Property Acquisition Study for Areas near the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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This report presents the results of a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated water near the Paducah Gaseous Diffusion Plant. The alternatives considered in this study and the associated presentation of those alternatives are not meant to be pre-decisional, but are meant to provide additional insight into a range of actions that could be taken to protect human health and the environment while taking into consideration what is in the best interest of the taxpayers. The ultimate selection of specific actions, including decisions regarding purchase of property or easements on property, will be made in accordance with applicable law and agreements.

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ACRONYMS

ACO	Administrative Consent Order
ARAR	Applicable or Relevant and Appropriate Requirements
C400	Groundwater response action in the vicinity of the C-400 building
CAB	Paducah Gaseous Diffusion Plant Citizens Advisory Board
C-Sparge	Patented oxidation treatment method using ozone bubbles
DCE	dichloroethene
D&D	decontamination and decommissioning
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
ELCR	Excess Lifetime Cancer Risk
EPA	U.S. Environmental Protection Agency
ERH	Electrical Resistance Heating
FS	Feasibility Study
GIS	geographic information system
GWOU	Groundwater Operable Unit
KDOW	Kentucky Division of Water
KDFWR	Kentucky Department of Fish and Wildlife Resources
KRCEE	Kentucky Research Consortium for Energy and the Environment
KRS	Kentucky Revised Statutes
MCL	Maximum Contaminant Level
MODFLOWT	an enhanced groundwater transport model developed by USGS
NCRP	National Council on Radiation Protection
OU	Operable Unit
P&T	Pump and Treat
PGDP	Paducah Gaseous Diffusion Plant
PTZ	Permeable Treatment Zone
PVA	Property Valuation Administrator
RAO	Remedial Action Objective
RGA	Regional Gravel Aquifer
S&M	Surveillance and Maintenance
SDWA	Safe Drinking Water Act
SWMU	Solid Waste Management Unit
^{99}Tc	technetium-99 (TC-99)
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
TMDL	total maximum daily load
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
URD	UCRS, RGA, and dissolved phase response action
USGS	United States Geological Survey
VC	vinyl chloride
VOC	Volatile Organic Compound
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

This study was performed in order to meet requirements established in the Energy and Water Development Appropriations Bill, 2006 (Senate Report 109-084), which states:

"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated water near the [Paducah Gaseous Diffusion Plant] facility site. The study shall evaluate the adequate protection of human health and the environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers."

For this study, the phrase "best interest of the taxpayers" has been interpreted to mean "ensuring protection of human health and the environment from exposure to contaminated groundwater in the most cost effective manner possible." Consistent with these requirements, the following seven tasks were completed:

Identify property overlying and adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways near the Paducah facility.

Using a Geographical Information System (GIS), maps of properties were overlain with existing and projected groundwater plume maps to identify those properties whose groundwater is (or may become) contaminated. Identified properties were subdivided into four broad classifications: 1) DOE-owned property, 2) private property, 3) TVA-owned property, and 3) properties associated with the West Kentucky Wildlife Management Area. Since the DOE-owned property, TVA-owned property, and properties associated with the West Kentucky Wildlife Management Area are owned by governmental agencies, the focus of the study was restricted to private properties. Detailed information about the private properties was obtained using information from the McCracken County Valuation Administrator. A database was created for use with a Geographic Information System (GIS) to support the project in the evaluation of property costs. Privately owned parcels potentially impacted by contaminated groundwater (identified through modeling) included 64 farm parcels (5,783 acres) and 101 rural residential parcels (271 acres).

Delineate approaches for property purchase or for obtaining other legal interests in the private properties to limit or eliminate exposure to contaminated groundwater.

A range of property acquisition alternatives were identified and evaluated for use in restricting the access of private property owners to contaminated groundwater. These alternatives included outright property purchase through fee simple ownership and a range of restrictive easements.

Develop cost estimates for acquiring interests in private property based upon the approaches for property purchase or for obtaining other legal interests.

A simplified mass appraisal approach was used to estimate fair market purchase costs for fee simple and easement interests based on the highest and best use of the private parcels. Recent sales of rural residential and agricultural properties were used to develop unit value ranges ($115,293-$133,301/residential parcel; $2,705-$3,016/agricultural acre). Purchase values based upon the potential value of agriculture land converted for development purposes were also considered ($6,441-$7,500/acre). Easement values were estimated for a range of property use restrictions (limited scope, expanded scope, and monitoring access) for both residential and agricultural properties (ranges of $1-$33,325/residential parcel and $400-$2,700/agricultural acre).

Summarize remedial action assumptions for response actions directed at primary, secondary, and dissolved phase sources contributing contamination to groundwater.

Remedial action assumptions contained in reports produced earlier by DOE were examined. In these reports, which contained remedial technology screening, DOE identified twelve technologies that have the potential to reduce the toxicity, volume, and mobility of contaminants present in primary source, secondary source, and dissolved phase plume areas. Estimated costs and potential level of contaminant reduction were tabulated for these technologies. Four different groundwater response actions made up of combinations of the twelve technologies were selected to determine what property might be required to ensure *"adequate protection of human health and the environment from exposure to contaminated groundwater"* while also ensuring a final solution that *"is in the best interest of taxpayers."*

Utilize numerical modeling to determine how groundwater contaminant migration could differ in the future.

Predictions of the maximum extent of the contaminant plumes over a 100-year period were modeled to identify properties potentially impacted by contaminated groundwater. In completing this work, four potential response action scenarios were considered. In addition, the changes in contaminant migration that might occur if the plant ceased operations were also considered.

Identify conditions necessary to render property acquisition cost-effective while ensuring protection for human health and the environment.

Conditions were identified that would ensure protection of human health in the most cost effective manner. In this analysis, a combination of groundwater response actions and mechanisms to limit or eliminate exposure to contaminated groundwater (property purchase or restrictive easements) were considered.

Complete an economic analysis of the potential purchase options through integration with information on groundwater response actions.

Costs of different property acquisition alternatives were determined for each of the four potential response actions considered. These costs were summarized in tables.

Study Assumptions:

- All models by definition represent approximations of reality. The computer models used in this study rely upon field and laboratory point data to simulate the physical and chemical conditions that occur in the environment. As such, the baseline PGDP groundwater flow and transport model has been routinely updated with critical field data to reflect, as accurately as possible, the groundwater flow and contaminant transport system at the PGDP. However, there are several model input parameters that, under the present state of knowledge at the PGDP, are uncertain and could change in the future based upon ongoing environmental field projects. Changes in those uncertain parameters could result in significant changes to the results of the baseline models and models utilized for this study. Should data become available for any of these uncertain parameters, the baseline and current model for this study should be reviewed to ensure that prediction of future groundwater conditions and affect of remedial responses remain accurate.

- The ultimate potential extent of each plume was determined by adding a 1000 foot buffer around the modeled maximum extent of the plume. This was done to accommodate potential uncertainties associated with the groundwater modeling and to account for any further movement of the plume due to any groundwater pumping that might occur beyond the plume area.

- With the exception of a 1400 acre property on the west side of the PGDP, an entire property was assumed to be impacted if any part of the property was predicted to be impacted by the groundwater plume modeling.

- Both property purchase and restrictive easement property acquisition alternatives were assumed to be implemented at the beginning of the evaluation period for all impacted properties, regardless of the exact time over which a property was determined to be impacted.

- The estimated cost of each evaluated property acquisition alternative was determined using an average or zonal analysis as opposed to an individual property analysis, consistent with the "Uniform Appraisal Standards for Federal Property Acquisition."

- For the purposes of mass appraisal of properties in the study area, it was assumed that the "highest and best uses" of the property are farmland (the antecedent land use) and rural residential development (the consequent dominant development pattern outside the publicly-owned properties). This assumption meets the tests of general property valuation. Although McCracken County has a zoning ordinance and industrially zoned property surrounding the PGDP site, land use conversion of private properties to industrial use is neither likely nor probable given the current economic environment in the county. Based on this rationale, the assumed "highest and best" land use for this property valuation analysis results in only two parcel classifications: farm and rural residential.

- The subdivision of properties into either rural residential and farm (agricultural) was made solely on the basis of area. Consistent with the Kentucky Water Quality Act, all properties equal to or greater than 10 acres were assumed to be agricultural and all properties less than 10 acres were assumed to be rural residential.

- The total cost associated with a particular land use classification (e.g. rural residential or agricultural) was determined by multiplying the total number of rural residential parcels or total acreage of agricultural parcels by a corresponding average unit cost. The resulting unit costs were thus not reflective of the actual value of a particular individual property, but simply reflective of the average value of the aggregate set evaluated.

- The cost of each property purchase alternative was estimated assuming that the Water Policy would be terminated. The cost of each property easement alternative was estimated assuming the Water Policy would be continued. If the Water Policy is terminated, it is assumed that the easement costs would range between the current estimate and a value equal to the sum of the current estimate and the cost of the Water Policy.

- In the case of a restrictive easement, it was assumed that the property owner would be given a lump sum payment today for the restrictive use of his or her property over an indefinite extended period (e.g., 100 years).

- Consistent with the existing Water Policy, it was assumed that no new properties would be added through the subdivision of existing properties. However, it was assumed that properties would be added to the Water Policy if the groundwater modeling indicated that any properties beyond the existing Water Policy area would be impacted.

General Findings:

- An analysis of a range of possible property acquisition options under several different potential response action scenarios reveals that the total cost of acquiring properties (regardless of the approach) is essentially independent of the response actions considered. Thus, even if all contaminant sources were removed today, residual, dissolved-phased contamination will remain under impacted properties and will likely spread and impact new properties throughout the expected life of most current residents.

- The property acquisition analysis suggests that fee simple interests, easements, and a combination of these approaches are possible alternatives to limit or prevent exposure to contaminated groundwater by potential receptors. Acquisition of other legal interests may not be as appropriate, but identifying and eliminating a variety of other pre-existing interests in the property may be necessary for the purchase of easements or fee simple interests.

- While the property purchase alternatives are generally more expensive than restrictive easements, additional factors may directly influence such a comparison. For example, outright purchase of properties may minimize or eliminate future liabilities that may continue to exist with a restrictive easement alternative. Conversely, property purchase alternatives may carry with them additional potential maintenance or demolition costs that may be avoided through the use of restrictive easements. Due to future uncertainties associated with these issues, neither factor was explicitly quantified in this study, however both factors should be implicitly considered when weighing alternatives.

This report presents the results of a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated water near the Paducah Gaseous Diffusion Plant. The alternatives considered in this study and the associated presentation of those alternatives are not meant to be pre-decisional, but are meant to provide additional insight into a range of actions that could be taken to protect human health and the environment while taking into consideration what is in the best interest of the taxpayers. The ultimate selection of specific actions, including decisions regarding purchase of property or easements on property, will be made in accordance with applicable law and agreements.

INTRODUCTION

1.1 SCOPE OF STUDY

This project was performed in order to meet requirements established in the Energy and Water Development Appropriations Bill, 2006 (Senate Report 109-084), which states:

"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated water near the [Paducah Gaseous Diffusion Plant] facility site. The study shall evaluate the adequate protection of human health and the environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers."

For this study, the phrase "best interest of the taxpayers" has been interpreted to mean "ensuring protection of human health and the environment from exposure to contaminated groundwater in the most cost effective manner possible." Consistent with these requirements, the following seven tasks were performed:

Identify property overlying and adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways near the Paducah facility.

Delineate approaches for property purchase or for obtaining other legal interests in the private properties to limit or eliminate exposure to contaminated groundwater.

Develop cost estimates for acquiring interests in private property based upon the approaches for property purchase or for obtaining other legal interests.

Summarize remedial action assumptions for response actions directed at primary, secondary, and dissolved phase sources contributing contamination to groundwater.

Utilize numerical modeling to determine how groundwater contaminant migration could differ in the future.

Identify conditions necessary to render property acquisition cost-effective while ensuring protection for human health and the environment

Complete an economic analysis of the potential purchase options through integration with information on groundwater response actions.

When identifying private properties potentially impacted by contaminated groundwater as the plumes migrate from their current locations, modeling considered both the continuation of current conditions and plant closure. Additionally, predictions of impacted properties were developed assuming each of four response action scenarios. However, due to uncertainties in plant decontamination and decommissioning, the impacts of infrastructure removal (e.g., removal of the large process buildings) on groundwater migration were not considered.

In addition to completing the technical tasks, significant public interaction occurred during this project. The materials developed during this activity and summaries of public briefings are also included in this report (Appendix H).

1.2 GENERAL SITE INFORMATION

The Paducah Gaseous Diffusion Plant (PGDP) is an active uranium enrichment facility located approximately 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River in the western part of McCracken County (Figure 1.2.1). The plant is on a U.S. Department of Energy (DOE) reservation; the total acreage is divided as follows:

- 748 acres-within a restricted area that encompasses plant industrial operations;
- Approximately 822 acres uninhabited buffer zone surrounding the restricted area; and
- 1986 acres - leased to Commonwealth of Kentucky as part of West Kentucky Wildlife Management Area. (WKWMA).

Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation occupied by the Shawnee Steam Plant. Several private properties (both agricultural and rural residential) border the DOE reservation to the east and west (Figure 1.2.2).

Following the initial discovery of contamination in nearby drinking water wells, DOE initiated a Water Policy, which provides potable water to properties overlying or potentially overlying a contaminated groundwater plume. The boundary of the area encompassed by the Water Policy is shown in red in Figure 1.2.2.

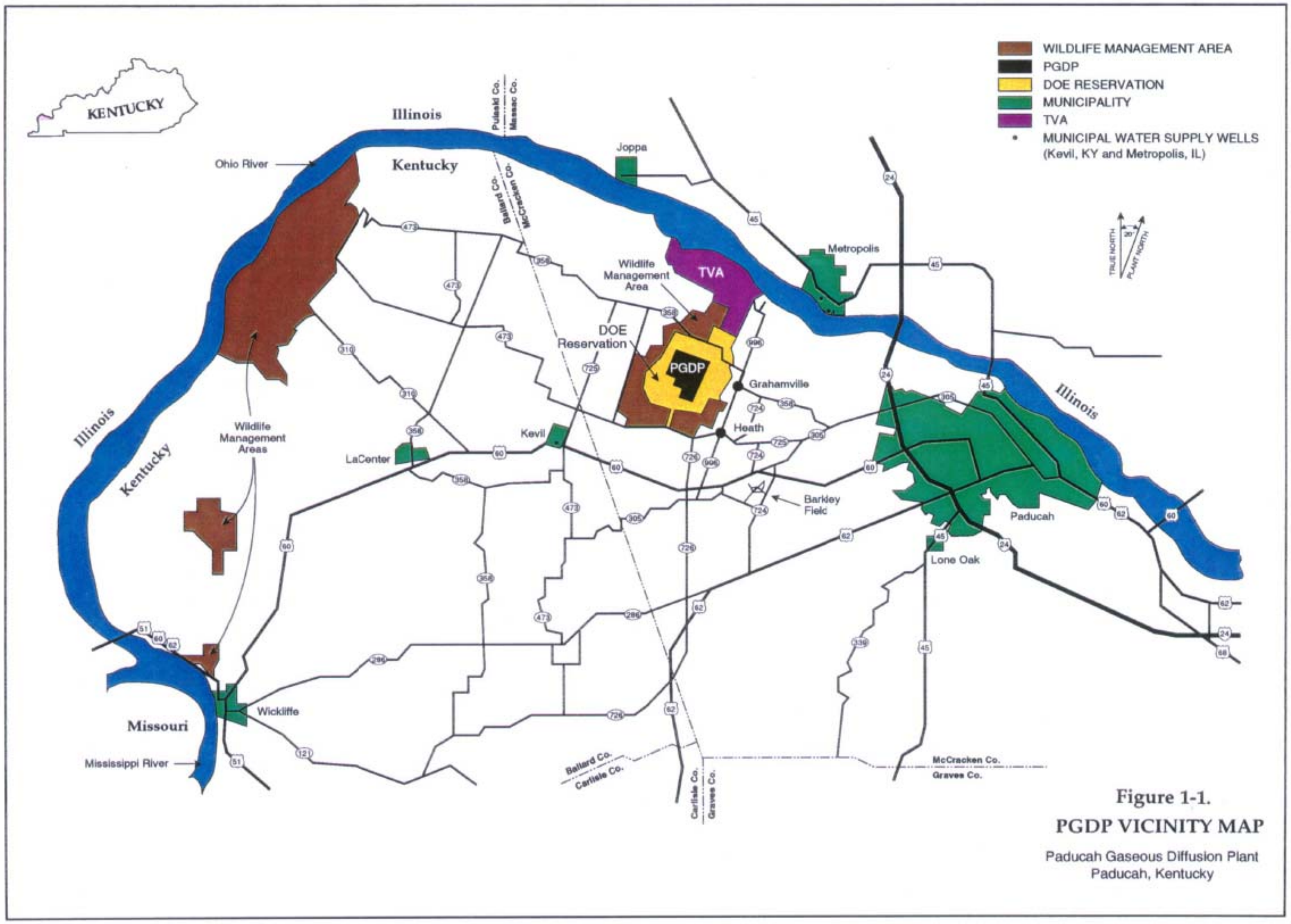

Figure 1.2.1 PGDP Vicinity Map (DOE, 2001a)

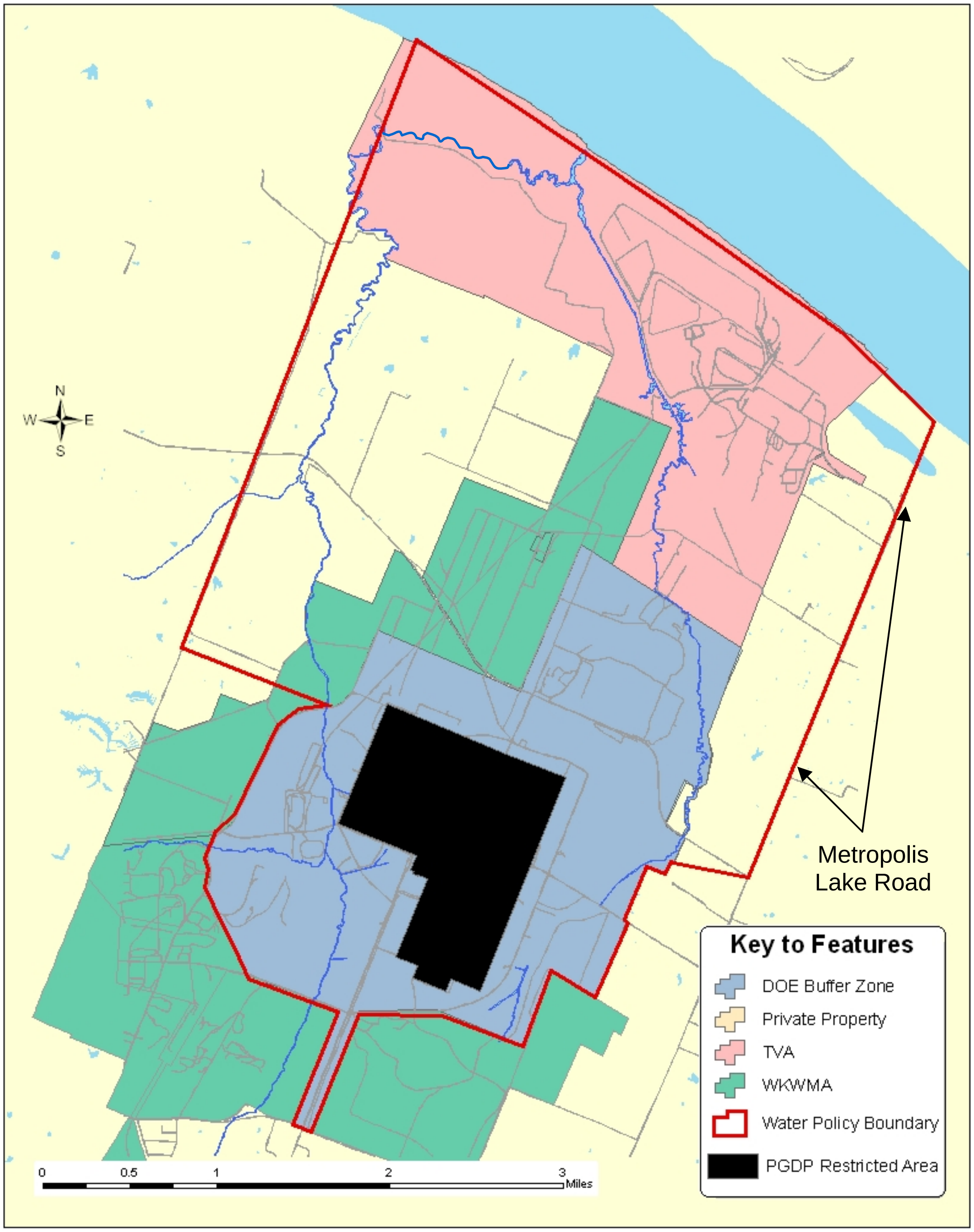

Figure 1.2.2 PGDP Site Location and Adjacent Properties

1.3 HYDROGEOLOGY AND CONTAMINANT PLUMES

Groundwater flow at PGDP occurs primarily within unconsolidated sediments that overlie the consolidated bedrock beneath the site (DOE 1997, DOE 1999, DOE 2005a). The top of consolidated limestone occurs beneath PGDP at 335 to 350 feet below ground surface (Figure 1.3.1).

The McNairy Formation consists of intermingled lenses of sand, silt, and clay at depths ranging from 100 to 350 feet. In the vicinity of PGDP, the upper to middle portions of the formation are predominantly silty and clayey fine sands, but in some locations, coarser-grained sediments at the top of the McNairy are in contact with the overlying Regional Gravel Aquifer.

In the southern part of the DOE property, a terrace formed on top of a thick clay unit known as the Porters Creek Clay that is immediately above the McNairy. The unit is composed of a massive glauconitic clay with lesser interbeds of sand. Gravels and sands cap the terrace, but the fine grained nature of the main clay unit tends to limit groundwater flow toward the south.

The Regional Gravel Aquifer (RGA) consists primarily of coarse sand and gravel overlying the McNairy Formation throughout the plant area and to the north, but pinches out to the south along the Porters Creek Clay terrace. The gravel deposits average approximately 30 feet thick, but some thicker deposits (as much as 50 feet) exist in deeper scour channels that trend east-west across the site. Because of the relatively high hydraulic conductivity of this unit, it represents the dominant groundwater flow system in the area extending from PGDP north to the Ohio River. The RGA is the dominant pathway by which groundwater contamination moves off-site.

The overlying Upper Continental Recharge System (UCRS) consists of clayey silt with lenses of sand and occasional gravel up to 50 feet in thickness. The predominant groundwater flow in the UCRS is vertically downward into the RGA. Contamination associated with PGDP is found in the UCRS at many places within the industrialized areas at PGDP, but due to the vertical nature of flow it does not represent a major pathway for contamination to move laterally off-site.

Additional detailed information about 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).

Trichloroethene (TCE) is a chlorinated solvent that is a volatile organic compound (VOC). It is the most widespread groundwater contaminant associated with PGDP. TCE contamination defines three dissolved phase plumes that are migrating from PGDP toward the Ohio River. These groundwater plumes include the Northwest Groundwater Plume, the Northeast Groundwater Plume, and the Southwest Groundwater Plume. A plume of technetium-99 (^{99}Tc), a man-made radioisotope, has also been identified in groundwater at PGDP. This plume extends from the center of PGDP toward the Ohio River (DOE 2006).

The most recent plume data available at the time of this study is from a report based on samples collected in 2004 *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer* (DOE 2005b). The maps of the TCE and ^{99}Tc plumes taken from this source are provided as Figures 1.3.2 and 1.3.3, respectively.

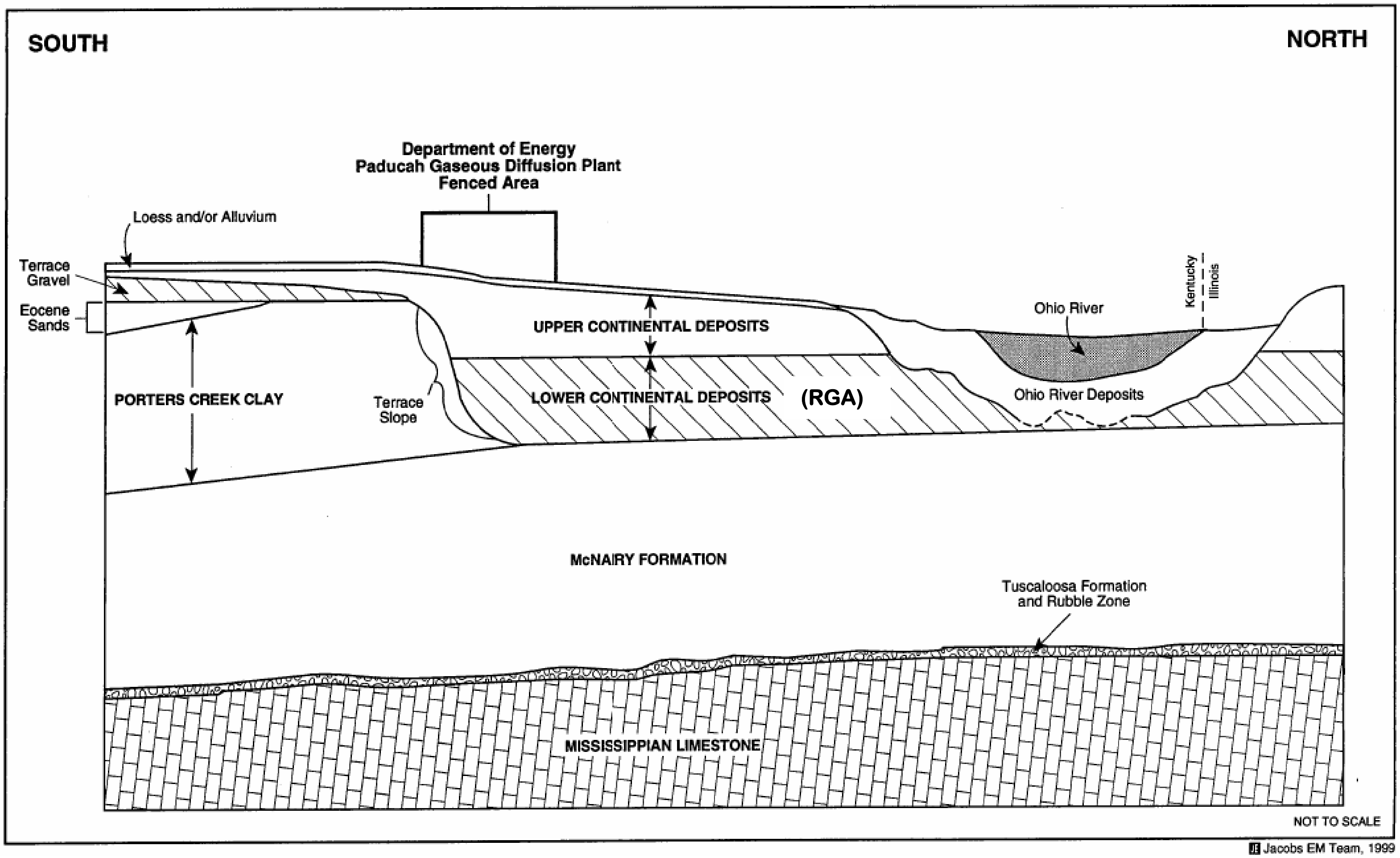

Figure 1.3.1 Conceptual Stratigraphic and Structural Relationships Near PGDP (DOE, 2005b)

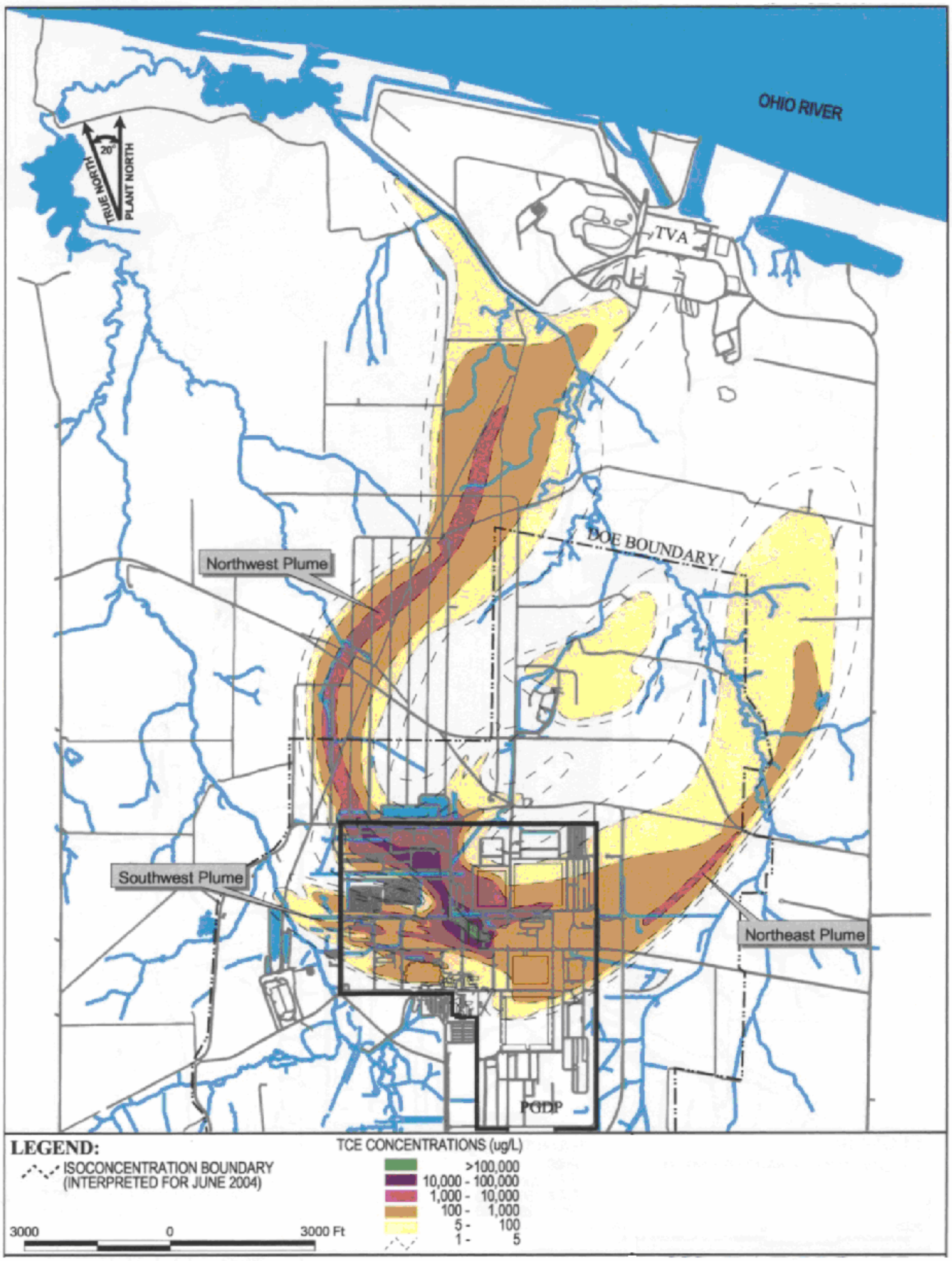

Figure 1.3.2 Trichloroethene Plume Locations (DOE 2005b)

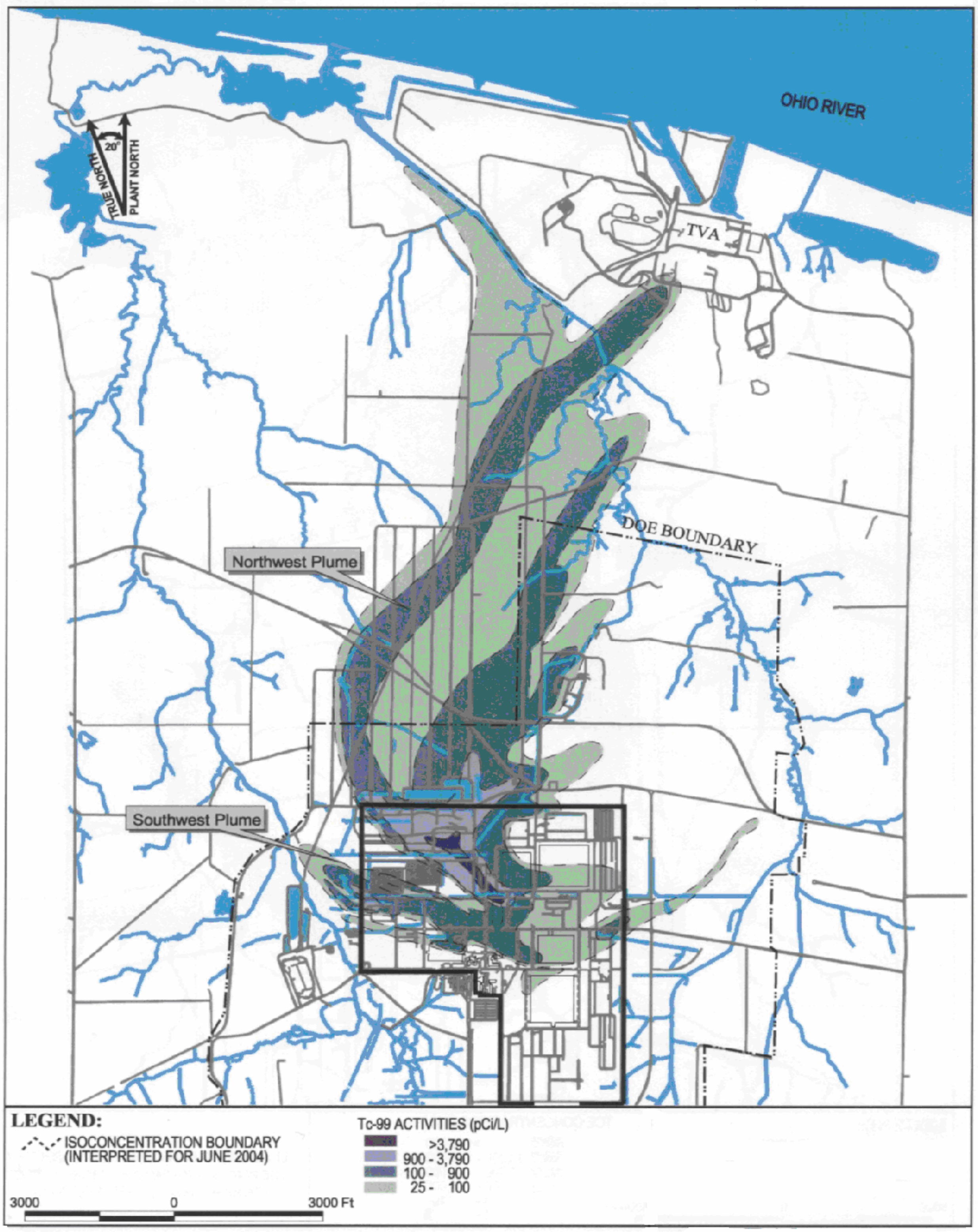

Figure 1.3.3 ^{99}Tc Plume Locations (DOE 2005b)

2. METHODS

Interrelated technical tasks were completed concurrently during this project. These tasks are summarized and provided in Section 3. Detailed information regarding each task is presented in Appendices A through G.

Initial groundwater modeling was used to estimate a probable maximum plume extent to be considered for property acquisition. Private parcels in the vicinity of the groundwater plumes were identified using information from the McCracken County Property Valuation Administrator (PVA) and a database was created for use with a Geographic Information System (GIS) to support the project. Property acquisition strategies were considered and possible approaches for acquisition were described. Local cost estimates were developed using a mass appraisal approach based upon unit costs for property acquisition determined from available information associated with recent transactions. Groundwater response actions previously identified by DOE to address contamination at PGDP were reviewed and summarized. Numerical modeling was used to forecast the maximum groundwater plume extents associated with TCE concentrations of 5 µg/L or greater resulting from the application of response actions described in earlier DOE reports. The private properties in the vicinity of the various predicted plumes were determined, and costs were quantified using the unit cost estimates. The costs for property acquisition were compared with the remediation cost estimates for the selected response actions and analyzed.

3. TECHNICAL SUMMARY

3.1 PROPERTY ANALYSIS

When groundwater contamination was detected in private wells located north of the PGDP in August 1988, DOE immediately placed affected residencies/businesses on alternative water supplies and began an intensive monitoring and investigation program to define the extent and temporal variations of groundwater contaminant plumes (DOE 2003). In June 1994, DOE signed the Action Memorandum for the PGDP Water Policy in which DOE formally offered to provide municipal water to all existing residences and businesses within the affected area surrounding PGDP (see Figure 3.1.1). The number of accounts under the Water Policy has remained fairly static since the program's inception varying from 98 in 1994 to 100 in 2007.

In order to determine those properties overlying and immediately adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways (i.e., along Bayou and Little Bayou Creeks) associated with the PGDP, geographical information system (GIS) datasets of the site were obtained from the KRCEE PGDP GIS Database (KRCEE 2006). The database contains GIS datasets that have been assembled as part of ongoing characterization and remediation activities at the PGDP. Included in the database are datasets containing individual property parcels that surround the DOE property. Once the datasets were assembled, the current TCE and ^{99}Tc plume maps were overlain onto the PGDP property map to identify impacted and potentially impacted properties. Subsequently, detailed information about the identified properties was obtained from the local McCracken County PVA office. Details of this analysis are provided in Appendix A

In order to ensure that the initial data retrieval included properties that could be impacted by the potential future migration of contaminated plumes beyond the current Water Policy Boundary, a conservative buffer zone was also included when developing the detailed set of property parcels (i.e., the Potential Acquisition Zone; see Figure 3.1.1). Four different categories of property ownership were identified in the set of property parcels developed (see Table 3.1.1). The category with the largest acreage was private owners, which encompassed 6054 acres in 165 parcels. The category with the next largest acreage was DOE, which encompassed 3,556 acres. The third and fourth categories were property owned by TVA (2,669 acres) and the State of Kentucky (WKWMA; 1,290 acres), respectively (Figure 3.1.1).

The area retained for evaluation in the study (i.e., the area shown as the Potential Acquisition Zone on Figure 3.1.1) includes the 165 privately-owned farm and residential parcels covering 6,054 acres. For the purpose of this study, residential parcels were subsequently defined as those parcels that were less than 10 acres, and farm parcels were defined as those parcels 10 acres or more. Additionally, if any portion of a parcel was identified through the groundwater modeling to be potentially impacted, then the whole parcel was retained for evaluation. This conservative approach in identification of impacted properties was used to address uncertainties in the groundwater modeling that was used to predict which properties might overlie a contaminant plume in the future. The total 6,054 acres conservatively estimates the maximum size of the privately-owned properties that might be impacted by groundwater contamination in the future.

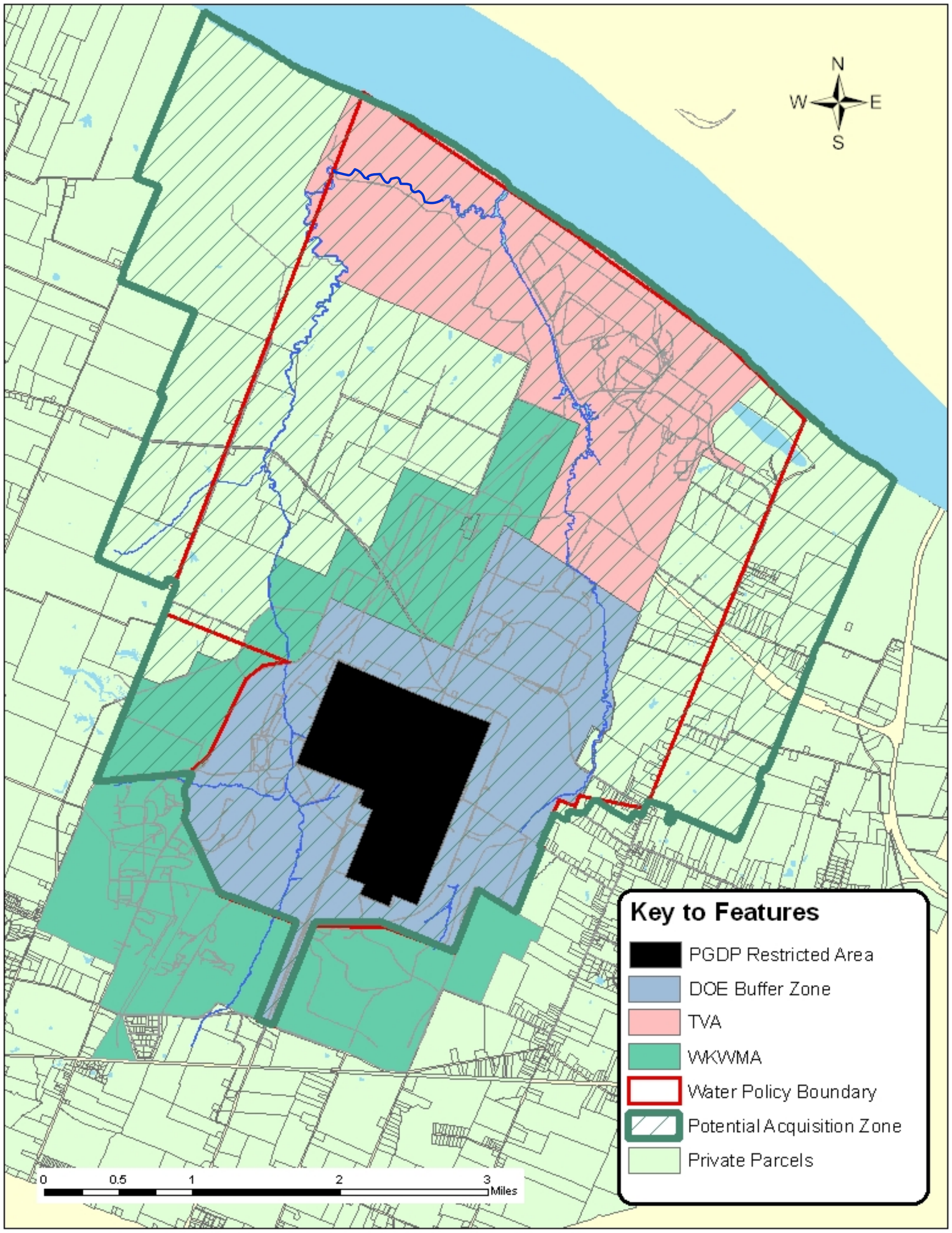

Figure 3.1.1 Potential Property Acquisition Zone Surrounding PGDP

A GIS analysis of the property data was performed in order to determine the range of property sizes for potentially impacted residential and farm parcels. The average size of the residential parcels was found to be approximately 3 acres while the median size was determined to be approximately 1.5 acres. With the exclusion of one 1400 acre farm parcel on the west side of the WKWMA, the average size of the farm parcels was found to be approximately 65 acres while the median size was determined to be approximately 26 acres.

3.2 PROPERTY PURCHASE ANALYSIS

Details of the property analysis are provided in Appendix B. The analysis suggests that several real property interests are available to limit or prevent exposure to contaminated groundwater by potential receptors. These include outright property purchase (i.e. owning property in fee simple), easements, and combinations of these. Additionally, the particular real property interest pursued for a specific parcel could vary over time depending on the length of the period contamination of the groundwater is expected to be present.

Kentucky best practices suggest that the fee simple interest may be appropriate in most cases where exposure to contaminated groundwater should be prevented. The principal possessory interests are discussed at fee simple, life estate, and leasehold. Fee simple is especially applicable where the property is currently owned by DOE (i.e., held in fee simple), or where an interest in property is acquired because contaminated groundwater is likely to be present for many years. Kentucky best practices suggest that easements may be applicable when contaminated groundwater may be present for a shorter period; while leaseholds and purchase options are of less use. Kentucky best practices suggest that other interests, such as life estate possessory interest, concurrent estates, non-possessory future interests, and licenses may not be appropriate, except when identifying and eliminating pre-existing interests in property in order to pursue an appropriate interest.

The following table summarizes the range of options theoretically available for use with respect to preventing exposure to contaminated groundwater. Within this matrix "Yes" indicates an option that is consistent with Kentucky best practices and "No" indicates an option that is not consistent with Kentucky best practices.

Table 3.2.1 Property Acquisition Matrix

Interest	Present DOE Property	Parcels Not DOE-owned			
		Monitoring Easement	Limited Scope Easement	Expanded Scope Easement	Title Clearing
Fee Simple	Yes	No	Yes/$	Yes/$	Yes
Life Estate	No	No	No	No	Yes
Leasehold	No	No	Yes/$	Yes/$	Yes
Concurrent Estates	No	No	No	No	Yes
Nonpossessory Future Interests	No	No	No	No	Yes
Purchase Option	No	No	No	No	Yes
License	No	No	No	No	Yes
Easement	No	Yes	Yes	Yes	Yes
Real Covenants / Equitable Servitudes	No	Yes	Yes	Yes	Yes

"/$" indicates a workable option that would likely be significantly more costly than other options.

3.3 DEVELOPMENT OF COST ESTIMATES TO ACQUIRE PROPERTY

The purpose of this study was to develop an indicative range of acquisition costs for properties near the PGDP which are affected by groundwater contamination. Using a mass appraisal approach consistent with federal agency guidelines for property acquisition, indicative acquisition costs were estimated for purchase in fee simple and easements based on the principle of "highest and best use" to determine fair market value. Detailed descriptions of the approach and results of appear in Appendix C.

With the exception of a couple of small commercial properties along Metropolis Lake Road, and a small mobile home park along Woodville Road (both of which are outside the study area), the dominant private land use around the PGDP facility is rural residential (predominately on the east side) and agricultural (predominately on the west side). In 2001, the McCracken County Planning Commission completed a new zoning ordinance which re-classified various properties in the study region according to five different land uses: agricultural, rural residential, heavy industrial, commercial, and mobile home parks. In addition to existing private properties (both agricultural and rural residential) that were re-classified as heavy industrial, the proposed zoning map also classified the TVA property, the PGDP property, and the WKWMA property all as heavy industrial land use (see Figure 3.3.1).

The zoning of properties as heavy industrial does not necessitate nor require such a land use, but only provides for such a future use, or any other less restrictive land use. Thus, land zoned as heavy industrial that is currently being used for either agricultural or rural residential purposes can continue to be used as such both now and in the future. Further, such properties could be sold to other individuals who could continue to maintain the current land use or develop the property into another land use. For example, there would be nothing to prevent an owner of an agricultural property from developing the property into rural residential properties,

Based on conversations with state officials (KDFWR, 2006), it seems highly unlikely that property in the Western Kentucky Wildlife Management Area will ever be used for industrial purposes. Further, based on conversations with local planning officials (Paducah Planning Office, 2006; McCracken County Planning Commission, 2007), it seems unlikely that any of the properties in the study area will likely be developed as commercial or heavy industrial properties. According to these officials, most of the economic development in the county is occurring in the south. Further, other industrial parks have been developed in the region that are likely to attract any industry before new industry would be expected to locate next to the existing PGPD.

For the purpose of this study, the value of existing properties was determined on the basis of their existing use and or their "highest and best use" based on Federal Interagency Land Acquisition Guidelines (Appraisal Institute, 2000). As such, properties were classified as either rural residential properties or farm parcels. The statutory definition of "agricultural operations" in Kentucky (KRS 224.71) was used to define those parcels of 10 acres or more as "farms" for valuation purposes regardless of current use activities. Those parcels under 10 acres were defined as "rural residential" real estate regardless of current agricultural or recreational uses. If any portion of these parcels was identified through the groundwater modeling to be potentially impacted, then the interest of the entire parcel was assumed to be acquired. The approach used for valuation delineated the parcels, estimated average fair market values for fee simple and easement interests for each parcel, and summarized the range of total acquisition costs for both fee simple ownership and easement interests for privately held property in the study area.

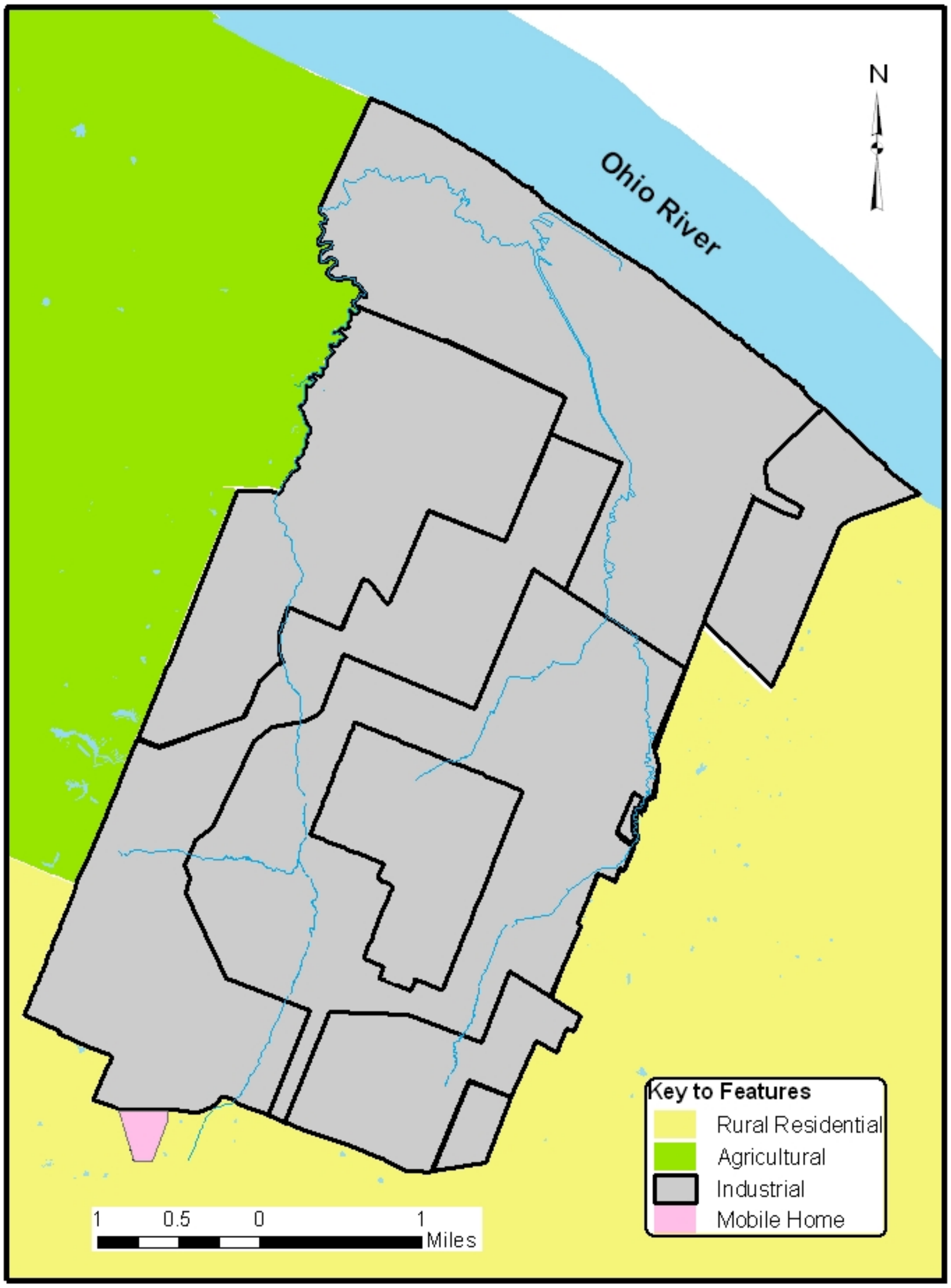

Figure 3.3.1 2001 Zoning Map for PGDP and Surrounding Area

3.3.1 Unit Costs for Property Purchase

Using secondary information on comparable residential and farm properties (including the value of homes and other farm structures), the fair market value of fee simple interests were estimated for all parcels in the potential purchase zone. In addition, a supplementary calculation was undertaken to determine the value of farm parcels based on development value (rather than fair market agricultural value). An upper and lower range of values were estimated for each set of parcels in order to give a realistic indicative cost estimate. The resulting unit costs are provided in Table 3.3.1.

Table 3.3.1 Range of Estimated Per Unit Acquisition Costs for Fee Simple Purchase of Properties

Study Area Properties	**Units**	**Estimated Range of Acquisition Costs Per Parcel or Per Acre**	
		Upper Range	Lower Range
Residential	Per Parcel	$138,301	$120,293
Farm:[1]			
Fair Market Value	Per acre	$3,099	$2,788
Development Value	Per acre	$7,583	$6,524

[1] Acquisition costs include the value of homes and other farm structures.

