2.32E-01	NA	7.71E-01	NA
Dichloroethene, 1,1-	2.53E-02	5.37E-04	1.03E+00	NA
Dichloroethane, 1,2-	4.74E-02	3.22E-04	1.02E+01	NA
Acetone	4.90E-02	NA	1.78E-01	NA
Benzene	1.60E-02	4.15E-05	3.18E+00	NA
Bromomethane	4.10E-03	NA	1.05E+00	NA
Carbon tetrachloride	1.03E-01	5.66E-04	5.40E+01	NA
Chloroform	1.30E-01	5.97E-04	4.52E+02	NA
Dibromochloromethane	2.00E-03	1.25E-05	3.64E-02	NA
Methylene chloride	4.81E-02	1.13E-05	7.01E-02	NA
Tetrachloroethene	4.00E-03	6.88E-06	4.75E-02	NA
Trichloroethene	5.97E+00	3.46E-03	3.74E+02	NA
Vinyl chloride	1.90E-02	5.44E-04	6.22E-01	NA
Dichloroethene, *cis*-1,2-	4.30E-01	NA	1.57E+01	NA
Dichloroethene, *trans*-1,2-	3.44E-02	NA	6.27E-01	NA
Technetium-99	1.66E+02	1.18E-05	NA	NA

NA = not applicable to this pathway or not available   Max = maximum

[a] Southwest Plume risk values are taken from the preliminary document for the Southwest Plume Site Investigation, D2 (DOE 2006a), Appendix G, Pages G-116 to G-126. The point of exposure for the Southwest Plume was assumed to be a location on the DOE property boundary where the plume is projected to leave DOE property at some time in the future. Values presented are those at the source.

[b] Cancer risk to a resident that uses groundwater in the home as drinking water, while showering, and for other purposes.

[c] Hazard index for a child resident exposed as discussed above. Hazard index for an adult would be less.

Under the potential end state alternative, the potential receptors affected during implementation of the response actions (see Figure 4.1b3) are the environmental sampler, remediation worker, maintenance worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The environmental sampler could be exposed during sampling activities. The maintenance worker could be exposed while maintaining access controls. The remediation worker and ecological receptors could be exposed during completion of the heating technology for subsurface soil and groundwater at the C-400 Building and while constructing the burial ground cap. The general site worker could be exposed during implementation of the source actions. The disposal worker could be exposed while accepting waste derived from implementing the source actions at C-400. The transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels using barriers to prevent exposure. Because contamination would continue to exist at levels above MCLs in groundwater, MNA, which may require approval of an alternate concentration limit (ACL) petition and/or a technical impractability (TI) waiver, would be required until MCLs are met.

4.2 HAZARD AREA 2—SWOU

This hazard area is composed of the facilities and SWMUs listed below, which are sources of contamination to the SWOU and include contaminated sediments and soils. Major contributing sources are the outfalls and their associated internal ditches and areas, NSDD, Little Bayou and Bayou Creeks, the storm sewers and the former scrap yards which are depicted in Figure 4.2a1. A description of each facility and SWMU is presented in the following section.

- SWMUs 60, 61, 62, 63, 66, 67, 68, 69, 168, and 526: Internal plant ditches and outfalls including SWMUs 92 and 97
- SWMUs 58 and 59: NSDD
- SWMU 64: Little Bayou Creek
- SWMU 65: Bayou Creek
- SWMU 102: Storm sewer systems
- SWMUs 13, 14, 15, 16, and 520: Scrap yards

4.2.1 Current State

Sources

The *Internal Plant Ditches and Outfalls* are part of the original construction of PGDP. These originally were designed to convey plant effluents to one of the surrounding creeks. Currently, the water quality of each effluent ditch is regulated by a KPDES permit. Each ditch has an established monitoring station where water quality is tested regularly, in accordance with the conditions of the facility permit. The SWMUs making up the internal plant ditches and outfalls and their approximate sizes are as follows:

- SWMU 60: Outfall 002 ditch located on the east side of PGDP; 4.2 acres

- SWMU 61: Outfall 013 ditch located on the east side of PGDP; 1.9 acres
- SWMU 62: Outfall 009 ditch located on the southwest side of PGDP; 5.3 acres
- SWMU 63: Outfall 008 ditch located on the west side of PGDP; 7.8 acres
- SWMU 66: Outfall 010 ditch located on the east side of PGDP; 5.8 acres
- SWMU 67: Outfall 011 ditch located on the east side of PGDP; 0.6 acres
- SWMU 68: Outfall 015 ditch located on the west side of PGDP; 5.5 acres
- SWMU 69: Outfall 001 ditch located on the west side of PGDP; 13.8 acres
- SWMU 168: Outfall 012 ditch located on the east side of PGDP; 0.8 acres

In addition, the internal plant drainage system is SWMU 526 including SWMU 92 and 97. The area covered by this system is greater than 100 acres. The storm sewer system (SWMU 102) is approximately 16,360 linear ft.

The primary contaminants in the internal plant ditches and outfalls are PCBs, metals, and radionuclides. (In the past, dioxins and furans potentially were identified at very low concentrations in some areas; however, it is uncertain if these analytes still are present in ditch sediments.) The SWOU (On-Site) SI (DOE 2008b) identified potential "hot spots" in four of the seven internal plant ditches (outfalls 001, (SWMU 69), 008 (SWMU 63), 010 (SWMU 66) and 015 (SWMU 68). A removal action of these "hot spots" was completed in 2010 (DOE 2011d).

The *NSDD* (SWMUs 58 and 59) is located in the north-central portion of PGDP and was part of the original plant construction. At one time, this ditch served as Outfall 003 and conveyed plant effluent from sources in the central portion of PGDP, including the C-400 Building, to the north with ultimate discharge to Little Bayou Creek. This ditch no longer conveys effluents and the portion located within the industrialized portion of PGDP (SWMU 59), which is about 2,600 ft long, has undergone remediation (i.e., excavation) under a ROD (DOE 2002b). The portion of the ditch located outside the industrialized portion of PGDP (SWMU 58), which is about 8,400 ft long, also was investigated as part of the SWOU (On-Site) SI (DOE 2008b). The principal contaminants associated with the sediments and soils of the NSDD are radionuclides, metals, and PCBs. Potential "hot spots" were identified in Section 3 and Section 5 of the NSDD during the investigation. A removal action of these "hot spots" was completed in 2010 (DOE 2011d).

Little Bayou Creek (SWMU 64) is a perennial stream under current conditions that begins approximately 0.4 miles south of PGDP (off DOE property) and flows along the east side of PGDP (within the DOE property, but outside of the industrialized portion of PGDP) to a confluence with Bayou Creek that is off DOE property. The ultimate discharge point of Little Bayou and Bayou Creeks is the Ohio River. Little Bayou Creek has received effluent from the process facilities located on the east side of PGDP since operation of the plant began. The east side of the plant contains the most heavily industrialized area of the plant, including the main uranium processing buildings.

Previous investigations of Little Bayou Creek have been limited to SIs. No RIs of Little Bayou Creek have been completed. The primary contaminants found within Little Bayou Creek sediments are metals, PCBs, and radionuclides.

Bayou Creek (SWMU 65) is a perennial stream that flows generally northward along the western boundary of PGDP from approximately 2.5 miles south of the plant to the Ohio River. Both upstream and downstream reaches extend beyond the DOE property boundaries. The ultimate discharge point of Bayou Creek is the Ohio River. Bayou Creek has received effluent from the process facilities located on the west and south sides of PGDP since operation of the plant began. Additional contaminant sources include facilities located outside the main industrial area, but adjacent to Bayou Creek. These include the C-746-K Landfill (SWMU 8) and the C-611 Water Treatment Plant.

Previous investigations of Bayou Creek have been limited to SIs. No RIs of Bayou Creek have been completed. The primary contaminants found in Bayou Creek are metals, PCBs, and radionuclides.

The *Storm Sewer Systems* (SWMU 102) carry precipitation runoff from building roof drains and ground surfaces within the industrialized portion of PGDP to various regulated outfalls around the plant. Materials from spills and leaks also may have been transported by the storm sewer system. Portions of the storm sewer system have been qualitatively evaluated during the various site and RIs performed for source areas. These evaluations have determined that the storm sewer system is a potential transport pathway to the SWOU. Limited investigations of contaminant levels within the storm sewer system and within the bedding materials surrounding the sewers have been performed, and areas of the storm sewer system have been sampled as part of investigations supporting cleanup activities for the GWOU and SWOU. Potential contaminants thought to have a source at the storm sewer systems are solvents, SVOCs, PCBs, metals, and radionuclides. Further investigation during the SWOU (On-Site) SI (DOE 2008b) indicates that there have been no releases of uranium, PCBs, or TCE for the storm sewers associated with C-333-A, C-337-A, C-340, C-535, and C-537 above the maximum MCLs.

The *Scrap Yards* consisted of several SWMUs, covering a total of approximately 23 acres, located in the industrialized portion of PGDP. These scrap yards contained both clean and contaminated scrap derived from plant processes. The majority of these scrap yards were located on the north side of the industrialized portion of PGDP. These SWMUs and their approximate sizes are as follows:

- SWMU 13: C-746-P Clean Scrap Yard; 6.8 acres
- SWMU 14: C-746-E Contaminated Scrap Yard; 5.9 acres
- SWMU 15: C-746-C Scrap Yard; 5.4 acres
- SWMU 16: C-746-D Classified Scrap Yard; 2.2 acres
- SWMU 520: Scrap Material West of C-746-A; 2.9 acres

The material in each of these scrap yards has been removed as part of a CERCLA action that resulted in on- and off-site disposal of the scrap (DOE 2001c). Contaminants for the scrap yards were SVOCs, PCBs, metals, and radionuclides. Any contaminants remaining in the soil of the former scrap yards are being addressed by the SOU (Section 4.4).

Pathways

In the current CSM for the SWOU (see Figure 4.2a2), bank soil, sediment, and waste from past enrichment operations (i.e., scrap) are identified as sources of contamination. Contaminants found in these sources are available for direct contact on-site or for transport to areas outside the industrialized area of PGDP. Once in the environment, contaminants could directly affect ecological receptors or enter the food chain.

Using this CSM, sediments (including bank soils) and surface water are of concern for Hazard Area 2. Receptors potentially exposed to sediment and surface water are also workers, visitors, and ecological receptors. The resident, visitor, and ecological receptor potentially are exposed through the food chain.

Under current conditions, the barriers to exposure are access controls to prevent exposure to contaminated sediments • and a sedimentation basin to prevent release of potentially contaminated sediments I . In addition, monitoring of effluents is ongoing to ensure that releases are identified quickly , . (As noted above, the material from the scrap yards has been removed as part of a CERCLA action.) Removal Action Completion Reports for the scrapmetal removal and the Surface Water "Hot Spot" Removal have been submitted to and approved by EPA and KY. The scrap and the internal ditches addressed by the Surface Water "Hot Spot" Removal no longer are considered a source of contamination (internal ditches associated with scrap yards in the northwest corner of PGDP and those leading to Outfall 016 are not included).

Risk Levels

As shown in Figure 4.2a2, no exposure pathways currently are complete for the SWOU due to the presence of barriers to exposure; however, the baseline or unmitigated risks that could be present if the barriers did not exist have been assessed. Tables 4.3a, 4.3b, and 4.3c summarize these results (updated based on more recent data collection efforts) for a recreational user and ecological receptors, respectively, potentially exposed to contaminated sediment found in four outfall ditches and to the portion of the NSDD located outside the industrialized area of PGDP. Tables 4.4a and 4.4b summarize the potential risks to a recreational user and worker exposed to surface water potentially contaminated by migration sediments found in the industrialized portion of PGDP. The points of exposure considered in Table 4.4a and Table 4.4b are where Bayou and Little Bayou Creek leave DOE-owned property and at the confluence of Bayou and Little Bayou Creeks near the Ohio River.

The contaminants included in Table 4.4a are PCBs, PAHs, and U-238. Only results for these contaminants are shown because only these contaminants were determined in the draft sitewide risk assessment to migrate from the industrialized portions of PGDP and result in potentially measurable concentrations in surface water (DOE 2003e). Table 4.4b shows the results of migration modeling from the SWOU (On-Site) SI (DOE 2008b). The modeling performed as part of the SI report for the outfalls and their associated internal ditches indicates that no contaminants are migrating in surface water (dissolved or through sediment) from the ditches to surrounding creeks at concentrations that may adversely impact human health.

Risks to human health have been further reduced by removal of "hot spots" from contaminated sediment defined in the SWOU (On-Site) SI. Completion of this removal action reduced the risk to current and future workers, excavation workers, and recreators from direct contact by removing known sources of contamination (DOE 2011d). A complete residual risk evaluation is forthcoming.

Risks Posed by Consumption of Plants and Animals

Since the 1950s, the PGDP has produced an Annual Site Environmental Report (e.g., DOE 2010e). These reports, which are based on thousands of environmental samples collected at or near the PGDP as part of an integrated monitoring program, present the data collected and the details of the PGDP environmental management program. As part of these reports, concentrations of selected contaminants found in animals (i.e., game) and plants have been reported and evaluated. (Note that recent reports do not contain information concerning plants because DOE no longer operates any major air emissions sources; therefore, contamination of plants is not expected.)

In the most recent report (DOE 2010e), the contaminant concentrations in deer and fish were evaluated. For deer, this evaluation determined the following when considering consumption of venison:

- Concentrations of PCBs were below the standard (3 ppm for red meat) set by the Food and Drug Administration and would pose risks near or below *de minimis* levels; risk was calculated to be 5.8 chances of cancer development (over a lifetime) per 100,000 people eating deer;
- Concentrations of metals present were not elevated; and
- Radionuclide dose essentially was zero, which is less than the DOE limit and EPA benchmark for exposure by the public (i.e., 100 and 15 mrem/yr, respectively).

For fish, this evaluation determined the following when considering PCB concentrations and consumption:

- Concentrations of PCBs present in fish taken near the PGDP were greater than those in fish from a background location;
- Fish consumption (assuming average PCB concentrations) should be limited to 4 oz. of fish/month for healthy adults; and
- Pregnant or nursing women and children under 15 years should not eat any fish.

4.2.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.2.1 for a discussion of sources and pathways of exposure.

Table 4.3a. Risk Assessment Summary[a] for Recreational User Exposure to Contaminated Sediments Found in Outfall Ditches and Portions of NSDD Located Outside of the Industrialized Portion of the PGDP

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level[h]
Outfall 008 ditch sediment/soils (discharges to Bayou Creek)	Industrial	N	Recreational user	Antimony	2	HI = 1	2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	17,341	HI = 2	8,830	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Manganese	818	HI = 4	193	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Vanadium	26	HI = 2	14	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 010 ditch sediment/soils (discharges to Little Bayou Creek)	Industrial	N	Recreational user	Antimony	2	HI = 1	2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	19,765	HI = 2	8,830	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Vanadium	35	HI = 3	14	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 011 ditch sediment/soils (discharges to Little Bayou Creek)	Industrial	N	Recreational user	Uranium[l]	391	HI = 5	87	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Vanadium	43	HI = 3	14	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PAHs	8	ELCR = 6E-4	0.0133	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCBs	21	ELCR = 2E-4	32[i]	TSCA	25 mg/kg
				U-238	52	ELCR = 1E-4	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 015 ditch sediment/soils (discharges to Little Bayou	Industrial	N	Recreational user	Antimony	2	HI = 1	2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Cs-137	52	ELCR = 3E-4	0.18	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.

Table 4.3a. Risk Assessment Summary[a] for Recreational User Exposure to Contaminated Sediments Found in Outfall Ditches and Portions of NSDD Located Outside of the Industrialized Portion of the PGDP (Continued)

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level[h]
NSDD—Hot Spot[j]	Industrial	Y	Recreational user	Antimony	14	HI= 9	2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	11,177	HI=1	8,830	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Uranium[l]	328	HI=4	87	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCBs	2.7	ELCR=4E-6	25	TSCA	25 mg/kg
NSDD—Excluding The Hot Spot[k]	Industrial	Y	Recreational user	Antimony	10	HI=6	2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	9,331	HI=1	8,830	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Uranium[l]	164	HI=2	87	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.

TSCA = Toxic Substances Control Act

[a] Results for outfall ditches taken from BJC 2003a. Results for NSDD Sections 3, 4, and 5 taken from BJC 2003b. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers. The results presented were prior to the removal action performed in 2010. These risks will be reduced once a complete residual risk assessment for the action is available.

[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all sediment samples collected along the outfall ditch or NSDD. For the NSDD, Section 3 of the ditch is that portion closest to the industrialized area, and Section 5 of the ditch is that portion farthest from the industrialized area. Section 4 of the ditch lies between Sections 3 and 5 and is that portion of the ditch located near the landfills found outside of the industrialized area (see Section 5).

[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.

[d] Recreational user exposure includes child/teen (140 d/yr, 6 yr) and adult (104 d/yr, 34 yr).

[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.

[f] "PRG" is the preliminary remediation goal used when considering potential response actions.

[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default recreational user at risk level 1E-06 and hazard of 1.

[h] Risk and hazard targets projected to be used when calculating cleanup concentrations under the potential end state alternative.

[i] The PRG for Total PCBs has been changed from 0.127 ppm to 32 ppm to reflect levels consistent with those identified in the preliminary Engineering Evaluation/Cost Analysis for the SWOU (On-Site) Removal Action.

[j] The NSDD Hot Spot is defined as that area inside Section 3 of the NSDD which contains exposure units (EUs) 01 and 02 [SWOU (On-Site) SI (DOE 2008b)].

[k] The NSDD Excluding the Hot Spot contains a subsection of Section 3 of the NSDD, which contains EU 3 and all of Sections 4 and 5 of the NSDD [SWOU (On-Site) SI (DOE 2008b)].

[l] Uranium denoted here is total uranium (metal) in mg/kg.

Table 4.3b. Risk Assessment Summary[a] for Future Industrial Worker Exposure to Contaminated Sediments Found in Outfall Ditches Located Inside the Industrialized Portion of the PGDP

Location[b]	Land Use	Risk[c]	Risk Scenario	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[d]	PRG[e] (mg/kg or pCi/g)	Basis for PRG[f]	Actual or Expected Post Cleanup Concentration or Risk Level[g]
Outfall 001 (EU 13 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	9.9	HI=0.2	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 001 (EU 14 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	15	HI=0.2	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCB	22	ELCR=3E-6	25	TSCA	25 mg/kg
				Total PAH (as BaPE)	184	ELCR=4E-4	0.03	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 001 (EU 15 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	10	HI=0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Uranium	642	HI=0.2	200	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCB	52	ELCR=7E-6	25	TSCA	25 mg/kg
				Total PAH (as BaPE)	5	ELCR=1E-5	0.03	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 001 (EU 16 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	10	HI=0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	182,000	HI=0.5	20,000	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 001 (EU 18 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	10	HI=0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 001 (EU 20 Hot Spot)	Industrial	Y	Future Industrial user	Antimony	10	HI=0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 008 Hot Spot (EUs 08 and 11)	Industrial	Y	Future Industrial user	Antimony	10	HI = 0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCBs	32	HI = 4E-6	25	TSCA	25 mg/kg
Outfall 010 Hot Spot (EU 10)	Industrial	N	Future Industrial user	Antimony	10	HI = 0.1	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PCBs	19	HI = 3E-6	25	TSCA	25 mg/kg
				Total PAH (as BaPE)	3	ELCR=6E-6	0.03	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.

Table 4.3b. Risk Assessment Summary[a] for Future Industrial Worker Exposure to Contaminated Sediments Found in Outfall Ditches Located Inside the Industrialized Portion of the PGDP (Continued)

Location[b]	Land Use	Risk[c]	Risk Scenario	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[d]	PRG[e] (mg/kg or pCi/g)	Basis for PRG[f]	Actual or Expected Post Cleanup Concentration or Risk Level[g]
Outfall 011 Hot Spot (EU 01)	Industrial	N	Future Industrial user	Antimony	17	HI = 0.3	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Iron	14,665	HI=0.1	20,000	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Uranium	920	HI=0.1	200	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Total PAH (as BaPE)	1	ELCR=3E-4	0.03	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Outfall 015 Hot Spot (EUs 1-7 and 8)	Industrial	N	Future Industrial user	Antimony	11	HI = 0.2	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
				Uranium	920	HI=0.3	200	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.
Within the Fence Excluding Hot Spots	Industrial	N	Future Industrial user	Antimony	11	HI=0.2	4	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI = 1.

TSCA = Toxic Substances Control Act
BaPE = benzo(a)pyrene equivalent
[a] Results for outfall ditches taken from SWOU (On-Site) SI (DOE 2008b). The results presented were prior to the removal action performed in 2010. These risks will be reduced once a complete residual risk assessment for the action is available.
[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all sediment samples collected along the respective outfalls as defined in SWOU (On-Site) SI (DOE 2008b).
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.
[e] "PRG" is the preliminary remediation goal used when considering potential response actions and is based on a ELCR of 1E-04 and a HI=1.
[f] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1.
[g] Risk and hazard targets projected to be used when calculating cleanup concentrations under the potential end state alternative.

Table 4.3c. Risk Assessment Summary[a] for Ecological Receptors Exposure to Contaminated Sediments Found in Outfall Ditches and Portions of NSDD Located Outside of the Industrialized Portion of the PGDP

Location	Land Use	Risk[b]	Risk Scenario	Contaminant Description	Maximum Concentration[c] (mg/kg)	Frequency above USV Level[d]	USV[e] (mg/kg)	Basis for USV	Actual or Expected Post Cleanup Concentration or Risk Level
Outfall 001—sediment	Industrial	N	Ecological	Arsenic	33.7	3/6	17	Abiotic value	NA
				Nickel	73.5	2/6	36	Abiotic value	NA
				Benzo(a)anthracene	0.69	2/6	0.385	Abiotic value	NA
				Phenanthrene	0.69	3/6	0.515	Abiotic value	NA
				PCBs	35.1	16/25	0.277	Abiotic value	NA
Outfall 008—sediment	Industrial	N	Ecological	Mercury	3.28	1/6	0.486	Abiotic value	NA
				Fluoranthene	2.8	1/4	2.23	Abiotic value	NA
				Phenanthrene	2.8	1/4	0.515	Abiotic value	NA
				Pyrene	2.8	1/4	0.875	Abiotic value	NA
				PCBs	1.4	4/8	0.277	Abiotic value	NA
Outfall 010—sediment	Industrial	N	Ecological	None	NA	NA	NA	NA	NA
Outfall 011—sediment	Industrial	N	Ecological	Chromium	160	1/2	90	Abiotic value	NA
				Benz(a)anthracene	1.1	1/2	0.385	Abiotic value	NA
				Benzo(a)pyrene	1.2	1/2	0.782	Abiotic value	NA
				Chrysene	1.3	1/2	0.862	Abiotic value	NA
				Fluoranthene	2.9	1/2	2.23	Abiotic value	NA
				Phenanthrene	2.3	2/2	0.515	Abiotic value	NA
				Pyrene	2.3	1/2	0.875	Abiotic value	NA
				PCBs	55	52/66	0.277	Abiotic value	NA
Outfall 015—sediment	Industrial	N	Ecological	PCBs	0.8	2/6	0.277	Abiotic value	NA

Table 4.3c. Risk Assessment Summary[a] for Ecological Receptors Exposure to Contaminated Sediments Found in Outfall Ditches and Portions of NSDD Located Outside of the Industrialized Portion of the PGDP (Continued)

Location	Land Use	Risk[b]	Risk Scenario	Contaminant Description	Maximum Concentration[c] (mg/kg)	Frequency above USV Level[d]	USV[e] (mg/kg)	Basis for USV	Actual or Expected Post Cleanup Concentration or Risk Level
Sections 3,4 and 5 of the NSDD[f]	Industrial	N	Ecological	Antimony	9.99	47/94	2	Abiotic value	NA
				Arsenic	57.1	43/94	5.9	Abiotic value	NA
				Cadmium	4.91	5/94	0.27	Abiotic value	NA
				Chromium	473	94/94	37.3	Abiotic value	NA
				Copper	234	90/94	30	Abiotic value	NA
				Iron	82,600	94/94	2000	Abiotic value	NA
				Lead	58.9	23/94	12	Abiotic value	NA
				Manganese	4,470	94/94	614	Abiotic value	NA
				Mercury	0.76	21/94	0.16	Abiotic value	NA
				Nickel	150	74/94	16	Abiotic value	NA
				Selenium	27.9	1/94	0.05	Abiotic value	NA
				Silver	10.6	47/94	0.00038	Abiotic value	NA
				Vanadium	104	94/94	0.2	Abiotic value	NA
				Zinc	196	78/94	4.7	Abiotic value	NA
				Total PAHs	1.61	NA	1.61	Abiotic value	NA
				Total PCBs	28.9	84/408	0.032	Abiotic value	NA

NA = not applicable
[a] Results are taken from BJC 2003a. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers. The results presented were prior to the removal action performed in 2010. These risks will be reduced once a complete residual risk assessment for the action is available.
[b] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[c] Contaminant concentrations used for the assessment were the maximum detected concentration.
[d] "USV" is the upper screening value. Values are taken from the 2001 Risk Methods Document (DOE 2001b) as used in the SWOU (On-Site) SI (DOE 2008b).
[e] USVs are chemical concentrations in abiotic media that pose a high probability of adverse effects to ecological receptors based on ingestion of soil/sediment or ingestion of food so exposed.
[f] Results for NSDD are taken from SWOU (On-Site) SI (DOE 2008b). Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.

Table 4.4a. Risk Assessment Summary[a] for Exposure to Maximum Modeled Concentrations in Surface Water from Sources at the PGDP

Receptor	Bayou Creek	Little Bayou Creek	Confluence
	***Risks*[b]**		
Recreational Swimmer	1.94E-05	6.49E-07	3.93E-06
Recreational Wader	2.23E-05	3.14E-07	4.33E-06
Industrial Worker	1.30E-05	1.84E-07	2.53E-06
Residential Fish Ingestion*	3.74E-03	1.39E-04	1.87E-03
	***Hazards*[c]**		
Recreational Swimmer	6.04E-02	8.92E-03	1.77E-02
Recreational Wader	6.46E-02	1.06E-02	1.88E-02
Industrial Worker	2.75E-02	4.51E-03	8.01E-03
Residential Fish Ingestion*	3.67E-03	1.13E-03	1.98E-03
	Doses*[d] *(mrem/yr)		
Recreational Swimmer	7.79E-04	2.42E-02	8.73E-03
Recreational Wader	NA	NA	NA
Industrial Worker	NA	NA	NA
Residential Fish Ingestion*	1.82E-02	1.98E+00	2.74E-01

NA = not applicable
[a] Values in the table are from a draft sitewide risk assessment completed for the PGDP in 2003 (DOE 2003e). The risks reported are baseline or unmitigated risks that assume no barriers to exposure. The points of exposure considered were where Bayou and Little Bayou Creeks leave DOE-owned property and at the confluence of these creeks near the Ohio River. Contaminant concentrations used in this assessment are the maximum expected over 30 years from present, assuming no source actions. Contaminants in derivation of risk, hazard, and dose values are PCBs, PAHs, and U-238.
[b] Cancer risk to a recreational user assumes lifetime exposure at the point of exposure (i.e., over 40 years).
[c] Hazard index is for a child recreational user. Hazard index for an adult would be less.
[d] Dose is not age dependent under the scenario assessed; therefore, the values presented are relevant to all age cohorts.
* Fish ingestion results based on average modeled concentrations. In addition to examining the potential cancer risks, hazards, and doses posed to the recreational user from direct contact with surface water, the risks, hazards, and doses posed from consuming fish exposed to the potentially contaminated surface water also were estimated using the screening values for fish consumption presented in DOE 2003e. These results were calculated using average concentrations produced by the Storm Water Management Model.

Table 4.4b. Modeled Contaminant Concentrations[a] of PGDP Surface Water at Multiple Receptor Locations

Action level	Total PCBs	Uranium-238
Industrial Worker (Action)	1.65E-02 mg/L	NA
Industrial Worker (No Action)	1.65E-04 mg/L	NA
Child Recreational (Action)	1.12E-02/9.61E-03 mg/L	4.91E+03 pCi/L
Child Recreational (No Action)	1.12E-04/9.61E-05 mg/L	4.91E+01 pCi/L

	SWMU Predicted Surface Water Concentrations[c]			
	Total PCBs		**Uranium-238**	
Receptor Location[b]	**Average (mg/L)**	**Maximum (mg/L)**	**Average (pCi/L)**	**Maximum (pCi/L)**
Outfall 001	**1.18E-04**	**5.27E-04**	1.06E+01	**5.15E+01**
Outfall 008	**1.84E-04**	**8.11E-04**	1.94E+00	9.26E+00
Outfall 010	**4.21E-04**	**1.70E-03**	0.00E+00	0.00E+00
Outfall 015	**1.58E-04**	**6.68E-04**	4.07E+00	1.73E+01
B09 (IP for Bayou Creek)	8.50E-06	1.46E-05	4.40E-02	8.18E-01
B06 (from OF 008)	4.80E-07	1.98E-05	5.06E-03	2.27E-01
L05 (from OF 010)	2.16E-06	1.91E-05	0.00E+00	0.00E+00
B07 (from OF 015)	5.57E-07	4.13E-05	7.70E-03	7.13E-01
L07 (IP for Little Bayou Creek)	1.37E-06	7.93E-06	0.00E+00	0.00E+00

NA = not applicable IP = Integrator Point. OF = Outfall.
[a] Values in the table are from the SWOU (On-Site) SI (DOE 2008b).
[b] Outfall concentrations are at the pipe, and creek concentrations are immediately downgradient of the outfalls.
[c] Predicted concentrations are based on 30-year simulations.
L04, L05, and L07 are discharge points in Little Bayou Creek.
B06, B07, and B09 are discharge points in Bayou Creek.
Bolded values represent exceedance of one or more of no action level values.

Barriers and Actions

The barriers to exposure at the potential end state alternative (see Figures 4.2b1 and 4.2b2) are continued access controls to prevent exposure to source material • until such time as the source material is removed. Source actions are planned under the potential end state alternative to remove the sources of surface water contamination (i.e., soil and sediments) ƒ . Finally, monitoring of effluents would continue to ensure that any future releases are identified quickly , .

Under the potential end state alternative, potential receptors affected during implementation of the response actions (see Figure 4.2b3) are the environmental sampler, maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The environmental sampler could be exposed during sampling activities. The maintenance worker could be exposed while performing maintenance activities. The remediation worker and ecological receptors could be exposed during completion of source actions (anticipated to be characterization and disposal of scrap and excavation of sediments). The general site worker also could be exposed during implementation of the source actions. The disposal worker could be exposed while accepting waste from the scrap disposal and excavation activities. The transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels due either to the presence of barriers that prevent exposure or the removal of scrap and contaminated sediments and soil. The risk target for cleanup levels for sediments under the potential end state alternative at locations inside the industrialized area is an industrial risk of 1E-04. The PCB concentration target for sediments in industrial areas is 25 ppm. The risk target for cleanup levels for sediments under the potential end state alternative at locations outside the industrialized area is a recreational risk of 1E-04. The PCB concentration target for sediments in recreational use areas is 1 ppm. For both the industrial worker and the recreational user, these target risks will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit appropriate for the area's land use. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

4.3 HAZARD AREA 3—BGOU (GROUP 1)

This hazard area is composed of a burial ground located in the northwestern corner of the industrialized portion of PGDP and one landfill to the north of the industrialized portion of the plant. This hazard area is depicted in Figure 4.3a1. A description of each facility and SWMU is presented in the following section. Note that none of these burial grounds currently is accepting waste, and waste in each currently is covered with soil. The following are the burial grounds included.

- SWMU 6: C-747-B Burial Ground
- SWMU 145: Residential/Inert Landfill Borrow Area (and old NSDD Channel)

4.3.1 Current State

Sources

The *C-747-B Burial Ground* (SWMU 6) is located in the northwest portion of the industrialized portion of PGDP and covers about 0.83 acres. It accepted waste from 1960 to 1976. It consists of five burial pits of various sizes containing contaminated equipment and drums of metal scrap. Each pit contains a specific type of waste. After placement of the waste, each pit was covered with 3 to 5 ft of soil. The southern half of the area is a storage yard for contaminated vehicles that no longer are functional. An RI for the burial ground was completed in 1999 (DOE 2000b). Contaminants determined to be associated with this burial ground are metals, radionuclides, and PCBs. A second RI for the BGOU, including this SWMU, was completed in 2007 (DOE 2010f). The results from this RI were used to prepare the FS for the BGOU that includes this area currently under review.

The *Residential/Inert Landfill Borrow Area (and old NSDD Channel)* (SWMU 145) is located outside the industrialized portion of PGDP, but on DOE-owned property, immediately north of Ogden Landing Road. This area covers about 44 acres. It consists of areas containing materials disposed of when the GDP was under construction and immediately thereafter (called the "P-Landfill") and a section of the NSDD that was filled with debris when a new channel was constructed for the ditch. An investigation of the old NSDD channel, which covers about 1.5 acres, was performed in 1999 to determine the types of materials that may have been placed in that area. Two test pits were excavated, and only construction debris was found. Contaminants believed to be associated with the NSDD channel and other portions of SWMU 145 are radionuclides and metals. An RI for the BGOU, including this SWMU, was completed in 2007 (DOE 2010f). The RI Report was completed in 2010. While not included in the FS for the BGOU, the SMP suggests SWMU 145 likely will undergo capping (DOE 2011a).

Pathways

In the current CSM for the BGOU (Group 1) (see Figure 4.3a2), waste materials from plant operations and surface and subsurface soil are current sources of contamination. Contaminants found in waste and soil are available for direct contact on-site. Migration of contamination from these burial grounds is not expected due to the nature of the wastes. Ecological receptors potentially could contact contaminants at the burial grounds resulting in contamination entering the food chain, but impacts from this pathway would be limited because the burial grounds are located in industrialized areas.

Using this CSM, the waste materials, surface soil, and subsurface soil are of concern for Hazard Area 3. Receptors potentially exposed to waste material and soil are workers, visitors, and ecological receptors. In addition, the ecological receptor potentially is exposed through the food chain.

Under current conditions, the only barrier to exposure that prevents exposure to waste and soil at SWMUs 6 and 145 is access controls • . (Note that although waste is covered with soil at SWMU 6, there is some potential for exposure to contaminants found in the soil cover. A similar condition may exist at SWMU 145.)

Risk Levels

As shown in Figure 4.3a2, no pathways currently are complete for the BGOU (Group 1); however, the baseline or unmitigated risks that could be present if the barriers did not exist have been assessed for SWMU 6. Tables 4.5a and 4.5b summarize these results for an industrial worker and ecological receptors, respectively, potentially exposed to surface soil at this burial ground. (Results are not shown for SWMU 145 because assessments using representative data are not available for these areas.)

4.3.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.3.1 for a discussion of sources and pathways of exposure.

Table 4.5a. Risk Assessment Summary[a] for Industrial Worker Exposure to Contaminated Surface Soil Found at SWMU 6: C-747-B Burial Ground

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
C-747-B Burial Ground	Industrial	N	Industrial	Beryllium	0.676	ELCR = 2E-4	2.83E-03	Risk-Based	*de minimis*
				Total PAHs	0.649	ELCR = 2E-5	1.94E-02	Risk-Based	*de minimis*

[a] Results are taken from DOE 2010f. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.
[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all soil samples collected at the burial ground.
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] Industrial worker exposure (250 d/yr for 25 yr).
[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.
[f] "PRG" is the preliminary remediation goal used when considering potential response actions.
[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1.

Table 4.5b. Risk Assessment Summary[a] for Ecological Receptors Exposed to Contaminated Surface Soil Found at SWMU 6: C-747-B Burial Ground

Location	Land Use	Risk[b]	Risk Scenario	Contaminant Description	Representative Concentration[c] (mg/kg)	Baseline Risk Level[d]	PRG[e] (mg/kg)	Basis for PRG	Actual or Expected Post Cleanup Concentration or Risk Level
C-747-B Burial Ground	Industrial	Y	Ecological—Plants	Nickel	43.2	HQ = 1	NA	NA	NA
				Zinc	128	HQ = 3	NA	NA	NA
			Ecological—Soil invertebrates	Zinc	128	HQ = 1	NA	NA	NA
			Ecological—Woodcock	Zinc	78.4	HQ = 3	NA	NA	NA
				Di-n-butyl phthalate	0.986	HQ = 1	NA	NA	NA

NA = not applicable
[a] Results are taken from DOE 2010f. Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers. Only constituents considered above background were included.
[b] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[c] Contaminant concentrations used for the assessment were the maximum detected concentration (for plants, invertebrates, and microbes), and the lower of the maximum detected concentration or the upper 95% confidence limit on the mean concentration (for wildlife species).
[d] "HQ" is the hazard quotient, a measure for potential systemic toxicity. Values greater than 1 indicate that the receptor may be harmed.
[e] "PRG" is the preliminary remediation goal used when considering potential response actions. Ecological PRGs have not been established.

Barriers and Actions

The barriers to exposure at the potential end state alternative (see Figures 4.3b1 and 4.3b2) are continued access controls • and/or capping or cover , to prevent direct contact exposure to waste and soil.

Under the potential end state alternative, potential receptors during implementation of the response actions (see Figure 4.3b3) are the maintenance worker and remediation worker. The maintenance worker could be exposed during site maintenance activities performed as part of access controls. The remediation worker could be exposed while capping the burial grounds.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels due to the barriers that prevent exposure.

4.4 HAZARD AREA 4—SOU

This hazard area is composed of surface soils found within the industrialized areas of PGDP that are not included in other hazard areas. This hazard area is depicted in Figure 4.4a1.

4.4.1 Current State

Sources

This hazard area is composed of units that make up the SOU. It encompasses all areas inside the industrialized portion of PGDP (approximately 40 acres) that contain potential contamination that is not suspected of impacting the GWOU or SWOU. An RI of these areas was performed during the summer of 2010. Samples collected as part of other projects indicate that contaminants associated with the SOU are metals, PAHs, PCBs, and radionuclides. An RI Report for the SOU is under development.

This hazard area also encompasses the soil and rubble areas that have been identified both on and off DOE property that may contain contaminated soils or materials (DOE 2008a; 2010a; 2010b; and 2010c). These soil and rubble areas have been investigated and identified for removal or remedial action, as appropriate.

A removal action to excavate two inactive facilities was completed in 2010 (DOE 2010g). This removal action excavated the C-218 Firing Range and the C-410-B Hydrogen Fluoride (HF) Neutralization Lagoon (see also Section 4.8).

Pathways

In the current CSM for the SOU (see Figure 4.4a2), past spills and releases from operations and soils impacted by overlying contaminated scrap are identified as the primary source of contamination, and surface soil is identified as the current source of contamination. Contaminants found in soil are available for direct contact on-site. Migration of contamination from the SOU areas is not expected (i.e., uncertain pathway); however, it is possible that ecological receptors could contact contaminants within source areas resulting in contamination entering the food chain.

Using this CSM, the medium of concern for Hazard Area 4 is surface soil. Receptors potentially exposed to soil are workers, visitors, and ecological receptors. In addition, the ecological receptor potentially is exposed through the food chain. Under current conditions, the only barrier to exposure is access controls to prevent exposure to soil • .

Risk Levels

As shown in Figure 4.4a2, no pathways currently are considered complete for the SOU; however, the baseline or unmitigated risks that could be present if the barriers did not exist have been assessed for some areas included in the SOU. Table 4.6 summarizes the results for an industrial worker exposed to surface soil at some of the areas included in the SOU. A summary for ecological risks is not available.

4.4.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.4.1 for a discussion of sources and pathways of exposure.

Barriers and Actions

The barriers to exposure at the potential end state alternative (see Figures 4.4b1 and 4.4b2) are continued access controls to prevent exposure to soil • . In addition, source actions to remove the "hot spot" soil , also are planned under the end state.

Under the potential end state alternative, potential receptors during implementation of the response actions (see Figure 4.4b3) are the maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The maintenance worker potentially could be exposed during site maintenance activities performed as part of access controls. The remediation worker, general site worker, and ecological receptors potentially could be exposed during the excavation of contaminated soil "hot spots." The disposal worker potentially could be exposed while accepting waste, and the transportation worker, public, and ecological receptors potentially could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels due to the barriers that prevent exposure and removal of contaminated soil. The risk target for cleanup levels under the potential end state alternative is a worker risk of 1E-04. The PCB concentration target is 25 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit appropriate for the area's land use. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

Table 4.6. Risk Assessment Summary[a] for Industrial Worker Exposure to Contaminated Surface Soil Found at Selected Areas in the SOU

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level[h]
C-728 Clean Waste Oil Tank	Industrial	N	Industrial	Manganese	415	HI = 1	452	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Vanadium	19.8	HI = 0.6	33.2	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Total PCBs	104	ELCR = 5E-4	PCB at 25	TSCA	25 mg/kg
C-615 Sewage Treatment Plant	Industrial	N	Industrial	Manganese	511	HI = 1	452	Risk-Based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Uranium[i]	1,850	HI = 9	202	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Total PCBs	46.4	ELCR = 2E-4	PCB at 25	TSCA	25 mg/kg
				Cs-137	3.05	ELCR = 4E-5	0.0858	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
C-540-A PCB Staging Area	Industrial	N	Industrial	Manganese	232	HI = 1	452	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Vanadium	27.8	HI = 1	33.2	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Total PCBs	93.4	ELCR = 5E-4	PCB at 25	TSCA	25 mg/kg
C-541-A PCB Waste Staging Area	Industrial	N	Industrial	Arsenic	13.4	ELCR = 3E-5	0.523	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Manganese	704	HI = 2	452	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Uranium[i]	4,140	HI = 20	202	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Total PAHs	0.15	ELCR = 7E-6	0.0212	Risk-based	Average concentration to achieve ELCR = 1E-4 and HI=1
				Total PCBs	7.11	ELCR = 4E-5	PCB at 25	TSCA	25 mg/kg

[a] Values in the table are from a draft sitewide risk assessment completed for the PGDP (DOE 2003e). Risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.
[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all soil samples collected within that area mentioned.
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] Industrial worker exposure (250 d/yr for 25 yr).
[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.
[f] "PRG" is the preliminary remediation goal used when considering potential response actions.
[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1. "TSCA" is based upon Toxic Substances Control Act.
[h] Risk and hazard targets projected to be used to attain the potential end state alternative.
[i] Uranium denoted here is total uranium (metal) in mg/kg.

4.5 HAZARD AREA 5—PERMITTED LANDFILLS

This hazard area is composed of the permitted landfills found at PGDP. This hazard area is depicted in Figure 4.5a1. A description of each landfill is presented in the following section. The permitted landfills included currently are these.

- SWMU 9: C-746-S Residential Landfill
- SWMU 10: C-746-T Inert Landfill
- SWMU 208: C-746-U Landfill

(Note that a potential CERCLA Cell is another permitted landfill that may exist at PGDP when the potential end state alternative is attained. This potential facility is discussed in Section 4.5.2.)

4.5.1 Current State

<u>Sources</u>

The *C-746-S Residential Landfill* (SWMU 9) is located to the north of the industrialized portion of PGDP. This unit covers about 5 acres and was the PGDP sanitary landfill from 1981 to 1995. Before the construction and permitting of the C-746-S Landfill, the area was used for the disposal of scrap and waste. C-746-S consists of 6 cells, each of which was lined with 12 inches of clay. The landfill permit allowed the disposal of industrial operations refuse, debris, and combustible and noncombustible garbage. Trash was compacted daily and covered with 6 inches of soil.

The Kentucky Division of Waste Management (KDWM) issued a permit for the construction of the C-746-S Residential Landfill in April of 1981. DOE complied with required modifications to landfill operations in July 1993, designed to promote groundwater and surface water protection, and completed a certified closure of the last landfill cell in June of 1995. A continuing groundwater and surface water monitoring program is in place to trigger corrective action requirements, should actions be needed.

An RI for the C-746-S Landfill has not been completed. The landfill is a potential source of solvents, metals, and radionuclides. An SI to determine if the landfill is a source of solvent contamination was completed in 2004 (DOE 2006b).

The *C-746-T Inert Landfill* (SWMU 10) is located adjacent to the C-746-S Landfill (SWMU 9). It covers about 8.4 acres and was used for the disposal of industrial trash from 1985 through 1992. Common buried debris includes concrete, wood, and rock, with steam plant fly ash used as filler material. The C-746-T operating permit required that the waste be covered with clay and a vegetative cover for closure. The KDWM issued a permit for the construction of the C-746-T Inert Landfill in February of 1985. DOE completed a certified closure of the landfill in November of 1992. A continuing groundwater and surface water monitoring program is in place to trigger corrective action requirements, should actions be needed.

An RI for the C-746-T Landfill has not been completed. The landfill is a potential source of solvents, metals, radionuclides, and asbestos. An SI to determine if the landfill is a source of solvent contamination was completed in 2004 (DOE 2006b).

The *C-746-U Landfill* (SWMU 208) is an operating Subtitle D solid waste landfill located directly north of the C-746-S&T Landfills. It covers 59.7 acres and includes a liner and leachate collection system. This landfill started receiving waste in 1997. Waste accepted includes construction debris, industrial waste, asbestos material, incinerator ash, tires, paper, cardboard, and plastics. Leachate from the C-746-U

Landfill is treated at PGDP before being released to KPDES permitted outfalls. No releases to groundwater from this landfill are known to have occurred.

In August 2006, KDWM issued a letter to DOE that placed the C-746-U Landfill into groundwater contamination assessment. The letter stated that contaminants had exceeded either MCLs or statistical limits calculated relative to concentrations found in upgradient wells. A groundwater assessment plan has been developed to identify the actions that DOE will take to determine if the contamination is coming from the C-746-U Landfill or from another source. Once the source is identified, appropriate cleanup actions will occur.

<u>Pathways</u>

In the current CSM for the Permitted Landfills (see Figure 4.5a2), buried waste and soil are identified as current sources of contamination. Contaminants from these sources may migrate to both the groundwater and surface water; however, these are uncertain pathways due to the presence of leachate collection systems. Once in surface water, contaminants could affect ecological receptors or enter the food chain; however, this pathway is uncertain as well.

Using this CSM, buried waste, subsurface soil, groundwater, and surface water are of concern for Hazard Area 5. Receptors potentially exposed to waste and soil are workers, visitors, and ecological receptors. Receptors potentially exposed to groundwater are workers and residents. Receptors potentially exposed to surface water are workers, visitors, and ecological receptors. In addition, the visitor, resident, and ecological receptor potentially are exposed through the food chain.

Under current conditions, barriers to exposure are the current land cover • and access controls , , which prevent exposure to waste and soil; continuation of the PGDP Water Policy „ , and the landfill cap and leachate collection system ƒ , which minimizes contaminant migration. In addition, the landfills are monitored to ensure that these systems are working properly. (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.)

<u>Risk Levels</u>

Risk assessment results using adequate data are not available for the permitted landfills; therefore, it is not possible to report unmitigated or baseline risks. However, because all pathways are incomplete, all unmitigated risks can be assumed to be at *de minimis* levels.

4.5.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. The sources and pathways of exposure are discussed in Section 4.5.1, except for a potential CERCLA cell, which is described below. The potential CERCLA Cell for PGDP is a facility that has not yet been sited. Figure 4.5b1 shows the locations investigated as part of a siting study. This unit would provide PGDP with waste disposal alternatives for CERCLA-derived waste, such as low-level, Toxic Substances Control Act (TSCA), mixed, and hazard wastes. The waste would be generated from environmental restoration and D&D activities and, potentially, legacy and DMSA waste disposal. Decision documents to determine if a CERCLA Cell is a viable waste disposal option for the PGDP have not been completed; therefore, this facility is only one of several waste disposal options that could be used at the PGDP to attain the potential end state alternative.

Barriers and Actions

Barriers to exposure at the end state are similar to those currently in place. (See Figures 4.5b1 and 4.5b2.) These barriers are the current land cover • and access controls , , which prevent exposure to waste and soil; implementation of enhanced institutional controls, which will limit access to and use of groundwater…, and the landfill cap, leachate collection system, and monitoring ƒ , which minimizes contaminant migration. (Please see Section 4.1.2 for a discussion of enhanced institutional controls under the potential end state alternative.) Under the potential end state alternative, potential receptors in the treatment train (see Figure 4.5b3) are the maintenance worker and environmental sampler. The maintenance worker could be exposed while maintaining the access controls and landfill containment systems. The environmental sampler could be exposed during routine sampling activities.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels because barriers would prevent exposure.

4.6 HAZARD AREA 6—BGOU (GROUP 2)

This hazard area is composed of the facilities and SWMUs listed below. This hazard area is depicted in Figure 4.6a1. A description of each facility and SWMU is presented in the following section.

- SWMU 5: C-746-F Burial Ground
- SWMU 7: C-747-A Burial Ground
- SWMU 8: C-746-K Landfill
- SWMU 30: C-747-A Burn Area

4.6.1 Current State

Sources

The *C-746-F Burial Ground* (SWMU 5) is located in the northwest part of the industrialized portion of PGDP and covers approximately 6.3 acres. This burial ground was used for the disposal of radionuclide-contaminated and uncontaminated classified scrap beginning in 1965. An RI for the burial ground was completed in 1999 (DOE 2000b). Contaminants determined to be associated with this burial ground are uranium, Tc-99, tritium, Cobalt-60, and metals. A second RI for the BGOU, including this SWMU, was completed in 2007 (DOE 2010f). Results from this RI were incorporated into an FS that is currently under review.

The *C-747-A Burial Ground* (SWMU 7) is located in the extreme northwest corner of the industrialized portion of PGDP and covers approximately 2.9 acres. This burial ground was used for disposal of miscellaneous debris from 1957 to 1979. Within the boundaries of the burial ground are three burial pits that cover approximately 23,100 ft^2 and contain noncombustible, contaminated and uncontaminated trash and equipment; one burial pit that covers approximately 2,100 ft^2 and contains contaminated concrete; and another burial pit that covers 9,000 ft^2 and contains uranium-contaminated scrap metal and equipment. An RI for the burial ground was completed in 1997 (DOE 1998a). Contaminants found include metals, VC, SVOCs, PCBs, and radionuclides. A second RI for the BGOU, including this SWMU, was completed in 2007 (DOE 2010f). Results from this RI were incorporated into an FS that is currently under review.

The *C-746-K Landfill* (SWMU 8) is located to the southwest of the industrialized portion of PGDP and covers about 6.8 acres. This unit was used as a sanitary landfill from the early 1950s through the early 1980s. The landfill is known to contain sanitary trash (burned and unburned) and fly ash from coal-burning operations. Before 1967, trenches were cut in the ash to form burn pits. After 1967, the trash was buried in the ash without burning. Sludge from the C-615 Sewage Treatment Plant was reported to have been used as fill material. C-746-K possibly contains some slightly radionuclide-contaminated trash.

DOE closed the landfill in 1982 by covering the landfill with a 6-inch clay cap and a 18-inch vegetative cover. Seepage points were identified in a ditch adjacent to the unit in January of 1992. This landfill subsequently underwent an RI. A ROD was signed for this landfill (DOE 1998b). Corrective actions taken (1992) include installation of riprap along creek bank to prevent direct contact with the seeps, recontouring of the landfill cap to promote rainfall runoff, implementation of institutional controls, and long-term monitoring. The DOE placed deed restrictions on the landfill in 1997. Possible contaminants associated with the landfill are solvents and metals.

The *C-747-A Burn Area* (SWMU 30) is located to the west of the C-747-A Burial Ground and covers approximately 2.9 acres. The C-747-A Burn Area was operated from 1951 to 1970 for burning and disposal of combustible trash, some of which may have been contaminated with uranium. Burning was done at an incinerator, which subsequently has been demolished, and portions of it are buried within this SWMU's boundary. During operation of the C-747-A Burn Area, a waste burial pit was used for disposal of contaminated and uncontaminated trash, ash, and debris. An RI for the SWMU was completed in 1997 (DOE 1998a). Contaminants found include solvents, radionuclides, metals, SVOCs, and PCBs. A second RI for the BGOU, including this SWMU, was completed in 2007 (DOE 2010f). Results from this RI were incorporated into an FS that is currently under review.

Pathways

In the current CSM for the BGOU (Group 2) (see Figure 4.6a2), waste materials from plant operations and surface and subsurface soil are identified as current sources of contamination. Contaminants found in waste and soil are available for direct contact on-site. For all but the C-746-K Landfill (SWMU 8), migration of contamination from these burial grounds to surface water or groundwater is not expected due to the nature of the wastes. Similarly, for all but the C-746-K Landfill, ecological receptors potentially could contact contaminants at the burial grounds resulting in contamination entering the food chain, but impacts from this pathway would be limited because the burial grounds are located in industrialized areas. For the C-746-K Landfill, releases to surface water are known to have occurred in the past; these releases may impact ecological receptors in Bayou Creek in an area outside the industrialized portion of PGDP. Using this CSM, the waste materials, soil, groundwater, and surface water are of concern for Hazard Area 6. Receptors potentially exposed to waste and soil are workers, visitors, and ecological receptors. Receptors potentially exposed to groundwater are workers and residents. Receptors potentially exposed to surface water are workers, visitors, and ecological receptors. In addition, the visitor, resident, and ecological receptor potentially could be exposed through the food chain.

Under current conditions, the barriers to exposure are the current land cover • and access controls , , which prevent exposure to waste and subsurface soil (and surface water at the C-746-K Landfill), and continuation of the PGDP Water Policy ƒ . (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.)

Risk Levels

As shown in Figure 4.6a2, only the biota pathway though surface water currently is considered complete for the BGOU (Group 2); and, as discussed previously, this pathway is complete only for the C746-K Landfill. Representative ecological and human health risk assessments for this surface water pathway are not available; however, baseline (i.e., unmitigated) risk results for exposure by ecological receptors and humans to soils at the landfill are available and are presented in Tables 4.7a and 4.7b. Additionally, unmitigated risk results that could be present if barriers did not exist at the C-746-F Burial Ground (SWMU 5), the C-747-A Burial Ground (SWMU 7), and the C-747-A Burn Area (SWMU 30) are available. These results are presented in Tables 4.8a and 4.8b.

4.6.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.6.1 for a discussion of sources and pathways of exposure.