3.3.2 Unit Costs for Property Easements

For purchase of easements, a market-based approach was used to estimate both the "lost use" or "rights relinquished" dimensions as well as "before and after" neighborhood effects on residential properties. Since easement values are a direct function of the nature and the extent of the property use restrictions, values were estimated for both limited and expanded scope easements. A lump-sum payment for easements could be applied in easement situations, so all values were based on a one-time payment in 2006. It is generally recognized that easement values vary widely depending on geographic location and circumstances, so a wide range of values were developed to capture a reasonable range of estimated values. Acquisition costs were generated by including estimated closing costs on each residential property plus a per acre closing cost for farm properties.

Easements can have a very limited scope, such as a single prohibition on well drilling into the groundwater aquifer. Alternatively, the easements could be more expansive, such as prohibitions on well-drilling, subsurface disturbance for mining or swimming pool construction, installation of household waste water systems, or farm pond construction for aquaculture or animal water supply. Additional restrictions under an expansive easement could involve surface use restrictions on building construction or certain agricultural practices.

The scope of easement will determine the cost. The more expansive the scope, the higher the value to the property owner and, consequently, the higher the acquisition cost. The approach taken was to estimate potential costs for acquisition of limited scope or expanded scope easements for both agricultural and rural residential properties.

For the rural residential properties, the limited scope easement acquisition costs were estimated to be $4001 at the lower range where water supply is substituted for easement restrictions on groundwater pumping, to an upper range estimate of $17,330. With expanded scope easements on the residential parcels, the range of estimated acquisition costs was $16,529 to $38,325 per parcel. For the farm parcels, existing agricultural easement programs were used to guide easement valuation for both the limited scope and expanded scope easement conditions. Acquisition costs per acre for limited scope easements on farm parcels were estimated to be $472 to $872 and for expanded scope easements, which would potentially have a significant impact on agricultural operations, the upper and lower range of easement costs were estimated to be $2589 to $2789 per acre. The present value of future easements payments was calculated to determine a lump-sum payment for monitoring easements on both residential and farm properties. The unit costs for property easements are provided in Table 3.3.2.

Based on these procedures, the estimated range of easement acquisition costs are summarized in Table 3.3.2.

Table 3.3.2 Estimated Range of Acquisition Costs for Easements in the Potential Purchase Zone and the Monitoring Zone on a Per Parcel or Per Acre Basis

Easement Type	Parcel Type	
	Residential Parcels: Estimated Acquisition Cost Per Parcel	Farm Parcels: Estimated Acquisition Cost Per Acre
Limited Scope Restrictions		
Upper Range	$17,330	$872
Lower Range	$4,001	$472
Expanded Scope Restrictions		
Upper Range	$38,325	$2,789
Lower Range	$16,529	$2,589

The foregoing analysis was based on current property values adjusted for time trend through 2006. The estimated acquisition costs will rise if: (1) Home prices in McCracken County continue to increase in value by 5% - 8% per year; (2) Agricultural land continues to increase at 10% per year consistent with recent trends; (3) Existing parcels are subdivided into numerous new residential parcels, and (4) McCracken County continues economic growth by developing new business investment along the Highway 60 corridor.

3.4 IDENTIFICATION OF REMEDIAL ACTION ASSUMPTIONS

Technologies to address groundwater contamination were evaluated in a Feasibility Study (FS) (DOE 2001a). The GWOU FS (DOE, 2001a) included technologies that have the potential to address dissolved phase TCE, DNAPL TCE, degradation products of TCE, and ^{99}Tc. In the FS, source zones were segregated into Primary Source Areas, Secondary Source Areas, and Dissolved Phase Plume Areas (DOE 2001a). These were defined as:

- Primary Source Areas – Locations in the UCRS with TCE present.

- Secondary Source Areas - Locations in the RGA with TCE present at concentrations above 10 mg/L (i.e., at a concentration indicating presence of a TCE DNAPL).

- Dissolved Phase Plume Areas – Locations in the RGA with TCE present below DNAPL concentrations.

General response actions were developed to address TCE source zones (DOE 2001a). These include treatment, containment, excavation, extraction, and disposal of contaminated media. The general response actions were utilized to screen remedial technology applicability to groundwater contamination at PGDP.

The FS selected twelve technologies, including a No Action Alternative, that have the potential to reduce the toxicity, volume and mobility of contaminants present in the Primary Source, Secondary Source, and Dissolved Phase Plume Areas. The technologies analyzed were:

• Primary Source Areas	Vapor Extraction Technology Direct Heating Technology Excavation Technology
• Secondary Source Areas	Steam Extraction Technology Pump-and-Treat Technology Oxidation Technology
• Dissolved Phase Plume Areas	Pump-and-Treat Technology Ozonation Technology Permeable Treatment Zone (PTZ) Technology Oxidation Technology Bioremediation Technology

Each technology was evaluated against seven criteria. These included two "threshold criteria," Overall Protection of Human Health and the Environment and Compliance with Applicable or Relevant and Appropriate Requirements (ARARs), and five "primary balancing criteria," Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility, or Volume through Treatment; Short-term Effectiveness; Implementability; and Cost.

Four potential response actions were considered in the process of determining what property acquisition options might be required in order to ensure "*adequate protection of human health and environment from exposure to contaminated groundwater*" while also ensuring a solution that "*is in the best interest of taxpayers.*" The four actions considered were combinations of one or more of the alternatives presented in the FS. The four potential response action scenarios are summarized in Table 3.4.1. Since the P&T scenario represents a continuation of the existing pump and treat operations at the site, it may be considered a potential No Further Action response under CERCLA.

Table 3.4.1 Potential Response Action Scenarios		
Scenario	**ID**	**Description**
1	**P&T**	Continuation of existing pump and treat action
2	**C400**	Source reduction of contamination at C-400 building using direct heating technology
3	**URD**	Source reduction of UCRS and RGA sources using direct heating technology, and treatment of Southwest Plume using ozonation (i.e. C-Sparge) technology
4	**URD-PTZ**	Source reduction for all sources, treatment of Southwest Plume, and PTZ technology at the PGDP security fence.

Cost estimates for each of the potential response action scenarios were developed using the associated technology costs as developed in Table D.10 of Appendix D and are summarized in Table 3.4.2. With the exception of the pump and treat scenario, all costs were based on a 30 year time period. The costs associated with the pump and treat scenario were estimated for both 30 and 100 year periods.

Table 3.4.2 Range of the Present Value Remedial Action/S&M Costs					
		Remedial Costs $M		**S&M Costs $M**	
Scenario	**Scenario ID**	**30 years**	**100 years**	**30 years**	**100 years**
1	**P&T**	$ 32.0	$ 59.7	$ 36.1	$ 53.1
2	**C400**	$ 9.6	$ 9.6	$ 38.6	$ 67.2
3	**URD**	$ 48.7	$ 48.7	$ 38.4	$ 56.7
4	**URD-PTZ**	$ 151.4	$ 151.4	$ 37.9	$ 45.3

In addition to the potential response action costs, the associated site-wide surveillance and maintenance (S&M) costs were also computed for both 30 year and 100 year evaluation periods. A description of the development of these costs, including assumptions, is provided Appendix D.

3.5 ASSESSMENT OF GROUNDWATER CONTAMINATION PLUME EXTENT UNDER DIFFERENT RESPONSE ACTIONS

The most recent version of the site groundwater model was obtained from DOE, validated against the results from previous studies (DOE 1997; DOE 1999; DOE 2000; DOE 2001a), and then updated using the most recent information from the Southwest Plume investigation (DOE 2006). Previous DOE investigations identified at least seven major primary sources of TCE in the UCRS (i.e. C-400 Building-3 source areas, C-720-2 source areas, SWMU 1-1 source area, and SWMU 4-1 source area) and a significant secondary source in the RGA associated with the C-400 Building. Estimates of contaminant concentrations for use in the groundwater model have been developed from various field studies and associated reports (DOE 2001b). A detailed description of the modeling efforts is included in Appendix E.

Once the DOE groundwater model was updated and validated, the model was used to evaluate the four potential response action scenarios presented in Table 3.4.1 in order to forecast the potential spatial and temporal extent of contaminated groundwater plumes. A summary of the sources addressed under each scenario and the cleanup assumptions for each source is provided in Table 3.5.1. In each case, the response action was evaluated for the situation where the plant continued to operate indefinitely as well as assuming the plant was to shut down. The situation which resulted in a groundwater plume that resulted in the largest number of potentially impacted properties was then used in the subsequent economic analysis.

Table 3.5.1 Summary of Potential Response Action Scenarios

Scenario	ID	Existing Pump & Treat	Assumed TCE Concentration Reduction % RGA C-400	UCRS C-400	UCRS C-720	UCRS SWMU1	UCRS SWMU4	Dissolved Phase SW Plume	PTZ at Security Fence
1	P&T	yes							
2	C400		99%	95%					
3	URD		99%	95%	95%	95%	95%	yes	
4	URD-PTZ		99%	95%	95%	95%	95%	yes	yes

Using the updated groundwater model, the spatial extent of the concentration contour for the TCE maximum contaminant level (MCL) (5 µg/L) for each potential response action scenario at 5, 10, 15, 30, 50, and 100 year intervals was plotted. The extent of the TCE concentration contour for the TCE MCL for 10, 30, 50 and 100 years for each scenario are shown in Figures 3.5.1 through 3.5.4. The maximum plume extents were then used to identify the property parcels to be further considered in the acquisition study. The total number of properties impacted by scenario and year is provided in Table 3.5.2.

Table 3.5.2 Total Number of Properties for Each Potential Response Action

Year	P&T	C400	URD	URD-PTZ
2007	74	74	74	74
2012	82	89	89	89
2017	88	97	97	96
2022	85	98	98	96
2037	66	82	79	75
3057	12	26	15	0
2107	12	30	10	0

All models by definition represent approximations of reality. The PGDP MODFLOW and MODFLOWT models used in this study rely upon field and laboratory point data to simulate the physical and chemical conditions that occur in the environment. As such, the baseline PGDP groundwater flow and transport model has been routinely updated with critical field data to reflect, as accurately as possible, the groundwater flow and contaminant transport system at the PGDP. However, there are several model input parameters that, under the present state of knowledge at the PGDP, are uncertain and could change in the future based upon ongoing environmental field projects. Changes in those uncertain parameters could result in significant changes to the results of the baseline models and models utilized for this study. Those uncertain parameters include: 1) Hydraulic boundary conditions associated with the Porter's Clay boundary, 2) Source volumes in the UCRS; 3) Secondary source volumes in the RGA; 4) Biotic and abiotic source degradation rates in UCRS source areas and RGA secondary source areas; and 5) Biotic and abiotic degradation rates for the dissolved phase portion of PGDP TCE plumes. Should data become available for any of these uncertain parameters, the baseline and current model for this study should be reviewed to ensure that prediction of future groundwater conditions and affect of remedial responses remain accurate.

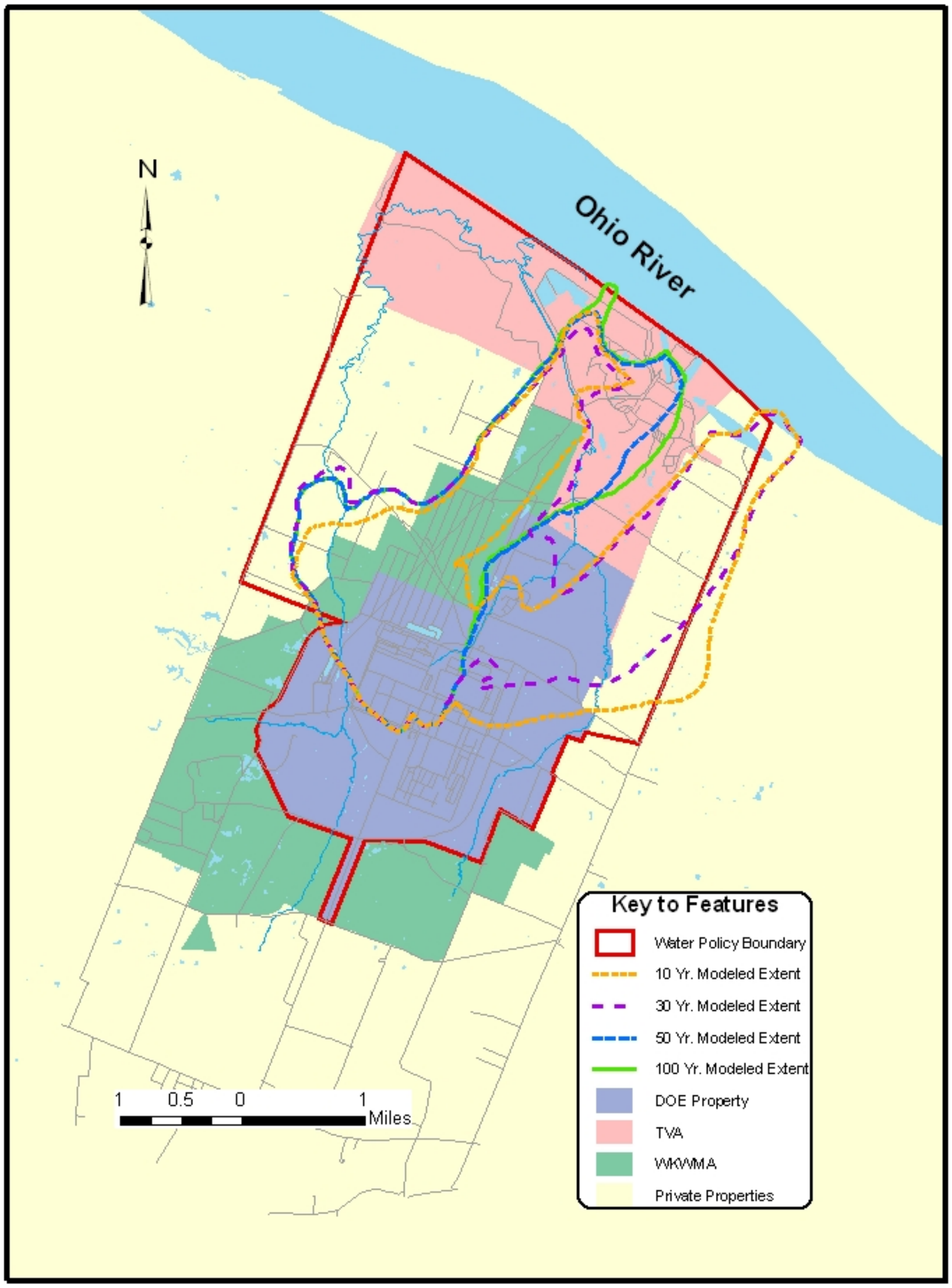

Figure 3.5.1 Predicted TCE Plume Contours (5 μg/L) Over Time under the Existing Pump and Treat Action (assuming plant shutdown) (Scenario 1)

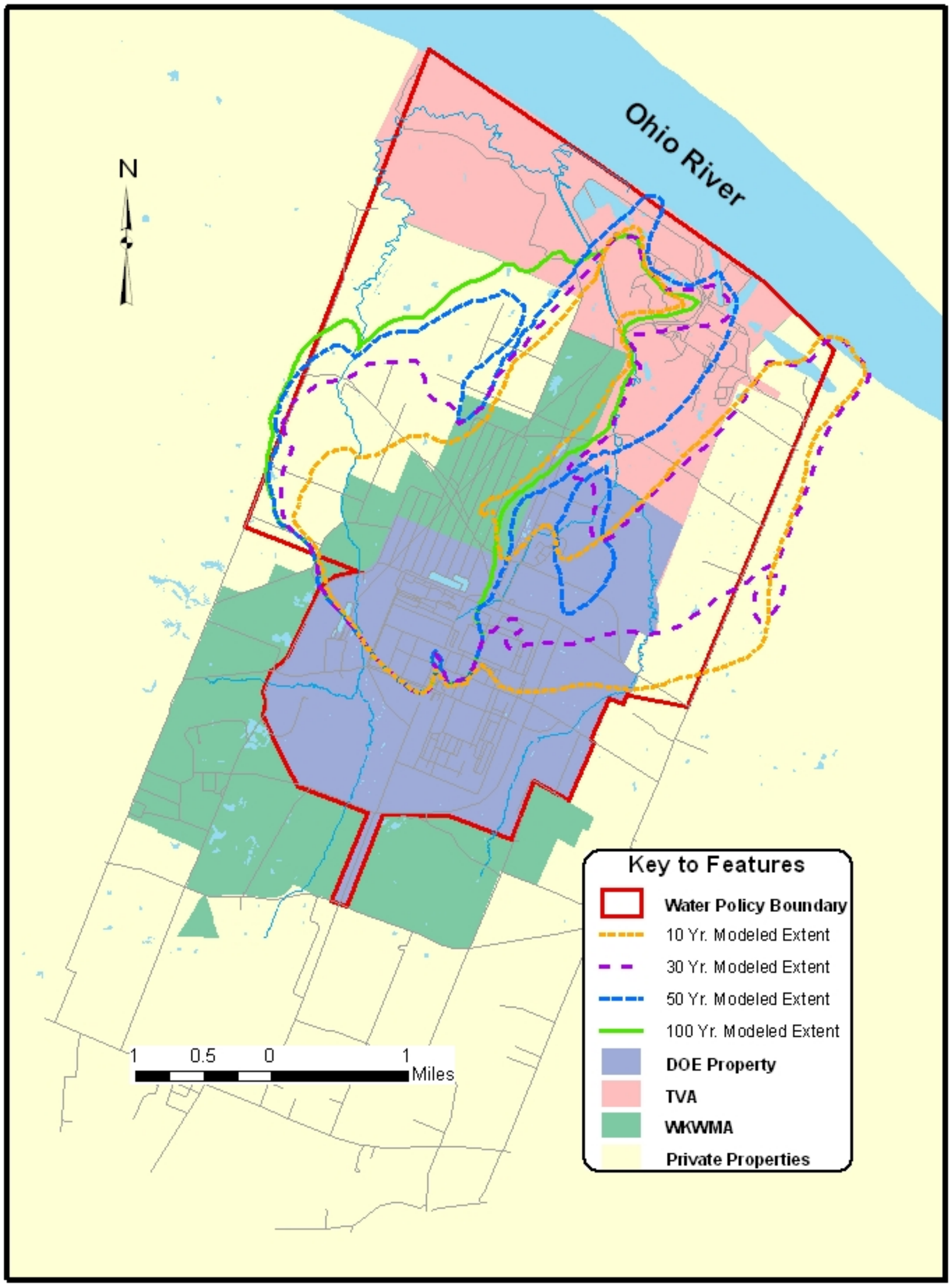

Figure 3.5.2 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reduction at C400 Building (assuming continued plant operation) (Scenario 2)

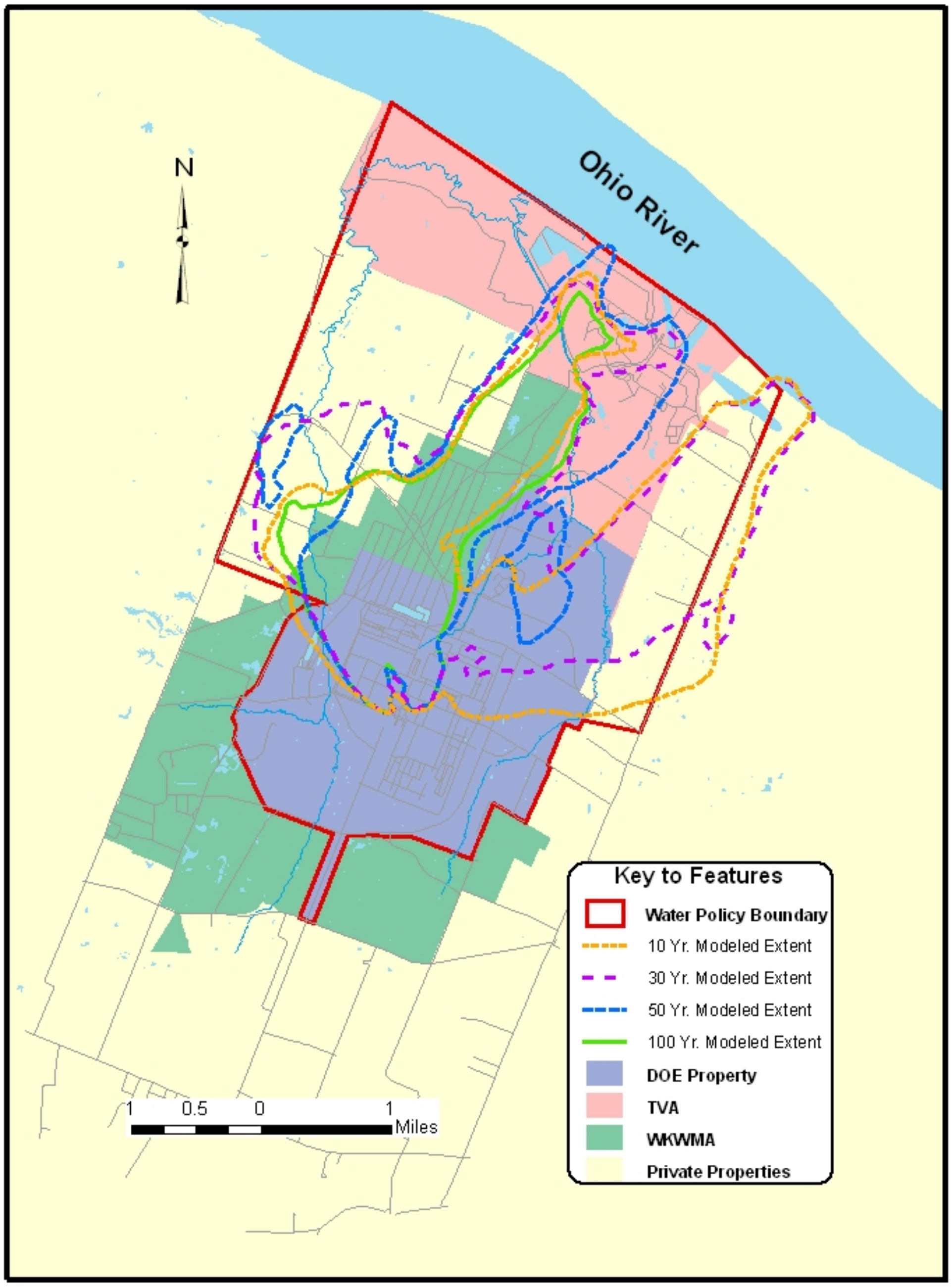

Figure 3.5.3 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reductions at C400, C720, SWMU1 and SWMU4 (including dissolved phase treatment of Southwest Plume) (Scenario 3)

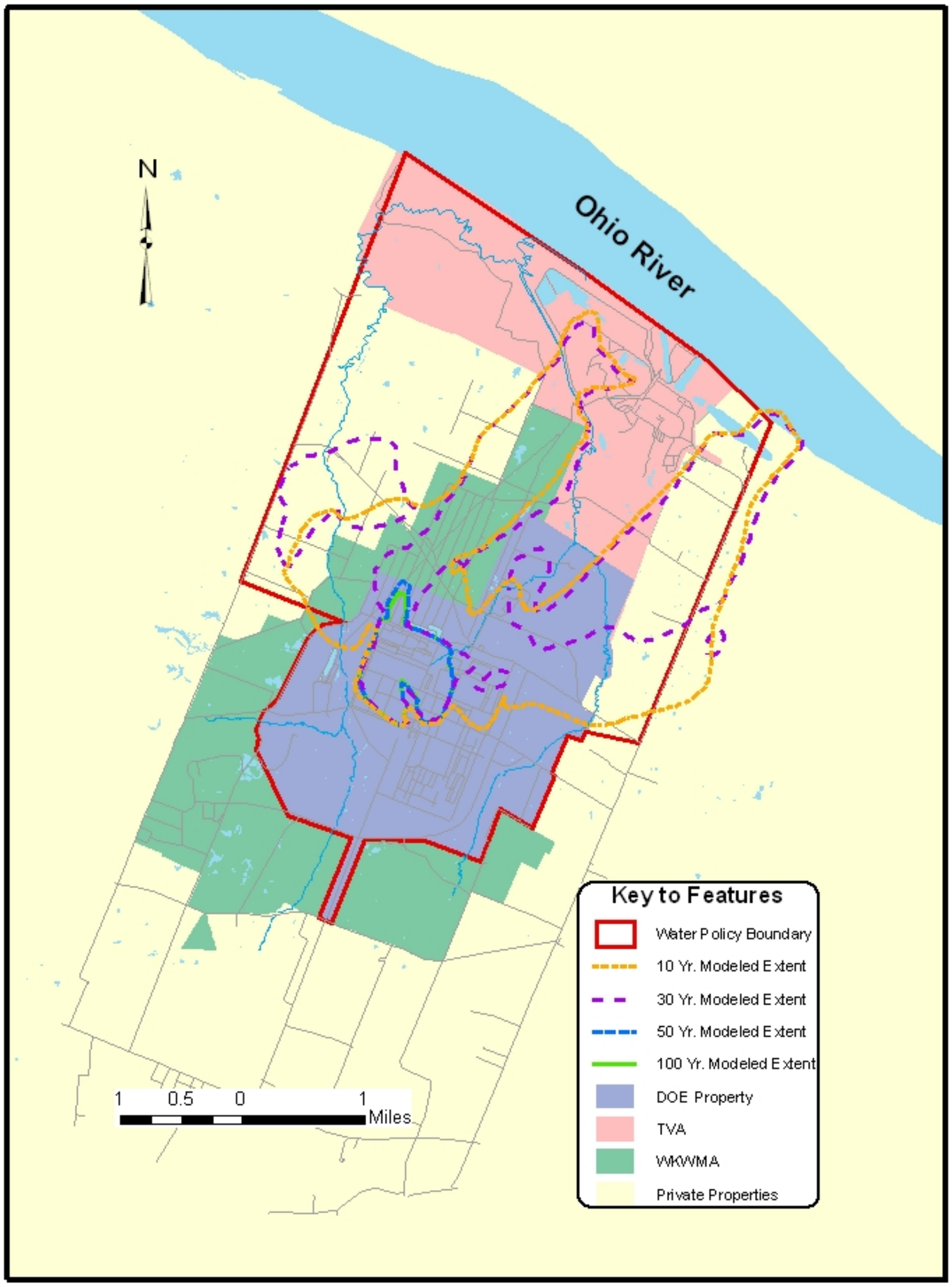

Figure 3.5.4 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reductions at C400, C720, SWMU1 and SWMU4 (including dissolved phase treatment of Southwest Plume and PTZ at facility fence) (Scenario 4)

3.6 ASSESSMENT OF EXTENT OF PROPERTY ACQUISITION NEEDED

The Congressional directive responsible for the initiation of this study states that: "*The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers.*" For this study, the phrase "best interest of the taxpayers" has been interpreted to mean "ensuring protection of human health and the environment from exposure to contaminated groundwater in the most cost effective manner possible."

For the purpose of this study, adequate environmental protection is defined as those actions that would ensure that the aquatic life in the streams surrounding the PDGP are protected in accordance with the water quality standards associated with their designated use. Recent studies by the Agency for Toxic Substances and Disease Registry (2001) failed to identify "*any potential future exposure pathways for surface water*" due to off-site discharges from the PGDP. More recently the Kentucky Division of Water (2005) determined that samples "*indicate that there is not an in-stream water-column impairment for radiation*."

Adequate human health protection is defined as those actions that would ensure that human exposure to potential contaminants from groundwater are below the MCLs established by the U.S. Environmental Protection Agency (EPA) as part of the Safe Drinking Water Act (SDWA). This study considered the two groundwater contaminants defining the contaminant plumes at the Paducah Gaseous Diffusion Plant (PGDP): 1) TCE and 2) ^{99}Tc and two possible exposure pathways relative to those contaminants in the groundwater: 1) exposure to groundwater pumped to the surface and 2) exposure to groundwater that migrates to the surface through an interaction with Little Bayou Creek. Risks associated with these contaminants can be eliminated or reduced by removal of the contaminants through one or more response actions or by limiting or preventing exposure to contaminated groundwater. The ^{99}Tc activities above the MCL are predicted to be confined within the DOE property boundary and a small part of the WKWMA. These activities are also confined within the spatial extent of associated TCE plumes. As a result, additional model simulations of the ^{99}Tc plume were not performed.

Remediation of contaminated groundwater to ensure the protection of human health in the most cost effective manner can be accomplished using one or more remediation technologies as discussed in Section 3.5. The costs associated with each technology are dependent upon several factors, including the area and time of application. Exposure to contaminated groundwater can be limited or prevented through 1) physical barriers (e.g., fencing), 2) restrictive easements or other restrictive agreements (such as the Water Policy), or 3) the fee simple purchase of parcels that currently or may potentially in the future overly contaminated groundwater.

The principal potential impact of the current groundwater contamination on the surface environment would be if contaminated groundwater was pumped to the surface and used for irrigation purposes or other commercial purposes. Such activities could be prevented by restricting the use of contaminated groundwater. There is the potential, however, for contaminated groundwater to migrate to the surface under normal hydrostatic conditions. Groundwater from the RGA currently migrates to the surface and discharges at seeps in the lower reaches of Little Bayou Creek Concentrations of TCE associated with such discharges have been observed to be as high as 400 µg/L. However, concentrations are below the TCE MCL of 5 µg/L within a mile downstream of the seeps as TCE volatilizes. Because the seeps are located on TVA property and are not adjacent to private property making repeated exposure by a human receptor unlikely, the implementation of additional institutional controls for the seeps was not considered further in this study.

As discussed in Section 3.5, four different groundwater response action scenarios were evaluated as part of the study. In order to determine the impact of each response action on the size of the areas that may need to be acquired to limit or eliminate exposure to contaminated groundwater (e.g. through restrictive easement or property purchase), the maximum TCE plume extent (based upon the TCE MCL of 5 µg/L) over a 100 year period was determined, and the footprint of the plume was plotted. This resulted in four different plume extent maps as shown in Figures 3.6.1 through 3.6.4. For each plume footprint, a 1,000 foot buffer zone was placed around the predicted boundaries to account for uncertainties in the groundwater modeling. [For example, modeling simulations indicate that groundwater pumping could pull the contaminated plume up to 1,000 feet beyond the maximum extent of the plume predicted by modeling. Generally, the 1,000 foot buffer is reflective of the anticipated maximum zone of influence of a groundwater well in the aquifer based on historical pumping and zone of influence studies (DOE 1996).] As can be seen from the figures, the southern extent of the buffer has been compressed or collapsed onto the maximum extent boundary, reflecting the presence of a geological barrier (i.e. the Porter's Creek Clay boundary) that prevents the physical movement of groundwater beyond the southern extent of the boundary.

Once the composite plume footprint was determined for each scenario, the parcels that would be totally or partially impacted were determined. The total acreage of agricultural parcels and the total number of residential parcels potentially overlying contaminated groundwater associated with each scenario are shown in Table 3.6.1. If any portion of these parcels was identified through the groundwater modeling to be potentially impacted, then the interest of the entire parcel was assumed to be acquired.

Table 3.6.1 Maximum Potential Extent of Property Impacted for Each Potential Response Action (100 year period)

Scenario	ID	Agricultural Parcels (acres)	Residential Parcels (number)
1	**P&T**	3531	80
2	**C400**	4370	85
3	**URD**	4102	85
4	**URD-PTZ**	4049	84

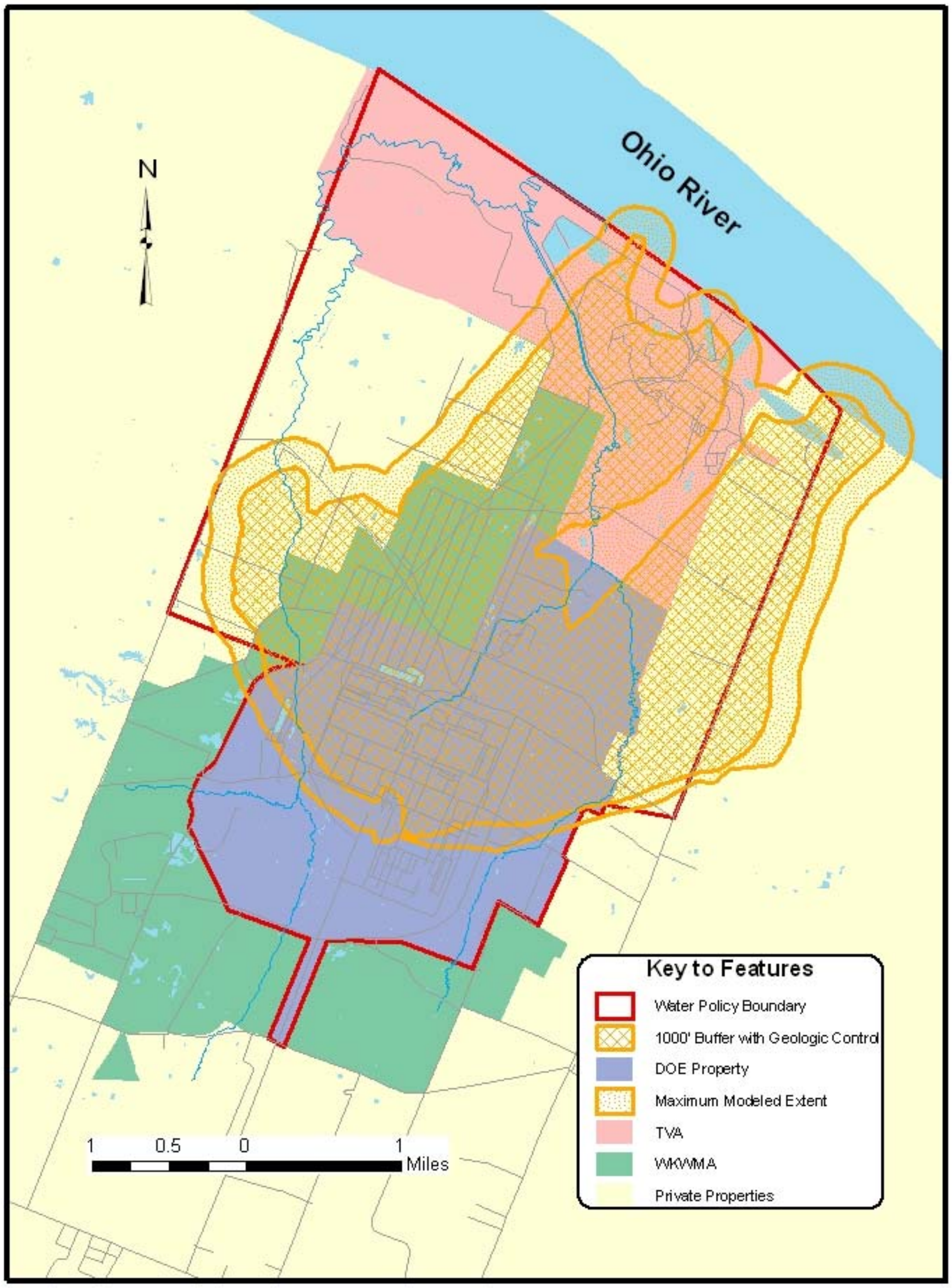

Figure 3.6.1 Predicted Maximum Plume Extent for TCE (5 μg/L) (with 1000 foot buffer) for the Existing Pump and Treat Action (with plant shutdown) (Scenario 1)

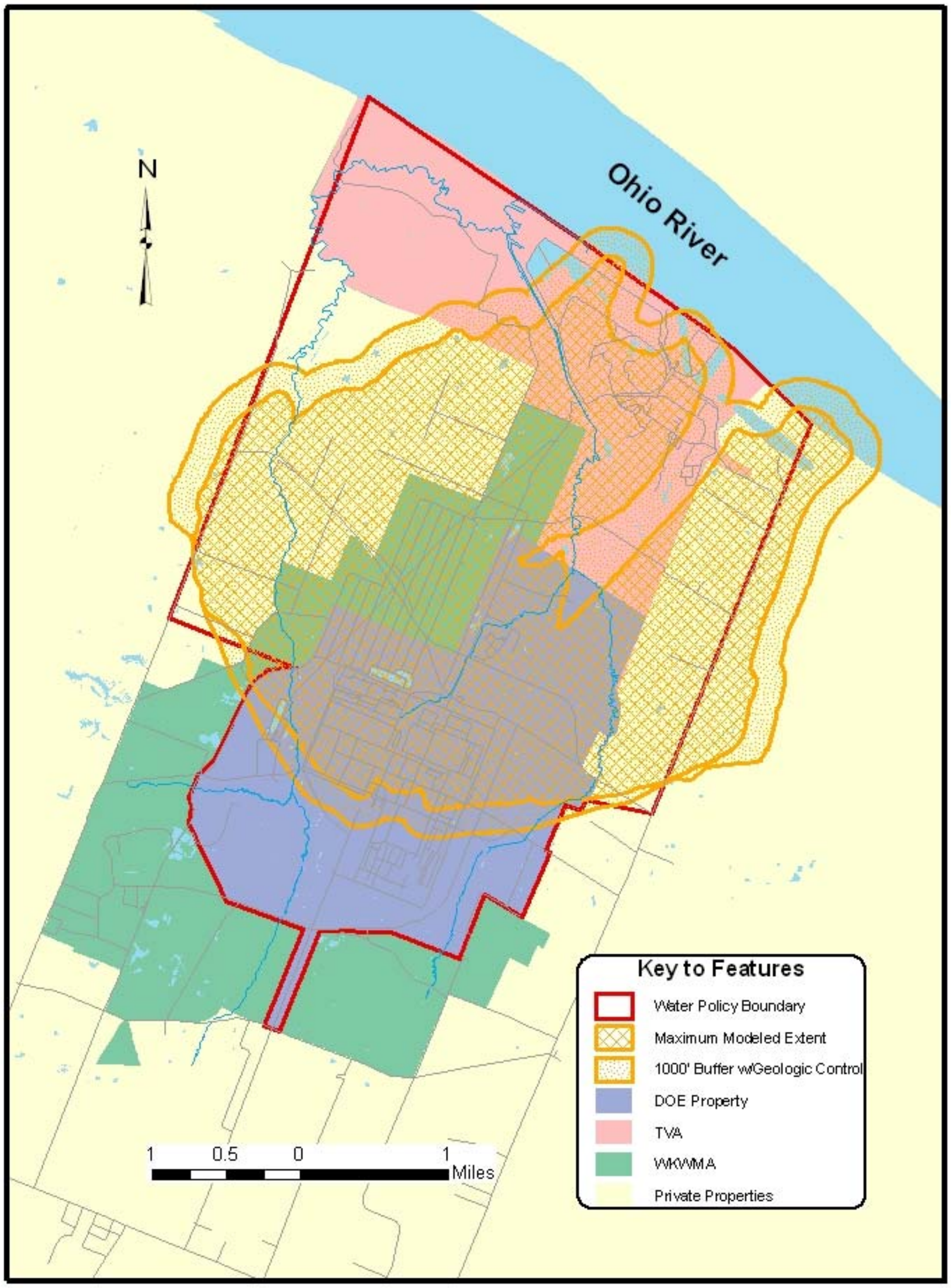

Figure 3.6.2 Predicted Maximum Plume Extent for TCE (5 μg/L) (with 1000 foot buffer) Source Reduction at C-400 Building (assuming continued plant operation) (Scenario 2)

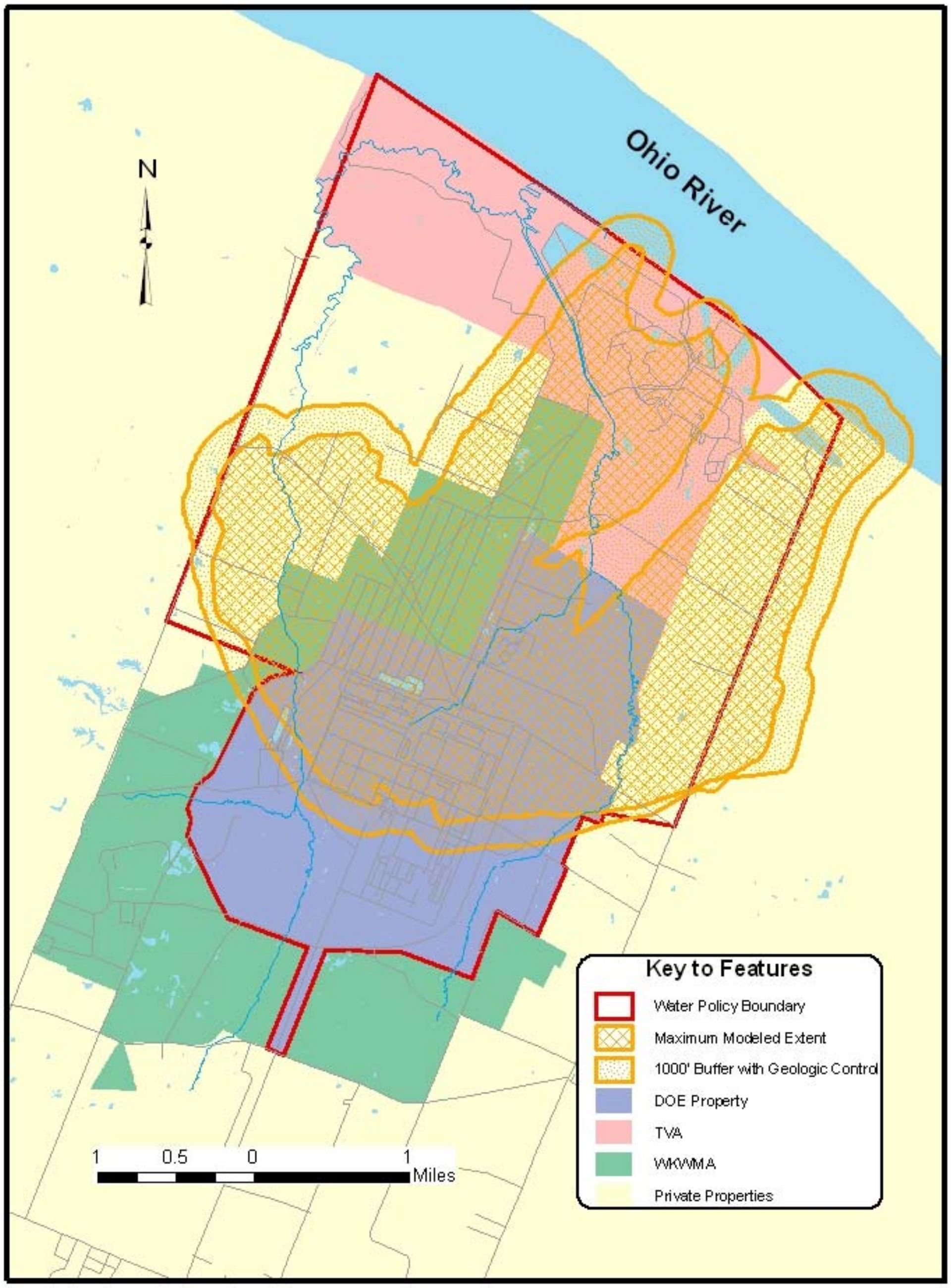

Figure 3.6.3 Predicted Maximum Plume Extent for TCE (5 µg/L) (with 1000 foot buffer) Assuming Source Reductions at C-400, C-720, SWMU1 and SWMU4 (including dissolved phase treatment of Southwest Plume) (Scenario 3)

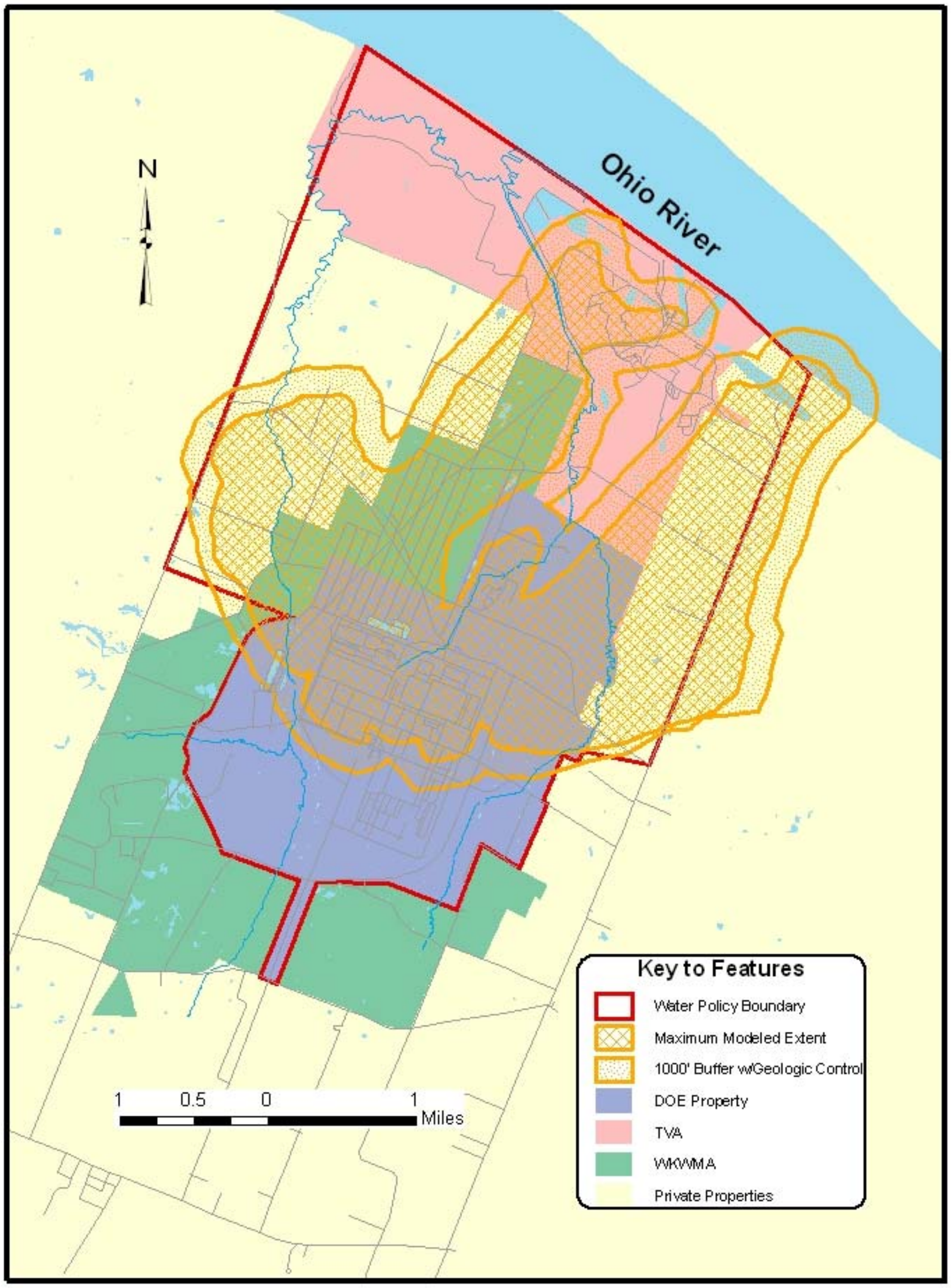

Figure 3.6.4 Predicted Maximum Plume Extent for TCE (5 µg/L) (with 1000 foot buffer) Assuming Source Reductions at C-400, C-720, SWMU1 and SWMU4 (including dissolved phase treatment of Southwest Plume and PTZ at security fence) (Scenario 4)

3.7 ECONOMIC ANALYSIS OF POTENTIAL PROPERTY ACQUISITION OPTIONS

As discussed earlier, two different property acquisition options to limit or eliminate exposure of humans to contaminated groundwater were evaluated in this study. These are: 1) outright purchase of property and 2) the use of restrictive easements. The restrictive easement costs have been estimated under an assumption that the current Water Policy will be continued into the future. If discontinued, it is expected that the restrictive easement costs will lie somewhere between the current easement estimates and the current easement estimates plus the costs of the Water Policy.

3.7.1 Cost of the Water Policy

The cost of providing water to those properties currently under the Water Policy is estimated to be approximately $78,000/year. Each year, $27,000 is estimated to be spent in support of monitoring activities associated with the Water Policy while an additional $50,000 is spent on costs associated with administering the Water Policy. Given the fact that it is likely that the monitoring activities would continue, even in the event of the termination of the Water Policy, the total cost of maintaining the current Water Policy was estimated to be $128,000/year (PRS, 2007).

In estimating the total cost of the Water Policy associated with a particular response action, the future costs have been amortized over a 100 year period using a discount rate of 5.05%. In determining the future costs of the Water Policy, it has been assumed that both the water costs and the monitoring costs would increase at an inflation rate of 3%. The analysis also included the costs of any potential increase in the number of Water Policy accounts that might occur as a result of any new additionally impacted properties that might lie beyond the current Water Policy boundary. For the purpose of this analysis, the cost of adding a new account (or property) to the expanded water policy area was estimated to be $14,500 (DOE, 1995).

The future costs of the water policy were not adjusted to take into account the possible subdivision of existing properties as consistent with the explicit language of the Water Policy Action Memorandum (DOE, 2003) which states “Water usage costs caused by increases in ….. subdivision of property would not be reimbursed under this action.” A review of the Water Policy over the last 14 years shows that the number of accounts has remained essentially the same since 1994. Recent conversations with local officials have underscored the conclusion that any significant subdivision of the existing properties in the current Water Policy area or any properties in a potentially expanded Water Policy area is unlikely to occur.

3.7.2 Cost of Property Acquisition Options

Property purchase (P) was assumed to be achieved through a fee simple interest. Property values were quantified for two major land use classifications: agricultural farm property and rural residential property. Agricultural farm properties were further valued using two different potential land-uses: existing agricultural land use (E) or future potential development use (D). In each case, an upper (U) and lower (L) range of potential costs were considered. This resulted in a total of four different fee simple purchase options: 1) PEL – property purchase using existing agricultural land values (lower cost range), 2) PEU – property purchase using existing agricultural land values (upper cost range), 3) PDL – property purchase using development agricultural land values (lower cost range), and 4) PDU – property purchase using development agricultural land values (upper cost range).

In addition to fee simple purchase, two different easement strategies were evaluated: limited scope easements (EL) and expanded scope easements (EE). In limited scope easements, it was assumed that restrictions would be placed on the groundwater underlying a property or the surface water running through the property. In expanded scope easements, it was assumed that restrictions would be placed on the groundwater and surface water as well as additional restrictions on the use of the property. As with the fee simple purchase, an upper (U) and lower (L) range of potential easement costs were considered. This resulted in a total of four different restrictive easement options: 1) ELL – limited restrictive easement (lower cost range), 2) ELU – limited restrictive easement (upper cost range), 3) EEL – expanded restrictive easement (lower cost range), and EEU – expanded restrictive easement (upper cost range).

The costs of the different property acquisition strategies have been quantified for each of the four potential response actions and summarized for a 100 year evaluation period. The total Water Policy cost associated with each potential response action was evaluated over a 100 year period by taking into consideration the potential expansion or contraction of the service area that might result from the implementation of each particular response action. The composite property acquisition costs for each potential response action are summarized in Tables 3.7.1 to 3.7.4 and Figures 3.7.1 to 3.7.4.

3.7.3 Discussion of Results

Based on a comparison of the costs of the different property acquisition options, the following observations can be made:

- In general, the property acquisition costs associated with a potential response action (i.e. Tables 3.7.1-3.7.4) tend to be inversely related to the associated remediation cost (i.e. Table 3.4.2). This reflects that the more expensive response options tend to result in less property impacts and, hence, a slightly smaller property acquisition cost. However, the resulting difference in the property acquisition costs is minimal. Thus, regardless of the potential remedial action, the overall costs for property acquisition (either by direct purchase or through restrictive easement) are essentially equal.

- While essentially the same, the acquisition costs associated with the C400 option are slightly higher than those associated with the other remedial options. Nonetheless, the results may suggest that the protection of human health and the environment from exposure to contaminated groundwater through property purchase or restrictive easement may be obtained at a cost somewhat independent of the cost of the associated remedial response action.

- In general, Water Policy costs tend to be proportional if not slightly greater than the restrictive easement costs for the lower range of limited scope easements and less than the restrictive easement costs for the other options.