Barriers and Actions

Barriers to exposure at the end state are depicted in Figures 4.6b1 and 4.6b2. These are the current land cover • and access controls , , which prevent exposure to waste and subsurface soil; enhanced institutional controls, which will limit use of and access to groundwater…; and the landfill cap „ , which mitigates contaminant migration. (Please see Section 4.1.2 for a discussion of enhanced institutional controls under the potential end state alternative.)

Under the potential end state alternative, potential receptors in the treatment train (see Figure 4.6b3) are the maintenance worker, remediation worker, environmental sampler, and ecological receptor. The maintenance worker could be exposed while maintaining the access controls and current cover. The remediation worker and ecological receptor could be exposed while the landfill caps are installed. The environmental sampler could be exposed during routine sampling activities.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels because barriers limit exposure or mitigate contaminant migration.

Table 4.7a. Risk Assessment Summary[a] for Industrial Worker Exposure to Contaminated Surface Soil Found at SWMU 8: C-747-K Landfill

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
C-746-K Landfill	Industrial	N	Industrial	Arsenic	11.5	ELCR = 2E-5	0.52	Risk-Based	*de minimis*—due to cap
				Antimony	3.7	HI = 1	3.8	Risk-Based	*de minimis*—due to cap
				Manganese	2,110	HI = 5	452	Risk-Based	*de minimis*—due to cap
				Vanadium	45	HI = 1	33.2	Risk-Based	*de minimis*—due to cap
				Total PAHs	0.35	ELCR = 2E-5	0.02	Risk-Based	*de minimis*—due to cap

NA = value is not available at this time.
[a] Values in the table are from a draft sitewide risk assessment completed for the PGDP (DOE 2003e). In all cases, risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.
[b] Contaminant concentrations used for the assessment were the upper 95% confidence limit on the average concentrations of all sediment samples collected from soil and/and or sediment at the C-746K Landfill.
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] Industrial worker exposure (250 d/yr for 25 yr).
[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.
[f] "PRG" is the preliminary remediation goal used when considering potential response actions.
[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1.

Table 4.8a. Risk Assessment Summary[a] for Industrial Worker Exposure to Contaminated Surface Soil Found at SWMUs 5, 7, and 30

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
SWMU 5: C-746-F Burial Ground	Industrial	Y	Industrial	Arsenic	7.55	ELCR = 2E-5	4.84E-01	Risk-Based	*de minimis*—due to cap
				Beryllium	0.615	ELCR = 2E-4	2.83E-03	Risk-Based	*de minimis*—due to cap
				Total PAHs	5.05	ELCR = 2E-4	1.94E-02	Risk-Based	*de minimis*—due to cap
SWMU 7: C-747-A Burial Ground	Industrial	Y	Industrial	Arsenic	7.21	ELCR = 2E-5	4.84E-01	Risk-Based	*de minimis*—due to cap
				Beryllium	11.4	ELCR = 4E-3	2.83E-03	Risk-Based	*de minimis*—due to cap
				Iron	21,900	HI = 1	1.90E+03	Risk-Based	*de minimis*—due to cap
				Total PAHs (BaP)	0.331	ELCR = 1E-5	1.94E-02	Risk-Based	*de minimis*—due to cap
				U-235/236	8.4	ELCR = 1E-5	3.95E-01	Risk-Based	*de minimis*—due to cap
				U-238	314	ELCR = 8E-5	1.70E+00	Risk-Based	*de minimis*—due to cap
SWMU 30: C-747-A Burn Area	Industrial	Y	Industrial	Arsenic	6.1[i]	ELCR = 2E-5	4.84E-01	Risk-Based	*de minimis*—due to cap
				Beryllium	11.1	ELCR = 4E-3	2.83E-03	Risk-Based	*de minimis*—due to cap
				PCB-1260	1.32	ELCR = 4E-6	1.75E-01	Risk-Based	*de minimis*—due to cap
				Total PAHs (BaP)	0.805	ELCR = 3E-5	1.94E-02	Risk-Based	*de minimis*—due to cap
				U-235/236	8.5	ELCR = 1E-5	3.95E-01	Risk-Based	*de minimis*—due to cap
				U-238	195	ELCR = 5E-5	1.70E+00	Risk-Based	*de minimis*—due to cap

NA = not available
BaP = benzo(a)pyrene, used for Total PAHs.
[a] Results are taken from DOE 2010f. In all cases, risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.
[b] Contaminant concentrations used for the assessment were the 95% upper confidence limit on the average concentrations of all soil samples collected at the burial ground.
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] Industrial worker exposure (250 d/yr for 25 yr).
[e] "ELCR" is the excess lifetime cancer risk level. Values from E-06 to E-04 are within EPA's acceptable risk range for site related exposures (EPA 1999). "HI" is the hazard index, a measure for potential systemic toxicity. Values greater than 1 indicate that a deleterious health effect is possible.
[f] "PRG" is the preliminary remediation goal used when considering potential response actions.
[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1.
[h] Uranium denoted here is total uranium (metal) in mg/kg.
[i] Subsurface value used as representative concentration.

Table 4.8b. Risk Assessment Summary[a] for the Ecological Receptor Exposure to Contaminated Surface Soil Found at SWMUs 5, 7, and 30

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
SWMU 5 C-746-F Burial Ground	Industrial	Y	Ecological—Terrestrial Plants	Aluminum	13,800	HQ = 276	NA	NA	NA
				Arsenic	12.2	HQ = 1	NA	NA	NA
				Chromium	20.5	HQ = 20	NA	NA	NA
				Nickel	119	HQ = 4	NA	NA	NA
				Zinc	163	HQ = 3	NA	NA	NA
			Ecological—Soil Invertebrates	Chromium	20.5	HQ = 51	NA	NA	NA
				Zinc	163	HQ = 2	NA	NA	NA
				Fluoranthene	53.3	HQ = 2	NA	NA	NA
				Phenanthrene	34.6	HQ = 1	NA	NA	NA
			Ecological—Vole	Aluminum Arsenic	13,800 12.2	HQ = 159 HQ = 3	NA NA	NA NA	NA NA
			Ecological—Weasel	Aluminum	13,800	HQ = 42	NA	NA	NA
			Ecological—Mouse	Aluminum	13,800	HQ = 24	NA	NA	NA
			Ecological—Shrew	Aluminum	13,800	HQ = 49	NA	NA	NA
				Arsenic	12.2	HQ = 7	NA	NA	NA
				Total PCBs	0.618	HQ = 4	NA	NA	NA
			Ecological—Woodcock	Aluminum	13,800	HQ = 11	NA	NA	NA
				Zinc	163	HQ = 7	NA	NA	NA
				di-n-butyl phthalate	1.7	HQ = 2	NA	NA	NA
				Total PCBs	0.618	HQ = 2	NA	NA	NA

Table 4.8b. Risk Assessment Summary[a] for the Ecological Receptor Exposure to Contaminated Surface Soil Found at SWMUs 5, 7, and 30 (Continued)

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
SWMU 7: C-747-A Burial Ground	Industrial	Y	Ecological—Terrestrial Plants	Aluminum	14,800	HQ = 296	NA	NA	NA
				Chromium	44	HQ = 44	NA	NA	NA
				Uranium	1,400	HQ = 280	NA	NA	NA
				Vanadium	52	HQ = 26	NA	NA	NA
			Ecological—Soil Microbes	Aluminum	14,800	HQ = 25	NA	NA	NA
				Iron	30,000	HQ = 150	NA	NA	NA
				Manganese	11,600	HQ = 12	NA	NA	NA
			Ecological—Earthworms	Chromium	44	HQ = 110	NA	NA	NA
			Ecological—Deer	Aluminum	9,670	HQ = 41	NA	NA	NA
				Vanadium	29.5	HQ = 2	NA	NA	NA
			Ecological—Mouse	Aluminum	9,670	HQ = 60	NA	NA	NA
				Arsenic	7.21	HQ = 4	NA	NA	NA
				Chromium	32.2	HQ = 3	NA	NA	NA
				PCB-1260	0.295	HQ = 5	NA	NA	NA
			Ecological—Shrew	Aluminum	9670	HQ = 620	NA	NA	NA
				PCB-1260	0.295	HQ = 33.2	NA	NA	NA
SWMU 30: C-747-A Burn Area	Industrial	Y	Ecological—Terrestrial Plants	Aluminum	15,000	HQ = 300	NA	NA	NA
				Beryllium	24	HQ = 2	NA	NA	NA
				Cadmium	9	HQ = 3	NA	NA	NA
				Chromium	38	HQ = 38	NA	NA	NA
				Manganese	624	HQ = 1	NA	NA	NA
				Mercury	2	HQ = 7	NA	NA	NA
				Nickel	66	HQ = 2	NA	NA	NA
				Silver	4	HQ = 2	NA	NA	NA
				Thallium	1.2	HQ = 1	NA	NA	NA
				Uranium	450	HQ = 90	NA	NA	NA
				Vanadium	34	HQ = 17	NA	NA	NA
				Zinc	155	HQ = 3	NA	NA	NA
			Ecological—Soil Microbes	Aluminum	15,000	HQ = 25	NA	NA	NA
				Chromium	38	HQ = 4	NA	NA	NA
				Iron	29,600	HQ = 148	NA	NA	NA
				Manganese	624	HQ = 6	NA	NA	NA
				Vanadium	34	HQ = 2	NA	NA	NA
				Zinc	155	HQ = 2	NA	NA	NA

Table 4.8b. Risk Assessment Summary[a] for the Ecological Receptor Exposure to Contaminated Surface Soil Found at SWMUs 5, 7, and 30 (Continued)

Location[b]	Land Use	Risk[c]	Risk Scenario[d]	Contaminant Description	Representative Concentration (mg/kg or pCi/g)	Baseline Risk Level[e]	PRG[f] (mg/kg or pCi/g)	Basis for PRG[g]	Actual or Expected Post Cleanup Concentration or Risk Level
SWMU 30: C-747-A Burn Area (Cont.)	Industrial	Y	Ecological—Earthworms	Chromium	38	HQ = 95	NA	NA	NA
				Copper	89	HQ = 2	NA	NA	NA
				Mercury	2	HQ = 20	NA	NA	NA
			Ecological—Deer	Aluminum	15,000	HQ = 44	NA	NA	NA
				Vanadium	34	HQ = 1	NA	NA	NA
			Ecological—	Aluminum	15,000	HQ = 65	NA	NA	NA
			Mouse	Arsenic	9	HQ = 3	NA	NA	NA
				Cadmium	9	HQ = 1	NA	NA	NA
				Chromium	38	HQ = 3	NA	NA	NA
				Mercury	2	HQ = 1	NA	NA	NA
				PCB-1260	150	HQ = 21	NA	NA	NA
			Ecological—	Aluminum	15,000	HQ = 678	NA	NA	NA
			Shrew	Arsenic	9	HQ = 23	NA	NA	NA
				Barium	161	HQ = 2	NA	NA	NA
				Beryllium	24	HQ = 6	NA	NA	NA
				Cadmium	9	HQ = 7	NA	NA	NA
				Chromium	38	HQ = 20	NA	NA	NA
				Mercury	2	HQ = 11	NA	NA	NA
				Nickel	66	HQ = 2	NA	NA	NA
				Thallium	1.2	HQ = 3	NA	NA	NA
				Uranium	450	HQ = 13	NA	NA	NA
				Vanadium	34	HQ = 8	NA	NA	NA
				PCB-1260	150	HQ = 148	NA	NA	NA

NA = not available
[a] Risks for ecological receptors are from DOE 1998a. In all cases, risks presented are "unmitigated" or baseline risks, which assume exposure with no barriers.
[b] Contaminant concentrations used for the assessment were the 95% upper confidence limit on the average concentrations of all soil samples collected at the burial ground.
[c] "Y" indicates the result came from a baseline risk assessment. "N" indicates the result came from a screening level risk assessment.
[d] All ecological exposures are assumed to be lifetime exposures.
[e] "HQ" is a hazard quotient for ecological receptors. A value greater than 1 indicates that a deleterious effect on the ecological receptor is possible.
[f] "PRG" is the preliminary remediation goal used when considering potential response actions.
[g] "Risk-Based" is value derived using a scenario appropriate to the land use and a target risk of either 1E-06 (cancer) or 1 (hazard). For this table, value reported is that for the default industrial worker at risk level 1E-06 and hazard of 1.

4.7 HAZARD AREA 7—CYLINDER YARDS AND CONVERSION FACILITY SITE

This hazard area is composed of 20 cylinder yards and the DUF_6 Conversion Facility that has been built and is operating. This facility will undergo D&D as part of the EM mission at PGDP. This hazard area is depicted in Figure 4.7a1. Please see the following section for a description of these areas.

4.7.1 Current State

Sources

The 20 cylinder yards are located throughout the site and together cover approximately 105 acres. These yards are used to store cylinders containing depleted uranium hexafluoride (UF_6). The yards are primarily gravel or concrete covered and contain cylinders held in place with creosote wood and concrete saddles. Most of the cylinders are 12 ft long and 4 ft in diameter, with a nominal wall thickness of 5/16 inch. The largest storage area at PGDP is in the southeast corner of the site. There are about 40,351 cylinders of depleted UF_6 stacked two layers high at Paducah; 28,351 of them were generated by DOE and about 12,000 were generated by USEC. The cylinders generated by USEC are not the responsibility of DOE and currently fall outside the EM mission.

DOE has built a facility to convert its UF_6 to a more stable form for long-term storage, use, or permanent disposal. (Disposal will be at an off-site location.)

Pathways

The current CSM for the Cylinder Yards and DUF_6 Conversion Facility (see Figure 4.7a2) identified the facility infrastructure, cylinders, and associated soils as current sources of contamination. Contaminants found associated with the facility infrastructure, cylinders, and soil are available for direct contact on-site (including external radiological exposure). Additionally, contaminants in surface soil potentially could migrate to surface water and sediment, but this is an uncertain pathway. Once in the environment, contaminants could directly affect ecological receptors or enter the food chain.

Using this CSM, the contaminants from the facility infrastructure and cylinders and in soil, sediments, and surface water are of concern for Hazard Area 8. Receptors potentially exposed to facility infrastructure, cylinders, and associated soil are workers and ecological receptors. Receptors potentially exposed to sediment and surface water are workers, visitors, and ecological receptors. In addition, the resident, visitor, and ecological receptor potentially are exposed through the food chain.

Under current conditions, the only barrier to exposure is access restrictions • to prevent exposure to the cylinders and soil. Additionally, any runoff impacting surface water, an uncertain pathway, is attenuated naturally.

Risk Levels

No risk information is available for the Cylinder Yards and DUF_6 Conversion Facility. Risks, however, are at *de minimis* levels because of the access restrictions. Unmitigated risks could be higher if, under unmitigated conditions, receptors are exposed to contamination for longer periods. The primary contributor to this risk would be from gamma emissions from the radioactive materials stored in the cylinders.

4.7.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.8.1 for a discussion of sources and pathways of exposure.

Barriers and Actions

At the end state, (see Figures 4.7b1 and 4.7b2) all sources of contamination are removed. The completion of the conversion mission ƒ includes off-site disposal of converted uranium; D&D of infrastructure, followed by on-site disposal „ ; and excavation of any contaminated soil….

Under the potential end state alternative, potential receptors during implementation of the response actions (see Figure 4.7b3) are the industrial worker, remediation worker, landfill worker, general site worker, and ecological receptor. The industrial worker would be exposed while working in the conversion facility. The remediation worker, general site worker, and ecological receptor could be exposed during the D&D of the facility infrastructure and excavation of soil. The landfill worker and general site worker could be exposed while waste is transported to, and accepted at, the potential on-site CERCLA Cell.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels due to D&D of facility infrastructure, completion of the conversion mission, and excavation of any contaminated soils. The risk target for cleanup levels for soil under the potential end state alternative is an industrial worker risk of 1E-04. The PCB concentration target is 25 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit appropriate for the area's land use. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

4.8 HAZARD AREA 8—GDP FACILITIES

This hazard area is composed primarily of the buildings and infrastructure currently leased to USEC for the enrichment of uranium. Please see Figure 4.8a1 for a depiction of the location of these buildings. The buildings and infrastructure include all of the following.

- C-331, C-333, C-335, and C-337 process buildings and associated switchyards and cooling towers
- C-710 Technical Service Building
- C-724/C-725 Paint Shop
- Sewage Treatment Plant
- Water Treatment Plants
- C-720 Building
- C-400 Cleaning Building

This hazard area also includes two large buildings and 15 smaller facilities that currently are at various stages of D&D as part of the D&D OU (see Chapter 1). These two large buildings are the C-410/C-420 Feed Plant and the C-340 Metals Plant. Please see the following section for additional information about these buildings and their associated contamination.

4.8.1 Current State

Sources

Process Buildings C-331, C-333, C-335, and C-337 are located along the east side of PGDP and cover approximately 12, 25, 12, and 25 acres, respectively. These buildings house equipment and facilities for the processing of uranium. These facilities could have multiple environmental impacts, including releases of Freon™ to the atmosphere, lubrication oil leaks, radionuclide contamination, PCB contamination, lead-based paint usage, TCE, Tc-99, and chromate water releases, and asbestos containing materials. Associated cooling towers are used to cool and recirculate process water used in the process buildings. The cooling tower system consists of recirculating pumps, evaporative cooling towers, catch basins, and associated piping and equipment. Heavy metals are the primary potential contaminants associated with the cooling tower system; however, PCBs and chlorinated solvents also are potential contaminants for the cooling tower systems.

The *C-710 Technical Services Building* is located in the central portion of the plant security area and occupies approximately 2.0 acres. The building and area consists of a gas cylinder storage area and office space for laboratories, a shop, and storage. Environmental impacts include UF_6, fluorine, mercury, arsenic acetone, iso-octane, hexane, methylene chloride, TCE, chlorine trifluoride (ClF_3), PCBs, uranium, concentrated acids, chromated water, lead, and asbestos containing materials.

The *C-724/C-725 Shops* house the primary facility maintenance-related paint shops at PGDP and cover about 0.33 acres. Potential environmental contamination sources include paint-related contaminants such as TCA, xylene, chromium VI, barium, total soluble phosphorus, titanium dioxide, and VOCs.

The *C-611 Water Treatment Plant* is a 15-acre area that consists of a treatment building and a series of lagoons. It is located on the west side of PGDP. Historical contamination consists of PCBs, mercury, ClF_3, nitric acid spills, radiological contamination, TCE releases from degreaser usage, and oil and grease.

The *C-615 Sewage Disposal Plant* is located in the southwest corner of the plant area and covers about 1.2 acres. This facility receives effluent discharges from within PGDP and treats those effluents before discharge to KPDES Outfall 004. The Sewage Disposal Plant has several sources of potential environmental impact including PCBs, uranium, chlorine, lead, and asbestos contaminated material.

The *C-410/C-420 Feed Plant* complex is located in the central portion of the industrialized area of PGDP and covers about 2.7 acres. The C-410/C-420 complex was constructed to produce UF_6 from uranium trioxide through a series of chemical reactions. Groundwater and soils in the vicinity of the C-410/C-420 complex were investigated as part of a remedial investigation (DOE 1999a). Contaminants found include solvents, PCBs, metals, and radionuclides. This facility currently is the subject of a removal action (DOE 2002c). A neutralization lagoon, formerly associated with the C-410 building was removed in 2010 (DOE 2010g).

The *C-340 Metals Plant* is located in the east-central portion of the industrialized portion of PGDP and covers about 0.87 acres. The facility was erected in 1957 with operations in the metals plant continuing until 1975. Final lockdown of the facility occurred in 1991. D&D activities began in 1992. Site investigations for the area of the C-340 Metals Plant (DOE 2000c) identified solvents, PCBs, metals, and radionuclides as contaminants.

The *C-720 Building* and the *C-400 Cleaning Building* are described in Section 4.1.1. As noted there, these buildings cover approximately 6.5 and 4.0 acres, respectively.

Pathways

D&D at the PGDP

No decision documents have been completed for final D&D of the GDP; therefore, the final disposition of these facilities is unknown. During preparation of the End State Vision Document, stakeholders indicated that any D&D decisions should include consideration of options ranging from demolition and disposal to decontamination and reuse. (Please see the Stakeholder Input Appendix.)

Although the end state discussed here is for demolition and disposal, this is a planning assumption and is not meant to preclude the consideration and implementation of other options. As noted earlier, the selection of specific actions will be made in the appropriate decision documents after receipt of stakeholder and public input, as required in accordance with applicable law and agreements.

Under the current CSM for the GDP Facilities (see Figure 4.8a2), contaminated infrastructure and soils were identified as current sources of contamination. Contaminants associated with infrastructure and soil may migrate to groundwater and be transported to areas off DOE property. Additionally, contaminants may migrate to surface water and sediment and be transported to locations off DOE property. Finally, groundwater could be discharged to surface water. Once in surface water, contaminants could affect ecological receptors or enter the food chain.

Using this CSM, the contaminated infrastructure, soil, groundwater, surface water, and sediments are of concern for Hazard Area 9. Receptors potentially exposed to contaminated infrastructure and soil are workers, visitors, and ecological receptors. Receptors potentially exposed to groundwater are workers and residents. Receptors potentially exposed to surface water are workers, visitors, and ecological receptors. In addition, the resident, visitor, and ecological receptors are exposed potentially through the food chain.

Barriers to exposure under the current state (see Figures 4.8a1 and 4.8a2) are access and excavation restrictions, which prevent exposure to contaminants in soil •, and continuation of the PGDP Water Policy , . (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.) Discharges to surface water are addressed under the potential end state alternative through natural attenuation „ . Finally, a "hot spot" pump-and-treat ƒ system, which consists of extraction wells within the high TCE concentration areas of the Northwest and Northeast Dissolved-Phase Plumes, is used to control the spread of high TCE concentration areas.

Risk Levels

Risk information is not available; however, risks are at *de minimis* levels because there are no complete pathways. Unmitigated risks could exceed *de minimis* levels under current conditions in many areas because the GDP is an operating industrial facility.

4.8.2 Potential End State Alternative

This section focuses on the barriers and actions that may be used to achieve the potential end state alternative and the risks that may remain at the end state. Please see Section 4.8.1 for a discussion of sources and pathways of exposure.

Barriers and Actions

Barriers to exposure at the end state (see Figures 4.8b1 and 4.8b2) are continued access and excavation restrictions, which prevents exposure to contaminants in soil •, and implementation of enhanced institutional controls…, which will limit access to and prevent use of groundwater. (Please see Section 4.1.2 for a discussion of enhanced institutional controls under the potential end state alternative.) Source actions are planned to meet the end state. These source actions include D&D of infrastructure with disposal in a potential on-site CERCLA Cell † and excavation of soil with disposal in the potential CERCLA Cell ‡. Discharges to surface water currently are planned to be addressed through natural attenuation „ , and MNA will be used to address contamination in source zones and groundwater ˆ .

Under the potential end state alternative, receptors potentially exposed during implementation of the response actions (see Figure 4.8b3) are the general site worker, environmental sampler, remediation worker, and landfill worker; additionally, if off-site disposal is required, the transportation worker, disposal worker, and the public could be exposed. (Off-site disposal of wastes derived from D&D of the C-340 and C-410/C-420 Buildings is possible if the D&D occurs before the potential CERCLA Cell is constructed and operating.) The general site worker and ecological receptors could be exposed during infrastructure D&D, excavation of soil, and disposal of waste. The environmental sampler could be exposed during sampling activities. The remediation worker could be exposed during completion of infrastructure D&D and soil excavation. The landfill and disposal workers could be exposed while accepting D&D waste and soil. Finally, the transportation worker, public, and ecological receptors could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the end state, risks to all potential receptors would be at *de minimis* levels using barriers to prevent exposure and through removal of infrastructure and contaminated soil. The soil cleanup risk targets would be for an industrial worker risk of 1E-04. The PCB target would be 25 ppm. For soils, attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit appropriate for the area’s land use. Similarly, the PCB concentration target in soil will be the average concentration within the exposure unit. Because contamination in groundwater would continue to exist at levels above MCLs, MNA would be required for groundwater until MCLs are met.

FIGURES

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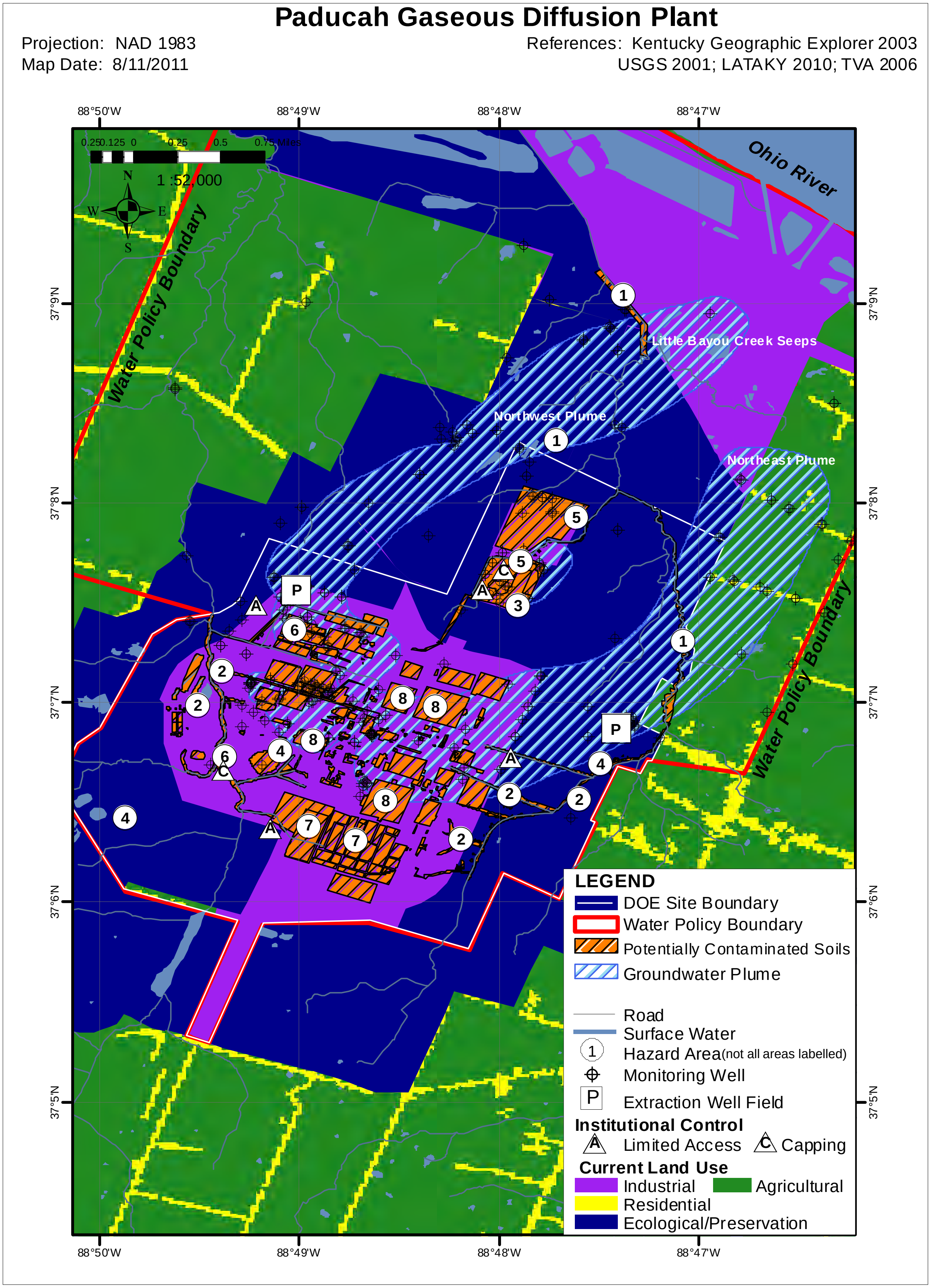


Figure 4.0a1. Hazard Areas - Current State

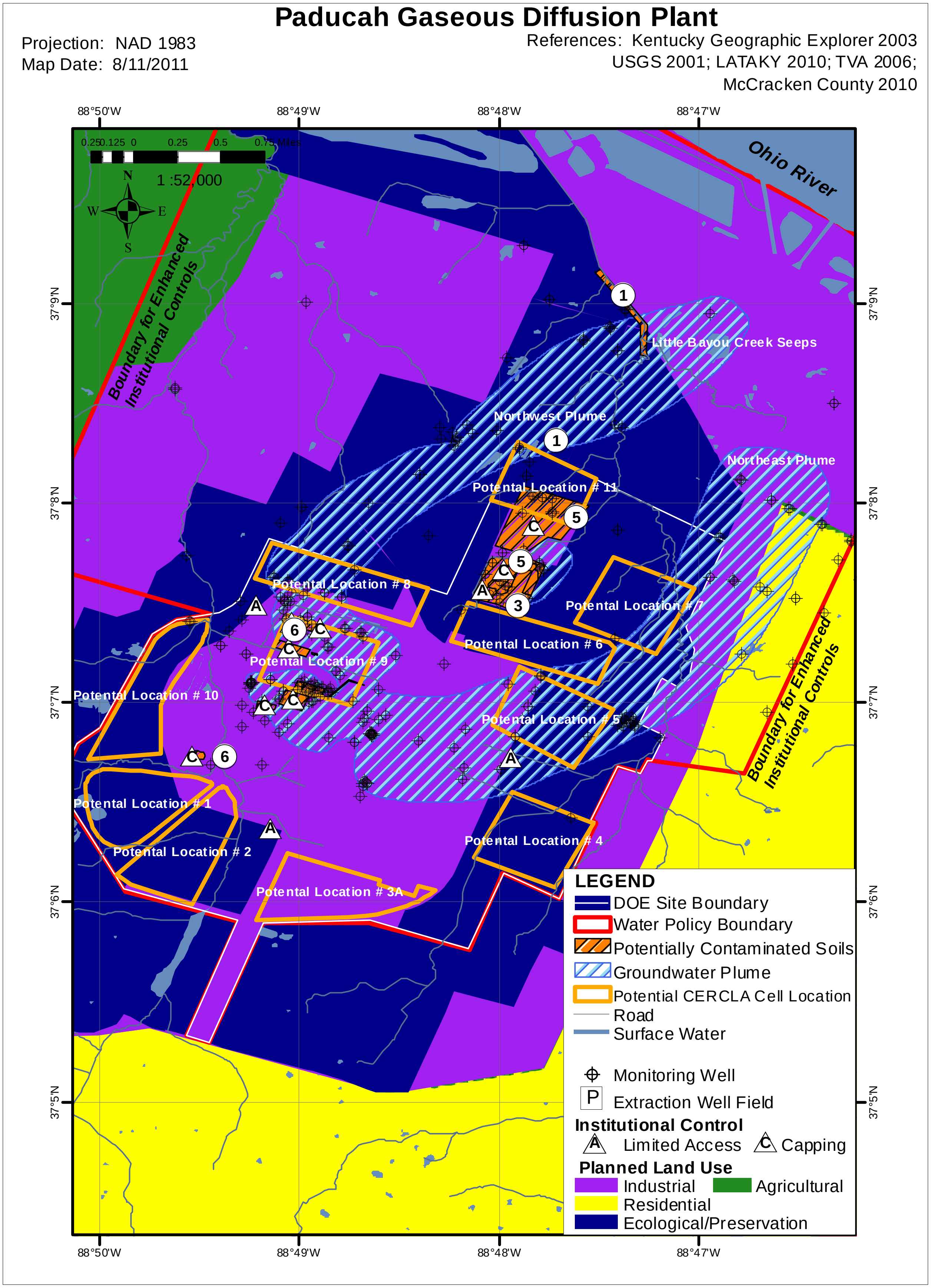


Figure 4.0b1. Hazard Areas - Potential End State Alternative

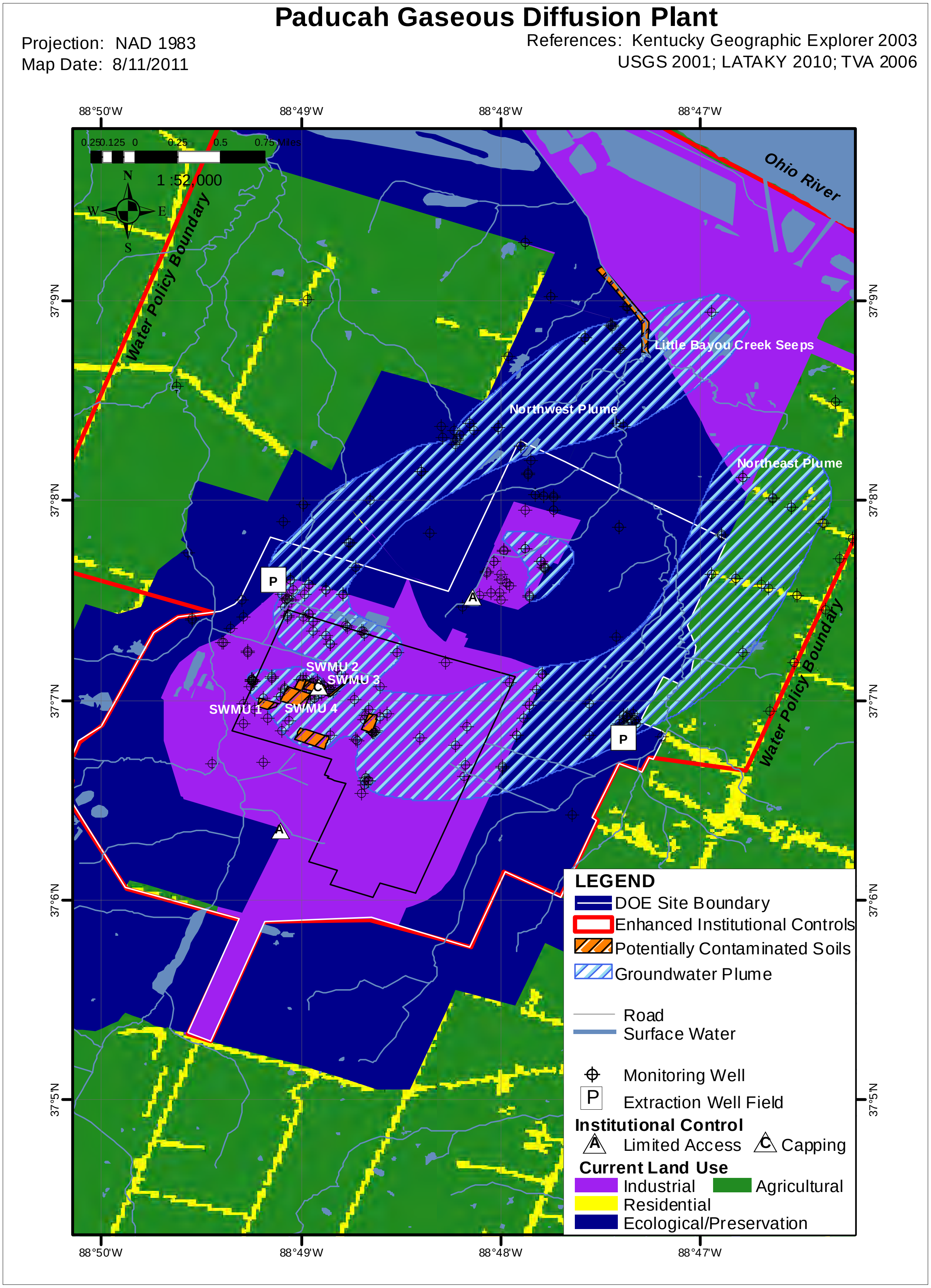
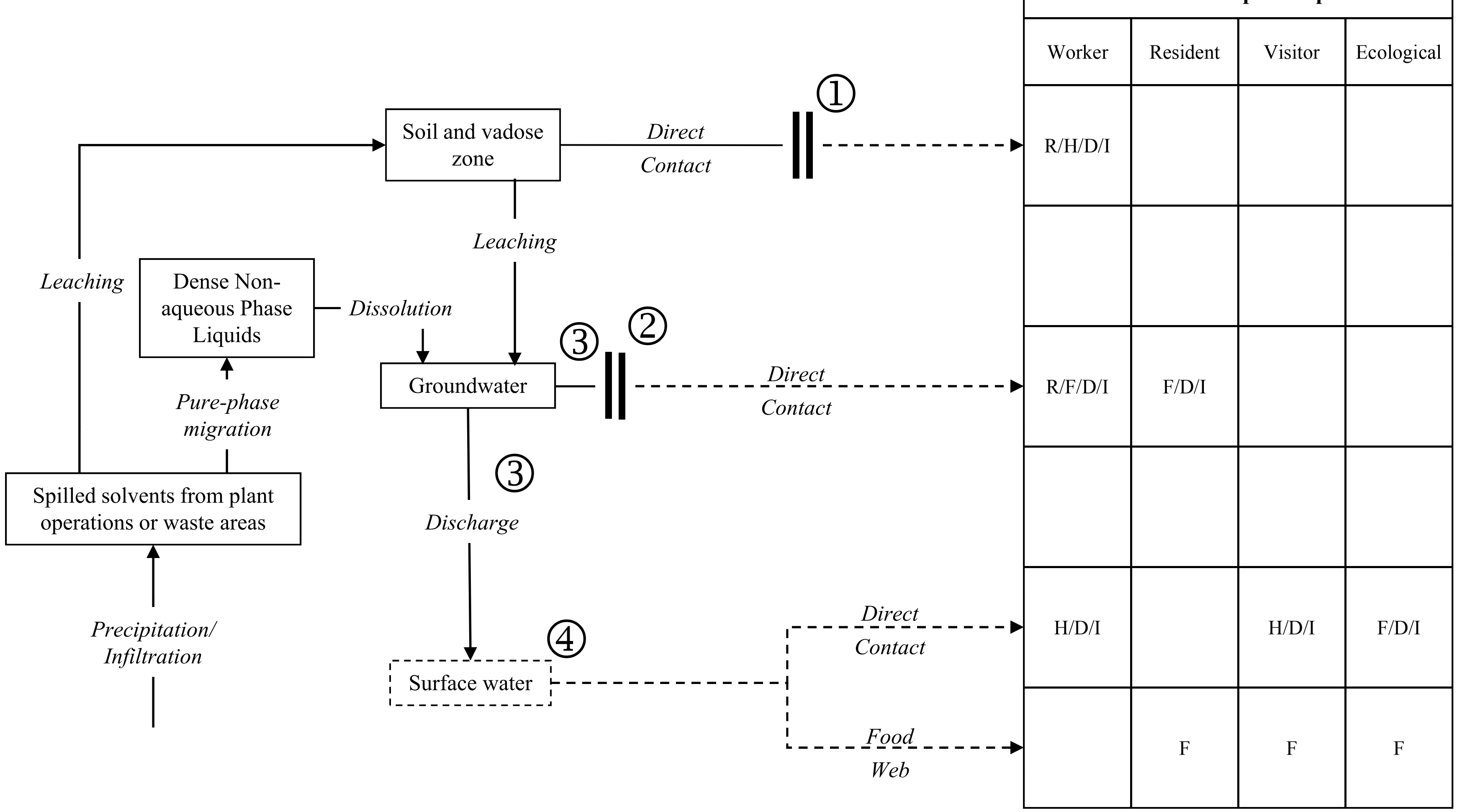


Figure 4.1a1. Hazard Area 1: GWOU - Current State

Hazard Area 1: Groundwater Operable Unit – Current State



<u>Current Controls or Actions</u>
① Access and excavation restrictions.
② PGDP Water Policy.
③ "Hot spot" pump and treat.
④ Attenuation.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.1a2. Hazard Area 1: Groundwater Operable Unit – Current State

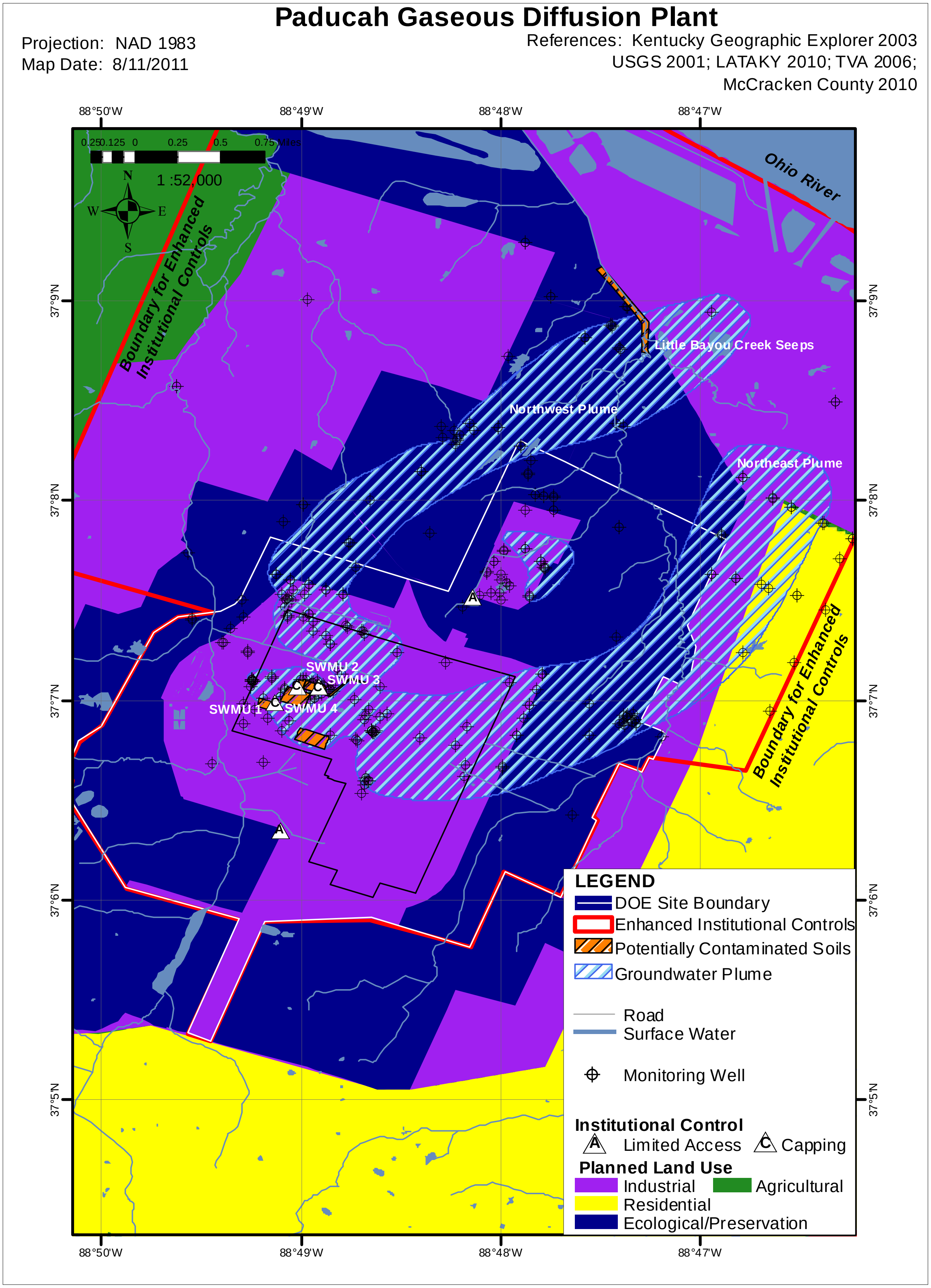
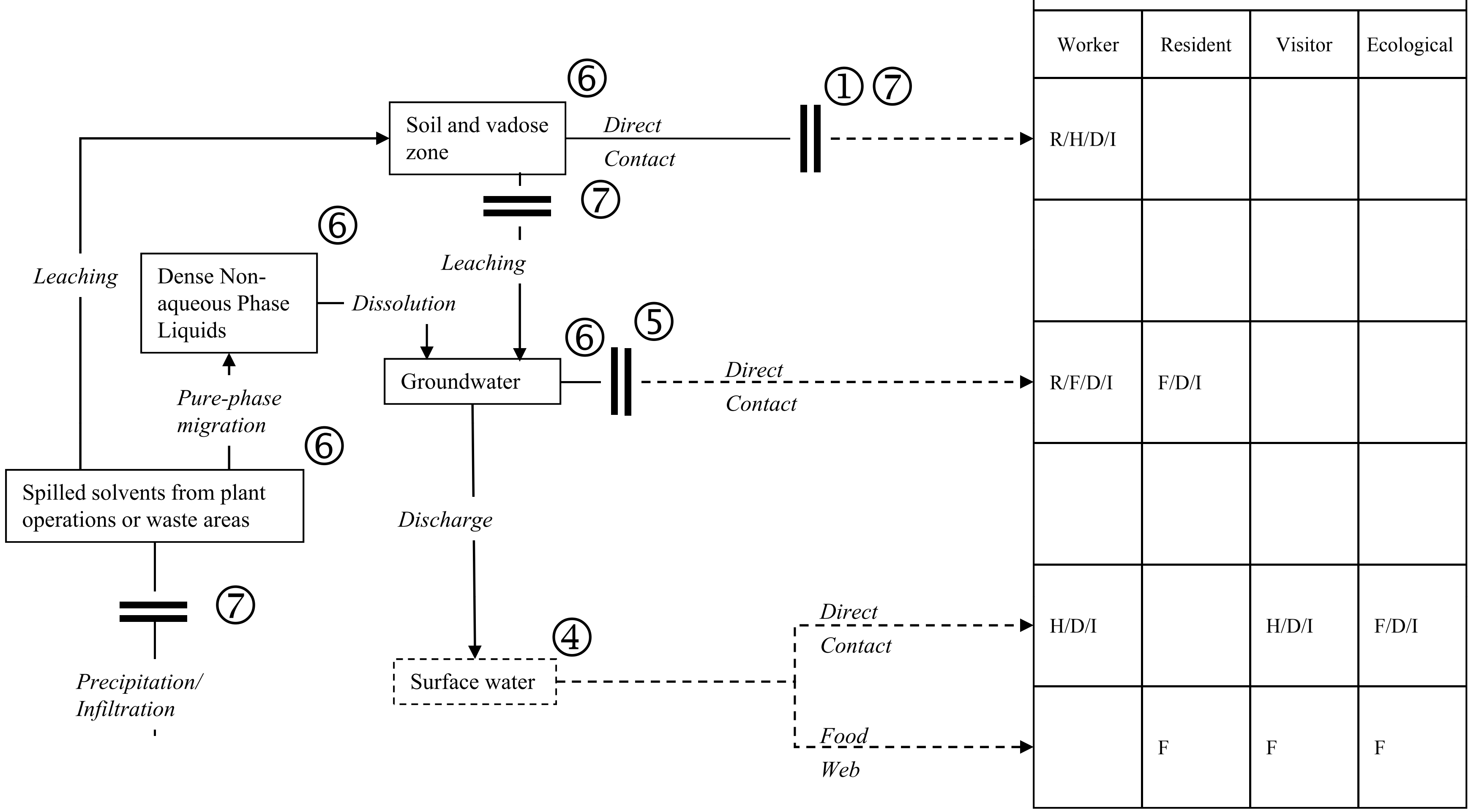


Figure 4.1b1. Hazard Area 1: GWOU - Potential End State Alternative

Hazard Area 1: Groundwater Operable Unit – End State



<u>RBES Controls or Actions</u>
① Access and excavation restrictions.
④ Attenuation.
⑤ Enhanced institutional controls to limit access and use of groundwater.
⑥ Monitored natural attenuation of sources and dissolved phase plume.
⑦ Cap at burial grounds.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.1b2. Hazard Area 1: Groundwater Operable Unit – End State

Hazard Area 1: Groundwater OU Treatment Train – End State

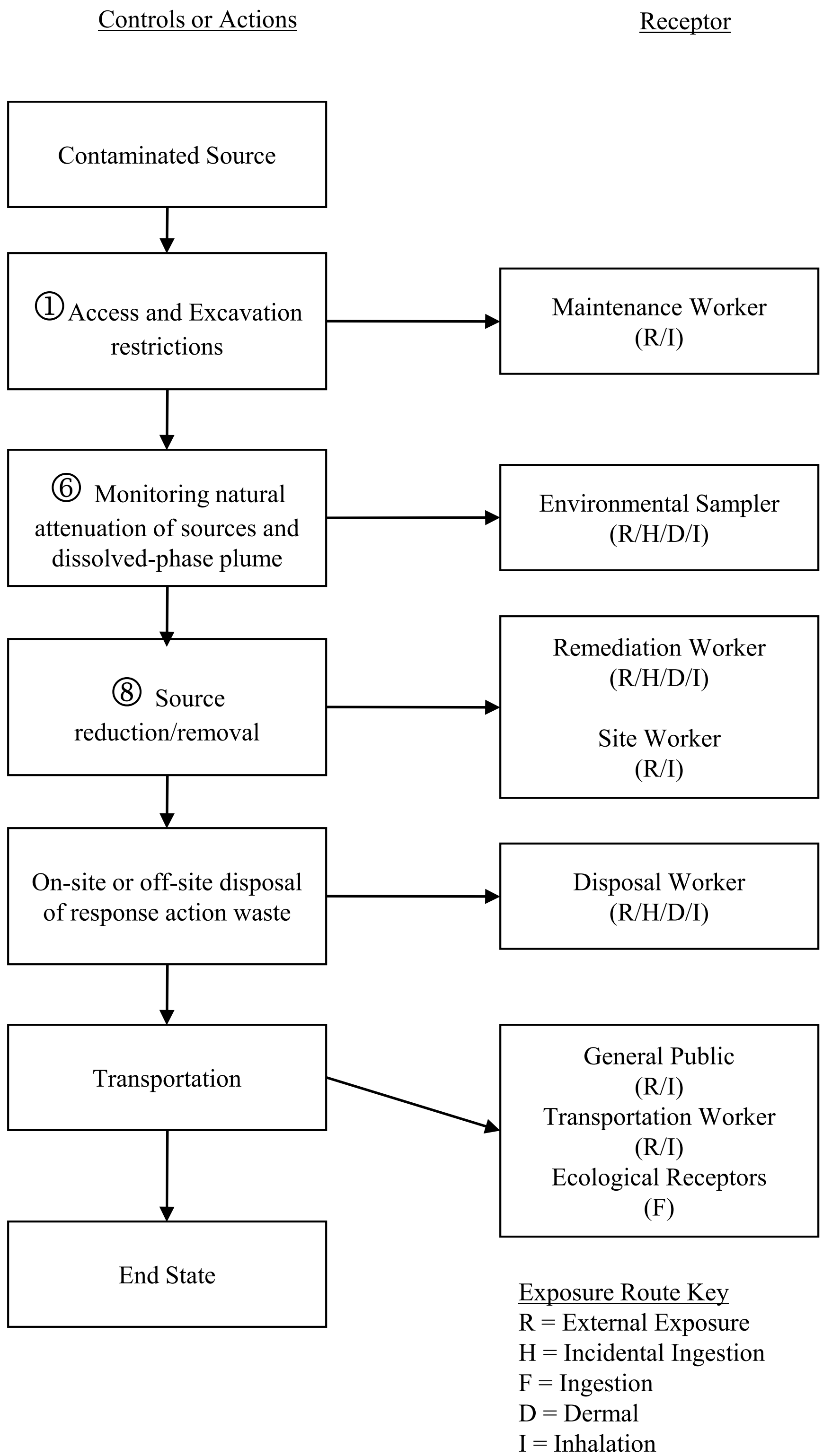


Figure 4.1b3. Hazard Area 1 Groundwater OU Treatment Train – End State

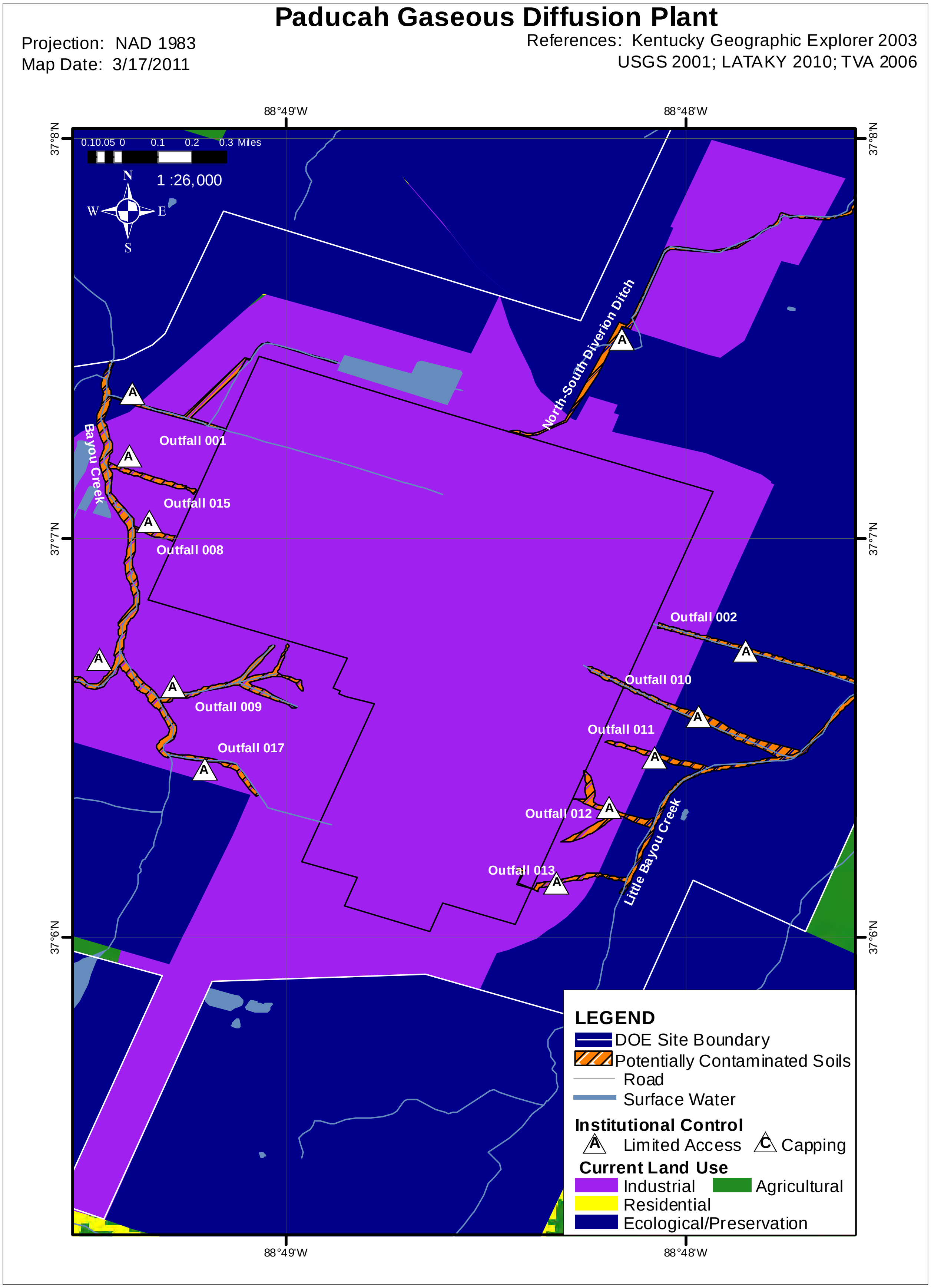
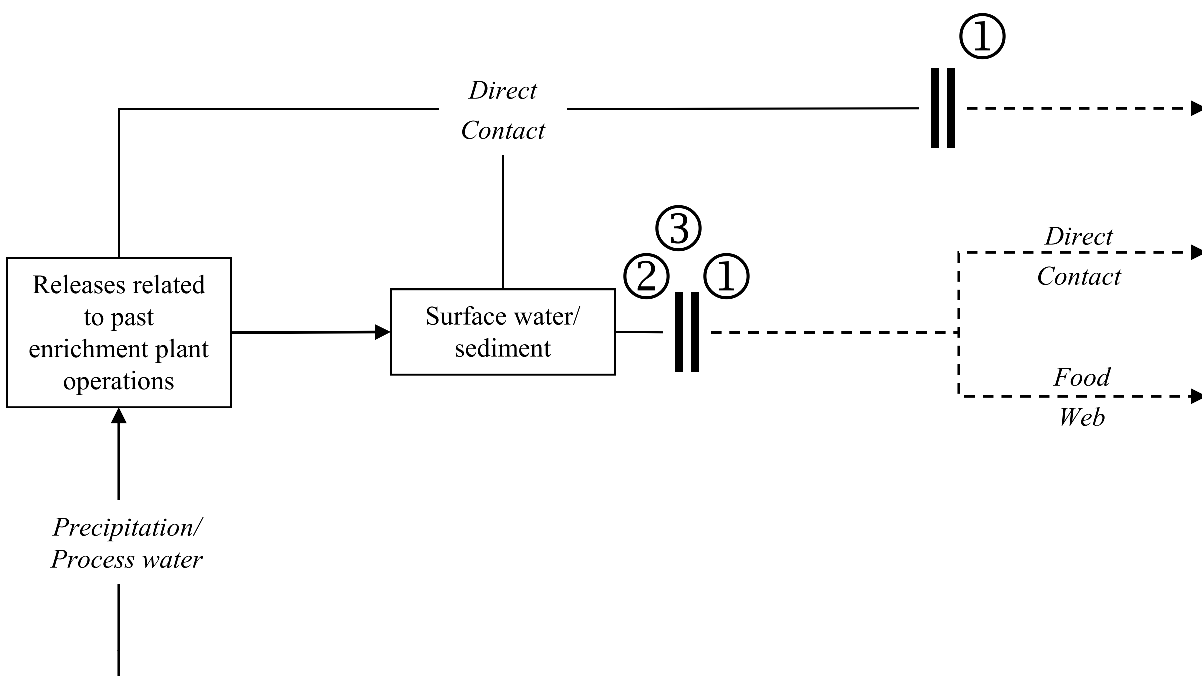


Figure 4.2a1. Hazard Area 2: SWOU - Current State

Hazard Area 2: Surface Water Operable Unit – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
H/D/I		H/D/I	F/D/I
	F	F	F

Current Controls and Action
①Access and use restrictions/posted warnings.
②Environmental monitoring.
③Sedimentation basin.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.2a2. Hazard Area 2: Surface Water Operable Unit – Current State

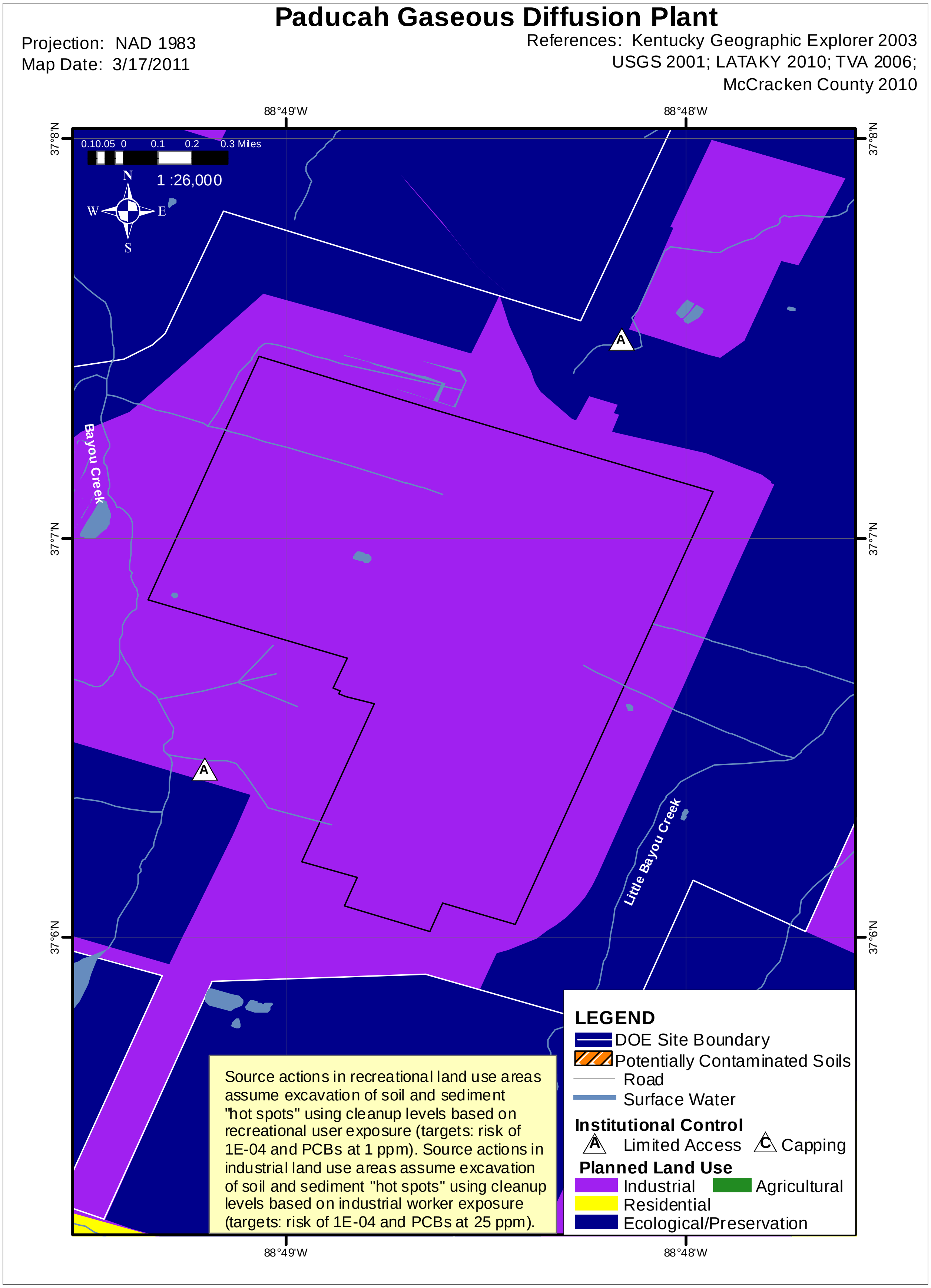
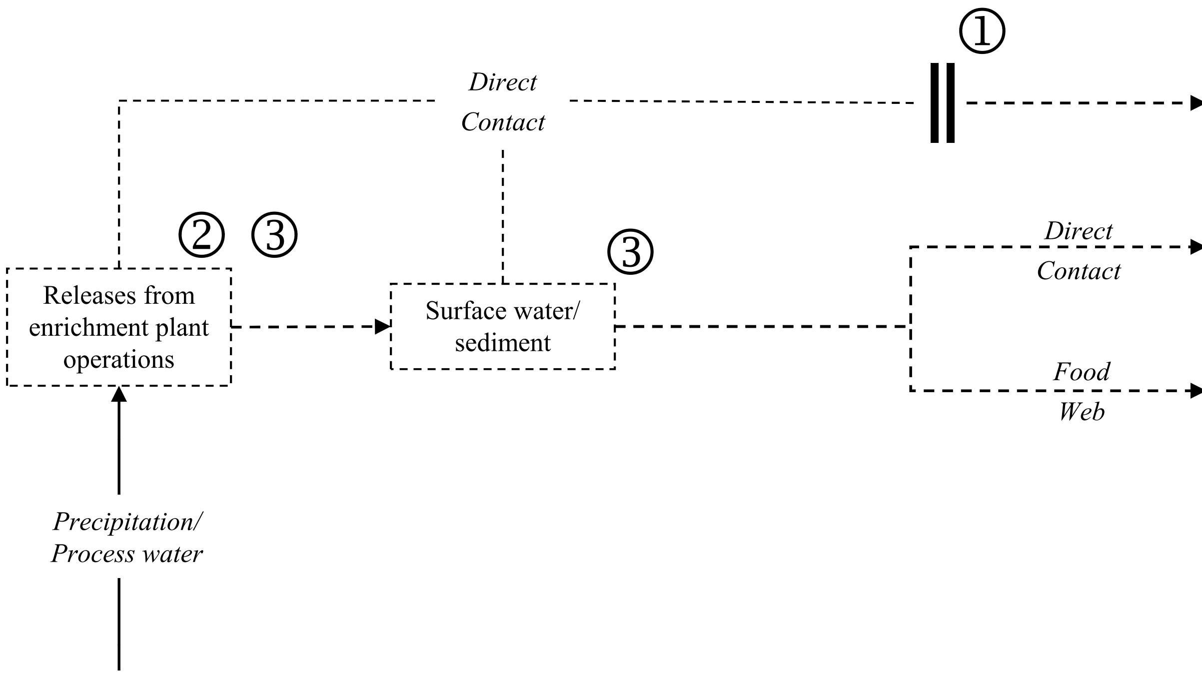


Figure 4.2b1. Hazard Area 2: SWOU - Potential End State Alternative

Hazard Area 2: Surface Water Operable Unit – End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
H/D/I		H/D/I	F/D/I
	F	F	F

<u>RBES Controls and Action</u>
① Access restrictions.
② Environmental monitoring.
③ Excavation of "hot spots" (target in industrial areas based on average exposure over entire unit: worker risk of 1E-04, PCBs at 25 ppm; target in recreational areas: recreational user risk of 1E-04, PCBs at 1ppm).

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.2b2. Hazard Area 2: Surface Water Operable Unit – End State

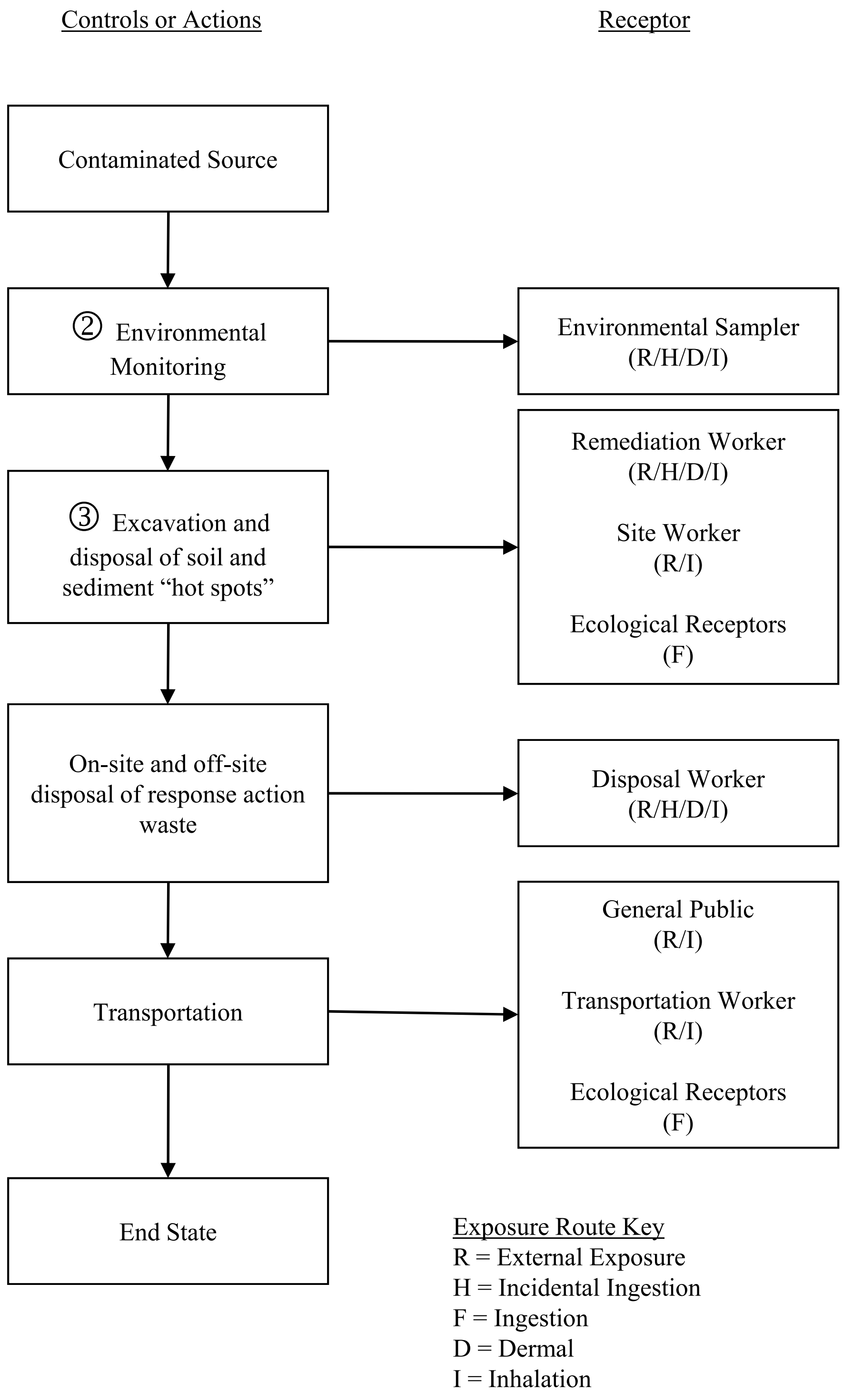


Figure 4.2b3. Hazard Area 2 Surface Water OU Treatment Train – End State

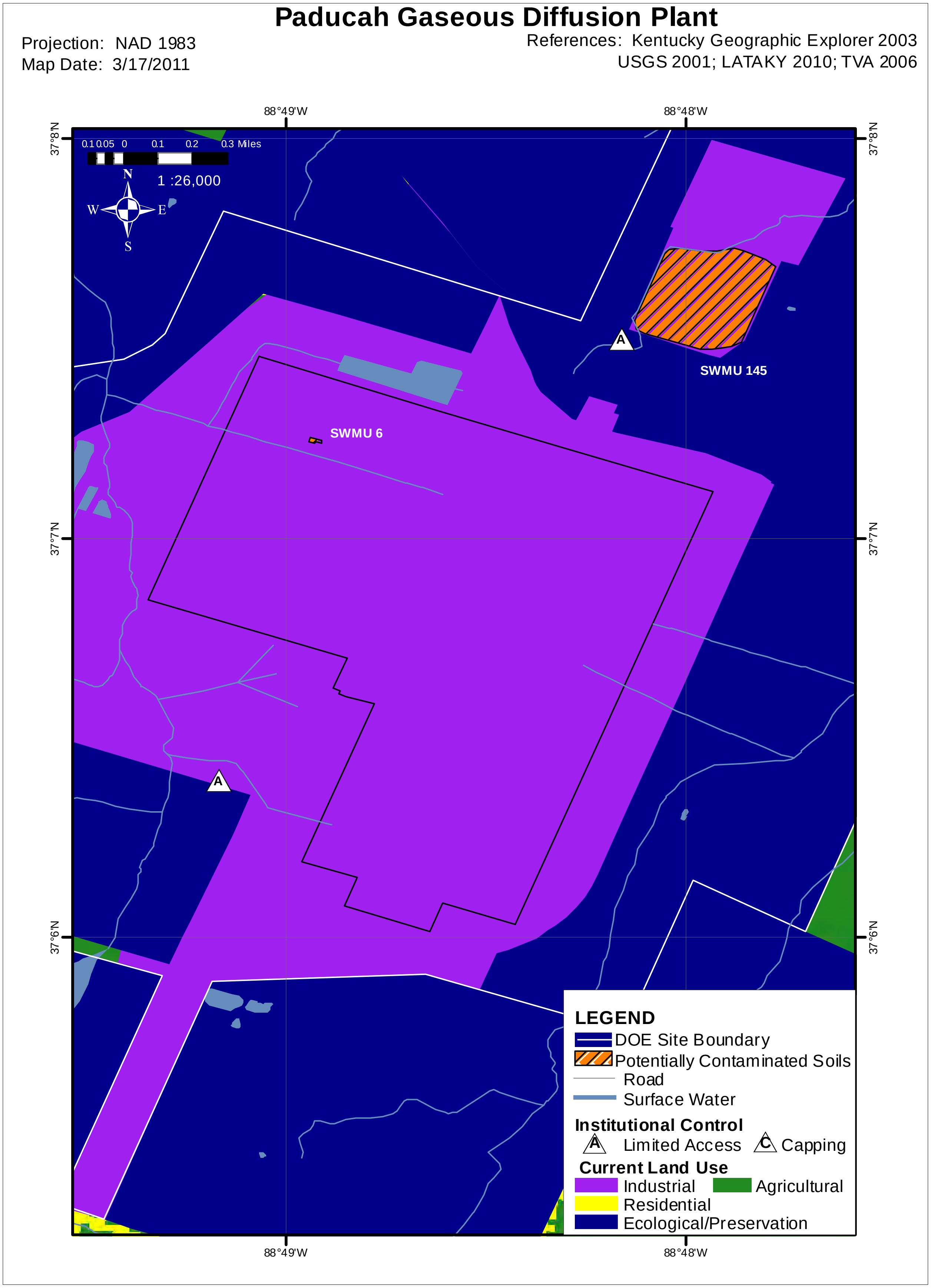
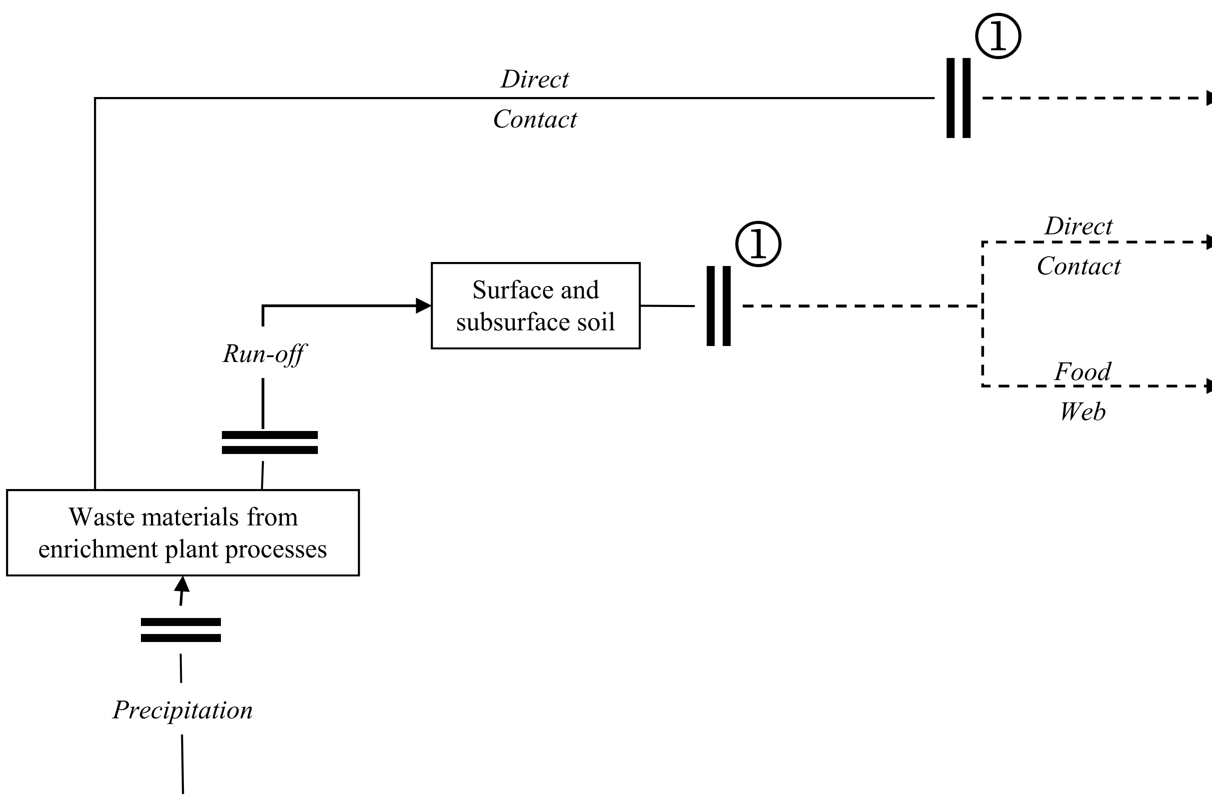


Figure 4.3a1. Hazard Area 3: BGOU (Group 1) - Current State

Hazard Area 3: Burial Grounds Operable Unit (Group 1) – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
			F

Current Controls and Actions
①Access and excavation restrictions.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.3a2. Hazard Area 3: Burial Grounds Operable Unit (Group 1) – Current State

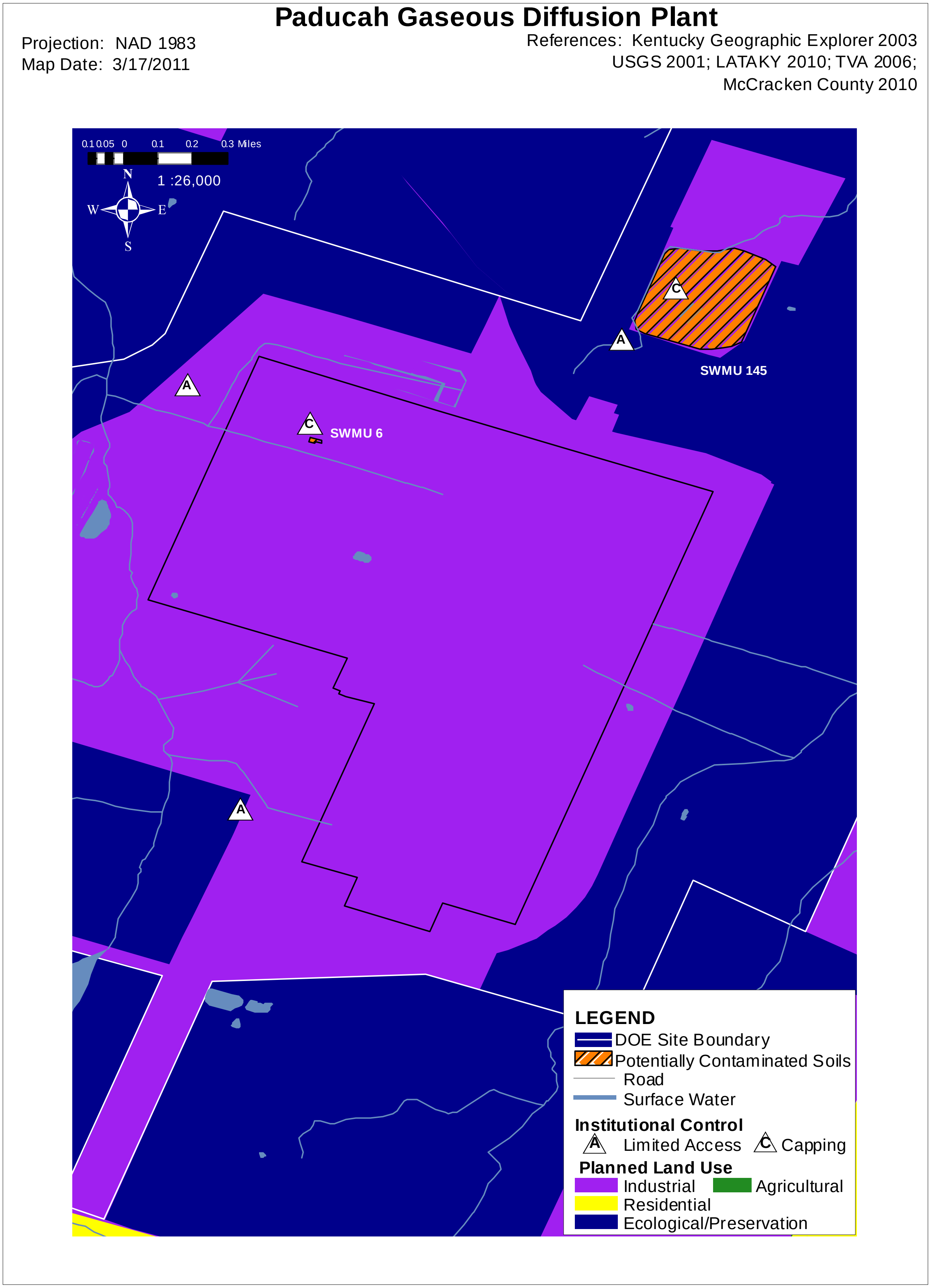
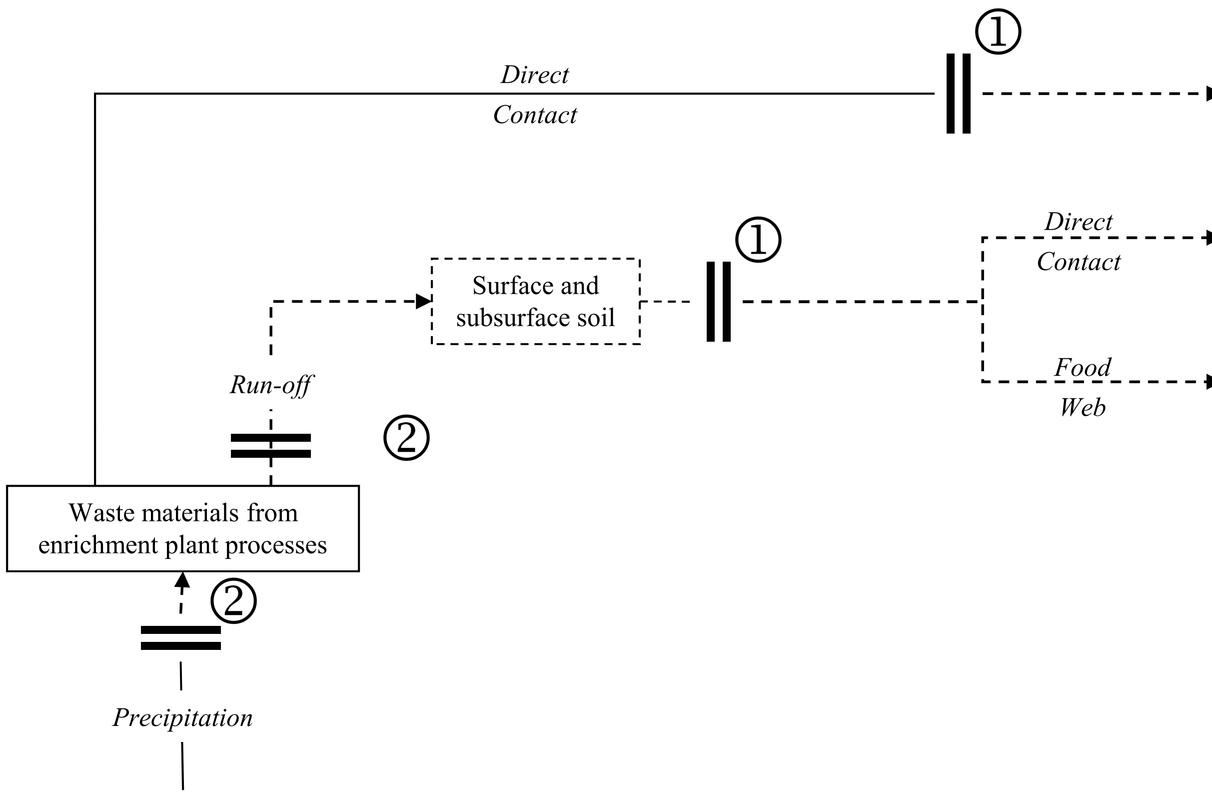


Figure 4.3b1. Hazard Area 3: BGOU (Group 1) - Potential End State Alternative

Hazard Area 3: Burial Grounds Operable Unit (Group 1)– End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
			F

RBES Controls and Actions
① Access and excavation restrictions.
② Capping.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.3b2. Hazard Area 3: Burial Grounds Operable Unit – End State

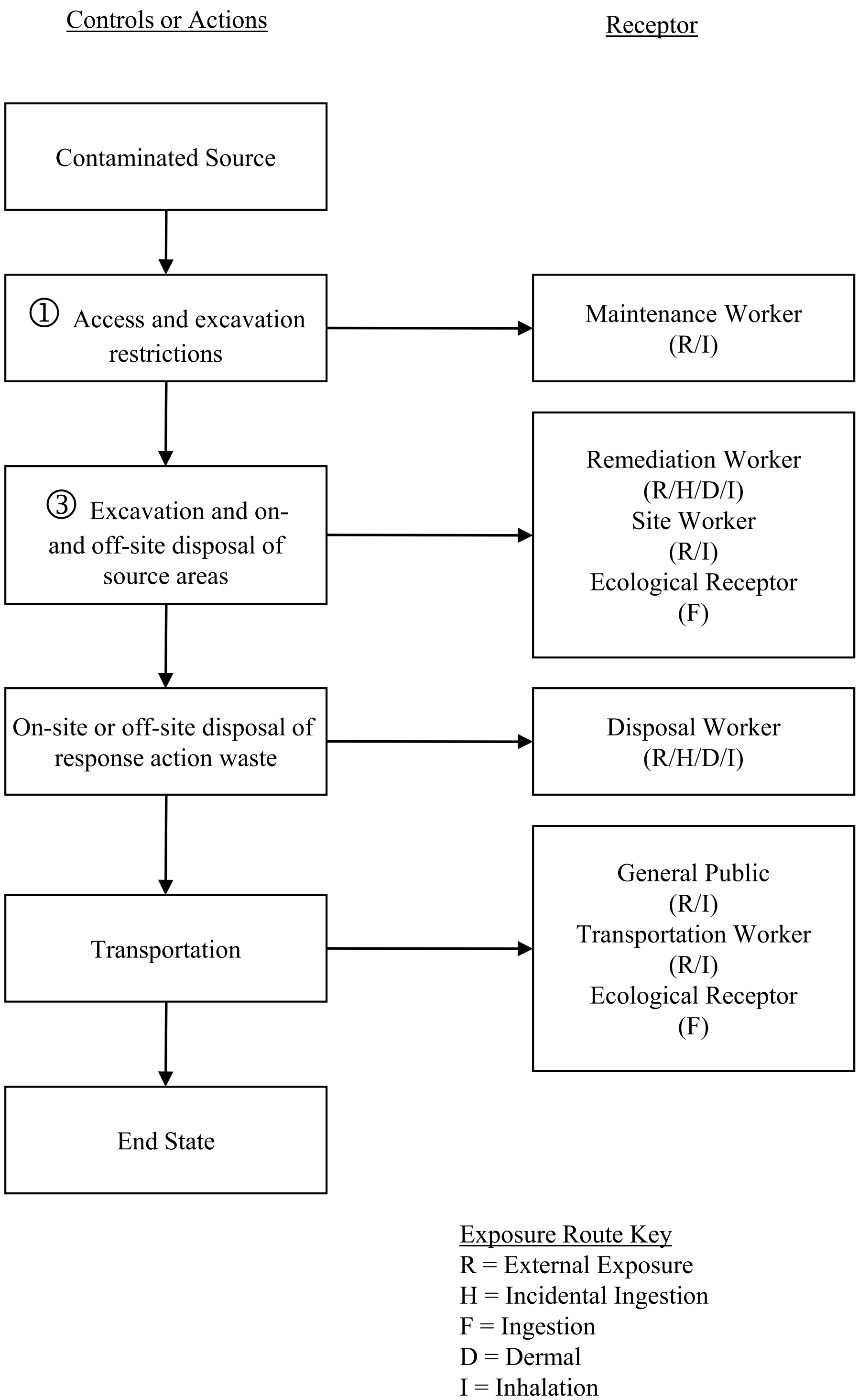


Figure 4.3b3. Hazard Area 3 Burial Grounds OU Treatment Train – End State

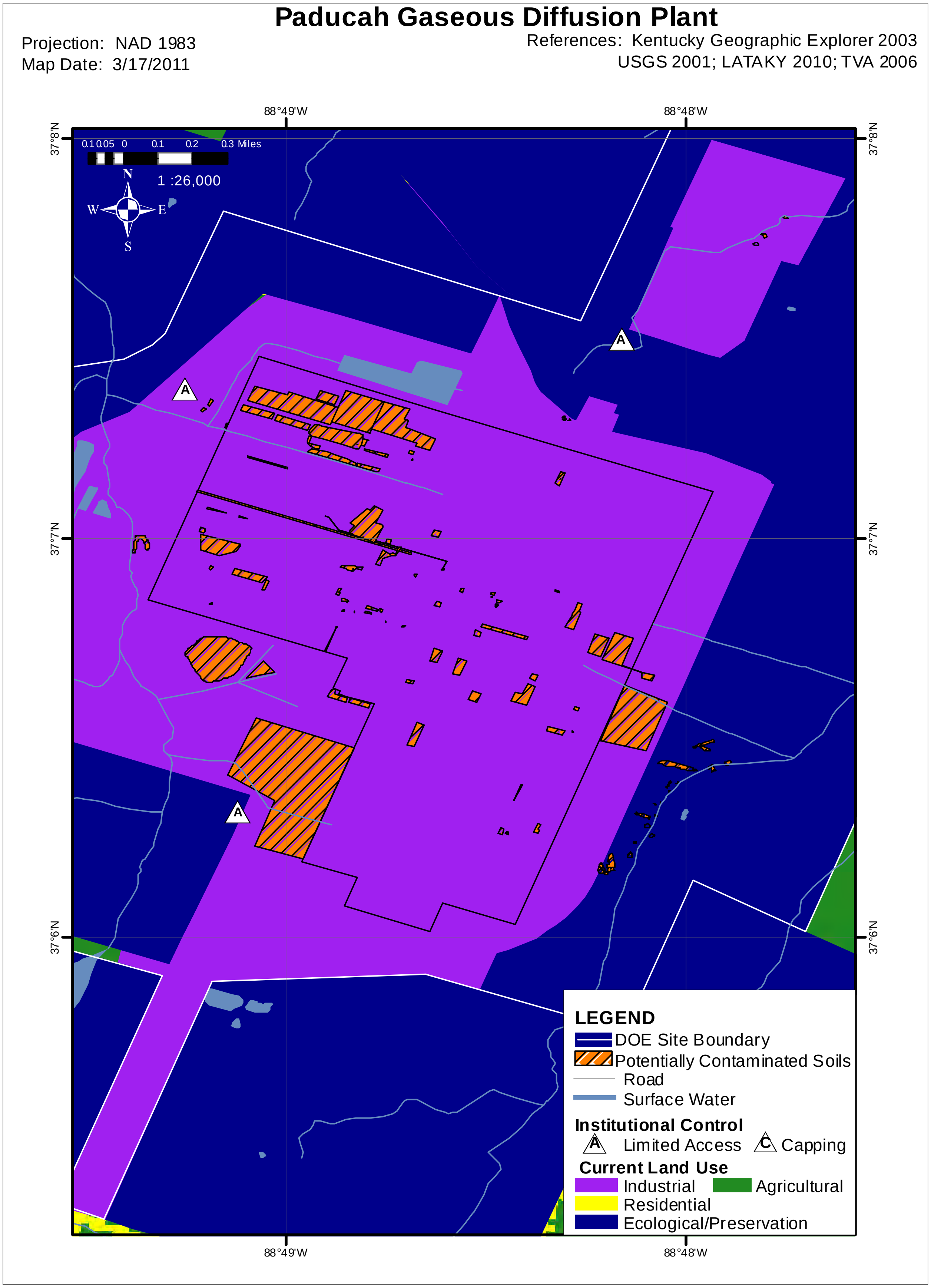
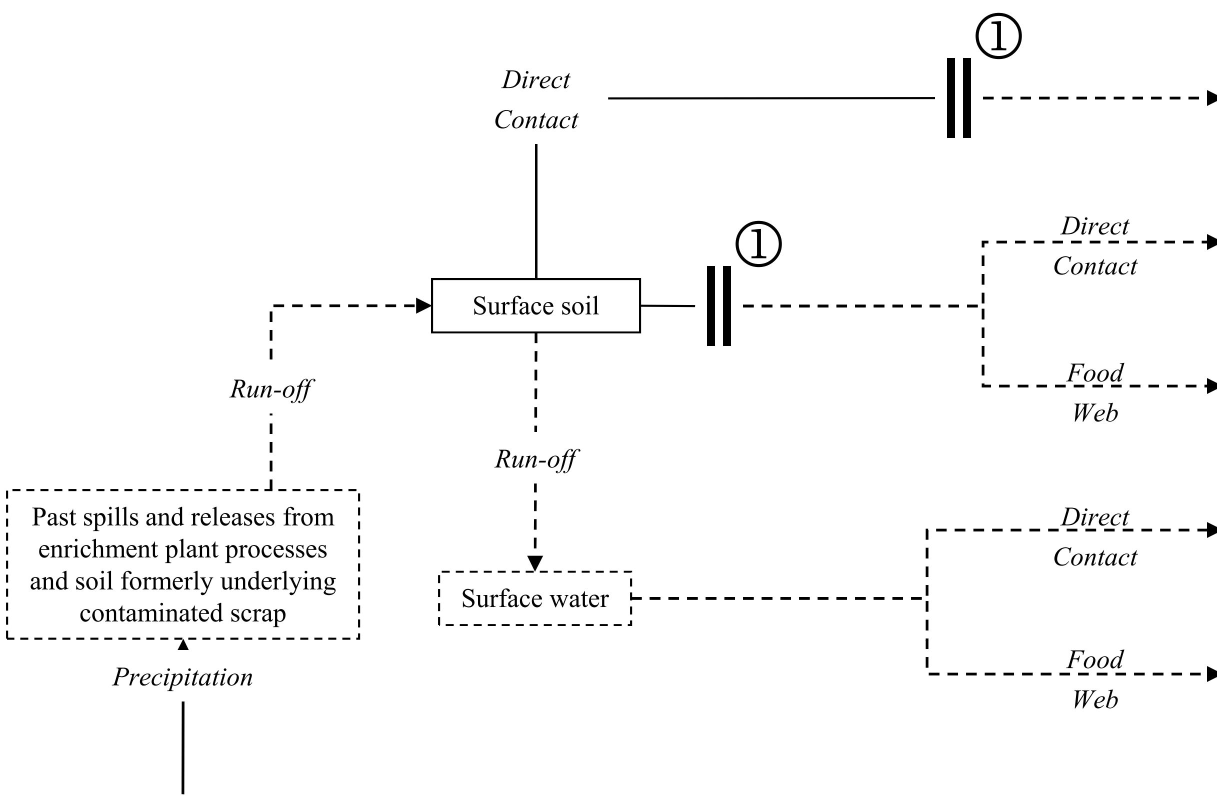


Figure 4.4a1. Hazard Area 4: SOU - Current State

Hazard Area 4: Soils Operable Unit – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
H/D/I		H/D/I	F/D/I
	F	F	F

<u>Current Controls and Actions</u>
① Access and excavation restrictions.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.4a2. Hazard Area 4: Soils Operable Unit – Current State

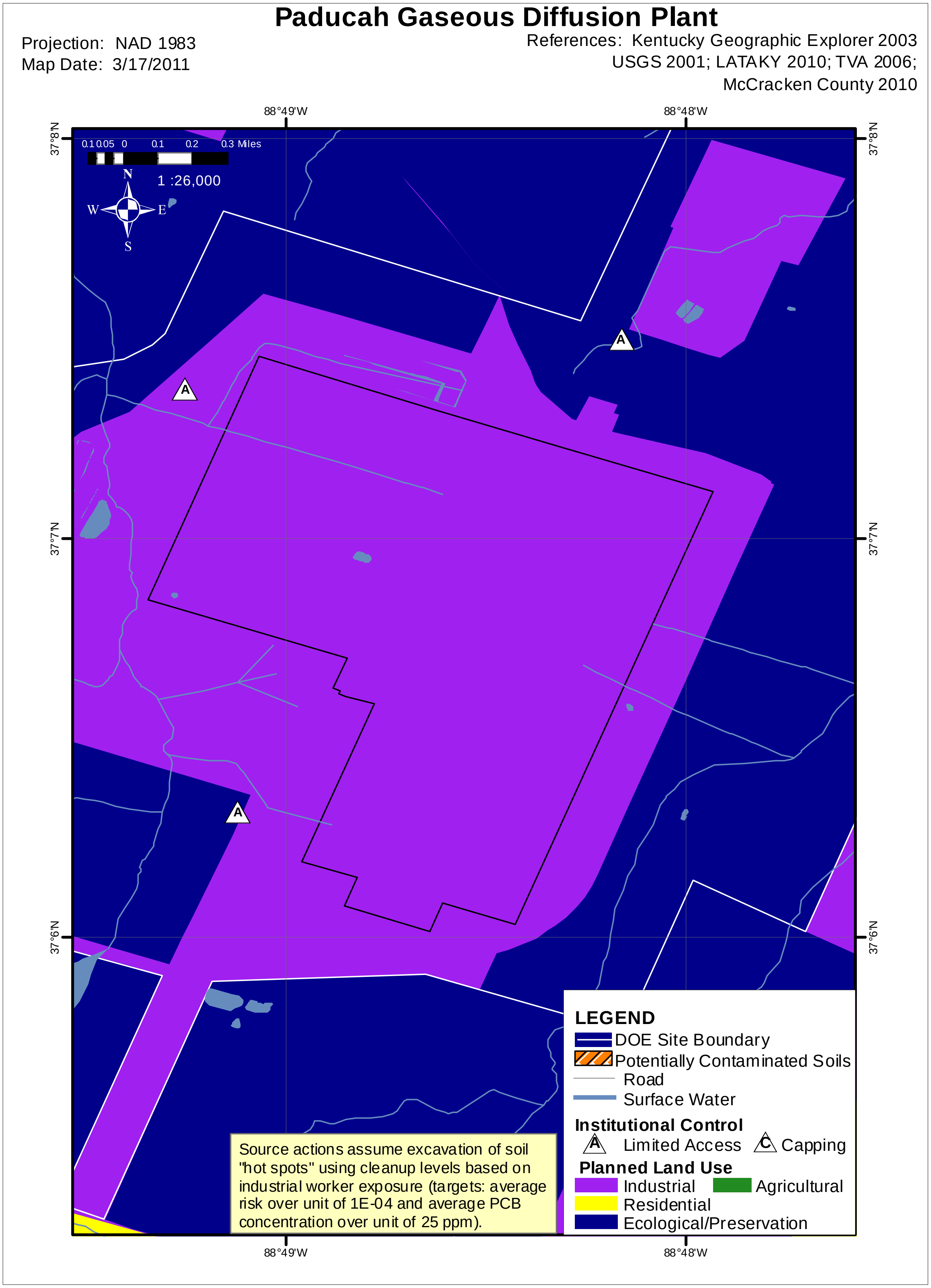
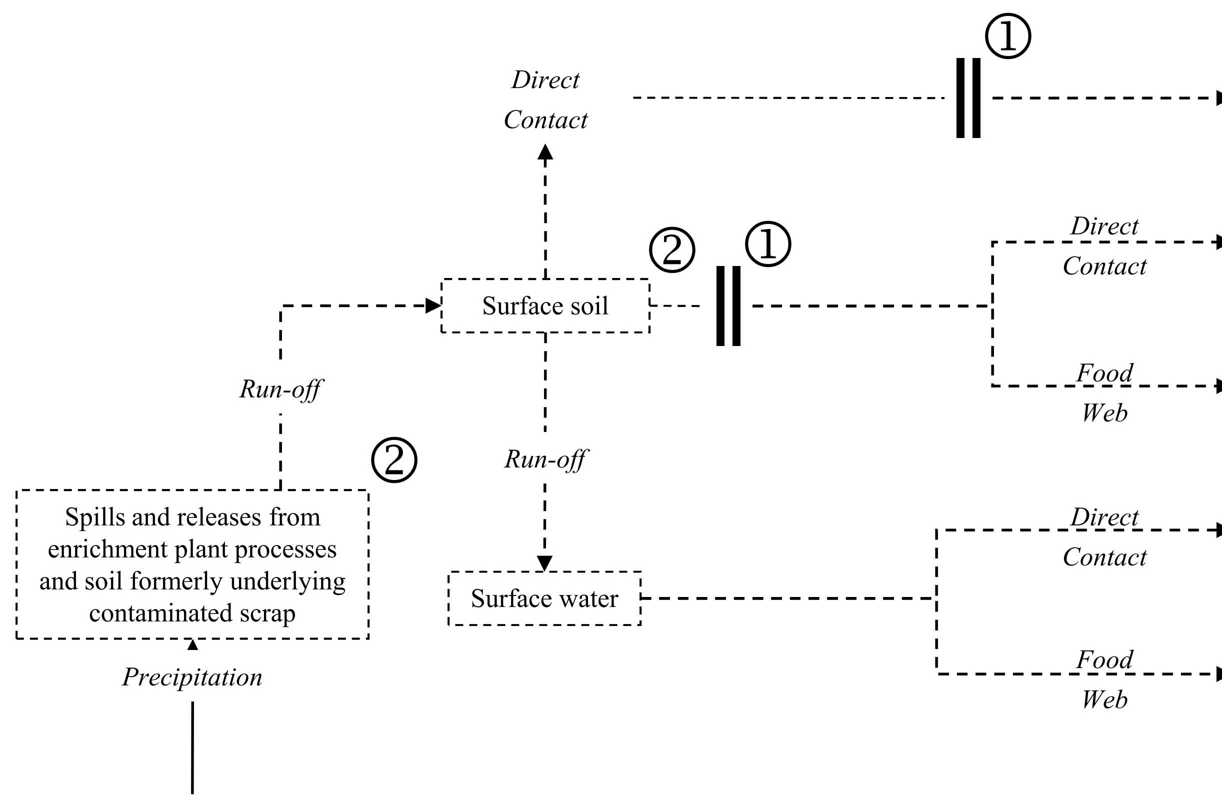


Figure 4.4b1. Hazard Area 4: SOU - Potential End State Alternative

Hazard Area 4: Soils Operable Unit – End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
H/D/I		H/D/I	F/D/I
	F	F	F

RBES Controls and Actions
① Access and excavation restrictions.
② Excavation of "hot spots" (target based on average exposure over entire unit: worker risk of 1E-04, PCBs at 25 ppm).