- The current Water Policy is assumed to be discontinued for each property purchase option considered. However, from the results, the property purchase options are significantly more expensive than the combined cost of a restrictive easement and continuation of the Water Policy, even for the case where the property purchase is based on existing, non-development property value estimates. As a result, it would appear that the property purchase options are not cost effective when compared to the restrictive easement and a continuance of the current Water Policy.

Table 3.7.1 Costs of Different Property Acquistion Options Associated with P&T Response Action (Scenario 1)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 19.5		$ 19.5
PEU	Fee Simple Purchase	Existing	Upper	$ 22.0		$ 22.0
PDL	Fee Simple Purchase	Development	Lower	$ 32.7		$ 32.7
PDU	Fee Simple Purchase	Development	Upper	$ 37.8		$ 37.8
ELL	Restrictive Easement	Limited	Lower	$ 2.0	$ 4.9	$ 6.9
ELU	Restrictive Easement	Limited	Upper	$ 4.5	$ 4.9	$ 9.4
EEL	Restrictive Easement	Expanded	Lower	$ 10.5	$ 4.9	$ 15.4
EEU	Restrictive Easement	Expanded	Upper	$ 12.9	$ 4.9	$ 17.8

Table 3.7.2 Costs of Different Property Acquistion Options Associated with C-400 Response Action (Scenario 2)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 22.4		$ 22.4
PEU	Fee Simple Purchase	Existing	Upper	$ 25.3		$ 25.3
PDL	Fee Simple Purchase	Development	Lower	$ 38.7		$ 38.7
PDU	Fee Simple Purchase	Development	Upper	$ 44.9		$ 44.9
ELL	Restrictive Easement	Limited	Lower	$ 2.4	$ 5.3	$ 7.7
ELU	Restrictive Easement	Limited	Upper	$ 5.2	$ 5.3	$ 10.5
EEL	Restrictive Easement	Expanded	Lower	$ 12.7	$ 5.3	$ 18.0
EEU	Restrictive Easement	Expanded	Upper	$ 15.4	$ 5.3	$ 20.8

Table 3.7.3 Costs of Different Property Acquistion Options Associated with URD Response Action (Scenario 3)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 21.7		$ 21.7
PEU	Fee Simple Purchase	Existing	Upper	$ 24.5		$ 24.5
PDL	Fee Simple Purchase	Development	Lower	$ 37.0		$ 37.0
PDU	Fee Simple Purchase	Development	Upper	$ 42.9		$ 42.9
ELL	Restrictive Easement	Limited	Lower	$ 2.3	$ 5.1	$ 7.4
ELU	Restrictive Easement	Limited	Upper	$ 5.1	$ 5.1	$ 10.2
EEL	Restrictive Easement	Expanded	Lower	$ 12.0	$ 5.1	$ 17.2
EEU	Restrictive Easement	Expanded	Upper	$ 14.7	$ 5.1	$ 19.8

Table 3.7.4 Costs of Different Property Acquistion Options Associated with URD-PTZ Response Action (Scen. 4)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 21.4		$ 21.4
PEU	Fee Simple Purchase	Existing	Upper	$ 24.2		$ 24.2
PDL	Fee Simple Purchase	Development	Lower	$ 36.5		$ 36.5
PDU	Fee Simple Purchase	Development	Upper	$ 42.3		$ 42.3
ELL	Restrictive Easement	Limited	Lower	$ 2.3	$ 4.8	$ 7.1
ELU	Restrictive Easement	Limited	Upper	$ 5.0	$ 4.1	$ 9.1
EEL	Restrictive Easement	Expanded	Lower	$ 11.9	$ 4.8	$ 16.7
EEU	Restrictive Easement	Expanded	Upper	$ 14.5	$ 4.8	$ 19.3

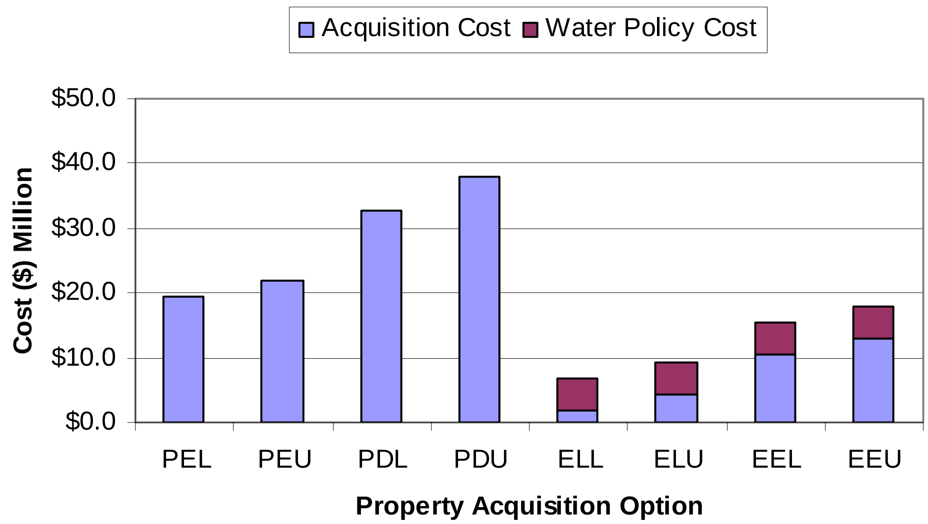

Figure 3.7.1 Range of Property Acquisition Costs for Potential Response Action Scenario 1: P&T (Continuing Pump and Treat) Evaluated Over 100 Years

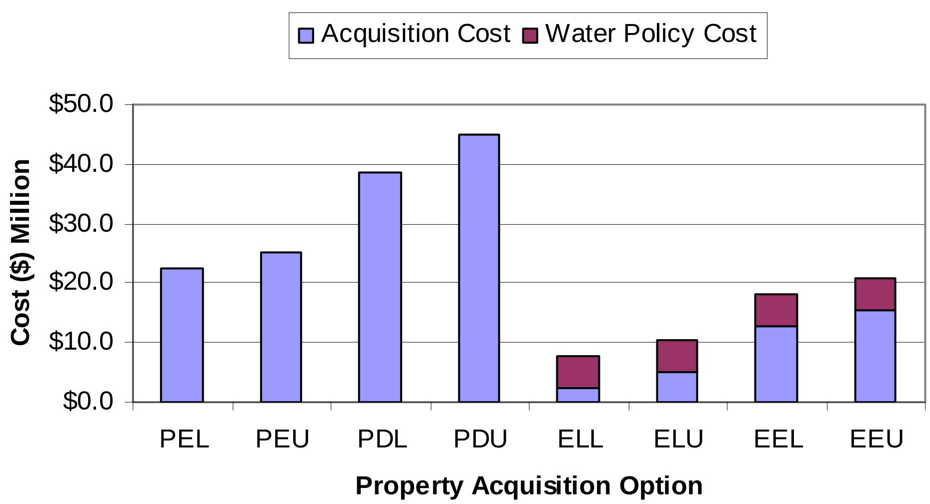

Figure 3.7.2 Range of Property Acquisition Costs for Potential Response Action Scenario 2: C400 (TCE Source Removal at C400 Building) Evaluated Over 100 Years

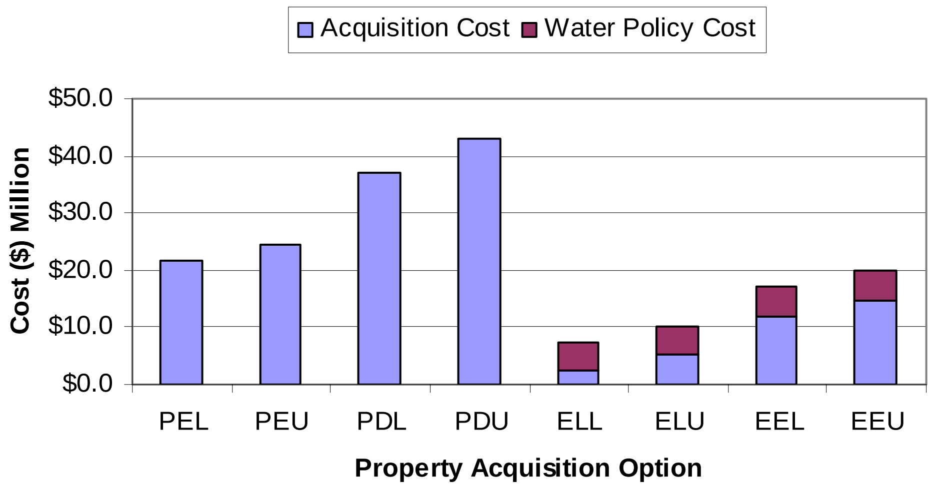

Figure 3.7.3 Range of Property Acquisition Costs for Potential Response Action Scenario 3: URD (TCE Source Removal from URCS, RGA, and Dissolved Phase of Plume associated with C400, C720, SWMU1, and SWMU4) Evaluated Over 100 Years

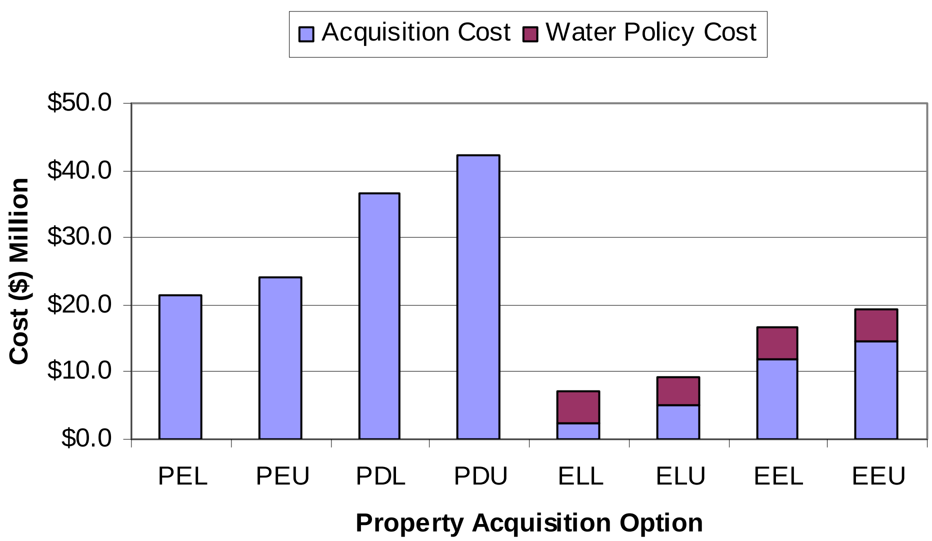

Figure 3.7.4 Range of Property Acquisition Costs for Potential Response Action Scenario 4: URD-PTZ (Scenario 3 plus the addition of a 14,000 foot PTZ along the northern boundary of the PGDP security fence) Evaluated Over 100 Years

4. SUMMARY OF STUDY ASSUMPTIONS

- All models by definition represent approximations of reality. The computer models used in this study rely upon field and laboratory point data to simulate the physical and chemical conditions that occur in the environment. As such, the baseline PGDP groundwater flow and transport model has been routinely updated with critical field data to reflect, as accurately as possible, the groundwater flow and contaminant transport system at the PGDP. However, there are several model input parameters that, under the present state of knowledge at the PGDP, are uncertain and could change in the future based upon ongoing environmental field projects. Changes in those uncertain parameters could result in significant changes to the results of the baseline models and models utilized for this study. Should data become available for any of these uncertain parameters, the baseline and current model for this study should be reviewed to ensure that prediction of future groundwater conditions and affect of remedial responses remain accurate.

- The ultimate potential extent of each plume was determined by adding a 1000 foot buffer around the modeled maximum extent of the plume. This was done to accommodate potential uncertainties associated with the groundwater modeling and to account for any further movement of the plume due to any groundwater pumping that might occur beyond the plume area.

- With the exception of a 1400 acre property on the west side of the PGDP, an entire property was assumed to be impacted if any part of the property was predicted to be impacted by the groundwater plume modeling.

- Both property purchase and restrictive easement property acquisition alternatives were assumed to be implemented at the beginning of the evaluation period for all impacted properties, regardless of the exact time over which a property was determined to be impacted.

- The estimated cost of each evaluated property acquisition alternative was determined using an average or zonal analysis as opposed to an individual property analysis, consistent with the "Uniform Appraisal Standards for Federal Property Acquisition."

- For the purposes of mass appraisal of properties in the study area, it was assumed that the "highest and best uses" of the property are farmland (the antecedent land use) and rural residential development (the consequent dominant development pattern outside the publicly-owned properties). This assumption meets the tests of general property valuation. Although McCracken County has a zoning ordinance and industrially zoned property surrounding the PGDP site, land use conversion of private properties to industrial use is neither likely nor probable given the current economic environment in the county. Based on this rationale, the assumed "highest and best" land use for this property valuation analysis results in only two parcel classifications: farm and rural residential.

- The subdivision of properties into either rural residential and farm (agricultural) was made solely on the basis of area. Consistent with the Kentucky Water Quality Act, all properties equal to or greater than 10 acres were assumed to be agricultural and all properties less than 10 acres were assumed to be rural residential.

- The total cost associated with a particular land use classification (e.g. rural residential or agricultural) was determined by multiplying the total number of rural residential parcels or total acreage of agricultural parcels by a corresponding average unit cost. The resulting unit costs were thus not reflective of the actual value of a particular individual property, but simply reflective of the average value of the aggregate set evaluated.

- The cost of each property purchase alternative was estimated assuming that the Water Policy would be terminated. The cost of each property easement alternative was estimated assuming the Water Policy would be continued. If the Water Policy is terminated, it is assumed that the easement costs would range between the current estimate and a value equal to the sum of the current estimate and the cost of the Water Policy.

- In the case of a restrictive easement, it was assumed that the property owner would be given a lump sum payment today for the restrictive use of his or her property over an indefinite extended period (e.g., 100 years).

- Consistent with the existing Water Policy, it was assumed that no new properties would be added through the subdivision of existing properties. However, it was assumed that properties would be added to the Water Policy if the groundwater modeling indicated that any current properties beyond the existing Water Policy area would be impacted.

5. GENERAL FINDINGS

- An analysis of a range of possible property acquisition options under several different potential response action scenarios reveals that the total cost of acquiring properties (regardless of the approach) is essentially independent of the response actions considered. Thus, even if all contaminant sources were removed today, residual, dissolved-phased contamination will remain on impacted properties and will likely spread and impact new properties throughout the expected life of most current residents.

- The property acquisition analysis suggests that fee simple interests, easements, and a combination of these approaches are possible alternatives to limit or prevent exposure to contaminated groundwater by potential receptors. Acquisition of other legal interests may not be as appropriate, but identifying and eliminating a variety of other pre-existing interests in the property may be necessary for the purchase of easements or fee simple interests.

- While the property purchase alternatives are generally more expensive than restrictive easements, additional factors may directly influence such a comparison. For example, outright purchase of properties may minimize or eliminate future liabilities that may continue to exist with a restrictive easement alternative. Conversely, property purchase alternatives may carry with them additional potential maintenance or demolition costs that may be avoided through the use of restrictive easements. Due to future uncertainties associated with these issues, neither factor was explicitly quantified in this study, however both factors should be implicitly considered when weighing alternatives.

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This report presents the results of a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated water near the Paducah Gaseous Diffusion Plant. The alternatives considered in this study and the associated presentation of those alternatives are not meant to be pre-decisional, but are meant to provide additional insight into a range of actions that could be taken to protect human health and the environment while taking into consideration what is in the best interest of the taxpayers. The ultimate selection of specific actions, including decisions regarding purchase of property or easements on property, will be made in accordance with applicable law and agreements.

APPENDIX A. TASK 1

IDENTIFICATION OF PROPERTY OVERLYING AND IMMEDIATELY ADJACENT TO THE CONTAMINATED GROUNDWATER PLUMES

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ACRONYMS

DOE	U.S. Department of Energy
PGDP	Paducah Gaseous Diffusion Plant
PVA	Property Valuation Administrator
GIS	geographical information system
KRCEE	Kentucky Research Consortium for Energy and the Environment
^{99}Tc	Technetium-99
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
TVA	Tennessee Valley Authority
WKWMA	West Kentucky Wildlife Management Area

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A.1 TASK OBJECTIVE

Task 1 of the study was to identify those properties overlying and immediately adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways associated with the Paducah Gaseous Diffusion Plant (PGDP). The plant is on a U.S. Department of Energy (DOE) reservation; the total acreage is divided as follows:

- 748 acres-within a restricted area that encompasses plant industrial operations;
- Approximately 822 acres uninhabited buffer zone surrounding the restricted area; and
- 1986 acres - leased to Commonwealth of Kentucky as part of West Kentucky Wildlife Management Area (WKWMA).

Bordering the PGDP reservation to the northeast, between the plant and the Ohio River, is a Tennessee Valley Authority (TVA) reservation occupied by the Shawnee Steam Plant. Several private properties (both agricultural and rural residential) border DOE reservation to the east and west (Figure A.1).

The most recent plume data available at the time of this study is from the 2004 report *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer* (DOE 2005). The maps of the trichloroethene (TCE) and technetium-99 (^{99}Tc) plumes taken from this source are in Figures A.2 and A.3, respectively.

Following the initial discovery of contamination in nearby drinking water wells, DOE initiated a Water Policy, which provides potable water to properties overlying or potentially overlying a contaminated groundwater plume. The boundary of the area encompassed by the Water Policy is shown in red in Figures A.1, A.2, and A.3. The number of accounts under the Water Policy has remained fairly static since the program's inception varying from 98 in 1994 to 100 in 2007.

A.2 PROPERTY IDENTIFICATION

In order to determine those properties overlying and immediately adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways (i.e., along Bayou and Little Bayou Creeks) associated with the PGDP, geographical information system (GIS) datasets of the site were obtained from the KRCEE PGDP GIS Database (KRCEE 2006). The database contains GIS datasets that have been assembled as part of ongoing characterization and remediation activities at the PGDP. Included in the database are datasets containing individual property parcels that surround the DOE property. Once the datasets were assembled, the current TCE and ^{99}Tc plume maps were overlain onto the PGDP property map to identify impacted and potentially impacted properties. Subsequently, detailed information about the identified properties was obtained from the local McCracken County Property Valuation Administrator (PVA) office.

In order to ensure that the initial data retrieval included properties that could be potentially impacted in the future, a conservative buffer zone was also included when developing the detailed set of property parcels (i.e., the Potential Acquisition Zone; see Figure A.4). Four different categories of property ownership were identified in the set of property parcels developed (see Table A.1). The category with the largest acreage was private owners, which encompassed 6054 acres in 165 parcels. The category with the next largest acreage was DOE, which encompassed 3,556 acres. The third and fourth categories were property owned by TVA (2,669 acres) and the State of Kentucky (WKWMA; 1,290 acres), respectively (Figure A.1).

The area retained for evaluation in the study (i.e., the area shown as the Potential Acquisition Zone on Figure A.4) includes the 165 privately-owned farm and residential parcels covering 6,054 acres. As discussed in Appendix C of this study, residential parcels were subsequently defined as those parcels that were under 10 acres in size, and farm parcels were defined as those parcels 10 acres or more in size. Additionally, if any portion of a parcel was identified through the groundwater modeling to be potentially impacted, then the whole parcel was retained for evaluation. This conservative approach in identification of impacted properties was used to address uncertainties in the groundwater modeling (Appendix E) that was used to predict which properties might overlie a contaminant plume in the future. Thus, the total acreage of 6,054 acres conservatively estimates the maximum size of the privately-owned properties might be impacted by groundwater contamination in the future.

Table A.1 Ownership Characteristics in the Area Impacted or Potentially Impacted by Contaminated Groundwater

Ownership	Number of Parcels	Area (Acres)
DOE	1	3,556
TVA (Shawnee Power Plant)	1	2,669
Kentucky (West Kentucky Wildlife Mgt. Area)	2	1,290[1]
Private Property	165	6,054
Farm	64	5,783
Rural Residential	101	271
Total	169	13,568

[1]Only that portion of the West Kentucky Wildlife Management Area which is or may be impacted by contaminated groundwater.

In addition to the Potential Acquisition Zone, a Monitoring Zone of 1,552 acres was also delimited. The Monitoring Zone includes farms and residences located outside, but adjacent to, the area that currently is or might become impacted by contaminated groundwater (Table A.2). These properties encompass an area where monitoring easements for research and testing purposes in the future are possible. As discussed in Appendix D, fee simple ownership was not considered for property parcels in the Monitoring Zone because these parcels lie outside the area currently impacted or predicted to be impacted by groundwater contamination.

Table A.2 Monitoring Zone Properties

Type	Number of parcels	Acres
Farm	15	1,522
Rural residential	17	30
Total	**32**	**1552**

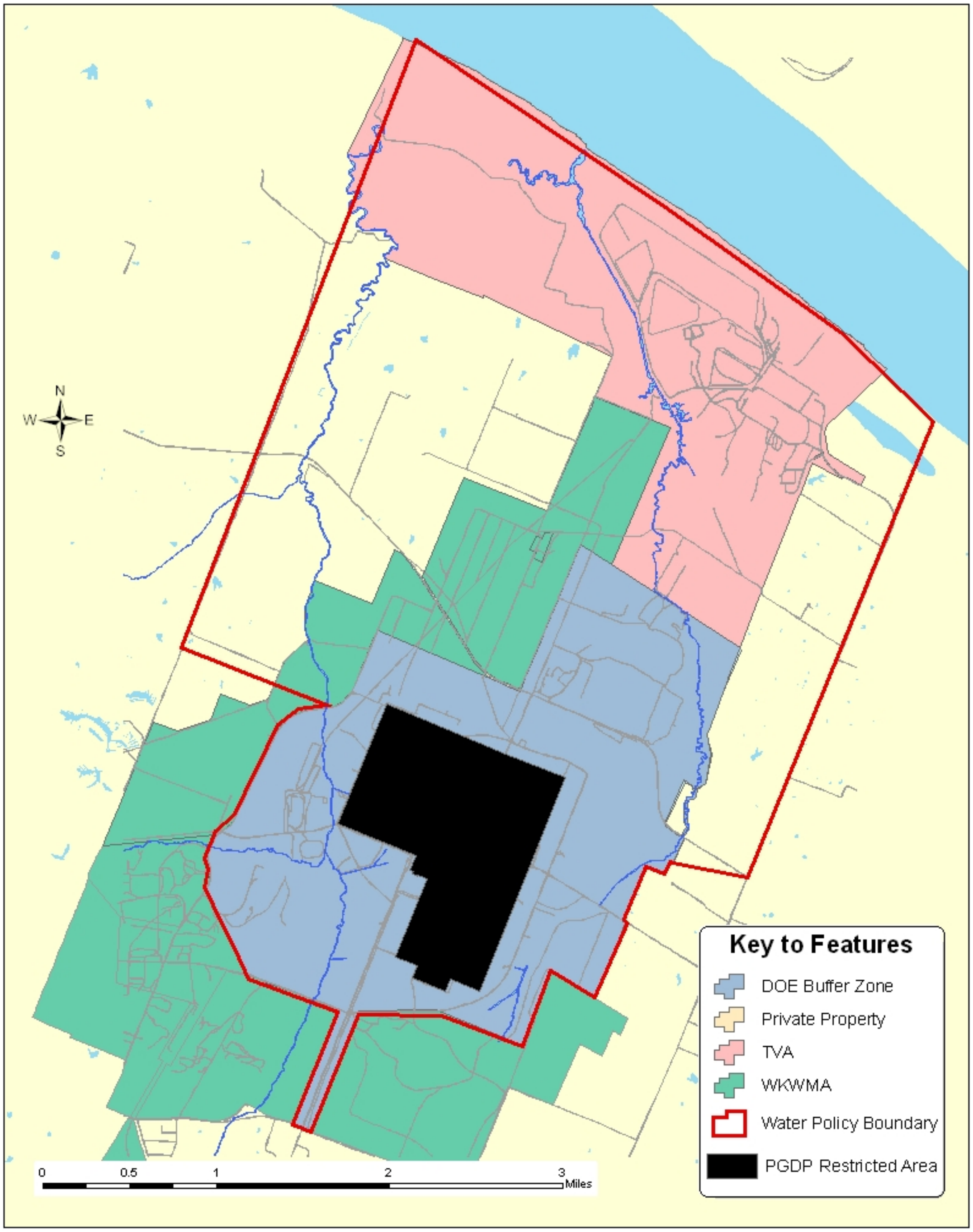

Figure A.1 PGDP Site Location and Adjacent Properties

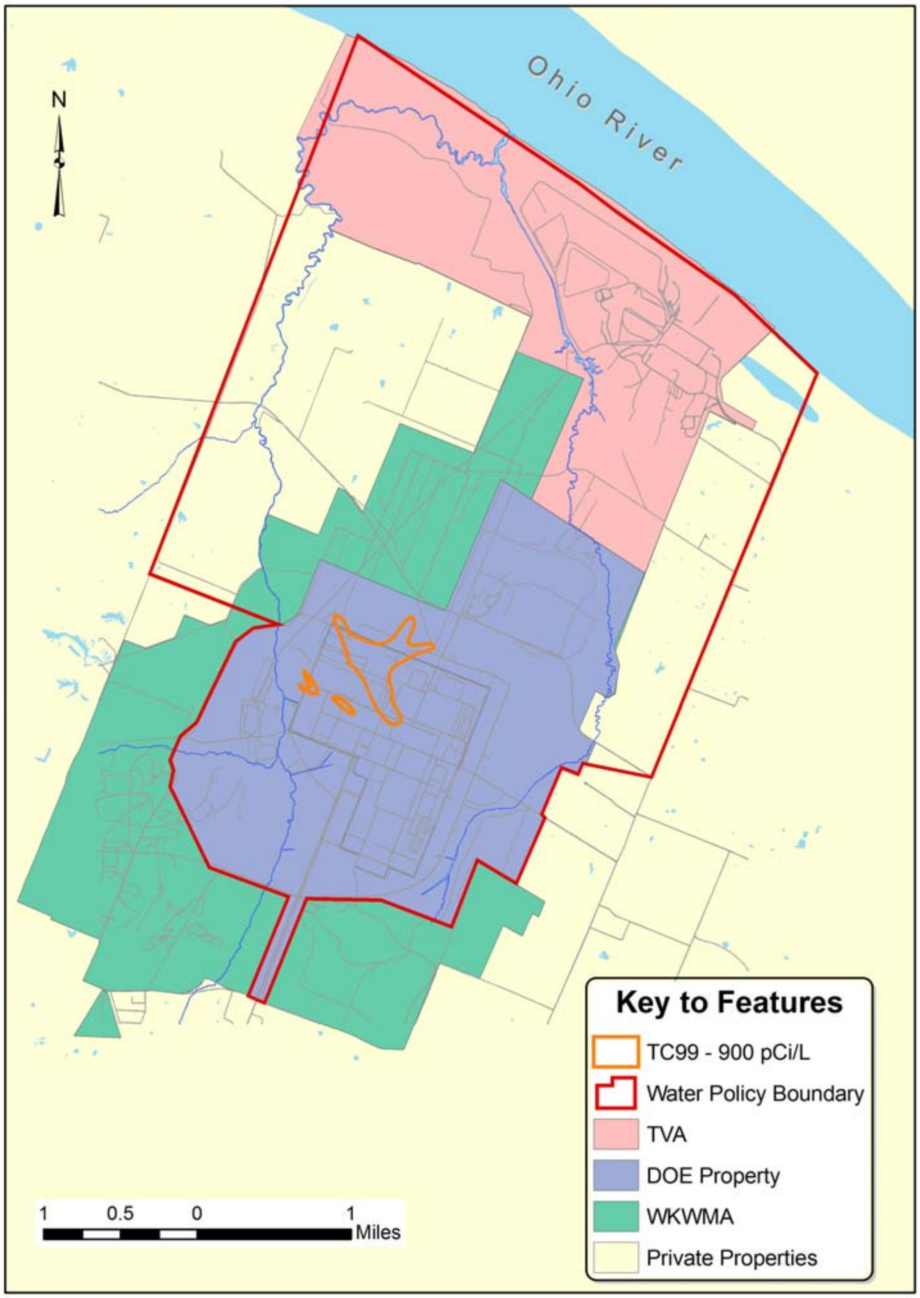

Figure A.3 Current Techetium-99 Plume (concentration > 900 pCi/L) at the PGDP (DOE 2005)

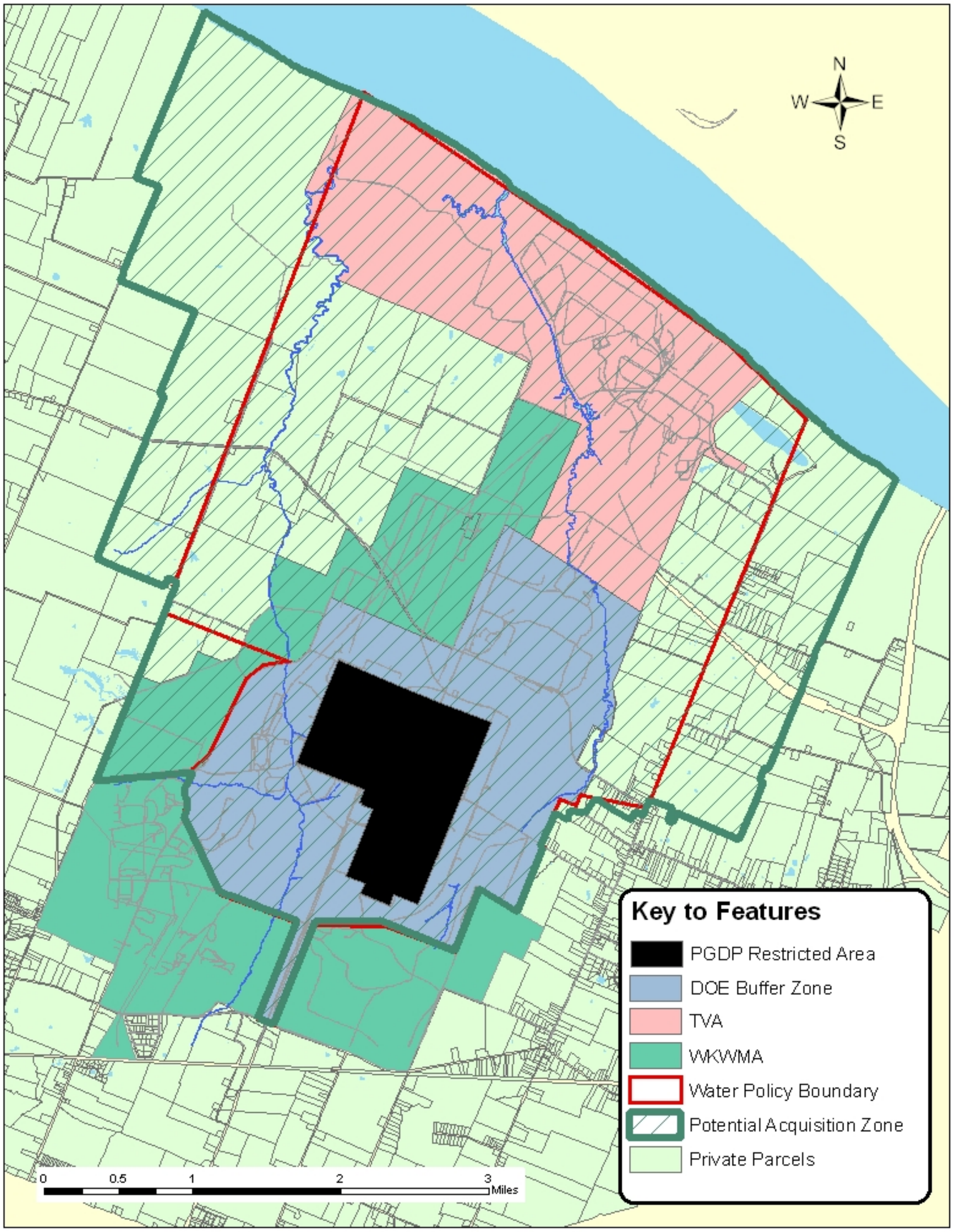

Figure A.4 Potential Property Acquisition Zone

A.3 PROPERTY ANALYSIS

A GIS analysis of the property data was performed in order to determine the range of property sizes for potentially impacted residential and farm parcels. The average size of the residential parcels was found to be approximately 3 acres. With the exclusion of one 1400 acre farm parcel on the west side of the WKWMA, the average size of the farm parcels was found to be approximately 65 acres. Histograms showing the distribution of both property classes are provided in Figures A.5 and A.6.

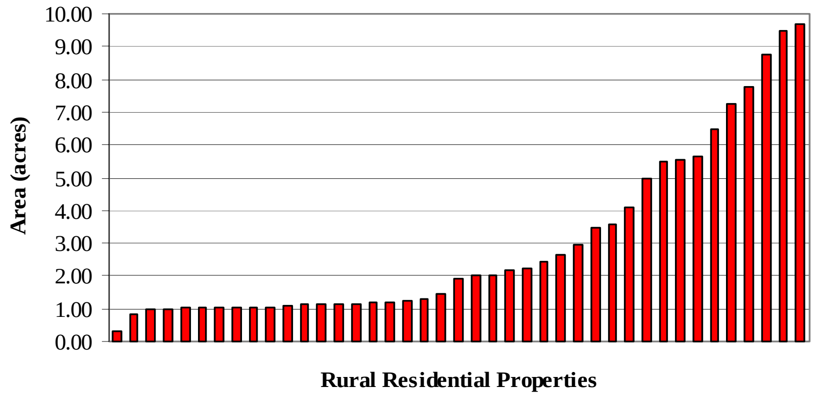

Figure A.5 Distribution Residential Parcel Sizes

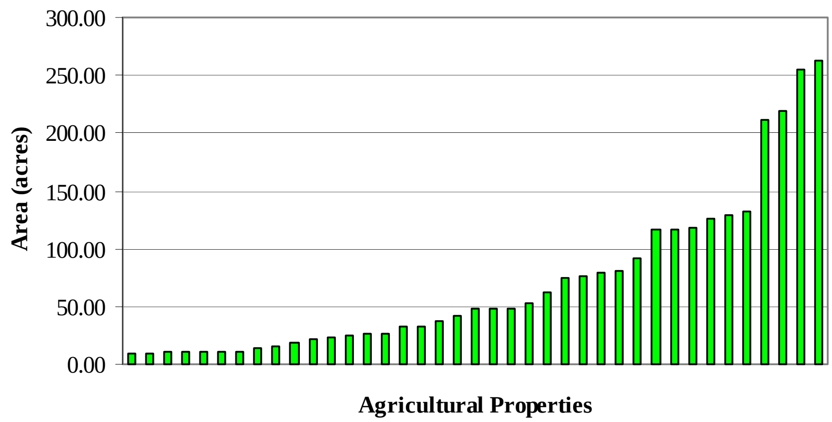

Figure A.6 Distribution of Farm Parcel Sizes (excluding 1400 acre parcel)

A.4 REFERENCES

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APPENDIX B. TASK 2
PROPERTY PURCHASE ANALYSIS

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ACRONYMS

DOE	U.S. Department of Energy
KRS	Kentucky Revised Statutes
PGDP	Paducah Gaseous Diffusion Plant
^{99}Tc	technetium-99 (^{99}Tc)
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
TVA	Tennessee Valley Authority

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B.1 INTRODUCTION

Parcels of land at and around the PGDP currently or potentially overlying groundwater plumes are owned by the DOE, the Tennessee Valley Authority (a federal corporation, TVA), the Commonwealth of Kentucky, and other private parties. A portion of the property owned by the DOE is subject to a lease to the Commonwealth of Kentucky.

The following discussion identifies the various interests in land, both possessory and non-possessory, available in Kentucky. The discussion covers the nature of the interest, and the types of situations (looking to best practices in Kentucky) where the particular interest could be usefully employed to limit or prevent exposure to contaminated groundwater. In some cases, there is no realistic possibility that the specific interest could be usefully employed within Kentucky best practices except as a means to identify and eliminate existing interests in a property.

B.2 OWNERSHIP INTERESTS IN LAND RECOGNIZED IN KENTUCKY

Estates and interests in real property are largely based on models developed in England long before the American Revolution. Under this scheme, interests in land are either possessory or nonpossessory. The holder of the right to possession has the right to physically occupy the land in question and to exclude others from entering it. Possessory interests in land include the fee simple, the life estate, and the leasehold. Nonpossessory interests include future interests and certain intangible rights known as incorporeal hereditaments. Future interests, which are presently nonpossessory but which may become possessory, include reversions, remainders and executory interests. Inchoate dower rights may also be regarded as a form of future interest. Incorporeal hereditaments and similar present nonpossessory interests in real property include easements, licenses, options, and equitable servitudes. Finally, landowners have rights to extract ground water, and they may also have the right to withdraw surface water from lakes and streams if they are riparian or littoral owners.

B.2.1 POSSESORY INTERESTS

The fee simple, the life estate and the leasehold are the principal possessory interests in land. By possessory, we mean that the owner or owners of the interest have the right to physically occupy the land and to exclude all others.

B.2.1.1 The Fee Simple

The fee simple is the most complete estate one can have in real property. It is an inheritable estate of potentially infinite duration in the owner and the owner's heirs or successors in interest.[1] One may acquire a fee simple interest in land by conveyance (deed), by will, or by inheritance. Furthermore, the owner of a fee simple estate may convey it to another by deed or dispose of it at death by will or under the laws of intestacy (i.e., dying without a will). Public policy favors the fee simple over other estates in

[1] Slayden v. Hardin, 79 S.W.2d 11, 12 (Ky. 1935).

land. Therefore, if a deed or will is ambiguous, courts will construe it as creating or transferring a fee simple absolute rather than some lesser estate.[2]

The fee simple can be divided into various subcategories. The preferred type of fee simple is the fee simple absolute. The distinguishing characteristic of the fee simple absolute is that the landowner's right to possession cannot ever be terminated because of subsequent actions or events. Of course, land that is owned in fee simple may still be subject to limitations imposed by governmental regulations such as zoning ordinances and by private restrictions embodied in easements or equitable servitudes (commonly known as restrictive covenants).

Certain types of fee simple estates, though potentially infinite in duration, may terminate because of limitations or conditions attached to them at the time of their creation.[3] These so-called defeasible fee simple estates include the fee simple determinable and the fee simple subject to condition subsequent.[4] A deed in which a fee simple determinable is conveyed will provide for the land to automatically revert to the grantor (or his/her heirs) if a specified event occurs.[5] The future interest retained by the grantor is known as a possibility of reverter.[6] Developers and others who wish to donate land to a governmental entity sometimes use this form of conveyance.[7] Kentucky abolished the fee simple determinable in 1960;[8] however, the statute is not retroactive and holders of possibility of reverters may preserve their rights by recording a preservation notice with the county clerk.[9]

In the case of a fee simple subject to condition subsequent, the grantor retains the right to terminate the fee interest if a specified act or event occurs. The interest retained by the grantor is known as a right of entry or a power of termination.[10] Unlike the case of the fee simple determinable, grantor must affirmatively exercise his or her right of entry in order to terminate the possessory interest the owner of a fee simple subject to condition subsequent. Unless and until that occurs, the holder of the fee simple on condition subsequent remains in possession of the property.

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[2] KRS § 381.060 (Mitchie 2002); Howard v. Gross, 153 S.W.2d 989, 991 (Ky. 1941); Sumner v. Borders, 98 S.W.2d 918, 919 (Ky. 1936).

[3] Fleming County Bd. of Education v. Hall, 380 S.W.2d 273, 274 (Ky. 1964).

[4] A third type of defeasible interest, known as the fee simple subject to executory limitation, is rarely found except when land is held in trust.

[5] For example, O's deed may purport to convey the land "to A and his heirs *so long as* liquor is not sold on the premises." The property will automatically revert back to O if liquor is ever served on the premises.

[6] Fleming County Board of Education v. Hall, 380 S.W.2d 273, 274 (Ky. 1964). A possibility of reverter is an inheritable interest and it may also be transferred to another by the owner. Cline v. Johnson County Board of Education, 548 S.W.2d 507, 508 (Ky. 1977).

[7] For example, O may convey land "to the School board so long as the property is used for school purposes." See Barron County Board of Education v. Jordan, 249 S.W.2d 814, 814-15 (Ky. 1952).

[8] KRS § 381.128 (Mitchie 2002).

[9] KRS § 381.221 (Mitchie 2002).

[10] Dennis v. Bird, 941 S.W.2d 486, 489 (Ky. Ct. App. 1997). A right of entry is an inheritable interest and it may also be transferred to another by the owner.

The acquisition of a fee simple determinable or a fee simple subject to condition subsequent by a subsequent purchaser does not extinguish any interest, such as a possibility of reverter or a right of entry, retained by the grantor. If a buyer wishes to acquire a full and unlimited interest in such property, he or she must acquire both the possessory interest and the interest that has been retained by the grantor. This means the buyer must negotiate with two parties instead of one, which may greatly increase acquisition costs.

Kentucky best practices suggest that the fee simple absolute possessory interest may be appropriate to limit or eliminate exposure to contaminated groundwater. This will be true where DOE currently owns the property in fee simple, or where DOE acquires an interest in additional property.[11] Defeasible fee simple estates may not be appropriate, except with respect to identifying and eliminating pre-existing defeasible fee simple estates.

B.2.1.2 Life Estates

A life estate is a possessory interest in land that lasts for the life of the owner, who is known as the life tenant.[12] When the owner of a fee simple absolute conveys a life estate to another, the property will revert to the owner of the fee (or his or her heirs, devisees or transferees) at the death of the life tenant.[13] A life estate may be sold to another. The estate that is transferred is known as a life estate *pur autre vie* and it will terminate at the death of the original life tenant, not the transferee.[14] Since the duration of a life estate is measured by a human life, one cannot create a life estate in which a governmental or corporate entity is the life tenant.[15]

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[11] Within the fee simple category, the fee simple absolute will be the most useful.

As the fee simple determinable was abolished prospectively in Kentucky in 1960, it will be of interest only with respect to identifying and eliminating pre-existing interests in property required for the monitoring and remediation plan.

It is expected that the fee simple subject to condition subsequent will be of interest with respect to identifying and eliminating pre-existing interests in property required for the monitoring and remediation plan. While, in theory, a fee simple subject to condition subsequent could be used, for example, to give an existing landowner a right to regain property should DOE remediation efforts reduce Tc-99 and TCE levels to an acceptable range, it is assumed that such arrangements would be rare and could be better accomplished through an option, discussed *infra.*

For purposes of this discussion any subsequent reference to a "fee simple" should be taken as a reference to a fee simple absolute, unless otherwise indicated.

[12] Life estates are not always possessory. If O conveys land "to A for life, then to B for life," B's estate will not become possessory until A dies. In this example, A would have a possessory life estate and B would have a remainder for life.

[13] The interest retained by the owner of the fee simple is known as a reversion. The owner could convey an inheritable interest to a third person that would become possessory when the life tenant died. This latter interest is called a remainder and its owner, whether male or female, is traditionally referred to as a remainderman. Thus, if O conveys land "to A for life, then to B and her heirs," A would have a life estate and B would have a vested remainder in fee simple.

[14] Leonard v. Williams, 295 S.W. 408, 409 (Ky. 1927).

[15] However, a governmental or corporate entity could purchase an existing life estate from a life tenant and hold it as a life estate *pur autre vie*.

Kentucky best practices suggest that the life estate possessory interest would not be useful to acquire property interests to limit or eliminate exposure to contaminated groundwater, except with respect to identifying and eliminating pre-existing life estates in property.

B.2.1.3 Leasehold Interests

A lease is the conveyance of a possessory interest in land leaving a reversion in the grantor.[16] The holder of the possessory interest is called the tenant or lessee, while the holder of the reversionary interest is called the landlord or lessor. There are three types of leases: a term of years, a periodic tenancy, and a tenancy at will. A term of years is a lease that lasts for some fixed period of time. The lease term can be for any length of time, including less than a year, as long as the lease specifies a date at which the lease will begin and when it will end. A periodic tenancy is a lease for a fixed period, such as a month or a year, that will be automatically renewed for additional periods until either the landlord or the tenant gives notice of termination to the other party.[17] A tenancy at will has no fixed duration, but rather endures until either the landlord or the tenant terminates it.[18]

Kentucky best practices suggest that leasehold interests would not be useful to acquire property interests to limit or eliminate exposure to contaminated groundwater over an extended period. However, existing leaseholds could need to be addressed in order to implement other options to acquire property interest (e.g., fee simple absolute).

B.2.1.4 Concurrent Estates

A piece of property may be owned by a single individual or by more than one individual.[19] When land is owned jointly by several individuals, it may be held as a tenancy in common, or a joint tenancy with right of survivorship. In addition, married couples may own land jointly as tenants by the entirety. These are known as concurrent estates. Although most concurrent estates are held in fee simple, it is possible to create a tenancy in common for life.

Tenants in common have separate, but undivided, interests in the property. A tenancy in common may be created by deed. Thus, an individual who is the sole owner of a piece of property may convey it to two or more third parties as tenants in common. A tenancy in common may also arise through intestacy. Any number of individuals can be tenants in common with respect to the same piece of property. Tenants in common do not have to have equal interests in the property. For example, if two persons own property as tenants in common, one may have a 1/3 interest and the other may have a 2/3 interest. Furthermore, if the tenancy in common is held in fee simple, the interest of each owner is descendible and may be transferred to another by deed or by will. There is no right of survivorship among tenants in common. Finally, the possessory interests of tenants in common are "undivided," meaning that each co-tenant theoretically has a right to possession of the whole piece of property.

[16] Cannon v. Carr, 168 S.W.2d 21, 22 (Ky. 1943); Moore v. Brandenburg, 28 S.W.2d 477, 478 (Ky. 1930).

[17] Horstman v. Newman, 291 S.W.2d 567, 567-68 (Ky.1956).

[18] Morgan v. Morgan, 218 S.W.2d 410, 411-12 (Ky. 1949).

[19] Real property may also be owned by corporate entities such as business corporations, churches, educational institutions or governmental entities.

Joint tenants also have separate, but undivided, interests in the property and any number of persons can be joint tenants However, unlike tenants in common, each joint tenant must have an equal undivided share. For example, if two individuals own a piece of property as joint tenants, each must have an undivided one-half interest. The right of survivorship is an important characteristic of the joint tenancy. According to this concept, when one joint tenant dies, his or her rights are extinguished. Thus, if three persons hold property as joint tenants and one joint tenant dies, the remaining joint tenants will have an undivided one-half interest in the property. When the second joint tenant dies, the joint tenancy will terminate and the survivor will own the property as a possessory fee simple. At that point, the property will become inheritable or devisable by will.

The final form of concurrent estate is the tenancy by the entirety. This estate can only be created in a husband and wife.[20] It is similar to a joint tenancy in the sense that each co-tenant must have an equal share and there is a right of survivorship. Divorce automatically terminates a tenancy by the entirety and turns it into a tenancy in common because marriage is an essential element of this estate.[21]

A tenancy in common, a joint tenancy or a tenancy by the entirety can be conveyed to a third party if all of the co-tenants join in the conveyance. In such cases, the concurrent estate would be destroyed and the purchaser would acquire a fee simple. The rules are somewhat more complicated when one co-tenant purports to convey his or her undivided interest to a third party. Any tenant in common can convey his or her interest to a third party and the grantee will have the same interest as the grantor. On the other hand, if a joint tenant purports to convey his or her undivided interest to a third party, the conveyance will be valid but the joint tenancy will be automatically converted into a tenancy in common and the right of survivorship will be destroyed. Finally, neither co-tenant can unilaterally convey his or her interest to a third party if the property is held as a tenancy by the entirety.[22]

When property is held as a tenancy in common or as a joint tenancy, any co-tenant can unilaterally terminate the concurrent estate by bringing a partition action. When this occurs, the court will either physically divide the property among the co-tenants or order the property to be sold and the proceeds divided among the co-tenants. A partition action is not available to those who hold property as tenants by the entirety, although such property may be partitioned as part of a divorce proceeding.

The inherent nature of concurrent estates makes them unsuitable for DOE for purposes of acquisition of property interests.

B.2.2 NONPOSSESSORY FUTURE INTERESTS

Nonpossessory future interests are rights to possession in the future after the termination of an existing possessory estate. There are five types of future interest. Two of these interests, the possibility of reverter and the right of entry, have been mentioned earlier. Other future interests include reversions, remainders and executory interests. Kentucky best practices suggest nonpossessory future interests would not be useful for acquisition of property interests to limit or eliminate exposure to contaminated groundwater. However, some land overlying or potentially overlying contaminated groundwater may be subject to existing nonpossessory future interests.

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[20] Nelson v. Mahurin, 994 S.W.2d 10, 14-15 (Ky. Ct. App. 1998).

[21] Nelson v. Mahurin, 994 S.W.2d 10, 14-15 (Ky. Ct. App. 1998).

[22] Hoffman v. Newell, 60 S.W.2d 607, 609 (Ky. 1932); Barton v. Hudson, 560 S.W.2d 20, 22 (Ky, Ct. App. 1978).

B.2.2.1 Possibilities of Reverter and Rights of Entry

The possibility of reverter is the future interest that retained by the owner of a fee simple absolute when he or she conveys a fee simple determinable. The right of entry is the future interest that is retained by the owner of a fee simple absolute when he or she conveys a fee simple subject to condition subsequent. (See Section B.2.1.)

B.2.2.2 Reversions, Remainders and Executory Interests

A reversion is a future interest retained by the owner of a fee simple when he or she conveys a lesser possessory interest, such as a life estate, to another.[23] For example, if the owner of real property held in fee simple absolute conveys a life estate to another person, the interest retained by the owner is a reversion. Possession will revert or return to the owner when the life tenant dies. On the other hand, a remainder is a future interest created in a third person when the owner of a fee simple also creates a lessor possessory interest to another.[24] For example, if the owner of a fee simple absolute executes a deed which purports to convey a life estate to one person and a fee interest to someone else at the death of the life tenant, the future interest which follows the possessory life estate is a remainder. Finally, it is possible to create a future interest, known as an executory interest that may cut off other interests, both future interests such as remainders and even possessory interests.

When land ownership is divided into a present possessory interest and a future interest, both interests must be acquired in order to obtain a fee simple absolute.

B.2.2.3 Trusts

Some of the land that might overlie contaminated groundwater may be held in trust. A trust is an asset management device that divides the burdens and benefits of property ownership between a trustee and one or more beneficiaries. Trusts may be created by an individual, known as the settlor, while he or she is alive. These are known as inter vivos trusts. Trusts also may be created by will. These are known as testamentary trusts. Inter vivos trusts may be revocable or irrevocable.

The trustee is a fiduciary who holds legal title to the property in the trust and typically has the right to buy and sell trust assets. Beneficiaries have beneficial or equitable interests in the trust property. These interests may be present interests, such as the right to some or all of the income produced by the trust, or they may be future interests such as reversions or remainders. The trustee may also have the right to appoint or allocate trust income or trust property to one or more beneficiaries. Both land and personal property can be put into trust. Trustees may be individuals, usually family members of the person who has established the trust (i.e., the settlor) or they may be financial institutions such as trust companies or banks.

As long as the trustee has the power to sell trust property, land can be acquired by purchasing it from the trustee. Sometimes the trust beneficiaries may have the right to veto a sale, particularly if the property in question is a family farm or a principal asset of the trust. Otherwise, a conveyance by the trustee will be valid and the proceeds of the sale will become part of the trust's property.

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[23] Fidelity & Columbia Trust Co. v. Williams, 105 S.W.2d 814, 815 (Ky. 1937).

[24] Georgetown College v. Alexander, 140 S.W.3d 6, 12 (Ky. Ct. App. 2003).

Kentucky best practices suggest that the trust form would not be useful to acquire property interests to limit or eliminate exposure to contaminated groundwater, except with respect to identifying and eliminating pre-existing trusts.

B.2.2.4 Inchoate Dower Rights

Another interest that should be mentioned is inchoate dower. Most states that do not recognize the concept of community property instead recognize dower rights. Dower rights are derived from English common law, but in Kentucky they are governed by statute. According to KRS § 392.020, if a married person dies without a will, the surviving spouse will receive one-half of the decedent's estate (after payment of debts, taxes and expenses of administration). In addition, the statute recognizes inchoate dower by providing that if a married person dies without a will, the surviving spouse will receive a life estate in one-third of any real estate owned by the decedent during the marriage, but not at death.[25] Of course, the remaining interest will continue to be owned by the person the deceased spouse sold it to. Inchoate dower rights can be released by the nonowner spouse when property is conveyed, but if that is not done, the surviving spouse may assert a claim to property when his or her spouse dies.[26] Therefore, it may be necessary to obtain a release of dower rights when purchasing property from a married person even though the other spouse is not a record title owner.