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.4b2. Hazard Area 4: Soils Operable Unit – End State

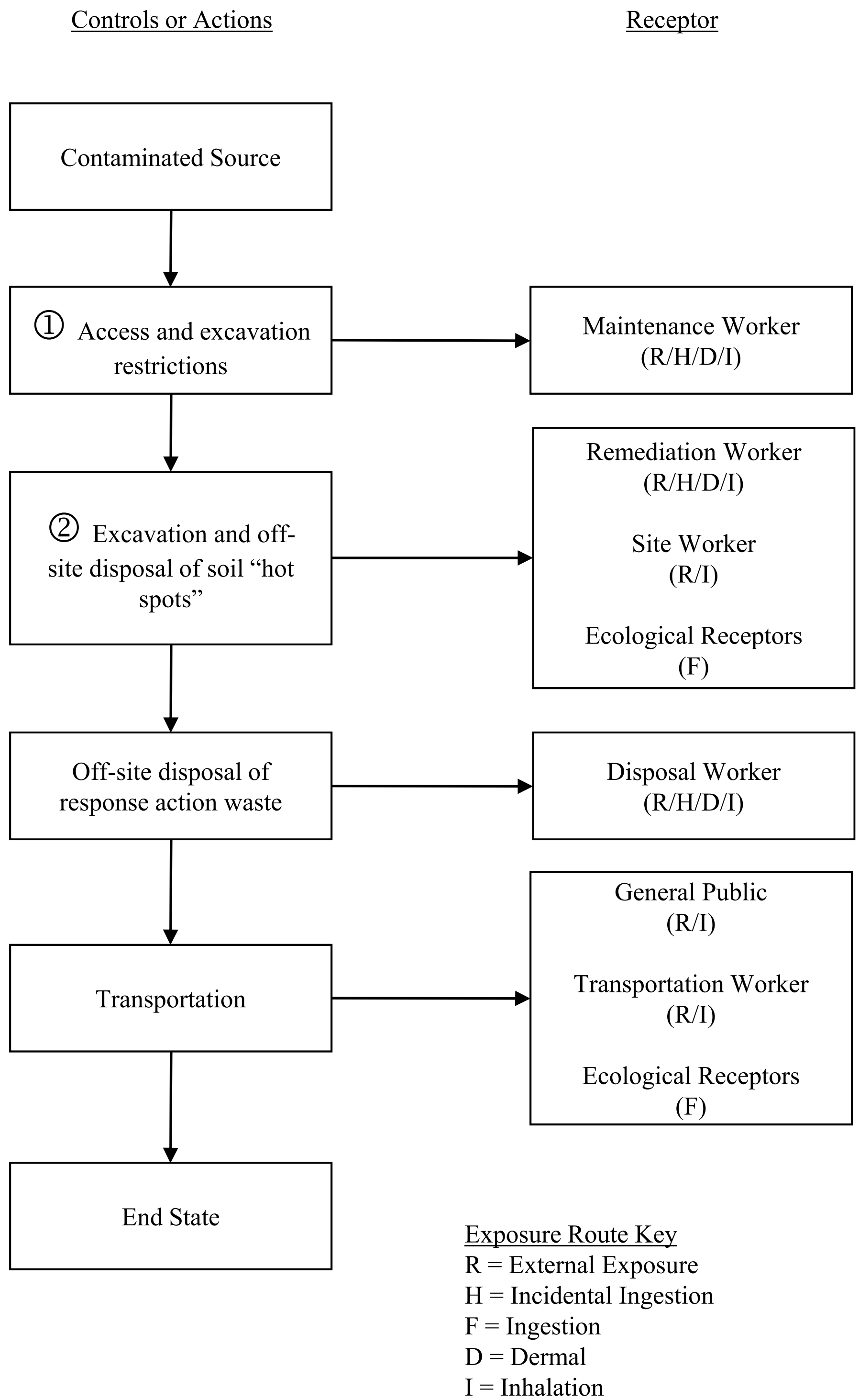


Figure 4.4b3. Hazard Area 4 Soils OU Treatment Train – End State

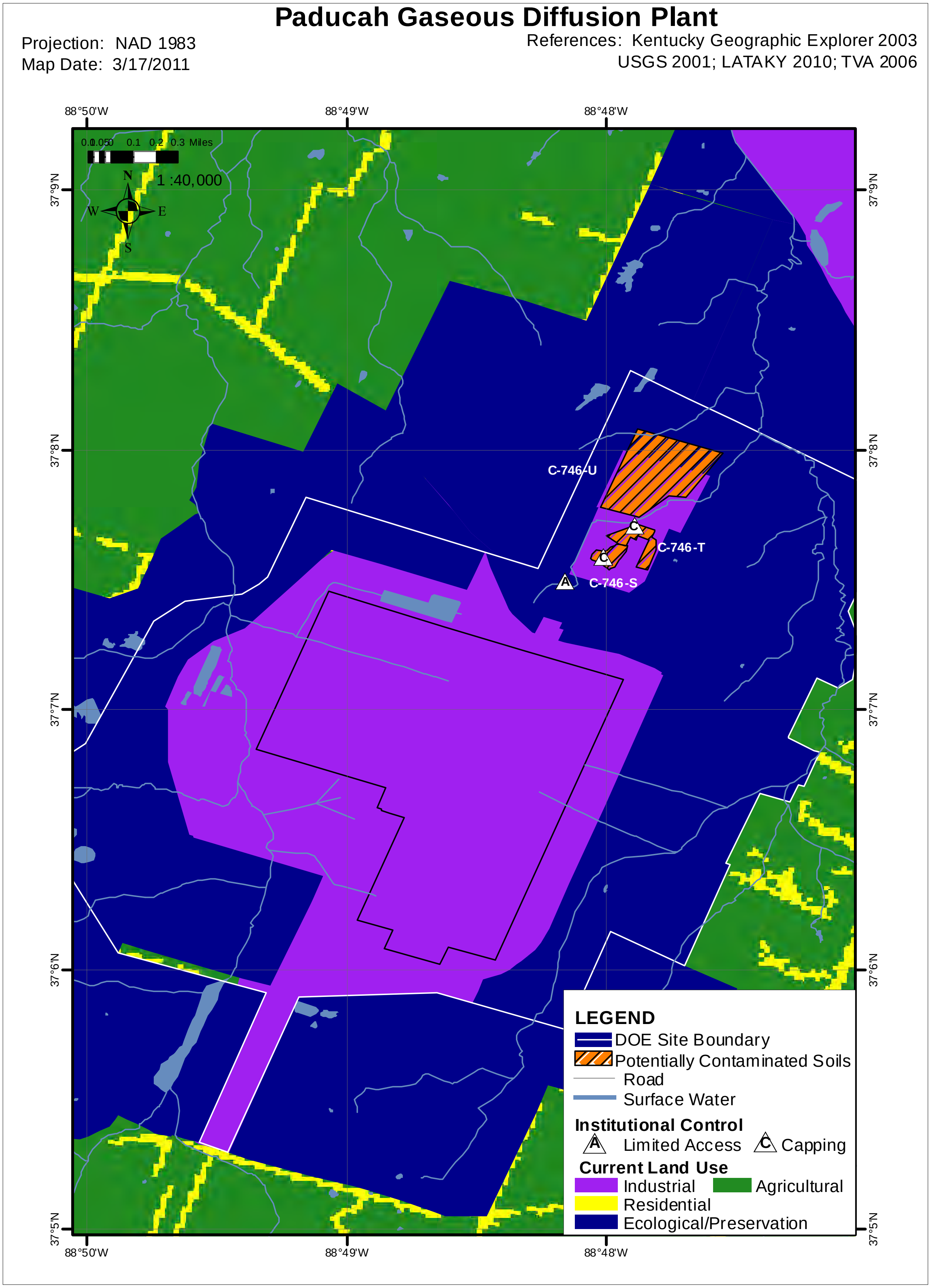
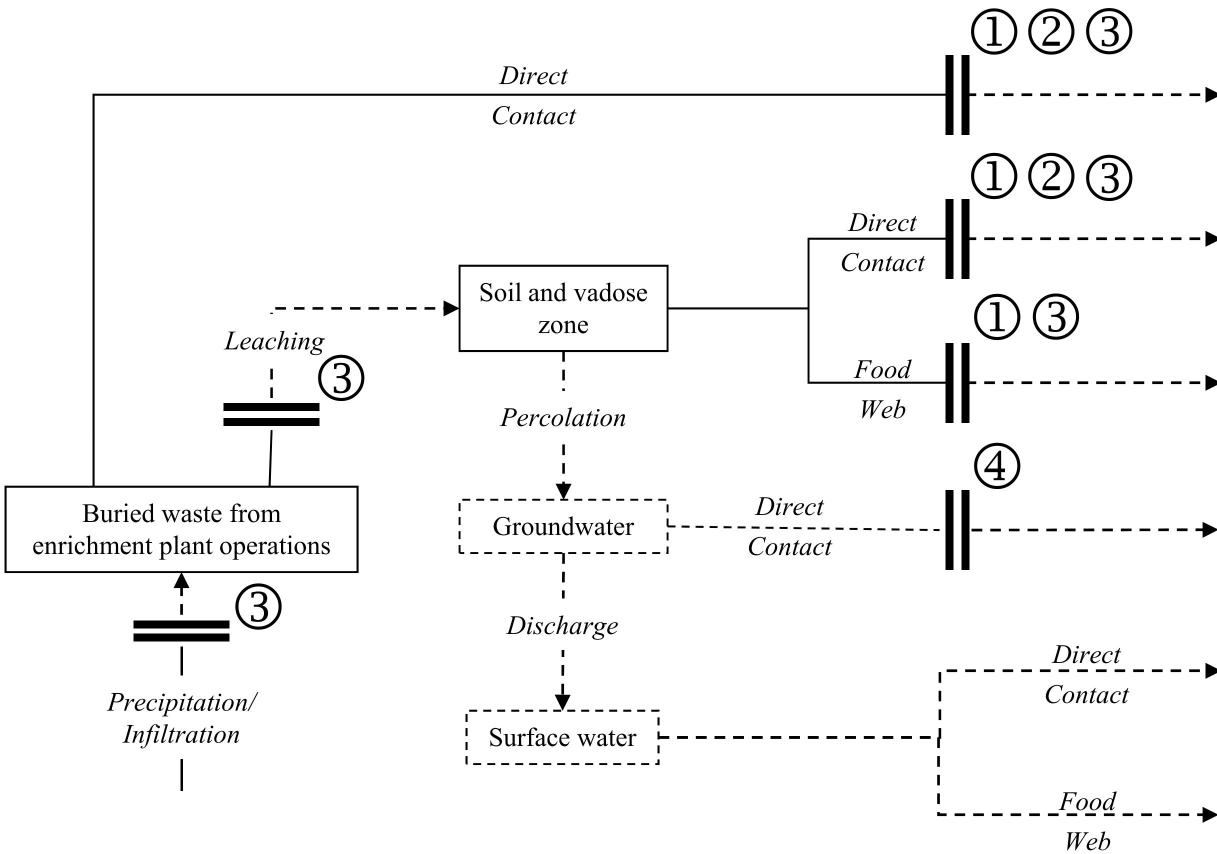


Figure 4.5a1. Hazard Area 5: Permitted Landfills - Current State

Hazard Area 5 Permitted Landfills – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

<u>Current Controls and Actions</u>
① Current land cover.
② Access and excavation restrictions.
③ Landfill cap, leachate collection system, and monitoring.
④ PGDP Water Policy.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.5a2. Hazard Area 5: Permitted Landfills – Current State

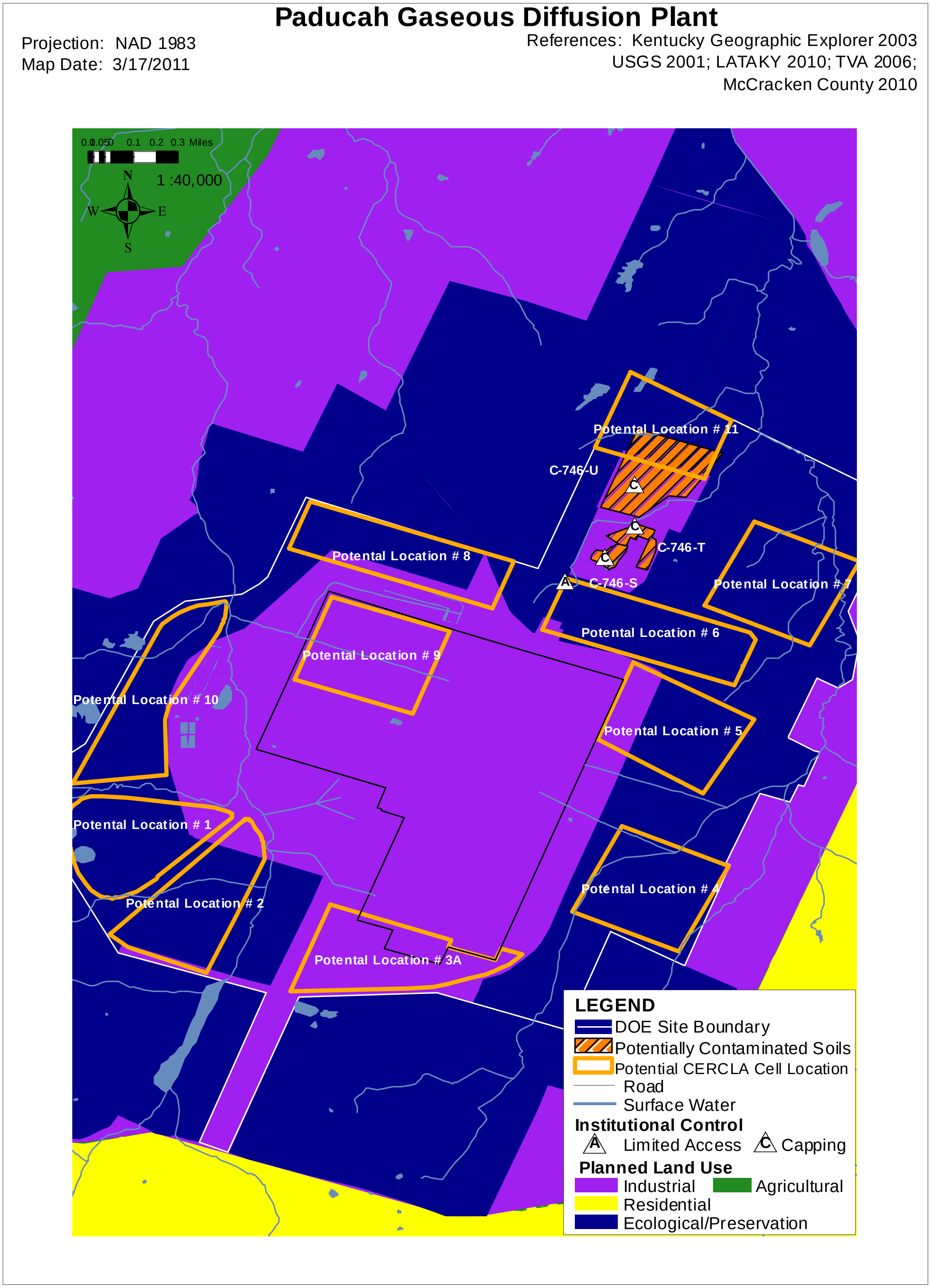
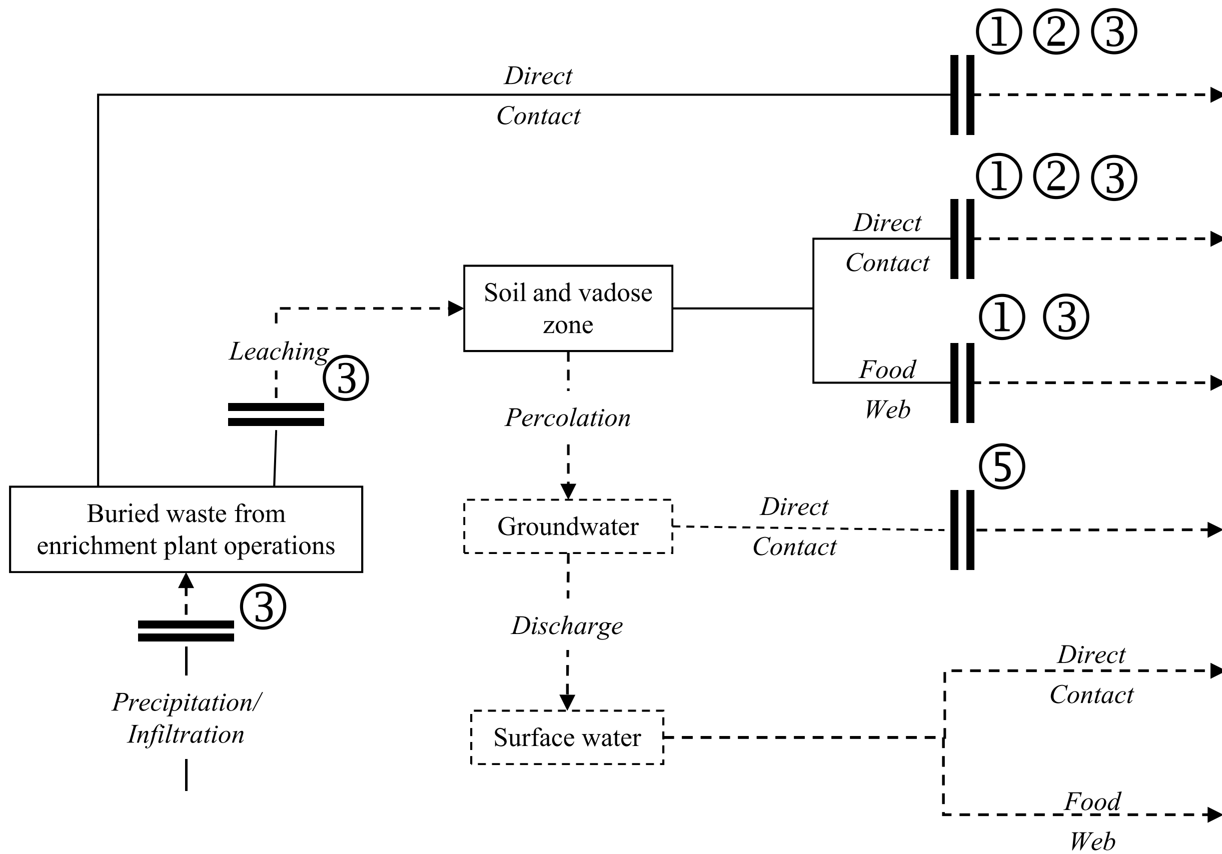


Figure 4.5b1. Hazard Area 5: Permitted Landfills - Potential End State Alternative

Hazard Area 5 Permitted Landfills – End State



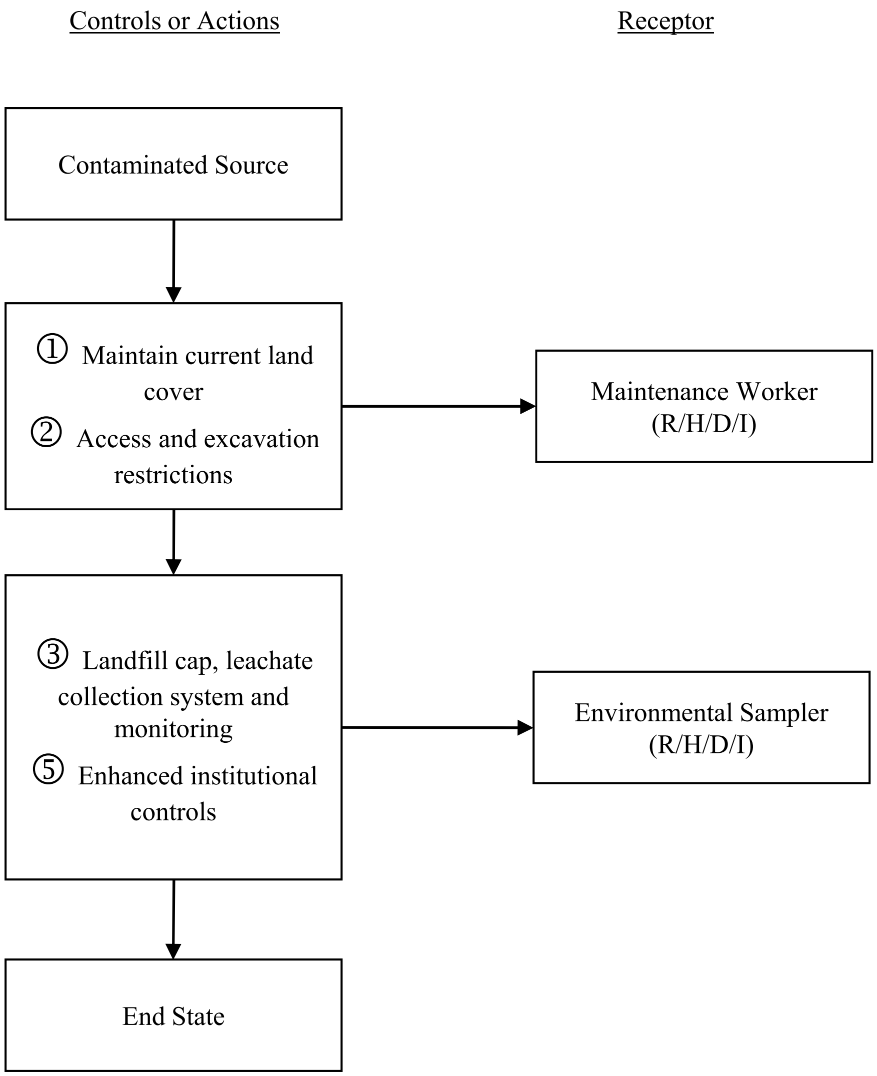
Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

RBES Controls and Actions
① Current land cover.
② Access and excavation restrictions.
③ Landfill cap, leachate collection system, and monitoring.
⑤ Enhanced institutional controls to limit access and use of groundwater.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.5b2. Hazard Area 5: Permitted Landfills – End State



Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.15b3. Hazard Area 5 Permitted Landfills Treatment Train – End State

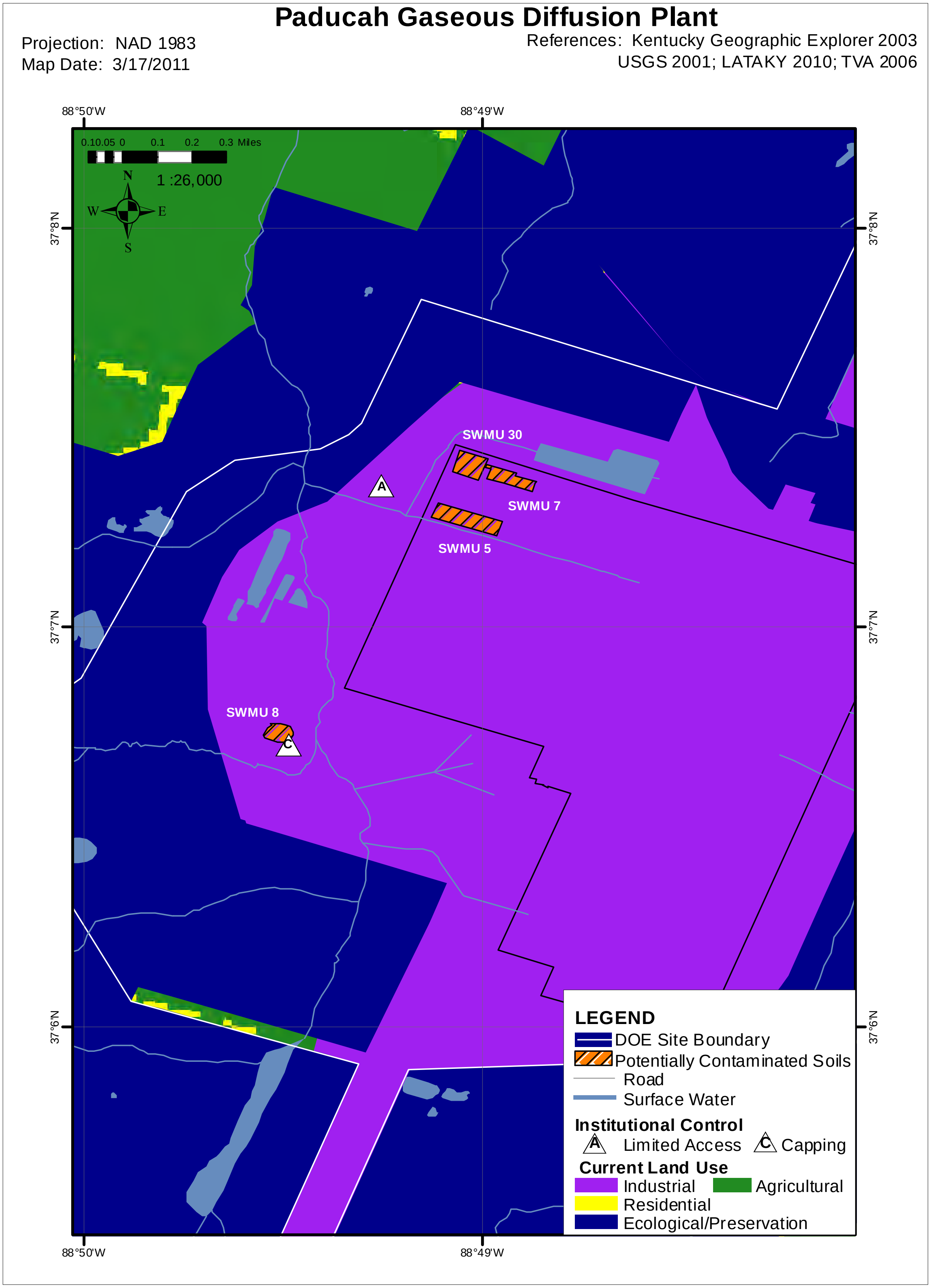
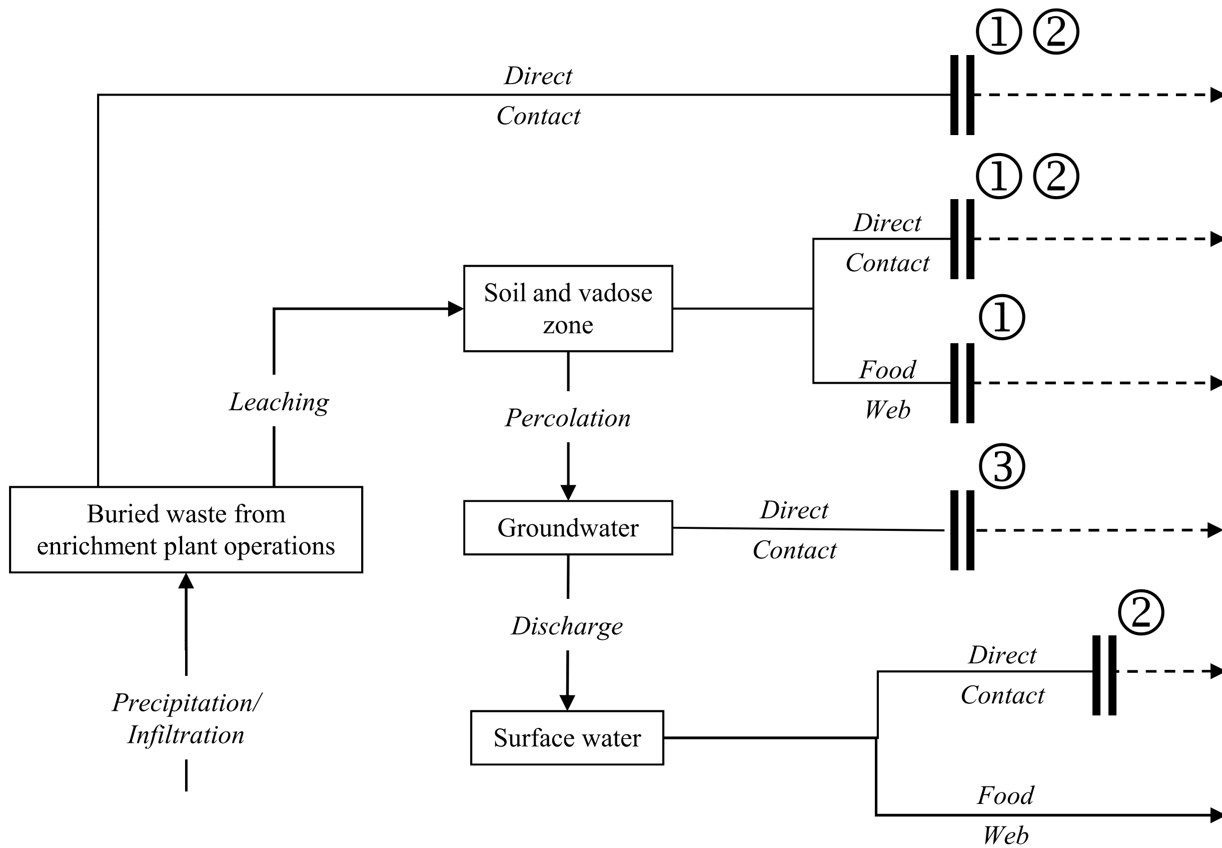


Figure 4.6a1. Hazard Area 6: BGOU (Group 2) - Current State

Hazard Area 6 Burial Grounds (Group 2) – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

Current Controls and Actions
① Current land cover.
② Access and excavation restrictions.
③ PGDP Water Policy.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.6a2. Hazard Area 6: BGOU (Group 2) – Current State

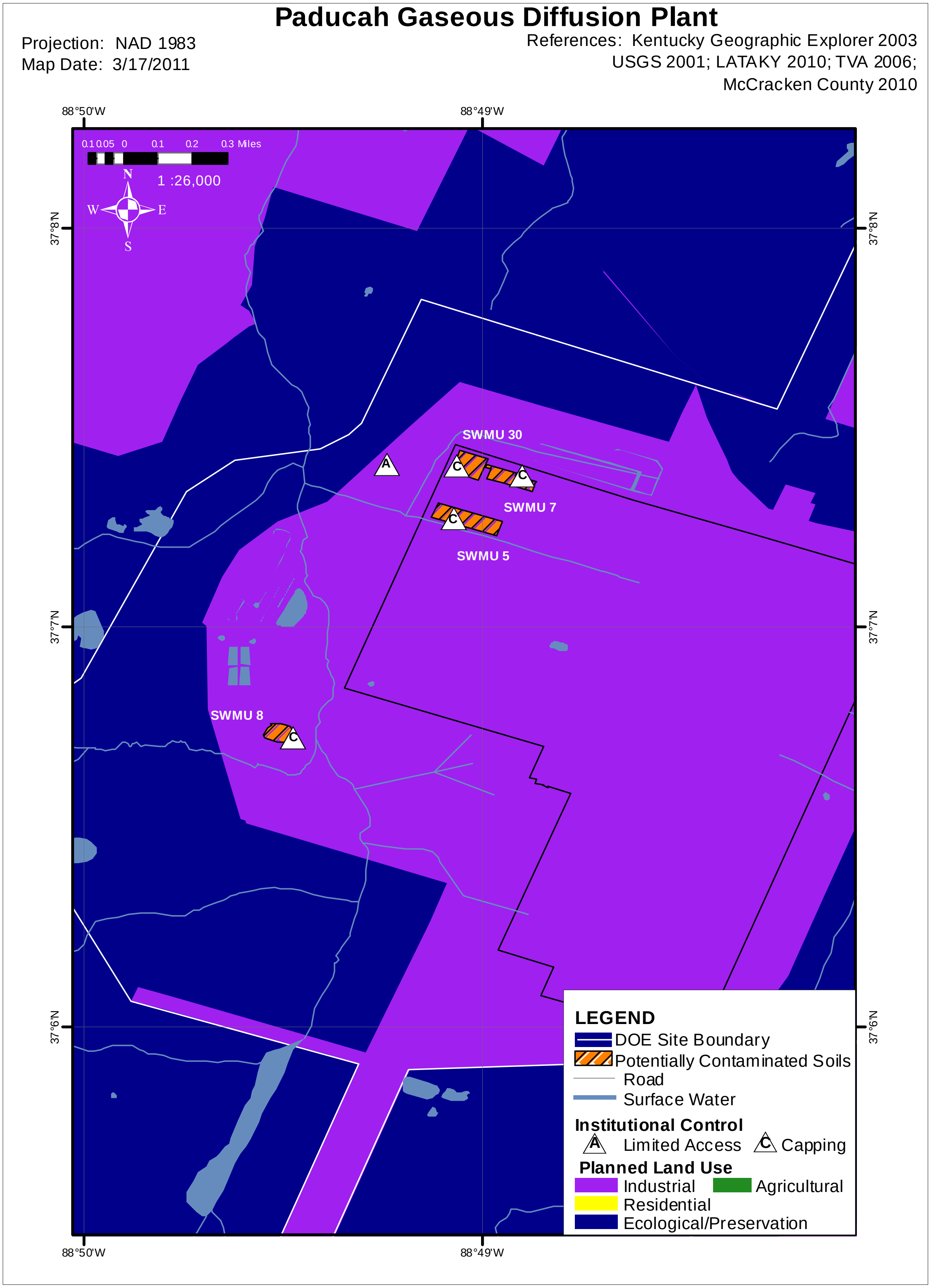
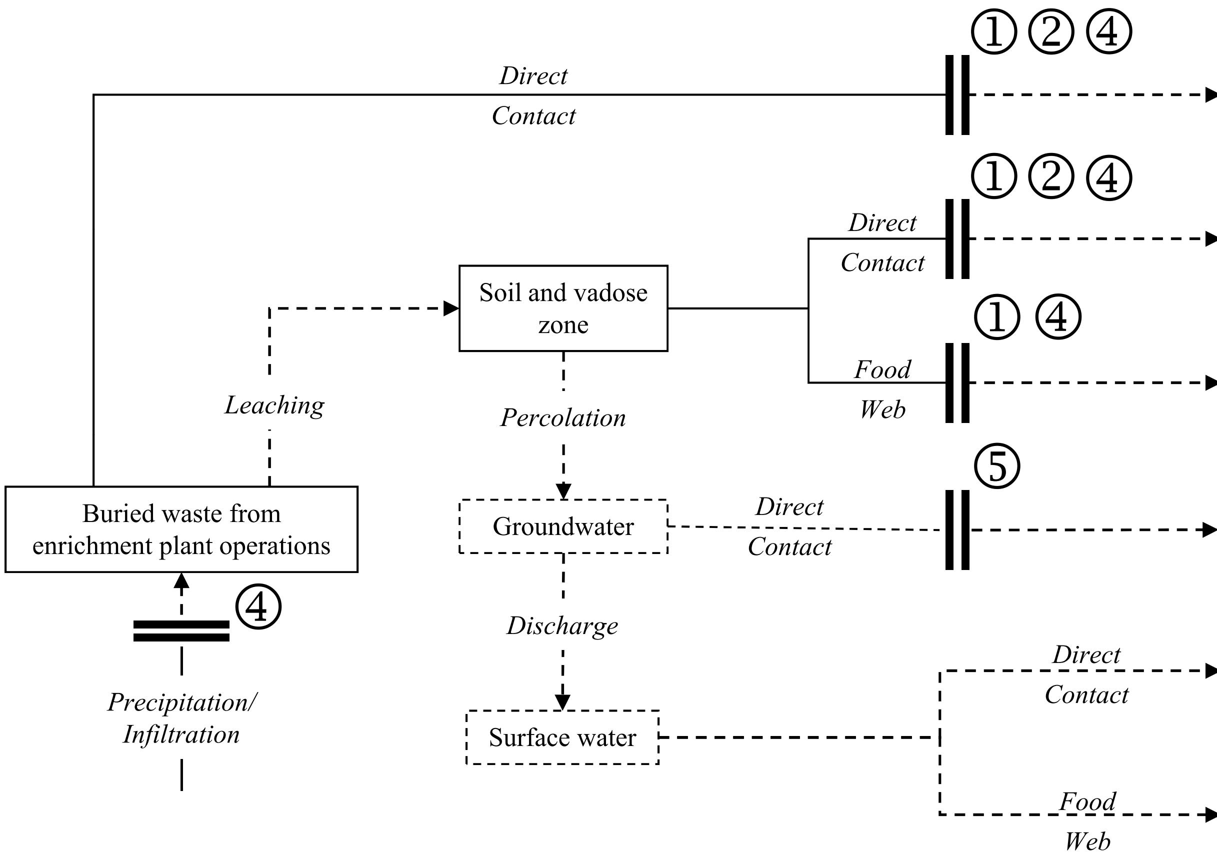


Figure 4.6b1. Hazard Area 6: BGOU (Group 2) - Potential End State Alternative

Hazard Area 6 Burial Grounds (Group 2) – End State



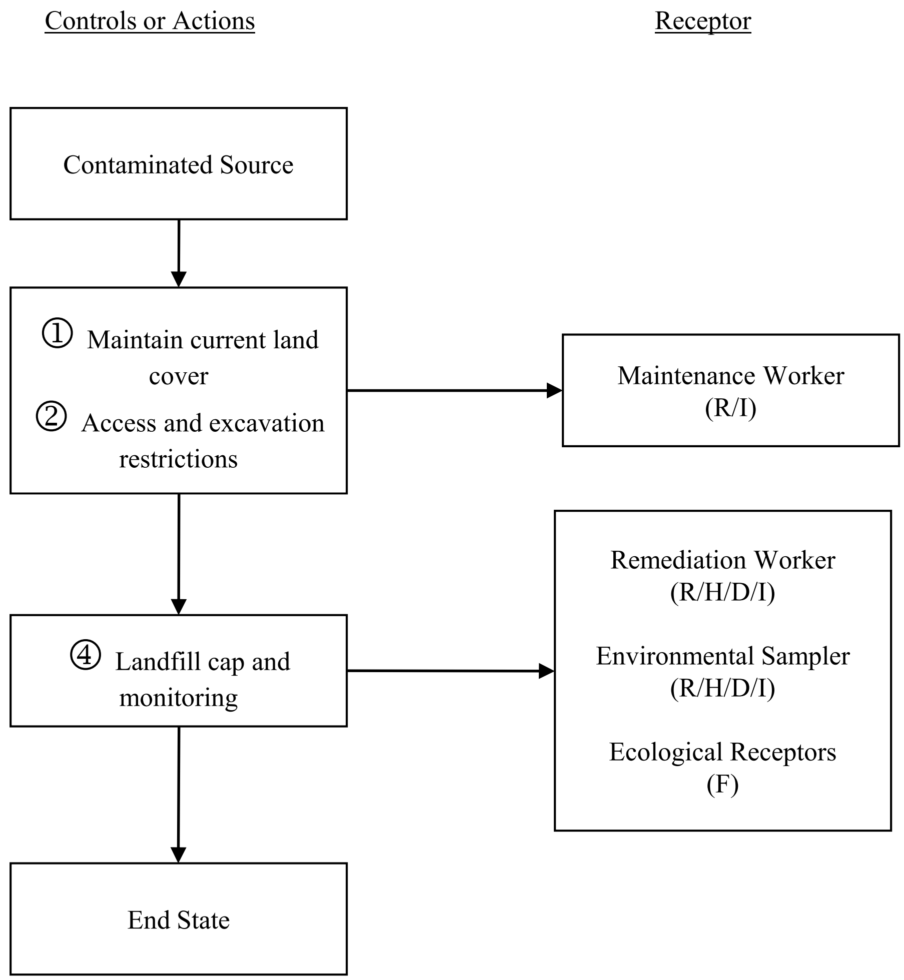
Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

RBES Controls and Actions
① Current land cover.
② Access and excavation restrictions.
④ Landfill cap and monitoring.
⑤ Enhanced institutional controls to limit access and use of groundwater.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.6b2. Hazard Area 6: Burial Grounds OU (Group 2) –End State

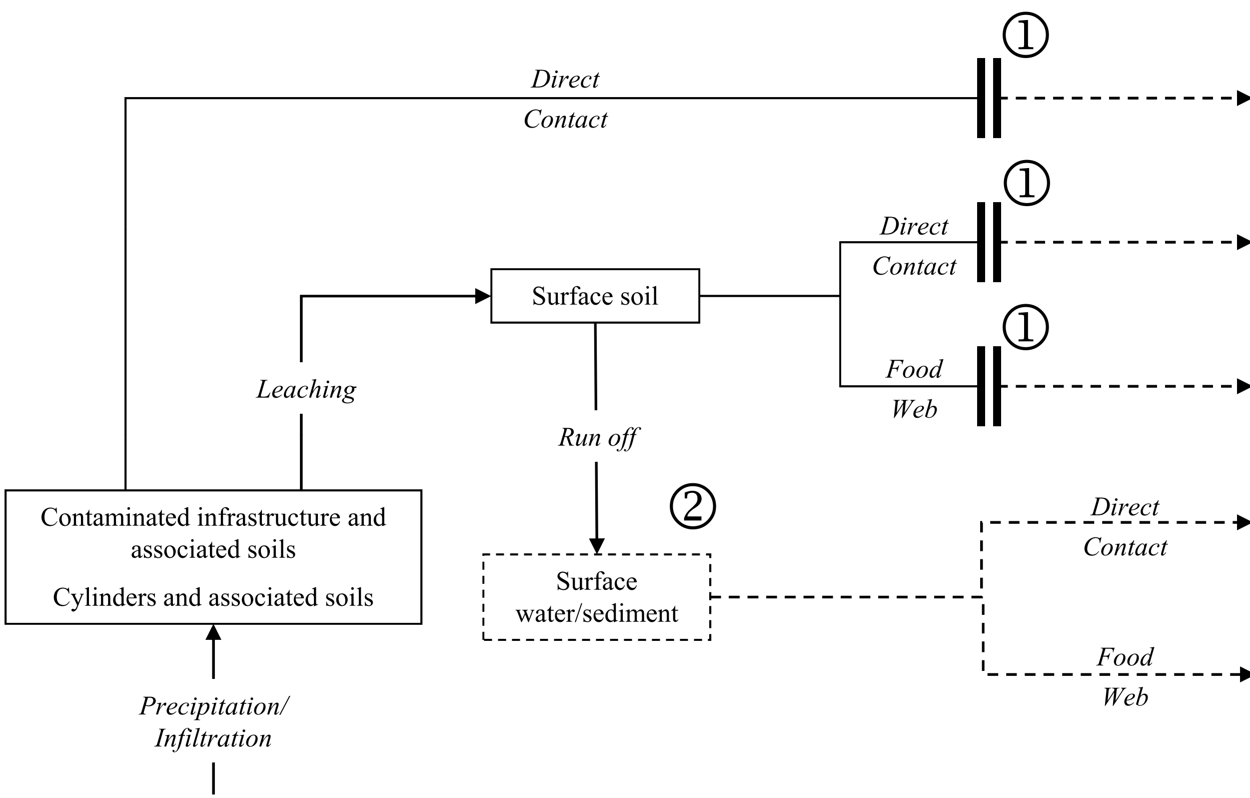


Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.6b3. Hazard Area 6: BGOU (Group 2) Treatment Train – End State

Figure 4.7a1. Hazard Area 7: Cylinder Yards and DUF_6 - Current State

Hazard Area 7 Cylinder Yards and DUF_6 Conversion Facility – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I			R/F/D/I
R/H/D/I			R/F/D/I
		F	F
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

Current Controls and Actions
① Access restrictions.
② Attenuation.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.7a2. Hazard Area 7: Cylinder Yards and DUF_6 Conversion Facility – Current State

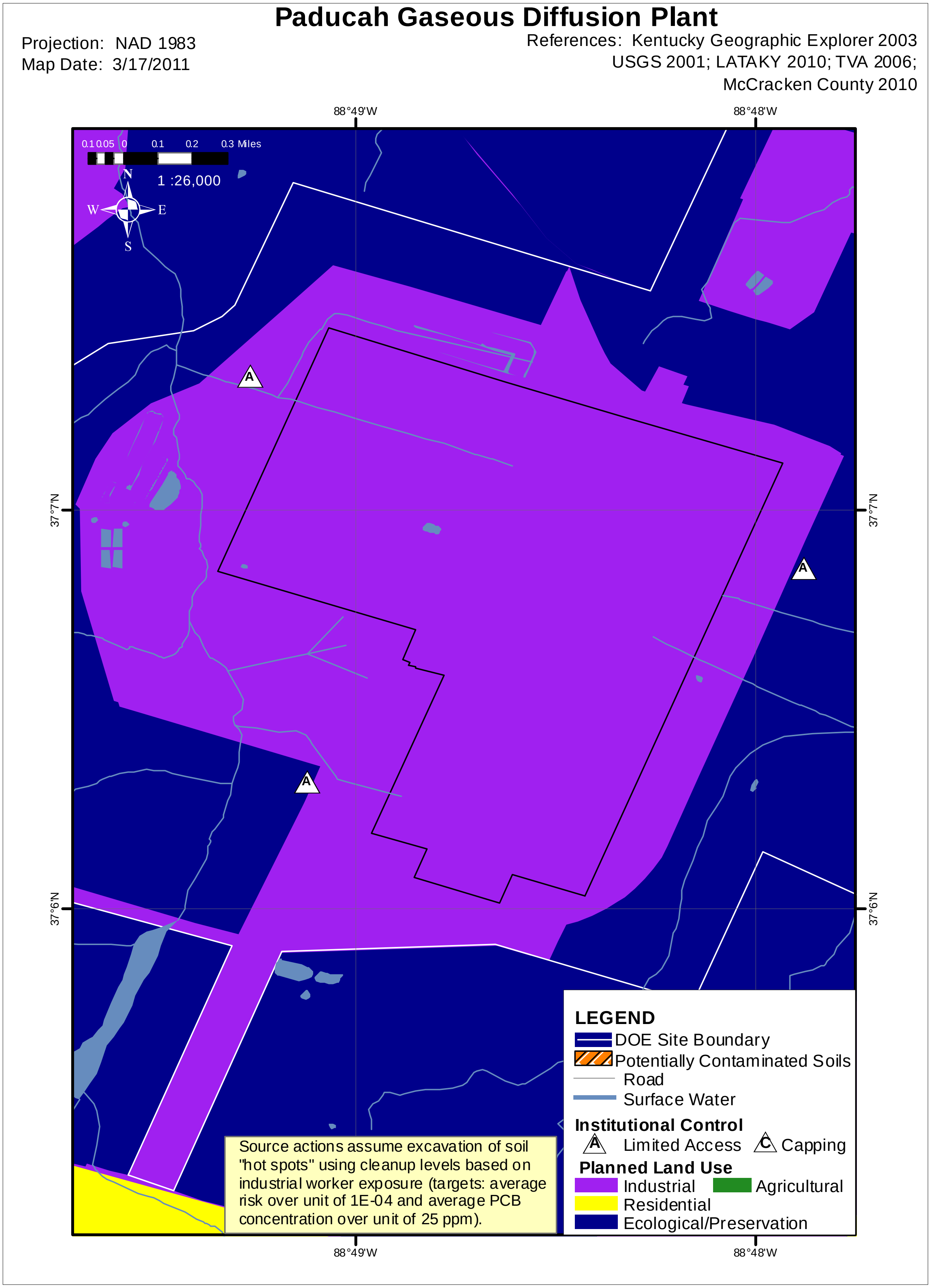
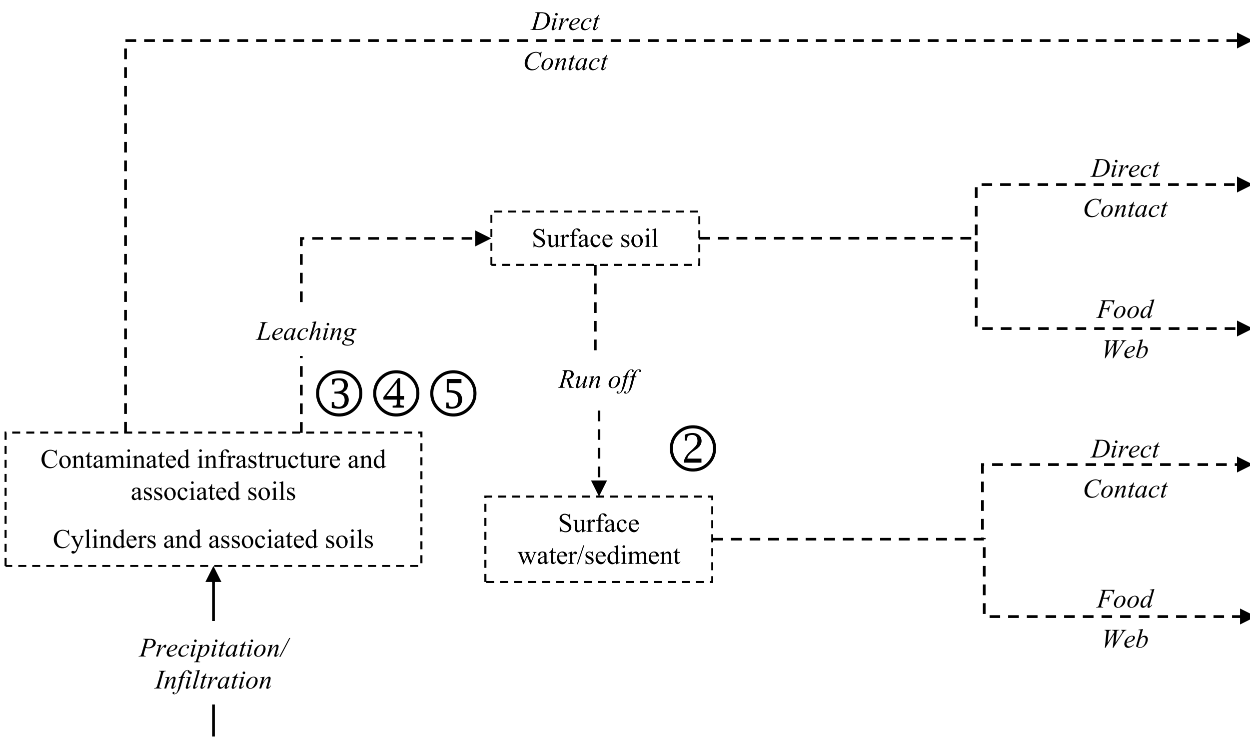


Figure 4.7b1. Hazard Area 7: Cylinder Yards and DUF_6 - Potential End State Alternative

Hazard Area 7 Cylinder Yards and DUF_6 Conversion Facility – End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I			R/F/D/I
R/H/D/I			R/F/D/I
		F	F
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

<u>RBES Controls and Actions</u>
② Attenuation.
③ Conversion of depleted UF_6 and disposal.
④ D&D of infrastructure.
⑤ Excavation of "hot spots" in surface soil (target based on average exposure over entire unit: worker risk of 1E-04, PCBs at 25 ppm).

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.7b2. Hazard Area 7: Cylinder Yards and DUF_6 Conversion Facility – End State

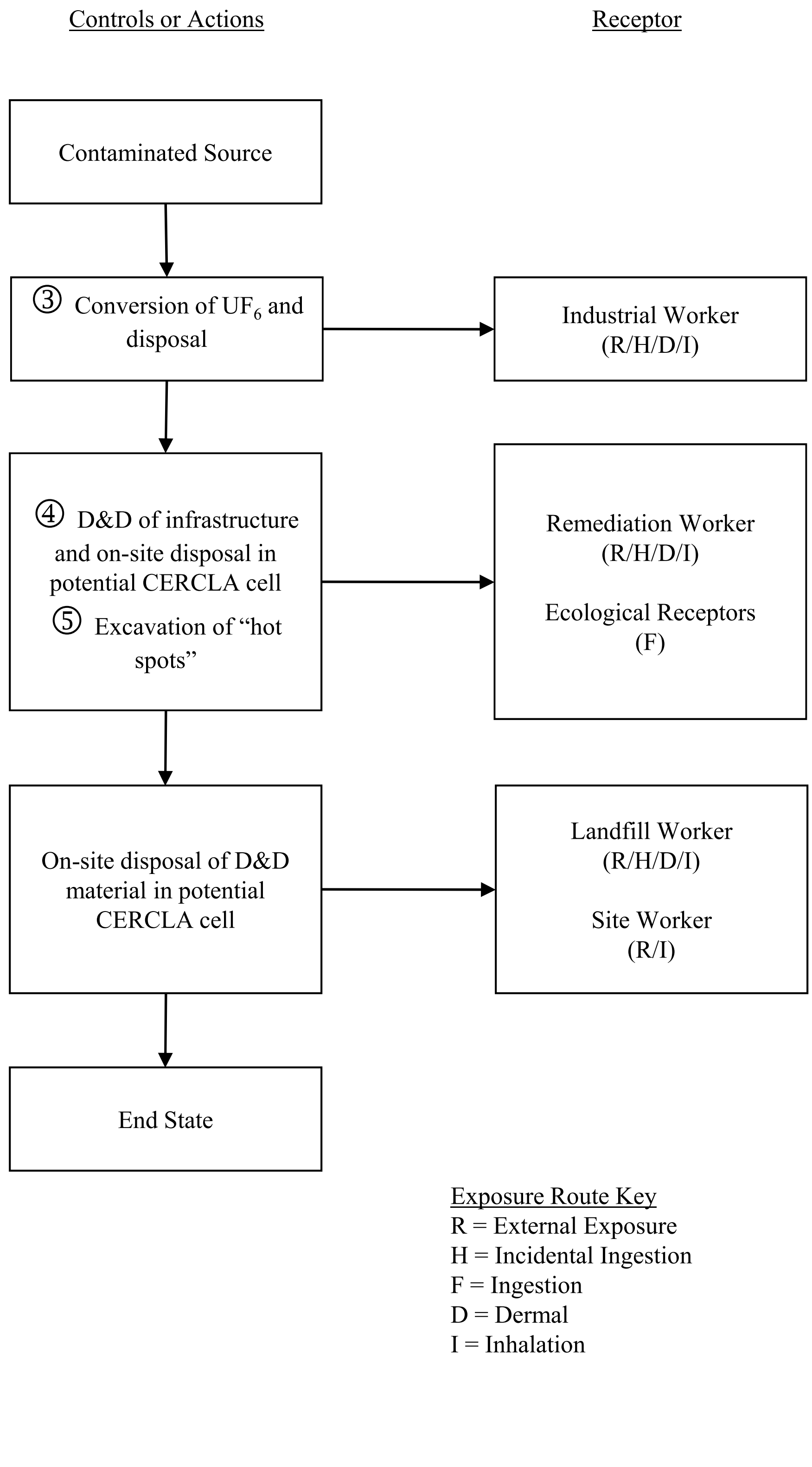


Figure 4.7b3. Hazard Area 7: Cylinder Yards and DUF_6 Conversion Facility Treatment Train – End State

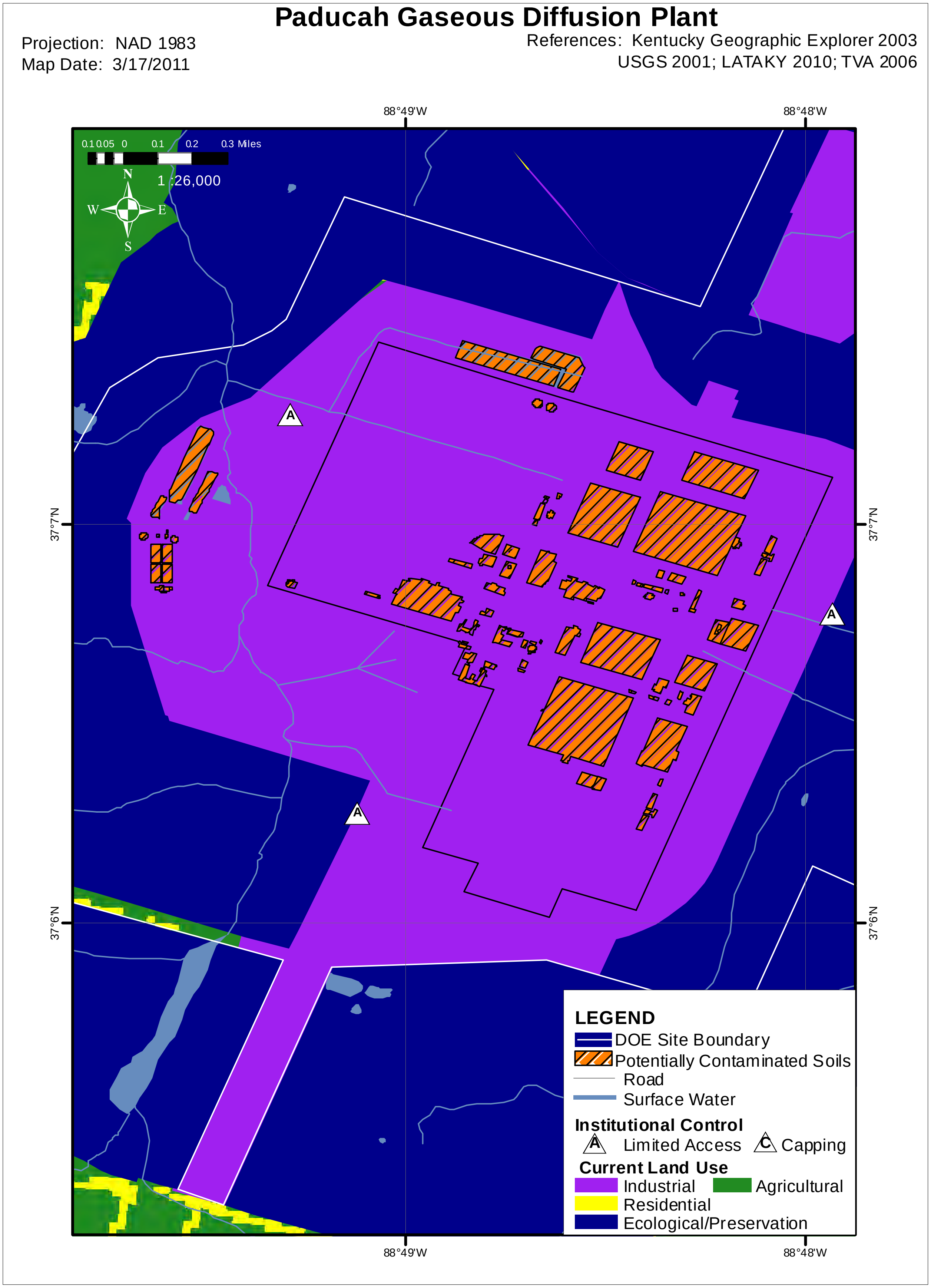
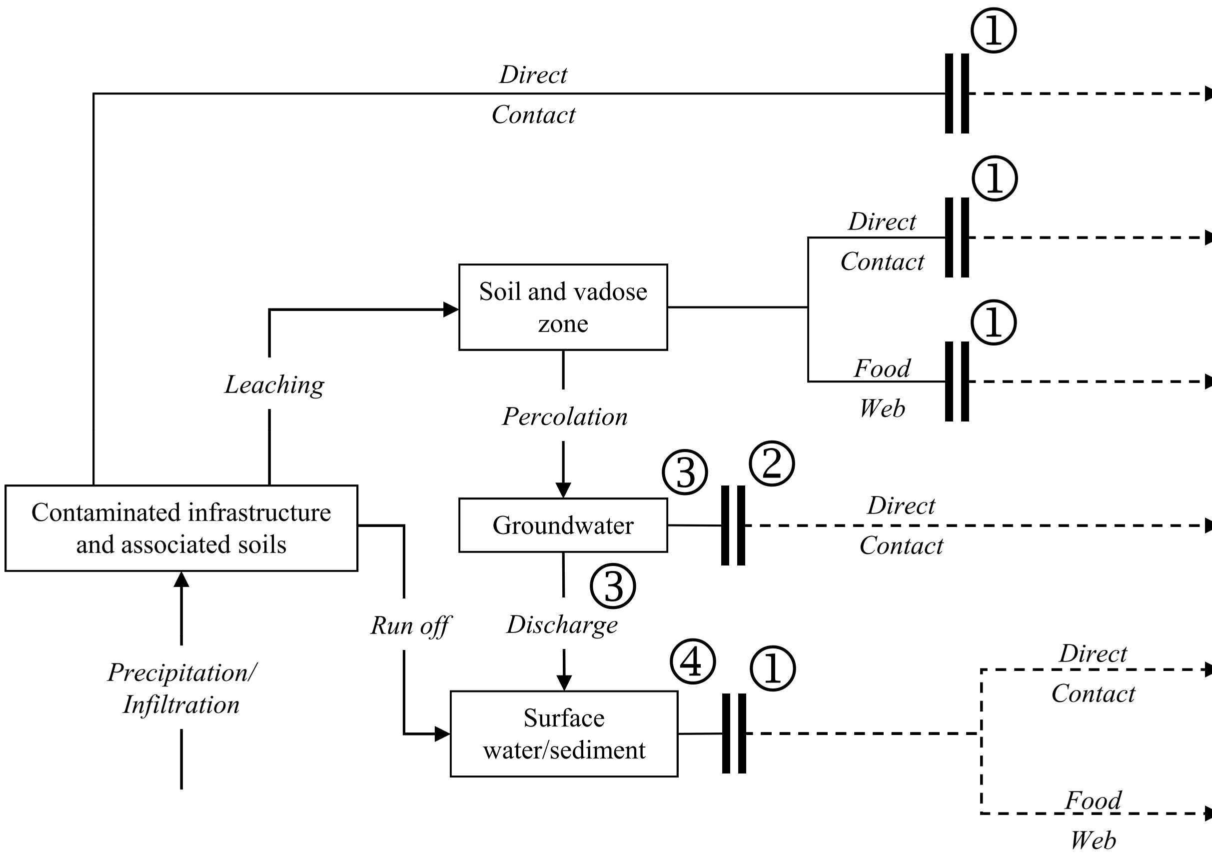


Figure 4.8a1. Hazard Area 8: GDP Facilties - Current State

Hazard Area 8 GDP Facilities – Current State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
	R/F/D/I		
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

<u>Current Controls and Actions</u>
① Access and excavation restrictions.
② PGDP Water Policy.
③ "Hot spot" pump and treat.
④ Natural attenuation.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.8a2. Hazard Area 8: GDP Facilities – Current State

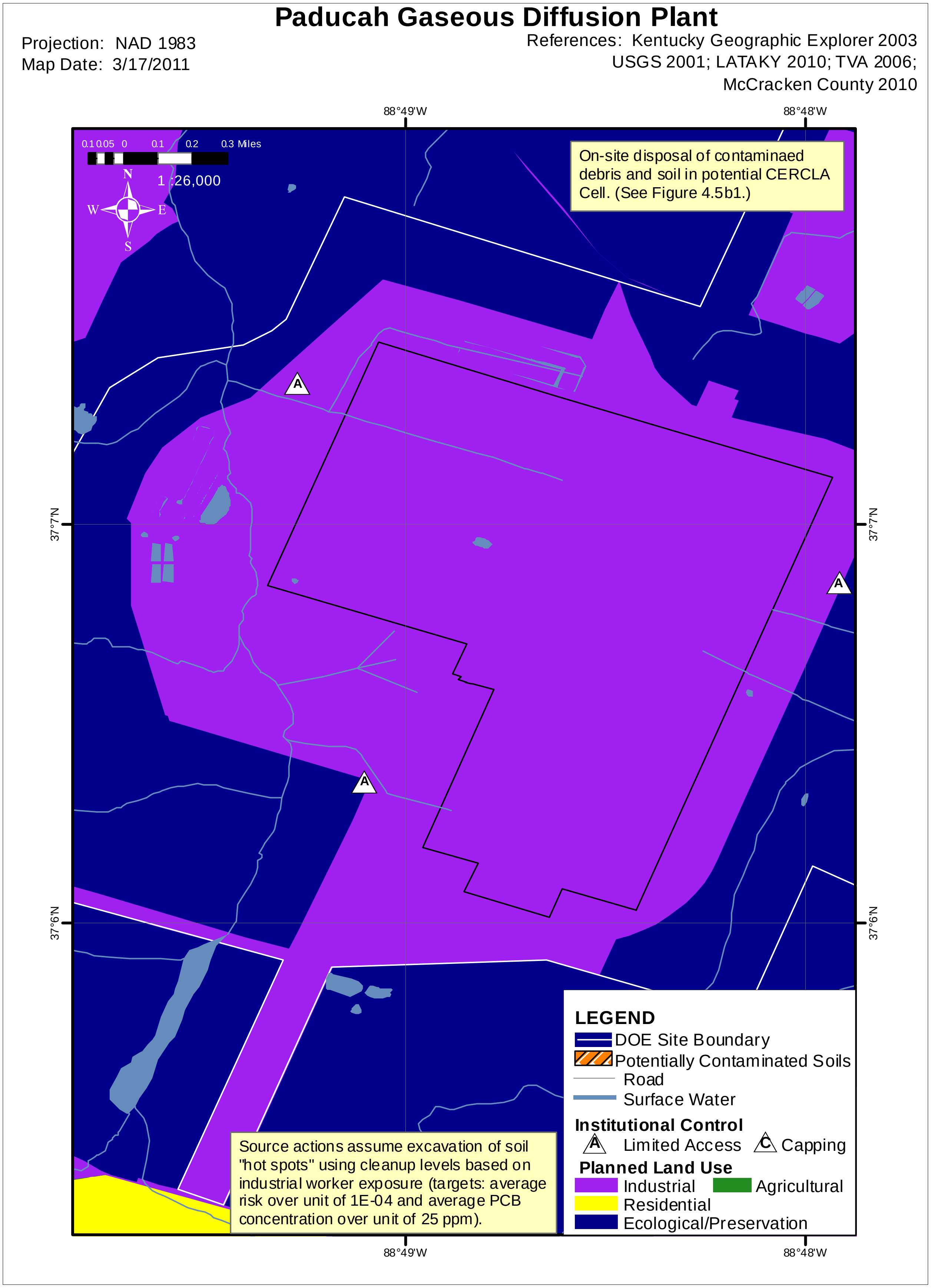
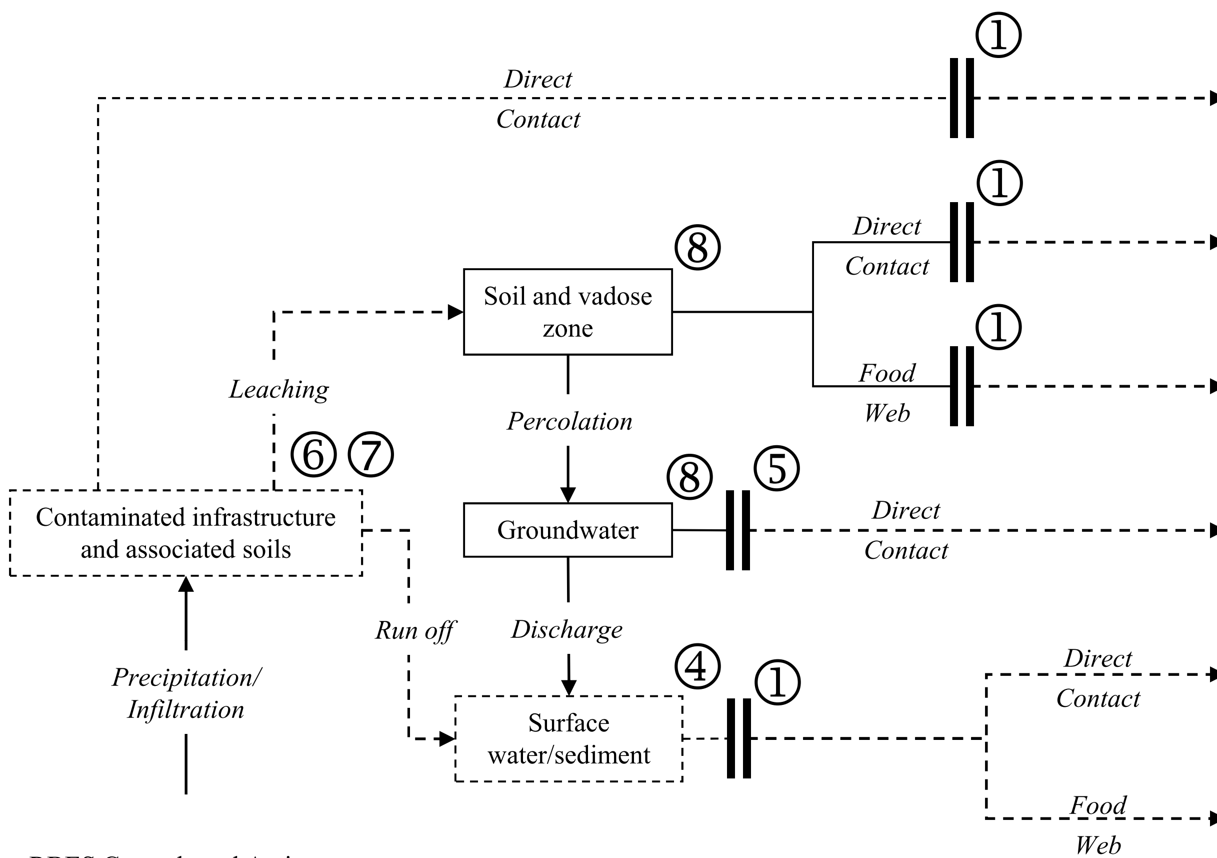


Figure 4.8b1. Hazard Area 8: GDP Facilties - Potential End State Alternative

Hazard Area 8 GDP Facilities – End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
	R/F/D/I		
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

RBES Controls and Actions
① Access and excavation restrictions.
④ Attenuation.
⑤ Enhanced institutional controls to limit access to and use of groundwater.
⑥ D&D of infrastructure and disposal in potential CERCLA Cell.
⑦ Excavation of soil “hot spots” (target based on average exposure over entire unit: worker risk of 1E-04, PCBs at 25 ppm).
⑧ Monitored natural attenuation of sources and plume.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 4.8b2. Hazard Area 8: GDP Facilities –End State

Hazard Area 8: GDP Facilities Treatment Train – End State

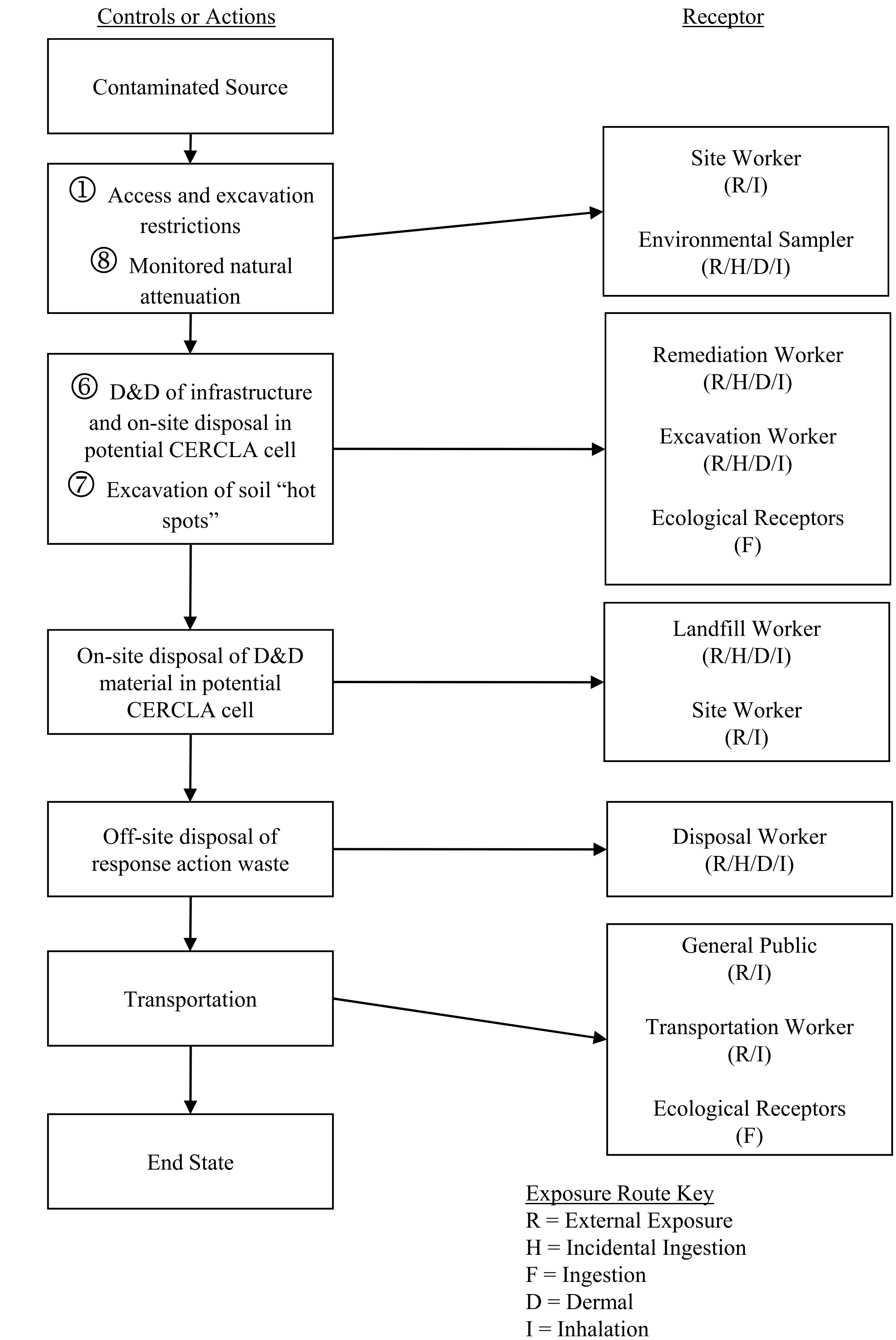


Figure 4.8b3. Hazard Area 8: GDP Facilities Treatment Train – End State

5. VARIANCE REPORT

This chapter contains discussions identifying and explaining the variances between the current planned end state and the potential end state alternative. To set the context for this discussion, maps, CSMs, and treatment trains for each of the hazard areas under the current planned end state are presented and discussed. Subsequently, variances are summarized by hazard area and over hazard areas. This summary includes a description of the variances; descriptions of impacts in terms of scope, cost, schedule, and risk (including risk balancing between the end states); challenges to achieving the potential end state alternative; and recommendations/next steps.

5.1 CURRENT PLANNED END STATE DESCRIPTIONS

This section presents the maps, CSMs, and treatment trains for each of the hazard areas under the current planned end state (see Figure 5.0c1). In addition, a short narrative is included for each of the hazard areas. This narrative includes the assumptions used to complete the current planned end state. This narrative includes the following information:

- Discussions of barriers and actions that eliminate those pathways under the current planned end state and

- Projected risk levels for affected receptors when the current planned end state is achieved.

For information on the areas and SWMUs included in each of the hazard areas, current pathways to the environment, and unmitigated risk levels, please see the information referenced in Chapter 4. As with the potential end state alternative descriptions presented in Chapter 4, risk estimates for the current planned end state are presented using qualitative statements that compare the risks at the current planned end state to those unmitigated and mitigated risks found under the current state.

5.1.1 Hazard Area 1—GWOU

This hazard area encompasses both the sources of contamination to groundwater and the dissolved-phase plumes. Sources considered are the C-400 Cleaning Building, located in the center of the industrialized area of PGDP; two burial grounds, located in the west-central portion of the industrialized area of PGDP; the C-720 Building, located in the southern part of PGDP; and an oil landfarm. **Please see Section 4.1.1 for a description of the sources and pathways of exposure under the current state.**

<u>Barriers and Actions</u>

Barriers to exposure at the current planned end state (see Figures 5.1c1 and 5.1c2) are continued access controls to prevent exposure to subsurface soil • and continuation of the PGDP Water Policy , , which provides an alternate water supply to residences affected by the dissolved-phase plumes. (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.) Source actions are planned under the current planned end state to reduce DNAPL concentrations in subsurface soil and the aquifer ˆ and to remove the potential DNAPL source at two burial grounds ˆ , if present. A plume action also is planned to reduce contaminant concentrations in the dissolved-phase plume‰. Natural attenuation „ will address discharges to surface water, and MNA will address residual contamination in source zones and groundwater after completion of the source actions † .

Under the current planned end state, potential receptors affected during implementation of the response actions (see Figure 5.1c3) are the environmental sampler, maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The environmental sampler could be exposed during sampling activities. The maintenance worker could be exposed while maintaining controls. The remediation worker and ecological receptors could be exposed during completion of source actions (anticipated to be a heating technology for subsurface soil, source zone pump-and-treat, and other supplemental techniques like chemical oxidation or surfactant flushing). The general site worker could be exposed during implementation of the source actions. The disposal worker could be exposed while accepting waste derived from the burial ground excavation and derived from implementing the source actions. The transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels using barriers to prevent exposure. In addition, source concentrations and plume concentrations would be reduced; however, preliminary modeling indicates that even after implementation of active technologies in source zones, contributions of solvents to groundwater would result in solvent concentrations in groundwater greater than MCLs (i.e., the assumed target cleanup level) for an extended period of time. Additionally, other groundwater contaminants (i.e., metals and radionuclides) would continue to be present in some areas at concentrations greater than their MCLs. Because contamination would continue to exist at levels above MCLs after the source actions, MNA would be required until MCLs for all contaminants are met.

5.1.2 Hazard Area 2—SWOU

This hazard area encompasses the sources of surface-water contamination found within the industrialized portion of PGDP; the plant ditches and outfalls found inside the industrialized portion of PGDP; the NSDD, a portion of which is located outside the industrialized portion of PGDP; and Bayou and Little Bayou Creeks, which are found outside the industrialized area and run both on and off DOE property. **Please see Section 4.2.1 for a description of the sources and pathways of exposure under the current state.**

Barriers and Actions

The barriers to exposure at the current planned end state (see Figures 5.2c1 and 5.2c2) are continued access controls to prevent exposure to source material • . Source actions are planned under the current planned end state to remove the sources of surface water contamination (i.e., sediments) „ . Finally, monitoring of effluents would continue to ensure that any future releases are identified quickly , .

Under the current planned end state, potential receptors during implementation of the response actions (see Figure 5.2c3) are the environmental sampler, maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The environmental sampler could be exposed during sampling activities. The maintenance worker could be exposed while maintaining controls. The remediation worker and ecological receptor could be exposed during completion of source actions. The general site worker also could be exposed during implementation of the source actions. The disposal worker could be exposed while accepting waste from excavation activities. The transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels due either to the presence of barriers that prevent exposure or to the removal of source material. The risk target for cleanup levels under the current planned end state at locations both inside and outside the industrialized area is a residential risk of 1E-06. The PCB concentration target in all areas is 1 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

5.1.3 Hazard Area 3—BGOU (Group 1)

This hazard area is composed of two areas included in the BGOU that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination, but for which the current planned end state and potential end state alternative differ. One of these areas is a burial ground located in the northwestern part of the industrialized area of PGDP. The other area is located in the north-central part of PGDP, outside of the industrialized area. **Please see Section 4.3.1 for a description of the sources and pathways of exposure under the current state.**

Barriers and Actions

The barriers to exposure at the current planned end state (see Figures 5.3c1 and 5.3c2) are continued access controls to prevent exposure to waste and soil • . Excavation and off-site disposal of waste and soil also are planned under the current planned end state ƒ .

Under the current planned end state, potential receptors during implementation of the response actions (see Figure 5.3c3) are the maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptor. The maintenance worker could be exposed during site maintenance activities performed as part of access controls. The remediation worker, general site worker, and ecological receptor could be exposed during the burial ground excavations. The disposal worker could be exposed while accepting waste, and the transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels due either to the barriers to prevent exposure or to the removal of waste and soil. Risk targets for cleanup levels during excavation have not been established at this time.

5.1.4 Hazard Area 4—SOU

This hazard area encompasses all areas containing contamination that do not impact the GWOU or SWOU. It includes all areas inside the industrialized portion of PGDP that are not part of other hazard areas, including those that are part of Hazard Area 8. **Please see Section 4.4.1 for a description of sources and pathways of exposure under the current state.**

Barriers and Actions

The barriers to exposure at the current planned end state (see Figures 5.4c1 and 5.4c2) are continued access controls to prevent exposure to waste and soil • . In addition, source actions to remove the waste and soil ƒ also are planned under the current planned end state.

Under the current planned end state, potential receptors during implementation of the response actions (see Figure 5.4c3) are the maintenance worker, remediation worker, general site worker, disposal worker, transportation worker, the public, and ecological receptors. The maintenance worker could be exposed during site maintenance activities performed as part of access controls. The remediation worker, general site worker, and ecological receptor could be exposed during the excavation of contaminated waste and soil. The disposal worker could be exposed while accepting waste, and the transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels due to the barriers to prevent exposure or removal of source material. The risk target for cleanup levels under the current planned end state is a residential risk of 1E-06. The PCB concentration target is 1 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

5.1.5 Hazard Area 5—Permitted Landfills

This hazard area is composed of two permitted, closed landfills, the currently operating permitted landfill, and, under future conditions, a potential CERCLA Cell that would be used to dispose of debris and other materials generated during GDP D&D. The two closed landfills and the operating landfills are located in the north-central portion of PGDP, outside the industrialized area. The site of the potential CERCLA Cell has not been determined at this time. **Please see Section 4.5.1 for a discussion of sources and pathways of exposure under the current state.**

Barriers and Actions

Barriers to exposure at the current planned end state match those currently in place. (See Figures 5.5c1 and 5.5c2.) These barriers are the current land cover • and access controls ‚ , which prevent exposure to waste and soil; continuation of the PGDP Water Policy „ , which provides an alternate water supply to any residences affected by contaminated groundwater; and the landfill cap and leachate collection system ƒ , which minimizes potential for contaminant migration. In addition, the landfills are monitored to ensure that these systems are working properly. (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.)

Under the current planned end state, potential receptors that are part of the treatment train (see Figure 5.5c3) are the maintenance worker and environmental sampler. The maintenance worker could be exposed while maintaining the access controls and landfill containment systems. The environmental sampler could be exposed during routine sampling activities.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels because barriers prevent exposure.

5.1.6 Hazard Area 6—BGOU (Group 2)

This hazard area is composed of four areas included in the BGOU that contain buried waste and/or soil that are not believed to serve as a source of groundwater contamination, but for which the current planned end state and potential end state alternative do not differ. These include a landfill located to the southwest of the industrialized portion of PGDP, adjacent to Bayou Creek, and three burial grounds located in the northwestern part of the industrialized area of PGDP. **Please see Section 4.6.1 for a description of sources and pathways of exposure under the current state.**

<u>Barriers and Actions</u>

Barriers to exposure at the current planned end state are depicted in Figure 5.6c1 and 5.6c2. These barriers are the current land cover • and access controls ‚ that prevent exposure to waste and subsurface soil; continuation of the PGDP Water Policy ƒ that provides an alternate water supply to any residences affected by contaminated groundwater; and the landfill cap „, which mitigates contaminant migration. (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.)

Under the current planned end state, potential receptors in the treatment train (see Figure 5.6c3) are the maintenance worker, remediation worker, environmental sampler, and ecological receptor. The maintenance worker could be exposed while maintaining the access controls and current cover. The remediation worker and ecological receptor could be exposed while installing the landfill cap. The environmental sampler could be exposed during routine sampling activities.

<u>Projected Risk Levels</u>

At the current planned end state, risks to all potential receptors would be at *de minimis* levels because barriers limit exposure or mitigate contaminant migration.

5.1.7 Hazard Area 7—Cylinder Yards and DUF_6 Conversion Facility

This hazard area is composed of the cylinder yards that contain DUF_6 and the operating facility being used to convert the DUF_6 to more stable uranium oxides before off-site shipment. The cylinder yards are located throughout the site, and the largest yard is in the southeast corner of the industrialized area of PGDP. **Please see Section 4.7.1 for a description of the sources and pathways of exposure under the current state.**

<u>Barriers and Actions</u>

At the current planned end state (see Figures 5.7c1 and 5.7c2), all sources of contamination are removed. The completion of the conversion mission ƒ includes off-site disposal of converted uranium; D&D of infrastructure, followed by on-site disposal „; and excavation of any contaminated soil…. In addition, any contamination in runoff is attenuated naturally by the time it reaches surface water ‚.

Under the current planned end state, potential receptors during implementation of the response actions (see Figure 5.7c3) are the industrial worker, remediation worker, landfill worker, general site worker, and ecological receptor. The industrial worker would be exposed while working in the conversion facility. The remediation worker, general site worker, and ecological receptor could be exposed during the D&D of the facility infrastructure and excavation of soil. The landfill worker and general site worker could be exposed while waste is transported to, and accepted at, the potential on-site CERCLA Cell.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels due to D&D of facility infrastructure, completion of the conversion mission, and excavation of any contaminated soils. The risk target for cleanup levels for soil under the current planned end state is a residential risk of 1E-06. The PCB concentration target is 1 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

5.1.8 Hazard Area 8—GDP Facilities

This hazard area is composed of the GDP facilities and infrastructure that will undergo D&D as part of either the D&D OU strategic initiative (see Chapter 1) or the final GDP D&D. This hazard area also encompasses any sources to groundwater and surface water not addressed in other hazard areas. **Please see Section 4.8.1 for a description of the sources and pathways of exposure under the current state. Additionally, please see Section 4.8.2 for a discussion of the range of options that may be considered when the GDP undergoes D&D.**

Barriers and Actions

Barriers to exposure at the current planned end state (see Figures 5.8c1 and 5.8c2) are continued access and excavation restrictions, which prevents exposure to contaminants in soil • and continuation of the PGDP Water Policy , , which provides an alternate water supply to affected residences. (Please see Section 4.1.1 for a discussion of the PGDP Water Policy.) Source actions are planned to meet the current planned end state. These source actions include D&D of infrastructure with disposal in a potential on-site CERCLA Cell †, excavation of soil with disposal in the potential CERCLA Cell‰, and treatment to reduce DNAPL concentrations in subsurface soil and the aquifer Š. Discharges to surface water are addressed through natural attenuation „ , and MNA will be used to address residual contamination in source zones and groundwater after completion of the source actions ˆ .

Under the current planned end state, receptors potentially exposed during implementation of the response actions (see Figure 5.8c3) are the general site worker, environmental sampler, remediation worker, landfill worker, ecological receptor; additionally, if off-site disposal is required, the transportation worker, disposal worker, and the public potentially could be exposed. (Off-site disposal of wastes derived from D&D of the C-340 and C-410/420 Buildings is possible if the D&D occurs before the potential CERCLA Cell is constructed and operating.) The general site worker and ecological receptor could be exposed during infrastructure D&D, excavation of soil, and disposal of waste. The environmental sampler could be exposed during sampling activities. The remediation worker could be exposed during completion of infrastructure D&D, soil excavation, and source actions to address groundwater contamination (anticipated to be a heating technology for subsurface soil and groundwater). The landfill and disposal workers could be exposed while accepting D&D waste, soil, and other waste derived when implementing the source actions for groundwater. Finally, the transportation worker, public, and ecological receptor could be exposed during transportation of waste to an off-site disposal location.

Projected Risk Levels

At the current planned end state, risks to all potential receptors would be at *de minimis* levels using barriers to prevent exposure. In addition, source concentrations and plume concentrations would be reduced; however, contamination above MCLs (i.e., the assumed target cleanup level) would remain in groundwater. Because contamination would continue to exist at levels above MCLs, MNA would be required. The risk target for cleanup levels for soil and building surfaces under the current planned end state is a residential risk of 1E-06. The PCB concentration target is 1 ppm. Attainment of the target risk will be determined using the average contaminant concentration (defined as the 95% upper confidence limit of the mean concentration) within the exposure unit. Similarly, the PCB concentration target will be the average concentration within the exposure unit.

5.2 VARIANCES BETWEEN CURRENT PLANNED END STATE AND POTENTIAL END STATE ALTERNATIVE

Risk Balancing

This section and its associated tables include discussions of risk balancing between the two end states for all hazard areas. These discussions include the identification of the differences in potential risks that could be posed to human and ecological receptors during the implementation of potential response actions and when each of the end states is achieved.

For example, at Hazard Area 3 (BGOU Group 1), the potential end state alternative is capping or covering with continued access and excavation restrictions, and the current planned end state is excavation with on- and off-site disposal of excavated material and continued access and excavation restrictions. Therefore, at the end states, the risks posed by the contamination to workers and the neighboring public would be identical (i.e., at *de minimis* levels) because the access and excavation restrictions prevent exposure to contaminated materials. The sustainability of the two end states does differ because excavation and on- and off-site disposal is a more permanent remedy for the waste in the burial grounds than capping, which would require continued maintenance in order to mitigate risk to receptors. Additionally, the unmitigated risk under the potential end state alternative to workers and the public would be greater than that under the current planned end state. This results because the potential end state alternative relies on maintenance of a cap/cover and access and excavation restrictions to prevent exposure to waste and residually contaminated media, while the current planned end state relies on the maintenance of access and excavation restrictions to prevent exposure to residually contaminated media only.

When considering the site in its entirety, with several burial areas scheduled to remain (including permitted/closed landfills), legacy management activities will be required for an extended period of time. Against this backdrop, there would be little incremental activity needed to sustain the access and excavation restrictions; this maintenance is within the routine legacy management mission of DOE.

Similarly, the risks posed to receptors during implementation of each end state's potential response actions can also be balanced. Under the potential end state alternative actions, the receptors potentially exposed are limited to the remediation workers installing the cap and the workers maintaining access controls. However, under the potential current planned end state actions, the receptors potentially exposed are the remediation worker, general site worker, and ecological receptor that could be exposed to waste during burial ground excavation; the maintenance worker that could be exposed while maintaining access controls, the disposal worker that could be exposed when accepting waste for disposal, and the transportation worker, public, and ecological receptors that could be exposed while transporting waste.

Therefore, cumulative risk over all receptors posed during implementation of response actions under the potential end state alternative would be less than that under the current planned end state. This is because no receptors are exposed to waste under the potential end state alternative, but several workers could be exposed to waste under the current planned end state.

This section presents tables identifying the variances between the current planned end state and the potential end state alternative. It begins with two tables that 1) compare the barriers and mechanisms and the risks (including risk balancing) under the two end states (Table 5.1) and 2) summarize the differences in the barriers and mechanisms under the two end states (Table 5.2). This section concludes with two large tables (Tables 5.3 and 5.4) that explore in greater detail the variances within and across hazard areas. These tables also include discussions of the scope, schedule, cost, and risk impacts of the variances; challenges related to the variance preventing the implementation of the potential end state alternative; and recommendations for addressing these challenges. (Note that in some cases cost and schedule information is not available. In these cases, the effect of the variance on cost and schedule is qualitatively estimated.)

The relative importance of the varying cleanup levels discussed in Tables 5.1 and 5.2 is illustrated in Figure 5.9 and 5.10. Figure 5.9 shows where PCBs have been sampled for, but have not been detected at concentrations greater than 1 ppm (grey dot); have been detected at a concentration greater than 1 ppm but less than 25 ppm (blue dot); and have been detected at a concentration greater than 25 ppm (red dot). Figure 5.10 shows where U-238 has been sampled for, but has not been detected at concentrations greater than 1.71 pCi/g (grey dot); has been detected at a concentration greater than 1.71 pCi/g, but less than 171 pCi/g (blue dot); and has been detected at a concentration greater than 171 pCi/g (red dot). (Note that 1.71 pCi/g and 171 pCi/g equate to cancer risk targets to an industrial worker of 1E-06 and 1E-04, respectively.) By comparing the size of the "blue dot" areas to the "red dot" areas in the figures, the areas that would require excavation under a 1 ppm PCB cleanup level or a 1E-06 target cancer risk are easily seen to be much greater than those that would require excavation under a 25 ppm PCB cleanup level or a 1E-04 target cancer risk. Similarly, the count of analyses performed and the number of results falling within each of the categories shown on the map also can be used to indicate the variance in potential excavation amounts. The figure has been updated to include recent data collected in support of the remediation program. These counts are as follows:

<u>PCBs</u>

Total analyses (equals sum of grey, blue and red dots) is 6,253.

PCBs < 1 ppm or not detected (equals number of grey dots) is 5,645 (90% of all samples).

PCBs ≥ 1 ppm (equals number of blue and red dots) is 608 (10% of all samples). PCBs ≥ 25 ppm (equals number of red dots) is 113 (1.8% of all samples).

<u>U-238</u>

Total analyses (equals sum of grey, blue and red dots) is 4,240.

U-238 < 1.71 pCi/g or not detected (equals number of grey dots) is 1,745 (41% of all samples).

U-238 ≥ 1.71 pCi/g (equals number of blue and red dots) is 2,495 (59% of all samples). U-238 ≥ 171 pCi/g (equals number of red dots) is 64 (1.5% of all samples).

Based upon these counts, it can be estimated that 6 times (10%/1.8%) as much soil would need to be excavated using a 1 ppm versus 25 ppm PCB target, and 39 times (59%/1.5%) as much soil would need to be excavated using 1E-06 cancer risk target versus a 1E-04 cancer risk target. Note, however, that these results are uncertain, because both PCB and U-238 sampling results are lacking for large portions of PGDP.

Table 5.1. Comparison by Hazard Area Between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative

Current Planned End State	Potential End State Alternative
Hazard Area 1: GWOU	
Access and excavation restrictions.	Same.
PGDP Water Policy.	Enhanced institutional controls.
Source treatment (i.e., resistance heating) at multiple sites with MNA.	Source treatment (i.e., resistance heating) at a single site with MNA.
Source removal (i.e., excavation) at burial grounds with MNA.	Cap/cover burial grounds with MNA.
Active contaminant reduction (e.g., oxidation) in the dissolved-phase plumes with MNA.	MNA.
Natural attenuation of contaminants discharged to surface water at seeps on Little Bayou Creek.	Same.

<u>Risk Balancing</u>

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to response actions and access restrictions.
  - ¾ Risks under the potential end state alternative would be lower than under the current planned end state because actions completed under enhanced institutional controls would be more likely to prevent groundwater use.
  - ¾ Ignoring controls on groundwater use, the residual risks from contaminant transport from solvent source areas would be lower under the current planned end state than under the potential end state alternative because a greater amount of solvents are removed.
  - ¾ Under the current planned end state, the monitoring period for solvents could be shorter because a greater amount of solvents is removed.
  - ¾ Under both the current planned end state and potential end state alternative, discharges to Little Bayou Creek would need to be monitored to ensure contaminant concentrations in seeps do not increase.
  - ¾ The sustainability of the potential end state alternative is greater because enhanced institutional controls would have greater permanence than the PGDP Water Policy.

- During implementation of potential response actions:
  - ¾ With source treatment and removal under the current planned end state, additional receptors (e.g., excavation, landfill, and transportation workers, the public, and ecological receptors) may be exposed during remediation, transportation, and waste disposal; therefore, remediation risks may be greater under the current planned end state than under the potential end state alternative.
  - ¾ Physical hazards to remediation workers would be greater during implementation under the current planned end state than under the potential end state alternative due to the installation of a greater number of treatment systems and greater use of reactive materials.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 2: SWOU	
Access and excavation restrictions.	Same.
Environmental monitoring with ecological risk assessment performed. Additional sitewide ecological risk assessment may be necessary to determine the risk to ecological receptors from potential operational releases that might have occurred between the initial watershed-specific ecological risk assessments and shutdown of the GDP.	Same.
Scrap removal.	Same.
In industrial areas, complete excavation of sediment and soil source areas; target risk based on residential risk of 1E-06, PCBs at 1 ppm.	In industrial areas, excavation of "hot spots" in soil and sediment; target risk based on worker risk of 1E-04, PCBs at 25 ppm.
In recreational areas, complete excavation of source areas; target risk based on residential risk of 1E-06, PCBs at 1 ppm.	In recreational areas, excavation of "hot spots" in soil and sediment; target risk based on recreational user risk of 1E-04, PCBs at 1 ppm.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to response actions and access restrictions.
  - ¾ Residual risks (ignoring access restrictions) due to direct contact after excavation of source areas would be less under the current planned end state than under the potential end state alternative due to the use of lower target cleanup levels; however, residual risks under both end states would be within or below EPA's risk range (EPA 1999). Additionally, the current planned end state cleanup targets based on residential use are inconsistent with the planned future uses.
  - ¾ Residual risks (ignoring access restrictions) due to contaminant migration would be the same under both end states because source areas are removed.
  - ¾ Sustainability of the response actions do not differ between end states.

- During implementation of potential response actions:
  - ¾ Remediation risks to remediation workers, general plant workers, landfill workers, transportation workers, the public, and ecological receptors would be greater under the current planned end state than under the potential end state alternative because the use of lower cleanup targets would result in a greater extent of excavation and a greater amount of waste to be transported and disposed of in approved landfills.
  - ¾ Physical hazards to remediation workers would be greater during implementation under the current planned end state than under the potential end state alternative due to the need to excavate and transport a greater amount of material.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 3: BGOU (Group 1)	
Access and excavation restrictions.	Same.
Excavate burial grounds.	Cap burial grounds.

<u>Risk Balancing</u>

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to access and excavation restrictions.
  - ¾ Ignoring access restriction, residual risks in on-site areas from direct contact with waste and contaminated media in burial grounds would be lower under the current planned end state than under the potential end state alternative because under the current planned end state waste would be removed from the burial grounds and disposed of in approved landfills.
  - ¾ Residual risk from migration of contaminants from burial grounds through the groundwater pathway could be lower under the current planned end state than under the potential end state alternative because waste material would be excavated and disposed of in a lined landfill at either an on-site or off-site location.
  - ¾ Excavation and disposal is a more sustainable response action than capping because maintenance of the cap would be required.

- During implementation of potential response actions:
  - ¾ Remediation risks to remediation workers, general plant workers, landfill workers, transportation workers, the public, and ecological receptors would be greater under the current planned end state than under the potential end state alternative because the chance of exposure to waste material and contaminated soils would greater when waste and soils are excavated, transported, and disposed of at an off-site location than when the waste and contaminated materials are capped.
  - ¾ Physical hazards to remediation workers would be greater under the current planned end state than under the potential end state alternative due to the need to excavate and transport waste material from burial grounds.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 4: SOU	
Access and excavation restrictions.	Same.
Complete excavation of soil source areas; target risk based on residential risk of 1E-06, PCBs at 1 ppm.	Excavation of "hot spots" in soil; target risk based on worker risk of 1E-04, PCBs at 25 ppm.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to response actions and access and excavation restrictions.
  - ¾ Residual risks after excavation of source areas without access restrictions would be less under the current planned end state than under the potential end state alternative due to the use of lower target cleanup levels; however, residual risks under both end states would be within or below EPA's risk range (EPA 1999). Additionally, the current planned end state cleanup targets based on residential use are inconsistent with the planned future uses.
  - ¾ The sustainability of the cleanup under the potential response actions does not differ between end states.
- During implementation of potential response actions:
  - ¾ Remediation risks to remediation workers, general plant workers, landfill workers, transportation workers, the public, and ecological receptors would be greater under the current planned end state than under the potential end state alternative because the use of lower cleanup targets would result in a greater extent of excavation and a greater amount of waste to dispose of in approved landfills.
  - ¾ Physical hazards to remediation workers would be greater during implementation under the current planned end state than under the potential end state alternative due to the need to excavate and transport a greater amount of material.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 5: Permitted Landfills	
Maintain current land cover.	Same.
Access and excavation restrictions.	Same.
Landfill cap and leachate collection system.	Same.
PGDP Water Policy.	Enhanced institutional controls.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to land cover, caps, and leachate collection system along with access restrictions.
  - ¾ If landfill fails, the risks under the potential end state alternative would be lower than under the current planned end state due to the actions completed under enhanced institutional controls, which are more likely to prevent groundwater use.
  - ¾ The sustainability of the potential end state alternative is greater because enhanced institutional controls would have greater permanence than the PGDP Water Policy.

- During implementation of potential response actions:
  - ¾ Risks to receptors during remediation do not differ.

Hazard Area 6: BGOU (Group 2)	
Maintain current land cover.	Same.
Access and excavation restrictions.	Same.
PGDP Water Policy.	Enhanced institutional controls.
Landfill cap.	Same.
Monitoring.	Same.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors would approach *de minimis* levels under both end states due to response actions and access and excavation restrictions.
  - ¾ Under both end states, monitoring would ensure that releases are detected early so that appropriate actions could be taken.
  - ¾ If contaminants do migrate from the burial grounds, the risks under the potential end state alternative would be lower than under the current planned end state due to the actions completed under enhanced institutional controls, which are more likely to prevent groundwater use.
  - ¾ The sustainability of the potential end state alternative is greater because enhanced institutional controls would have greater permanence that the PGDP Water Policy.

- During implementation of potential response actions:
  - ¾ Risks to receptors during remediation do not differ.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 7: Cylinder Yards and DUF_6 Conversion Facility	
Natural attenuation of runoff.	Same.
Conversion and disposal of UF_6.	Same.
D&D of infrastructure.	Same.
Excavation of soil source areas; target risk based on residential risk of 1E-06, PCBs at 1 ppm.	Excavation of "hot spots" in soil; target risk based on worker risk of 1E-04, PCBs at 25 ppm.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors would be at *de minimis* levels under both end states due to D&D and removal.
  - ¾ Residual risks after excavation of source areas would be lower under the current planned end state than under the potential end state alternative due to the use of lower target cleanup levels; however, residual risks under both end states would be within or below EPA's risk range (EPA 1999). Additionally, the current planned end state cleanup targets based on residential use are inconsistent with the planned future uses.
  - ¾ The sustainability of the cleanup under the potential response actions does not differ between end states.

- During implementation of potential response actions:
  - ¾ Remediation risks to remediation workers, general plant workers, landfill workers, transportation workers, the public, and ecological receptors would be greater under the current planned end state than under the potential end state alternative because the use of lower cleanup targets would result in a greater extent of excavation and a greater amount of waste to dispose of in approved landfills.
  - ¾ Physical hazards to remediation workers would be greater during implementation under the current planned end state than under the potential end state alternative due to the need to excavate and transport a greater amount of material.

Table 5.1. Comparison by Hazard Area between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternative (Continued)

Current Planned End State	Potential End State Alternative
Hazard Area 8: GDP Facilities	
Access and excavation restrictions.	Same.
PGDP Water Policy.	Enhanced institutional controls.
Natural attenuation of contaminants discharged to surface water at seeps on Little Bayou Creek.	Same.
D&D of infrastructure and disposal in potential on-site CERCLA Cell.	Same.
Excavation of soil source areas; target risk based on residential risk of 1E-06, PCBs at 1 ppm.	Excavation of "hot spots" in soil; target risk based on worker risk of 1E-04, PCBs at 25 ppm.
Source treatment with MNA.	MNA.
Active contaminant reduction (e.g., oxidation) in the dissolved-phase plumes with MNA.	MNA.

Risk Balancing

- When end state is achieved:
  - ¾ Risks to all receptors approach *de minimis* levels under both end states due to access restrictions and infrastructure removal.
  - ¾ Risks under the potential end state alternative would be lower than under the current planned end state because actions completed under enhanced institutional controls would be more likely to prevent groundwater use.
  - ¾ Under both the current planned end state and potential end state alternative, discharges to Little Bayou Creek would need to be monitored to ensure contaminant concentrations in seeps do not increase.
  - ¾ Ignoring controls on groundwater use, the residual risks from contaminant transport from solvent source areas would be lower under the current planned end state than under the potential end state alternative because a greater amount of solvents are removed.
  - ¾ Under the current planned end state, the monitoring period for solvents could be shorter because a greater amount of solvents is removed.
  - ¾ Residual risks (ignoring access restrictions) after excavation of source areas would be less under the current planned end state than under the potential end state alternative due to the use of lower target cleanup levels; however, residual risks under both end states would be within or below EPA's risk range (EPA 1999). Additionally, the current planned end state cleanup targets based on residential use are inconsistent with the planned future uses.
  - ¾ The sustainability of the potential end state alternative is greater because enhanced institutional controls would have greater permanence that the PGDP Water Policy.

- During implementation of potential response actions:
  - ¾ For groundwater, with source treatment and removal under the current planned end state, additional receptors (e.g., excavation, landfill, and transportation workers; the public; and ecological receptors) may be exposed during remediation and waste disposal; therefore, remediation risk may be greater under the current planned end state than under the potential end state alternative.
  - ¾ Use of lower target cleanup levels under the current planned end state would result in a greater extent of excavation and a greater amount of waste, resulting in higher remediation risks to workers and the public and greater impacts on ecological receptors than under the potential end state alternative; however, this variance is likely to be minimal because the soil would be only a small portion of the waste generated during D&D.
  - ¾ Physical hazards to remediation workers would be greater during implementation under the current planned end state than under the potential end state alternative due to 1) installation of a greater number of treatment systems and greater use of reactive materials and 2) need to excavate and transport a greater amount of material.

Table 5.2. Comparison Between Barriers and Mechanisms Used for the Current Planned End State and Potential End State Alternatives

Current Planned End State Actions	Potential End State Alternative Actions
Continued access and institutional controls (e.g., capping, controls on groundwater use).	Same.
Response actions at multiple locations to reduce the concentration of TCE and other solvents in subsurface areas that act as sources of groundwater contamination, and natural attenuation.	Response action at a single location to reduce the concentration of TCE and other solvents in subsurface at the location and monitored natural attenuation, with continued access and institutional controls.
Response actions to reduce TCE concentrations in the dissolved-phase plumes, and natural attenuation.	MNA of sources of the dissolved-phase plumes, with continued access and institutional controls.
MNA of sources of groundwater contamination and the dissolved-phase plumes following completion of response action to reduce TCE concentrations.	MNA of sources of groundwater contamination and the dissolved-phase plumes with continued access and institutional controls following completion of source action at one location.
Natural attenuation to reduce TCE concentrations in groundwater discharged to surface water.	Same.
Excavation and on- and off-site disposal of surface and subsurface soil and sediment to attain a target risk of 1E-06 for hypothetical residents and an average PCB concentration of 1 ppm within exposure units in industrial and recreational areas.	Excavation and on- and off-site disposal of contaminated surface soil and sediment to attain a target risk of 1E-04 to receptors consistent with current and future land use (i.e., industrial or recreational as appropriate) and an average PCB concentrations within exposure units of 25 ppm in industrial areas and 1 ppm in recreational areas.
Excavation and on- and off-site disposal of wastes from burial grounds.	Capping of burial grounds.
Characterization and on- and off-site disposal of legacy waste.	Same.
On- and off-site disposal of debris from D&D of facilities and infrastructure.	Same.

Table 5.3. Variance Report by Hazard Area

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
Hazard Area 1: GWOU				
V-1.1	**Current Planned End State:** Continuation of PGDP Water Policy **Alternative:** Enhanced institutional controls	Scope: The current planned end state includes continuation of the current PGDP Water Policy.[a] The potential end state alternative includes enhanced institutional controls,[b] which would supercede the current PGDP Water Policy. Under both end states, the goal would be to reduce risks to residents from exposure to groundwater to *de minimis* levels.[c]	Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.
		Cost: The cost variance has not been determined to date. The cost of water currently provided under the PGDP Water Policy ranges from $70,000 to $100,000 per year. Depending upon the specific enhanced institutional controls, the cost variance of the enhanced institutional controls could include some cost avoidance (if the PGDP Water Policy is replaced). Additionally, there could be some cost avoidance under other actions as well as discussed elsewhere in this variance report (e.g., excavation of burial grounds versus capping). The implementation of enhanced institutional controls would include costs for acquisition of rights to restrict groundwater use and continued monitoring to ensure continued long-term effectiveness of the enhanced institutional controls. Schedule: The PGDP Water Policy currently is in place. Implementation of the enhanced institutional controls would be a future planned CERCLA response action.	The regulatory position is that the current fence line (located well inside the property boundary) should be used as the point of exposure for determining compliance with MCLs. The regulatory position also insists that MCLs should be attained throughout the groundwater plume.	Initiate further discussion with regulators · to discuss willingness to consider enhanced institutional controls in conjunction with MNA in lieu of certain source and plume actions and · to discuss willingness to consider establishing points of compliance and exposure at the property boundary.
		Risk: The expected risk variance is zero under both the PGDP Water Policy and enhanced institutional controls because each would prevent exposure to contaminated groundwater, resulting in no risk. Enhanced institutional controls, however, would be more sustainable and, therefore, would result in greater long-term effectiveness because they would involve legally enforceable property restrictions and deed notices. (The agreements with landowners under the PGDP Water Policy do not restrict groundwater use, but only commit DOE to provide municipal water to replace the groundwater in return for the property owner's commitment not to use the groundwater. Thus, current or future property-owners could return to using groundwater in the home, completing this exposure pathway, and potentially raising risk from *de minimis* levels.[c])	DOE policy may limit options available under the enhanced institutional controls.	Revisit DOE policy concerning acquisition of property rights (including deed notices and permanent groundwater use restrictions).

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
V-1.2	**Current Planned End State:** Treatment to attain source reduction at multiple sites plus MNA(with either PGDP Water Policy or enhanced institutional controls; see V-1.1).	Scope: The current planned end state assumes implementation of DNAPL source reduction actions at multiple sites using *in situ* heating technologies or equivalent in combination with MNA with a point of exposure established at the PGDP fence line. The potential end state alternative includes a source reduction action using this technology at one location (i.e., C-400, which is believed to be the primary source of solvent contamination at PGDP) in combination with MNA with a point of exposure established at the DOE property boundary or at a downgradient location in accordance with the requirements of CERCLA.	Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.
	Alternative: Treatment to attain source reduction at one site plus MNA(with either PGDP Water Policy or enhanced institutional controls; see V-1.1) and a point of compliance at the DOE property boundary, in accordance with CERCLA requirements.	Cost: The combined cost of implementing *in situ* heating technology at the DNAPL source areas (i.e., C-400, C-720, and oil landfarm) is estimated to range from \$75,000,000 to \$140,000,000. The cost of implementing at the C-400 only is approximately \$75,000,000. The cost per year for MNA essentially would be the same under both the current planned end state and potential end state alternative; however, the duration of the monitoring/attenuation period could differ between the current planned end state (hundreds of years) and the potential end state alternative (potentially thousands of years). Schedule: Under the current planned end state, the construction and performance of the currently planned source actions would be completed by 2013, with associated monitoring/attenuation potentially continuing for hundreds of years. Under the potential end state alternative, the construction and performance of the currently planned source action would be implemented by 2010 (the current SMP milestone for the Remedial Action Completion Report is 2013), with associated monitoring/attenuation potentially continuing for thousands of years. Under both end states additional investigations to identify other source areas, if any, will be performed as part of the SOU and GDP D&D.	The regulators' position is that MNA would need to be supplemented by source actions at multiple locations to reduce contaminant concentrations to MCLs in a "reasonable" time frame; however, even with substantial source reduction, it would take hundreds of years to reach MCLs for the contaminants addressed (i.e., solvents), and contamination not addressed by the action (i.e., metals and radionuclides) would remain above MCLs, as well. (With source reduction at only one area, the monitoring period potentially could be thousands of years.)	Complete technical investigations at remaining sources and reach agreement with regulators on potential for contaminant migration.
		Risk: The only variance in risk between the current planned end state and the potential end state alternative is the amount of time necessary to achieve MCLs. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from off-site migration of DNAPL under both end states; however, the current planned end state could reduce the amount of time necessary to meet MCLs, thereby shortening the time period that the PGDP Water Policy or enhanced institutional controls would have to remain in effect. Implementation of *in situ* heating technology at multiple sites under the current planned end state could result in exposures of remediation workers to contaminated soil and	Despite national performance data indicating that no technologies currently exist that can reduce DNAPLs in source areas to MCLs within a "reasonable" period, the	Initiate discussion with regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the national performance data, and (2) determine what would be

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		groundwater and, potentially, gases, as well as physical hazards. Implementation of the source action could pose a risk of exposure to gases to general plant workers. Workers involved in disposal of materials contaminated during implementation of the source action also could be exposed. Finally, samplers involved in groundwater monitoring activities could be exposed. Except for risks to samplers, the magnitude of these risks has not been estimated at this time. Risks to remediation workers, general plant workers, and workers involved in disposal of materials contaminated during implementation of the *in situ* heating technology under the potential end state alternative would be less because only a single location would be addressed. Risks to samplers involved in groundwater monitoring activities under the potential end state alternative would be similar to those under the current planned end state; however, an assessment of these risks under current sampling protocols determined that risks to samplers are at *de minimis* levels.[c]	regulators' position is that TI waivers would be available only after a demonstrated, site-specific technology failure. DOE's position is that the current fence line (located well inside the property boundary) should be used as the point of exposure for determining compliance with MCLs. We recognize that the regulators' position is that the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	required to decide whether TI waiver should apply Initiate further discussion with regulators to determine willingness to consider recognizing the lack of a completed exposure pathway until such time as the MCLs can be obtained in a given area.
V-1.3	**Current Planned End State:** Excavation to remove suspected sources of groundwater contamination at burial grounds **Alternative:** Capping or covering and MNA(with either PGDP Water Policy or enhanced institutional controls; see V-1.1)	<u>Scope</u>: The current planned end state assumes the investigation and subsequent complete excavation of three burial grounds (C-749 Uranium Burial Ground, C-404 Low-level Radioactive Waste Burial Ground, and C-747 Contaminated Burial Yard) suspected to be sources of groundwater contamination, subsequent off-site disposal of excavated materials, and monitoring to determine the effectiveness of source removal. The potential end state alternative assumes the investigation and subsequent capping/covering and monitoring for these burial grounds. <u>Cost</u>: The variance between the combined cost of excavating the three burial grounds, off-site disposal of excavated material, and monitoring under the current planned end state and compared to the combined cost for capping and monitoring under the potential end state alternative is estimated to range to more than $450,000,000. <u>Schedule</u>: The source action under the current planned end state would be completed by 2030. Capping/covering under the potential end state alternative would be complete by 2019. Monitoring would follow both actions.	It is the regulators' position that capping, access controls, and/or enhanced institutional controls are inadequate to achieve long-term protectiveness for *in situ* management of contamination at burial grounds; therefore, their preference is to remove the burial grounds to prevent them from serving as long-term sources of groundwater contamination. Our position is that these controls are sufficient to establish a protective condition and the maintenance of this protectiveness is the only issue. DOE is required to	Complete technical investigations at remaining sources and reach agreement with regulators on potential for contaminant migration.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		Risk: The only potential risks posed by these burial grounds under current conditions are from possible migration of contaminants through groundwater to off-site residents and from direct contact at the burial ground by on-site industrial workers. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from contaminant migration under both end states, and current access controls mitigate risk from direct contact by on-site industrial workers. Excavation of the burial grounds under the current planned end state would remove the suspected source term, thereby reducing the amount of time taken to meet MCLs and shortening any monitoring period and the need for access controls. Capping of the burial grounds under the potential end state alternative would limit potential contact to the burial grounds and reduce possible migration of contamination to groundwater, but would require long-term monitoring and access controls. Off-site risks from contaminant migration would be controlled using enhanced institutional controls (see V-1.1). Excavation of the burial grounds would result in substantial risks to remediation workers through direct contact with wastes. (Note that one of the burial grounds to be excavated under the current planned end state contains pyrophoric uranium [i.e., uranium that spontaneously burns when exposed to air], which would pose significant inhalation risk and physical hazard to remediation workers.) Additionally, general site workers could be put at risk from exposure through inhalation of resuspended dust and vapors during excavation. Potential risks to the public and ecological receptors also would be increased during transportation of waste to the off-site disposal location. Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time. Capping of the burial grounds under the potential end state alternative would result in potential risks to remediation workers through direct contact with surface soil at the burial grounds, but not through direct contact with waste. Samplers involved in monitoring activities also could be at risk of exposure. The magnitude of these risks has not been estimated at this time. Note that risks to remediation and general site workers would be smaller under the potential end state alternative than under the current planned end state because, under the potential end state alternative, waste would not be dug up and moved,	maintain protectiveness through its legacy management mission. Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		and the duration of the activity would be shorter.		
V-1.4	**Current Planned End State:** Treatment to reduce contaminant concentrations in the dissolved-phase plume. **Alternative:** MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1.1) and a point of compliance at the DOE property boundary, in accordance with CERCLA requirements.	Scope: The current planned end state assumes implementation of oxidation technologies to remove TCE and other solvents from the dissolved-phase plumes followed by MNA. The potential end state alternative does not assume actions for the dissolved-phase plume and consists solely of MNA. Cost: The cost for implementing oxidation technologies in the dissolved-phase plumes has not been determined. The cost per year for MNA essentially would be the same under both the current planned end state and potential end state alternative; however, the duration of the monitoring/attenuation period could differ between the current planned end state (hundreds of years) and the potential end state alternative (potentially thousands of years). Schedule: Under the current planned end state, the construction and performance of the plume actions would be implemented by 2019 with associated monitoring/attenuation potentially continuing for decades. Additionally, any actions to address the dissolved-phase plumes under the current planned end state would need to follow source actions to be cost-effective. (See V-1.2 and V-1.3). Under the potential end state alternative, no additional construction beyond installation of additional monitoring wells would be required; however, monitoring/attenuation potentially could continue for thousands of years.	The regulators' position is that MNA would need to be supplemented by source actions at multiple locations to reduce contaminant concentrations to MCLs in a "reasonable" time frame ; however, even with source reduction, it would take hundreds of years to reach MCLs for the contamination addressed (i.e., sediments), and contaminants not addressed by the action (i.e., metals and radionuclides) would remain above MCLs, as well. (With source reduction at only one area, the monitoring period potentially could be thousands of years.)	Complete technical investigations of plume migration and attenuation and reach agreement with regulators on these issues.
		Risk: The only variance in risk between the current planned end state and the potential end state alternative is the amount of time necessary to achieve MCLs. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from TCE and other solvents in the dissolved-phase plumes under both end states. The current planned end state could reduce the length of time that the PGDP Water Policy or enhanced institutional controls would have to remain in effect depending on the extent and effectiveness of plume treatment. Note, however, that the oxidation technologies would not address other potential contaminants found in groundwater in on-site areas at PGDP (i.e., metals and radionuclides).	Despite national performance data indicating that no technologies currently exist that can reduce TCE and solvent concentrations in large plumes to MCLs within a reasonable time frame, the regulators' position is that TI waivers would be available only after a demonstrated, site-specific technology failure.	Initiate discussion with regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the national performance data, and (2) determine what would be required to decide whether TI waiver should apply
		Implementation of oxidation technologies would result in exposures of remediation workers to contaminated groundwater, as well as physical hazards. Workers involved in disposal of materials contaminated during implementation of	The regulators' position is that the goal for groundwater	Initiate further discussion with regulators to determine

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		the action also could be exposed. Finally, samplers involved in groundwater monitoring activities also could be exposed. Except for risks to samplers, the magnitude of these risks has not been estimated at this time. Risks under the potential end state alternative are limited to samplers involved in groundwater monitoring activities. An assessment of these risks under current sampling protocols determined that risks to samplers are at *de minimis* levels.[c]	restoration is to achieve MCLs at all locations in the plume. Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain.	willingness to consider establishing points of compliance and exposure at property boundary. Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.
V-1.5	**Current Planned End State:** Actions to reduce solvent concentrations in groundwater discharged to surface water or control these discharges **Alternative:** Continued monitoring of surface water concentrations at discharge point	Scope: The current planned end state assumes implementation of measures to reduce the solvent concentrations in the groundwater discharged to Little Bayou Creek and/or measures to control these discharges followed by monitoring. The potential end state alternative assumes continued monitoring. Cost: The cost of measures to reduce concentration in discharges and/or control discharges under the current planned end state has not been determined. Monitoring costs per year essentially would be the same under both the current planned end state and the potential end state alternative. Schedule: A schedule for implementation of the current planned end state actions is not available; however, the duration of monitoring under both the end states would be similar unless source and plume actions are taken. (See V-1.2, V-1.3, and V-1.4.) Risk: Screening human health and ecological risk assessments have determined that risks at the discharge point are at *de minimis* levels[c] for recreational user and ecological receptors. Modeling has indicated that contaminant concentrations could increase in the future, but these results, and estimates of risks derived using them, are uncertain. A baseline risk assessment has not been completed. Implementation of a technology to attenuate or control discharges would result in increased risks to remediation workers. Additionally, damage to the environment at the discharge point during implementation could lead to increased ecological risks. Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time.	Regulatory position is that releases at the seeps present unacceptable risks to human health and the environment. Commonwealth of Kentucky regulators' position has been that Kentucky policy requires cleanup actions to either attain an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level.	Complete technical investigations for impacts of releases and reach agreement with regulators concerning risks posed to human health and the environment. Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future use at the area in question and · to gain agreement that cleanup standards for proposed action will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999).