B.2.3 NONPOSSESSORY PRESENT INTERESTS

Real property may be subject to certain nonpossessory rights or interests held by someone other than the record title owner. The interests include options, licenses, easements, real covenants and equitable servitudes.

B.2.3.1 Purchase Options

A purchase option gives the option holder an exclusive right to purchase a piece of real property.[27] The most common form of purchase option allows the option holder to purchase the property according to specified terms and for a specified period of time. Another form of option is a preemptive option, commonly known as a right of first refusal.[28] A preemptive option gives the option holder the right to purchase the land by matching any offer from another purchaser.[29] Kentucky best practices suggest that purchase options could be used to acquire interests in property to limit or eliminate exposure to contaminated groundwater.

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[25] KRS § 392.020 (Mitchie 1999). See also Mattingly v. Gentry, 419 S.W.2d 745, 746 (Ky. 1967); Kentucky Bank & Trust Co. v. Ashland Oil & Transp. Co., 210 S.W.2d 287, 291 (Ky. 1958).

[26] Hannah's Assignees v. Gay, 78 S.W. 915, 916 (Ky. 1904).

[27] Walton's Executor v. Franks, 228 S.W. 1025, 1026 (Ky. 1921).

[28] Wilson v. Gray, 560 S.W.2d 561, 561 (Ky. 1978).

[29] Three Rivers Rock Co. v. Reed Crushed Stone Co., Inc., 530 S.W.2d 202, 208 (Ky. 1975).

B.2.3.2 Licenses

A licensee is one who comes upon land with the consent of the owner.[30] Most licenses are gratuitous and revocable by the licensor. For example, a landowner may allow someone to cross his or her land to reach a road. As long as this use is permissive, and not based on a claim of right, it would be a license. A license may become irrevocable when the licensee constructs improvements or makes substantial expenditures in reliance on the license.[31]

Kentucky best practices suggest that licenses may not be useful in acquiring property interests to limit or eliminate exposure to contaminated groundwater.

B.2.3.3 Easements

An easement is a privilege which one person has a right to enjoy over the land of another for the benefit of the easement holder's land, but it does not create an interest in the land itself.[32] Easements are usually created by written instruments, but they may also arise by implication or by prescription.[33] The burdens and benefits associated with easements are not personal to the original grantor and grantee, but attach to the land so that subsequent owners are similarly benefited or burdened.

There are various ways of looking at easements. For example, easements may be affirmative or negative. An affirmative easement or "right of way," gives the holder of the easement the right to enter the land that is subject to the easement, known as the servient tenement. In contrast, a negative easement is a restriction on the land of another. Traditionally, negative easements were limited to light, air, flowage and lateral and subjacent support. Kentucky by statute also recognizes scenic,[34] solar[35] and conservation[36] easements. According to modern legal scholars, negative easements continue to be restricted to these categories in the United States.[37] In his discussion of conservation easements, one commentator has observed that "[b]ecause of doubt over the common law validity of this form of negative easement most jurisdictions have enacted statutes explicitly permitting them."[38]

Another important distinction among easements is whether they are appurtenant or are held in gross. In the case of easements appurtenant, one piece of land, referred to as the dominant tenement, benefits from

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30 Bowers v. Schenley Distillers, Inc., 469 S.W.2d 565, 567 (Ky. 1971); Scifres v. Kraft, 916 S.W.2d 779, 781 (Ky. Ct. App. 1996).

31 Holbrook v. Taylor, 532 S.W.2d 763 (Ky. 1976); Cole v. Gilvin, 59 S.W.3d 468, 477-78 (Ky. Ct. App. 2001).

32 Meade v. Ginn, 159 S.W.3d 314 (Ky. 2004); Sumrall v. Maninni, 98 S.W. 301, 301 (Ky. 1906).

33 Loid v. Kell, 844 S.W.2d 428, 429 (Ky. Ct. App. 1992).

34 KRS § 65.410-480 (Mitchie 2002).

35 KRS § 381.200(2) (Mitchie 2002).

36 KRS §§ 382.800 to 382.860 (Mitchie 2002).

37 Korngold Private Land Use Arrangements § 2.02 (2d ed. 2004) (stating that "[t]he law has recognized only a few types of negative easements – light, air, and view; lateral support; and stream flow").

38 Thompson on Real Property § 60.02(e)(4).

the exercise of the easement, while an adjacent piece of property, the servient tenement, is burdened by the easement.[39] An easement in gross is a personal interest in or right to use the land of another. It is attached to and vested in, the person to whom it is granted. Where an easement is held in gross, a piece of land is burdened but no particular land is benefited.[40]

Putting these categories together produces a matrix of four types of easements: (1) affirmative easement appurtenant, (2) negative easement appurtenant, (3) affirmative easement in gross, and (4) negative easement in gross. An affirmative easement appurtenant is the most common form type of easement and is exemplified by the situation where one landowner has the right to cross the land of another to reach to road. A negative easement appurtenant is illustrated by solar or scenic easements when restrictions on one landowner benefit the adjoining land. Utility, railroad and street rights of way are examples of affirmative easements in gross, while scenic highway easements and conservation easements are illustrative of negative easements in gross.

Kentucky best practices suggest that easements may be appropriate in acquiring property interests to limit or eliminate exposure to contaminated groundwater. Additionally, affirmative easements may also be useful to provide access to private property for monitoring for the presence of contaminated groundwater or other activities.

A different analysis pertains to the use of easements to restrict the use of property, rather than to gain access to the property for monitoring purposes. Common law negative easements were restricted to categories – light, air, flowage and lateral and subjacent support – which would not be useful in limiting or eliminating exposure to contaminated groundwater. For example, it is doubtful that a traditional common law negative easement could be used to prevent the property owner from pumping water or developing the property. The statutory conservation easement, however, could provide a means to limit or eliminate exposure to contaminated groundwater by restricting the pumping of groundwater. It should be noted that the language of the statute is quite broad, and by its plain meaning could include a prohibition on the pumping of water:

> "Conservation easement" means a nonpossessory interest of a holder in real property imposing limitations or affirmative obligations, the purposes of which include retaining or protecting natural, scenic, or open-space values of real property, assuring its availability for agricultural, forest, recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural, archaeological, or cultural aspects of real property.[41]

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39 Martin v. Music, 254 S.W.2d 701, 703 (Ky. 1953); Hammonds v. Eads, 142 S.W. 379, 380 (Ky. 1912).

40 Meade v. Ginn, 159 S.W.3d 314, 320 (Ky. 2004).

41 KRS.382.800(1).

Therefore, a conservation easement to restrict the pumping of water or the residential or commercial development in the area could be used to limit or eliminate exposure to contaminated groundwater.[42]

B.2.3.4 Real Covenants and Equitable Servitudes

Real covenants and equitable servitudes are nothing more than promises respecting the use of land, however, unlike ordinary contracts, real covenants and equitable servitudes "run with the land" in a manner similar to easements. Equitable servitudes are much easier to create than real covenants and have largely replaced them in recent years.[43]

Real covenants and equitable servitudes can be either affirmative or negative. An affirmative real covenant or equitable servitude requires the burdened landowner to perform some service, such as maintaining a retaining wall or an irrigation canal or paying a sum of money for such purposes. Annual fees and assessments charged by homeowners' associations for the maintenance of streets, beaches and common areas are usually based on affirmative equitable servitudes. A negative real covenant or equitable servitude is a restriction on one tract of land for the benefit of another. Deed restrictions or "restrictive covenants" often found in upscale subdivisions are actually negative equitable servitudes. Although real covenants and equitable servitudes may last indefinitely, they often have fixed periods of duration (with a prescribed procedure for renewal). In addition, real covenants and equitable servitudes in urban areas may be terminated by a court because of non-enforcement or when a substantial change in the character of the neighborhood occurs.[44]

Unlike negative easements, which are quite limited in scope, virtually any activity or condition on real property can be the subject of a restrictive equitable servitude. Thus, an equitable servitude could be used

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[42] As is developed below, for purposes of this discussion we refer to a combined category of "easements" – including common law easements, statutory conservation easements, real covenants, and equitable servitudes – which includes forms which are technically "servitudes" under the Restatement (Restatement of the Law Third, Property, Chapter 1, § 1.1(1) (definition of servitude)). Such interests could include real covenants, equitable servitudes, statutory conservation easements and affirmative easements. Nevertheless, because this analysis focuses primarily on affirmative easements and conservation easements, we refer to the options involving less than fee simple ownership as "easements." Within the category of easements, we refer to three sub-types:

a. "monitoring easements" are easements, either affirmative easements or conservation easements, which provide for access to a parcel for purposes of monitoring and testing. Included in these easements would be access, the right to drill test wells, and the right to install monitoring equipment.
b. "limited scope easements" are conservation easements which are for a relatively limited purpose, such as a prohibition on the use of surface water or groundwater.
c. "expanded scope easements" are conservation easements which are for a relatively broader purpose, such as a prohibition on the sue of surface or subsurface water *and* a prohibition on the construction of swimming pools, septic systems, ponds and the like. The expanded scope easements could be used all the way up to a prohibition on all development on the parcel.

[43] A real covenant requires (1) intent that the burden or benefit run with the land, (2) privity of estate and (3) and that the burden or benefit "touch and concern" the land. Fishback v. Dozier, 362 S.W.2d 490, 491 (Ky. 1962); Bishop v. Rueff, Ky.App., 619 S.W.2d 718, 720 (Ky. Ct. App.1981). In contrast, to create an equitable servitude, there must be (1) an intent that the burden or benefit run with the land, (2) actual or constructive notice and (3) and that the burden or benefit "touch and concern" the land. Paine v. LaQuinta Motor Inns, Inc., 736 S.W.2d 355, 358 (Ky. Ct. App. 1987). Privity of estate is not required for the burden to run with the land and the privity requirements are considerably relaxed with respect to enforcement of the benefit.

[44] Elliott v. Jefferson County Fiscal Ct., 657 S.W.2d 237, 238 (Ky. 1983); Rieger v. Wessel, 319 S.W.2d 855, 858 (Ky. 1958).

to restrict or prohibit the drilling of water wells on the land, the pumping of water, or the further development of the property. This restriction would apply not only to the original landowner but would also be effective (with proper notice) against those who purchased the land from the original landowner. The only concern is that most states do not recognize equitable servitudes in gross, meaning that some property near, but not necessarily contiguous to, the burdened property that can benefit from the restriction would need to be retained.[45] This would not be a concern as long as DOE retains title to the PGDP facility.

Kentucky best practices suggest that real covenants and equitable servitudes may be useful in acquiring property interests to limit or eliminate exposure to contaminated groundwater.[46]

B.2.4 WATER RIGHTS

Various systems of water rights are applied in the United States. Depending on geographic location, surface water withdrawals may be subject to riparian rights, prior appropriation or a statutory permit system. Likewise, the pumping of percolating ground water may be controlled by the absolute ownership doctrine, the reasonable use rule, prior appropriation, or a statutory permit system.

B.2.4.1 Surface Water

Surface water rights in the United States are based on two basic systems: In the East, surface water rights derive from the ownership of "riparian" land, which is contiguous to a navigable lake or stream.[47] In most riparian states, water that is withdrawn from a lake or stream cannot be transported beyond riparian land even though the land belongs to a riparian owner.[48] This is the rule in Kentucky.[49] Furthermore, the

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[45] This is analogous to an easement appurtenant discussed above.

[46] For purposes of this discussion, to simplify the nomenclature, we refer to such real covenants and equitable servitudes as "easements." It is noted that the combined category of such easements – including common law easements, statutory conservation easements, real covenants, and equitable servitudes – includes forms which are technically "servitudes" under the Restatement (Restatement of the Law Third, Property, Chapter 1, § 1.1(1) (definition of servitude)). Such interests could include real covenants, equitable servitudes, statutory conservation easements and affirmative easements. Nevertheless, because this analysis focuses primarily on affirmative easements and conservation easements, we refer to the options involving less than fee simple ownership as "easements." Within the category of easements, we refer to three sub-types:

a. "monitoring easements" are easements, either affirmative easements or conservation easements, which provide for access to a parcel for purposes of monitoring and testing. Included in these easements would be access, the right to drill test wells, and the right to install monitoring equipment.
b. "limited scope easements" are conservation easements which are for a relatively limited purpose, such as a prohibition on the use of surface or subsurface water.
c. "expanded scope easements" are conservation easements which are for a relatively broader purpose, such as a prohibition on the sue of surface or subsurface water *and* a prohibition on the construction of swimming pools, septic systems, ponds and the like. The expanded scope easements could be used all the way up to a prohibition on all development on the parcel.

[47] Richard C. Ausness, Water Rights Legislation in the East: A Program for Reform, 24 Wm. & Mary L. Rev. 547 (1983).

[48] William H. Farnham, The Permissible Extent of Riparian Land, 7 Land & Water L. Rev. 31 (1972); Rancho Santa Margarita v. Vail, 81 P.2d 533 (Cal. 1935).

[49] Bank of Hopkinsville v. Western Kentucky Asylum for the Insane, 56 S.W. 525 (Ky. 1900).

size of a riparian tract cannot be increased by the purchase of contiguous nonriparian land[50] and if a back portion of riparian land is sold, it loses its riparian character.[51] In most states, riparian rights are not transferrable to nonriparian land.[52] In the few states that do allow such transfers, the rights of the transferee are derivative and are often inferior to the rights of other riparian owners.[53]

In riparian states, the right to withdraw water is determined by either the natural flow doctrine or the reasonable use rule. The natural flow doctrine allows a riparian owner to withdraw as much water from a stream as needed so long as the withdrawal does not diminish the stream's natural flow.[54] Most riparian states, however, now follow the reasonable use rule.[55] Under this approach, each riparian owner may withdraw and use water for any beneficial purpose, provided that the use is reasonable with respect to needs of other riparian users and does not unreasonably interfere with other water uses.[56] Kentucky adheres to the reasonable use rule.[57]

B.2.4.2 Ground Water

Kentucky employs a set of consumptive use rules other than prior appropriation to its ground water, including its many underground streams.[58] Under this approach, ground water is classified as an

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50 Title Ins. & Trust Co. v. Miller & Lux, 190 P. 433 (Cal. 1920).

51 Anaheim Union Water Co. v. Fuller, 88 P. 978 (Cal. 1907).

52 Frank J. Trelease, Coordination of Riparian and Appropriative Rights, 33 Tex. L. Rev. 24 (1954).

53 Stoner v. Patten, 63 S.E. 897 (Ga. 1909); Kennebunk v. Maine Turnpike auth., 84 A.2d 18 (Me. 1951); Roberts v. Martin, 77 S.E. 535 (W. Va. 1913).

54 Eva Morreale Hanks, The Law of Water in New Jersey, 22 Rutgers L. Rev. 621 (1968).

55 Richard C. Ausness, Water Use Permits in a Riparian State: Problems and Proposals, 66 Ky. L.J.191 (1977).

56 Restatement (Second) of Torts § 850A (1972).

57 Daugherty v. City of Lexington, 249 S.W.2d 755 (Ky. 1952); City of Louisville v. Tway, 180 S.W.2d 278 (Ky. 1944). Prior appropriation is the primary mechanism for surface water allocation in the western United States. Frank J. Trelease, Coordination of Riparian and Appropriative Rights, 33 Tex. L. Rev. 24 (1954).
The prior appropriation doctrine provides that right to make a consumptive use of water arises by diverting water from a stream and putting it to a beneficial use. Appropriations are made for a specific quantity of water and are often limited to specific times of the day or week. The appropriator does not have to be a riparian owner and the water does not have to be used on riparian land. Peter N. Davis, Australian and American Water Allocation Systems Compared, 9 B.C. Indus. & Com. L. Rev. 647 (1968). Priority is an important feature of the prior appropriation system: The earliest or most senior appropriator is entitled to withdraw the full amount of his or her appropriation before a later appropriator may withdraw water from the stream. Pasadena v. Alhambra, 207 P.2d 17 (Cal. 1949); Bailey v. Idaho Irr. Co., 227 P. 1055 (Idaho 1924). In other words, the subsequent or junior appropriator has a legal right to the water, but this right is subordinate to that of the senior appropriator. Finally, under some conditions, water rights can be transferred. Robert A. Kimsey, Note, Water Allocation in Utah–Protection of Instream Uses, 1975 Utah L. Rev. 687, 692. Prior appropriation is not the applicable rule in Kentucky.

58 Commonwealth v. Sebastian, 345 S.W.2d 46 (Ky. 1961); Nourse v. Andrews, 255 S.W. 84 (Ky. 1923).

underground stream or percolating ground water.[59] Underground or subsurface streams, which flow in well-defined channels below the surface of the ground, are subject to the same consumptive use rules that govern surface waters.[60] Various consumptive use rules are applicable to percolating ground water. Some states adhere to the "absolute ownership" or English rule.[61] Under this approach, overlying landowners may pump an unlimited quantity of percolating ground water from under their land and use it on overlying land or on distant land, regardless of whether this causes injury to adjacent landowners.[62]
The American or "reasonable use" rule (which should not be confused with the surface water reasonable use rule) allows landowners to pump as much percolating ground water as they need, regardless of any adverse effect on other landowners, as long as they use the water on overlying land.[63] Landowners may transport percolating ground water beyond their overlying land, but only if this does not cause harm to other landowners.[64] Kentucky follows this approach.[65]

B.2.4.3 State Regulation

In 1966, Kentucky enacted a comprehensive permit system that regulates many types of surface and ground water withdrawals.[66] A statute provides that landowners wishing to withdraw surface or groundwater must obtain a permit from the Natural Resources and Environmental Protection Cabinet.[67] However, the statute exempts domestic and agricultural uses from the permit requirements.[68] Consequently, most non-industrial water users in Kentucky are not subject to regulation under the statute and their right to withdraw water is instead governed by the common law allocation rules discussed above.

B.2.4.4 Water Rights to Limit or Eliminate Exposure to Contaminated Groundwater

The acquisition or exercise of water rights does not appear to be an effective method of property acquisition. Common law water rights doctrines, such as the absolute ownership doctrine and the groundwater reasonable use rule, are primarily concerned with allocating available supplies of

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[59] Bull v. Siegrist, 126 P.2d 832 (Or. 1942).

[60] Gagnon v. French Lick Springs Hotel Co., 72 N.E. 849 (Ind. 1904); Evans v. City of Seattle, 47 P.2d 984 (Wash. 1935).

[61] A. W. McHendrie, The Law of Underground Water, 13 Rocky Mtn. L. Rev. 1 (1940).

[62] Stoner v. Patten, 63 S.E. 897 (Ga. 1909); Edwards v. Haeger, 54 N.E. 176 (Ill. 1899).

[63] Bd. of Supervisors v. Miss. Lumber Co., 31 So. 905 (Miss. 1902); Drummond v. White Oak Fuel Co., 140 S.E. 57 (W. Va. 1927); Pence v. Carney, 52 S.E. 702 (W. Va. 1905).

[64] Schenk v. City of Ann Arbor, 163 N.W. 109 (Mich. 1917); Erickson v. Crookston Waterworks Power & Light Co., 111 N.W. 391 (Minn. 1907).

[65] Sycamore Coal Co. v. Stanley, 166 S.W.2d 293 (Ky. 1942).

[66] KSR §§ 151.100 to 151.460 (Mitchie 2001).

[67] KRS § 151.140 (Mitchie 2001).

[68] Id.

groundwater among competing consumptive users and cannot be used to prevent an overlying owner from pumping groundwater for use on overlying land. Even if groundwater is used elsewhere, none of these doctrines could be used to prevent pumping unless it could be shown that the water rights owner's ability to extract groundwater was being impaired. In other words, if DOE was not making a consumptive use of the groundwater, it could not invoke groundwater allocation doctrines to prevent other landowners from doing so.

Acquisition of water rights from other landowners could not be used to limit or eliminate exposure to contaminated groundwater. Unlike the situation in many western states, water rights in the East usually cannot be transferred. However, if water rights are severed from overlying land with an easement, the transferor could be prevented from continuing to pump ground water. Acquiring water rights from one landowner would not prevent another landowner from pumping. Therefore, in order to prevent the removal of ground water from a particular area, water rights would need to be acquired from all of the overlying landowners in the area it wished to control.

B.2.5 ACQUISITION OF PROPERTY INTERESTS

B.2.5.1 Posessory Interests

One approach to property acquisition relating to the ^{99}Tc and TCE contamination in groundwater at the PGDP would be the acquisition of a fee simple interest in any land overlying or potentially overlying contaminated groundwater. The advantage of this form of land ownership is that it is of potentially infinite duration and would provide the greatest flexibility with respect to institutional controls. Kentucky best practices suggest that long-term leases may be appropriate for situations where control is needed for a more limited duration.

Note that the acquisition of a fee simple absolute for any given property may not be a unitary transaction (i.e., be completed in a single transaction). If the interests in the property are fragmented, multiple transactions may be required to create a fee simple absolute title. For example, if an entity wanted to purchase a possessory fee simple absolute for a parcel of land which was occupied by a life tenant, the life tenant's interest as well as the reversionary interest retained by the original grantor would need to be purchased.[69] Obviously, the more fragmented these interests are, the more difficult it will be for a potential purchaser to locate all of the relevant parties and to negotiate with them. It could also be necessary to obtain a release of inchoate dower rights when purchasing land in fee simple from a married person. Fragmented interests also pose a problem when acquiring tenancies in common that has come into existence because of intestacy. For example, if the owner of a piece of property dies without making a will and is survived by several children, the children will hold the property as tenants in common. This type of tenancy in common is often referred to as "heir property." Such property can end up divided into numerous shares if several generations of tenants in common die intestate.[70] In such cases, it would be very difficult to track all of the owners down and negotiate with them.

[69] Under the doctrine of merger, when two vested interests, such as a life estate and a reversion come into common ownership, they merge to form a possessory fee simple. Larmon v. Larmon, 191 S.W. 110, 112 (Ky. 1917).

[70] For example, assume that O, the original owner of the property in question, dies intestate, leaving three children, A, B, and C. A dies intestate, leaving two children, E and F. B dies intestate, leaving five children, G, H, I, J and K. C died intestate, leaving three children, L, M and N. G dies intestate, leaving three children, O, P and Q. O's grandchildren and great-grandchildren, E, F, H, I, J, K, L, M, N, O, P and Q, are all tenants in common. E and F each have a 1/6th share, H, I, J and K each have a 1/15th share, L, M and N each have a 1/9th share, and O, P and Q each have a 1/45th share.

B.2.5.2 Nonpossessory Interests

The only apparent reason to purchase nonpossessory future interests such as reversions, remainders, executory interests, possibilities or reverter or rights of entry would be to obtain a fee simple absolute by merger as the result of purchasing several lesser interests in the same piece of property. The purchase of incorporeal hereditaments or other nonpossessory interests might be a useful way to limit or eliminate exposure to contaminated groundwater. An example of such an interest would be to purchase an option rather than immediate ownership in a piece of property. It should be noted that options are normally not valid for more than twenty-one years.

In cases where it is necessary to conduct long-term monitoring activities on a piece of land, obtaining a license from the landowner rather than purchasing an easement or a fee simple interest might be useful.

Easements are another possibility. For example, a conservation easement could effectively prevent residential or commercial development on the land, while still allowing the landowner to use it for agricultural purposes. A conservation easement of this sort could be granted in perpetuity or for a fixed period of years. Another approach could consist of purchasing an affirmative easement to allow monitoring activities on the site.

Since DOE owns land in the immediate area, these easements would probably be classified as easements appurtenant. They could also be effectively employed as easements in gross. The only disadvantage of an easement in gross is that the benefit is considered to be personal to the grantee and may not be transferable to another person or governmental entity.

B.2.5.3 Water Rights

Water rights give riparian and overlying owners the legal right to withdraw water for consumptive uses. They do not ordinarily give such owners the right to prevent other users from withdrawing water unless these withdrawals interfere with the owners' consumptive uses. Because water rights are appurtenant to riparian or overlying land, it is uncertain whether they could be purchased separately without also purchasing the land as well. In the case of ground water, even if such transfers were valid, they could only be used to prevent transferors from continuing to pump ground water. Therefore, in order to restrict or prohibit pumping in a particular area, water rights from every landowner in the area would need to be acquired.

B.2.5.4 Property Interests and Limitations on Groundwater Use

There are a variety of property interests that can be used in connection with limitations on groundwater use. Leases and fee interests provide complete control over a parcel of land, either indefinitely or for a fixed period of time. Licenses may not be useful to limit or eliminate exposure to contaminated groundwater but would be useful to allow entry to land to perform surveys and monitoring activities. Similarly, affirmative easements could be used to authorize entry to privately-owned land in order to monitor contamination, while conservation easements could be used to control residential or commercial development in a given area, which could include restrictions on groundwater pumping. Finally, equitable servitudes could be used to prevent well drilling and other activities.

B.3 CONCLUSION

The property purchase analysis suggests that several real property interests are available to limit or prevent exposure to contaminated groundwater by potential receptors. These include owning property in fee simple, easements, and combinations of these. Additionally, the particular real property interest pursued for a specific parcel could vary over time depending on the length of the period contamination of the groundwater is expected to be present.

Kentucky best practices suggest that the fee simple interest may be appropriate in most cases where exposure to contaminated groundwater should be prevented (the principal possessory interests are discussed at fee simple, life estate, and leasehold). Fee simple is especially applicable where the property is currently owned by DOE (i.e., held in fee simple), or where an interest in property is acquired because contaminated groundwater is likely to be present for many years. Kentucky best practices suggest that easements may be applicable when contaminated groundwater may be present for a shorter period; while leaseholds and purchase options are of less use. Kentucky best practices suggest that other interests, such as life estate possessory interest, concurrent estates, nonpossessory future interests, and licenses may not be appropriate, except when identifying and eliminating pre-existing interests in property in order to pursue an appropriate interest.

The following table (Table B.1) summarizes the range of options theoretically available for use with respect to preventing exposure to contaminated groundwater. Within this matrix “Yes” indicates an option that is consistent with Kentucky best practices and “No” indicates an option that is not consistent with Kentucky best practices.

Table B.1 Property Acquisition Matrix

Interest	**Present DOE Property**	**Parcels Not DOE-owned**			
		Monitoring Easement	**Limited Scope Easement**	**Expanded Scope Easement**	**Title Clearing**
Fee Simple	Yes	No	Yes/$	Yes/$	Yes
Life Estate	No	No	No	No	Yes
Leasehold	No	No	Yes/$	Yes/$	Yes
Concurrent Estates	No	No	No	No	Yes
Nonpossessory Future Interests	No	No	No	No	Yes
Purchase Option	No	No	No	No	Yes
License	No	No	No	No	Yes
Easement	No	Yes	Yes	Yes	Yes
Real Covenants / Equitable Servitudes	No	Yes	Yes	Yes	Yes

"/$" indicates a workable option that would likely be significantly more costly than other options.

APPENDIX C. TASK 3

DEVELOPMENT OF COST ESTIMATES TO ACQUIRE PROPERTY INTEREST

GENERAL APPROACH TO PROPERTY VALUATION

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ACRONYMS

DOE	U.S. Department of Energy
GIS	Geographic Information System
GRP	Grassland Reserve Program
KRS	Kentucky Revised Statutes
NASS	National Agricultural Statistics Service
PACE	Purchase of Agricultural Easements
PGDP	Paducah Gaseous Diffusion Plant
PVA	Property Valuation Administrator
TVA	Tennessee Valley Authority
UK	University of Kentucky
USDA	U.S. Department of Agriculture
WKWMA	West Kentucky Wildlife Management Area
WRP	Wetland Reserve Program

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C.1 GENERAL APPROACH TO PROPERTY VALUATION

C.1.1 BACKGROUND

The purpose of this analysis is to provide the Department of Energy (DOE) with an indicative range of values for the fair market value of property near the Paducah Gaseous Diffusion Plant (PGDP) which is potentially affected by groundwater contamination, given different potential purchase scenarios. These include purchase of fee simple ownership and/or easements in parcels, as appropriate.[1]

Actual property acquisition will probably be governed by the "Uniform Appraisal Standards for Federal Property Acquisition" (Appraisal Institute, 2000). Uniformity and fairness are the goals in these standards with the intention being that it "should make no difference to the landowner, whose property is being acquired, which agency is acquiring the land, or what method of acquisition" is actually utilized (p. 1).

In general, these federal property acquisition standards call for a systematic appraisal process which includes: (a) legal description; (b) area, city, and neighborhood data; (c) property data; (d) analysis of highest and best use; (e) valuation by cost approach, sales comparison approach, or income capitalization approach; and (f) final value justification.

The property valuation approach used here is intended to be consistent with the spirit of the federal guidelines. A simplified "mass appraisal" technique is outlined and pursued.

C.1.2 PROPERTY DESCRIPTION

The property impacted or potentially impacted by groundwater contamination is located in western McCracken County, Kentucky. This is a county with a population of 64,698, making it the 13th largest county in Kentucky and the most populous county in far western Kentucky. Population growth has been moderate, with a 4.2% increase between the 1990 Census and the 2000 Census. This rate of increase was lower than all surrounding counties (e.g., Ballard County, 4.9%; Graves County, 10.4%; Marshall County 10.7%; Livingston County, 8.2%). With the closure of PGDP, the county would lose a major employer which may result in slower population growth in the coming years.

The soils in McCracken County have been surveyed and are described in the U.S. Department of Agriculture publication "Soil Survey of Ballard and McCracken Counties, Kentucky" (USDA, 1976). This survey makes clear that soils in the Jackson Purchase physiographic region formed in thick loess and

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[1] As set forth in Appendix B, fee simple ownership is ownership of the full bundle of rights in a parcel. What are referred to as "easements" are technically "servitudes" under the Restatement (Restatement of the Law Third, Property, Chapter 1, § 1.1(1) (definition of servitude)). Such interests could include real covenants, equitable servitudes, statutory conservation easements, and affirmative easements. Nevertheless, because the analysis in Appendix B focuses primarily on affirmative easements and conservation easements, reference is made to the options involving less than fee simple ownership as "easements." Within this categorization of easements, reference is made to three sub-types: (a) "monitoring easements" are easements, either affirmative easements or conservation easements, which provide for access to a parcel for purposes of monitoring and testing. Included in these easements would be access, the right to drill test wells, and the right to install monitoring equipment; (b) "limited scope easements" are conservation easements which are for relatively limited purpose, such as a prohibition on the use of surface or subsurface water; and (c) "expanded scope easements" are conservation easements which are for a relatively broader purpose, such as prohibition on the use of surface or subsurface water *and* a prohibition on the construction of swimming pools, septic systems, ponds, and the like. The expanded scope easements could be used all the way up to a prohibition on all development on the parcel.

are generally poorly drained. For the property in the potential purchase zone, the soils are predominantly from the Calloway-Henry association, meaning they are nearly level, poorly drained, with medium textured soils on the uplands. There is a surface layer of dark-gray to light-gray silt loam. The subsoil is a yellowish-brown silt loam to a depth of 19-26 inches. Below 26 inches is a compact fragipan of dominantly gray silty clay loam. The Calloway-Henry soils are suitable for cultivated crops and pasture. The use of modern farm machinery is easy, because of the nearly level slopes, and the erosion hazard is slight however, drainage can be a problem, especially on the Henry soil types.

With a good soil structure, the western part of McCracken County has historically supported a mixed land use pattern of grain/livestock farms and rural residential development. During World War II, just over 16,000 acres of farmland in western McCracken County were acquired by the Department of Defense for public use as an ordnance depot. Now the public holdings in the western part of McCraken County include the PGDP site plus the Tennessee Valley Authority (TVA) Shawnee Power Plant and the state-owned West Kentucky Wildlife Management Area (WKWMA). New homes have emerged near the PGDP over recent years in a classic rural residential pattern of farmland conversion to subdivisions and single-family residences on various lot sizes. Some commercial development has emerged on the improved U.S. highway 60 which is south of the PGDP and runs east-west out of Paducah from Interstate-24.

In the last federal Agricultural Census (USDA, 2002), there were 531 official farms in McCracken County with 85,459 acres in production for an average farm size of 161 acres. (Note: By Agricultural Census definition, a “farm” is an agricultural enterprise with sales or potential sales of $1,000 or more in a crop year.) However, there were only 34 farms of 500 acres or more, which would typically be considered “commercial farms” in western Kentucky. The primary crops are wheat, soybeans, and corn, as is typical for the cropping systems in western Kentucky. With soybean yields of 41 bushels/acre and corn yields of 141 bushels/acre in 2005, McCracken County has some of the best cropland and farms in western Kentucky. Livestock production consists primarily of cattle on pasture and confined poultry. Total agricultural sales are reaching $30,000,000 per year.

In general, the same economic forces that are influencing property values in other rural Kentucky counties are in operation in McCracken County. These factors are a strong agricultural economy; high government payments to farmers producing corn, wheat, and soybeans (the principal field crops in McCracken County); and demand for new rural residential housing.

Therefore, for purposes of mass appraisal of properties in the study area, it would seem reasonable to assume that the highest and best uses for most of the property are farmland (the antecedent land use) and rural residential development (the consequent dominant development pattern outside the publicly-owned properties). This assumption also meets the tests of general property valuation. Although McCracken County has a zoning ordinance and industrially zoned property surrounding the PGDP site, land use conversion of private properties to industrial use is neither likely nor probable given the current economic environment in the county. Based on this rationale, the assumed “highest and best” land use for this property valuation analysis results in only two parcel classifications: farm and rural residential.

C.1.3 PARCEL DELINEATION

Parcels whose underlying groundwater may be subject to contamination have been previously identified in Appendix A. In order to facilitate a zonal analysis, all potential parcels were included in a potential acquisition zone. The parcels within the potential acquisition zone are a diverse collection of small and large farm properties intermingled with numerous rural residential properties on various lot sizes. The optimal approach to categorizing these parcels by land use (e.g., “farm,” “rural residential,” “forest,” etc.) would be on-site property inspection and title research. Since that was not feasible in terms of time or budget under the current study, an alternative approach was utilized.

The USDA definition of a farm (section C.1.2) is based on sales from agricultural enterprises. Since this study deals with the geographic extent of the potentially contaminated properties, a reasonable areal definition of “farm” would allow categorization of the parcels into “farm” and “rural residential” properties.

One viable alternative is to utilize the definition of a “farm” as outlined in KRS 224.71, The Kentucky Agriculture Water Quality Act, which was passed in 1994 and applies state-wide. In this act, an “agriculture operation” is defined as any farm operation on a tract of land, including all income producing improvements and farm dwellings, together with other farm buildings and structures incident to the operation and maintenance of the farm, situated on ten (10) contiguous acres or more of land used for the production of livestock, poultry, crops, or silviculture (see www.conservation.ky.gov/programs/kawqa). Under this act, landowners with “farms” of ten acres or more must file a water quality plan with the local conservation district. It defines a farm in areal terms and has been in operation for twelve years. Thus, for purposes of this study, regardless of current use, rural residential real estate was deemed to consist of all those parcels under 10 acres and agricultural real estate was deemed to consist of parcels of 10 acres or more.

C.1.4 GENERAL PROPERTY VALUATION ALTERNATIVES

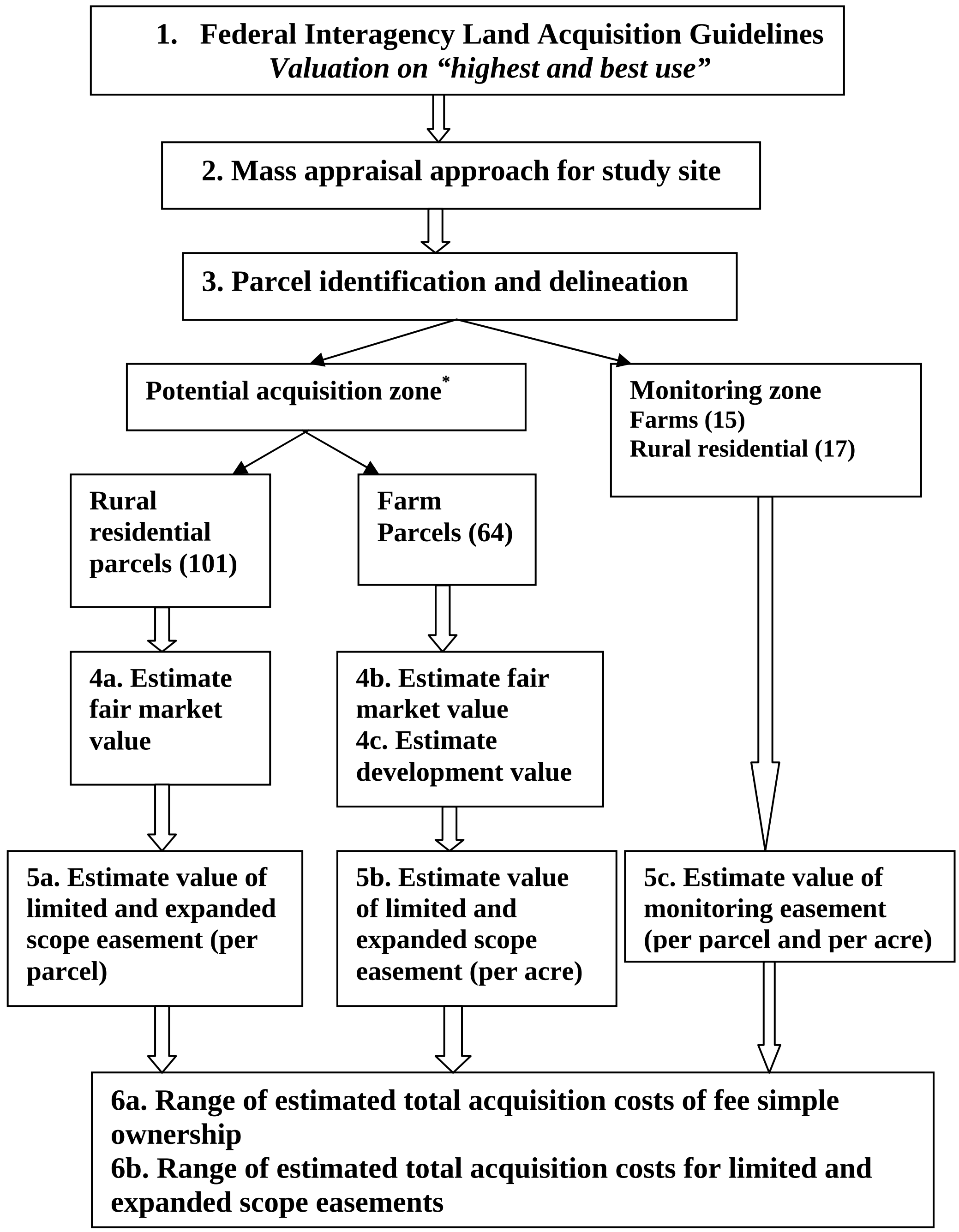
In normal federal property acquisition procedures, properties are appraised based on an analysis of “highest and best use” to determine fair market value. In real estate valuation, the test of highest and best use generally involves evaluation on four criteria: (a) legally allowable land use, (b) a physically possible land use, (c) a financially viable land use in terms of market demand in the locality, and (4) the maximum possible economic use of the land. The actual valuation process involves third-party certified appraisers using three approaches: replacement cost, sales comparison, and income capitalization. For structures, appraisers use either estimated replacement cost or comparable sales. For real property with an infinite productive life (cropland, forest land), appraisers use either an income approach or comparable sales. Appraisals are thus unique to the location and characteristics of each parcel.

Given the time and budget constraints for this current study, appraisals of individual parcels were not feasible. During actual property acquisition, individual properties would be appraised using general real estate standards. In this process, factors such as zoning could play a role in determining valuation. For example, for some of the properties in the study area which now fall in the Industrial Use zone, one factor in the valuation process of individual properties could be assessment of effective demand for industrial properties in the locale at the time of appraisal.

In the mass appraisal approach used for the current study, it was not possible to identify specific parcel characteristics and factor them into valuation (e.g., parcel zoning). The approach used generates a generalized valuation for the target properties utilizing secondary information sources to estimate fair market acquisition cost based on highest and best use. In general, the highest and best use is either agricultural or rural residential in the current economic environment. The approach used here delineated the parcels, estimated average fair market values for fee simple and easement interests for each parcel, and summarized the range of estimated acquisition costs. The "development value" for farm parcels was recognized to be largely based on rural residential conversion, the dominant land use trend, but could potentially include conversion to commercial or industrial use at some future point in time. To assume highest and best use to be based on potential conversion of study area properties to commercial or industrial use would be hypothetical and inconsistent with current land use trends. In addition, it would be difficult to identify comparable industrial use properties as a valuation factor. Thus, the use of development values based on rural residential land use conversion meets the test of "financially viable land use in terms of market demand in the locality." The intention is to provide a range of indicative values that should approximate the magnitude of reasonable acquisition costs for both fee simple ownership and easement interests for privately held parcels in the study area.

C.1.5 SCHEMATIC SUMMARY OF VALUATION PROCEDURES

The general procedure followed for developing estimated valuation of the property interests in both the potential purchase zone and the monitoring zone is shown in the following schematic:



***Note: Potential groundwater contamination of any portion of a parcel results in the assumption that the entire parcel would potentially be impacted and therefore acquired.**

C.2 VALUATION ANALYSIS FOR ACQUISITION OF FEE SIMPLE OWNERSHIP

C.2.1 VALUATION BASED ON PROPERTY TAX ASSESSMENTS

Given the location, development history, and soil characteristics of these properties, the reasonable assumption about highest and best use is either (1) farmland (cropland and pasture) or (2) rural residential real estate. This approach is consistent with the general intent under “highest and best use” as applied in real estate valuation. Thus, the fair market value of the existing property parcels was estimated on the basis of current use as “highest and best use.” Since there is some limited potential for conversion of existing farm parcels to higher use development (e.g., residential or commercial development), a secondary estimate of farm parcels valued on the basis of conversion to rural residential real estate was conducted.

The Office of the Property Valuation Administrator (PVA) assesses the value of all real estate for tax purposes using comparable sales and supplemental appraisal techniques; these assessed valuations capture recent market values for properties county-wide. PVA valuation techniques should capture the essential market forces at work for both residential and agricultural properties – the dominant land uses in the potential purchase zone. The assessed values from the 2005 Certified Tax Roll were obtained from the McCracken County PVA. Excluded from this analysis were a few properties which were cemeteries, properties in life estates, and properties in probate.

Inspection of approximately 95% of the PVA tax assessment summaries revealed: (1) assessments in this quadrant of McCracken County were done in 2003 and now lag current fair market values except for parcels with ownership transfer since 2003; (2) there have been recent real property divisions for which GIS data are available but the tax records are not yet complete; (3) some property divisions which appear in the Geographic Information System (GIS) parcel set are included in a tax assessment for a larger property (and therefore have no separate tax assessment); and (4) there are a few inconsistencies between the tax roll areal data and the GIS parcel areal measurements. Consequently, the PVA assessed values were used only to give a general indication of reasonable fair market values for the rural residential parcels as a baseline for comparative purposes.

PVA assessments commonly do not reflect actual sales proceeds. The State of Kentucky conducts evaluations of the performance of PVA assessment effectiveness on a county-by-county basis. These studies measure the ratio of assessed values by class (residential, agricultural, or commercial) to actual sales and supplemental appraisal data. The target ratio is 100% (i.e., assessed value = fair market values as measured from actual sales) and the coefficient of dispersion is supposed to be under 20%. Ratio results are generally considered “in compliance” by the KY Department of Revenue if the ratio results fall between 90% and 110%. The results from the most recent ratio studies available from the Kentucky Department of Revenue are summarized in Table C.1.

Table C.1 McCracken County PVA Residential Ratio Results

	2004	**2003**	**2002**
Median Ratio	89.7%	88.2%	90.5%
Coefficient of Dispersion[1]	9.1%	10.9%	12.2%
Number of Sales	497	481	373

Source: Office of Property Valuation, Department of Revenue, Frankfort

[1]Coefficient of dispersion of a statistical measure of average error for individual assessment values around a calculated median level of assessment and is generally applied as the measure of uniformity. The lower the dispersion, the more uniform and “fair” the property value assessment.

In using tax assessment data to estimate the fair market value of the privately-owned residential real estate in the potential purchase zone, McCracken County PVA assessed valuation was adjusted up by 10.5%, the average ratio for the last three years reported to the Office of Property Valuation in Frankfort. In addition, since property in the potential purchase zone has not been revalued for property tax purposes since 2003, the assessed values were also adjusted for housing price trend in the area.

The housing market in McCracken County has been active over the last five years. The more modest two-and-three bedroom homes have shown a positive trend in actual home sales over the 2001-2006 period, although there have been years when average sale values declined from the previous years' levels (see Table C.2). The smaller two-bedroom homes have risen 34% over the last five years (6% per year) and three-bedroom homes have increased nearly 48% (8% per year). These data clearly establish increasing property values for homes in McCracken County and this trend is likely evident among the mixed rural residential homes in the potential purchase zone.

Table C.2 Home Price Trends by Size, McCracken County, 2001-2006[1]

No. of Bedrooms	2001	2002	2003	2004	2005	2006
Two	$40,808	$49,558	$53,243	$52,581	$40,647	$54,828
Three	80,470	99,338	99,965	98,910	96,257	118,862
Four	186,490	150,386	161,047	169,992	175,062	213,449
Five+	180,877	151,792	173,800	176,135	290,000	223,500

[1]Average sales prices in first quarter of each year.
Source: Paducah Board of Realtors, 2006

Although actual housing prices have fluctuated dramatically over the last six years in McCracken County, there is an approximate average upward trend of 7% per year. Therefore, to adjust property tax assessments for time trend in housing prices, the adjusted assessed value for rural residential properties were increased by 7% per year since revaluation in 2003. This results in an estimate of fair market value which is adjusted by the ratio study and home price trends (Table C.3).

The assessed value of farm parcels was also adjusted by 10.5% from the Ratio Study (although the ratio analysis includes only residential sales). In addition, farm property assessed values were adjusted for land price trend by 10% per year to reflect the current farmland price trends (see discussion in analysis of Farm Real Estate Valuation, Section C.2.3). The result is a farm market value based on adjusted tax assessment valuation and price trend. These data are also summarized in Table C.3.

Table C.3 Summary of Fair Market Value of Farm and Residential Properties Based on Adjusted Tax Assessment Valuation

Class of Parcel	Number	Approximate Property Tax Assessed Value[1]	Adjusted Tax Assessed Value[2]	Price Trend Adjustment (per year)[3]	Fair Market Value Based on Adjusted Assessed Values[4]
Farm	64	$5,500,000	$6,077,500	10%	$8,898,068
Rural Residential	101	$4,500,000	$4,972,500	7%	$6,517,933
Totals	165	$10,000,000	$11,050,000		$15,416,001

[1]Based on examination of about 95% of assessment records, McCracken County PVA Office.
[2]Assessed value adjusted by state-mandated property tax ratio study results although it is recognized that the ratio analysis was based on residential sales.
[3]Price trend for homes and farmland applied to 2003, 2004, 2005, and 2006.
[4]Tax assessed values adjusted by property tax ratio study and price trends.

One serious limitation of this approach is the fact that much of the farmland in Kentucky is assessed for tax purposes based on “agricultural value,” as permitted by KRS 132. The McCracken PVA indicated that all the agricultural land in the potential purchase zone is assessed at agricultural value. The assessed valuation of farm parcels does not reflect what would customarily be considered “fair market value.”

The average parcel value for farmland using the adjusted tax assessment approach is $1538/acre, predictably below current market values. The adjusted tax assessment approach yielded an average value for rural residential parcels of $64,534. This value would seem to significantly under-estimate the fair market value of the residential property in the potential purchase zone. These results from the examination of the tax assessment data indicated the need for a different approach to mass appraisal to generate indicative costs.

C.2.2 RURAL RESIDENTIAL REAL ESTATE VALUATION BASED UPON COMPARABLE SALES

As an alternative to adjusted tax assessment valuation, data were obtained from real estate transactions in the county to develop a valuation based on comparable sales. Recent data on residential property sales selected from data published by the Paducah Board of Realtors are summarized in the table below. The average residential sale in the school district which includes the potential purchase zone was $124,580 with a median value of the 18 home sales of $119,000 (Table C.4).

Table C.4 Real Estate Transactions, McCracken County, 2006

Area	Number of Sales	Average Value
McCracken County	401	$184,496
Heath High School District[1]	18	$124,580 (Median Value = $119,000)

Source: Paducah Board of Realtors, March 31, 2006 summary of first quarter real estate transactions.
[1]Includes residential real estate transactions in the potential purchase zone but excludes sales in The Pines subdivision which are not representative of the rural residential real estate in the potential purchase zone.

Examining four comparable recent home sales from the potential purchase zone (summarized in Table C.5) reveals an average residential sale value of $107,750. Given the mixed rural real estate development pattern in the potential purchase zone, it would be logical to expect <u>average</u> home values to be at or below the High School District average of $124,580.

Table C.5 Comparable Rural Residential Real Estate Transactions, McCracken County[1]

Rural residence	Location	House Size (sq. ft.)	Price	Year
A	Mayfield Metropolis Rd	1400	$88,000	2006
B	Ogden Landing Rd	1757	$139,000	2005
C	Ogden Landing Rd	1368	$120,000	2005
D	Metropolis Lake Rd.	1152	$84,000	2005
Average Value			$107,750	

[1]Source: Jackson Purchase Agricultural Credit Association, Kevil, Kentucky. Sales in ACA Zone #1 which includes the potential purchase zone.

Using the data from real estate transactions in the county and the potential purchase zone, an upper range estimate of the value per parcel would be the average value of all real estate transactions in the Heath School District ($124,580), adjusted for 2006 price trend (7%), resulting in an average per parcel fair market value of $133,301. For a lower range, the average value of comparable properties sold during the first quarter of 2006 within the study area ($107,750, adjusted for 2006 price trend of 7%), results in an average per parcel value of $115,293. When estimated closing costs are included, the range of acquisition costs is $138,301 to $120,293 (Table C.6).

The fair market value will differ widely among rural residential properties in the potential purchase zone, but an indicative range of average per parcel costs of $138,301 to $120,293 should provide a reasonable mass appraisal estimate of total acquisition costs. This range of residential parcel values is certainly more indicative of actual acquisition costs than available PVA assessed valuations, which even with adjustments for ratio studies and price trend resulted in an average parcel value of about $64,500.

Based on the analysis and procedures identified above, the estimated acquisition cost range for fee simple ownership interests of the 101 residential parcels in the potential purchase zone is $12,149,593 to $13,968,401 as shown in Table C.6. The total acreage for all parcels in the potential purchase zone was calculated assuming acquisition of an entire parcel even though only a portion may be potentially affected by contamination.

Table C.6 Estimated Range of Fee Simple Acquisition Costs for Rural Residential Parcels

	Number of Parcels	Acres	Estimated Average Value Per Parcel	Estimated Closing Costs[1]	Estimated Average Acquisition Cost Per Parcel[2]	Estimated Total Acquisition Costs
Residential Parcels	101	270.8				
Upper Range			$133,301	$505,000	$138,301	**$13,968,401**
Lower Range			$115,293	$505,000	$120,293	**$12,149,593**

[1]Estimated closing costs include appraisals, legal fees, and recording fees on all parcels.
[2]Acquisition cost includes value of parcel plus estimated closing costs.

C.2.3 FARM REAL ESTATE VALUATION BASED ON SURVEY DATA AND COMPARABLE SALES

The mass appraisal of farmland was pursued using three sources of farmland price data: (1) the annual survey by the National Agricultural Statistics Service (NASS) which supplies state-wide average prices; (2) the informed expert survey released annually by Dr. Richard Trimble of the University of Kentucky which provides regional farmland price estimates; and (3) recent comparable farm sales data from McCracken County.

The two major sources of survey price data on farmland are summarized in the Table C.7. Farm real estate prices reflect the value of all land in the farm plus buildings (residence, barn, sheds, grain bins, etc.) and thus are a measure of farm parcel value per acre. The NASS data are state-wide averages for all 120 counties. The West Kentucky Informed Expert Survey is conducted annually by Dr. Richard Trimble at the University of Kentucky. The study collects and aggregates price data from three regions. The West Kentucky data generally reflect prices for large grain and livestock farms in the western counties, the major crop production region in Kentucky.