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		Risks under the potential end state alternative are limited to samplers involved in monitoring activities. The magnitude of these risks has not been estimated at this time.		
Hazard Area 2: SWOU				
V-2.1	**Current Planned End State:** Excavation of source sediments and soils **Alternative:** Excavation of sediments and soils "hot spots"	Scope: The current planned end state assumes excavation of contaminated source sediments and soils to levels that achieve a target risk of 1E-06 under a residential scenario and a PCB concentration of 1 ppm. The potential end state alternative assumes excavations of "hot spots" in sediment and soil using a target risk and PCB future land use of areas currently in the industrialized areas of PGDP is industrial and that the future use of areas currently outside of the industrialized areas but on DOE property is recreational.) Under the potential end state alternative, therefore, the action in recreational areas would achieve a target risk of 1E-04 to a recreational user and a PCB concentration of 1 ppm. Cost: Based on existing PCB and U-238 sampling results, approximately 7 to 17 times as much soil and sediment would be required to be removed under the current planned end state cleanup target than under the potential end state alternative cleanup target, resulting in a cost variance of proportional size. Because many areas have not been fully characterized, there is a high degree of uncertainty in this estimate. Schedule: The investigation and removal of "hot spots" of the SWOU (On-Site) is complete. The investigation of the remainder of the SWOU is ongoing. The completion dates under the current planned end state and potential end state alternative is 2017. Risk: Under the current state, the only potential risks posed by sediment and soils to humans are from direct contact by industrial workers and recreational users with these media. However, these risks currently are mitigated through institutional and access controls that limit exposure. Ecological receptors could be at risk in some industrial and nonindustrial areas; however, a baseline ecological risk assessment confirming this has not been completed. Potential risk in all areas under the current planned end state would be reduced to E-06 using a residential scenario in industrial and recreational areas. Additionally, protection of ecological receptors would be demonstrated by an ecological risk assessment. Potential risk under the potential end state alternative would be reduced to a value falling within EPA's acceptable risk range for site-related	Commonwealth of Kentucky regulators' position is that Kentucky policy requires cleanup actions either to attain an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level. Commonwealth of Kentucky regulators' position is that Kentucky policy requires that cleanup of PCBs in soils and sediments located in industrial areas must attain 1 ppm (as opposed to federal TSCA regulations allowing ≤ 25 ppm for "low occupancy areas" [e.g., industrial areas] ≤1 ppm for "high occupancy areas" [e.g., residential areas], and >1 ppm to ≤ 10 ppm for "high occupancy areas" if covered by a cap with institutional controls).	Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for area in question; · to gain agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999); and · to seek agreement that national TSCA PCB cleanup standards for low occupancy (e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA PCB cleanup standards for high occupancy (e.g., residential) areas (1 ppm) should be adopted for recreational areas.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		exposures (i.e., E-06 to E-04) using a worker scenario for industrial areas and a recreational user scenario in recreational areas (EPA 1999). Additionally, protection of ecological receptors would be demonstrated by an ecological risk assessment. Risks during excavation and disposal under both the current planned end state and potential end state alternative would affect remediation workers, general site workers, transportation workers (on- and off-site disposal anticipated), landfill workers, the public, and ecological receptors. The magnitude of these risks under the current planned end state and potential end state alternative have not been assessed at this time; however, because a greater amount of material would be excavated under the current planned end state than under the potential end state alternative, risks to all receptors would be expected to be greater under the current planned end state than under the potential end state alternative.		
Hazard Area 3: BGOU (Group 1)				
V-3.1	**Current Planned End State:** Excavation of burial grounds **Alternative:** Capping of burial grounds with access controls	<u>Scope</u>: Under the current planned end state, certain burial grounds are to be excavated and materials disposed of in on- and off-site locations. Under the potential end state alternative, these burial grounds are capped to limit exposure, and the caps are maintained, including monitoring. For both end states, the goal of the action is to reduce risk to workers by eliminating or limiting exposure to contamination associated with the burial grounds. <u>Cost</u>: The variance between the cost of excavating the burial grounds and disposing of the materials under the current planned end state versus capping and monitoring the burial grounds under the potential end state alternative is estimated to range from $185,000,000 to $1,000,000,000, reflecting current basis of estimating. <u>Schedule</u>: The source action under the current planned end state would be completed by 2030. Capping under the potential end state alternative would be complete by 2019. Monitoring under the potential end state alternative could continue for several decades. <u>Risk:</u> The only potential risks posed to humans are from direct contact at the burial ground by on-site industrial workers. Risks are driven by the presence of uranium isotopes, arsenic, PAHs, and PCBs in surface soils; however, current access controls mitigate risk from direct contact by on-site industrial workers. Screening ecological risk assessments determined that ecological risks for contact at the	It is the regulators' position that capping and access controls are inadequate to achieve long-term protectiveness for *in situ* management of contamination at burial grounds; therefore, their preference is to remove the burial grounds to achieve long-term protectiveness. It is the regulators' position that existing data are insufficient to characterize the contents and releases from the burial grounds.	Complete technical investigations at remaining sources and reach agreement with regulators effectiveness and sustainability of capping as a protective remedy.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		burial grounds were at *de minimis* levels[c] assuming future industrial use of the areas encompassing the burial grounds. Excavation of the burial grounds would result in substantial risks to remediation workers through direct contact with wastes. Additionally, general site workers could be put at risk from exposure through inhalation of resuspended dust and vapors during excavation. Potential risks to the public and ecological receptors also would be increased during transportation of waste to the off-site disposal location. Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time. Capping of the burial grounds under the potential end state alternative would result in potential risks to remediation workers through direct contact with surface soil at the burial grounds. Samplers involved in monitoring activities also could be at risk of exposure. The magnitude of these risks has not been estimated at this time. Note that risks to remediation and general site workers would be smaller under the potential end state alternative than under the current planned end state because, under the potential end state alternative, waste would not be dug up and moved, and the duration of the activity would be shorter.		
Hazard Area 4: SOU				
V-4.1	**Current Planned End State:** Excavation of soil **Alternative:** Excavation of soil "hot spots"	Scope: The current planned end state assumes excavation of contaminated soil to levels that achieve a target risk of 1E-06 under a residential scenario and a PCB concentration of 1 ppm. The potential end state alternative assumes excavations of "hot spots" in soil using a target risk of 1E-04 under a worker scenario, the most likely future use of the affected areas per past agreements with the regulators and the public. The PCB concentration target under the potential end state alternative would be 25 ppm. Cost: Based on existing PCB and U-238 sampling results, approximately 7 to 17 times as much soil would need to be removed under the current planned end state cleanup target than under the potential end state alternative cleanup target, resulting in a cost variance of proportional size. Because many areas have not been fully characterized, there is a high degree of uncertainty in this estimate. Schedule: The field investigation of the SOU is complete. Remedial Investigation report is being developed. Remedial Action completion for the current end state and potential end state is 2016.	Commonwealth of Kentucky regulators' position is that Kentucky policy requires cleanup actions to either attain an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level. Commonwealth of Kentucky regulators' position is that Kentucky policy requires that cleanup of PCBs in soils and sediments located in industrial areas must attain 1 ppm (as opposed to federal TSCA regulations	Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for the area in question; and · Seek agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999); and · to seek agreement that national TSCA PCB cleanup standards for low occupancy

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		Risk: Under the current state, the only potential risks posed by surface soils are from direct contact by on-site industrial workers. However, these risks currently are mitigated through institutional and access controls that limit exposure. The ecological risks were determined to be at *de minimis* levels[c] as long as the area remains industrial. Potential risk under the current planned end state would be reduced to E-06 using a residential scenario in an industrial area. Potential risk under the potential end state alternative would be reduced to a value falling within EPA's acceptable risk range for site-related exposures (i.e., E-06 to E-04) using a worker scenario for these industrial areas (EPA 1999). Risks during excavation and disposal under both the current planned end state and potential end state alternative would affect remediation workers, general site workers, transportation workers (off-site disposal anticipated), landfill workers, and the public. The magnitude of these risks under the current planned end state and potential end state alternative have not been assessed at this time; however, because a greater amount of material would be excavated under the current planned end state than under the potential end state alternative, risks over the duration of the response action likely would be greater under the current planned end state than under the potential end state alternative.	allowing ≤25 ppm for "low occupancy areas" [e.g., industrial areas] ≤1 ppm for "high occupancy areas" [e.g., residential areas], and >1 ppm to ≤ 10 ppm for "high occupancy areas" if covered by a cap with institutional controls).	(e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA PCB cleanup standards for high occupancy (e.g., residential) areas (1 ppm) should be adopted for recreational areas.
Hazard Area 5: Permitted Landfills				
V-5.1	**Current Planned End State:** Continuation of PGDP Water Policy **Alternative:** Enhanced institutional controls	Scope: The current planned end state includes continuation of the current PGDP Water Policy.[a] The potential end state alternative includes enhanced institutional controls,[b] which would take the place of the current PGDP Water Policy. Under both end states, the goal would be to reduce risks to residents from exposure to groundwater to *de minimis* levels.[c] Cost: The cost variance has not been determined to date. The cost of water currently provided under the PGDP Water Policy ranges from $70,000 to $100,000 per year. Depending upon the specific enhanced institutional controls, the cost variance of the enhanced institutional controls could include some cost avoidance (if the PGDP Water Policy is replaced). Additionally, there could be some cost avoidance under other actions as well as discussed elsewhere in this variance report (e.g., excavation of burial grounds versus capping). The implementation of enhanced institutional controls would include costs for acquisition of rights to restrict groundwater use and continued monitoring to ensure continued long-term effectiveness of the enhanced institutional controls.	Public and regulator acceptance of range of options included in enhanced institutional controls in uncertain. DOE policy may limit options available under the enhanced institutional controls. The regulators' position is that	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions. Revisit DOE policy concerning acquisition of property rights (including deed notices and permanent groundwater use restrictions). Initiate further discussion

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		Schedule: The PGDP Water Policy currently is in place. Implementation of the enhanced institutional controls would be a future planned CERCLA response action. Risk: The expected risk variance is zero under both the PGDP Water Policy and enhanced institutional controls because each would prevent exposure to contaminated groundwater, resulting in no risk. Enhanced institutional controls, however, would be more sustainable and, therefore, would result in greater long-term effectiveness because they would involve legally enforceable property restrictions and deed notices. (The agreements with landowners under the PGDP Water Policy do not restrict groundwater use, but only commit DOE to provide municipal water to replace the groundwater in return for the property owner's commitment not to use the groundwater. Thus, current or future property owners could decide to return to using groundwater in the home, completing this exposure pathway and potentially raising risk from *de minimis* levels.[c])	the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	with regulators · to discuss willingness to consider enhanced institutional controls in conjunction with MNA in lieu of source and plume actions and · to discuss willingness to consider establishing points of compliance and exposure at the property boundary.
Hazard Area 6: BGOU (Group 2)				
V-6.1	**Current Planned End State:** Continuation of PGDP Water Policy **Alternative:** Enhanced institutional controls	Scope: The current planned end state includes continuation of the current PGDP Water Policy.[a] The potential end state alternative includes enhanced institutional controls,[b] which would supercede the current PGDP Water Policy. Under both end states, the goal would be to reduce risks to residents from exposure to groundwater to *de minimis* levels.[c] Cost: The cost variance has not been determined to date. The cost of water currently provided under the PGDP Water Policy ranges from $70,000 to $100,000 per year. Depending upon the specific enhanced institutional controls, the cost variance of the enhanced institutional controls could include some cost avoidance (if the PGDP Water Policy is replaced). Additionally, there could be some cost avoidance under other actions as well as discussed elsewhere in this variance report (e.g., excavation of burial grounds versus capping). The implementation of enhanced institutional controls would include costs for acquisition of rights to restrict groundwater use and continued monitoring to ensure continued long-term effectiveness of the enhanced institutional controls. Schedule: The PGDP Water Policy currently is in place. Implementation of the enhanced institutional controls would be a future planned CERCLA response action. Risk: The expected risk variance is zero under both the PGDP Water Policy and	Public and regulator acceptance of range of options included in enhanced institutional controls in uncertain. DOE policy may limit options available under the enhanced institutional controls. The regulators' position is that the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions. Revisit DOE policy concerning acquisition of property rights (including deed notices and permanent groundwater use restrictions). Initiate further discussion with regulators · to discuss willingness to consider enhanced institutional controls in

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		enhanced institutional controls because each would prevent exposure to contaminated groundwater, resulting in no risk. Enhanced institutional controls, would be more sustainable and, therefore, would result in greater long-term effectiveness because they would involve legally enforceable property restrictions and deed notices. (The agreements with landowners under the PGDP Water Policy do not restrict groundwater use, but only commit DOE to provide municipal water to replace the groundwater in return for the property owner's commitment not to use the groundwater. Thus, current or future property-owners could return to using groundwater in the home, completing this exposure pathway and potentially raising risk from *de minimis* levels.[c])		conjunction with MNA in lieu of certain source and plume actions and · to discuss willingness to consider establishing points of compliance and exposure at the property boundary.
V-7.1				·
Hazard Area 7: Cylinder Yards and DUF_6 Conversion Facility				
V-7.1	**Current Planned End State:** Excavation of soil **Alternative:** Excavation of soil "hot spots"	Scope: The current planned end state assumes excavation of contaminated soils following completion of the DUF_6 conversion mission to levels that achieve a target risk of 1E-06 under a residential scenario and a PCB concentration of 1 ppm. The potential end state alternative assumes excavation of "hot spots" in soil using a target risk of 1E-04 under a worker scenario, the most likely future use of the affected areas per past agreements with the regulators and the public. The PCB concentration under the potential end state alternative would be 25 ppm. Cost: Based on existing PCB and U-238 sampling results, approximately 7 to 17 times as much soil would need to be removed under the current planned end state cleanup target than under the potential end state alternative cleanup target, resulting a cost variance of proportional size. Because many areas have not been fully characterized, there is a high degree of uncertainty in this estimate. Schedule: No schedule is available because the conversion mission is expected to last for decades. Risk: Under the current state, the only potential risks posed by surface soils are from direct contact by on-site industrial workers; however, these risks currently are mitigated through institutional and access controls that limit exposure. The ecological risks are expected to be at *de minimis* levels[c] as long as the area remains industrial. Potential risk under the current planned end state would be reduced to E-06 using a residential scenario in an industrial area. Potential risk under the potential end state alternative would be reduced to a value falling within EPA's acceptable risk range for site-related exposures (i.e., E-06 to E-04) using a worker scenario for these industrial areas (EPA 1999). Risks during excavation under both	Commonwealth of Kentucky regulators' position is that Kentucky policy requires cleanup actions to attain either an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level. Commonwealth of Kentucky regulators' position is that Kentucky policy requires that cleanup of PCBs in soils and sediments located in industrial areas must attain 1 ppm (as opposed to federal TSCA regulations allowing $\leq$ 25 ppm for "low occupancy areas" [e.g., industrial areas] $\leq$1 ppm for "high occupancy areas" [e.g., residential areas], and >1 ppm to $\leq$ 10 ppm for "high occupancy areas" if covered by a cap with institutional	Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for the area in question; · to gain agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999); and · to seek agreement that national TSCA PCB cleanup standards for low occupancy (e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA PCB cleanup standards for high occupancy (e.g., residential) areas (1 ppm) should be adopted for recreational areas.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		the current planned end state and potential end state alternative would affect remediation workers, general site workers, transportation workers (off-site disposal anticipated), landfill workers, and the public. The magnitude of these risks under the current planned end state and potential end state alternative have not been assessed at this time; however, because a greater amount of material would be excavated under the current planned end state than under the potential end state alternative, risks over the duration of the response action likely would be greater under the current planned end state than under the potential end state alternative.	controls).	
Hazard Area 8: GDP Facilities				
V-8.1	**Current Planned End State:** Continuation of PGDP Water Policy **Alternative:** Enhanced institutional controls	<u>Scope</u>: The current planned end state includes continuation of the current PGDP Water Policy.[a] The potential end state alternative includes enhanced institutional controls,[b] which would supercede the current PGDP Water Policy. Under both end states, the goal would be to reduce risks to residents from exposure to groundwater to *de minimis* levels.[c] <u>Cost</u>: The cost variance has not been determined to date. The cost of water currently provided under the PGDP Water Policy ranges from $70,000 to $100,000 per year. Depending upon the specific enhanced institutional controls, the cost variance of the enhanced institutional controls could include some cost avoidance (if the PGDP Water Policy is replaced). Additionally, there could be some cost avoidance under other actions as well as discussed elsewhere in this variance report (e.g., excavation of burial grounds versus capping).T the implementation of enhanced institutional controls would include costs for acquisition of rights to restrict groundwater use and continued monitoring to ensure continued long-term effectiveness of the enhanced institutional controls. <u>Schedule</u>: The PGDP Water Policy currently is in place. Implementation of the enhanced institutional controls would be a future planned CERCLA response action. <u>Risk</u>: The expected risk variance is zero under both the PGDP Water Policy and enhanced institutional controls because each would prevent exposure to contaminated groundwater, resulting in no risk. Enhanced institutional controls, however, would be more sustainable and, therefore, would result in greater long-term effectiveness because they would involve legally enforceable property restrictions and deed notices. (The agreements with landowners under the PGDP Water Policy do not restrict groundwater use, but only commit DOE to provide municipal water to replace the groundwater in return for the property owner's	Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain. DOE policy may limit options available under the enhanced institutional controls. The regulators' position is that the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions. Revisit DOE policy concerning acquisition of property rights (including deed notices and permanent groundwater use restrictions). Initiate further discussion with regulators · to discuss willingness to consider enhanced institutional controls in conjunction with MNA in lieu of certain source and plume actions and · to discuss willingness to consider establishing points of compliance and exposure at the property boundary.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		commitment not to use the groundwater. Thus, current or future property owners could return to using groundwater in the home, completing this exposure pathway and potentially raising risk from *de minimis* levels.[c])		
V-8.2	**Current Planned End State:** Excavation of soil **Alternative:** Excavation of soil "hot spots"	Scope: Excavation of contaminated soils is planned under both the current planned end state and potential end state alternative as part of D&D of the GDP. The current planned end state assumes excavation of contaminated soils to levels that achieve a target risk of 1E-06 under a residential scenario and a PCB concentration of 1 ppm. The potential end state alternative assumes excavation of "hot spots" in soil using a target risk of 1E-04 under a worker scenario, the most likely future use of the affected areas per past agreements with the regulators and the public. The PCB concentration under the potential end state alternative would be 25 ppm. Cost: Based on existing PCB and U-238 sampling results, approximately 7 to 17 times as much soil would need to be removed under the current planned end state cleanup target than under the potential end state alternative cleanup target, resulting in a cost variance of proportional size. Because most areas associated with GDP D&D have not been fully characterized, there is a very high degree of uncertainty in this estimate. Schedule: The schedule for GDP D&D and the subsequent CSOU will be determined 6 months before GDP shutdown. Risk: Under the current state, the only potential risks posed by surface soils are from direct contact by on-site industrial workers. However, these risks currently are mitigated through institutional and access controls that limit exposure. The ecological risks likely are at *de minimis* levels[c] because the GDP facilities are in industrialized areas of PGDP. Potential risk under the current planned end state would be reduced to E-06 using a residential scenario in industrial areas. Potential risk under the potential end state alternative would be reduced to a value falling within EPA's acceptable risk range for site-related exposures (i.e., E-06 to E-04) using a worker scenario for these industrial areas (EPA 1999). Risks during excavation under both the current planned end state and potential end state alternative would affect remediation workers, general site workers, transportation workers (off-site disposal anticipated), landfill workers, the public, and ecological receptors. The magnitude of these risks under the current planned end state and potential end state alternative have not been assessed at this time; however, because a greater amount of material would be excavated under the current planned end state than under the potential end state alternative, risks over	Commonwealth of Kentucky regulators' position is that Kentucky policy requires cleanup actions to attain either an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level. Commonwealth of Kentucky regulators' position is that Kentucky policy requires that cleanup of PCBs in soils and sediments located in industrial areas must attain 1 ppm (as opposed to federal TSCA regulations allowing ≤25 ppm for "low occupancy areas" [e.g., industrial areas] ≤1 ppm for "high occupancy areas" [e.g., residential areas], and >1 ppm to ≤ 10 ppm for "high occupancy areas" if covered by a cap with institutional controls).	Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for the area in question; · to gain agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999); and · to seek agreement that national TSCA PCB cleanup standards for low occupancy (e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA PCB cleanup standards for high occupancy (e.g., residential) areas (1 ppm) should be adopted for recreational areas.

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		the duration of the response action likely would be greater under the current planned end state than under the potential end state alternative.		
V-8.3	**Current Planned End State:** Treatment to attain source reduction with MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1.1) and a point of compliance at the PGDP fence line. **Alternative:** MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1.1) and a point of compliance at the DOE property boundary in accordance with CERCLA requirements.	Scope: The current planned end state assumes implementation of DNAPL source reduction actions at additional sites using *in situ* heating technologies in combination with MNA as part of D&D of the GDP or as part of the CSOU. The potential end state alternative does not assume additional source actions and consists solely of MNA with a point of exposure established at the DOE property boundary or at a downgradient location in accordance with the requirements of CERCLA. Cost: The combined costs of implementing *in situ* heating technology at the DNAPL source areas associated with D&D of the GDP are unknown. The cost per year for MNA essentially would be the same under both the current planned end state and potential end state alternative; however, the duration of the monitoring/attenuation period could differ between the current planned end state (hundreds of years) and the potential end state alternative (potentially thousands of years). Schedule: The schedule for GDP D&D and the subsequent CSOU will be determined 6 months before GDP shutdown. Additional schedule information is not available at this time.	The regulators' position is that MNA would need to be supplemented by source actions at multiple locations to reduce contaminant concentrations to MCLs in a "reasonable" time frame (e.g., ≤ 100 years); however, even with source reduction, it would take hundreds of years to reach MCLs for the contaminants addressed (i.e., solvents), and contamination not addressed by the action (i.e., metals and radionuclides) would remain above MCLs, as well. (With source reduction at only one area, the monitoring period potentially could be thousands of years.)	Complete technical investigations at remaining sources and reach agreement with regulators on potential for contaminant migration.
		Risk: The only variance in risk between the current planned end state and the potential end state alternative is the amount of time necessary to achieve MCLs. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from off-site migration of DNAPL under both end states. The current planned end state could reduce the amount of time necessary to meet MCLs, thereby shortening the time period that the PGDP Water Policy or enhanced institutional controls would have to remain in effect.	Despite national performance data indicating that no technologies currently exist that can reduce DNAPLs in source areas to MCLs within a "reasonable" period, the regulators' position is that TI waivers would be available only after a demonstrated, site-specific technology failure.	Initiate discussions with regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the national performance data, and (2) determine what would be required to decide whether TI waiver should apply.
		Implementation of *in situ* heating technology under the current planned end state could result in exposures of remediation workers to contaminated soil and groundwater and, potentially, gases, as well as physical hazards. Implementation of the source action could pose a risk of exposure to gases to general plant workers. Workers involved in disposal of materials contaminated during implementation of the source action also could be exposed. Finally, samplers involved in groundwater monitoring activities could be exposed. Except for risks to samplers, the magnitude of these risks has not been estimated at this time.	The regulators' position is that the current fence line (located well inside the property	Initiate further discussion with regulators to determine willingness to consider

Table 5.3. Variance Report by Hazard Area (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance	Impacts	Challenges in Achieving Alternative	Recommendations
		Risks under the potential end state alternative are limited to samplers involved in groundwater monitoring activities. An assessment of these risks under current sampling protocols determined that risks to samplers are at *de minimis* levels.[c]	boundary) should be used as the point of exposure.	establishing points of compliance and exposure at property boundary.
			Public and regulator acceptance of range of options included in enhanced institutional controls is uncertain.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.

[a] The PGDP Water Policy is a removal action instituted to limit the use of potentially contaminated groundwater by off-site residences. This policy is discussed in *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, U.S. Department of Energy, Paducah, KY, June 1994 (DOE 1994).

[b] Enhanced institutional controls under the potential end state alternative would be implemented on both DOE- and non-DOE-owned property. These controls could range from implementation of legal agreements with surrounding landowners to place enforceable restrictions on groundwater use to DOE's acquiring rights from surrounding property owners and directly implementing restrictions on groundwater and property use.

[c] "*De minimis*" levels of risk, as used here, are defined as risks determined to be at or below the lower limit of EPA's acceptable risk range for site-related exposures (i.e., E-06) by the receptor(s) mentioned (EPA 1999).

Table 5.4. Variance Report over Hazard Areas[a]

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
V-1	**Current Planned End State:** Continuation of PGDP Water Policy **Alternative:** Enhanced institutional controls **Hazard Areas Affected:** 1: GWOU 5: Permitted Landfills 6: BGOU (Group 2) 8: GDP Facilities	Scope: The current planned end state includes continuation of the current PGDP Water Policy.[b] The potential end state alternative includes enhanced institutional controls,[c] which would supercede the current PGDP Water Policy. Under both end states, the goal would be to reduce risks to residents from exposure to groundwater to *de minimis* levels.[d]	Public and regulator acceptance of range of options included in enhanced institutional controls in uncertain.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions.
		Cost: The cost variance has not been determined to date. The cost of water currently provided under the PGDP Water Policy ranges from $70,000 to $100,000 per year. Depending upon the specific enhanced institutional controls, the cost variance of the enhanced institutional controls could include some cost avoidance (if the PGDP Water Policy is replaced). Additionally, there could be some cost avoidance under other actions as well as discussed elsewhere in this variance report (e.g., excavation of burial grounds versus capping). The implementation of enhanced institutional controls would include costs for acquisition of rights to restrict groundwater use and continued monitoring to ensure continued long-term effectiveness of the enhanced institutional controls.	DOE policy may limit options available under the enhanced institutional controls.	Revisit DOE policy concerning acquisition of property rights (including property easements and use restrictions).
		Schedule: The PGDP Water Policy currently is in place. Implementation of the enhanced institutional controls would be a future planned CERCLA response action.		
		Risk: The expected risk variance is zero under both the PGDP Water Policy and enhanced institutional controls because each would prevent exposure to contaminated groundwater, resulting in no risk. Enhanced institutional controls would be more sustainable and, therefore, would result in greater long-term effectiveness because they would involve legally enforceable property restrictions and deed notices. (The agreements with landowners under the PGDP Water Policy do not restrict groundwater use, but only commit DOE to provide municipal water to replace the groundwater in return for the property owner's commitment not to use the groundwater. Thus, current or future property-owners could return to using groundwater in the home, completing this exposure pathway, and potentially raising risk from *de minimis* levels.[d])	The regulators' position is that the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	Initiate further discussion with regulators · to discuss willingness to consider enhanced institutional controls in conjunction with MNA in lieu of certain source and plume actions and · to discuss willingness to consider establishing points of compliance and exposure at the property boundary.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
V-2	**Current Planned End State:** Treatment to attain source reduction at multiple sites with MNA (with either PGDP Water Policy or enhanced institutional controls, see V-1) **Alternative:** Treatment to attain source reduction at one site with MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1) and a point of compliance at the DOE property boundary in accordance with CERCLA requirements. **Hazard Areas Affected:** 1: GWOU 8: GDP Facilities	<u>Scope</u>: The current planned end state assumes implementation of DNAPL source reduction actions at multiple sites using *in situ* heating technologies in combination with MNA with a point of exposure established at the PGDP fence line. The potential end state alternative includes a source reduction using this technology at one location (i.e., C-400, which is believed to be the primary source of solvent contamination at PGDP) in combination with MNA with a point of exposure established at the DOE property boundary or at a downgradient location in accordance with the requirements of CERCLA. <u>Cost</u>: Cost over all potential sites is unknown. For Hazard Area 1 alone, the combined cost of implementing *in situ* heating technology at the DNAPL source areas (i.e., C-400, C-720, and oil landfarm) is estimated to range from $75,000,000 to $140,000,000. The cost of implementing at the C-400 only is approximately $60,000,000. The cost per year for MNA essentially would be the same under both the current planned end state and potential end state alternative; however, the duration of the monitoring/attenuation period could differ between the current planned end state (hundreds of years) and the potential end state alternative (potentially thousands of years). <u>Schedule</u>: Under the current planned end state and the potential end state alternative for Hazard Area 1, all currently planned source actions would be completed by 2013 (the current SMP milestone for the Remedial Action Completion Report is 2013); however, associated monitoring/attenuation under the current planned end state would continue for hundreds of years. The monitoring/attenuation under the potential end state alternative could continue for thousands of years. Also, under both end states investigations to identify other source areas, if any, will be performed as part of the SOU and GDP D&D. No schedule information is available for the Hazard Area 8. The schedule for GDP D&D and the subsequent CSOU will be determined 6 months before GDP shutdown. <u>Risk</u>: The only variance in risk between the current planned end state and the potential end state alternative for both hazard areas is the amount of time necessary to achieve MCLs. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from off-site migration of DNAPL under both end states. However, the current planned end state could reduce the amount of time necessary to meet MCLs, thereby shortening the time period that the PGDP Water	The regulators' position is that monitored natural attenuation would need to be supplemented by source actions at multiple locations to reduce contaminant concentrations to MCLs in a "reasonable" time frame (e.g., $\leq$ 100 years); however, even with source reduction, it would take hundreds of years to reach MCLs for the contaminants addressed (i.e., solvents), and contamination not addressed by the action (i.e., metals and radionuclides) would remain above MCLs, as well. (With source reduction at only one area, the monitoring period potentially could be thousands of years.) Despite national performance data indicating that no technologies currently exist that can reduce DNAPLs in source areas to MCLs within a "reasonable" period, the regulators' position is that TI waivers would be available only after a demonstrated, site-specific technology failure.	Complete technical investigations at remaining sources and reach agreement with regulators on potential for contamination migration. Initiate discussion with the regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the national performance data, and 2) determine what would be required to decide whether TI waiver should apply.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		Policy or enhanced institutional controls would have to remain in effect. Implementation of *in situ* heating technology at multiple sites under the current planned end state could result in exposures of remediation workers to contaminated soil and groundwater and, potentially, gases, as well as physical hazards. Implementation of the source action could pose a risk of exposure to gases to general plant workers. Workers involved in disposal of materials contaminated during implementation of the source action also could be exposed. Finally, samplers involved in groundwater monitoring activities could be exposed. Except for risks to samplers, the magnitude of these risks has not been estimated at this time. Risks to remediation workers, general plant workers, and workers involved in disposal of materials contaminated during implementation of the *in situ* heating technology under the potential end state alternative would be less because only a single location would be addressed. Risks to samplers involved in groundwater monitoring activities under the potential end state alternative would be similar to those under the current planned end state; however, an assessment of these risks under current sampling protocols determined that risks to samplers are at *de minimis* levels.[d]	Public and regulator acceptance of range of options included in enhanced institutional controls in uncertain. The regulators' position is that the goal for groundwater restoration is to achieve MCLs at all locations in the plume.	Initiate further discussion with the public and regulators to determine acceptability of acquisition of property rights including deed notices and permanent groundwater use restrictions. Initiate further discussion with regulatory agencies to determine willingness to consider establishing points of compliance and exposure at property boundary.
V-3	**Current Planned End State:** Excavation to remove suspected sources of groundwater contamination at burial grounds **Alternative:** Capping and MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1) **Hazard Areas Affected:**	Scope: The current planned end state assumes the investigation and subsequent complete excavation of three burial grounds (C-749 Uranium Burial Ground, C-404 Low-level Radioactive Waste Burial Ground, and C-747 Contaminated Burial Yard) suspected to be sources of groundwater contamination, subsequent off-site disposal of excavated materials, and monitoring to determine the effectiveness of source removal. This has been updated from two to three burial grounds to include the C-404 Low-level Radioactive Waste Burial Ground due to more recent data evaluations that indicate an increased potential to be a source of groundwater contamination. The potential end state alternative assumes the investigation and subsequent capping and monitoring for these burial grounds. Cost: The variance between the combined cost of excavating the three burial grounds, off-site disposal of excavated material, and monitoring under the current planned end state compared to and the combined cost for capping and monitoring under the potential end state alternative is estimated to range from \$85,000,000 to \$418,000,000, which now includes the addition of the third burial ground. Schedule: The source action under the current planned end state would be completed by 2030. Capping under the potential end state alternative would be complete by	It is the regulators' position that capping, access controls, and/or enhanced institutional controls are inadequate to achieve long-term protectiveness for *in situ* management of contamination at burial grounds; therefore, their preference is to remove the burial grounds to prevent them from serving as long-term sources of groundwater contamination. Public and regulator acceptance of range of options included in enhanced institutional	Complete technical investigations at remaining sources and reach agreement with regulators on potential for contaminant migration.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
	1: GWOU	2019. Monitoring would follow both actions. <u>Risk</u>: The only potential risks posed by these burial grounds under current conditions are from possible migration of contaminants through groundwater to off-site residents and from direct contact at the burial ground by on-site industrial workers. However, the PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from contaminant migration under both end states, and current access controls mitigate risk from direct contact by on-site industrial workers. Excavation of the burial grounds under the current planned end state would remove the suspected source term, thereby reducing the amount of time taken to meet MCLs and shortening any monitoring period and the need for access controls. Capping of the burial grounds under the potential end state alternative would limit potential contact to the burial grounds and reduce possible migration of contamination to groundwater, but would require long-term monitoring and access controls. Off-site risks from contaminant migration would be controlled using enhanced institutional controls (see V-1). Excavation of the burial grounds would result in substantial risks to remediation workers through direct contact with wastes. (Note that one of the burial grounds to be excavated under the current planned end state contains pyrophoric uranium [i.e., uranium that spontaneously burns when exposed to air], which would pose significant inhalation risk and physical hazard to remediation workers.) Additionally, general site workers could be put at risk from exposure through inhalation of resuspended dust and vapors during excavation. Potential risks to the public and ecological receptors also would be increased during transportation of waste to the off-site disposal location. Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time. Capping of the burial grounds under the potential end state alternative would result in potential risks to remediation workers through direct contact with surface soil at the burial grounds, but not through direct contact with waste. Samplers involved in monitoring activities also could be at risk of exposure. The magnitude of these risks has not been estimated at this time. Note that risks to remediation and general site workers would be smaller under the potential end state alternative than under the current planned end state because,	controls in uncertain.	

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		under the potential end state alternative, waste would not be dug up and moved, and the duration of the activity would be shorter.		
V-4	**Current Planned End State:** Treatment to reduce contaminant concentrations in the dissolved-phase **Alternative:** MNA (with either PGDP Water Policy or enhanced institutional controls; see V-1) and a point of compliance at the DOE property boundary in accordance with CERCLA requirements **Hazard Areas Affected:** 1: GWOU	Scope: The current planned end state assumes implementation of oxidation technologies (e.g., C-Sparge™) to remove TCE and other solvents from the dissolved-phase plumes followed by MNA. The potential end state alternative does not assume actions for the dissolved-phased plumes and consists solely of MNA. Cost: The cost for implementing oxidation technologies in the dissolved-phase plumes has not been determined. The cost per year for MNA essentially would be the same under both the current planned end state and potential end state alternative; however, the duration of the monitoring/attenuation period could differ between the current planned end state (hundreds of years) and the potential end state alternative (potentially thousands of years). Schedule: Under the current planned end state, the construction and performance of the plume actions would be implemented by 2019 with associated monitoring/attenuation potentially continuing for decades. Additionally, any actions to address the dissolved-phase plumes under the current planned end state would need to follow source actions to be cost-effective. (See V-1.2 and V-1.3). Under the potential end state alternative, no additional construction beyond installation of additional monitoring wells would be required; however, monitoring/attenuation potentially could continue for thousands of years. Risk: The only variance in risk between the current planned end state and the potential end state alternative is the amount of time necessary to achieve MCLs. The PGDP Water Policy and/or enhanced institutional controls would eliminate risks to the public from TCE and other solvents in the dissolved-phase plumes under both end states. The current planned end state could reduce the length of time that the PGDP Water Policy or enhanced institutional controls would have to remain in effect depending on the extent and effectiveness of plume treatment. Note, however, that the oxidation technologies would not address other potential contaminants found in groundwater in on-site areas at PGDP (i.e., metals and radionuclides). Implementation of oxidation technologies would result in exposures of remediation workers to contaminated groundwater, as well as physical hazards. Workers involved in disposal of materials contaminated during implementation of the action also could be exposed. Finally, samplers involved in groundwater monitoring activities also could be exposed. Except for risks to samplers, the magnitude of these	The regulators' position is that MNA would need to be supplemented by source actions at multiple locations to reduce contaminant concentrations to MCLs in a "reasonable" time frame (e.g., ≤ 100 years); however, even with source reduction, it would take hundreds of years to reach MCLs for the contaminants addressed (i.e., solvents), and contamination not addressed by the action (i.e., metals and radionuclides) would remain above MCLs, as well. (With source reduction at only one area, the monitoring period potentially could be thousands of years.) Despite national performance data indicating that no technologies currently exist that can reduce TCE and solvent concentrations in large plumes to MCLs within a reasonable time frame, the regulators' position is that TI waivers would be available only after a demonstrated, site-specific technology failure.	Complete technical investigations of plume migration and attenuation and reach agreement with regulators on these issues. Initiate discussion with the regulators to (1) determine the appropriateness of requiring a demonstrated failure, given the national performance data, and (2) determine what would be required to decide whether TI waiver should apply.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		risks has not been estimated at this time. Risks under the potential end state alternative are limited to samplers involved in groundwater monitoring activities. An assessment of these risks under current sampling protocols determined that risks to samplers are at *de minimis* levels.[d]	Public and regulator acceptance of range of options included in enhanced institutional controls in uncertain. The regulators' position is that the current fence line (located well inside the property boundary) should be used as the point of exposure for determining compliance with MCLs.	Initiate further discussion with regulators to determine willingness to consider establishing points of compliance and exposure at property boundary.
V-5	**Current Planned End State:** Actions to reduce solvent concentrations in groundwater discharged to surface water and/or control these discharges **Alternative:** Continued monitoring of surface water concentrations at discharge point **Hazard Areas Affected:** 1: GWOU	<u>Scope</u>: The current planned end state assumes implementation of measures to reduce the solvent concentrations in the groundwater discharged to Little Bayou Creek and/or measures to control these discharges followed by monitoring. The potential end state alternative assumes continued monitoring. <u>Cost</u>: The cost of measures to reduce concentration in discharges and/or control discharges under the current planned end state has not been determined. Monitoring costs per year essentially would be the same under both the current planned end state and the potential end state alternative. <u>Schedule</u>: A schedule for implementation of the current planned end state actions is not available; however, the duration of monitoring under both the end states would be similar unless source and plume actions are taken. (See V-2, V-3, and V-4.) <u>Risk</u>: Screening human health and ecological risk assessments have determined that risks at the discharge point are at *de minimis* levels[d] for recreational user and ecological receptors. Modeling has indicated that contaminant concentrations could increase in the future, but these results and estimates of risks derived using them are uncertain. A baseline risk assessment has not been completed. Implementation of a technology to attenuate or control discharges would result in increased risks to remediation workers. Additionally, damage to the environment at the discharge point during implementation could lead to increased ecological risks.	Regulatory position is that releases at seeps present unacceptable risks to human health and the environment. Commonwealth of Kentucky regulators' position has been that Kentucky policy requires cleanup actions to either attain an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level.	Complete technical investigations for impacts of releases and reach agreement with regulators concerning risks posed to human health and the environment. Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for the area in question and · to gain agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04)

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time. Risks under the potential end state alternative are limited to samplers involved in monitoring activities. The magnitude of these risks has not been estimated at this time.		(EPA 1999).
V-6	**Current Planned End State:** Excavation of source areas **Alternative:** Excavation of soil or sediment "hot spots" **Hazard Areas Affected:** 2: SWOU 4: SOU 7: Cylinder Yards and DUF_6 Conversion Facility 8: GDP Facilities	Scope: The current planned end state assumes excavation of contaminated source sediments and soils to levels that achieve a target risk of 1E-06 under a residential scenario and a PCB concentration of 1 ppm in all areas. The potential end state alternative assumes excavations of "hot spots" in sediment and soil using a target risk and PCB concentration consistent with the agreed future land use. (All parties have agreed that future land use of areas currently in the industrialized areas of PGDP is industrial and that the future use of areas currently outside of the industrialized areas, but on DOE property, is recreational.) Under the potential end state alternative, the action in recreational areas would achieve a target risk of 1E-04 to a recreational user and a PCB concentration of 1 ppm. Cost: Based on existing PCB and U-238 sampling results, approximately 7 to 17 times as much soil and sediment would be required to be removed under the current planned end state cleanup target than under the potential end state alternative cleanup target, resulting in a cost variance of proportional size. Because many areas have not been fully characterized, there is a high degree of uncertainty in this estimate. Schedule: The investigation of the Hazard Area 2 (SWOU) is ongoing. The completion dates under the current planned end state and potential end state alternative is 2017. The remediation of Hazard Area 4 (SOU) is not complete. For the potential end state alternative, the completion date is 2015. For Hazard Area 7 no schedule is available because the conversion mission is expected to last for decades. For Hazard Area 8, the schedule for GDP D&D and the subsequent CSOU will be determined 6 months before GDP shutdown. Risk: Under the current state, the only potential risks posed by sediment and soils to	Commonwealth of Kentucky regulators' position is that Kentucky policy requires cleanup actions to either attain an E-06 risk assuming residential exposure or be supplemented with institutional controls and/or engineering barriers to attain that risk level. Commonwealth of Kentucky regulators' position is that Kentucky policy requires that cleanup of PCBs in soils and sediments located in industrial areas must attain 1 ppm (as opposed to federal TSCA regulations allowing $\leq$25 ppm for "low occupancy areas" [e.g., industrial areas] $\leq$ 1 ppm for "high occupancy areas" [e.g., residential areas], and >1 ppm to $\leq$ 10 ppm for "high occupancy areas" if covered by a cap with institutional controls).	Initiate further discussion with regulators · to seek agreement that cleanup standards for proposed actions will be set based upon current and future land use for the area in question; · to gain agreement that cleanup standards for proposed actions will be set based on the CERCLA risk range (i.e., E-06 to E-04) (EPA 1999); and · to seek agreement that national TSCA PCB cleanup standards for low occupancy (e.g., industrial) areas (25 ppm) should be adopted for industrial areas and that national TSCA PCB cleanup standards for high occupancy (e.g., residential) areas (1 ppm) should be adopted for recreational areas.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		humans are from direct contact by industrial workers and recreational users with these media. These risks currently are mitigated through institutional and access controls that limit exposure. Ecological receptors could be at risk in some industrial and nonindustrial areas; however, a baseline ecological risk assessment confirming this has not been completed. Potential risk in all areas under the current planned end state would be reduced to E-06 using a residential scenario in industrial and recreational areas. Additionally, protection of ecological receptors would be demonstrated by an ecological risk assessment. Potential risk under the potential end state alternative would be reduced to a value falling within EPA's acceptable risk range for site-related exposures (i.e., E-06 to E-04) using a worker scenario for industrial areas and a recreational user scenario in recreational areas (EPA 1999). Additionally, protection of ecological receptors would be demonstrated by an ecological risk assessment. Risks during excavation and disposal under both the current planned end state and potential end state alternative would affect remediation workers, general site workers, transportation workers (off-site disposal anticipated), landfill workers, the public, and ecological receptors. The magnitude of these risks under the current planned end state and potential end state alternative have not been assessed at this time; however, because a greater amount of material would be excavated under the current planned end state than under the potential end state alternative, risks to all receptors would be expected to be greater under the current planned end state than under the potential end state alternative.		

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
V-7	**Current Planned End State:** Excavation of burial grounds **Alternative:** Capping of burial grounds, with access controls **Hazard Areas Affected:** 3: BGOU (Group 1)	<u>Scope:</u> Under the current planned end state, certain burial grounds are to be excavated and materials disposed of in on- and off-site locations. Under the potential end state alternative, these burial grounds are capped to limit exposure, and the caps are maintained, including monitoring. For both end states, the goal of the action is to reduce risk to workers by eliminating or limiting exposure to contamination associated with the burial grounds. <u>Cost</u>: The variance between the cost of excavating the burial grounds and disposing of the materials off-site under the current planned end state versus capping and monitoring the burial grounds under the potential end state alternative is estimated to range from $185,000,000 to $1,000,000,000, reflecting current basis of estimating.	It is the regulators' position that capping and access controls are inadequate to achieve long-term protectiveness for *in situ* management of contamination at burial grounds; therefore, their preference is to remove the burial grounds to achieve long-term protectiveness.	Complete technical investigations at remaining sources and reach agreement with regulators on potential impacts.
		<u>Schedule</u>: The source action under the current planned end state would be completed by 2030. Capping under the potential end state alternative would be complete by 2019. Monitoring under the potential end state alternative could continue for several decades. <u>Risk</u>: The only potential risks posed to humans are from direct contact at the burial ground by on-site industrial workers. Risks are driven by the presence of uranium isotopes, arsenic, PAHs, and PCBs in surface soils; however, current access controls mitigate risk from direct contact by on-site industrial workers. Screening ecological risk assessments determined that ecological risks for contact at the burial grounds were at *de minimis* levels[d] assuming future industrial use of the areas encompassing the burial grounds. Excavation of the burial grounds would result in substantial risks to remediation workers through direct contact with wastes. Additionally, general site workers could be put at risk from exposure through inhalation of resuspended dust and vapors during excavation. Potential risks to the public and ecological receptors also would be increased during transportation of waste to the off-site disposal location. Finally, samplers involved in monitoring activities could be exposed. The magnitude of these risks has not been estimated at this time. Capping of the burial grounds under the potential end state alternative would result in potential risks to remediation workers through direct contact with surface soil at the burial grounds. Samplers involved in monitoring activities also could be at risk of exposure. The magnitude of these risks has not been estimated at this time.	It is the regulators' position that existing data are insufficient to characterize the contents and releases from the burial grounds.	Initiate further discussions with the public and regulators following completion of the investigation/evaluation to reach consensus as to whether additional actions are necessary.

Table 5.4. Variance Report over Hazard Areas[a] (Continued)

(Please see Figures 5.11 and 5.12 for maps of the potential end state alternative and current planned end state, respectively, that depict these variances.)

ID. No.	Description of Variance/Hazard Areas Affected	Impacts	Challenges in Achieving Alternative	Recommendations
		Note that risks to remediation and general site workers would be smaller under the potential end state alternative than under the current planned end state because, under the potential end state alternative, waste would not be dug up and moved, and the duration of the activity would be shorter.		

[a] In this table, the "Impact" discussion is summarized over all hazard areas. Please see Table 5.1 for a discussion of the schedule, cost, and risk impacts of variances upon individual hazard areas.

[b] The PGDP Water Policy is a removal action instituted to limit the use of potentially contaminated groundwater by off-site residences. This policy is discussed in *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, U.S. Department of Energy, Paducah, KY, June 1994 (DOE 1994).

[c] Enhanced institutional controls under the potential end state alternative would be implemented on both DOE- and non-DOE-owned property. These controls could range from implementation of legal agreements with surrounding landowners to place enforceable restrictions on groundwater use to DOE's acquiring rights from surrounding property owners and directly implementing restrictions on groundwater and property use.

[d] "*De minimis*" levels of risk, as used here, are defined as risks determined to be at or below the lower limit of EPA's acceptable risk range for site-related exposures (i.e., E-06) by the receptor(s) mentioned (EPA 1999).