Table C.7 Selected Estimates of Kentucky Agricultural Lands		
	2005 NASS Estimated Prices ($/ac)[1]	**2005 West Kentucky Informed Expert Survey ($/ac)[2]**
Farm Real Estate[3]	$2200	$2742
Cropland only	2400	2468
Pasture only	1700	1642

[1]U.S. Department of Agriculture, National Agricultural Statistics Service, August 2005 (based on January 1, 2005 estimates.

[2]Source: Dr. Richard Trimble, University of Kentucky, annual survey.

[3]Includes value of agricultural lands and buildings.

These survey data can be compared to recent actual farm sales results from McCracken County. In the potential purchase zone, the range on farm size is 10 to 1412 acres with an average parcel size of 90 acres. Data on three recent farm sales near the potential purchase zone are in Table C.8. They represent the best approximation of "comparable farm sales" available near the study area for comparative purposes. (Note: Only about 2% of U.S. farmland is sold in any given year.) The average price per acre for farmland based on comparable farm sales is $2459 per acre, slightly less than the results of the West Kentucky survey but logical since McCracken County farms are smaller and less efficient than larger farms in neighboring Ballard and Graves counties.

Table C.8 Recent Farm Real Estate Transactions, McCracken County[1]					
Farm	**Acreage**	**Type of Sale**	**Price**	**Price/Acre**	**Year**
A	60	Auction	$151,800	$2530	2006
B	50	Private sale	$115,000	$2300	2006
C	54	Private sale	$137,500	$2546	2005
Average	55	-	$134,767	$2459	-

[1]Source: Jackson Purchase Agricultural Credit Association, Kevil, KY. Sales recorded from ACA Zone #1 which includes the potential purchase zone.

Using recent comparable sales, the closest approximation of fair cash value for farmland in McCracken County is $2459 per acre. This price estimate is consistent with the region-specific price data from the UK survey. In the absence of parcel inspection and evaluation, the comparable farm real estate price captures the value of both land and associated farm buildings, and reflects a reasonable mean (arithmetic average) value for the mass appraisal of farm real estate.

Agricultural land values have been rising in the U.S. and particularly in the Corn Belt States. For example, western Kentucky farmland values have been increasing by about 10% per year for the last three years according to the UK land value survey results. These land value increases are stimulated by the strong agricultural economy from the livestock and crop perspective plus high government payments. (The three major field crops in McCracken County – corn, wheat, and soybeans -- are all eligible for government subsidy payments.) The rising land values in western Kentucky are representative of the larger agricultural economy where land values have been increasing for the last several years (Table C.9).

Table C.9 Selected Land Value Estimates for U.S. Cropland			
Source/Year	**State(s)**	**State Average Value**	**Percent Increase**
Chicago Federal Reserve Bank, Ag Letter, 2006	Illinois, Indiana, Iowa, Wisconsin	N/A	9%
Iowa State University, 2005	Iowa	$2914	10.8%
University of Missouri, 2005	Missouri	$1657	10.6%
Purdue University, 2005	Indiana	$2693	7.3%

In order to reflect estimated impact of rising agricultural land values during 2006, the comparable farm price estimate ($2459) was increased by 10% to account for expected rising land values during this calendar year. The farmland in the potential purchase zone is valued at an average of $2705 per acre to provide a low range estimate of parcel value per acre.

An upper range estimate per acre was based on the UK land value survey data for western Kentucky ($2742), adjusted for 2006 price trend (10%), resulting in a per acre value estimate of $3016.

The average fair market value of farm parcels ("farm real estate" prices include land and buildings) in the study area can be estimated by multiplying the upper range price per acre ($3016) or lower range price estimate ($2705) times the number of acres in each parcel. The upper range estimated acquisition cost is $3099 per acre and the lower range is $2788 per acre which includes estimated closing costs on a per acre basis.

The fair market values will differ widely among farm properties in the potential purchase zone, but an indicative range of estimated acquisition costs per acre of $3099 to $2788 should provide a reasonable mass appraisal value estimate. This range of farm parcel values is more indicative of actual acquisition costs than available PVA assessed valuations based on agricultural use which yielded an average per acre value of just over $1500/acre.

Based on the analysis and procedures identified above, the estimated acquisition cost range for fee simple property interests for the 64 farm parcels in the purchase area is $16,123,031 to $17,921,547 (Table C.10). The total acreage for all parcels in the study was calculated assuming acquisition of an entire parcel even though only a portion may be potentially affected by contamination.

Table C.10 Estimated Range of Fee Simple Acquisition Costs for Farm Parcels						
	Number of Parcels	**Acres**	**Estimated Average Value Per Acre**	**Estimated Closing Costs[1]**	**Estimated Average Acquisition Cost Per Acre[2]**	**Estimated Total Acquisition Cost**
Farm Parcels	64	5783.01				
Upper Range			$3016	$480,000	$3099	**$17,921,547**
Lower Range			$2705	$480,000	$2788	**$16,123,031**

[1]Estimated closing costs include appraisals, legal fees, recording fees on all parcels.
[2]Acquisition cost includes value per acre plus estimated closing costs on a per acre basis.

C.2.4 FARM REAL ESTATE COMPARABLE SALES AT DEVELOPMENT VALUE

If an argument can be made that the "highest and best use" for the farmland in the study area would be rural residential development or limited commercial development, then the acquisition costs would of course increase substantially. Conversion of the farm parcels in the potential purchase zone to higher economic uses would be a continuation of the current trend which is apparent on the eastern side of the potential purchase zone. This argument must be tempered by these factors: (1) This farmland lies outside the projected "growth area" for the McCracken County draft comprehensive plan, which intends to focus on in-fill development within the growth boundary and farmland preservation in rural areas; (2) This farmland is poorly drained and home sites have problems passing percolation tests for household waste water systems; and (3) Rural residential expansion towards the west side of the study area is, in some respects, "blocked" by the presence of the DOE property, the Wildlife Management Area, and the TVA property.

If farm parcels were to be valued at a "highest and best use" of rural residential development, then reasonable value estimates can be derived from comparable farm sales in McCracken County which are seemingly intended for residential development. Working with informed experts in the area, four farm sales were identified as probable "sales for development purposes." These farms averaged 88.7 acres and sold for an average of $6441 per acre (see Table C.11).

Table C.11 Illustrative Development Value of Farm Real Estate, McCracken County[1]

Farm	Acreage	Price	Price/Acre	Year
A	80	$488,000	$6100	2006
B	88	$445,368	$5061	2006
C	50	$355,000	$7100	2005
D	136.6	$1,025,000	$7503	2005
Average	**88.7**	**$578,342**	**$6441**	-

[1]Source: Jackson Purchase Agricultural Credit Association, Kevil, KY. Sales in ACA Zone #2 which is adjacent to the potential purchase zone has similar soils, topography, and farming systems.

Farm sales at these prices cannot be justified economically given the current price levels for corn, wheat and soybeans with accompanying government payments. These farm sales are indicative of "development value" for farmland in McCracken County, so a lower range value of $6441 (the mean value of comparable farm sale price per acre) was applied along with an upper range value of $7500 (approximate value of highest-priced comparable farm). Table C.12 includes estimated closing costs an upper range value of $7583 and a lower range value of $6524 for estimated average acquisition cost per acre based on development value for the farm parcels (Table C.12). Consequently, if the farm parcels were to be valued on the basis of highest and best use as residential development properties, then the upper and lower range for fee simple acquisition costs would increase to $43,852,564 and $37,728,357.

Table C.12 Estimated Range of Fee Simple Acquisition Costs for Farm Parcels Based on Development Value

	Number of Parcels	Acres	Estimated Average Value Per Acre	Estimated Closing Costs[1]	Estimated Average Acquisition Cost Per Acre[2]	Estimated Total Acquisition Costs
Farm Parcels	64	5783.01				
Upper Range			$7500	$480,000	$7583	**$43,852,564**
Lower Range			$6441	$480,000	$6524	**$37,728,357**

[1]Estimated closing costs include appraisals, legal fees, and recording fees on all parcels.
[2]Acquisition costs include value per acre plus estimated closing costs on a per acre basis.

C.2.5 RANGE OF PER UNIT ACQUISITION COSTS FOR RESIDENTIAL AND FARM PARCELS

Based on the foregoing mass appraisal approach, the upper and lower range of estimated average unit acquisition costs are summarized in Table C.13. Residential acquisition costs are expressed on a per parcel basis and farm property acquisition costs, which include acquisition of buildings, are expressed on a per acre basis. These per unit costs are used to calculate the estimated total acquisition costs for fee simple purchase of properties when the remediation alternatives are compared, resulting in differing estimates of total area impacted.

Table C.13 Range of Estimated Per Unit Acquisition Costs for Fee Simple Purchase of Properties

Study Area Properties	**Units**	**Estimated Range of Acquisition Costs Per Parcel or Per Acre**	
		Upper Range	Lower Range
Residential	101 Parcels	$138,301	$120,293
Farm	5783.01 Acres		
Fair Market Value		$3,099	$2,788
Development Value		$7,583	$6,524

C.2.6 COST SAVINGS ON WATER POLICY

If fee simple property interests in the 165 privately-held parcels identified are acquired in the potential purchase zone, then the current policy of providing municipal water supply to the properties in Water Policy Area could be discontinued. An argument could be made to consider the “costs avoided” for water supply termination as a “cost savings” to fee simple acquisition. In this case, the current Water Policy represents a stream of annual costs that could extend for decades. The present value of these annual costs could be included as “cost savings” or “costs avoided” in the estimated total acquisition costs for property acquisition. Although the annual costs of water supply vary, the estimated average annual cost is cited as $78,000 per year, so this value was used to calculate water policy cost savings (DOE, 2000). The current cost of capital is assumed to be the long-term U.S. Treasury Bond rate of 5.05% (Treasury bonds, >10 year maturity, August 17, 2006). Present value calculations were based on an interest rate of 5.05% and calculated over 30 years (recognizing this time period may be too short), resulting in a present value of $1,192,247 of “cost savings” from termination of the current Water Policy in the affected area.

C.3 VALUATION OPTIONS FOR PURCHASE OF EASEMENT INTERESTS

C.3.1 GENERAL APPROACH

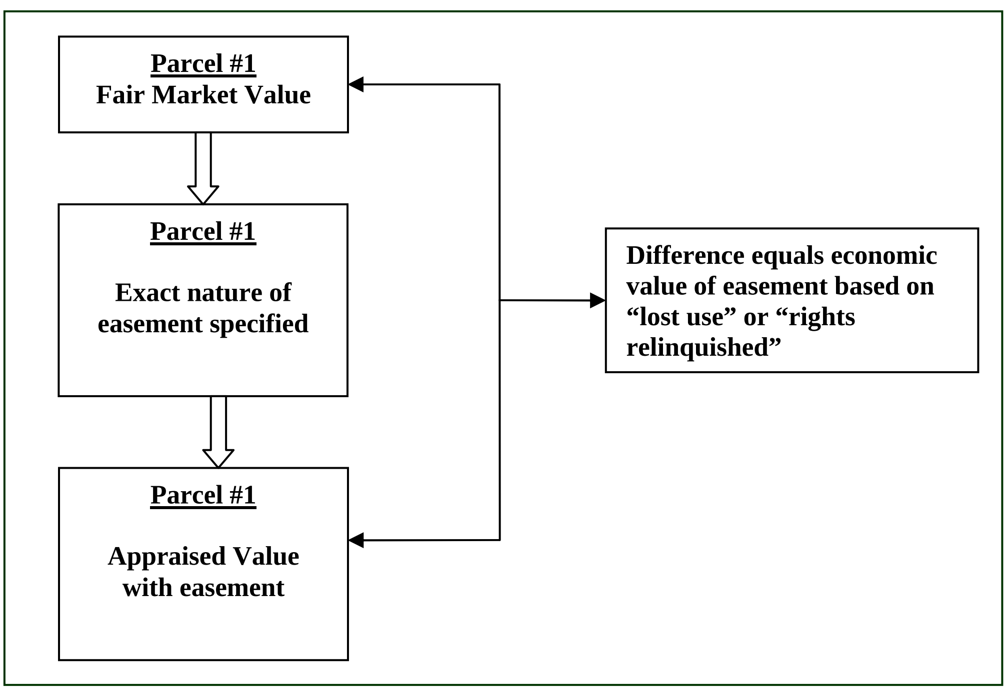
DOE has pursued the acquisition of easement interests as part of institutional controls at contaminated sites in other regions. Art Kleinrath and Vijay Kothari of the DOE Office of Legacy Management explain the goals of this strategy as: (1) To be protective of human health and the environment; (2) For disposal sites, keep the site safe; (3) Maintain the remedy; and (4) Prevent inappropriate use and eliminate exposure (Kleinrath and Kothari, 2006). DOE has utilized limited property restrictions at other contamination sites in the form of access easements, restrictive covenants, and permanent deed restrictions. According to Mr. Kleinrath (personal conversation, 8-18-06), DOE is moving towards easement restrictions which have one-time costs, are permanently attached to the land, and have a single, lump-sum payment. Consequently, this analysis pursues this general approach.

For the current study, there are properties, where purchase of fee simple property interests is not necessarily warranted but some other option may be feasible for the affected properties and buffer zones. This could involve purchase of some form of easement property interests (see discussion in Appendix B). These easements could have a very limited scope, such as a single prohibition on well drilling into the groundwater aquifer. Alternatively, the easements could be more expansive, such as prohibitions on well-drilling, subsurface disturbance for mining or swimming pool construction, installation of household waste water systems, or farm pond construction for aquaculture or animal water supply. Additional restrictions under an expansive easement could involve surface use restrictions on building construction or certain agricultural practices.

The scope of easement will determine the cost. The more expansive the scope, the higher the value to the property owner and, consequently, the higher the acquisition cost. The approach taken was to estimate potential costs for acquisition of limited scope or expanded scope easements in the purchase zone (165 parcels) and monitoring easements in the monitoring zone (32 parcels).

Although the value of an easement on private property will certainly be viewed subjectively by different landowners, there is a straight-forward theoretical basis for easement valuation. In general, the value of real property will be different with/without the easement conditions. This general concept is illustrated in Figure C.1.

Figure C.1 Theoretical Basis for Easement Valuation



The difference between the value of the property without easement restrictions versus the value of the property with restricted property interests is a measure of the economic value of the easement. In other words, payment for an easement or equitable servitude is compensation for lost uses of private property or, alternatively, the rights relinquished. In a common, real-world example, the Purchase of Agricultural Conservation Easements (PACE) program is administered such that the property value difference is measured between the "fair market value" of farmland versus an estimated "agricultural value" based on an income generation appraisal for agricultural use only (development being prohibited by the conservation easement). The PACE easement values differ depending on the development value of farmland in different locations in Kentucky.

Given the nature of groundwater contamination near the PGDP and the extent of the private property parcels, estimating the value of easements is difficult. There are few precedents and market transactions to reveal actual property owner behavior and valuation. Currently in western Kentucky, natural gas exploration contracts are being signed with farm owners which pay the landowner $10-$20 per acre per year for an up-to-five-years "access only" option to drill exploratory wells (Cotton, 2006). There are also precedents in the easement purchase programs conducted by USDA and the State Department of Agriculture (Table C.14).

In the case of residential properties, the valuation process for easements which accomplish the purposes of remediation will be much more speculative. The guiding principal must be impact on overall home value, i.e. how do the rights relinquished affect overall property value? The focus of an appraisal is "lost use" or "rights relinquished" but there is also a consideration of "before and after" in a market sense.

C.3.2 LIMITED INFORMATION ON EXISTING EASEMENT PURCHASE COSTS

DOE maintains no database on payments for easements at contaminated sites (Kleinrath 2006). These data and information are contained in site-specific files. In a more general summary, Art Kleinrath reports that the range of DOE easement costs is $50 per year for an access easement to $250,000 for a one-time cost payment, and furthermore, "size, location, and legal drivers seem to help little to predict costs." (Kleinrath and Kothari, 2006). Similarly, a review of Army Corps of Engineers' easement payments for "flowage easements" in Mississippi indicated a wide range of easement costs on agricultural property ($400 – 1200 per acre) (Delta Land Trust, 2004). It would appear that the range of easement values that would reasonably be expected on the PGDP site is likely to be highly dependent on exact geographic location, contamination circumstances, and other related factors.

C.3.3 AGRICULTURAL EASEMENT PURCHASE PROGRAMS OPERATING IN KENTUCKY

Several programs are in operation in Kentucky which restricts agricultural land use through different forms of agricultural conservation easements to accomplish program goals (Table C.14). The most well-known program is the purchase of agricultural conservation easements as implemented since 1994 by the Kentucky Department of Agriculture and the Purchase of Agricultural Conservation Easements (PACE) Corporation. The PACE Program version of a conservation easement restricts subdivision and confines future land use solely to the production of crops and livestock. Mineral rights remain although extraction is limited to techniques which do not affect the primary land use. Through 2005, the PACE Program had purchased conservation easements on 88 farms totaling nearly 21,000 acres with per acre average costs being $854. Although no conservation easements have been purchased in McCracken County, there have been other purchases in western Kentucky (Fulton and Trigg counties) where per acre easement costs have been $499.

The U.S. Department of Agriculture offers two conservation easement programs with different goals and use restrictions, the Wetlands Reserve Program (WRP) and the Grassland Reserve Program (GRP). The WRP is designed to restore functioning wetlands from farmed wetlands and prior converted croplands in an environmentally beneficial and cost-effective manner. This is a voluntary program which operates on a bid/application basis with evaluation criteria to rank applicants. The easement restrictions are broad and leave the landowner with the right to quiet enjoyment, control of access, recreational uses, and subsurface resources. Through early-2006 USDA has enrolled nearly 13,000 acres in the WRP. Although the WRP offers 10-year, 30-year, and permanent easements, the important alternative for this current study is the value of the permanent easements. The “bids” are capped with regional price levels obtained from the University of Kentucky land value survey done annually by Dr. Richard Trimble. The result is that maximum acceptable bids are set at the average cropland value by region. Actual bids in WRP have been $887 per acre statewide and $769 per acre in McCracken County (Table C.14).

A similar USDA easement program is the Grassland Reserve, another voluntary program to enhance, restore, and protect grasslands. The GRP easements can be either 30-year or permanent. For the permanent easement, subsequent land use is restricted to grazing and haying, timber harvest, and recreational uses. Since 2003 nearly 2,000 acres have been accepted into contracts for permanent easements with a state-wide average cost of $1230 per acre. In Marshall and McLean counties, three GRP contracts have been accepted at easement values averaging $1149 per acre (Table C.14). This easement value represents the difference between the appraised agricultural value minus the subsequent “encumbered” value (as restricted by the GRP deed) as determined by certified appraisers. There have been no GRP contracts in McCracken County.

Table C.14 Selected Easement Purchase Programs for Rural Lands in Kentucky			
Program	**Agency**	**Nature of Easement**	**Average Costs/Ac**
Agricultural Conservation Easements	Kentucky Department of Agriculture through the Purchase of Agricultural Conservation Easements (PACE) Board[1]	Development prohibited but title remains and permitted uses include crop and livestock production; uses inconsistent with agricultural uses prohibited.	$854/acre, statewide average (2005); $499/acre in western Kentucky
Wetland Reserve Program	U.S. Department of Agriculture, Natural Resources Conservation Service[2]	All rights except title, quiet enjoyment, control of access, recreational uses, and subsurface resources.	$887/acre, statewide average (1995-2006); $769/acre average for McCracken County
Grassland Reserve Program	U.S. Department of Agriculture, Natural Resources Conservation Service[2]	Title remains and permitted uses include grazing and haying, timber harvesting, recreational uses, and water rights. Prohibited uses include acts inconsistent with purposes of the deed restrictions, crop cultivation, non-grassland land uses, alteration of topography, dumping of refuse and waste, mining, paved roads, ATV use, development uses, billboards, introduction of exotic species, subdivision, new utilities.	$1230/acre statewide average (2003-2005); three contracts in Marshall and McLean counties averaged $1149/per acre.

[1]Data from the Kentucky Department of Agriculture website (www.kyagr.enviro_out/pace/index.htm) and personal correspondence, June 2006.
[2]Data from Kentucky office of the U.S. Department of Agriculture Natural Resources Conservation Service, June 2006.

C.3.4 ESTIMATED VALUE OF EASEMENTS

Valuation of easements is fundamentally different for residential parcels than for agricultural lands. In the case of residential properties, it seems logical to approach the valuation question on a per parcel basis, regardless of the lot size or acreage. For residential property, the fundamental value is the residence within the property setting. In the case of farmland, the valuation question should be approached on a per acre basis since the amount and quality of cropland is the fundamental determinant of farm value, not the residence or other structures.

For the residential parcels, a limited scope easement, which prohibited only well-drilling and groundwater access would probably have minimal impact on actual “lost use” if municipal water were supplied free-of-charge, as is currently the case for properties in the Water Policy area. The theoretical and practical value of a single-purpose easement prohibiting only groundwater pumping would be effectively zero (but valued at a token $1 in the cost calculations for contract “consideration”). Property owners may attempt to make the case that there is a negative effect (i.e., property value reduction in comparison to comparable properties) from the presence of a restriction on well-drilling. If this is the case, the appraised value of the residential property may be lower from the mere presence of a limited scope easement, and consequently, the economic value of the easement should compensate the homeowner for the reduced property value. In the case of a limited scope easement (e.g., only well-drilling) the impact on home value may be modest – possibly 10% of total property value, assuming the Water Policy is continued. Thus, in estimating the value of the limited scope easement, the low range was assumed to be $1 while the high range was calculated based on 10% of the upper range average value of residential properties ($133,301).

Expanded scope easements for the residential properties also could be acquired. Examples of expanded scope restrictions may include no wells or groundwater pumping, no below-ground-level swimming pools, no subsurface disturbance for septic systems, no access to surface streams, and related restrictions. In this situation, the impact of the expanded scope easement on property values may be much larger, possibly 10% to 25% of fair market value for residential properties based on “lost use” and a negative neighborhood effect (assuming the property owners can successfully make their case for this effect). Thus, in estimating the value of the expanded scope easement, the low range was calculated based on 10% of the lower range estimated value of residential properties ($115,293) while the high range was calculated as 25% of the upper range average value of residential properties ($133,301). (See Table C.6 for estimated value of residential properties).

The estimated value of easements on farm parcels within the purchase zone will, of course, be dependent on the nature of the easement. A limited scope easement on farm parcels which prohibited only groundwater pumping may have a relatively large impact on agricultural operations since groundwater use for irrigation cannot reasonably be replaced by public water supply. The PACE, WRP and GRP contract summary data (see Table C.14) provide observable, voluntary transactions which reveal the value of conservation easements on agricultural lands in Western Kentucky. Using the PACE contract values as a pricing guide, a limited scope easement may be valued conservatively at $400 to $800 per acre, since the PACE easement is functionally a single-restriction easement (development) in which the landowner retains all other rights.

For the expanded scope easements on farm parcels, the prohibitions may involve subsurface disturbance for tile drainage, pond construction, and access to surface streams. These restrictions may potentially be so disruptive to agricultural operations that, similar to the case of the Wetland Reserve Program, the value of the easement approaches the value of the land. In this study, expanded scope easements on farm parcels were valued at 90% of the estimated upper and lower fair market values for the farm parcels (see Table C.12) in order to calculate a range of indicative acquisition costs.

In the case of the monitoring zone parcels, a monitoring easement could be acquired with a lump-sum payment for the option to enter the property at some future date for research and testing purposes. The cost of these easements should be minimal compared to the restrictive easements which may be needed for the parcels in the potential acquisition zone. For the 32 properties in the monitoring zone, the value of the monitoring easement was calculated as a lump-sum payment for this property interest which would represent the present value of a future stream of payments. A representative range of annual payments was used which is based on what landowners are currently receiving from natural gas exploration companies operating in western Kentucky, $20 as a lower range and $40 (double current rates) as an upper range for payments per acre per year. This payment would be reasonable for farm parcels. For residential properties, access for monitoring purposes, especially well-drilling, would be far more disruptive to "quiet enjoyment of property." A higher range of annual payments consequently was used, $100 - $500 per year per parcel. In calculating the lump-sum payment, the current cost of capital is assumed to be the long-term U.S. Treasury Bond rate which was 5.05% (Treasury bonds, >10 year maturity, August 17, 2006). Present value calculations were based on an interest rate of 5.05% over 30 years.

The estimated easement values are summarized in Table C.15 for both the potential purchase zone and the monitoring zone. For residential parcels, the estimated value of the limited scope easements is $1 at the lower range to $13,330 at the upper range while the expanded scope easement is valued at $11,529 to $33,325 per parcel. For farm parcels, the estimated value of the limited scope easement per acre is $400 to $800 while the expanded scope easement is valued at $2500 to $2700. In the monitoring zone, the estimated lump-sum payments for residential properties range from $1529 to $7643 while the range for farm parcels is $306 to $611 per acre.

Table C.15 Estimated Range of Values for Easements on Residential and Farm Parcels[1]

Study Area Zone	**Residential Parcels**	**Farm Parcels**
Potential Purchase Zone	(per parcel)	(per acre)
<u>Limited Scope Restrictions</u>		
Upper Range	$13,330	$800
Lower Range	$1	$400
<u>Expanded Scope Restrictions</u>		
Upper Range	$33,325	$2700
Lower Range	$11,529	$2500
Monitoring Zone(monitoring easements)		
Upper Range	$7643	$611
Lower Range	$1529	$306

[1]Estimated easement value only, not including closing costs.

Acquisition cost for easement property interests must include estimated closing costs. These closing costs were estimated on a per parcel basis for both residential and farm parcels but then allocated on a per acre basis for farm parcels to generate a per unit estimated acquisition cost for easements. The range of easement acquisition costs are shown in Table C.16. These acquisition costs are assumed to be reasonable estimates for willing sellers, given normal circumstances.

Table C.16 Estimated Range of Acquisition Costs for Easements in the Potential Purchase Zone and the Monitoring Zone on a Per Parcel or Per Acre Basis						
	Residential Parcels			**Farm Parcels**		
Study Area	**Estimated Easement Value**	**Estimated Closing Costs[1]**	**Estimated Acquisition Cost Per Parcel[2]**	**Estimated Easement Value**	**Estimated Closing Costs[1]**	**Estimated Acquisition Cost Per Acre[2]**
Potential Purchase Zone						
Limited Scope Restrictions						
Upper Range	$13,330	$404,000	$17,330	$800	$416,000	$872
Lower Range	$1	$404,000	$4,001	$400	$416,000	$472
Expanded Scope Restrictions						
Upper Range	$33,325	$505,000	$38,325	$2,700	$512,000	$2,789
Lower Range	$11,529	$505,000	$16,529	$2,500	$512,000	$2,589
Monitoring Zone (monitoring easements only)						
Upper Range	$7,643	$68,000	$11,643	$611	$60,000	$650
Lower Range	$1,529	$68,000	$5,529	$306	$60,000	$345

[1]Estimated closing costs including appraisals, legal fees, and recording fees for each parcel.
[2] Acquisition cost includes value of easement plus estimated closing costs on a per parcel or per acre basis.

If easements are acquired and landowners maintain current occupation and use, the current Water Policy will likely have to continue provision of drinking water to all the affected properties. This is a stream of costs that could extend for many years. The present value of these costs should logically be included in the estimated acquisition costs for limited and expanded scope easements (where groundwater pumping is restricted). Current water policy costs to 104 properties are estimated to have an average total cost of $78,000 per year. The costs of the Water Policy for providing municipal water supply under easement conditions may increase since the number of potentially affected properties increases from 104 to 165 parcels. If the assumption of increased water costs under easement conditions is valid, then average total costs for water supply each year were estimated to be $127,000 – a 63% increase – to anticipate the higher water costs with easements on 165 potentially affected properties. The current cost of capital to the federal government is assumed to be the long-term U.S. Treasury Bond rate of 5.05% (Treasury bonds, >10 year maturity, August 17, 2006). Present value calculations were based on an interest rate of 5.05% over 30 years, resulting in a present value of $1,941,223 as the current value of the long-term commitment to water provision.

Based on the analysis identified above, the estimated total acquisition costs for easements are summarized in Table C.17. For limited scope easements in the purchase zone, acquisition costs may range from $3,133,677 to $6,793,106 plus the cost of continuing water provision to affected parcels ($1,941,223). For expanded scope easements -- where the easement value for agricultural property could approach the full fair market value -- the estimated acquisition costs are estimated to be $16,641,616 to $19,999,612 plus the cost of water provision ($1,941,223). In the monitoring zone, the range of estimated acquisition costs for monitoring easements is $619,083 to $1,187,231.

Table C.17 Estimated Range of Total Acquisition Costs For Limited and Expanded Easements in the Potential Purchase Zone and Monitoring Zone					
	Residential Parcels		**Farm Parcels**		
Study Area	**Easement Cost Per Parcel**	**Estimated Acquisition Costs[1]**	**Easement Cost Per Acre**	**Estimated Acquisition Costs[1]**	**Estimated Total Acquisition Costs**
Purchase Zone Limited Scope Easements					
Upper Range	$17,330	$1,750,330	$872	$5,042,776	$6,793,106
Lower Range	$4,001	$404,101	$472	$2,729,576	$3,133,677
Expanded Scope Easements					
Upper Range	$38,325	$3,870,825	$2789	$16,128,787	$19,999,612
Lower Range	$16,529	$1,669,429	$2589	$14,972,187	$16,641,616
Monitoring Zone (monitoring easements only)					
Upper Range	$11,643	$197,931	$650	$989,300	$1,187,231
Lower Range	$5,529	$93,993	$345	$525,090	$619,083
Estimated Cost of Water Policy Continuation[2]					$1,941,223
Total Estimated Acquisition Costs					
Upper Range					**$29,921,172**
Lower Range					**$22,335,599**

[1] Includes estimated value of easement plus estimated closing costs on a per parcel or per acre basis.
[2] Present value of projected average water costs continued for 30 years to the 165 properties in the potential purchase zone.

C.4 SUMMARY

C.4.1 ANALYSIS APPROACH AND RESULTS

The purpose of this study was to develop an indicative range of acquisition costs for properties near the PGDP which are affected by groundwater contamination. Using a mass appraisal approach consistent with federal agency guidelines for property acquisition, indicative acquisition costs were estimated for purchase in fee simple and easements based on the principle of "highest and best use" to determine fair market value.

The potential purchase zone covers approximately 6,054 acres in 101 rural residential properties and 64 farm parcels. In addition, a monitoring zone of 1,551 acres was identified including 15 farms and 17 rural residential properties.

Using secondary information on comparable residential and farm properties, the fair market value of fee simple interests were estimated for all parcels in the potential purchase zone. In addition, a supplementary calculation was undertaken to determine the value of farm parcels based on development value (rather than fair market agricultural value). An upper and lower range of values were estimated for each set of parcels in order to give a realistic indicative cost estimate. Based on these procedures, the estimated fee simple acquisition cost for residential properties is $12,149,593 to $13,968,401 (Table C.18). For farm parcels valued at fair market agricultural value, the range of estimated fee simple acquisition costs is

$16,123,031 to $17,921,547. Total estimated acquisition costs for fee simple purchase of all residential and farm parcels ranged from $28,272,624 to $31,889,948 (without regard to water policy cost savings).

Table C.18 Estimated Range of Acquisition Costs for Potential Purchase of Fee Simple Property Interests			
	Number of Parcels	**Acres**	**Estimated Total Acquisition Cost**
Rural Residential	101	270.8	
Upper Range			$13,968,401
Lower Range			$12,149,593
Farm Parcels	64	5783.01	
Upper Range			$17,921,547
Lower Range			$16,123,031
Totals	165	6053.81	
Upper Range			**$31,889,948**
Lower Range			**$28,272,624**

If farm parcels are appraised at development value versus fair market value, then estimated fee simple acquisition costs are $37,728,357 to $43,852,564 – more than double the cost of purchase at agricultural fair market value (Table C.19). This increases the estimated range of fee simple net acquisition costs to $49,877,950 to $57,820,965 (without consideration of water policy cost savings).

Table C.19 Estimated Range of Acquisition Costs for Potential Purchase of Fee Simple Property Interests With Farm Parcels Valued at Development Value			
	Number of Parcels	**Acres**	**Estimated Total Acquisition Cost**
Rural Residential	101	270.8	
Upper Range			$13,968,401
Lower Range			$12,149,593
Farm Parcels	64	5783.01	
Upper Range			$43,852,564
Lower Range			$37,728,357
Totals	165	6053.81	
Upper Range			**$57,820,965**
Lower Range			**$49,877,950**

Purchase of fee simple property interests could avoid the current annual average water supply costs of $78,000 to the 104 properties in the Water Policy area. If this can be recognized as a cost "savings" from fee simple acquisition, then avoided future costs of water provision can be treated as a deduction from the total acquisition cost of fee simple purchase. The present value of future water costs were estimated to be $1,192,247, so the estimated range of net acquisition costs is $27,080,377 to $30,697,701 (Table C.20). With farm parcels valued at potential development value, the cost savings from discontinuing water supply reduces estimated acquisition costs to $48,685,703 to $56,628,718 (Table C.21).

Table C.20 Estimated Range of Acquisition Costs for Potential Purchase of Fee Simple Property Interests			
	Number of Parcels	**Acres**	**Estimated Total Acquisition Cost**
Rural Residential	101	270.8	
Upper Range			$13,968,401
Lower Range			$12,149,593
Farm Parcels	64	5783.01	
Upper Range			$17,921,547
Lower Range			$16,123,031
Totals	165	6053.81	
Upper Range			$31,889,948
Lower Range			$28,272,624
Water Policy Cost Savings[1]			-$1,192,247
Net Upper Range Acquisition Costs			**$30,697,701**
Net Lower Range Acquisition Costs			**$27,080,377**

[1]Present value of $78,000 in average annual water costs to the Water Policy area avoided by fee simple acquisition.

Table C.21 Estimated Range of Acquisition Costs for Potential Purchase of Fee Simple Property Interests With Farm Parcels Valued at Development Value			
	Number of Parcels	**Acres**	**Estimated Total Acquisition Cost**
Rural Residential	101	270.8	
Upper Range			$13,968,401
Lower Range			$12,149,593
Farm Parcels	64	5783.01	
Upper Range			$43,852,564
Lower Range			$37,728,357
Totals	165	6053.81	
Upper Range			$57,820,965
Lower Range			$49,877,950
Water Policy Cost Savings[1]			-$1,192,247
Net Upper Range Acquisition Costs			**$56,628,718**
Net Lower Range Acquisition Costs			**$48,685,703**

[1]Present value of $78,000 in average annual water costs to the Water Policy area avoided by fee simple acquisition.

For purchase of easements, a market-based approach was used to estimate both the “lost use” or “rights relinquished” dimensions as well as “before and after” neighborhood effects on residential properties. Since easement values are a direct function of the nature and the extent of the property use restrictions, values were estimated for both limited and expanded scope easements as well as monitoring easements in the monitoring zone. A lump-sum payment for easements can be applied in easement situations, so all values were based on a one-time payment in 2006. It is generally recognized that easement values vary widely depending on geographic location and circumstances, so a wide range of values were developed to capture a reasonable range of estimated values. Acquisition costs were generated by including estimated closing costs on each residential property plus a per acre closing cost for farm properties.

For the 101 rural residential properties, the limited scope easement acquisition costs were estimated to be $4001 at the lower range where water supply is substituted for easement restrictions on groundwater pumping, to an upper range estimate of $17,330. With expanded scope easements on the residential parcels, the range of estimated acquisition costs was $16,529 to $38,325 per parcel. For the 64 farm parcels, existing agricultural easement programs were used to guide easement valuation for both the limited scope and expanded scope easement conditions. Acquisition costs per acre for limited scope easements on farm parcels were estimated to be $472 to $872 and for expanded scope easements, which would potentially have a significant impact on agricultural operations, the upper and lower range of easement costs were estimated to be $2589 to $2789 per acre. For the 32 monitoring zone properties, an easement allowing potential future access for monitoring purposes, was valued based on existing natural gas access easements. The present value of future easements payments was calculated to determine a lump-sum payment for monitoring easements on both residential and farm properties. The monitoring easements have an estimated acquisition cost between $5,529 to $11,643 per residential parcel and $345 to $650 per acre on farm parcels.

Based on these procedures, the estimated range of easement acquisition costs are summarized in Table C.22. It was conservatively assumed that expansion of provision of municipal water supply to all 165 properties in the purchase zone would occur as easements are acquired. For the full purchase zone, this expanded water provision was estimated to cost $127,000 annually. The present value of those water costs over 30 years is estimated to be $1,941,223 and becomes an additional cost to purchase zone easement costs. Therefore, the acquisition cost for the limited scope easements was estimated to be $5,074,900 to $8,734,329 (including water policy continuation). The range of acquisition costs for expanded scope easements was estimated to be substantially higher -- $18,582,839 to $21,940,835 (including water policy continuation) – due primarily to the impact of the expanded scope easement on farm parcels. Finally, for the monitoring zone the easement acquisition costs were estimated to be between $619,083 and $1,187,231. Total estimated acquisition costs for easements in the potential purchase area and monitoring zone range from $5,693,983 to $23,128,066.

Table C.22 Estimated Range of Acquisition Costs for Easements in the Potential Purchase Zone and Monitoring Zone

Purchase Zone	Number of Parcels	Limited Scope Easements	Expanded Scope Easements
Rural Residential	101		
Upper Range		$1,750,330	$3,870,825
Lower Range		$404,101	$1,669,429
Farm Parcels	64		
Upper Range		$5,042,776	$16,128,787
Lower Range		$2,729,576	$14,972,187
Water Policy Continuation[1]		$1,941,223	$1,941,223
Subtotal	165		
Upper Range		$8,734,329	$21,940,835
Lower Range		$5,074,900	$18,582,839
Monitoring Zone	32 (monitoring easements only)		
Upper Range		$1,187,231	
Lower Range		$619,083	
Total Estimated Acquisition Costs	197		
Upper Range		**$9,921,560**	**$23,128,066**
Lower Range		**$5,693,983**	**$19,201,922**

[1] Present value of $127,000 per year in water costs for 165 properties (larger than the current Water Policy area).

C.4.2 IMPACT OF TIME ON ESTIMATED ACQUISITION COSTS

The foregoing analysis was based on current property values adjusted for time trend through 2006. The estimated acquisition costs will rise if: (1) Home prices in McCracken County continue to increase in value by 5% - 8% per year; (2) Agricultural land continues to increase at 10% per year consistent with recent trends; and (3) McCracken County continues economic growth by developing new business investment along the Highway 60 corridor.

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APPENDIX D. TASK 4

IDENTIFICATION OF REMEDIAL ACTION ASSUMPTIONS

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ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
BGOU	Burial Ground Operable Unit
C400	Source reduction of contamination at the C-400 Building
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C-Sparge	A patented oxidation method using ozone bubbles
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
FS	Feasibility Study
GWOU	Groundwater Operable Unit
MCL	Maximum Contaminant Level
OU	Operable Unit
P&T	Pump and Treat groundwater response action
PGDP	Paducah Gaseous Diffusion Plant
POC	Pathway of Concern
PTZ	Permeable Treatment Zone
RAO	Remedial Action Objective
RGA	Regional Gravel Aquifer
S&M	Surveillance & Maintenance
SWMU	Solid Waste Management Unit
^{99}TC	technetium-99 (TC-99)
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
UCRS	Upper Continental Recharge System
URD	Reduction of sources in the UCRS, RGA, and treatment of the Dissolved Southwest Plume
URD-PTZ	Source reduction for UCRS, RGA, and Dissolved Plume with a Permeable Treatment Zone at the security fence
VOC	Volatile Organic Compound

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D.1 INTRODUCTION

This appendix presents four potential response actions that were used in considering property acquisition alternatives that might be employed at the site. The four response actions represent combinations of one or more of the alternatives presented in the Feasibility Study (DOE 2001). Presentation of the selected response actions is not meant to be pre-decisional. The ultimate selection of specific actions will be made in accordance with applicable law and agreements.

The PGDP is the only active uranium enrichment facility in the United States. It is a large industrial plant that has been in operation since 1952. There are 748 acres within a restricted area. The restricted area includes four uranium process buildings, maintenance and storage buildings, cleaning building, electrical switchyards, cooling towers, and a number of support facilities. In addition, large storage areas for depleted uranium, a byproduct of uranium enrichment, and several burial grounds exist within the restricted area.

The U.S. Department of Energy's (DOE) remedial activities at the Paducah Gaseous Diffusion Plant include the characterization, assessment, and remediation of groundwater contamination associated with historical uranium enrichment processes. The DOE is conducting remedial activities, including groundwater characterization, assessment, and remediation, under a Federal Facility Agreement (DOE 1998).

D.2 CONTAMINATED ZONES AT PGDP

The Groundwater Operable Unit (GWOU) is one of five media specific Operable Units (OUs) being characterized and assessed at the PGDP to determine the need for response actions. The following are the five OUs being investigated:

- Burial Grounds OU (BGOU)
- Decontamination and Decommissioning OU
- Groundwater OU (GWOU)
- Soils OU
- Surface Water OU

Solid Waste Management Units (SWMUs) impacting groundwater at PGDP have been characterized and assessed by remedial investigations. The SWMUs included in the GWOU are provided in Table D.1 (DOE 2001). The need for additional characterization of SWMUs that are impacting groundwater will be addressed in specific remedial action work plans for the SWMUs.

Figure D.1 illustrates the known or suspected sources of TCE (i.e., TCE source zones) at the PGDP (DOE 2001). In addition to the C-400 and C-720 Building areas, some burial grounds have also been identified as potential sources of groundwater contamination (SWMUs 2, 3, 4, 7, and 30).

D.3 GROUNDWATER PLUMES

Characterization and assessment of SWMUs impacting groundwater and groundwater monitoring have provided data regarding the Upper Continental Recharge System (UCRS) and the Regional Gravel Aquifer (RGA) at the PGDP: 1) Source areas in the UCRS are co-located adjacent to or immediately below SWMUs; 2) Secondary Source areas are sources in the RGA that are generally located near UCRS source areas; and 3) three plumes of contaminated groundwater have been shown to exist in the RGA downgradient of UCRS source and RGA secondary source areas. The contaminated groundwater plumes are called the Southwest, Northwest, and Northeast Plumes.

The Northwest and Northeast Plumes have migrated off DOE property. The Southwest Plume extends west of the PGDP restricted area but does not extend beyond DOE's property boundary. Soil areas in the UCRS adjacent to the C-400 Building are major sources of the Northwest and Northeast Plumes. Furthermore, investigations support the presence of TCE as a dense non-aqueous phase liquid (DNAPL) in the RGA in the area of C-400 Building (DOE 2001).

Table D.1 GWOU SWMUs[a,b]

SWMU No.	Description	Active Remediation Operable Unit
11	C-400 Trichloroethene Leak Site	GWOU
26	C-400 to C-404 Underground Transfer Line	GWOU
40	C-403 Neutralization Tank	GWOU
47	C-400 Technetium Storage Tank Area	GWOU
203	C-400 Sump	GWOU
1	C-747-C Oil Land Farm	GWOU
196	C-746-A Septic System	GWOU
209	C-720 Compressor Shop Pit Sump	GWOU
211	C-720 TCE Spill Site Northeast	GWOU
99	C-745 Kellogg Building Site (previously AOC #C)	GWOU
183	McGraw Underground Storage Tank	GWOU
193	McGraw Const Facilities (Southside Cylinder Yards)	GWOU
194	McGraw Construction Facilities (Southside)	GWOU
204	Dykes Road Historical Staging Area	GWOU
201	Northwest Groundwater Plume	GWOU
202	Northeast Groundwater Plume	GWOU
210	Southwest Groundwater Plume	GWOU
91	UF_6 Cylinder Drop Test Area	Lasagna™[c]

[a]Potential GWOU source areas including SWMUs 2, 3, 4, 7, and 30 are being address as part of the BGOU.
[b] *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant Paducah, Kentucky Volume 1. Main Text, DOE/OR/07-1857& D2,* August 2001
[c] Lasagna™ is a remediation technology that was implemented at SWMU 91 to address soil and groundwater contamination.

The *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2006) identified SWMU 1, SWMU 4, and the C-720 Building as the major sources of TCE contamination in the Southwest Plume.

Technetium-99 (^{99}Tc) is a contaminant in the Northwest, Northeast, and Southwest Plumes (DOE 2001). Technetium-99 exists at elevated levels in groundwater inside the PGDP restricted area in the Northeast Plume but at lower levels outside the PGDP restricted area. Technetium-99 contamination in the Northeast Plume does not extend beyond the DOE property boundary. Inside the PGDP restricted area, concentrations of ^{99}Tc in excess of 16,000 and 5,000 pCi/L have been detected in the Northwest and Southwest Plumes, respectively. Technetium-99 at lower levels exists in groundwater in the Southwest and Northwest Plumes outside the restricted area. Figures D.2 and D.3 show the TCE and ^{99}Tc plumes at the PGDP resulting from known or suspected TCE DNAPL and ^{99}Tc Source Zones (DOE 2001).

D.4 SOURCE AREAS

Technologies to address groundwater contamination were evaluated in a Feasibility Study (FS) (DOE 2001). The GWOU FS (DOE 2001) included technologies that have the potential to address dissolved phase trichloroethene (TCE), DNAPL TCE, degradation products of TCE, and ^{99}Tc. In the FS, source zones were segregated into Primary Source Areas, Secondary Source Areas, and Dissolved Phase Plume Areas (DOE 2001). These were defined as:

- Primary Source Areas – Locations in the UCRS with TCE present.
- Secondary Source Areas **-** Locations in the RGA with TCE present at concentrations above 10 mg/L (i.e., at a concentration indicative present of a TCE DNAPL).
- Dissolved Phase Plume Areas – Locations in the RGA with TCE present below DNAPL concentrations.

The following tables provide estimates of the volume of the UCRS source areas that are suspected of contributing to groundwater contamination. These source volumes and zones were taken from DOE groundwater documents (DOE 2001 and 2006) and are used to estimate the cost of implementing the technologies discussed later in this appendix. The groundwater documents should be consulted to understand the uncertainties related to the sources and volumes of TCE contamination.