FIGURES

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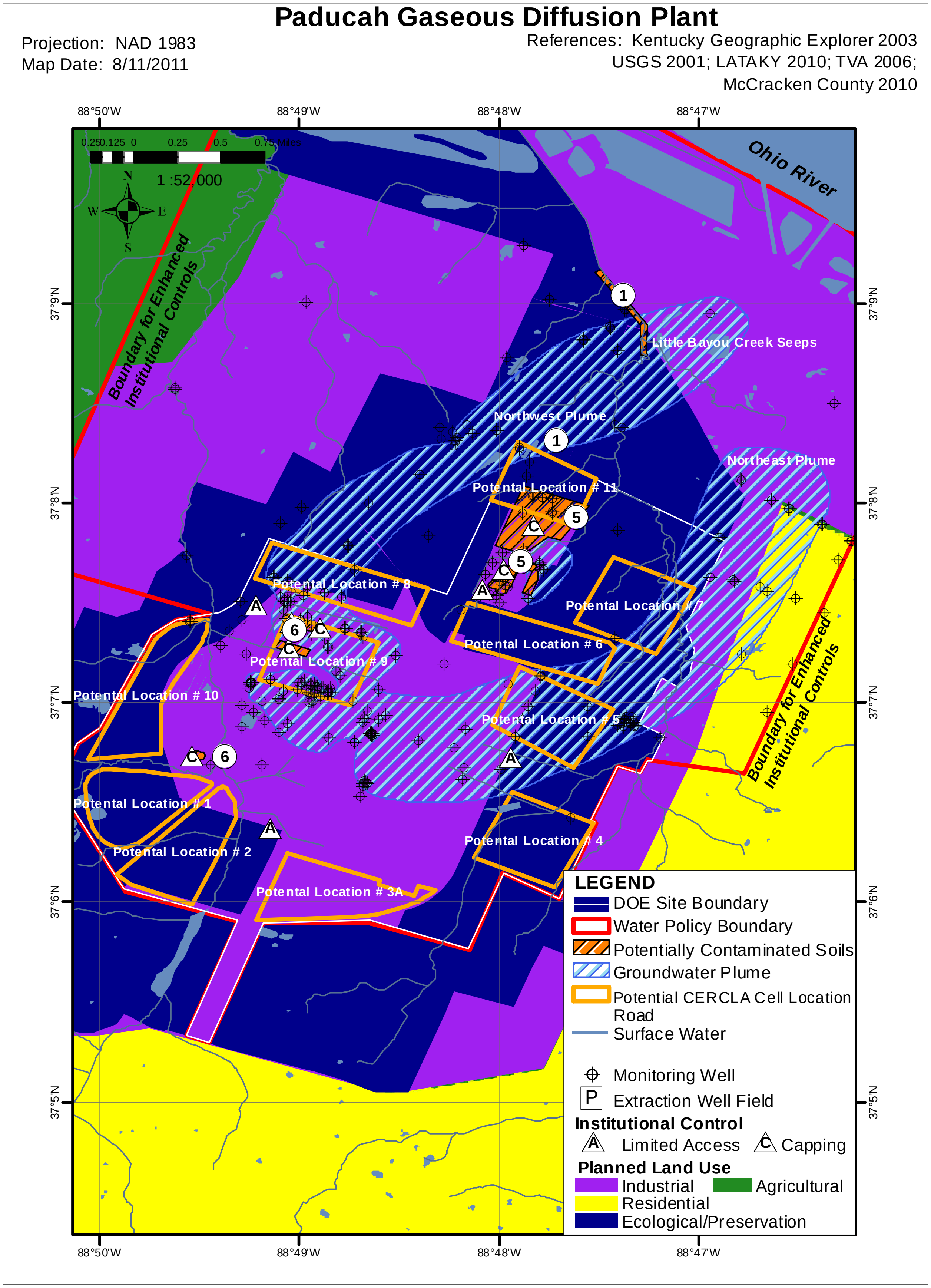


Figure 5.0c1. Hazard Areas - Current Planned End State

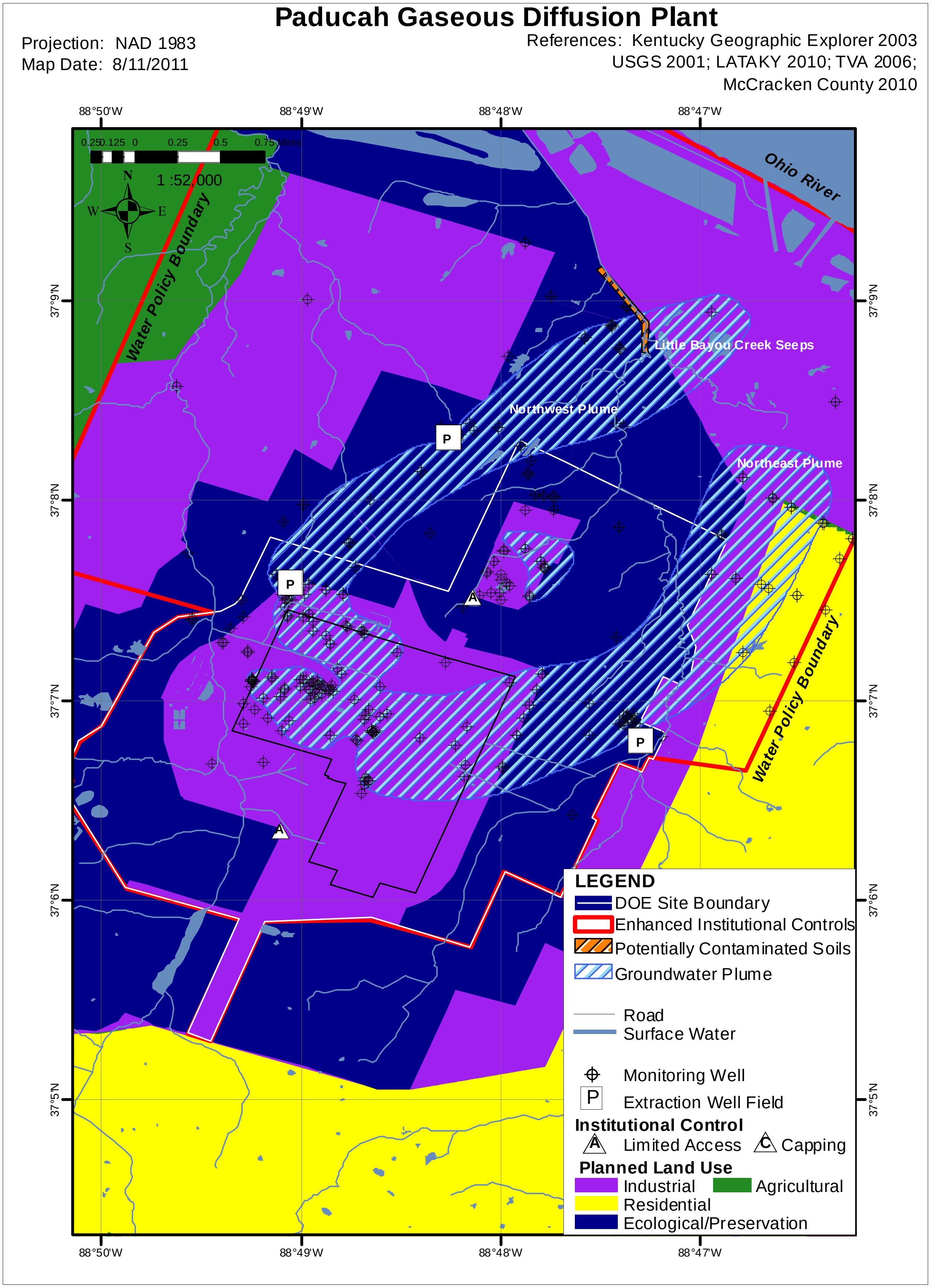
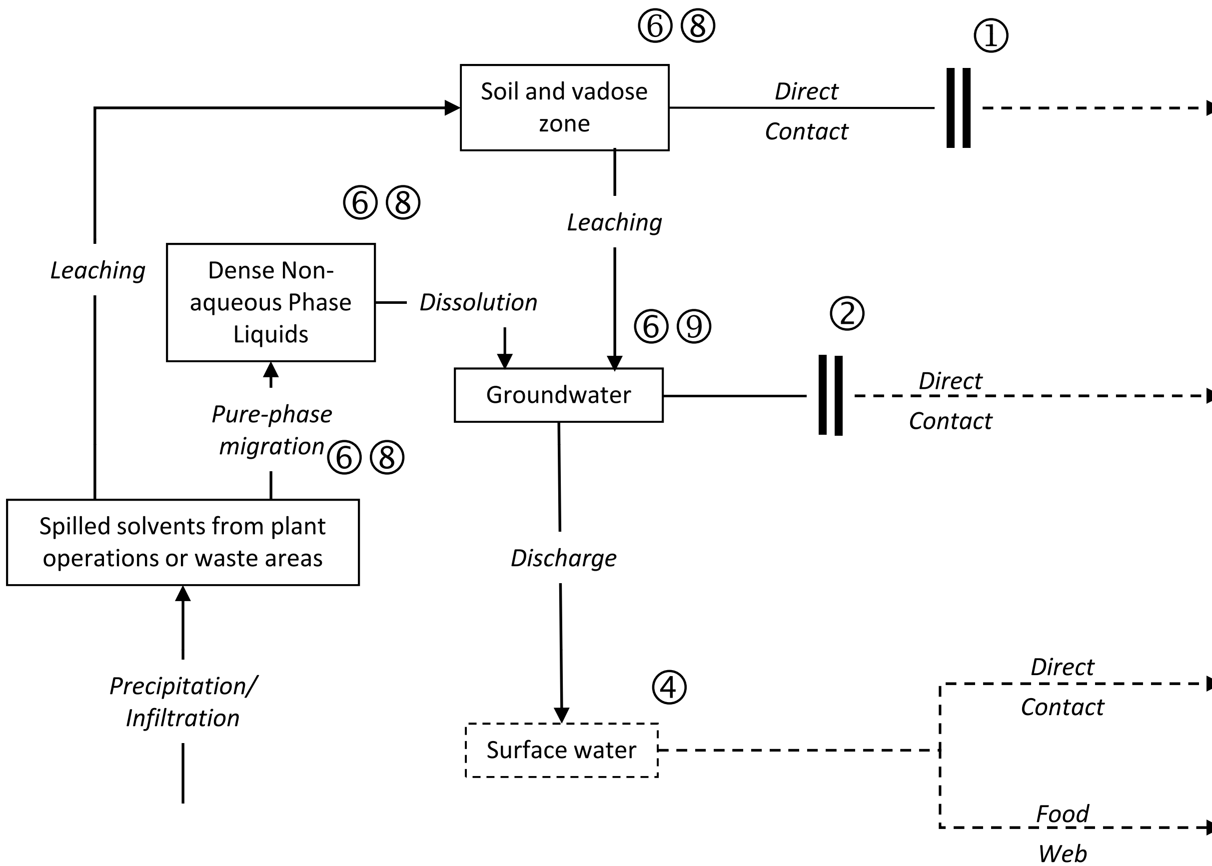


Figure 5.1c1. Hazard Area 1: GWOU - Current Planned End State

Hazard Area 1: Groundwater Operable Unit – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I			
R/F/D/I	F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

Current Planned Controls or Actions
① Access and excavation restrictions.
② PGDP Water Policy.
④ Natural attenuation.
⑥ Monitored natural attenuation of sources and dissolved phase plume.
⑧ Source reduction/removal.
⑨ Active contaminant reduction in dissolved phase plume.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.1c2. Hazard Area 1: Groundwater Operable Unit – Current Planned End State

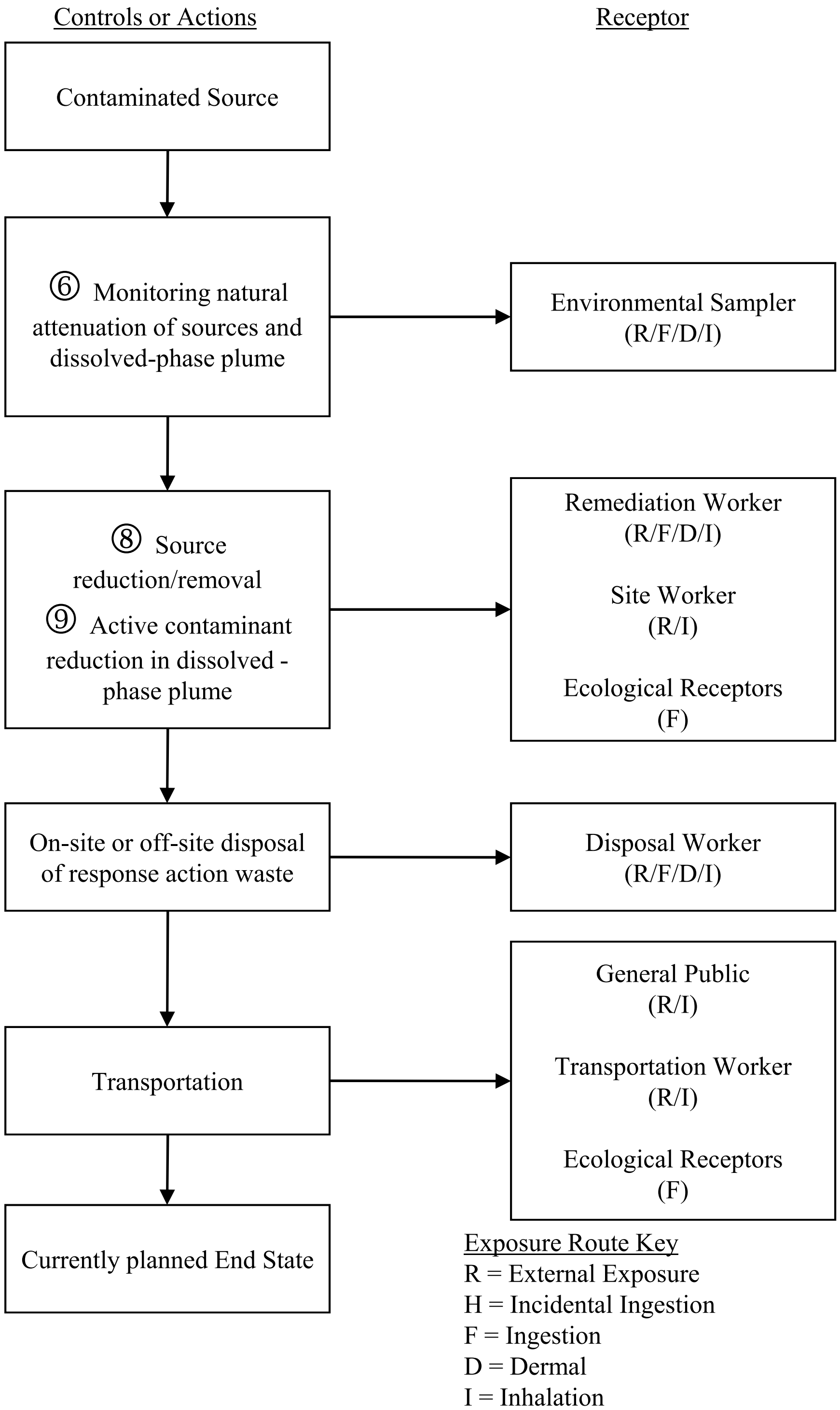


Figure 5.1c3. Hazard Area 1: Groundwater OU Treatment Train – Current Planned End State

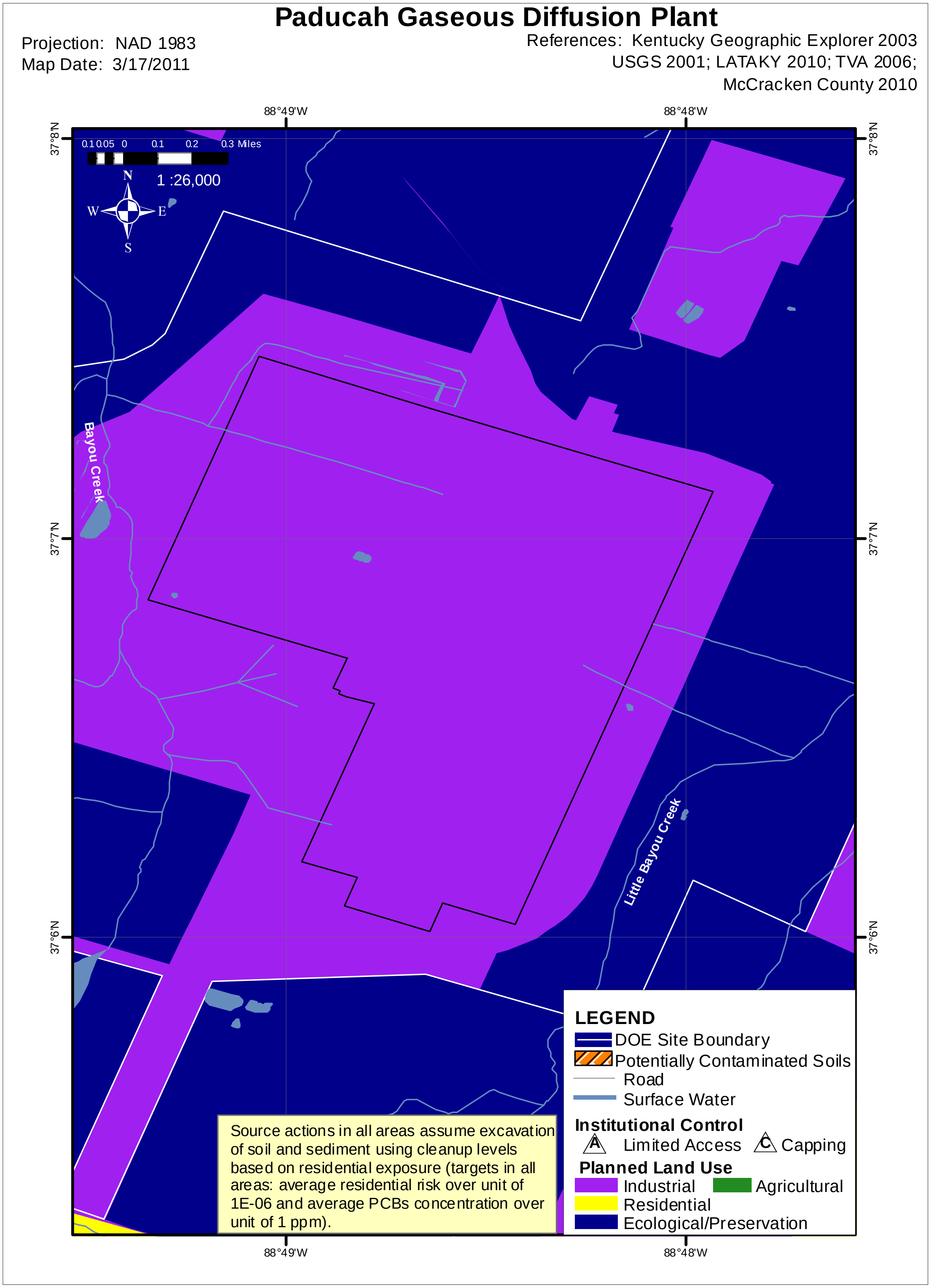
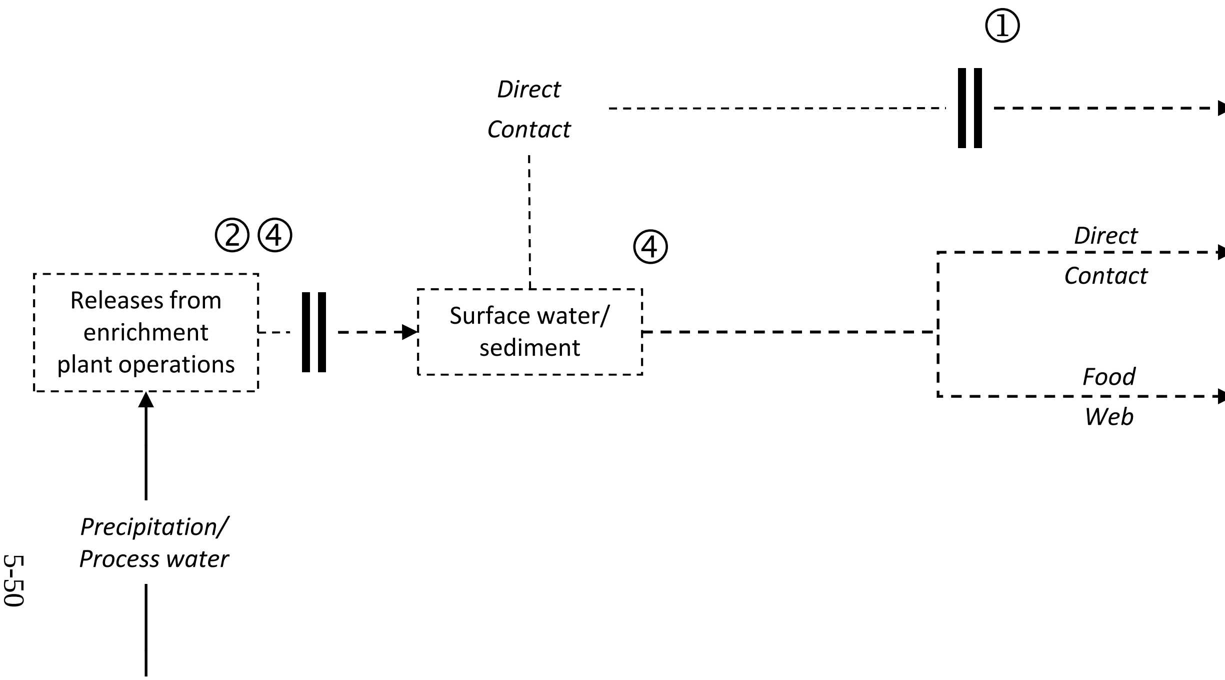


Figure 5.2c1. Hazard Area 2: SWOU - Current Planned End State

Hazard Area 2: Surface Water Operable Unit – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
H/D/I		H/D/I	F/D/I
	F	F	F

Current Planned Controls and Action
① Access restrictions.
② Environmental monitoring.
④ Excavation of source areas (target in all areas based on average exposure over entire unit:residential risk of 1E-06, PCBs at 1 ppm).

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.2c2. Hazard Area 2: Surface Water Operable Unit – Current Planned End State

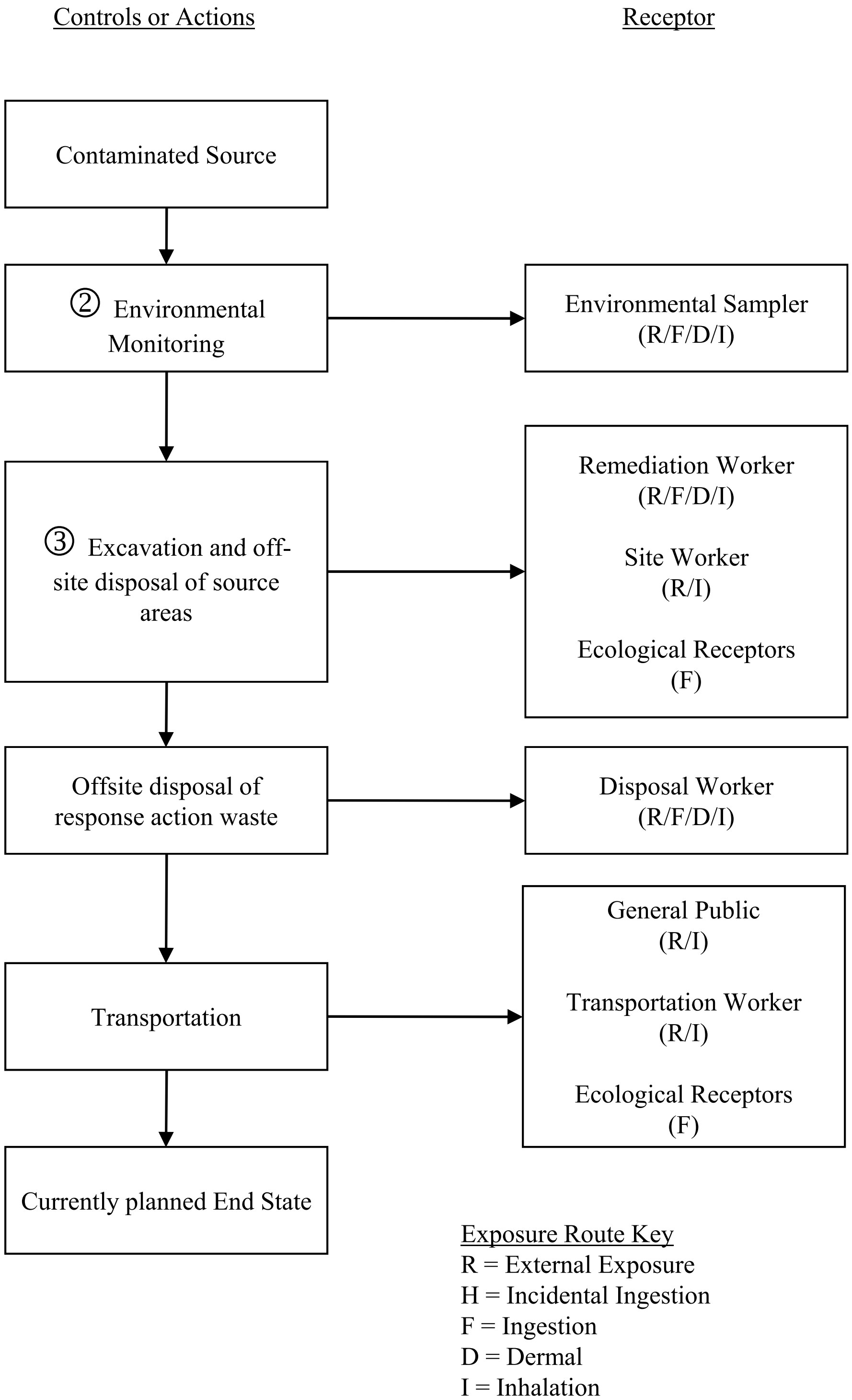


Figure 5.2c3. Hazard Area 2: Surface Water OU Treatment Train – Current Planned End State

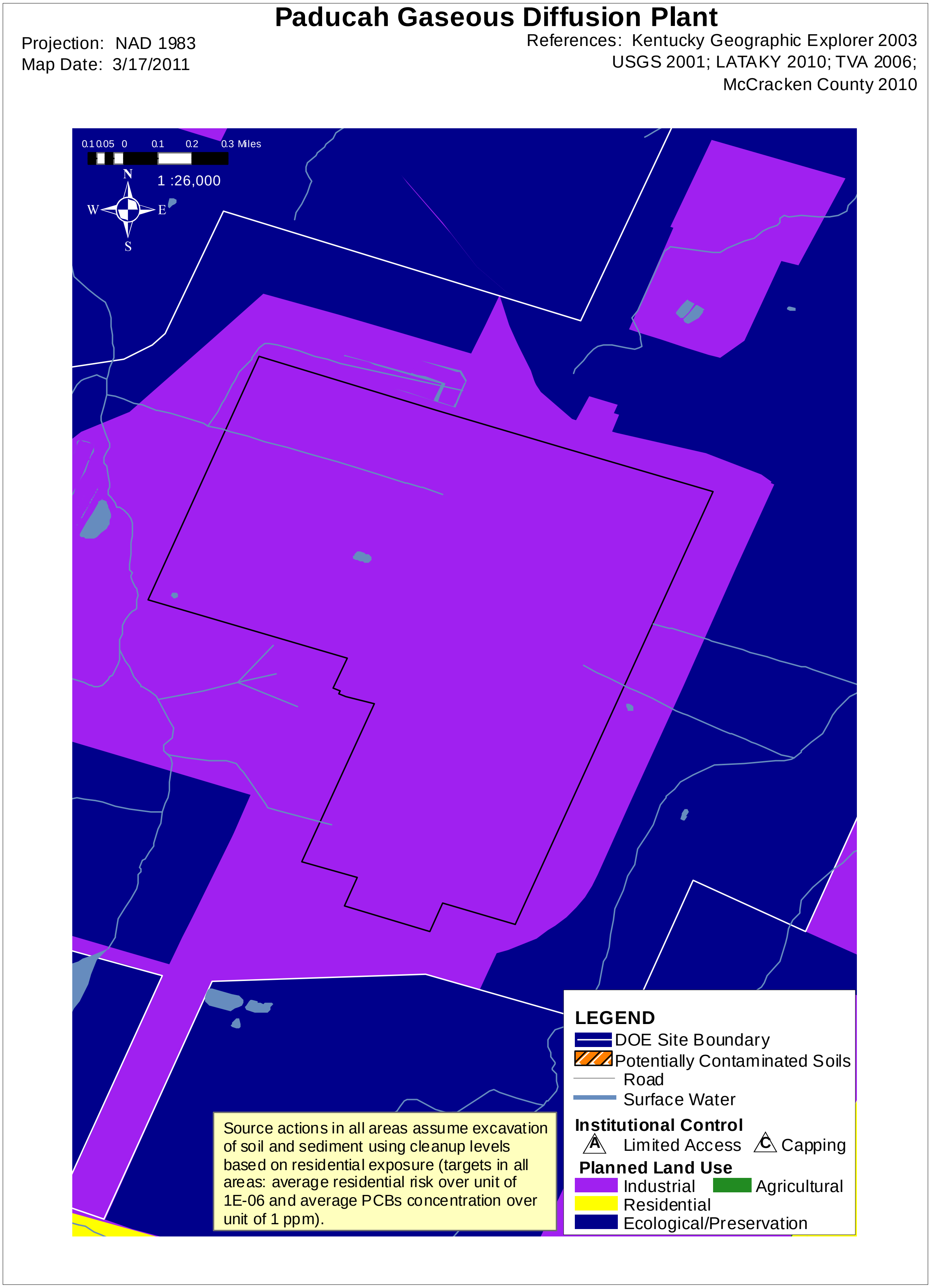
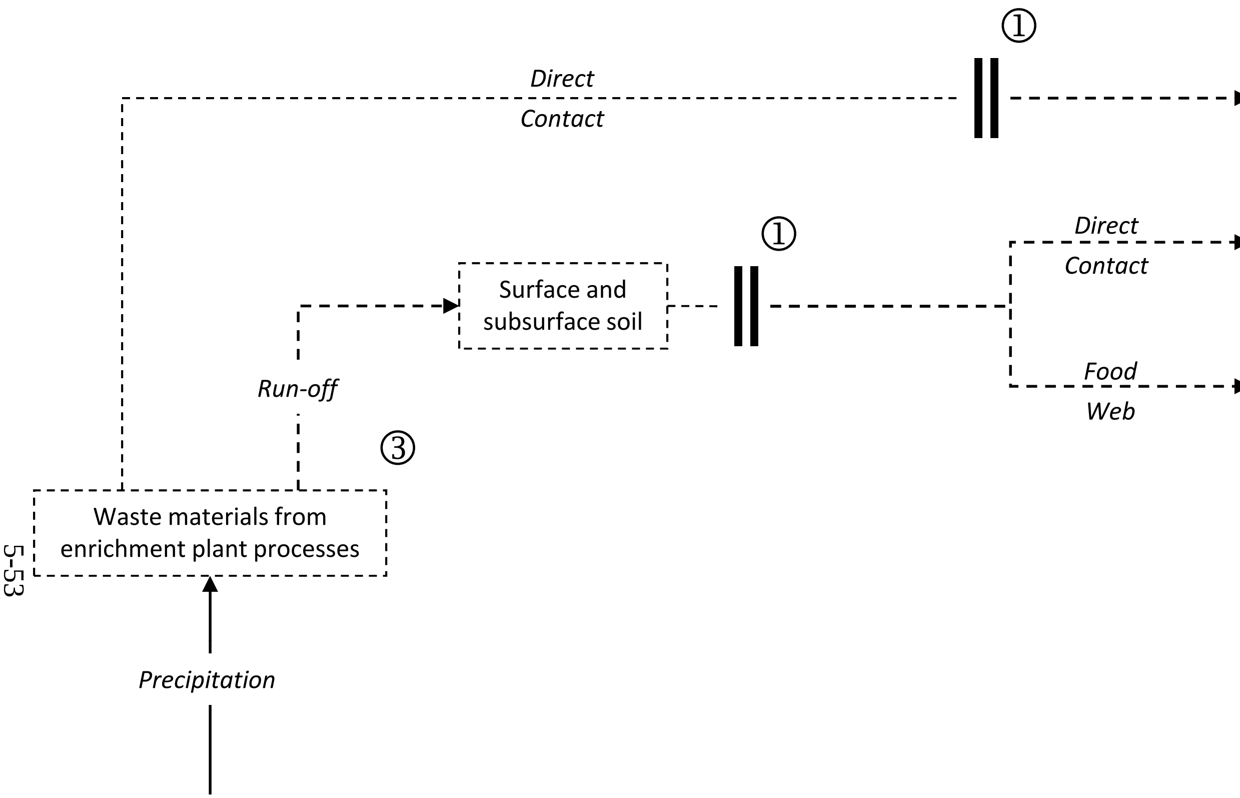


Figure 5.3c1. Hazard Area 3: BGOU (Group 1) - Current Planned End State

Hazard Area 3: Burial Grounds Operable Unit (Group 1) – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
			F

<u>Current Planned Controls and Actions</u>
① Access and excavation restrictions.
③ Excavation of burial grounds.

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.3c2. Hazard Area 3: Burial Grounds Operable Unit (Group 1) – Current Planned End State

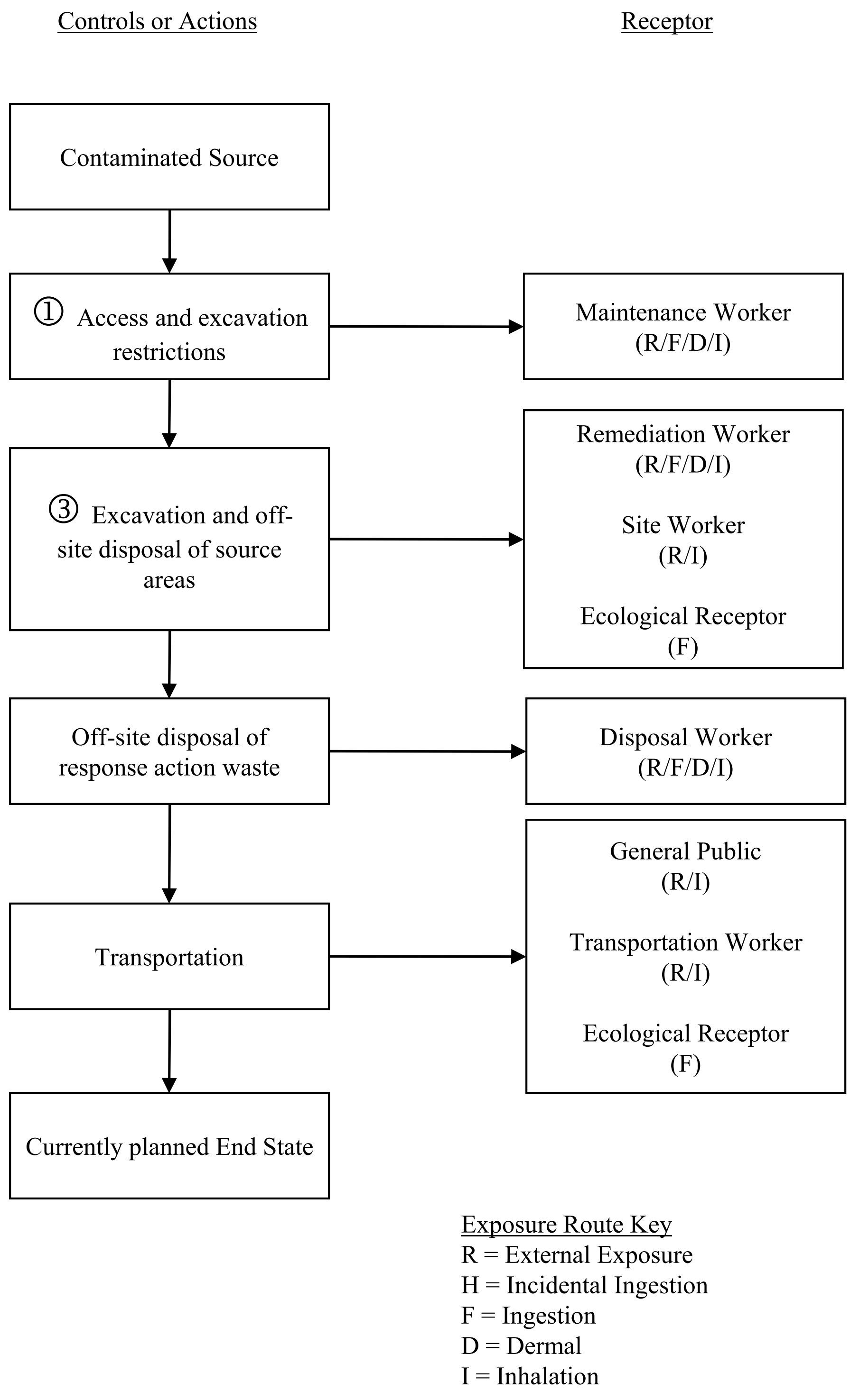


Figure 5.3c3. Hazard Area 3: Burial Grounds OU (Group 1) Treatment Train – Current Planned End State

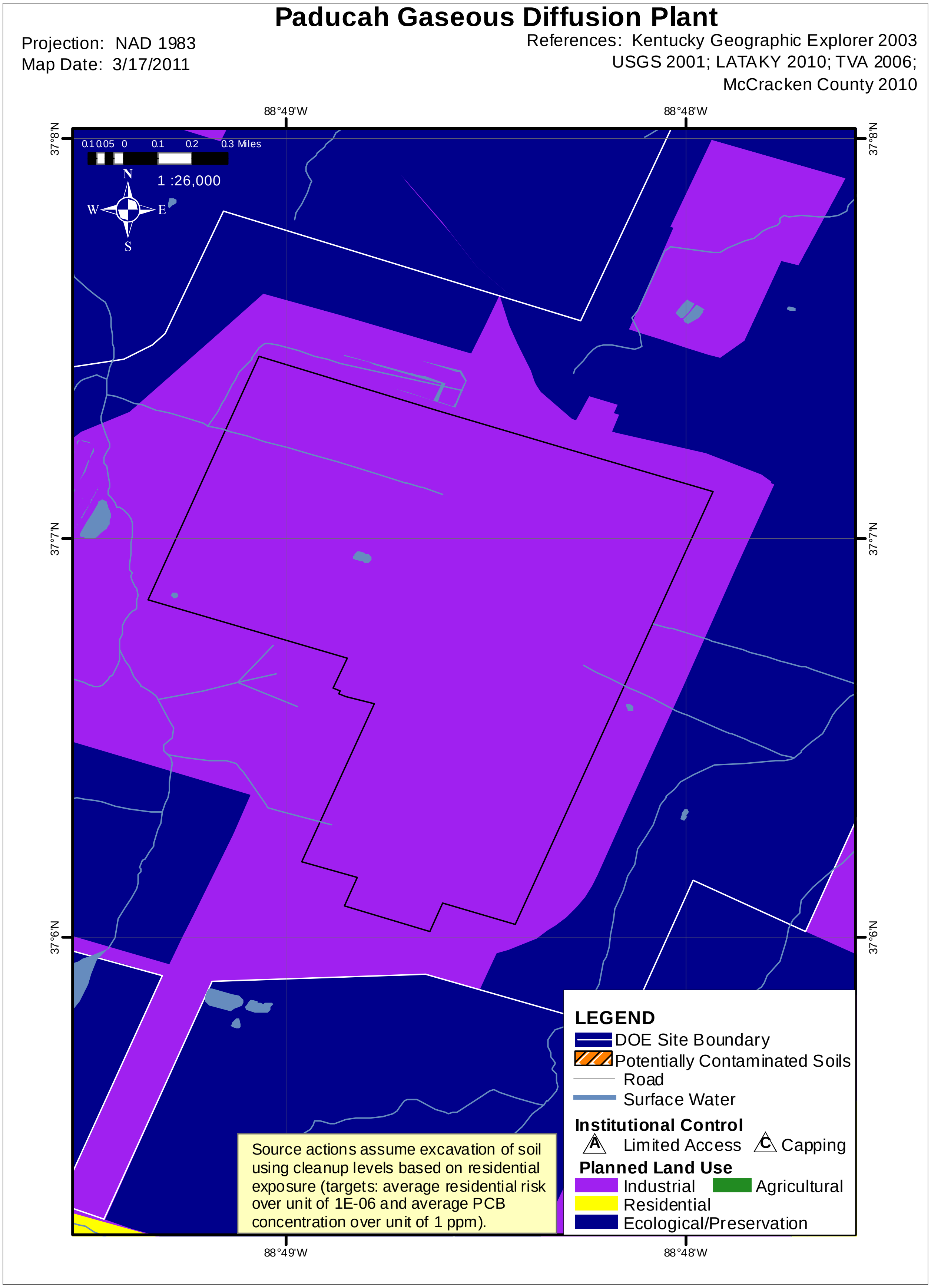
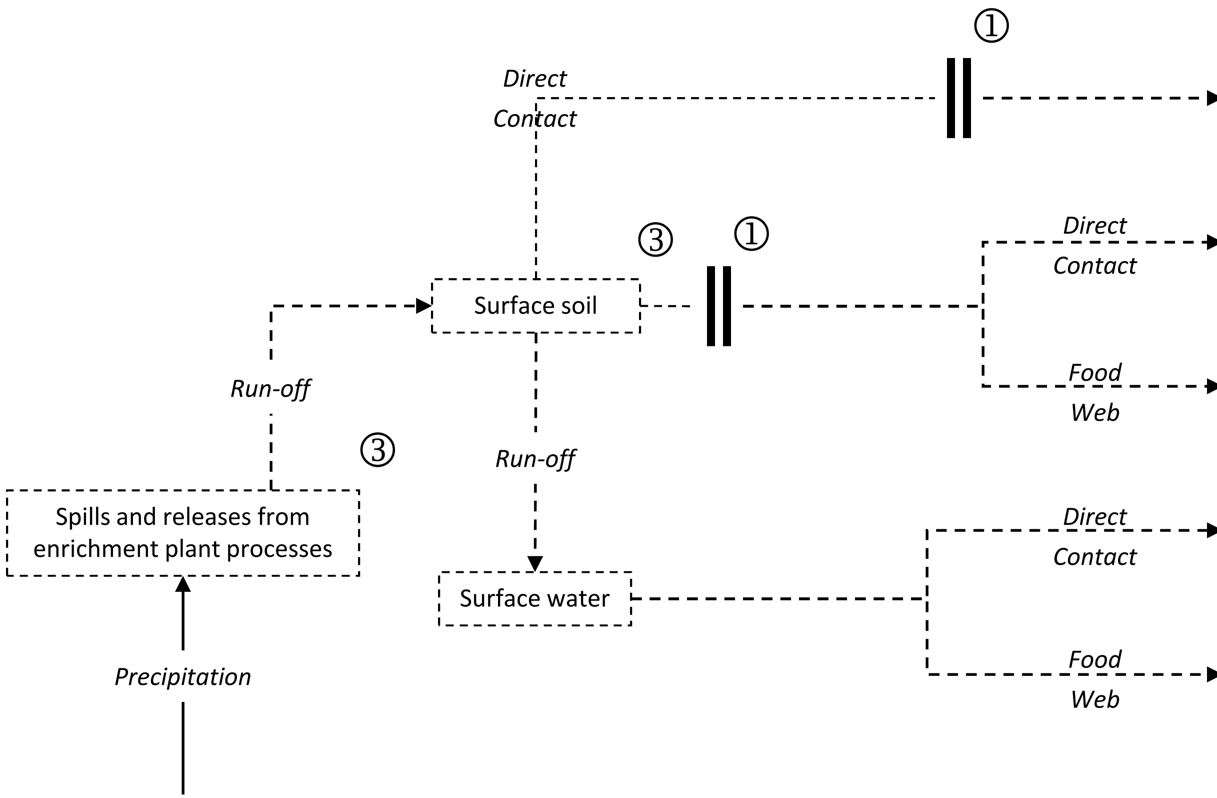


Figure 5.4c1. Hazard Area 4: SOU - Current Planned End State

Hazard Area 4: Soils Operable Unit – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
H/D/I		H/D/I	F/D/I
	F	F	F

<u>Current Planned Controls and Actions</u>
① Access and excavation restrictions.
③ Excavation of soil (target based on average exposure over entire unit: residential risk of 1E-06, PCBs at 1 ppm).

<u>Receptor Key</u>
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.4c2. Hazard Area 4: Soils Operable Unit – Current Planned End State

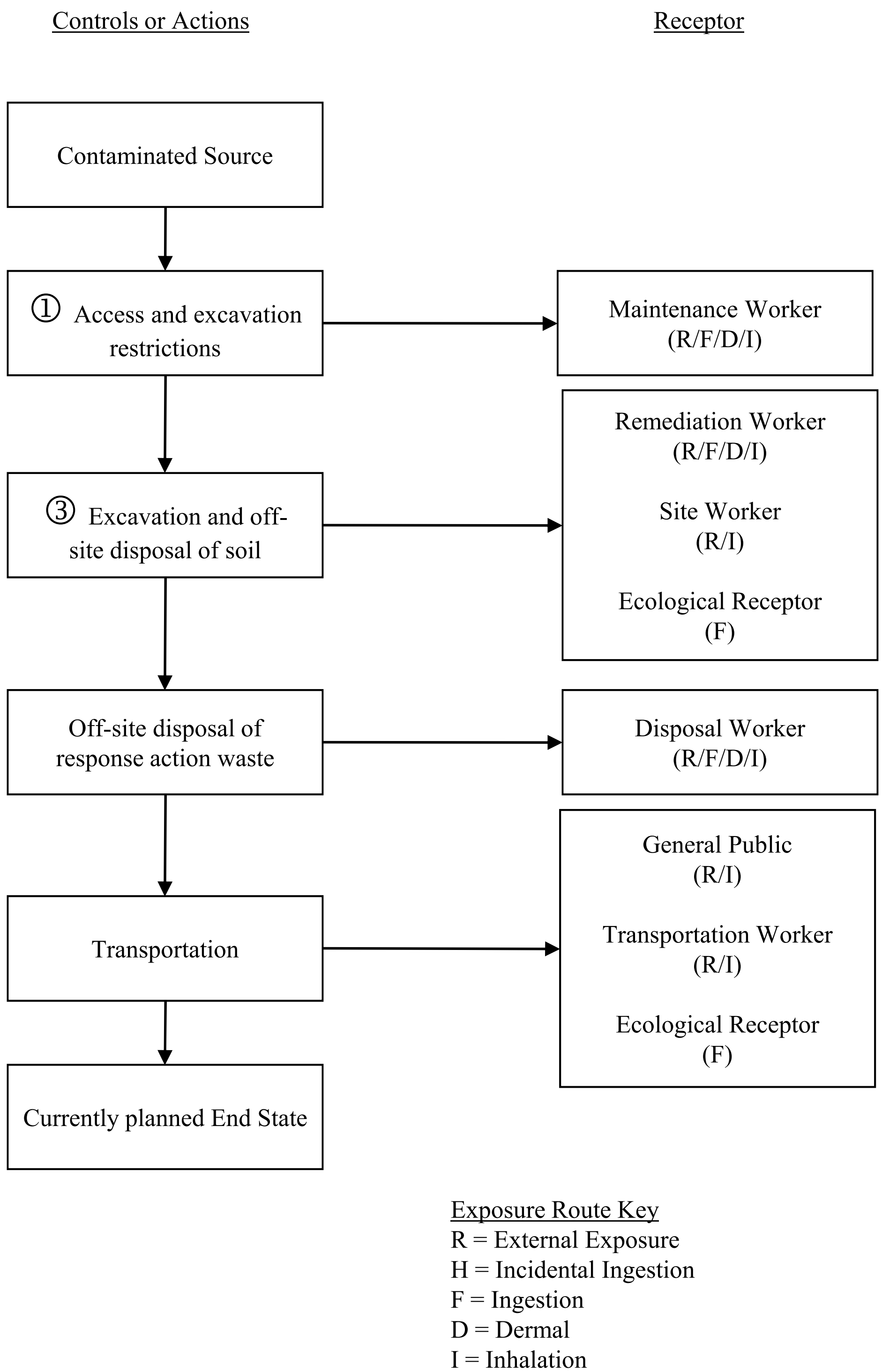


Figure 5.4c3. Hazard Area 4: Soils OU Treatment - Train Current Planned End State

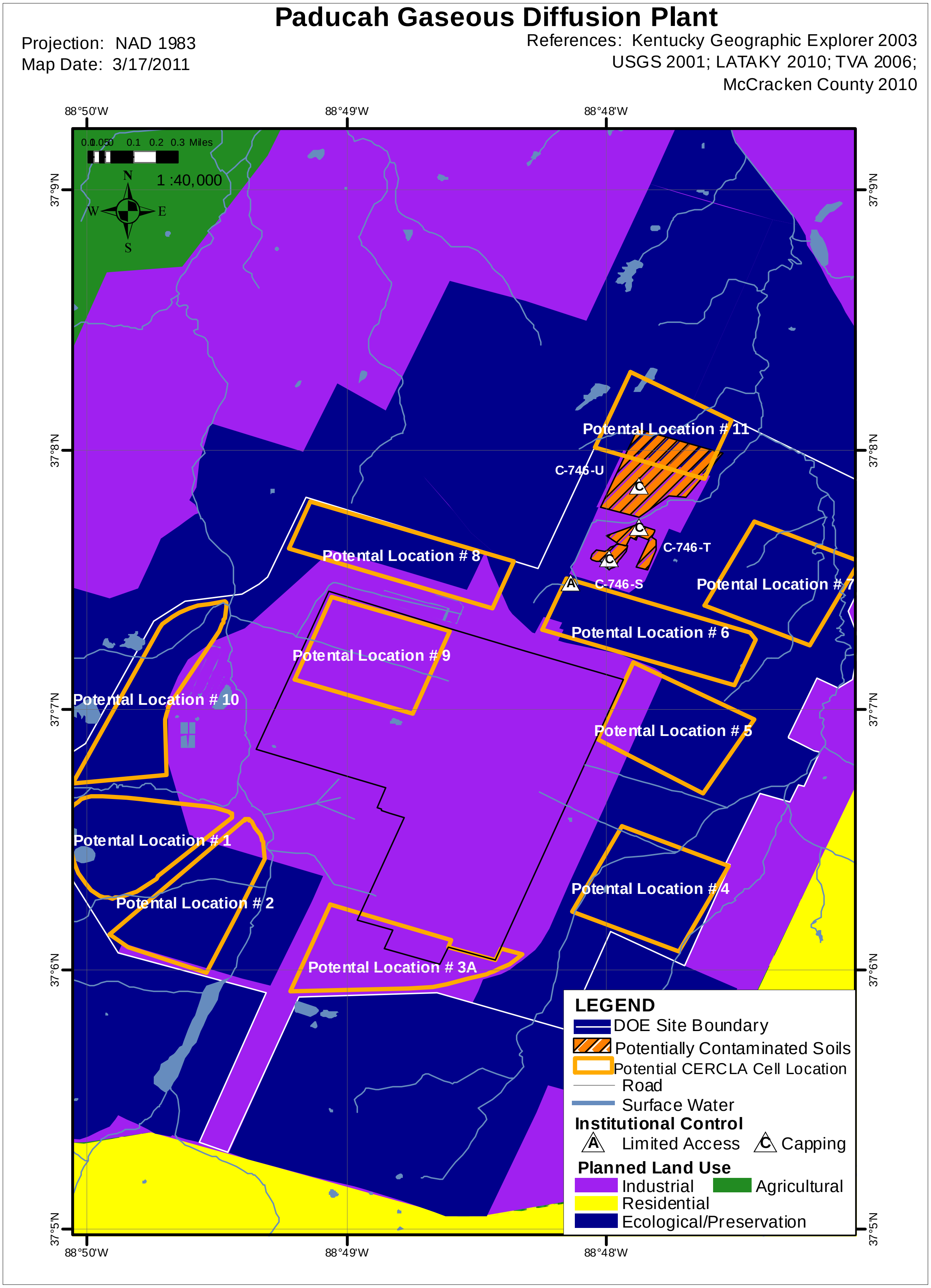
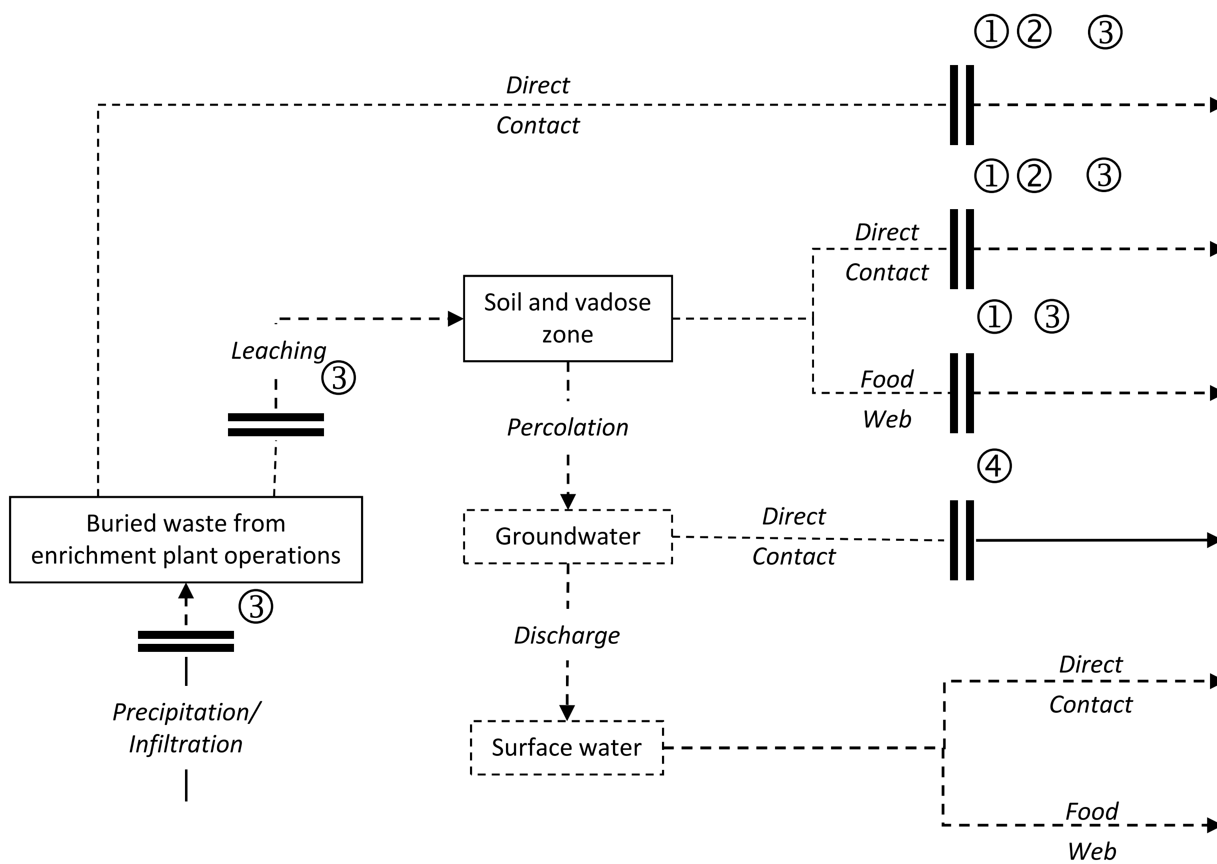


Figure 5.5c1. Hazard Area 5: Permitted Landfills - Current Planned End State

Hazard Area 5 Permitted Landfills – Current Planned End State



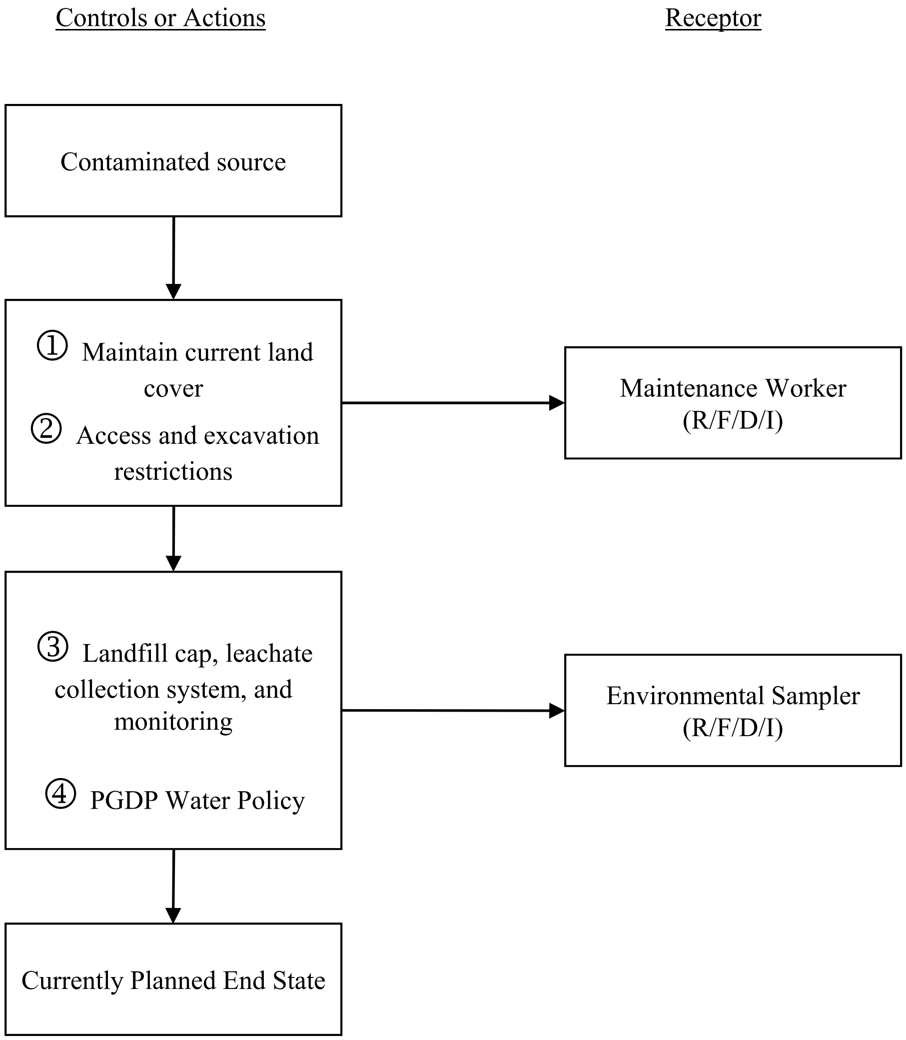
Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

Current Planned Controls and Actions
① Current land cover.
② Access and excavation restrictions.
③ Landfill cap, leachate collection system, and monitoring.
④ PGDP Water Policy.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.5c2. Hazard Area 5 Permitted Landfills – Current Planned End State



Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.5c3. Hazard Area 5: Permitted Landfills Treatment Train – Current Planned End State

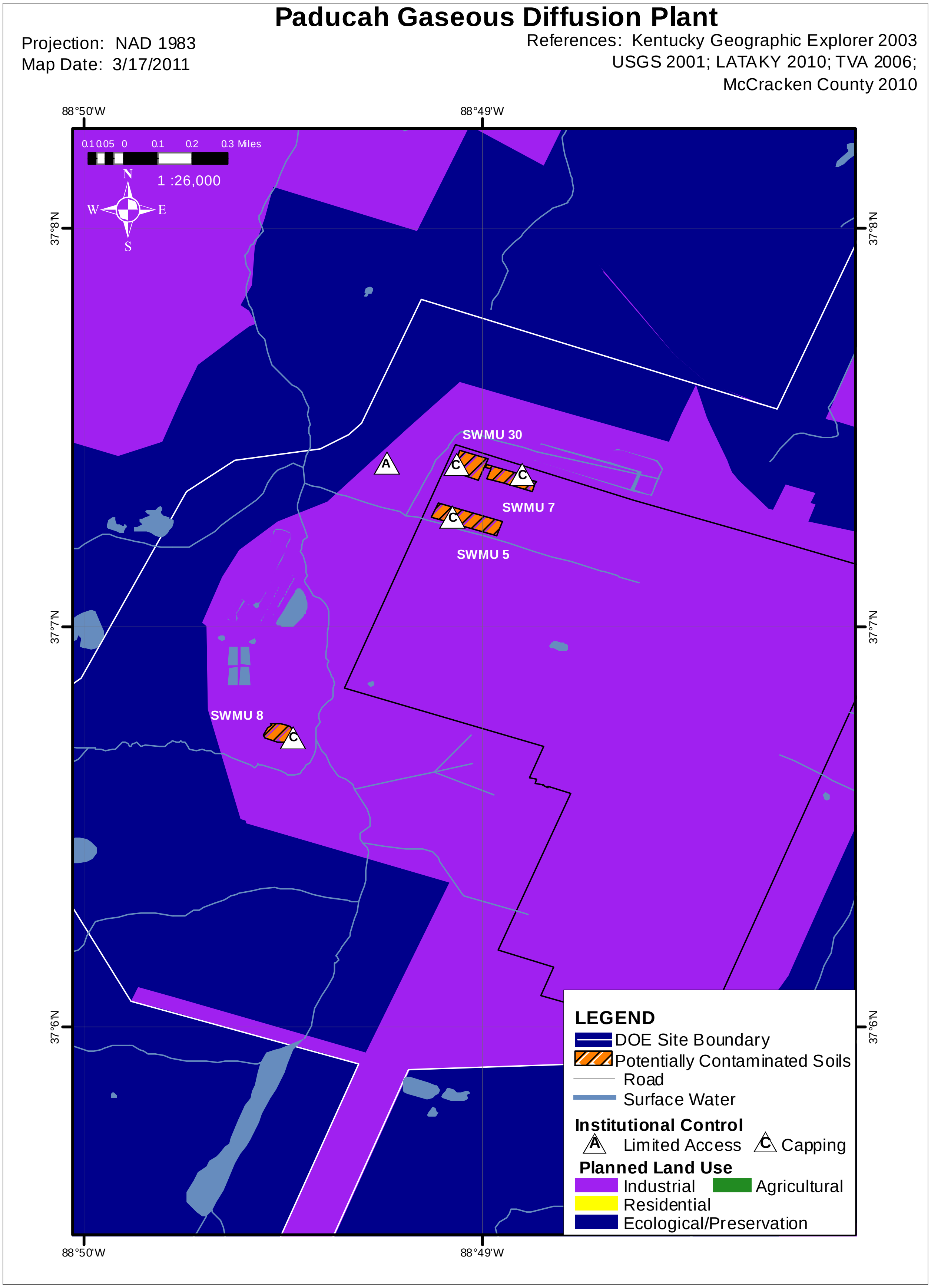
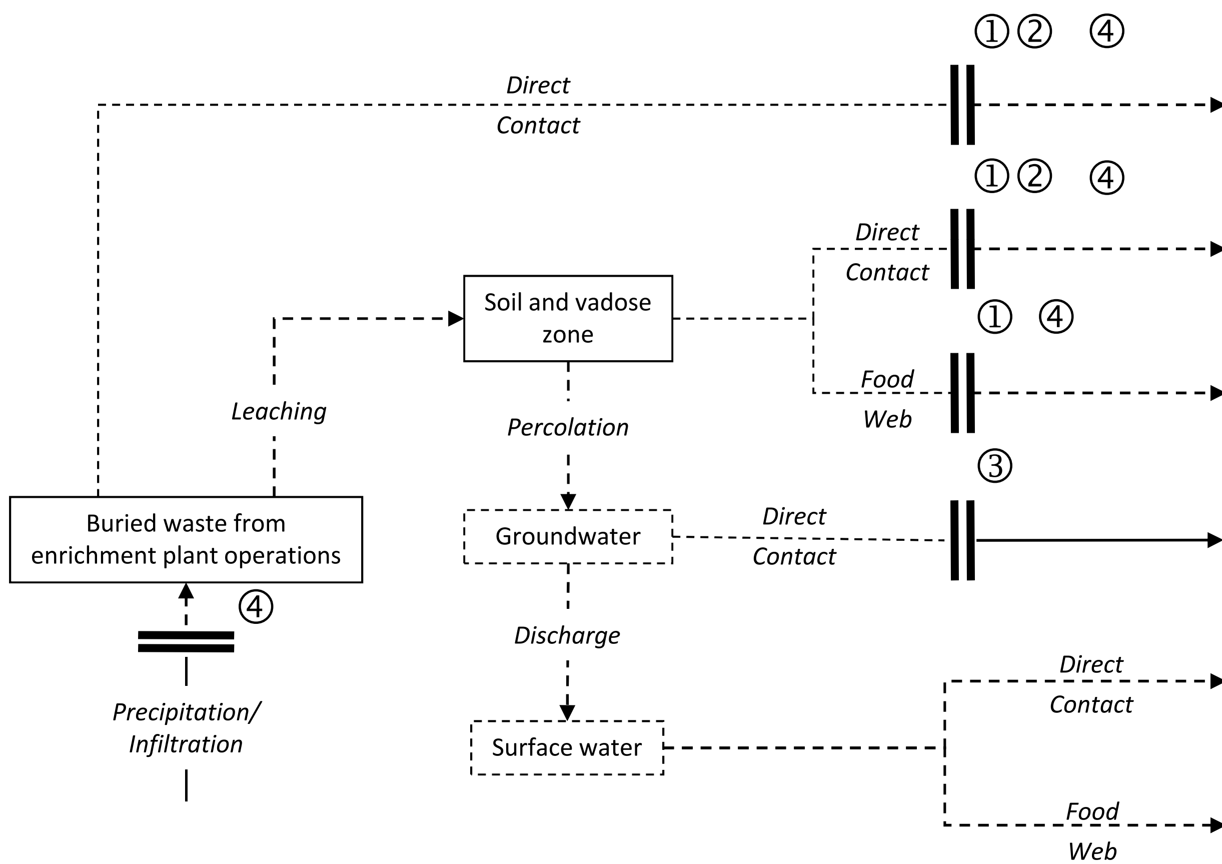


Figure 5.6c1. Hazard Area 6: BGOU (Group 2) - Current Planned End State

Hazard Area 6 Burial Grounds Operable Unit (Group 2) – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
		F	F
R/F/D/I	R/F/D/I		
H/D/I		H/D/I	F/D/I
	F	F	F

Current Planned Controls and Actions
① Current land cover.
② Access and excavation restrictions.
③ PGDP Water Policy.
④ Landfill cap and monitoring.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.6c2. Hazard Area 6: Burial Grounds Operable Unit (Group 2) – Current Planned End State

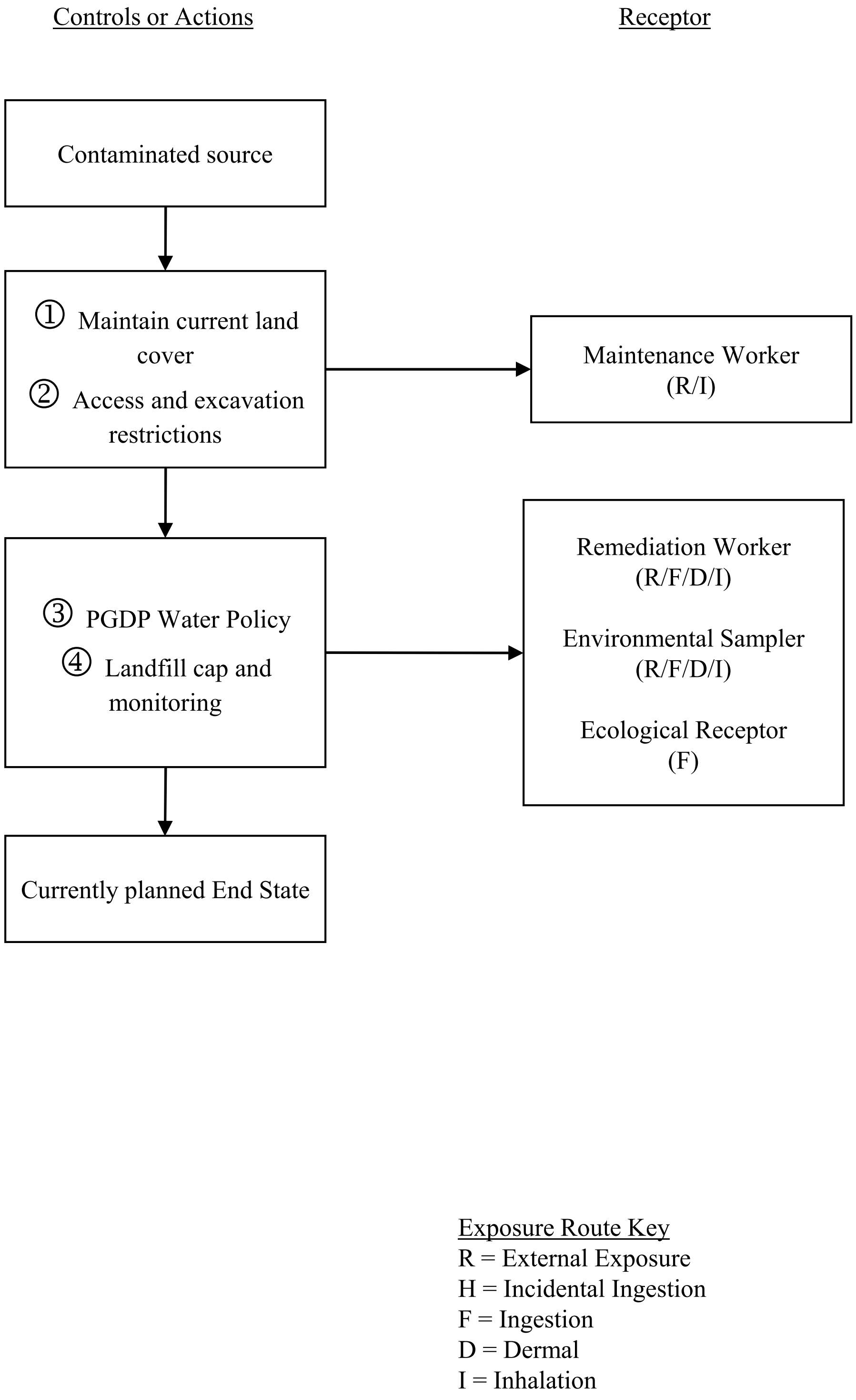


Figure 5.6c3 Hazard Area 6 Burial Grounds Operable Unit Group 2 Treatment Train - Current Planned End State

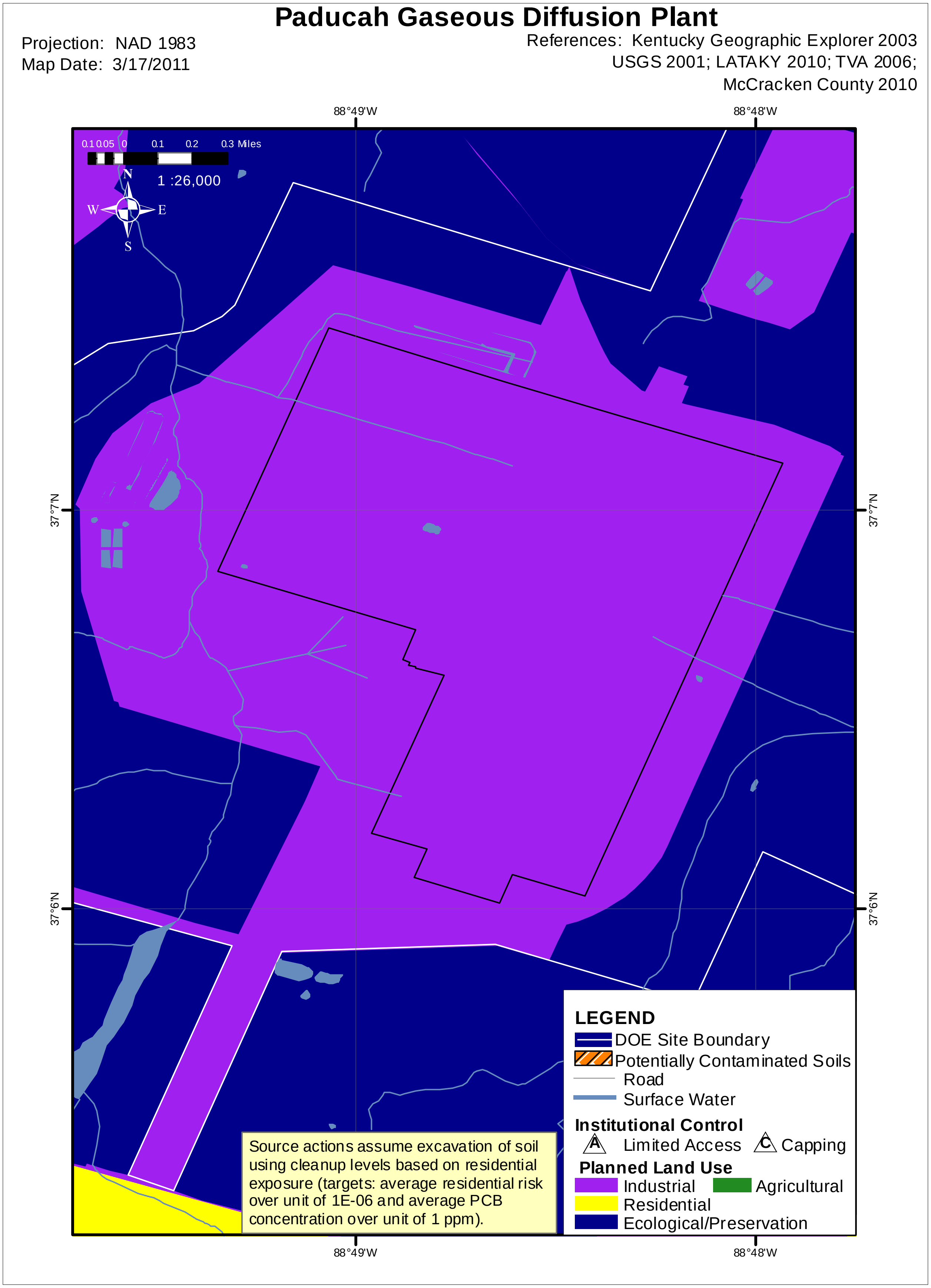
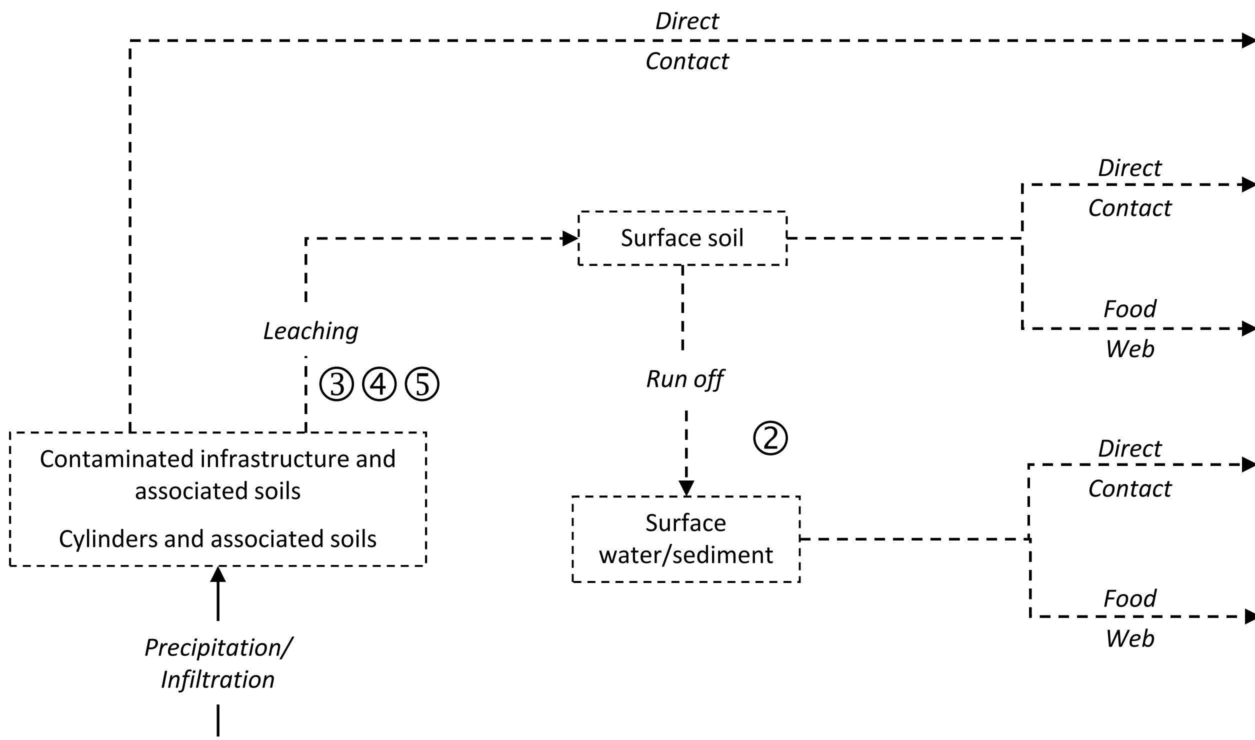


Figure 5.7c1. Hazard Area 7: Cylinder Yards and DUF_6 - Current Planned End State

Hazard Area 7 Cylinder Yards and DUF$_6$ Conversion Facility – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I			R/F/D/I
R/H/D/I			R/F/D/I
		F	F
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

<u>Current Planned Controls and Actions</u>

② Attenuation.
③ Conversion of depleted UF$_6$ and disposal.
④ D&D of infrastructure.
⑤ Excavation of surface soil (target based on average exposure over entire unit: residential risk of 1E-06, PCBs at 1 ppm).

<u>Receptor Key</u>

Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

<u>Exposure Route Key</u>

R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.7c2. Hazard Area 7: Cylinder Yards and DUF$_6$ Conversion Facility – Current Planned End State

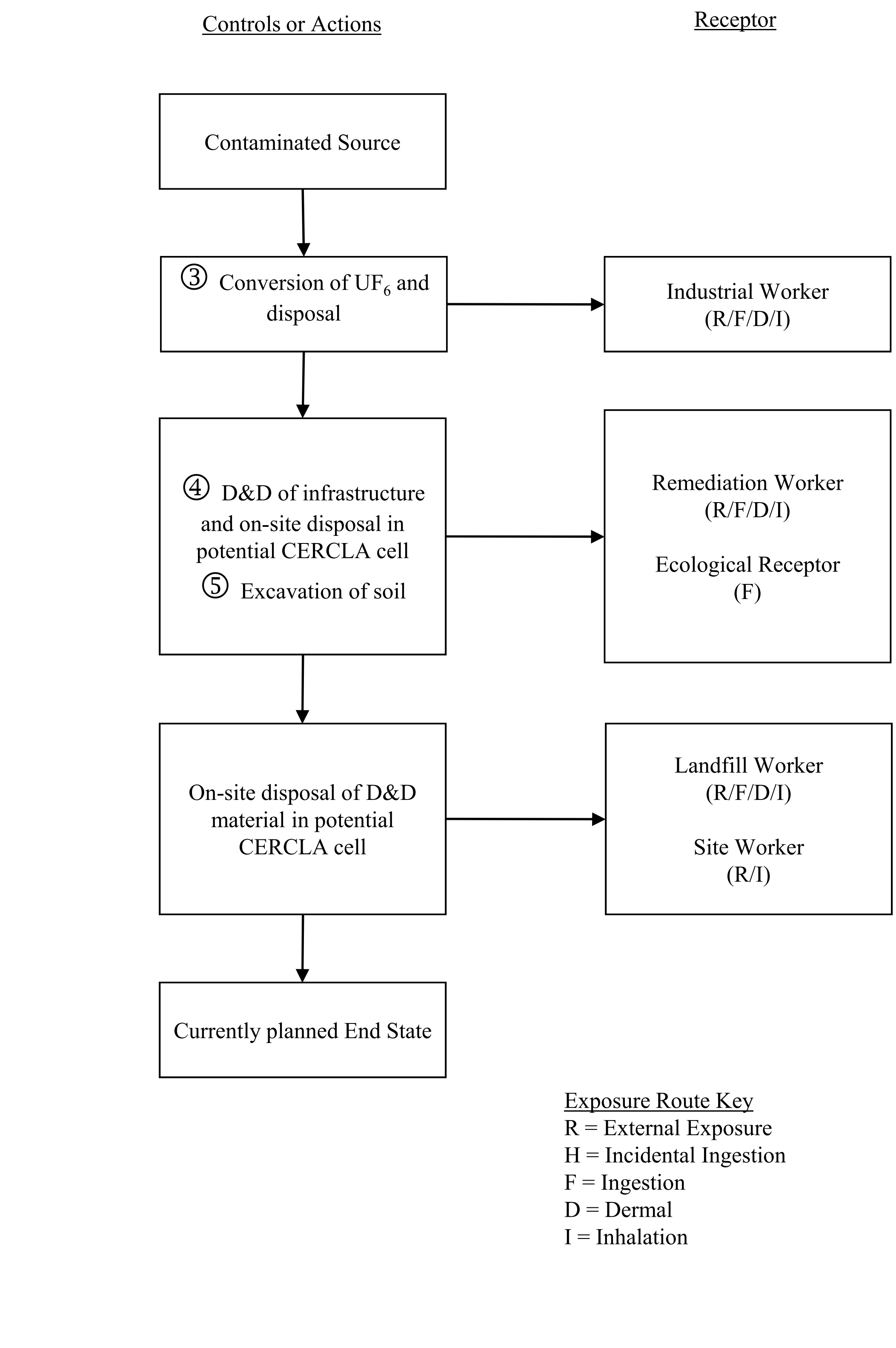


Figure 5.7c3. Hazard Area 7 Cylinder Yards and DUF_6 Conversion Facility Treatment Train Current Planned End State

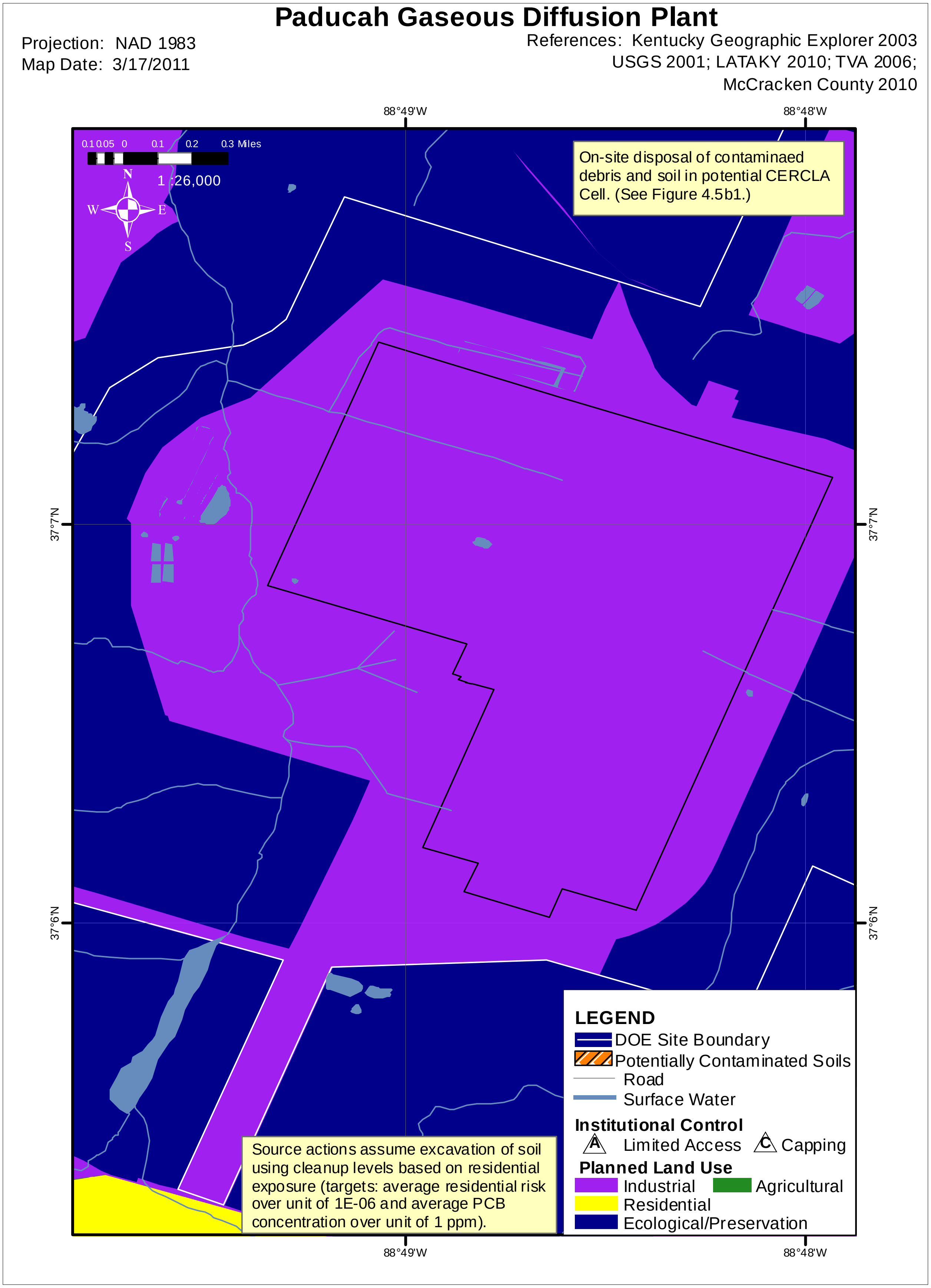
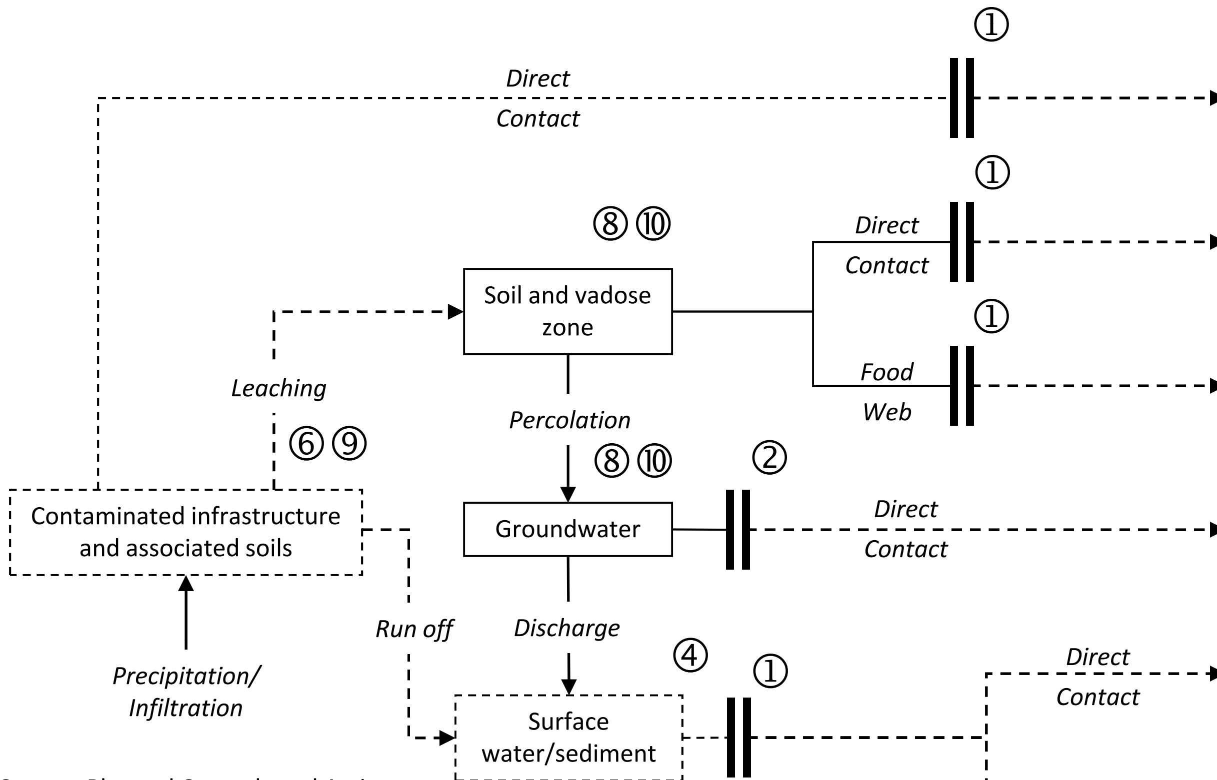


Figure 5.8c1. Hazard Area 8: GDP Facilties - Current Planned End State

Hazard Area 8 GDP Facilities – Current Planned End State



Potential Receptor Exposed			
Worker	Resident	Visitor	Ecological
R/H/D/I		R/H/D/I	R/F/D/I
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F
	R/F/D/I		
R/H/D/I		R/H/D/I	R/F/D/I
	F	F	F

Current Planned Controls and Actions
① Access and excavation restrictions.
② PGDP Water Policy.
④ Attenuation.
⑥ D&D of infrastructure and disposal in potential CERCLA Cell.
⑧ Monitored natural attenuation of sources and plume.
⑨ Excavation of soil (target based on average exposure over entire unit: residential risk of 1E-06, PCBs at 1 ppm).
⑩ Source reduction/removal and active contaminant reduction in dissolved phase plume.

Receptor Key
Worker – includes workers exposed during inside and outside activities, including the remediation worker.
Resident – includes residents engaged in all but recreation activities.
Visitor – includes recreational users, intruders, and trespassers.
Ecological – includes on- and offsite aquatic and terrestrial ecological receptors.

Exposure Route Key
R = External Exposure
H = Incidental Ingestion
F = Ingestion
D = Dermal
I = Inhalation

Figure 5.8c2. Hazard Area 8: GDP Facilities – Current Planned End State

Hazard Area 8: GDP Facilities Treatment Train –Current Planned End State

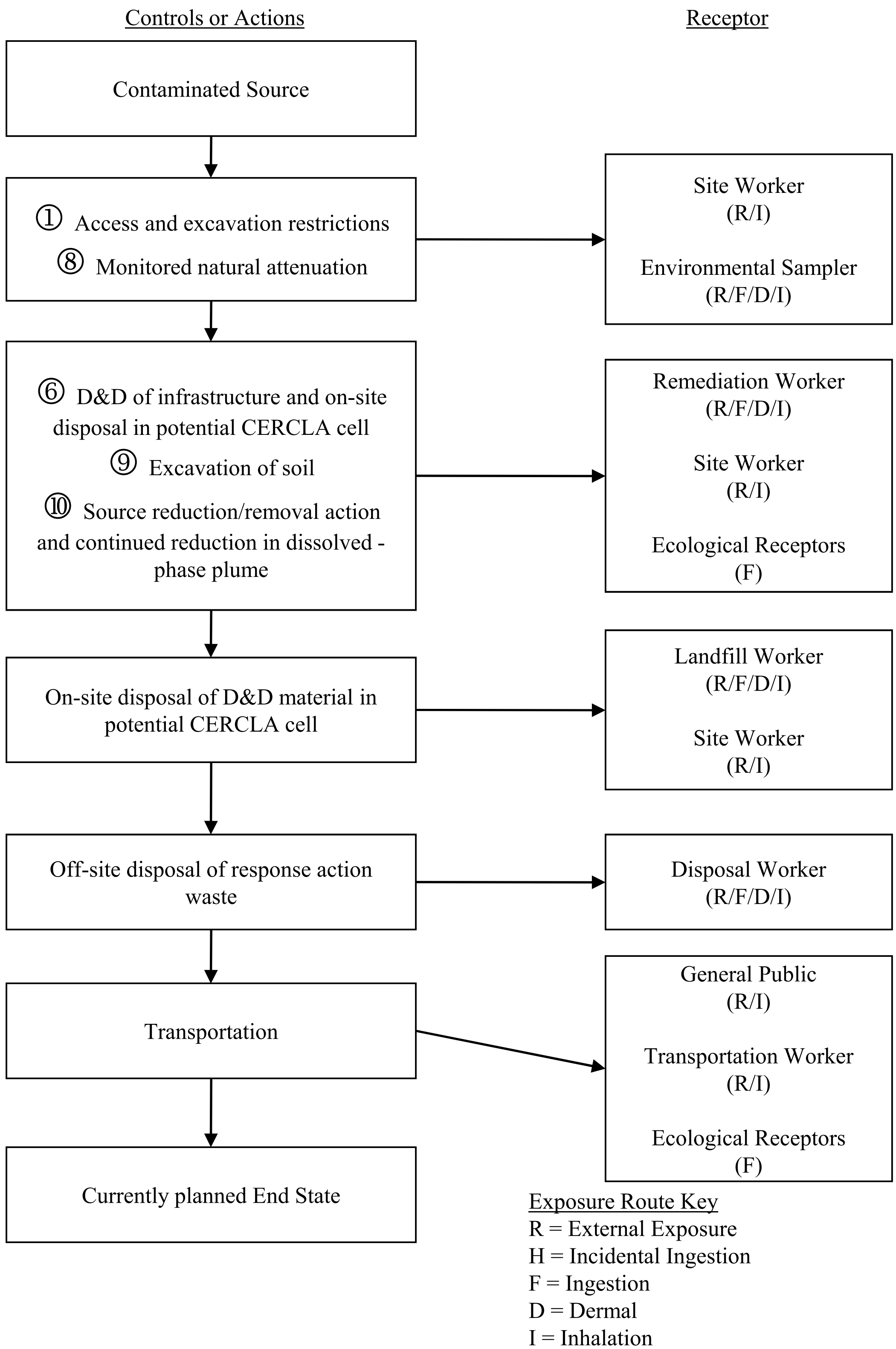


Figure 5.8c3. Hazard Area 8 GDP Facilities Treatment Train - Current Planned End State

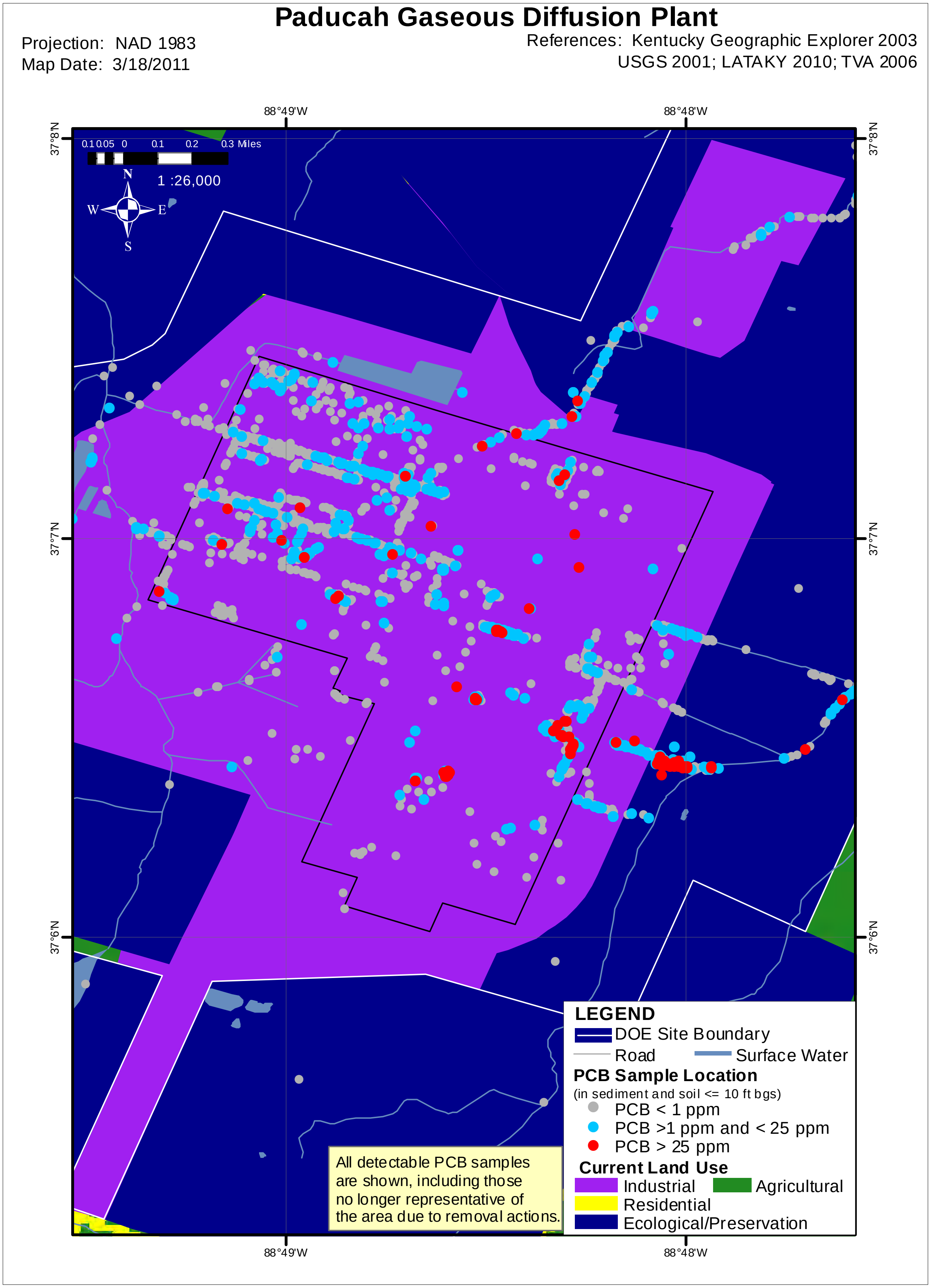


Figure 5.9. PCB Detected in Shallow Soil

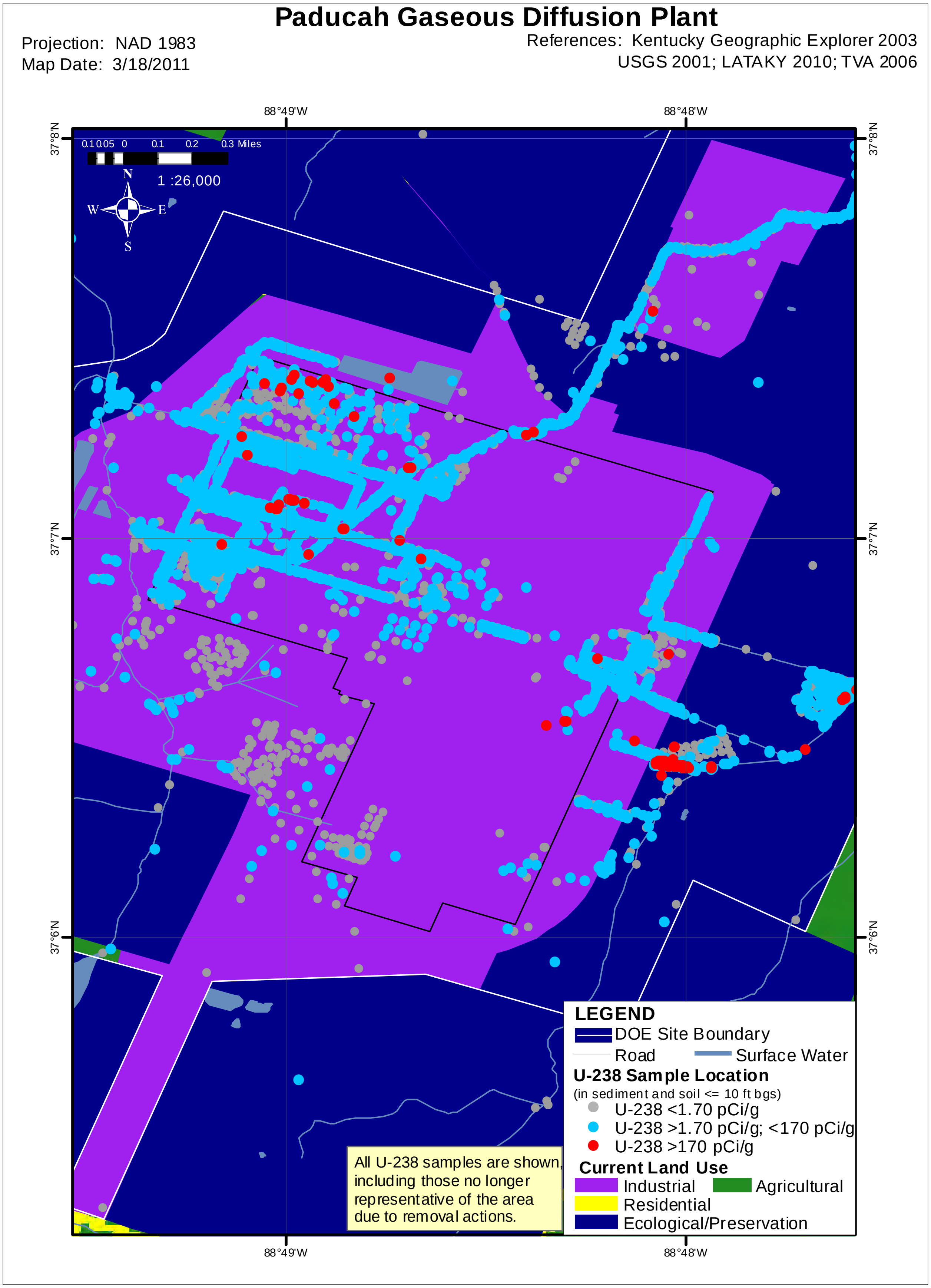


Figure 5.10. Uranium-238 in Shallow Soil

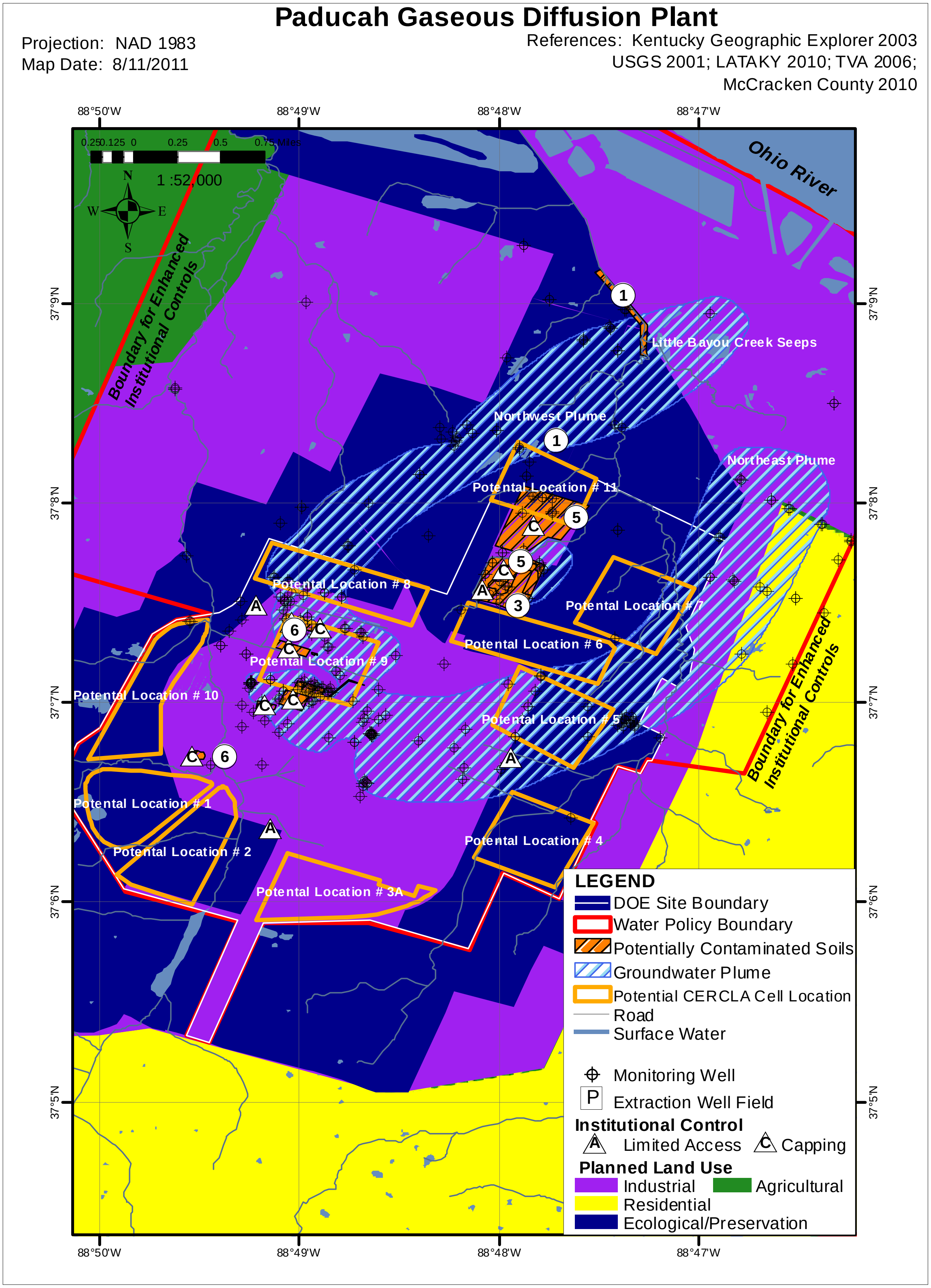


Figure 5.11. Hazard Areas – Potential End State Alternative

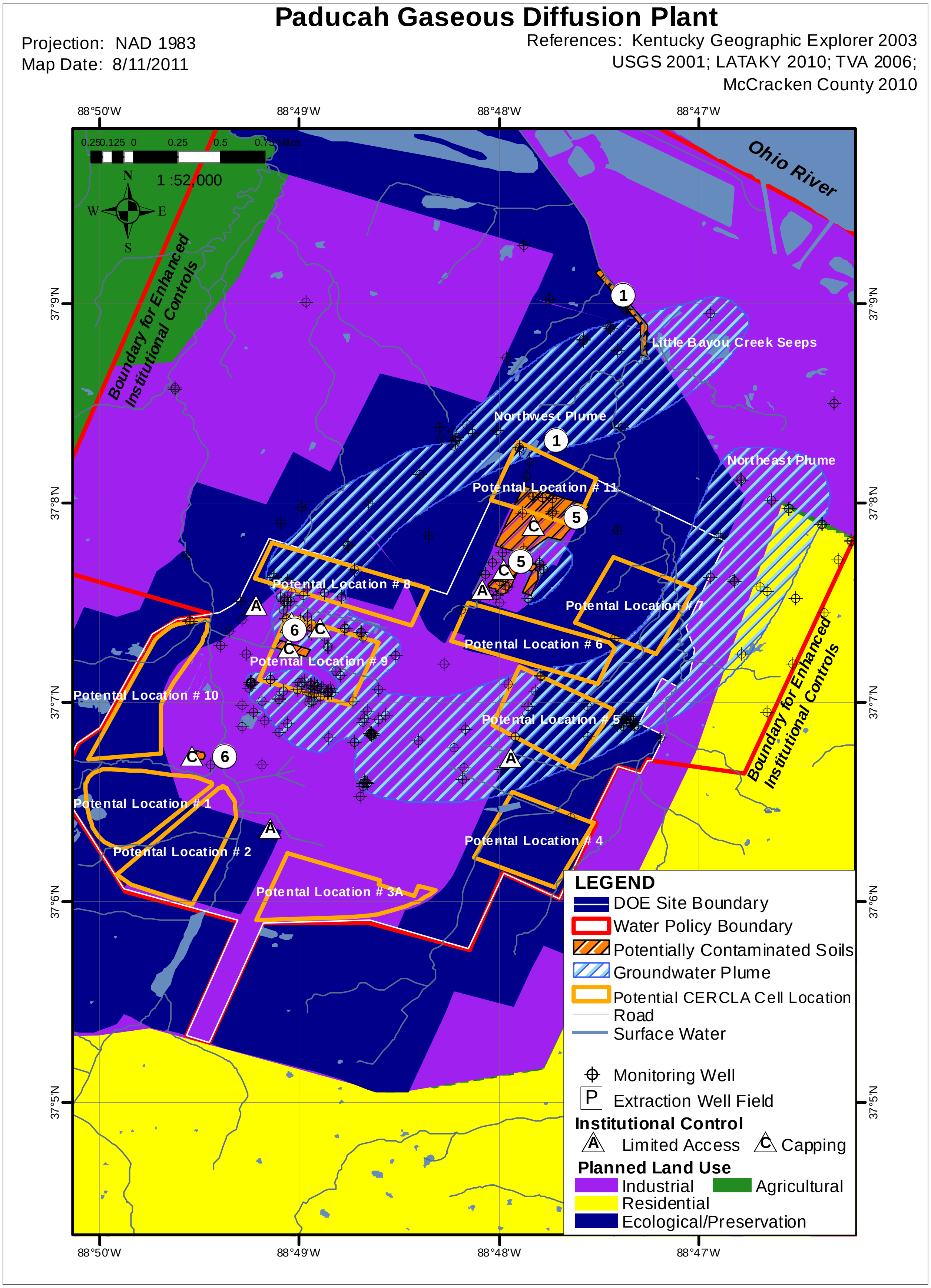


Figure 5.12. Hazard Areas – Current Planned End State

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