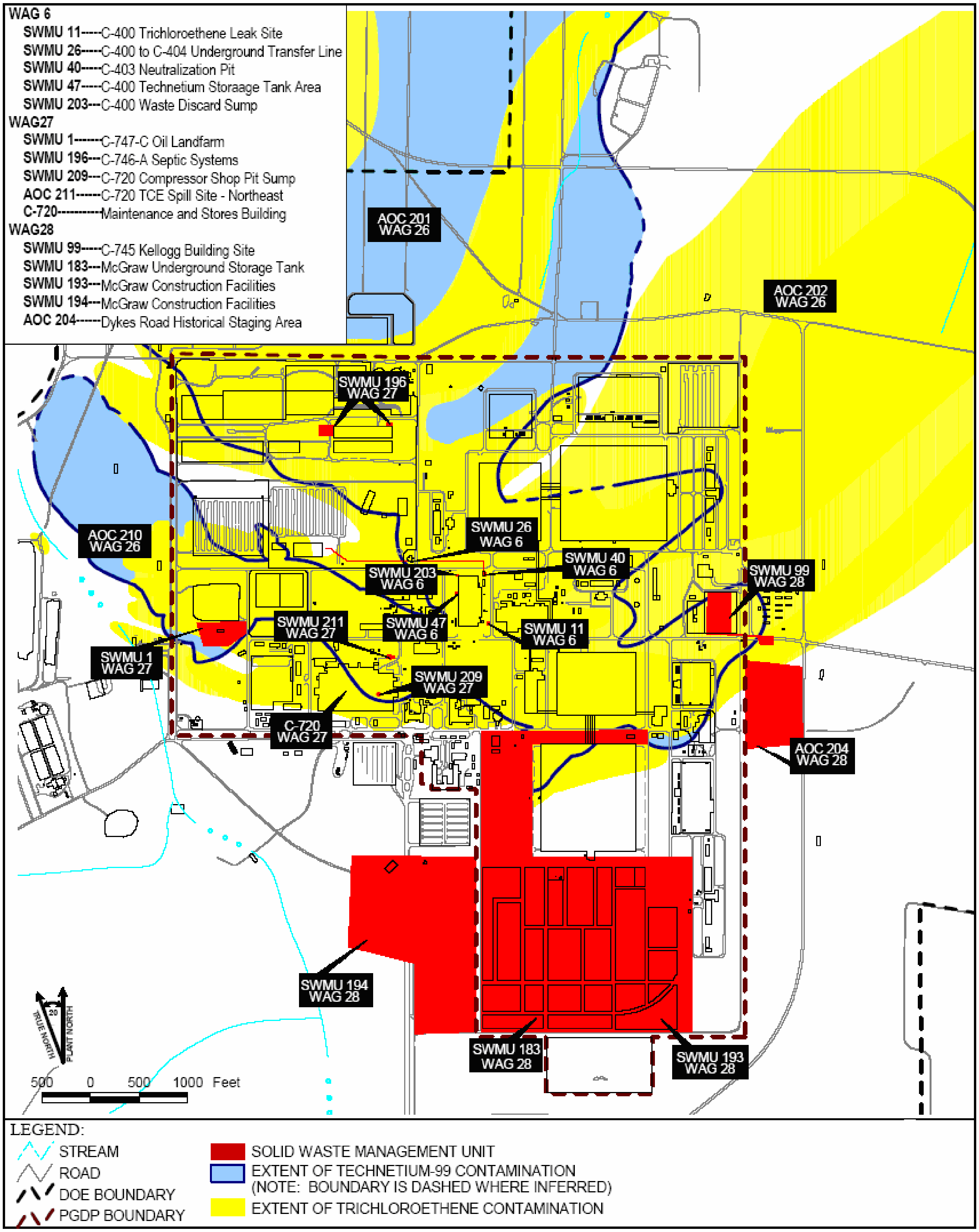

Figure D.1 Known or Suspected Source Zones at PGDP (DOE 2001)

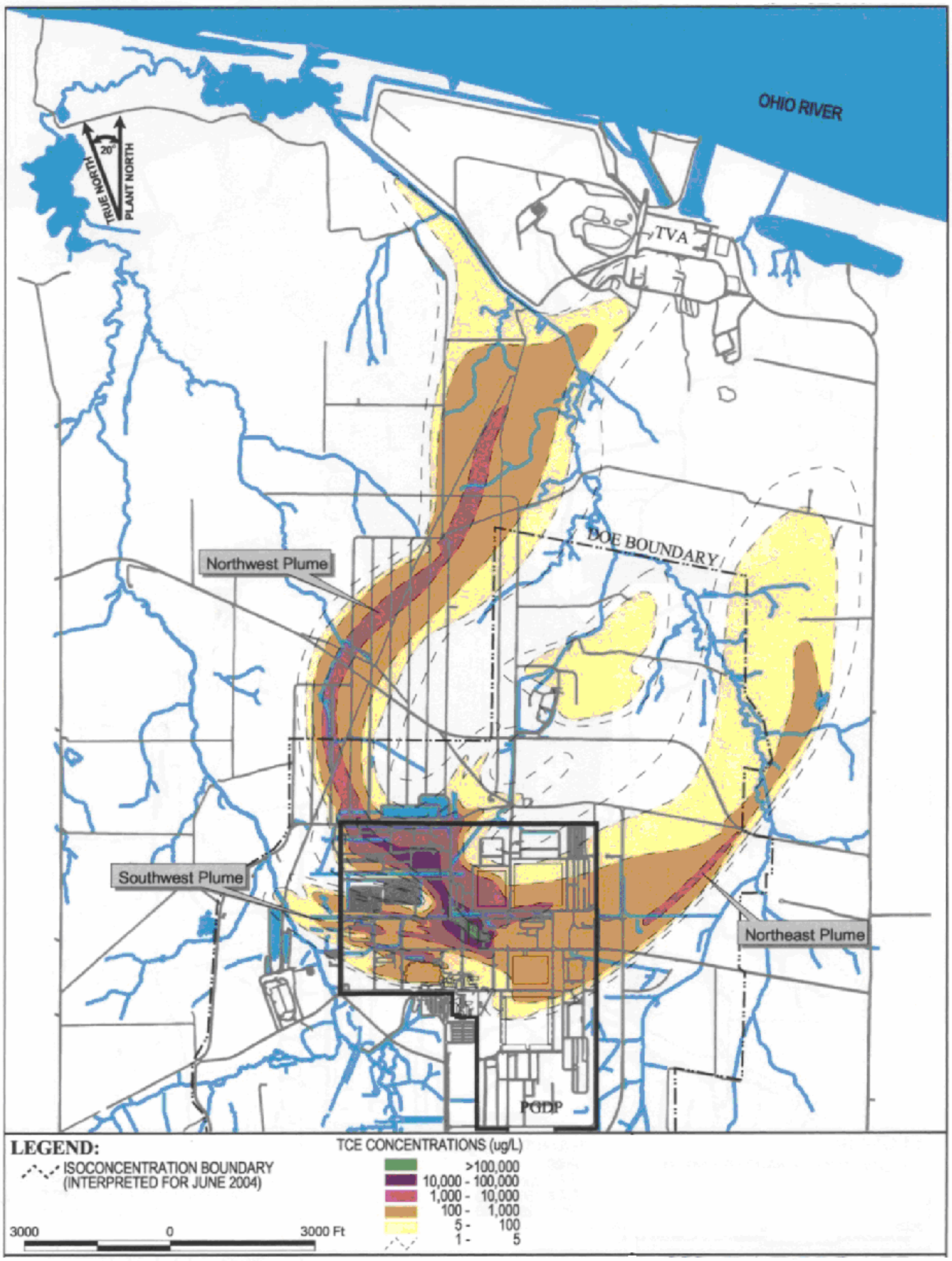

Figure D.2 Trichloroethene Plumes at PGPD (DOE 2001)

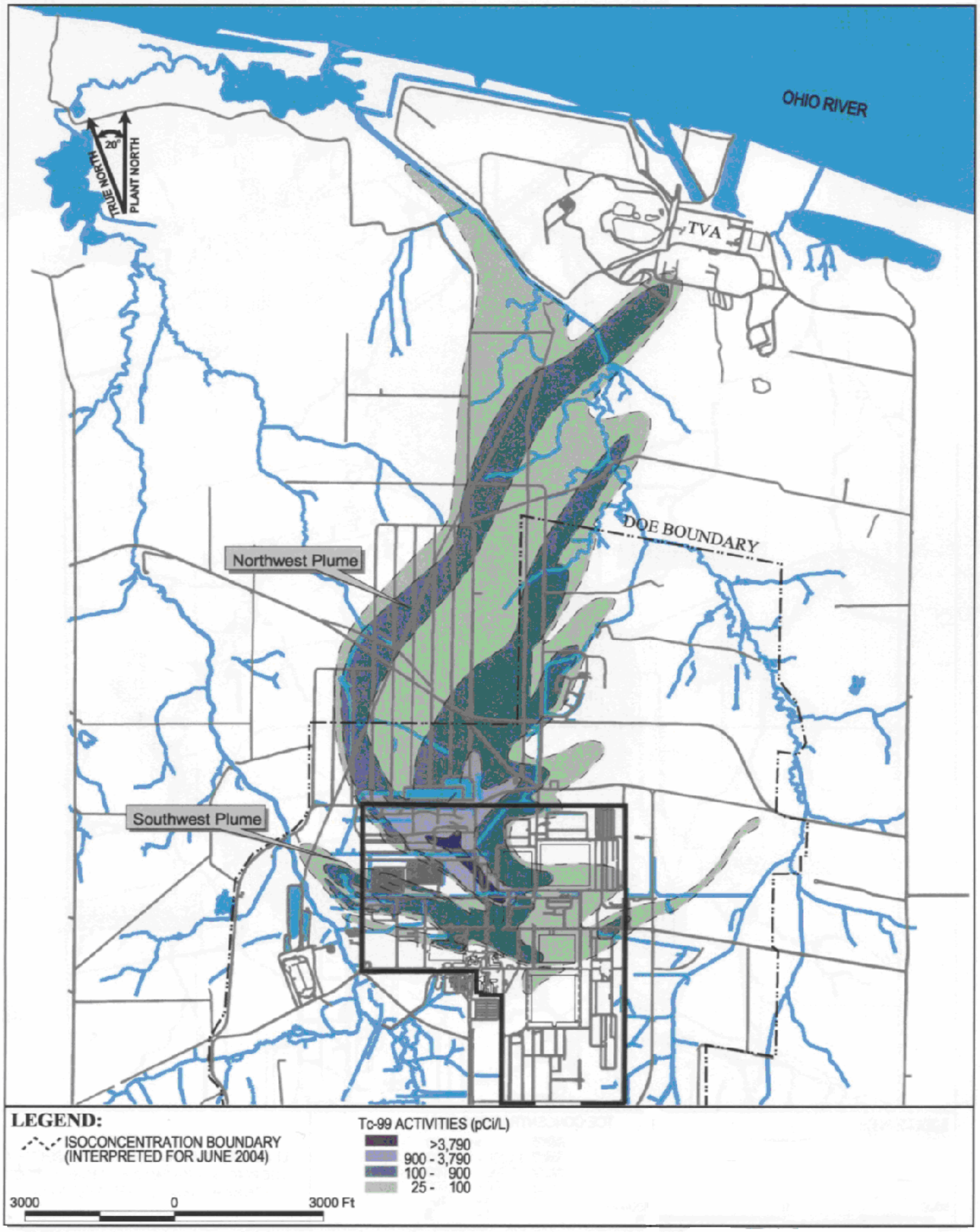

Figure D.3 Technetium-99 Plumes at PGDP (DOE 2001)

Table D.2 Estimated Primary Source Zones in the UCRS at the C-400 Building PGDP[a] Estimated Source Zone Areas and Volumes for TCE Transfer Pump and TCE Leak Site (SWMU 11)			
Depth Interval (ft)	**Area Containing 100 ppm TCE or Greater (ft^2)**	**Thickness Represented (ft)**	**Volume Represented (ft^3)**
365.0 - 369.9	4,000	14*	56,000
360.0 - 364.9	3,400	5	17,000
355.0 - 359.9	5,070	5	25,350
350.0 - 354.9	3,730	5	18,650
345.0 - 349.9	2,500	5	12,500
340.0 - 344.9	3,560	5	17,800
335.0 - 339.9	2,130	5	10,650
330.0 - 334.9	3,330	8**	26,640
		Total (ft^3)	**184,590**

*Land Surface to subsurface elevation 365.0 ft

**Elevation 334.9 ft to top of the RGA at 327 ft elevation

[a]All information extracted from *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky; Volume 4. Appendix C5*, DOE/OR/07-1857&D2, August 2001

Table D.2 Estimated Primary Source Zones in the UCRS at the C-400 Building Paducah Gaseous Diffusion Plant (Con't) **Source Zone Areas and Volumes for South-End C-400 Building Storm Sewer and C-403 Neutralization Pit (SWMU 40)**			
	Height (ft)	**Radius (ft)**	**Volume Represented (ft^3)**
	South-End Storm Sewer Source (324.5-376.5 ft elevation)		
	52	30	**147,027**
	C-403 Neutralization Pit Source (336.5 -378.5 ft elevation)		
	42	6.25	**5,154**

[a] All information extracted from *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky; Volume 4. Appendix C5*, DOE/OR/07-1857&D2, August 2001

Table D.3 Estimated Secondary Source Zones in the RGA at the C-400 Building Paducah Gaseous Diffusion Plant[a]				
Estimated Source Zone Areas and Volumes for RGA DNAPL Source Zones				
TCE DNAPL Source Zone	**Areal Dimensions Radius (ft)**	**Area (ft^2)**	**Thickness (ft)**	**Volume (ft^3)**
TCE Transfer Pump (305-327 ft elevation)	90	25,447	22	**559,834**
TCE Transfer Pump (286-305 ft elevation)	19	1,963	19	**37,297**
TCE Leak Site (SWMU 11) (305-327 ft elevation)	22	1,000	22	**22,000**
South-End Storm Sewer (322-324.5 ft elevation)	2.5	1,963	2.5	**4,908**

[a]All information extracted from *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky; Volume 4. Appendix C5, DOE/OR/07-1857&D*2, August 2001

Table D.4 Estimated Primary and Secondary Source TCE DNAPL Volumes at the C-400 Building Paducah Gaseous Diffusion Plant([a])				
Estimated Source Zone DNAPL TCE Volumes for UCRS and RGA				
TCE DNAP Source Zone	**Soil Source Zone Volume (ft^3)**	**Assumed Porosity (%)**	**Assumed Saturation (%)**	**TCE DNAP Volume (ft^3)**
UCRS				
TCE Transfer Pump and TCE Leak Site (SWMU 11) (322.0-379.0 ft elevation)	184,590	36	5.7	**3,788**
South-End Storm Sewer Source (324.5-376.5 ft elevation)	147,027	36	5.7	**3,017**
C-403 Neutralization Pit Source (336.5 - 378.5 ft elevation)	5,154	36	5.7	**106**
RGA				
TCE Transfer Pump (305-327 ft elevation)	559,834	40	8.1	**18,139**
TCE Transfer Pump (286-305 ft elevation)	37,297	40	8.1	**1,208**
TCE Leak Site (SWMU 11) (305-327 ft elevation)	22,000	40	8.1	**713**
South-End Storm Sewer (322-324.5 ft elevation)	4,908	40	8.1	**159**

[a]All information extracted from *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky; Volume 4. Appendix C5, DOE/OR/07-1857&D2,* August 2001

Table D.5 Estimated Source Zone Areas and Mass for SWMU 1					
Layer	**Depth (ft)**	**Average TCE Concentration (mg/Kg)**	**Area (ft^2)**	**Area (ft^3)**	**Mass (g)**
Layer 1	00-10	7.59	4,375	43,750	13,723
Layer 2	10-20	110.80	3,125	31,250	143,177
Layer 3	20-30	17.60	6,250	62,500	45,503
Layer 4	30-40	13.00	5,625	56,250	30,283
Layer 5	40-50	13.60	5,625	56,250	31,516
layer 6	50-55	5.74	7,500	37,500	8,902
				Total Mass	**273,104**

[a] All information extracted from *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,* DOE/OR/07-1880&D2

Table D.6 Estimated Source Zone Areas and Mass for the C-720 Building Area[a]					
Layer	**Depth (ft)**	**Average TCE Concentration (mg/Kg)**	**Area (ft^2)**	**Area (ft^3)**	**Mass (g)**
Layer 1	00-10	2.96	7,500	75,000	9,185
Layer 2	10-20	6.37	7,500	7,500	19,751
Layer 3	20-30	11.90	15,000	150,000	73,900
Layer 4	30-40	1.55	6,875	68,750	4,393
Layer 5	40-50	1.20	6,875	68,750	3,411
layer 6	50-60	0.10	6,875	68,750	282
				Total Mass	**110,922**

[a] All information extracted from *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,* DOE/OR/07-1880&D2

Table D.7 Estimated Source Zone Areas and Mass for SWMU 4[a]					
Layer	**Depth (ft)**	**Average TCE Concentration (mg/Kg)**	**Area (ft^2)**	**Area (ft^3)**	**Mass (g)**
Layer 1	00-10				
Layer 2	10-20				
Layer 3	20-30	18.77	37,500	375,000	290,987
Layer 4	30-40	19.83	39,375	393,750	322,769
Layer 5	40-50	1.20	57,500	575,000	132,831
layer 6	50-55	0.10	77,500	387,500	141,913
				Total Mass	**888,500**

[a] All information extracted from *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant Paducah, Kentucky,* DOE/OR/07-1880&D2

D.5 ALTERNATIVES

General response actions were developed to address TCE source zones (DOE 2001). These include treatment, containment, excavation, extraction, and disposal of contaminated media. The general response actions were utilized to screen remedial technology applicability to groundwater contamination at PGDP.

The FS selected twelve technologies, including a No Action Alternative, that have the potential to reduce the toxicity, volume and mobility of contaminants present in the Primary Source, Secondary Source, and Dissolved Phase Plume Areas. The technologies analyzed were:

• Primary Source Areas	Vapor Extraction Technology Direct Heating Technology Excavation Technology
• Secondary Source Areas	Steam Extraction Technology Pump-and-Treat Technology Oxidation Technology
• Dissolved Phase Plume Areas	Pump-and-Treat Technology Ozonation Technology Permeable Treatment Zone (PTZ) Technology Oxidation Technology Bioremediation Technology

Each technology was evaluated against seven criteria. These included two “threshold criteria,” Overall Protection of Human Health and the Environment and Compliance with Applicable or Relevant and Appropriate Requirements (ARARs), and five “primary balancing criteria,” Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility, or Volume through Treatment; Short-term Effectiveness; Implementability; and Cost.

The FS developed the cost for the implementation of a technology based on an acre-foot of contamination area using ‘*case scenarios*’ (DOE 2001). An acre-foot is a unit volume that is equivalent to the area of one acre with a thickness of one foot. The area definition was used in the FS because technologies were not analyzed for a specific location. Because of the lack of specificity for technology implementation at a defined contaminated area, cost estimates for each alternative were derived in the FS using the C-400 Building Southeast area as a case scenario for Primary and Secondary Source Areas (DOE 2001a). For alternatives addressing the Dissolved Phase Plume Area, the FS developed cost estimates using a segment of the Northwest Plume near the boundary of the PGDP restricted area as a case scenario (DOE 2001a). It should be noted that the cost estimates in the FS are presented as having an expected accuracy of –30% to +50% (DOE 2001).

Table D.8 and D.9, taken from DOE 2001; include the comparative analysis of technologies for Primary and Secondary Source Areas and the comparative analysis of technologies for Dissolved Phase Plume Areas, respectively. Material presented below provides additional information about each of the technologies evaluated in the GWOU FS.

D.5.1 NO ACTION

The No Action Alternative is an alternative in which remedial action would not be implemented to address groundwater contamination associated with the Primary Source, Secondary Source, and Dissolved Phase Plume Areas. Because remedial actions would not be implemented, the no action alternative does not include costs. Similarly, because there is no removal of source mass, the time required to attain remedial objectives is based solely on natural attenuation of groundwater contamination. The FS (DOE 2001) estimates that 7,000 years would be required for natural attenuation to remove the TCE DNAPL (Table D.8).

D.5.2 PRIMARY SOURCE AREA – VAPOR EXTRACTION

Vapor Extraction Technology can be used to treat areas in the UCRS contaminated with volatile organic compounds (TCE). The TCE partitions to soil gas and an extraction well uses vacuum to remove the soil gas with the contaminants. A number of technologies are available to treat the off-gas.

The FS chooses Dual Phase Extraction for implementation in UCRS Primary Source Areas. Dual Phase Extraction combines the use of vacuum to remove soil gas with a pump at the bottom of a well to remove groundwater and lower the water table. In addition to removal of TCE, Dual Phase Extraction could remove ^{99}Tc in the water stream from contaminated areas. Vapor Extraction Technology would not treat Secondary Source Areas or Dissolved Phase Plumes.

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Primary Source Zone in the UCRS within the restricted area at PGDP (DOE 2001). As shown in Table D.10, the FS presents a unit cost of $554,393 per acre-foot to implement this technology for remediation of Primary URCS Source Zones (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Primary Source Zones at PGDP.

D.5.3 PRIMARY SOURCE AREAS – DIRECT HEATING TECHNOLOGY

Direct Heating Technology utilizes heating of UCRS soils to partition TCE to the soil gaseous phase with subsequent soil vapor extraction and treatment. Six-Phase Heating is the technology chosen in the FS for implementation in Primary Source Areas. Six-Phase Heating uses an array of 7-electrodes with a hexagonal pattern perimeter of six electrodes and a neutral electrode located in the center of the hexagon. The treatment zone has a diameter of 8-11 m (25-35 ft), and the heated area is normally 40% larger than the treatment zone (DOE 2001). Some ^{99}Tc may be removed during treatment; however, this technology is not effective in removal of ^{99}Tc from the Primary UCRS Source Zones.

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Primary Source Zone in the UCRS within the restricted area at PGDP (DOE 2001). As shown in Table D.10, the FS provides a unit cost of $434,759 per acre-foot to implement this technology for remediation of Primary URCS Source Zones (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Primary Source Zones at PGDP.

D.5.4 PRIMARY SOURCE AREAS – EXCAVATION TECHNOLOGY

All contaminants would be removed from the Primary UCRS Source Zones by excavation. Excavation would occur laterally in source zones until soil samples collected from the sidewalls indicated cleanup levels had been achieved. Excavation would occur vertically until either soil samples collected from the floor of the excavation were "clean" or a practical limit of excavation was reached (DOE 2001). Contaminated soils removed from the Primary UCRS Source Zones would be treated and/or disposed of appropriately.

In areas where complete excavation was achievable, 100% of the contamination would be removed from Primary UCRS Source Zones. In areas not completely excavated, additional remedial alternatives could be necessary to address residual contamination.

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Primary Source Zone in the UCRS within the restricted area at PGDP (DOE 2001). The FS presents a unit cost of $5,930,929 per acre-foot to implement this technology for remediation of Primary URCS Source Zones (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Primary Source Zones at PGDP.

D.5.5 SECONDARY SOURCE AREA – STEAM EXTRACTION TECHNOLOGY

Steam Extraction Technology would be applicable to Secondary RGA Source Areas. Steam extraction is implemented by utilizing injection and extraction wells in the treatment areas. Injected steam volatilizes TCE and moves to an extraction well. Extracted vapor is collected at the surface and treated to remove TCE. In addition to vapor, some liquids could be entrained by the vapor extraction process, and those liquids could contain other contaminants. Treatment of liquids would occur.

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Secondary RGA Source Zones within the restricted area at PGDP (DOE 2001). The FS provides a unit cost of $1,042,276 per acre-foot to implement this technology for remediation of Secondary RGA Source Zones (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Secondary Source Zones at PGDP.

D.5.6 SECONDARY SOURCE AREA – PUMP-AND-TREAT TECHNOLOGY

Pump-and-Treat Technology includes placing extraction wells in targeted Secondary RGA Source Zones and pumping and treating contaminated groundwater. This technology is effective for removal of TCE and other contaminants from the targeted zones; however, removal of contaminants may require an extended treatment time period. Extracted water would require treatment prior to being released (DOE 2001).

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Secondary RGA Source Zones within the restricted area at PGDP (DOE 2001). The FS presents a unit cost of $1,076,353 per acre-foot to implement this technology to remediate Secondary RGA Source Zones (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Secondary Source Zones at PGDP.

D.5.7 SECONDARY SOURCE AREA – OXIDATION TECHNOLOGY

Oxidation Technology for Secondary RGA Source Areas would remove of TCE. Under this technology, a series of injection wells would be drilled in Secondary RGA Source Areas and oxidizing compounds, such as potassium permanganate or sodium permanganate, would be injected using these wells. The oxidizing compound then reacts with and destroys TCE. Technetium-99 contamination would not be addressed by the Oxidation Technology.

Table D.10 provides the contaminant reduction attainable if this technology is implemented to address the Secondary Source Zone in the RGA within the restricted area at PGDP. The FS presents a unit cost of $12,218,892 per acre-foot to implement this technology to remediate Secondary Source Areas (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Secondary Source Zones at PGDP.

D.5.8 DISSOLVED PHASE PLUME AREA – PUMP-AND-TREAT TECHNOLOGY

Pump-and-Treat Technology implemented in targeted areas or over the entire Dissolved Phase Plumes both on and off DOE property would address dissolved phase contaminants. Pump-and-Treat Technology would remove TCE and other contaminants in the Dissolved Phase Plumes. Unlike the Secondary Source Area Pump-and-Treat Technology, this technology would only remove dissolved phase contaminants. Under this technology, extraction wells spaced across the entire plume area or in a linear arrangement would permit specific sections of the plume to be remediated. The extracted water would be treated (DOE 2001).

Table D.10 provides the contaminant reduction attainable (DOE 2001) if this technology is implemented to address the Dissolved Phase Plumes in the RGA. The FS provides a unit cost of $361,039 per acre-foot to implement this technology for remediation of the Dissolved Phase Plumes (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Secondary Source Zones at PGDP.

D.5.9 DISSOLVED PHASE PLUME AREA – OZONATION TECHNOLOGY

Ozonation Technology implemented in targeted areas or over the entire Dissolved Phase Plumes both on and off DOE property would address TCE and ^{99}Tc. Unlike Ozonation implemented for the Secondary Source Areas, the treatment of the Dissolved Phase Plume would remove only dissolved phase contaminants. Under this technology, injection wells would be drilled into the RGA at target locations either across the entire plume area or in a linear arrangement that would permit specific sections of the plume to be remediated. The injected ozone would then react with and destroy TCE. Although not remediated by ozone, ^{99}Tc in groundwater would be treated by circulating groundwater through an ion exchange device that captures ^{99}Tc. Ozonation Technology is an *in situ* process and would not require the extraction of groundwater from the Dissolved Phase Plume (DOE 2001).

Table D.10 presents the reduction attainable if this technology is implemented to address the Dissolved Phase Plumes in the RGA (DOE 2001). The FS presents a unit cost of $75,065 per acre-foot to implement this technology to remediate Dissolved Phase Plumes (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Secondary Source Zones at PGDP.

D.5.10 DISSOLVED PHASE PLUME AREA – PERMEABLE TREATMENT ZONE TECHNOLOGY

Permeable Treatment Zone (PTZ) technology would utilize reactive media zones to remove contaminants from the Northwest, Southwest, and the Northeast Plumes as groundwater in these plumes passes through the reactive media zones. This technology could be implemented in order to treat the high concentration portions of the plumes or implemented to treat entire plumes at targeted locations. In the FS, iron is the reactive media selected to destroy TCE and capture ^{99}Tc (DOE 2001).

Table D.10 presents the contaminant reduction attainable if this technology is implemented to address the Dissolved Phase RGA Plumes (DOE 2001). The FS provides a unit cost of $124,285 per acre-foot to implement this technology to address the Dissolved Phase Plumes (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Dissolved Phase Plumes at PGDP.

D.5.11 DISSOLVED PHASE PLUME AREA – OXIDATION TECHNOLOGY

Oxidation Technology implemented in targeted areas or over the entire Dissolved Phase Plumes both on and off DOE property would result in the destruction of dissolved phase TCE. Unlike the Secondary Source Zone treatment technology, Oxidation Technology would only destroy dissolved phase contaminants. Under this technology, injection wells would be installed in target areas either spaced across the entire plume area or in a linear arrangement that would permit treatment of specific sections of the plume. An oxidizing compound, such as potassium permanganate or sodium permanganate, would then be injected in order to react with and destroy TCE. Using a “blanket” installation approach, the wells would be spaced in order to permit the oxidant to be injected over the entire target area. Technetium-99 would not be treated by the oxidation technology (DOE 2001).

Table D.10 presents the contaminant reduction attainable if this technology is implemented to address the Dissolved Phase RGA Plumes (DOE 2001). The FS provides a unit cost of $157,636 per acre-foot to implement this technology to address the Dissolved Phase Plumes (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Dissolved Phase Plumes at PGDP.

D.5.12 DISSOLVED PHASE PLUME AREA - BIOREMEDIATION

Bioremediation Technology would address TCE contamination in the Dissolved Phase Plumes both on and off DOE property. Under this technology, injection wells would be spaced across the entire Dissolved Phase Plume or in a linear arrangement that would permit specific sections of the Dissolved Phase Plume to be treated. Injection wells would then be used to inject a nutrient solution into the RGA. The nutrient solution would promote bacterial activity leading to the destruction of TCE (DOE 2001).

As discussed in the FS, destruction of TCE can occur through two mechanisms (DOE 2001). These are anaerobic and aerobic bacterial metabolism. Through anaerobic metabolism, the anaerobic bacteria present in the subsurface utilize TCE as an energy source and produce some TCE degradation products (e.g., vinyl chloride) that are more toxic than TCE. However, because the TCE would be utilized by bacteria as an energy source, anaerobic metabolism would be the fastest form of bioremediation. In order to convert the existing aerobic RGA to an anaerobic environment, a large volume of substrate would need to be added to the RGA. This step would be essential because the RGA in its present state is aerobic with oxygen concentrations as high as 8 ppm. With the increased concentration of substrate, aerobic bacterial action would increase and consume the oxygen in the RGA. As a result, the oxygen concentration would decrease, aerobic bacterial activity would decrease, and the aquifer would revert to an anaerobic environment. Anaerobic bacteria would subsequently consume TCE with the potential to generate the toxic TCE degradation products (DOE 2001).

Through aerobic metabolism, indigenous aerobic bacteria present in the subsurface would destroy TCE through cometabolism. Aerobic bacterial processes require the introduction of an energy source (primary food source) to the RGA to enhance the activity of the bacteria. The bacteria would consume the primary food source, and TCE would be destroyed by enzymes released by the bacteria. The bacteria are in turn affected by the destruction of the TCE, which results in the production of an epoxide toxic to the aerobic bacteria. This toxic effect limits aerobic metabolism because it reduces the number of bacteria present. Technetium-99 would not be affected by either bioremediation mechanism (DOE 2001).

Table D10 provides the contaminant reduction attainable if this technology is implemented to address the Dissolved Phase Plumes in the RGA (DOE 2001). The FS presents a unit cost of $205,154 per acre-foot to implement this technology to remediate Dissolved Phase Plumes (DOE 2001). This information is subsequently used in Table D.10 to derive the cost of applying this technology to Dissolved Phase Plumes at PGDP.

Table D.8 Comparative Analysis of Technologies for Primary and Secondary Source Areas (taken from DOE 2001)							
Criteria	**No Action**	**Primary Source Areas**			**Secondary Source Areas**		
Description	No Action	Vapor Extraction Technology	Direct Heating Technology	Excavation	Steam Extraction Technology	Pump-and-Treat Technology	Oxidation Technology
Overall Protection of Human Health and the Environment							
Human health protection	Does not protect human health	Not protective unless combined with additional measures.	Not protective unless combined with additional measures.	Not protective unless combined with additional measures.	Not protective unless combined with additional measures.	Not protective unless combined with additional measures.	Not protective unless combined with additional measures.
Environmental protection	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.	Discharges from the Northwest Plume into Little Bayou Creek will continue.
Compliance with ARARs							
Chemical-specific	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater or surface water.
Location-specific	No location-specific ARARs were identified for this alternative.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.

Table D.8 Comparative Analysis of Technologies for Primary and Secondary Source Areas (taken from DOE 2001)							
Criteria	**No Action**	**Primary Source Areas**			**Secondary Source Areas**		
Description	No Action	Vapor Extraction Technology	Direct Heating Technology	Excavation	Steam Extraction Technology	Pump-and-Treat Technology	Oxidation Technology
Action-specific	No action-specific ARARs were identified for this alternative.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.
Other criteria and guidance	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.
Long-Term Effectiveness and Permanence							
Magnitude of residual risk	Residual risks remain high during the first 30 years; residual risks will be reduced in 7,000 years.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the POC.
Adequacy and reliability of controls	No implementation of controls preventing exposure to potential receptors.	Adequate and reliable.	Adequate and reliable.	Adequate and very reliable where applicable. Reliability decreases where infrastructure impedes implementation.	Adequate and reliable.	Adequate and reliable.	Adequate and moderately reliable.
Need for 5-year review	Required	Required	Required	Required	Required	Required	Required

Table D.8 Comparative Analysis of Technologies for Primary and Secondary Source Areas (taken from DOE 2001)							
Criteria	**No Action**	**Primary Source Areas**			**Secondary Source Areas**		
Description	No Action	Vapor Extraction Technology	Direct Heating Technology	Excavation	Steam Extraction Technology	Pump-and-Treat Technology	Oxidation Technology
Environmental impacts and mitigative measures	No action would allow current rates of contamination to continue.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.	Minimal overall environmental impacts and mitigative measures. However, local impacts will be significant.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.
Reduction of Toxicity, Mobility, or Volume through Treatment							
Treatment processes used	None	Vapor extraction; ion exchange and air stripper with cat/ox system.	Direct heating with ion exchange and air stripper with cat/ox system.	Excavation with *ex situ* thermal treatment of soil.	Steam extraction; ion exchange and air stripper with cat/ox system.	Pump-and-treat; ion exchange and air stripper with cat/ox system.	*In situ* oxidation
Amount destroyed or treated	None	TCE and VOCs will be treated. Moderately effective on DNAPL. Minimal ^{99}Tc will be captured.	TCE and VOCs will be treated. Highly effective on DNAPL. Minimal ^{99}Tc will be captured.	All contaminated soils will be removed. TCE and other VOCs will be treated. Highly effective on DNAPL if within excavation zone.	TCE and VOCs will be treated. Highly effective on DNAPL. ^{99}Tc will be captured.	TCE and VOCs will be treated. Minimally effective on DNAPL. Minimal ^{99}Tc will be captured.	TCE and VOCs will be treated. Moderately to highly effective on DNAPL. Not effective on ^{99}Tc.
Degree of reduction of toxicity, mobility, or volume	No reduction in toxicity, mobility, and volume.	High reduction in VOC toxicity and volume of sources. Minimal reduction in ^{99}Tc volume.	High reduction in VOC toxicity and volume of sources. Minimal reduction in ^{99}Tc volume.	High reduction in VOC toxicity and volume of VOC and ^{99}Tc sources within the zone of excavation.	High reduction in VOC toxicity and volume of sources. Moderate reductions in ^{99}Tc volume.	Low volume of VOC contaminants recovered. High reduction in toxicity of VOCs recovered. Large reductions in ^{99}Tc volume.	High reduction in VOC toxicity. No impact on ^{99}Tc.
Irreversibility of treatment	Not applicable.	Reversible.	Irreversible.	Irreversible.	Reversible.	Reversible.	Irreversible.
Type/quantity of residuals remaining after treatment	Not applicable.	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	None.

Table D.8 Comparative Analysis of Technologies for Primary and Secondary Source Areas (taken from DOE 2001)							
Criteria	**No Action**	**Primary Source Areas**			**Secondary Source Areas**		
Description	No Action	Vapor Extraction Technology	Direct Heating Technology	Excavation	Steam Extraction Technology	Pump-and-Treat Technology	Oxidation Technology
Statutory preference for treatment	Not applicable.	Satisfied for VOCs.	Satisfied for VOCs.	Satisfied for VOCs.	Satisfied for VOCs.	Satisfied for VOCs.	Satisfied for VOCs.
Short-term Effectiveness							
Community protection	No increase in risk to community as no action is taken.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.
Worker protection	No risks to workers as no action is taken.	Minimal risks to workers from handling contaminated groundwater. Risks can be minimized through adherence to health/safety protocols.	Minimal risks to workers from handling contaminated groundwater. Large volumes of electricity are used. Risks can be minimized through adherence to health/safety protocols.	Risks to workers from handling contaminated soils. Risks can be minimized through adherence to health/safety protocols.	Minimal risks to workers from handling contaminated groundwater. Potential exposure to steam under pressure. Risks can be minimized through adherence to health/safety protocols.	Risks to workers from handling contaminated groundwater. Risks can be minimized through adherence to health/safety protocols.	Risks to workers from handling oxidant. Risks can be minimized through adherence to health/ safety protocols.
Environmental impacts and mitigative measures	No action would allow current rates of contamination to continue.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.	Minimal environmental impacts and mitigative measures.	Increase in discharge to creeks will result.	Minimal environmental impacts and mitigative measures.
Time until action is complete	Time until the groundwater is attenuated is 7,000 years.	Approximately 1,000 years.	Approximately 1,000 years.	Approximately 1,000 years.	Approximately 7,000 years.	Approximately 7,000 years.	Approximately 7,000 years.

Table D.8 Comparative Analysis of Technologies for Primary and Secondary Source Areas (taken from DOE 2001)							
Criteria	**No Action**	**Primary Source Areas**			**Secondary Source Areas**		
Description	No Action	Vapor Extraction Technology	Direct Heating Technology	Excavation	Steam Extraction Technology	Pump-and-Treat Technology	Oxidation Technology
Implementability							
Technical feasibility	Feasible to implement.	Feasible to implement.	Feasible to implement.	Feasible to implement above water table and where infrastructure allows.	Feasible to implement.	Feasible to implement.	Feasible to implement.
Administrative feasibility	Feasible to implement. ARARs waiver required.	Feasible to implement. ARARs waiver required.	Feasible to implement. ARARs waiver required.	Feasible to implement. ARARs waiver required.	Feasible to implement. ARARs waiver required.	Feasible to implement. Long-term presence required. ARARs waiver required.	Feasible to implement. ARARs waiver required.
Availability of services and materials	Feasible to implement.	Services and materials are readily available.	Availability of vendors and equipment is limited.	Services and materials are readily available.	Availability of vendors is limited.	Services and materials are readily available.	Availability of vendors is limited.
Unit Cost (Per acre-foot and in dollars)							
Total cost: escalated	$0	$687,648	$694,837	$8,131,025	$2,083,677	$2,318,211	$12,304,300
Total costs: present worth	$0	$554,393	$434,759	$5,930,929	$1,042,276	$1,076,353	$12,218,892
Commonwealth Acceptance							
General	Comments from the Commonwealth of Kentucky will be incorporated into this FS report as appropriate following review of the draft report.						
Community Acceptance							
General	Following a formal public comment period on the PRAP, comments from the community will be addressed in a responsiveness summary, which will be presented in the GWOU ROD documents.						

ARAR = applicable or relevant and appropriate requirement
MCL = maximum contaminant levels
POC = pathway of concern
RAO = remedial action objective
RGA = Regional Gravel Aquifer
TCE = trichloroethene
UCRS = Upper Continental Recharge System
VOC = volatile organic compound
^{99}Tc = technetium-99

Table D.9 Comparative Analysis of Technologies for Dissolved Phase Plumes (taken from DOE 2001)					
Criteria	**Dissolved Phase Areas**				
Description	**Pump and Treat Technology**	**Ozonation Technology**	**Permeable Treatment Zone Technology**	**Oxidation Technology**	**Bioremediation Technology**
Overall Protection of Human Health and the Environment					
Human health protection	Not protective unless combined with additional measures	Not protective unless combined with additional measures	Not protective unless combined with additional measures	Not protective unless combined with additional measures	Not protective unless combined with additional measures
Environmental protection	May remediate discharges from the Northwest Plume into Little Bayou Creek. Long-term presence will be required.	May remediate discharges from the Northwest Plume into Little Bayou Creek. Long-term presence will be required.	May remediate discharges from the Northwest Plume into Little Bayou Creek. Long-term presence will be required.	May remediate discharges from the Northwest Plume into Little Bayou Creek. Long-term presence will be required.	May remediate discharges from the Northwest Plume into Little Bayou Creek. Long-term presence will be required.
Compliance with ARARs					
Chemical-specific	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater.	Long time frame needed to comply with chemical-specific ARARs associated with contaminated groundwater.
Location-specific	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.	Complies with identified location-specific ARARs by incorporation of requirements into design and pre-construction planning.
Action-specific	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.	Compliance with the identified action-specific ARARs will be achieved through incorporation of the requirements in the design and planning phase of implementation.
Other criteria and guidance	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.	Compliance with identified criteria will be achieved.
Long-Term Effectiveness and Permanence					

Table D.9 Comparative Analysis of Technologies for Dissolved Phase Plumes (taken from DOE 2001)					
Criteria	**Dissolved Phase Areas**				
Description	**Pump and Treat Technology**	**Ozonation Technology**	**Permeable Treatment Zone Technology**	**Oxidation Technology**	**Bioremediation Technology**
Magnitude of residual risk	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the source zones.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the source zones.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the source zones.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the source zones.	Residual risks remain high during the first 30 years; will require additional measures to meet MCLs at the source zones.
Adequacy and reliability of controls	Adequate and reliable	Adequate and reliable	Adequate and reliable	Adequate and reliable.	Adequate and reliable
Need for 5-year review	Required	Required	Required	Required	Required
Environmental impacts and mitigative measures	Moderate environmental impacts and mitigative measures	Low environmental impacts and mitigative measures	Low environmental impacts and mitigative measures	Low environmental impacts and mitigative measures	Low environmental impacts and mitigative measures
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment processes used	Pump and treat, ion exchange and air stripper with cat/ox system.	*In situ* ozonation with ion exchange	*In situ* PTZ	*In situ* oxidation	*In situ* bioremediation
Amount destroyed or treated	TCE and VOCs will be treated. ^{99}Tc will be captured.	TCE and VOCs will be treated. ^{99}Tc will be captured.	TCE and VOCs will be treated. ^{99}Tc will be captured and held within the aquifer.	TCE and VOCs will be treated. ^{99}Tc will not be captured.	TCE and VOCs will be treated to a level of approximately 100 μg/L. ^{99}Tc will not be captured.
Degree of reduction of toxicity, mobility, or volume	High reduction in dissolved phase VOC toxicity and volume. High reduction in dissolved phase ^{99}Tc volume.	High reduction in dissolved phase VOC toxicity and volume. High reduction in dissolved phase ^{99}Tc volume.	High reduction in dissolved phase VOC toxicity and volume. High reduction in dissolved phase ^{99}Tc volume.	High reduction in dissolved phase VOC toxicity and volume.	High reduction in dissolved phase VOC toxicity and volume.
Irreversibility of treatment	Reversible	Irreversible	Irreversible.	Irreversible.	Reversible
Type/quantity of residuals remaining after treatment	Treatment residuals include ^{99}Tc contaminated ion-exchange resin and salt from off-gas treatment.	Treatment residuals are ^{99}Tc contaminated ion-exchange resin.	Treatment residuals are ^{99}Tc contaminated iron filings.	None	100 μg/L VOCs. Note: residual VOCs may lead to higher risk than original VOCs due to degradation.
Statutory preference for treatment	Satisfied for VOCs	Satisfied for VOCs	Satisfied for VOCs and ^{99}Tc.	Satisfied for VOCs	Satisfied for VOCs

Table D.9 Comparative Analysis of Technologies for Dissolved Phase Plumes (taken from DOE 2001)					
Criteria	**Dissolved Phase Areas**				
Description	**Pump and Treat Technology**	**Ozonation Technology**	**Permeable Treatment Zone Technology**	**Oxidation Technology**	**Bioremediation Technology**
Short-term Effectiveness					
Community protection	Minimal negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.	Potential negative impacts to the community are anticipated.	No negative impacts to the community are anticipated.
Worker protection	Minimal risks to workers from handling contaminated groundwater. Risks can be minimized through adherence to health/safety protocols.	Minimal risks to workers from handling contaminated groundwater. Risks can be minimized through adherence to health/safety protocols.	Risks to workers from handling contaminated soils. Risks can be minimized through adherence to health/safety protocols.	Minimal risks to workers from handling contaminated groundwater. Potential exposure to oxidant. Risks can be minimized through adherence to health/safety protocols.	Risks to workers from handling contaminated groundwater. Risks can be minimized through adherence to health/safety protocols.
Environmental impacts and mitigative measures	Moderate environmental impact. May eliminate contaminant discharge to Little Bayou Creek. Increase in water discharge to creeks will result.	Moderate environmental impact. May eliminate VOC discharge to Little Bayou Creek.	Moderate environmental impact. May eliminate contaminant discharge to Little Bayou Creek.	Moderate environmental impact. May eliminate VOC discharge to Little Bayou Creek.	Moderate environmental impact. May decrease VOC discharge to Little Bayou Creek.
Time until action is complete	Approximately 7,000 years in source areas. Approximately 100 yrs or less in downgradient areas.	Approximately 7,000 years in source areas. Approximately 100 yrs or less in downgradient areas.	Approximately 7,000 years in source areas. Approximately 100 yrs or less in downgradient areas.	Approximately 7,000 years in source areas. ^{99}Tc levels will not be affected.	Approximately 7,000 years in source areas. ^{99}Tc levels will not be affected.
Implementability					
Technical feasibility	Feasible to implement	Feasible to implement	Feasible to implement	Feasible to implement	Feasible to implement
Administrative feasibility	Feasible to implement. Long-term presence required. ARARs waiver required.	Feasible to implement. Long-term presence required. ARARs waiver required.	Feasible to implement. Long-term presence required. ARARs waiver required.	Feasible to implement. Long-term presence required. ARARs waiver required.	Feasible to implement. Long-term presence required. ARARs waiver required.
Availability of services and materials	Services and materials are readily available.	Services and materials are readily available.	Availability of vendors is limited	Availability of vendors is limited	Services and materials are readily available.

Table D.9 Comparative Analysis of Technologies for Dissolved Phase Plumes (taken from DOE 2001)					
Criteria	**Dissolved Phase Areas**				
Description	**Pump and Treat Technology**	**Ozonation Technology**	**Permeable Treatment Zone Technology**	**Oxidation Technology**	**Bioremediation Technology**
Cost (in thousands of dollars per acre-foot)					
Total cost: escalated	$692,703	$134,477	$180,269	$209,601	$248,424
Total costs: present worth	$361,039	$75,065	$124,285	$157,636	$205,154
Commonwealth Acceptance					
General	Comments from the Commonwealth of Kentucky will be incorporated into this feasibility study report as appropriate following review of the draft report.				
Community Acceptance					
General	Following a formal public comment period on the proposed plan, comments from the community will be addressed in a responsiveness summary, which will be presented in the GWOU ROD documents.				

ARAR = applicable or relevant and appropriate requirement
RAO = remedial action objective
RGA = Regional Gravel Aquifer
TCE = trichloroethene
UCRS = Upper Continental Recharge System
VOC = volatile organic compound
^{99}Tc = technetium-99
Acre-Foot = A volume that is equivalent to the coverage of one acre to a depth of one foot

Table D.10 Estimated Costs and Expected TCE Volume Reduction within 30 years				
Technology	**Estimated Cost per Acre-Foot**	**Estimated Number of Acre-Feet Blocks In Targeted Area**	**Total Cost for Targeted Area**	**Reduction Toxicity, Mobility or Volume TCE (%) in Targeted Area[a]**
Primary Source Zone Technologies (UCRS)				
Vapor Extraction (All UCRS Sources)	$554,393	64.1	$35,536,591	Up to 90
-UCRS Without SWMU 4	$554,393	24.4	$13,527,189	Up to 90
C-400 ONLY	$554,393	7.7	$4,286,122	Up to 90
SWMU 4	$554,393	39.7	$22,033,813	Up to 90
Direct Heating (All UCRS Sources)	$434,759	64.1	$27,868,052	95
-UCRS Without SWMU 4	$434,759	24.4	$10,608,120	95
C-400 ONLY	$434,759	7.7	$3,361,208	95
SWMU 4	$434,759	39.7	$17,279,075	95
Excavation (All UCRS Sources)	$5,930,929	64.1	$380,172,549	100
-UCRS Without SWMU 4	$5,930,929	24.4	$144,714,668	100
C-400 ONLY	$5,930,929	7.7	$45,853,188	100
SWMU 4	$5,930,929	39.7	$235,719,027	100
Secondary Source Zone Technologies (RGA)				
Steam Extraction (C-400 Building RGA)	$1,042,276	14.3	$14,904,547	70-95
Pump-and-Treat (C-400 Building RGA)	$1,076,353	14.3	$15,391,848	38
Direct Heating (C-400 Building RGA)	$434,759	14.3	$6,217,053.7	99
Oxidation (C-400 Building RGA)	$12,218,892	14.3	$174,730,156	60-90
Dissolved Phase Plume Technologies (RGA)				
Pump-and-Treat Inside DOE Property Boundary (Plume Core)	$361,039	826	$298,218,214	NP[b,c]
Ozonation Inside DOE Property Boundary (Plume Core)	$75,065	826	$62,003,690	100[b,c]
Ozonation SW Plume Inside DOE Property Boundary (Plume Core)	$75,065	195	$14,637,675.0	100[b,c]
Permeable Treatment Zone Inside DOE Property Boundary (Plume Core)	$124,285	826	$102,659,410	NP[b,c]
Oxidative Inside DOE Property Boundary (Plume Core)	$157,636	826	$130,207,336	60-90[b,c]
Bioremediation Inside DOE Property Boundary (Plume Core)	$205,154	826	$169,457,204	90[b,c]
a- reflects potential percent reduction in contamination level in target area only. Does not reflect reduction in total site contaminant levels				
b- NP, specific value for targeted area is not provided in FS (DOE, 2001). The FS states, "High reduction in dissolved phase VOC toxicity and volume. High reduction in dissolved phase ^{99}Tc volume." Percent reduction of total TCE volume in all areas provided in FS (DOE, 2001)				
c-Target area TCE concentrations will rebound to initial levels unless technology implementation is continued past 30 year O & M period and if TCE concentrations in primary and secondary source areas are not reduced.				

D.6 POTENTIAL RESPONSE ACTIONS

Four potential response actions were considered in the process of determining what property acquisition options might be required in order to ensure "*adequate protection of human health and environment from exposure to contaminated groundwater*" while also ensuring a solution that "*is in the best interest of taxpayers.*" The four actions considered were combinations of one or more of the alternatives presented in the FS. The four potential response action scenarios are summarized in Table D.11.

Table D.11 Potential Response Action Scenarios

Scenario	ID	Description
1	**P&T**	Continuation of existing pump and treat action
2	**C400**	Source reduction of contamination at C-400 building
3	**URD**	Source reduction of UCRS and RGA sources, and treatment of Southwest Plume
4	**URD-PTZ**	Source reduction for all sources, treatment of Southwest Plume, and PTZ at the PGDP security fence.

D.7 COST ESTIMATES OF POTENTIAL RESPONSE ACTIONS

Cost estimates for each of the potential response action scenarios were developed using the associated technology costs as developed in Table D.10 and are summarized in Table D.12. With the exception of the pump and treat scenario, all costs were based on a 30 year time period. The costs associated with the pump and treat scenario were estimated for both 30 and 100 year periods.

In addition to the potential response action costs, the associated site-wide surveillance and maintenance (S&M) costs were also computed for both 30 year and 100 year evaluation periods. A brief description of the basic assumptions in the development of these costs is provided in the following sections.

Table D.12 Range of the Present Value Remedial Action/S&M Costs

		Remedial Costs $M		S&M Costs $M	
Scenario	**Scenario ID**	**30 years**	**100 years**	**30 years**	**100 years**
1	**P&T**	$ 32.0	$ 59.7	$ 36.1	$ 53.1
2	**C400**	$ 9.6	$ 9.6	$ 38.6	$ 67.2
3	**URD**	$ 48.7	$ 48.7	$ 38.4	$ 56.7
4	**URD-PTZ**	$ 151.4	$ 151.4	$ 37.9	$ 45.3

D.7.1 ASSUMPTIONS USED IN DEVELOPING POTENTIAL RESPONSE ACTION COSTS

Several assumptions were made concerning the nature of the costs of the response actions. These assumptions are summarized as follows:

D.7.1.1 Scenario 1 (Continuation of Existing Pump and Treat Operations)

This scenario represents a continuation of the existing pump and treat operations at the site, and thus represents a potential No Further Action response under CERCLA. The annual cost of the existing pump and treat operations is estimated to be $1.3 million. In addition, approximately $77,000 is spent each year for monitoring associated with the pump and treat operations (PRS, 2007). In order to project the present value of this remedial action over a 30 and 100 year period, an inflation rate of 3% was used to reflect the incremental increase of costs over time. Future costs were then discounted to the present using annual interest rate of 5.05%. Long-term site-wide surveillance and maintenance (S&M) costs were assumed to continue over the course of the 100 year evaluation period, adjusted annually assuming a 3% inflation rate. Further, the S&M costs were adjusted on an annual basis to reflect potential changes in these costs due to changes in the size of the contaminated area predicted by computer modeling of the response action (Appendix E). Once developed, these future costs were then discounted to the present using an annual interest rate of 5.05%.

D.7.1.2 Scenario 2 (C-400 Source Action)

This scenario assumes a 99% removal of TCE source volumes from the RGA and a 95% removal of TCE source volumes from the UCRS associated with the C-400 building. The contaminants are assumed to be removed using direct heating technology. Both the RGA and UCRS source actions are assumed to be completed within a 30 year period. However, long-term site-wide surveillance and maintenance (S&M) costs were assumed to continue over the course of the 100 year evaluation period, adjusted annually assuming a 3% inflation rate. Further, the S&M costs were adjusted on an annual basis to reflect potential changes in these costs due to changes in the size of the contaminated area predicted by computer modeling of the response action (Appendix E). Once developed, these future costs were then discounted to the present using an annual interest rate of 5.05%.

D.7.1.3 Scenario 3 (Comprehensive Source Action plus Dissolved Phase Treatment of SW Plume)

This scenario assumes a 99% removal of TCE source volumes from the RGA associated with contamination adjacent to the C-400 building, and a 95% removal of TCE source volumes from the URCS associated with contamination adjacent to the C-400 and C-720 Buildings as well as contamination associated with SWMU1 and SWMU4. Dissolved phase TCE within the restricted area is assumed to be removed from the Southwest Plume using C-Sparge (i.e., ozonation) technology. All removals are assumed to occur within a 30 year period. However, long-term site-wide surveillance and maintenance (S&M) costs are assumed to continue over the course of the 100 year evaluation period, adjusted annually assuming a 3% inflation rate. Further, the S&M costs were adjusted on an annual basis to reflect potential changes in these costs due to changes in the size of the contaminated area predicted by computer modeling of the response action (Appendix E). Once developed, these future costs were then discounted to the present using an annual interest rate of 5.05%.

D.7.1.4 Scenario 4 (Scenario 3 Plus PTZ Along Security Fence Boundary)

This scenario assumes the same course of action as Scenario 3, with the addition of a 14,000 foot PTZ in the RGA located along the northern boundary of the restricted area. As with Scenarios 2 and 3, this scenario is assumed to have been completed within 30 years of installation. However, long-term site-wide surveillance and maintenance (S&M) costs are assumed to continue over the course of the 100 year evaluation period, adjusted annually assuming a 3% inflation rate. Further, the S&M costs were adjusted on an annual basis to reflect potential changes in these costs due to changes in the predicted size of the contaminated area. Once developed, these future costs were then discounted to the present using an annual interest rate of 5.05%.

D.7.2 ASSUMPTIONS USED IN DEVELOPING SURVELLIENCE AND MAINTENANCE COSTS

The current total annual S&M costs are estimated to be approximately $1.6 million dollars (PRS, 2007). Included in this total is approximately $77,000/year for monitoring associated with the existing pump and treat operations, and an additional $26,804/year for monitoring associated with the existing Water Policy. For the purposes of this analysis, the actual annual S&M costs associated with a particular remedial action were assumed to be $1.53 million dollars (i.e. the total minus the costs for P&T monitoring). S&M costs were assumed to change over time depending upon the potential expansion or contraction of the existing groundwater plumes in response to different potential response actions. The S&M costs associated with each potential response action were determined by estimating the total annual plume foot print over both a 30 year and 100 year period. Annual S&M costs were then computed for each year depending on the spatial extent of the plume for that year. Future S&M costs were assumed to increase using a 3% annual inflation rate. The present value of the S&M costs for an associated potential response action was obtain by discounting the future values to the present for both 30 year and 100 year time horizons assuming a discount factor of 5.05%.

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APPENDIX E. TASK 5

ASSESSMENT OF GROUNDWATER CONTAMINATION PLUME EXTENT UNDER DIFFERENT RESPONSE ACTIONS

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ACRONYMS

AOC	area of concern
C400	response scenario at C-400 Building
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
HU	hydrogeologic unit
KWMA	Kentucky Wildlife Management Area
MCL	Maximum Contaminant Level
MODFLOW	U.S. Geological Survey modular three-dimensional finite-difference ground-water-flow model
MODFLOWT	an enhanced version of MODFLOW for simulating three-dimensional advective-dispersive contaminant transport
PGDP	Paducah Gaseous Diffusion Plant
P&T	Pump and Treat Response Scenario
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
SOU	Soils Operable Unit
SWMU	solid waste management unit
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
^{99}Tc	technetium-99
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
URD	UCRS, RGA, and Dissolved source response scenario
URD-PTZ	Response Scenario including UCRS, RGA, Dissolved Source Permeable Treatment Zone
USGS	United States Geological Survey
WKWMA	West Kentucky Wildlife Management Area

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E.1 INTRODUCTION

In order to determine the potentially impacted properties and associated property acquisition options that might be required to ensure that any potential response action is in the "best interest of the taxpayers," a method to predict the potential future spatial and temporal extents of the contaminated groundwater plumes was needed. The most effective way to make this determination was through the use of numerical groundwater-modeling computer programs such as the MODFLOW groundwater flow program and the associated MODFLOWT groundwater transport model.

The MODFLOW and MODFLOWT groundwater models have been developed for and applied to past Paducah Gaseous Diffusion Plant (PGDP) projects, including the Groundwater Operable Unit (GWOU) Feasibility Study (FS) for the PGDP (DOE, 2001). For the current work, the most recent versions of the PGDP MODFLOW and MODFLOWT models were obtained from DOE and validated against results of previous monitoring and modeling studies. Once validated, the models were used to evaluate the potential affect of response actions on the future extent of the contaminated groundwater plumes in order to forecast the temporal and spatial extent of these plumes. Modeled plume extents were then used to identify the property parcels potentially impacted by contaminated groundwater under the response actions.

Four potential remedial response actions were evaluated with the flow and transport models (Table E.1). These actions are discussed in detail in Appendix D. Each response action was modeled for two potential situations: 1) continued operation of the PGDP; and 2) PGDP shut down. The resulting model-run results were evaluated, and the impact of those situations on the spatial extent of the resulting groundwater plumes was identified. The modeled groundwater plumes from the continued operation and shutdown runs that resulted in the largest number of potentially impacted properties were used in the subsequent economic analysis.

Table E.1 Potential Response Action Scenarios

Scenario	ID	Description
1	P&T	Existing pump and treat action
2	C400	Source reduction of contamination at C400 building
3	URD	Source reduction of contamination all sources, with dissolved phase treatment of southwest plume
4	URD-PTZ	Source reduction of contamination all sources, with dissolved phase treatment of southwest plume and PTZ at the PGDP security fence

E.2 MODEL DESCRIPTION

MODFLOW is a numerical finite-difference groundwater flow model developed by the USGS that is capable of simulating saturated flow in three dimensions (McDonald and Harbaugh 1988). MODFLOWT is an enhanced version of MODFLOW capable of modeling the transport of different constituents or contaminants through a groundwater aquifer in three dimensions. Development and application of both MODFLOW and MODFLOWT to the PGDP have been extensively documented in previous DOE publications (DOE 1997; DOE 1999; DOE 2000; DOE 2001).

E.2.1 CONCEPTUAL MODEL

MODFLOW and MODFLOWT require the development of site-specific geologic and hydrogeologic conceptual models and translation of the conceptual models into data sets for entry and computational use. The site-specific conceptual models were developed and constructed to correspond to the general stratigraphic and structural features underlying the PGDP that influence groundwater flow and contaminant transport (Figure E.1).

E.2.1.1 Geology

Mississippian to Pleistocene aged subsurface soil and bedrock underlie the PGDP. The Illinois Basin, the Mississippi Embayment, and ancestral Tennessee River basin are the structural/erosional features that controlled the deposition and distribution of sediments in the shallow subsurface underlying the PGDP (DOE, 1997). Mississippian limestone bedrock occurs at approximately 300’ below ground surface (bgs) at the PGDP and is overlain by Mississippi Embayment sediments of the Cretaceous McNairy Formation (90 – 300’ bgs), Paleocene Porters Creek Clay, Pleistocene sands and gravels of the Lower Continental Deposits (60 – 100’ bgs), Pleistocene sands and silts of the Upper Continental Deposits (20 – 60’ bgs), and loess (0 – 40’ bgs).

E.2.1.2 Hydrogeology

The PGDP industrial facility and its northern environs are located above the Upper and Lower Continental Deposits and the McNairy Formation. The sand and gravel deposits of the ancestral (Pleistocene-age) Tennessee River occur at a depth of 20 to 30 m (60 to 90’) bgs and form the Regional Gravel Aquifer (RGA), which is the shallowest aquifer beneath the PGDP. The RGA is the primary groundwater pathway for contaminant migration at the PGDP.

Immediately beneath the PGDP industrial area, the predominant orientation of RGA sand and gravel deposits is east-west. The orientation of the RGA deposits in combination with leakage from water utilities results in the divergence of groundwater flow under the PGDP. Northeast Plume groundwater flows to the east under the restricted area, leaves the restricted area on the east side, and migrates northward toward the Ohio River. Northwest Plume groundwater flows to the northwest under the restricted area, leaves the restricted area in the area’s northwest corner, and migrates north toward the Ohio River. The Southwest Plume flows to the west in the southwest portion of the restricted area and leaves the restricted area on the west side.

South of the PGDP, the geology is dominated by the Porter’s Creek Clay Formation, which is underlain by the McNairy formation. The northern boundary of the Porter’s Creek Clay is an erosional terrace that lies under the southern extent of the PGDP (Figure E.2), terminates the southern end of the Lower Continental Deposits (RGA), and serves as a natural barrier to groundwater flow to the south (DOE 1997). The Porter’s Creek Clay Formation also effectively serves as a natural barrier to contaminant migration to the south.

In the conceptualization of the groundwater flow system, the lithologic units are grouped into hydrogeologic units (HUs) according to their hydraulic function as aquifers and aquitards. At the PGDP, six major HUs have been identified and are classified as follows (also see Figure E.3):

HU 1 Loess (Surficial deposits)
HU 2 Permeable horizons (sands) within the Upper Continental Deposits
HU 3 Upper Confining Unit within the Upper Continental Deposits (silts & clays)
HU 4 Upward fining sands of the Lower Continental Deposits (RGA)

HU 5 Coarse sands/gravels of the Lower Continental Deposits and fine sands of upper McNairy (RGA)
HU 6 McNairy Formation Flow System

In general, groundwater flows vertically down through the Upper Continental Deposits, also referred to as the Upper Continental Recharge System (UCRS), until it encounters the RGA. Once in the RGA, groundwater moves laterally through the RGA because the hydraulic conductivity of the underlying McNairy formation is much lower than that of the RGA (Table E.2). Hence, the RGA serves as the primary lateral pathway for groundwater flow and contaminant transport beneath the PGDP (Figure E.4). The dominant groundwater flow direction in the McNairy Formation is horizontal towards the Ohio River, although vertically upward gradients have been measured in the vicinity of the river (DOE 2005).

Table E.2 Hydraulic Conductivity Data for the PGDP (DOE, 1999)

HU	Low	Mean	High	Type of test and reference
UCRS (K_h)	**UCRS (K_h)**	**UCRS (K_h)**	**UCRS (K_h)**	**UCRS (K_h)**
(cm/sec) (ft/day)	1.0×10^{-8} 2.9×10^{-5}		6.9×10^{-4} 1.96	Slug tests (CH2M HILL 1992)
HU3 (K_v)	**HU3 (K_v)**	**HU3 (K_v)**	**HU3 (K_v)**	**HU3 (K_v)**
(cm/sec) (ft/day)		2.0×10^{-4} 5.7×10^{-1}		Pumping test at C-404 (Terran 1990)
(cm/sec) (ft/day)	1.1×10^{-5} 3.0×10^{-2}		1.1×10^{-4} 3.0×10^{-1}	Pumping test at C-333 (Terran 1992)
RGA (K_h)	**RGA (K_h)**	**RGA (K_h)**	**RGA (K_h)**	**RGA (K_h)**
(cm/sec) (ft/day)	1.9 -$\times 10^{-2}$ 53		3.8×10^{-2} 107	Pumping test at C-404 (Terran 1990)
(cm/sec) (ft/day)	3.2×10^{-5} 9.1×10^{-2}		5.2×10^{-2} 146	Slug tests (CH2M HILL 1992)
(cm/sec) (ft/day)	3.5×10^{-2} 100		5.3×10^{-2} 150	Pumping test at C-537 (CH2M HILL 1992)
(cm/sec) (ft/day)	3.5×10^{-1} 1,000		4.2×10^{-1} 1,200	Pumping test at C-333 (Terran 1992)
(cm/sec) (ft/day)	1.9×10^{-1} 529		4.3×10^{-1} 1,213	Pumping test at Northeast Plume containment well field (DOE 1997a)
(cm/sec) (ft/day)	9.5×10^{-1} 2,686		2 5,700	Pumping test at Northwest Plume north containment well field (LMES 1996a)
McNairy (K_h)	**McNairy (K_h)**	**McNairy (K_h)**	**McNairy (K_h)**	**McNairy (K_h)**
(cm/sec) (ft/day)		6.2×10^{-6} 1.7×10^{-2}		Analysis of cyclic water level trends in McNairy wells (LMES 1996b)
(cm/sec) (ft/day)	2.9×10^{-5} 8.2×10^{-2}		1.8×10^{-4} 5.2×10^{-1}	Slug tests (CH2M HILL 1992)
McNairy (K_v)	**McNairy (K_v)**	**McNairy (K_v)**	**McNairy (K_v)**	**McNairy (K_v)**
(cm/sec) (ft/day)	1.8×10^{-8} 5.1×10^{-5}		5.0×10^{-4} 1	Permeameter tests of C-746-U landfill and Northwest Plume containment well field samples (LMES 1996b)
(cm/sec) (ft/day)		1.6×10^{-7} 4.5×10^{-4}		Analysis of cyclic water level trends in McNairy wells (LMES 1996b)

HU = hydrogeologic unit
PGDP = Paducah Gaseous Diffusion Plant
RGA = Regional Gravel Aquifer
UCRS = Upper Continental Recharge System

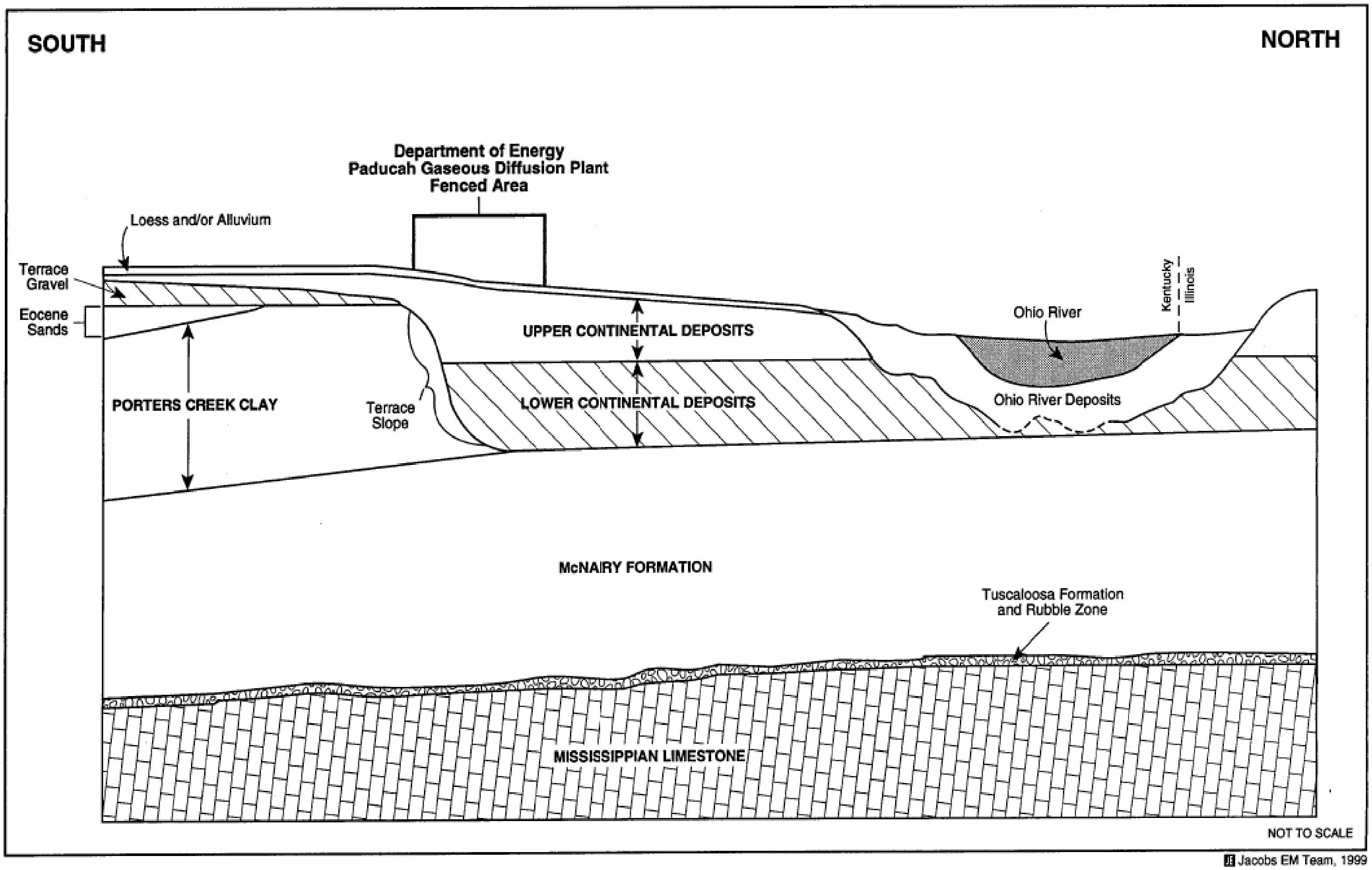

Figure E.1 Conceptual Stratigraphic and Structural Relationships Near the PGDP (DOE 2005)

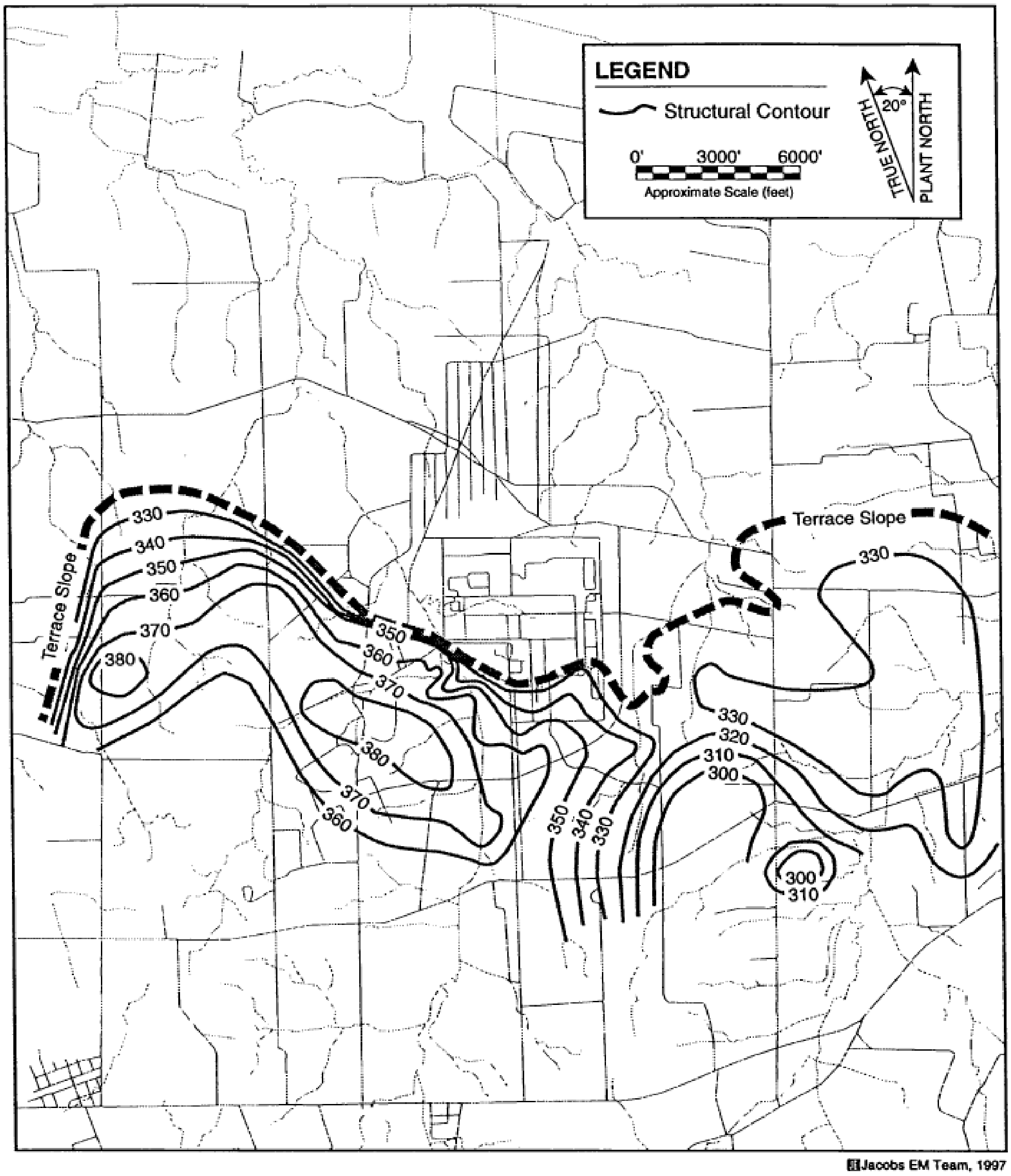

Figure E.2 Top of the Porters Creek Clay in the Terrace Deposits Area (DOE 1997)

E.2.2 MODFLOW and MODFLOWT CONFIGURATION

The PGDP groundwater flow and transport models encompass nearly 100 km^2 (38.60 mi^2) and simulate groundwater flow and contaminant transport on a regional scale. The model domain extends well beyond the PGDP property encompassing approximately 7.82 km (4.86 miles) between east to west boundaries and 11.00 km (6.86 miles) between the north and south boundaries. The boundaries of the regional model coincide with natural boundaries, where possible, and minimize the influence of model boundaries on simulation results.

The vertical extents of the PGDP groundwater flow and transport models have been divided into four layers that correspond to the geology and HUs that occur at the PGDP (Table E.3).

Table E.3. PGDP MODFLOW Model Layers

Model Layer	Equivalent Geology/Lithology	Hydrogeologic Unit	Model Layer Name
Layer 1	Gravels of Upper Continental Deposits	HU1 & HU2	UCRS1
Layer 2	Silts and sands of Upper Continental Deposits	HU3	UCRS2
Layer 3	Lower Continental Deposits; Uppermost McNairy fine sands	HU4, HU5	RGA
Layer 4	McNairy Formation	HU6	McNairy

The PGDP groundwater flow system is modeled as a series of three-dimensional cubes or cells that cumulatively represent the areal extent of each of the modeled layers. The finite-difference grid consists of 190 columns, 167 rows, and four layers for a total of 31,730 grid cells and 126,920 grid nodes. The model grid uses a uniform 15.25 m (50 ft) areal grid spacing in the vicinity of the restricted area to provide increased computational detail in that area and grades to larger grid spacing at greater distances from the restricted area (DOE 1999).

A schematic showing the spatial extent of the computational cells used to model the groundwater aquifer is provided in Figure E.5. MODFLOW and MODFLOWT solve a series of groundwater and water quality conservation of mass and momentum differential equations for each cell in order to predict the associated groundwater levels, groundwater flow rates, and constituent concentrations over time.

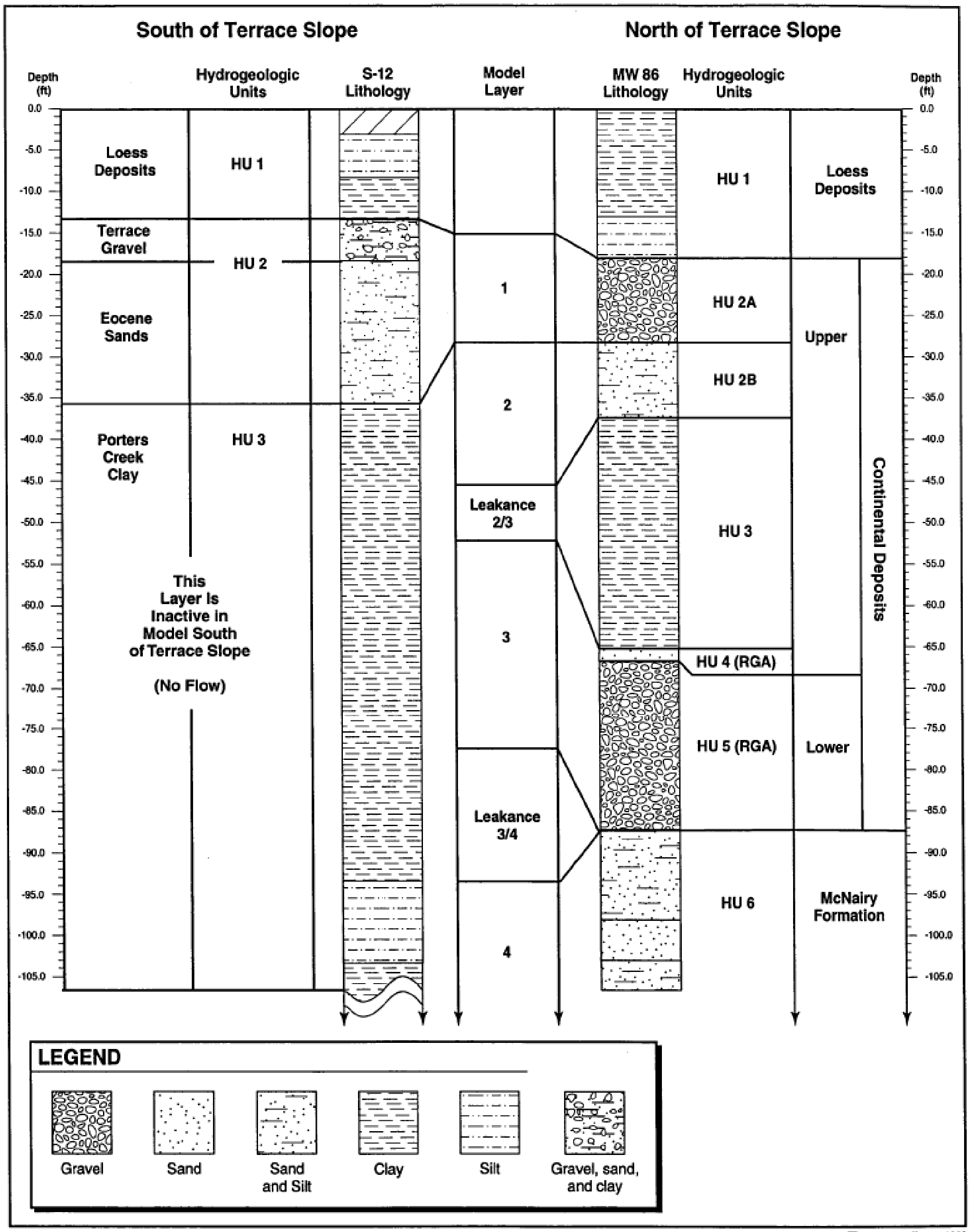

Figure E.3 General Stratigraphic Column and Vertical Discretization of Model at the Paducah Gaseous Diffusion Plant (DOE 1999)

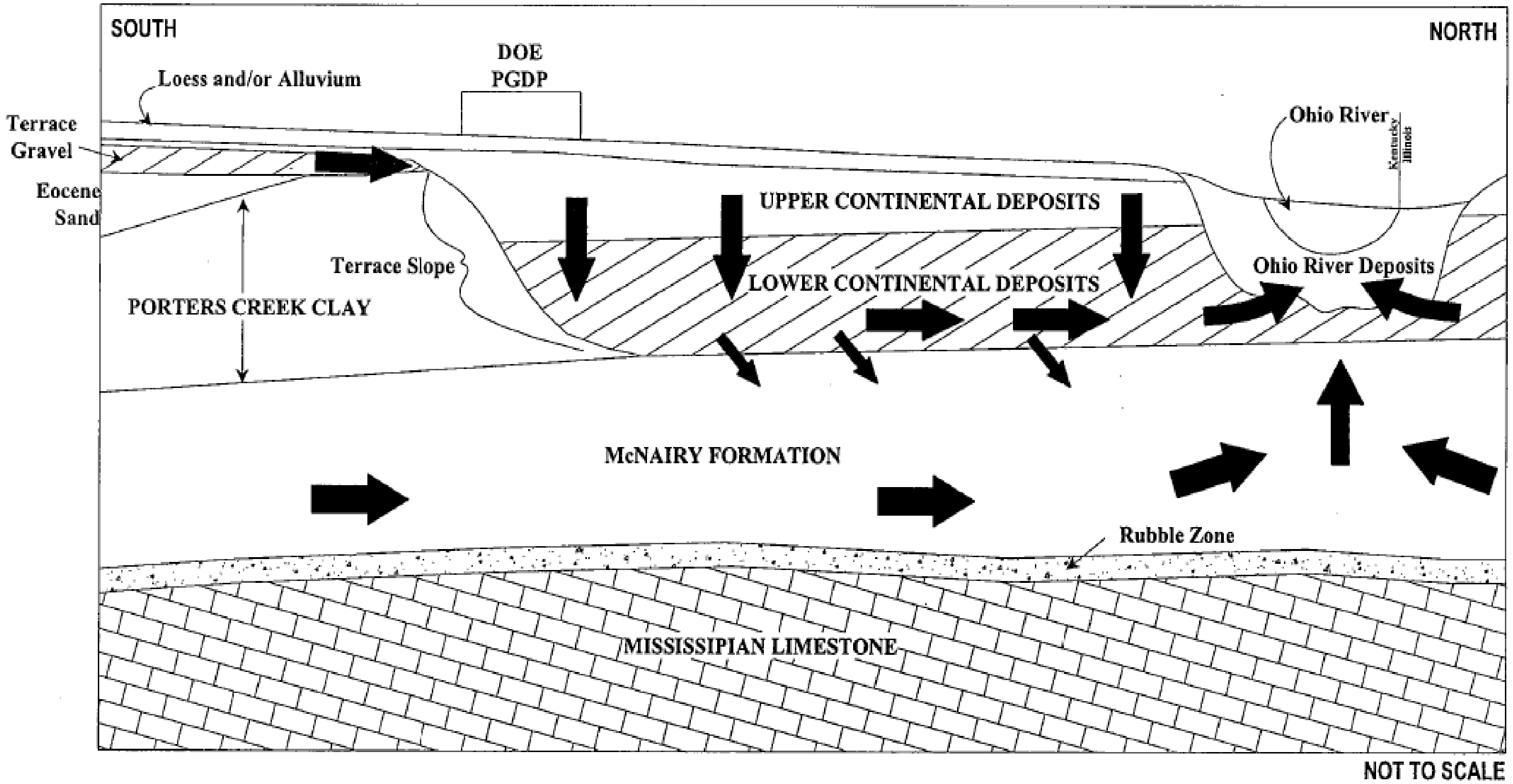

Figure E.4 Schematic of Groundwater Flow Relationships Near the PGDP (DOE 2005)

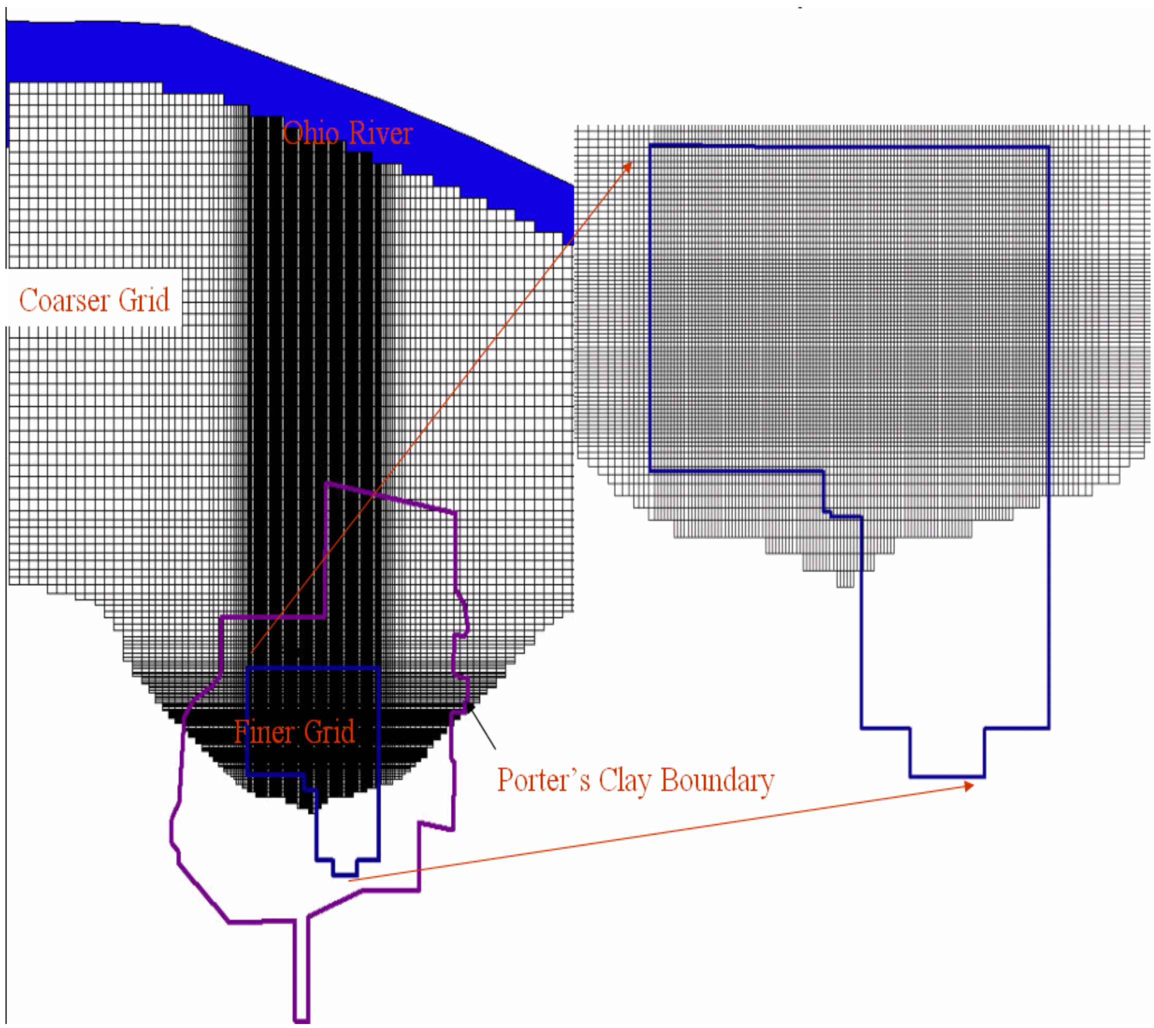

Figure E.5 Computational Cells Used in the MODFOWT Model of the PGDP

E.2.3 TCE SOURCE CHARACTERIZATION AND MODELING

Previous DOE investigations identified at least five major sources of TCE in the UCRS and a significant secondary source of TCE in the RGA that is associated with the C-400 building. Volumetric estimates of contaminant concentrations used in the model were developed from point concentration data collected during various field studies and contained in associated reports (e.g. DOE 2001). A summary of known and suspected TCE source zones at the PGDP is provided in Table E.4. The source, secondary source, and dissolved phase plume concentrations were used in the past to establish the initial source concentration conditions for the MODFLOWT model (DOE 2001) and are used as such in the current model.

Recently, the Southwest Plume Investigation (DOE 2006) identified two additional sources in the UCRS associated with Solid Waste Management Unit (SWMU) 1 and SWMU 4. According to the report, *"Several soil samples collected from a previous investigation below the waste pit have TCE levels in excess of 10 mg/kg and associated UCRS groundwater samples commonly have TCE levels greater than 10,000 μg/L. TCE concentrations in the UCRS associated with SWMU 1 were estimated to be 1,230 μg/L. In addition, TCE levels in groundwater samples indicated the presence of a secondary source of TCE Dissolved Non Aqueous Phase Liquid (DNAPL) in the RGA. The TCE DNAPL mass estimated to be at SWMU 4 is significantly greater than that estimated either for SWMU 1 or the C-720 area. The largest contaminated area as defined by TCE contamination is 77,500 ft^2 (1.8 acres) of the total SWMU 4 area of 265,716 ft^2 (6.1 acres)."* This source area extends through the UCRS to a depth of 55' bgs which approximates the top of the RGA (DOE 2001). In the current study, two additional source areas were added to the model to reflect the findings of the recent Southwest Plume Investigation.

In the current model, the seven sources of TCE in the UCRS were modeled as constant point sources. The large secondary source of TCE in the RGA was modeled by assigning a group of cells an initial concentration based upon observed field conditions which is consistent with previous MODLFOWT applications (DOE 2001). The initial TCE concentrations within the PGDP facility that were applied in MODFLOWT at the beginning of the current simulation are shown in Figure E.6. The seven locations of the assumed primary sources in the UCRS are also shown. Derived and/or assumed concentrations for each of the primary sources in the UCRS are provided in Table E.4 (DOE 2001; DOE 2006).

Recent DOE investigations have identified a significant secondary source in the RGA associated with the C-400 building. This source was modeled by assigning initial concentrations to 18 different cells in the RGA as consistent with the values used in the original MODFLOWT baseline model. A map of the location of the cells and the initial concentrations used in each cell is provided in Figure E.7.

Table E.4 Representative Known and Suspected TCE Source Zones at the PGDP (DOE 1999)

Free Product Zone		Source Zone Volume (meters^3)	Free Product Volume (liters)	Setting	Operable Unit Assignment for Source Zone
Northwest Plume					
UCRS	C-400 (Southeast) TCE Transfer Pump	5,228	107,259	Heavy industrial setting	GWOU
	C-400 (Southeast) Leak Site (SWMU 11)				
	C-400 South End Storm Sewer	4,164	85,427	Heavy industrial setting	GWOU
	C-747-A Burial Ground (SWMU 7)	28,037	Unknown, may be small	Zone below mixed-waste burial cell	BGOU
	C-745-B Cylinder Drop Test Area (SWMU 91)	5,947	1,635	Remediation technology selected (Lasagna™)	GWOU
RGA	C-400 (Southeast) TCE Transfer Pump	16,911	547,822	Heavy industrial setting	GWOU
	C-400 (Southeast) Leak Site (SWMU 11)	623	20,189	Heavy industrial setting	GWOU
	C-400 South End Storm Sewer	139	4,500	Heavy industrial setting	GWOU
Southwest Plume					
UCRS	Southeast C-720 Building Storm Sewer	368	6,624	Heavy industrial setting	GWOU
	Northeast Corner of C-720 Building	9	189	Moderate industrial setting	GWOU
	C-747-C Former Oil Landfarm (SWMU 1)	9	189	Grassed field	GWOU
	C-749 Uranium Burial Ground (SWMU 2)	27,187	<1,703	Zone below pyrophoric uranium burial ground	BGOU
	C-404 Low-Level Waste Burial Ground (SWMU 3)	73,825	Unknown, may be small	Zone below RCRA-closed mixed-waste burial ground	BGOU
	C-747-C Contaminated Burial Yard (SWMU 4)	Small	>4,000	Grassed field	BGOU
	TCE Spill Site (SWMU 136)	46	<189	Roofed drum storage pad	No Assignment
Northeast Plume					
UCRS	C-403 Neutralization Pit (SWMU 40)	146	3,002	Heavy industrial setting	GWOU
RGA	Undefined Source	Small	> 4,000	Near northeast corner of C-333 Building	GWOU
Terrace Deposits					
	Dykes Road Historical Staging Area (AOC 204)	4	<189	Level field bisected by deep drainage ditch	SOU

AOC = area of concern
DNAPL = dense nonaqueous-phase liquid
RCRA = Resource Conservation and Recovery Act
RGA = Regional Gravel Aquifer
SOU = Soils Operable Unit
SWMU = solid waste management unit
TCE = trichloroethene
UCRS = Upper Continental Recharge System

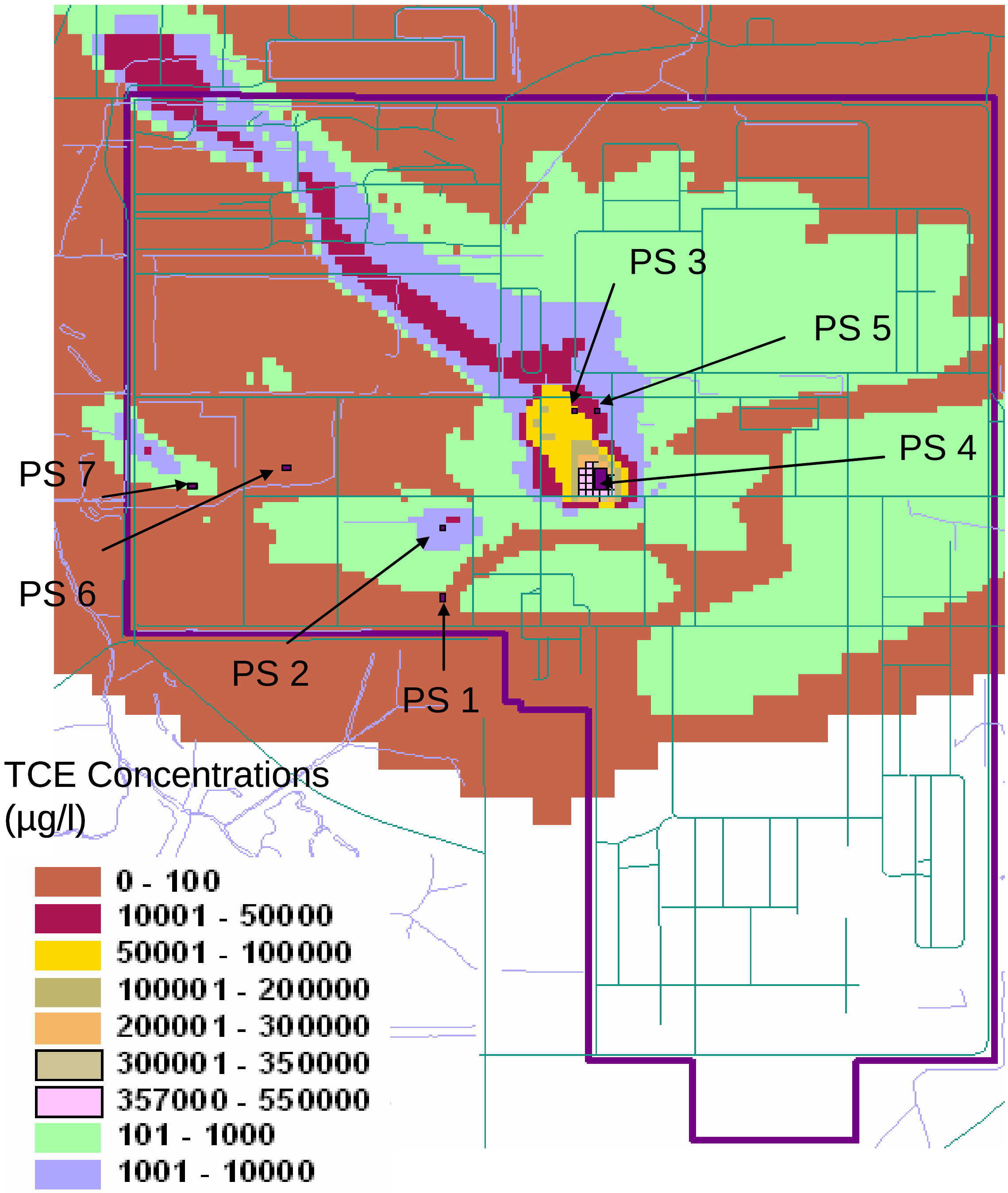

Figure E.6 Spatial Distribution of Initial Concentrations of TCE in the RGA and the Locations of the Six Primary Sources in the UCRS

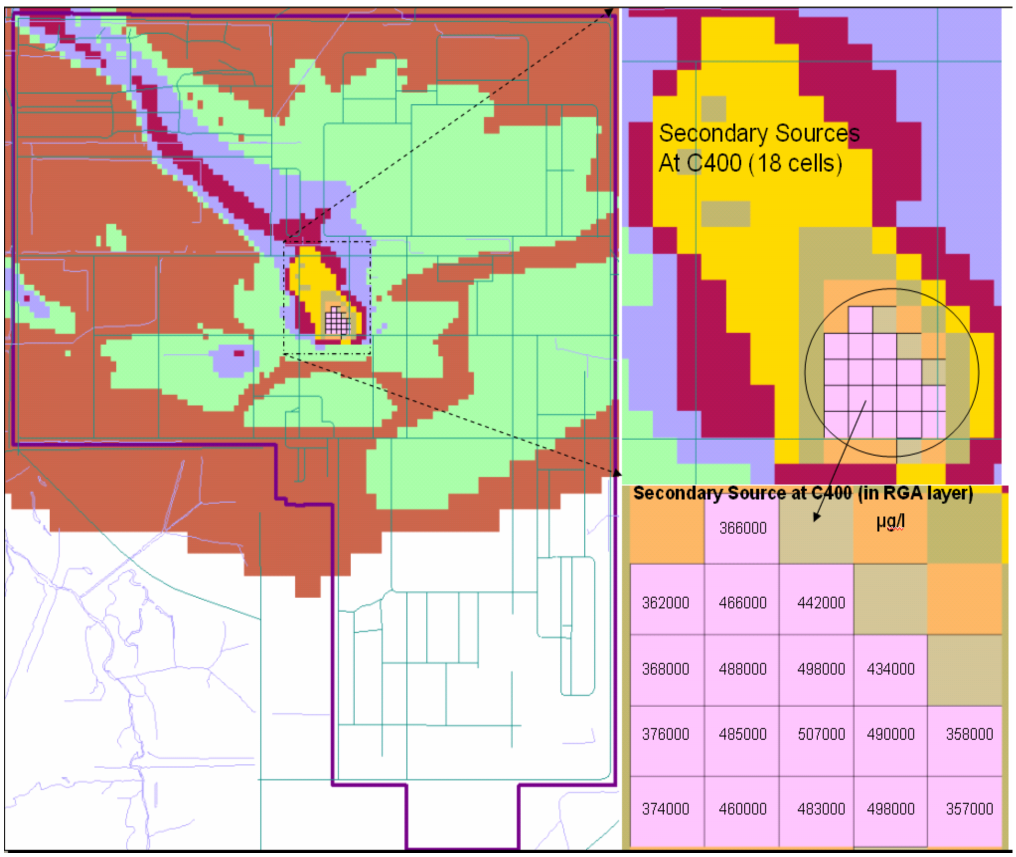

Figure E.7 Cells Representing TCE Sources in the RGA and Initial Concentrations

Table E.5 Concentrations for the Primary Sources in the UCRS			
Sl.No	Plant Location	Model Location (Row, Column)	Constant Source Concentration (μg/l)
TCE Primary Sources			
PS 1	C-720 Building Area Location A	127,80	10000
PS 2	C-720 Building Area Location B	117,80	1230
PS 3	C-400, South West Corner	100,98	100000
PS 4	C-400, South East Corner	109,101 110,101 111,101 109,102 110,102 111,102	700000
PS 5	C-400, North East Corner	100,101	19000
PS 6	SWMU 4	109,59	10000
PS 7	SWMU 1	110,44	1230
Technitium-99 Primary Source			
1	C-400, North West Corner	100,96	43000 (pCi/l)

E.2.4 TECHNETIUM-99 SOURCE CHARACTERIZATION AND MODELING

Past DOE investigations identified the presence of technetium-99 (^{99}Tc) in the northwest corner of the C-400 building. The estimated concentration of ^{99}Tc was 43,000 picoCuries per liter (pCi/L) (DOE 2001). This concentration was used to establish the initial boundary conditions for the baseline MODFLOWT model (DOE 2001) and was, therefore, used in the current model. The ^{99}Tc was modeled as a constant point source in the UCRS layer of the MODFLOWT model. Consistent with previous model applications, additional cells in the RGA were initialized to reflect historical monitoring data and the values used in the baseline version of the MODFLOWT model.

E.3 MODEL VALIDATION

In order to evaluate the impacts of different remediation strategies on the predicted TCE and ^{99}Tc plumes at the PGDP, the original PGDP or "baseline" version of MODFLOW and MODFLOWT models were obtained from the DOE. These models were run and the results were validated by comparison with previously published "baseline" model results. These validations confirmed that the model used in this study was consistent with the baseline model used in previous DOE studies.

E.3.1 BASELINE MODEL UPDATES

Before using the model to evaluate the four potential response action scenarios listed in Table E.1, the baseline model was updated to 1) incorporate new contaminant sources identified in the Southwest Plume investigation (DOE 2006) and 2) to expand the spatial coverage of the model to the east past Metropolis Lake road to accommodate potential migration of the Northeast Plume beyond the original model boundary. The contaminant source modification is discussed in section E.2.2.

Preliminary model evaluations indicated the potential for the Northeast Plume to migrate beyond the boundary of the baseline MODFLOW model domain. As a result, the model domain was expanded to the east in order to provide additional computational cells. The physical parameters used in the new cells were consistent with the values used in the cells of the eastern boundary in the baseline model.

E.3.2 MODEL PARAMETERS

The differential equations solved in MODLOW and MODFLOWT utilize several parameters to characterize the physical characteristics of the groundwater aquifer and the modeled contaminants (TCE and ^{99}Tc). The parameters may be subdivided into those that affect the simulation of flow through the aquifer (hydrologic parameters) and those that affect the migration of a solute through the aquifer (water quality parameters). Relevant hydrologic parameters include: porosity, hydraulic conductivity, leakage rate, and recharge rate. Relevant water quality parameters include: the initial concentrations of the contaminants, bulk density, dispersivity, adsorption (characterized as the distribution coefficient Kd), and degradation. The parameters used in the current study were consistent with those used in previous modeling studies (DOE 1998; DOE 1999; DOE 2000; LMES 1997).

E.4 EXISTING CONDITIONS

Maps of the existing TCE and ^{99}Tc plumes based upon the most recent monitoring results at the site are provided in Figures E.8 and E.9 (DOE 2005).

E.5 MODEL APPLICATION

In order to evaluate the remedial response action scenarios, the current model was used to predict the spatial extent of both the TCE and ^{99}Tc groundwater plumes over a 100 year simulation period. Consistent with previous modeling studies, the model was applied over two incremental simulation periods: 1) a 10 year initialization period used to represent conditions from 1996 to the present, and 2) a 100 year prediction period used to forecast conditions in the future. The results of the simulations are discussed in the following sections.

E.5.1 Technetium-99 MODEL RESULTS

The ^{99}Tc plume was simulated using a no-action scenario under the assumption that the PGDP would continue to operate. The predicted maximum extent of the ^{99}Tc plume above the maximum contaminant level (MCL) of 900 pCi/L after 100 years is provided in Figure E.10. The ^{99}Tc activities above the MCL are predicted to be confined within the DOE property boundary and a small part of the WKWMA. These activities are also confined within the spatial extent of associated TCE plumes. As a result, additional model simulations of the ^{99}Tc plume were not performed.

E.5.2 TCE MODEL RESULTS

TCE was simulated for four different potential remedial response action scenarios (see Appendix D). A summary of the assumptions related to each modeled remedial response action scenario is provided in Table E.6. The spatial extent of the concentration contour for the TCE MCL (5 µg/L) for each remedial response action scenario at 5, 10, 15, 30, 50, and 100 year intervals was determined. The extent of the TCE concentration contour for the TCE MCL for 10, 30, 50 and 100 years for each scenario are shown in Figures E.11 – E14. Once the spatial extents were determined, the associated footprints were overlain the parcel map in order to determine the total number of parcels that would be impacted over time. The results of this analysis are provided in Table E.7.

Table E.6 Summary of Potential Response Action Scenarios

Scenario	ID	Existing Pump & Treat	Assumed TCE Concentration Reduction % RGA C-400	UCRS C-400	UCRS C-720	UCRS SWMU1	UCRS SWMU4	Dissolved Phase SW Plume	PTZ at Security Fence
1	P&T	yes							
2	C400	no	99%	95%					
3	URD	no	99%	95%	95%	95%	95%	yes	
4	URD-PTZ	no	99%	95%	95%	95%	95%	yes	yes

Table E.7 Total Number of Properties Impacted by Potential Response Action Scenario and Year

Year	P&T	C400	URD	URD-PTZ
2007	74	74	74	74
2012	82	89	89	89
2017	88	97	97	96
2022	85	98	98	96
2037	66	82	79	75
3057	12	26	15	0
2107	12	30	10	0

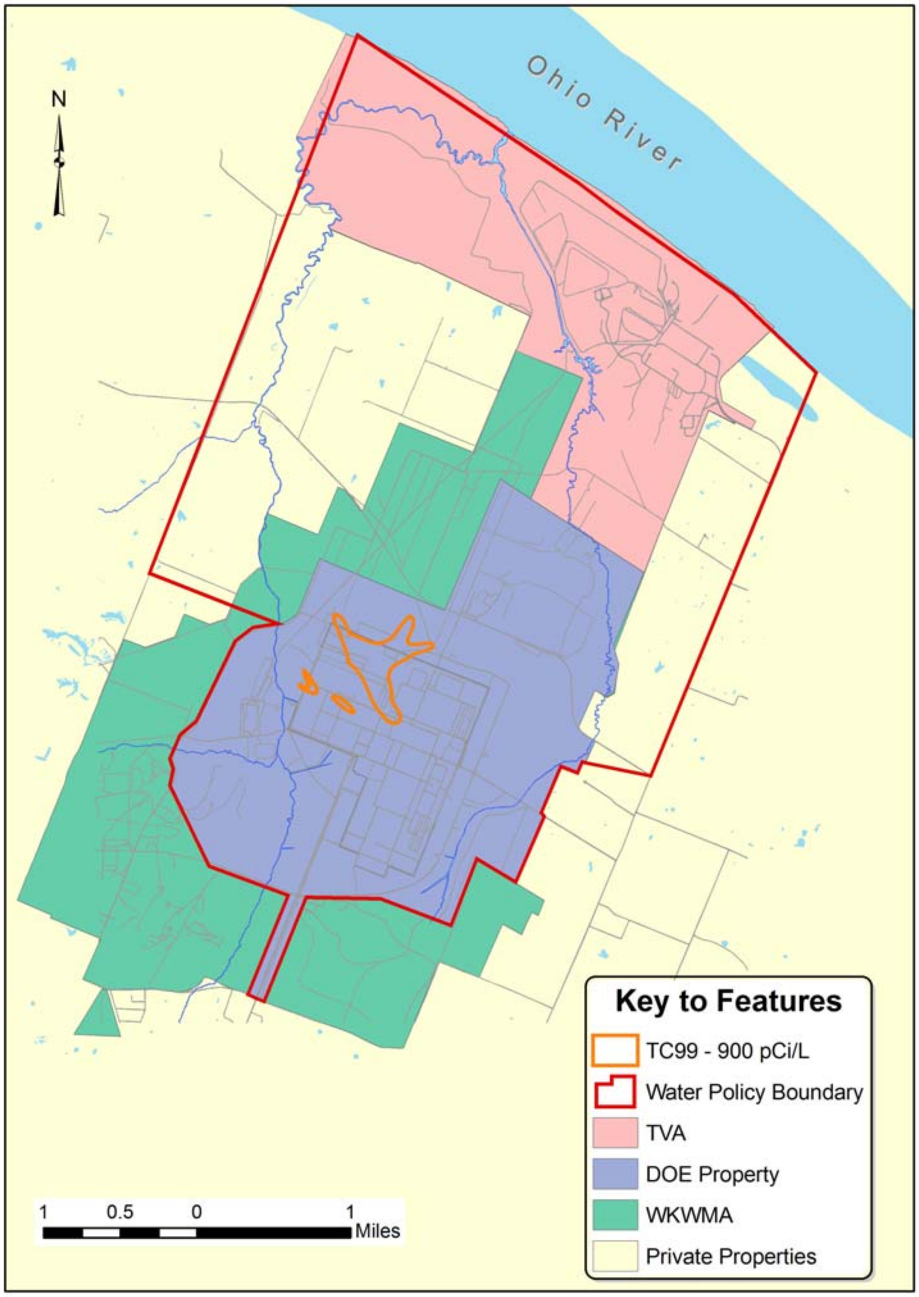

Figure E.8 Current ^{99}Tc Plume Contours North of the PGDP (DOE 2005)

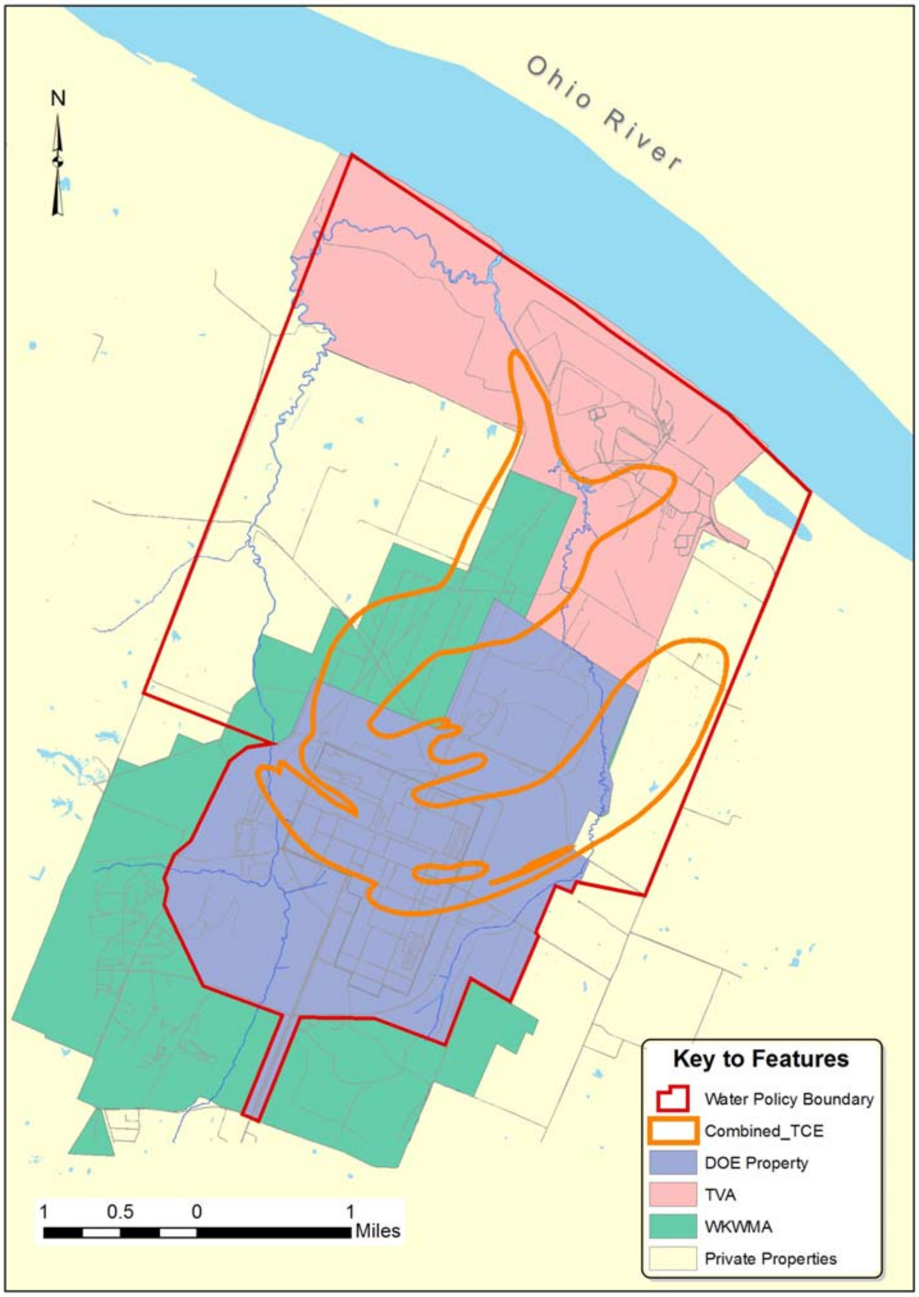

Figure E.9 Current TCE Plume Contours (5 µg/L) North of the PGDP (DOE 2005)

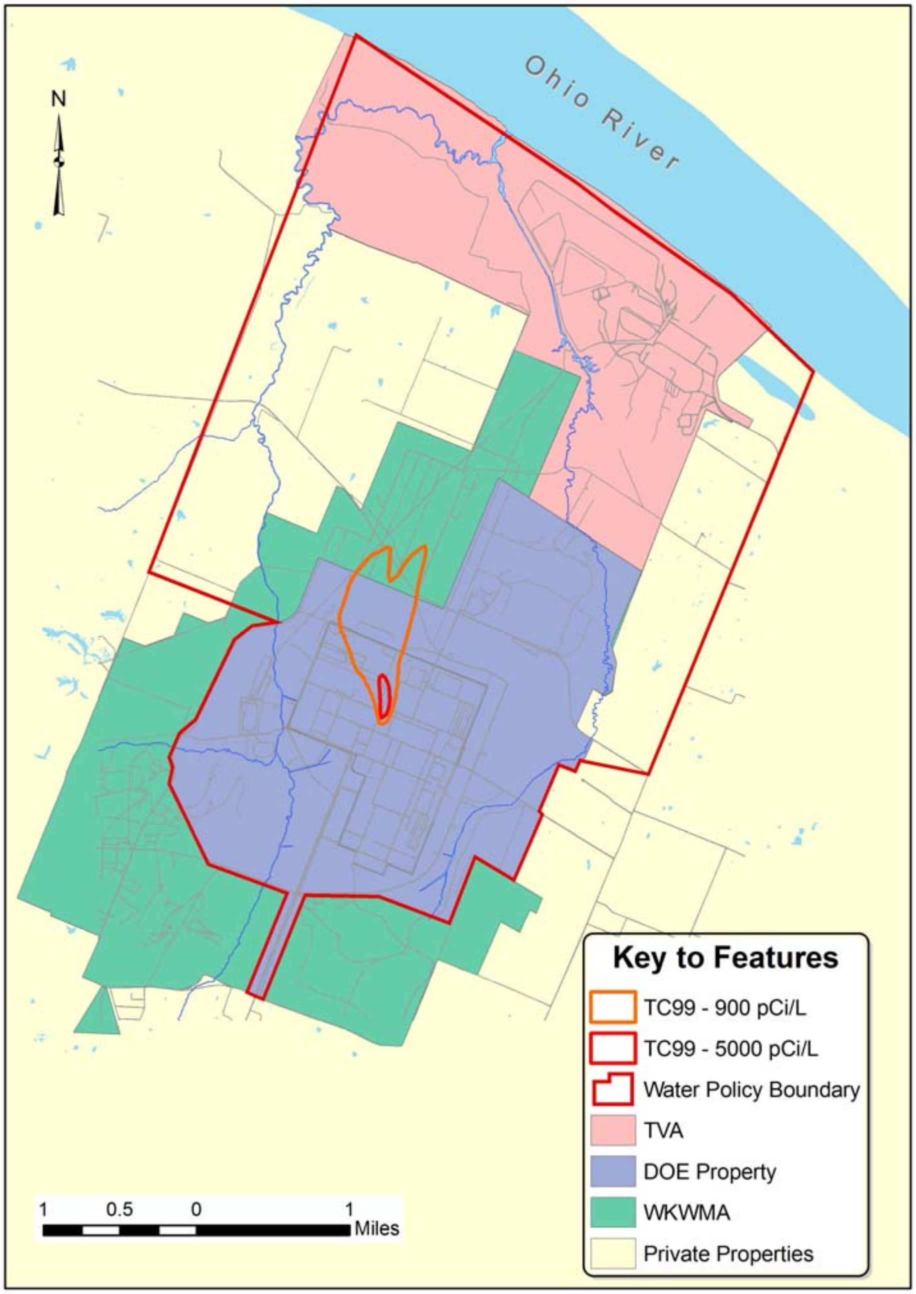

Figure E.10 Predicted ^{99}Tc Plume Contours at the End of 100 year Simulation

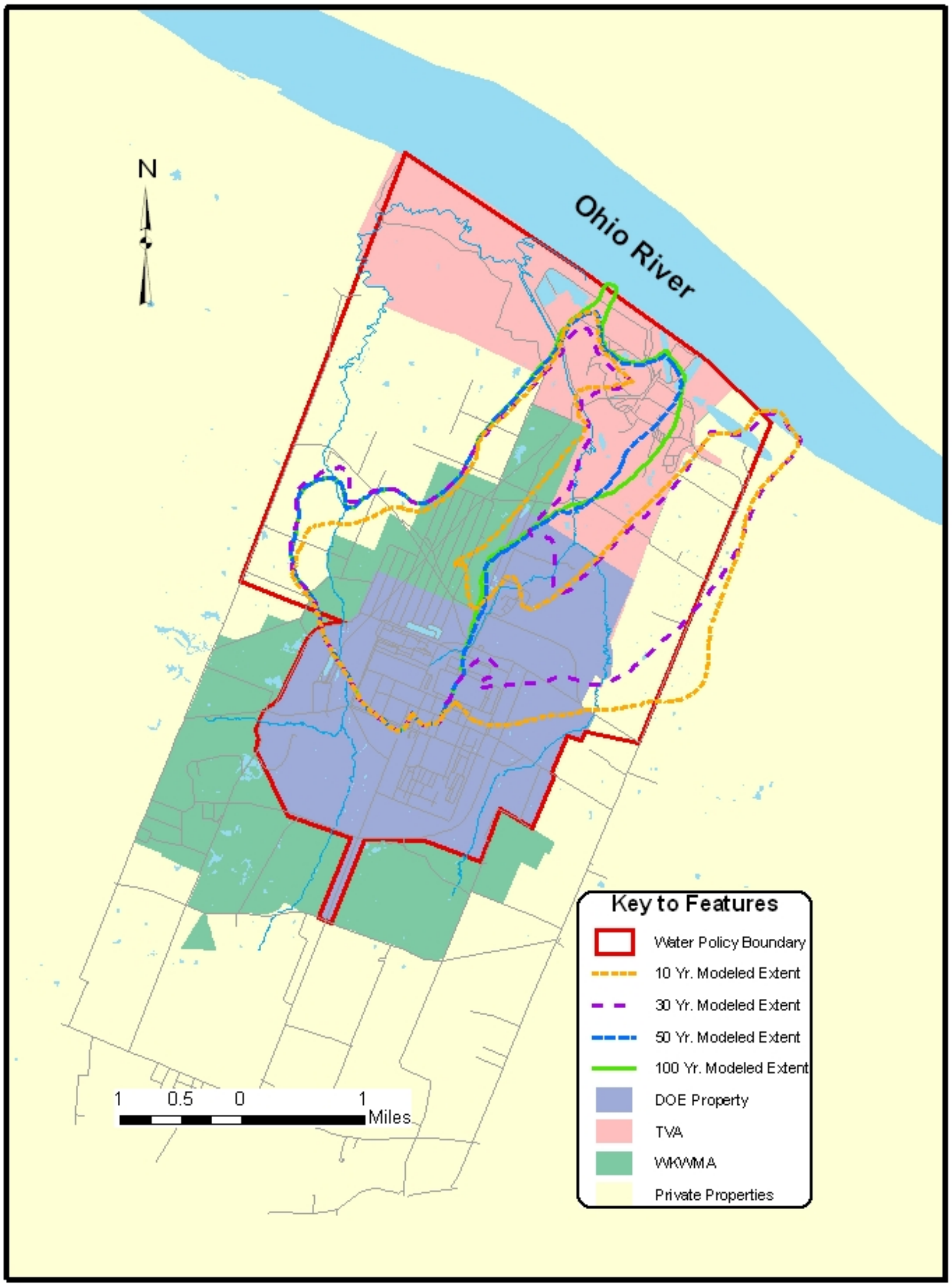

Figure E.11 Predicted TCE Plume Contours (5 µg/L) Over Time under the Existing Pump and Treat Action (assuming plant shutdown) (Scenario 1)

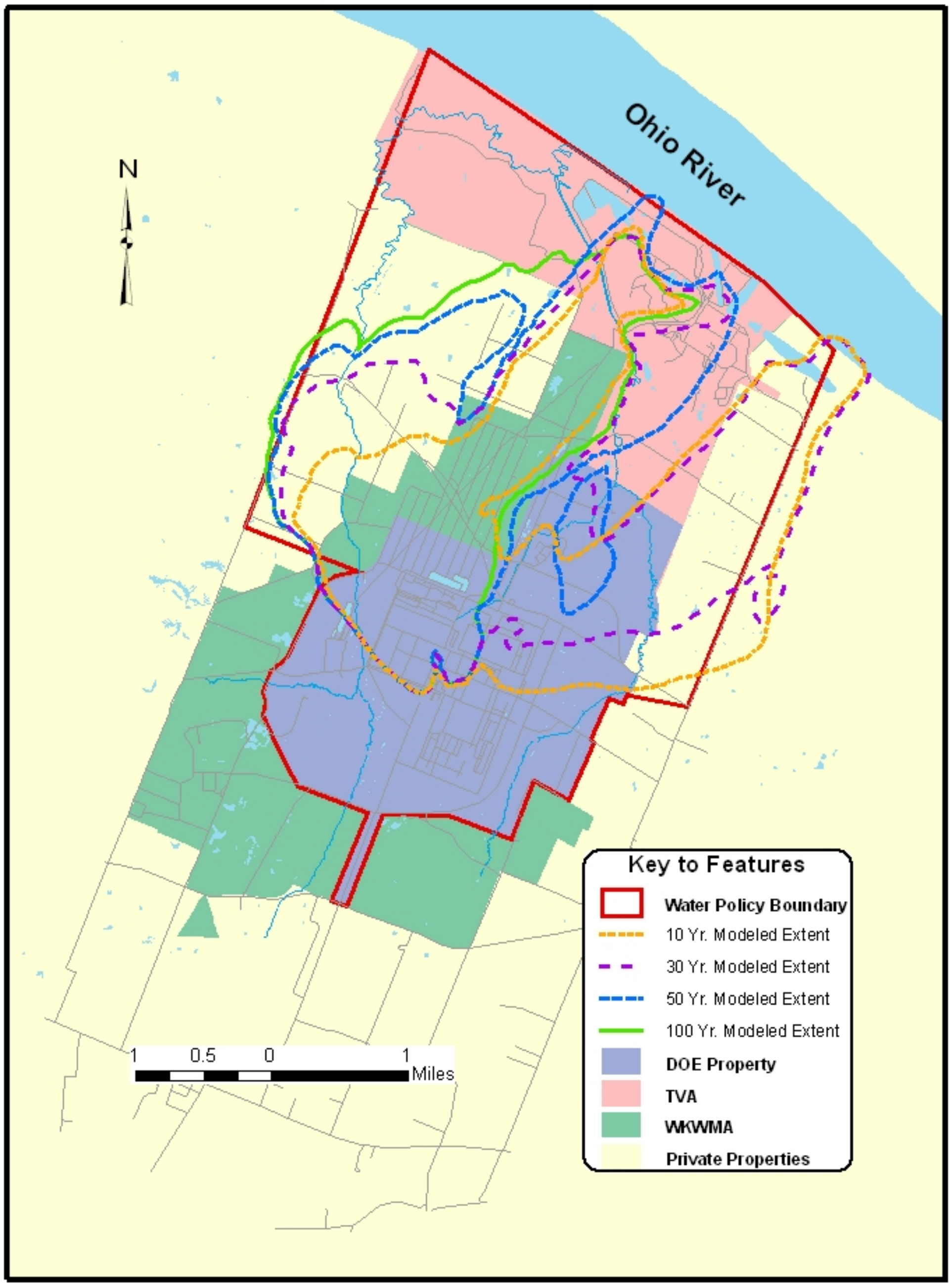

Figure E.12 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reduction at C-400 Building (assuming continued plant operation) (Scenario 2)

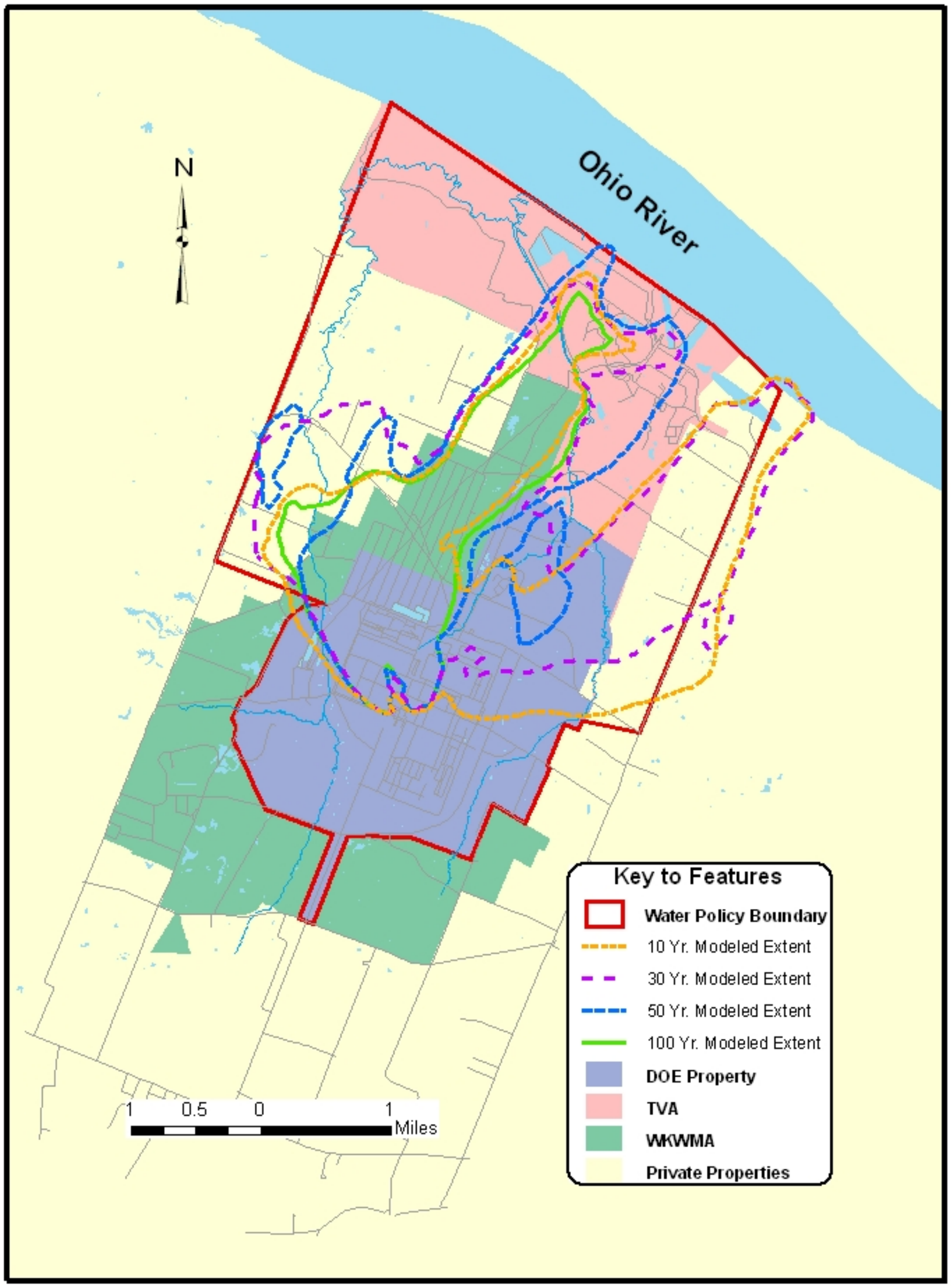

Figure E.13 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reductions at C-400, C-720, SWMU 1 and SWMU 4 (including dissolved phase treatment of Southwest Plume) (Scenario 3)

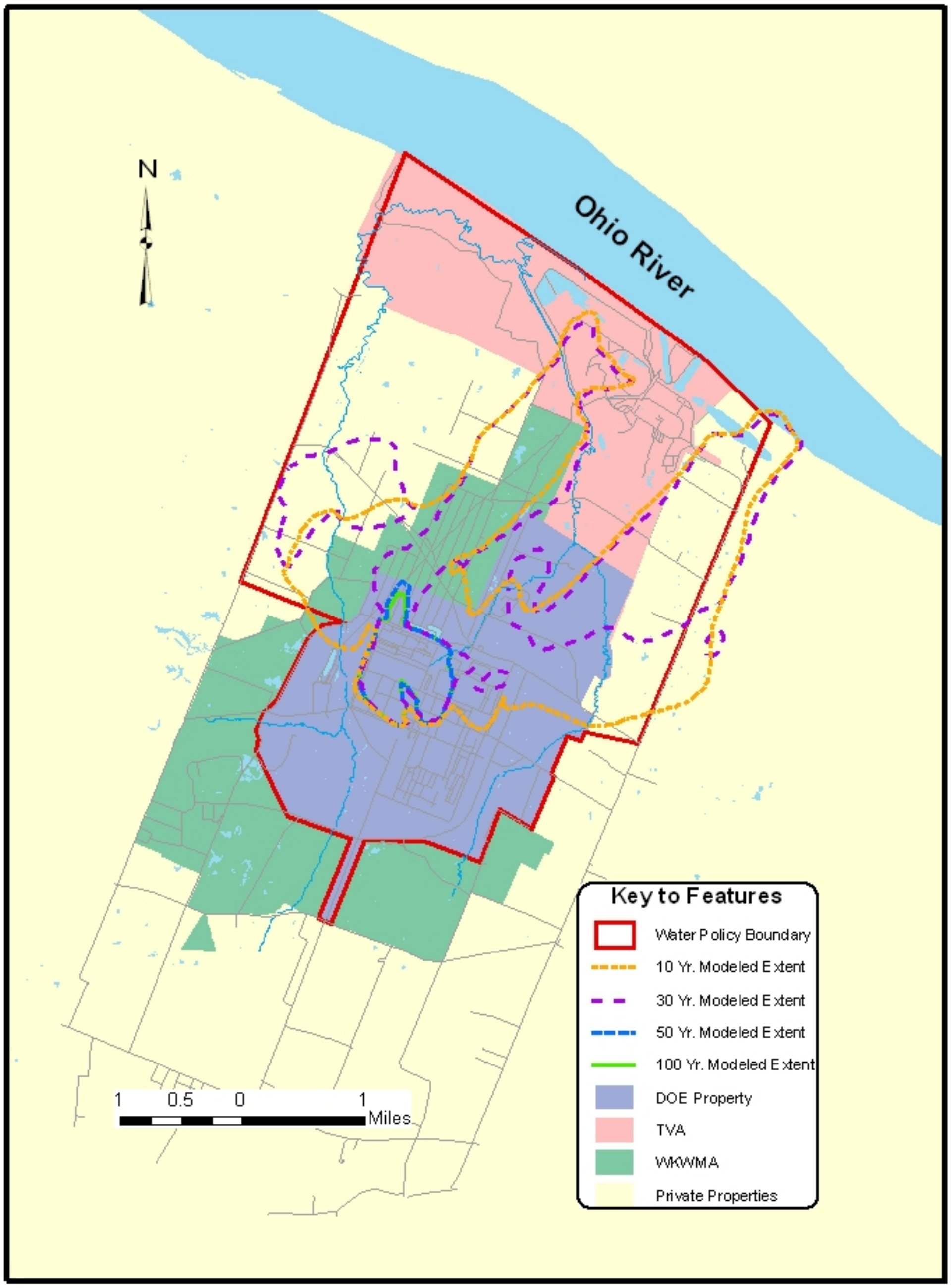

Figure E.14 Predicted TCE Plume Contours (5 µg/L) Over Time Assuming Source Reductions at C-400, C-720, SWMU 1 and SWMU 4 (including dissolved phase treatment of Southwest Plume and PTZ at facility fence) (Scenario 4)

E.6 MODEL UNCERTAINTIES

The PGDP MODFLOW and MODFLOWT models rely upon field and laboratory point data to simulate the physical and chemical conditions that occur in the environment. As such, the baseline PGDP groundwater flow and transport model has been routinely updated with critical field data to reflect, as accurately as possible, the groundwater flow and contaminant transport system at the PGDP. However, there are several model input parameters that, under the present state of knowledge at the PGDP, are uncertain and could change in the future based upon ongoing environmental field projects. Changes in those uncertain parameters could result in significant changes to the results of the baseline models and models utilized for this study. Those uncertain parameters include: 1) Hydraulic boundary conditions associated with the Porter's Creek Clay boundary, 2) Source volumes in the UCRS; 3) Secondary source volumes in the RGA; 4) Biotic and abiotic source degradation rates in UCRS source areas and RGA secondary source areas; and 5) Biotic and abiotic degradation rates for the dissolved phase portion of PGDP TCE plumes. Should data become available for any of these uncertain parameters, the baseline and current model for this study should be reviewed to ensure that prediction of future groundwater conditions and affect of remedial responses remain accurate.

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APPENDIX F. TASK 6

ASSESSMENT OF EXTENT OF PROPERTY ACQUISITION NEEDED

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Table F.1 Predicted Maximum Potential Extent of Property Impacted for Each Response Remediation Scenario (100 year period)...F-13

ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
C-Sparge	Patented oxidation treatment method using ozone bubbles
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U S. Environmental Protection Agency
ERH	Electrical Resistance Heating
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
ISCO	Teledyne Isco, Inc. automatic sampler
KAR	Kentucky Administrative Regulations
KYDOW	Kentucky Division of Water
MCL	maximum contaminant level
NCRP	National Council on Radiation Protection and Measurements
NTP	National Toxicology Program
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PTZ	Permeable Treatment Zone
RGA	Regional Gravel Aquifer
SDWA	Safe Drinking Water Act
SWMU	Solid Waste Management Unit
^{99}Tc	technetium 99
TCE	trichloroethene, trichloroethylene ($ClCH=Cl_2$)
TMDL	total maximum daily load
TVA	Tennessee Valley Authority
WKWMA	West Kentucky Wildlife Management Area

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F.1 INTRODUCTION

The Congressional directive responsible for the initiation of this study states that: "*The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers.*" For this study, the phrase "best interest of the taxpayers" has been interpreted to mean ensuring protection of human health and the environment from exposure to contaminated groundwater in the most cost effective manner possible. The assumed criteria for evaluation of this directive are summarized below.

F.2 ASSESSSMENT OF CONDITIONS TO ENSURE ADEQUATE PROTECTION OF HUMAN HEALTH

Adequate human health protection is defined as those actions that would ensure that human exposure to potential contaminants from groundwater are below the maximum contaminant levels (MCLs) established by the U.S. Environmental Protection Agency (EPA) as part of the Safe Drinking Water Act (SDWA). This study considered the two groundwater contaminants defining the contaminant plumes at the Paducah Gaseous Diffusion Plant (PGDP): 1) trichloroethene (TCE) and 2) technetium-99 (^{99}Tc) and two possible exposure pathways relative to those contaminants in the groundwater: 1) exposure to groundwater pumped to the surface and 2) exposure to groundwater that migrates to the surface through an interaction with Little Bayou Creek. Risks associated with these contaminants can be eliminated or reduced by removal of the contaminants through one or more response actions or by limiting or preventing exposure to contaminated groundwater.

Remediation of contaminated groundwater through a response action can be accomplished using several technologies (see Appendix D) Technologies considered previously in the groundwater operable unit (GWOU) feasibility study (FS) include, for example, 1) Electrical Resistance Heating (ERH), 2) C-Sparge, and 3) Permeable Treatment Zones (PTZ). The costs associated with such technologies are dependent upon several factors, including the area to be treated and time of application. Exposure to contaminated groundwater can be limited or prevented through 1) physical barriers (e,g., fencing), 2) restrictive easements or other restrictive agreements (such as the Water Policy), or 3) the fee simple purchase of parcels that currently or may potentially in the future overly contaminated groundwater.

F.2.1 TCE MCLs

Trichloroethene is a nonflammable, colorless liquid that is used as a solvent to remove grease from metals parts and was used extensively in the past at the PGDP to clean process equipment. Because TCE is essentially insoluble, it can remain in groundwater for a long time. When TCE is exposed in surface waters it quickly vaporizes. TCE has not been found to build up significantly in plants and animals, but in the 9th Report on Carcinogens, the National Toxicology Program (NTP) determined that trichloroethylene is "*reasonably anticipated to be a human carcinogen*." The International Agency for Research on Cancer (IARC) has determined that TCE is "*probably carcinogenic to humans*." (ATSDR 2001)

The SDWA MCL for TCE in drinking water is 5 parts per billion (or 5µg/L). There are several potential sources for TCE at the PGDP (Appendix E). These include the C-400 and C-720 Building areas, SWMU 1, and several burial grounds (i.e. Solid Waste Management Units 2, 3, 4, 7, and 30). These sources have resulted in contaminated groundwater plumes with concentrations above the MCL that have migrated outside the PDGP restricted area and off DOE property.

F.2.2 TECHNETIUM-99 MCLs

Technetium-99 is a silvery gray metal that looks similar to platinum and tarnishes slowly in moist air. Most technetium found on earth is a by-product of fission of uranium-235 in nuclear reactors and has been extracted from nuclear fuel rods. Technetium-99 is a radioactive isotope of technetium with a half-life of 210,000 years (EPA, 2002).

The SDWA MCL for ^{99}Tc is 900 pCi/L (picoCuries per liter). Primary sources for ^{99}Tc are the C-400 building area and SWMU 4 (Appendix E). Inside the PGDP restricted area, concentrations of ^{99}Tc in excess of 16,000 and 5,000 pCi/L have been detected in the Northwest and Southwest Plumes, respectively.

F.2.3 SURFACE WATER PATHWAYS

The PGDP sits between Bayou (locally known as Big Bayou) and Little Bayou Creek drainage areas (Figure F.1). Surface water flow from PGDP's drainage ditches is east-northeast to Little Bayou Creek and west-northwest towards Bayou Creek. Most of the flow within the creeks is from the PGDP's drainage ditches that receive runoff and process water from plant facilities. Surface water contribution from PGDP to Bayou and Little Bayou Creeks account for 85% and 100% of creek flows, respectively. Bayou Creek is a perennial stream that has a 9 mile course to the west-northwest of PGDP. Little Bayou Creek becomes a perennial stream at PGDP with a 4.5 mile course to the east-northeast of PGDP.

According to the 2001 Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment, "*With partial restrictions on access to Little Bayou Creek, permitting discharges to off-site surface water, and remedial activities to remove sources of contamination, future exposures to surface water contaminants should either not occur or be much lower than current exposures.* Therefore, ATSDR scientists did not identify any potential future exposure pathways for surface water. *However, if* new processes *are initiated at the site or* new sources *of contamination are identified, future exposures should be addressed at that time…… the highest concentrations of all surface water contaminants occur at one of two locations: either within the WKWMA property directly adjacent to the southwest landfill or in DOE buffer property at surface and storm water outfalls into Little Bayou Creek. (This includes the North-South Diversion Ditch.) Although exposure is possible in these areas, ongoing monthly ingestion of surface water is unlikely. Also, the 67th percentile concentrations of off-site contaminant levels are much more realistic for calculating potential surface water exposures around PGDP*" (ATSDR 2001).

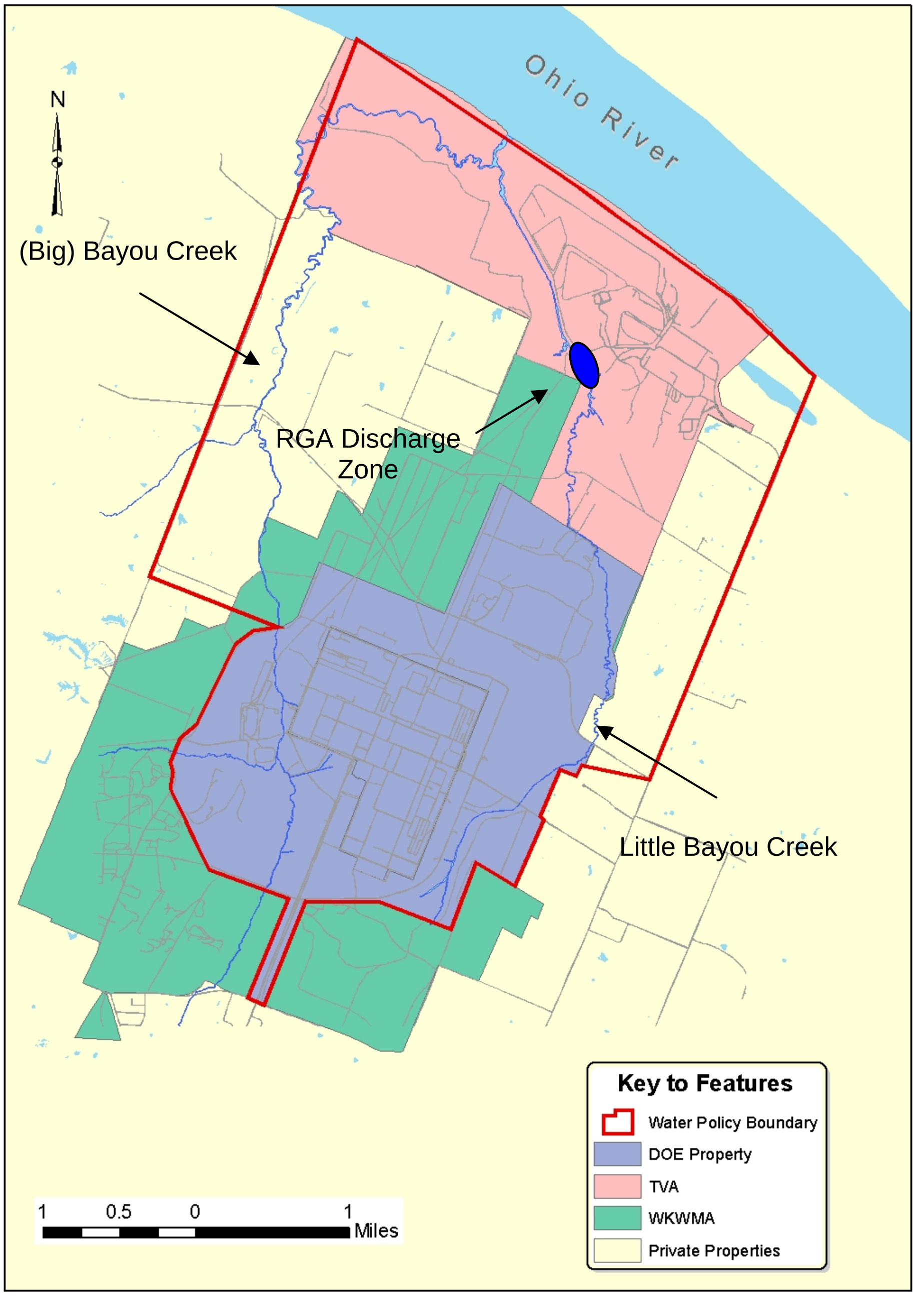


Figure F.1 Location of Little Bayou and Bayou Creeks and the RGA Discharge Zone

Both Little Bayou and Bayou Creeks pass through areas within the Potential Acquisition Zone identified based on the impacts of groundwater (Appendix A). Since properties potentially impacted by contaminated surface water are covered by the Potential Acquisition Zone overlying the contaminated groundwater, a separate assessment of property adjacent to surface water courses is not necessary and was not pursued as part of the current study.

Under certain response scenarios, property along stretches of Bayou Creek may not fall within the Potential Acquisition Zone (see Appendix E). Recent radionuclide data from Bayou Creek (CHFS, 2004) indicate levels less than screening criteria for all radionuclides tested other than for ^{99}Tc, uranium-234 (^{234}U), and uranium-238 (^{238}U). These were found at levels associated with radiation doses which were orders of magnitude less than the negligible individual risk level proposed in NCRP Report 116 (NCRP 1993).

F.2.4 GROUNDWATER PATHWAYS

According to the 2001 ATSDR Public Health Assessment for the Paducah Gaseous Diffusion Plant, *"Currently, off-site residents are not being exposed to groundwater contamination originating from the PGDP site. Former residential wells within the northwest and northeast plumes either are used to monitor contaminant distributions or have been plugged using procedures approved by EPA and the Kentucky Department for Environmental Protection (Clausen et al. 1992a). Although contaminated groundwater from the northwest plume may be discharging into the Ohio River or the portion of Big Bayou Creek directly adjacent to the Ohio River, the concentrations at those locations do not exceed comparison values (Clausen et al. 1992b). Therefore, there are no exposure pathways identified for current exposure to groundwater contaminants from the site.*

For the northeast plume, the primary contaminant of concern is TCE…Although other contaminants (such as Tc-99 and arsenic) have been detected in the northeast plume; they have not migrated off site at concentrations exceeding health comparison values. The northeast plume is migrating to the northeast and is close to the eastern boundary of the Water Policy-affected area (Metropolis Lake Road), shown in Figure F.2. *Although a groundwater extraction and treatment system was established for this plume in August 1997, contaminants at the leading edge may migrate beyond Metropolis Lake Road in the future. If the plume continues to migrate, it may contaminate additional private water wells before it discharges into the Ohio River. DOE is continuing to monitor the movement of the northeast plume. DOE has indicated that they will expand the boundaries of the Water Policy area if ongoing monitoring indicates that additional wells may become contaminated (DOE 1994). If the plume migrates outside the water policy boundary and contaminated wells are capped using approved procedures, no exposure will occur.*

Residents who have been provided with municipal water have agreed not to drill additional wells; however, new residents or new landowners in the area are not restricted from drilling new wells within the area of groundwater contamination. Therefore, there is a potential for future exposure if new wells are drilled into the northeast or northwest contaminant plumes.

The southwest plume was recently characterized. There is no current completed exposure pathway for this plume. Its future migration direction is unknown. The plume may turn north and join with the northwest plume."

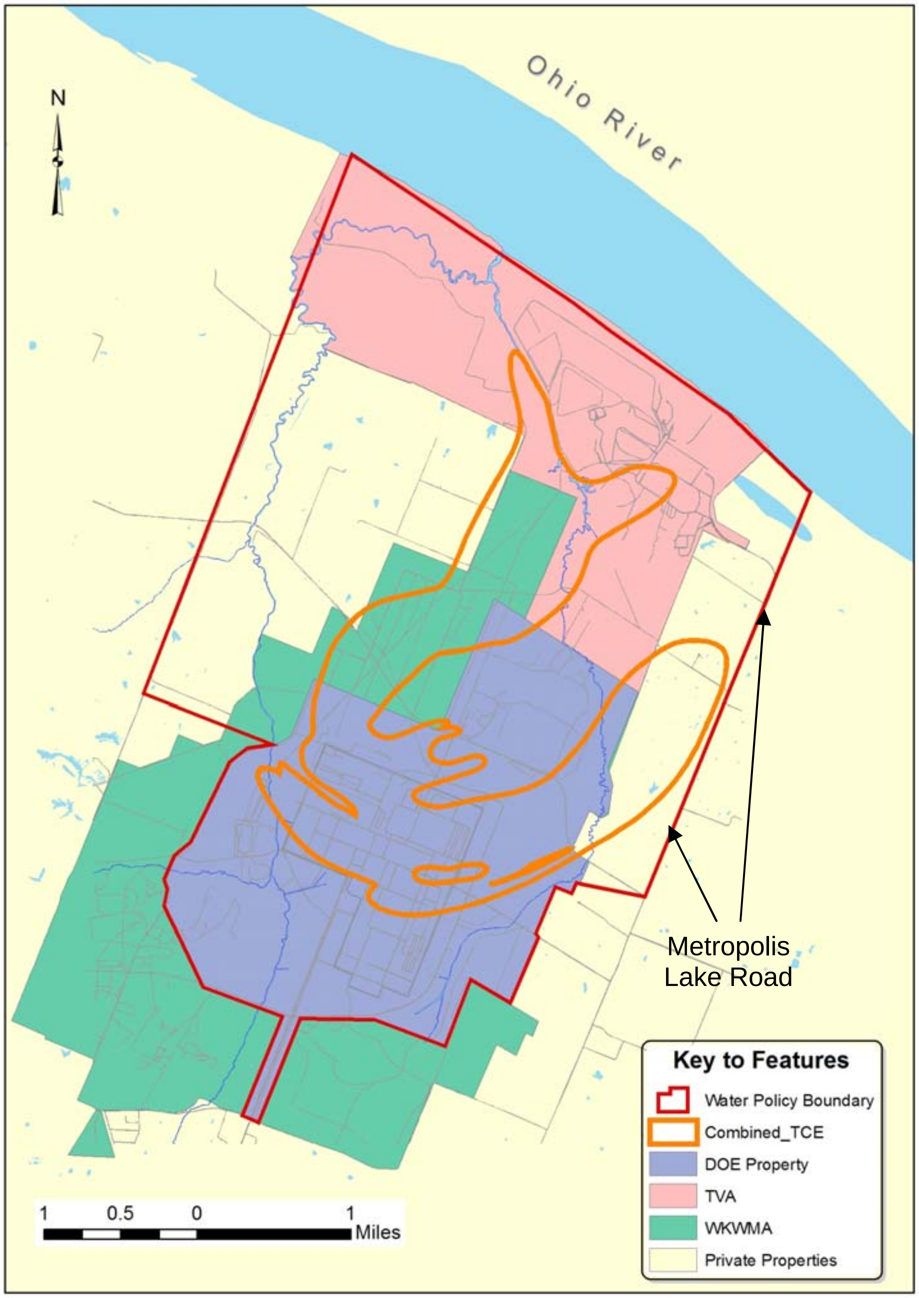


Figure F.2 Existing TCE Groundwater Plume Showing Current Water Policy Area

F.3 ASSESSSMENT OF CONDITIONS TO ENSURE ADEQUATE PROTECTION OF THE ENVIRONMENT

F.3.1 SURFACE WATER CRITERIA

Adequate environmental protection is defined, for the purpose of this study, as those actions that would ensure that the aquatic life in the streams surrounding the PDGP are protected in accordance with the water quality standards associated with their designated use. The Kentucky Division of Water has established general water quality criteria for all listed waters of the Commonwealth as promulgated through Kentucky Administrative Regulations Section 401 KAR 5:031. These criteria establish water quality limits for various constituents in order to maintain the designated uses (i.e. aquatic life, primary and secondary contact, domestic water supply, etc.).

In order to ensure compliance with these standards, the Division conducts annual sampling of various streams as consistent with the Kentucky Watershed Management Framework. As mandated by Section 305(b) of the Clean Water Act, the state must identify and report all streams that do not currently meet their designated uses. For all stream segments that do not meet their designated use, the state is required to develop a total maximum daily load (TMDL) for each constituent in violation of their associate water quality limits.

According to the 2004 305(b) and 303(d) reports, Bayou Creek and Little Bayou Creeks are not currently meeting their designated uses for aquatic life. Constituents of concern include metals, PCBs, and radiation (KYDOW 2004; KYDOW 2005). A TMDL for PCBs for both creeks has already been developed. According to the 303(d) report, "*The impairment created by radiation is more accurately defined as an impairment of the minimum criteria for all surface waters. Therefore, that impaired use has been included in this listing. The original listing for radiation was based on discharge monitoring report (DMR) data. There was no in-stream data available. Since that time, in-stream data has been collected at a few locations and the data indicate that there is not in-stream water-column impairment for radiation*" (KYDOW 2005). A subsequent review of data by faculty at Murray State University determined that all observed in-stream levels of ^{99}Tc were well below the MCL levels (Kemp, et al. 2005).

F.3.2 GROUND WATER CRITERIA

The principal potential impact of the current groundwater contamination on the surface environment would be if contaminated groundwater was pumped to the surface and used for irrigation purposes or other commercial purposes. Such activities could be prevented by restricting the use of contaminated groundwater. There is the potential, however, for contaminated groundwater to migrate to the surface under normal hydrostatic conditions. Groundwater from the RGA currently migrates to the surface and discharges at seeps in the lower reaches of Little Bayou Creek (Figure F.1). Concentrations of TCE associated with such discharges have been observed to be as high as 400 µg/L. However, concentrations are below the TCE MCL of 5 µg/L within a mile downstream of the seeps as TCE volatilizes. Because the seeps are located on TVA property and are not adjacent to private property, the implementation of additional institutional controls external to this area will not influence the associated impact, and, thus, the seeps are not considered further in this study.

F.4 IMPACTS OF REMEDIAL ACTIONS

Four different groundwater response action scenarios were investigated as part of the study (see Appendix E). In order to determine the impact of each response action on the size of the areas that may need to be acquired to limit or eliminate exposure to contaminated groundwater (e.g. through restrictive easement or property purchase), the maximum TCE plume extent (based upon the TCE MCL of 5 µg/L) over a 100 year period was determined, and the footprint of the plume was plotted. This resulted in four different plume extent maps as shown in Figures F.3 through F.6. For each plume footprint, a 1,000 foot buffer zone was placed around the predicted boundaries to account for uncertainties in the groundwater modeling. [For example, modeling simulations indicate that groundwater pumping could pull the contaminated plume up to 1,000 feet beyond the maximum extent of the plume predicted by modeling. Generally, the 1,000 foot buffer is reflective of the anticipated maximum zone of influence of a groundwater well in the aquifer based on historical pumping and zone of influence studies (DOE 1996).] As can be seen from the figures, the southern extent of the buffer has been compressed or collapsed onto the maximum extent boundary, reflecting the presence of a geological barrier (i.e. the Porter's Creek Clay boundary) that prevents the physical movement of groundwater beyond the southern extent of the boundary.

Once the composite plume footprint was determined for each scenario, the parcels that would be totally or partially impacted were determined. The total acreage of agricultural parcels and the total number of residential parcels potentially overlying contaminated groundwater associated with each scenario are shown in Table F.1.

Table F.1 Predicted Maximum Potential Extent of Property Impacted for Each Potential Response Action (100 year period)

Scenario	ID	Agricultural Parcels (acres)	Residential Parcels (number)
1	**P&T**	3531	80
2	**C400**	4370	85
3	**URD**	4102	85
4	**URD-PTZ**	4049	84

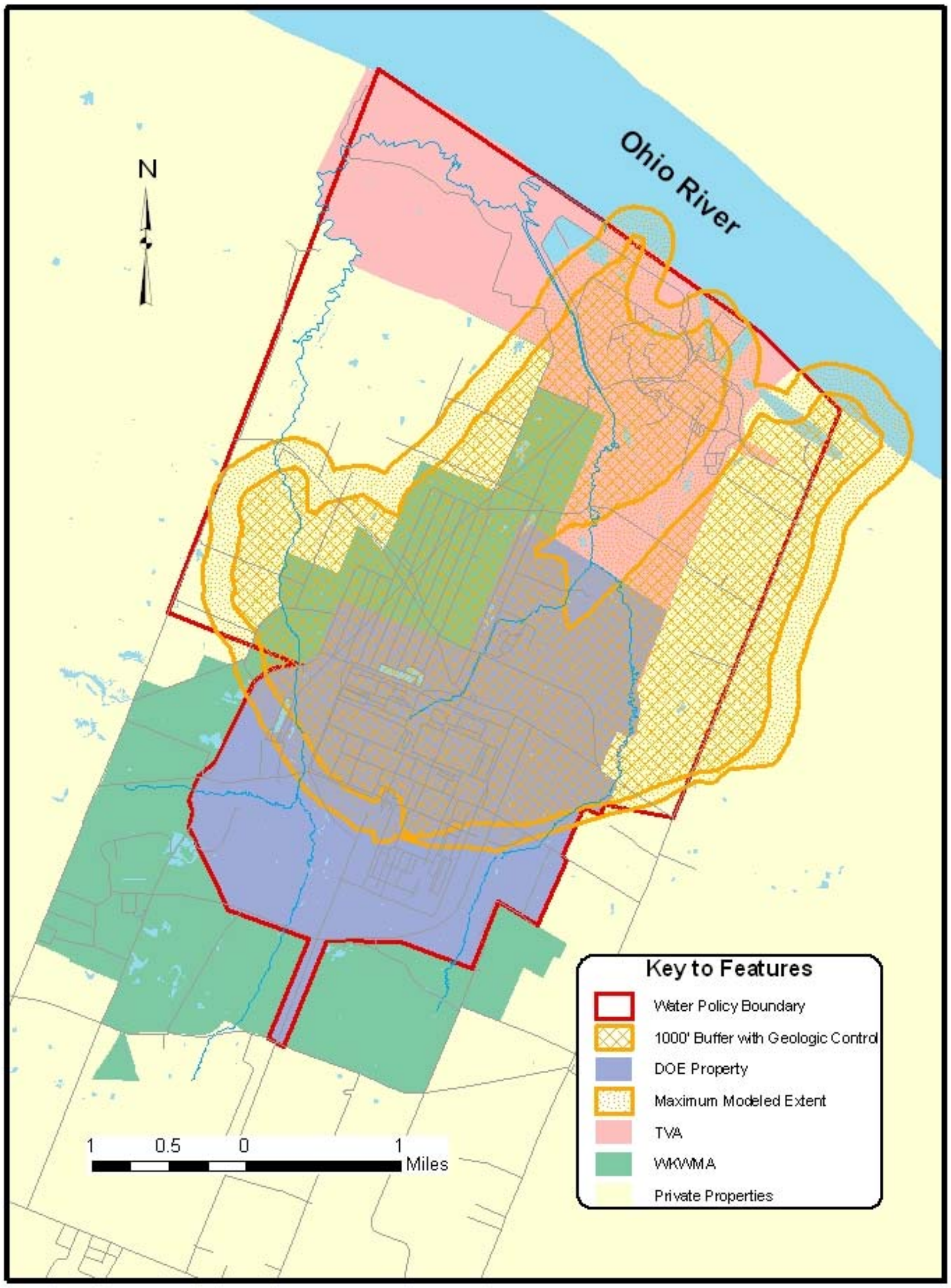


Figure F.3 Predicted Maximum Plume Extent for TCE (5 μg/L) (with 1000 foot buffer) for the Existing Pump and Treat Action (with plant shutdown) (Scenario 1)

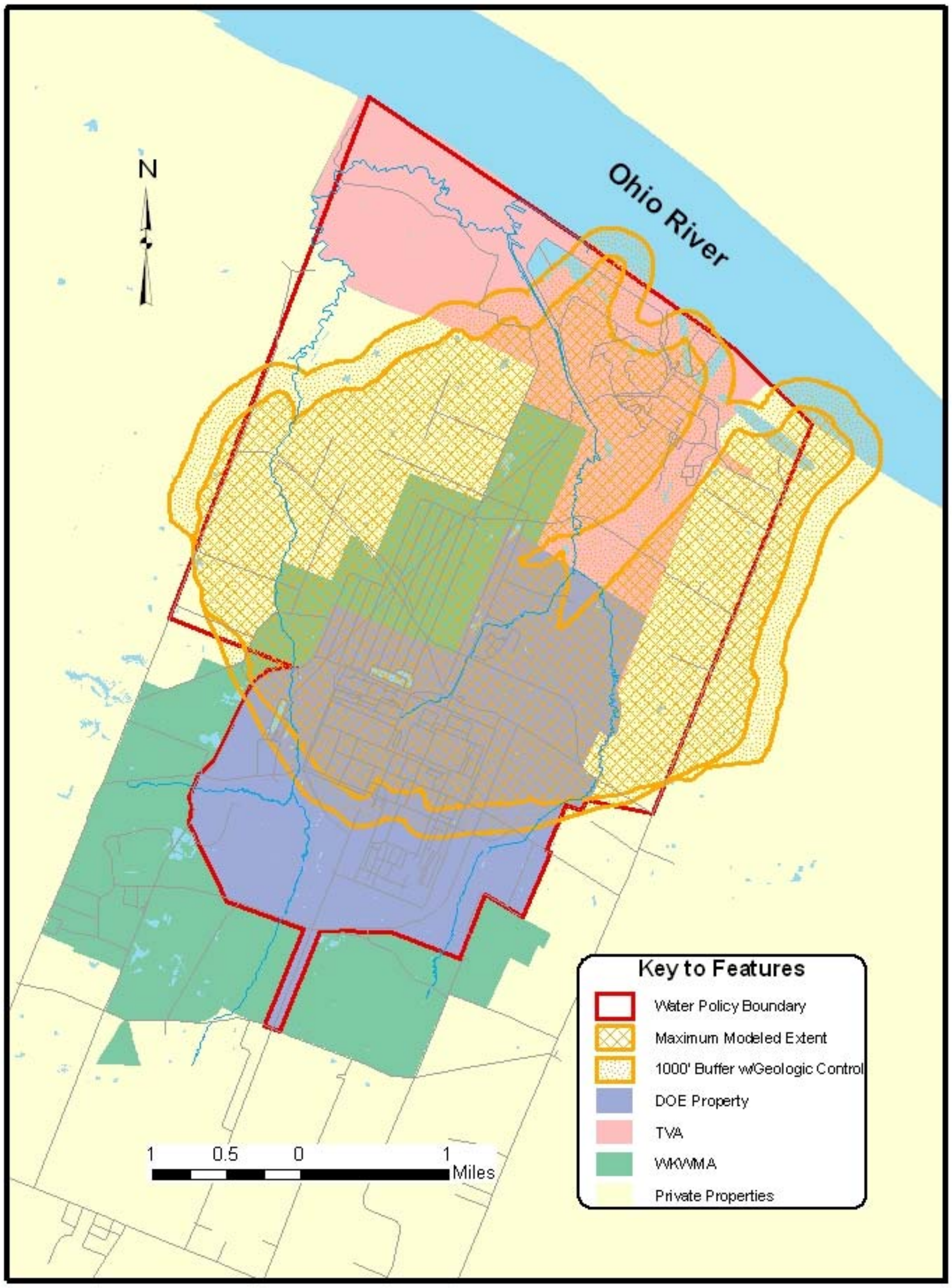


Figure F.4 Predicted Maximum Plume Extent for TCE (5 μg/L) (with 1000 foot buffer) Source Reduction at C-400 Building (assuming continued plant operation) (Scenario 2)

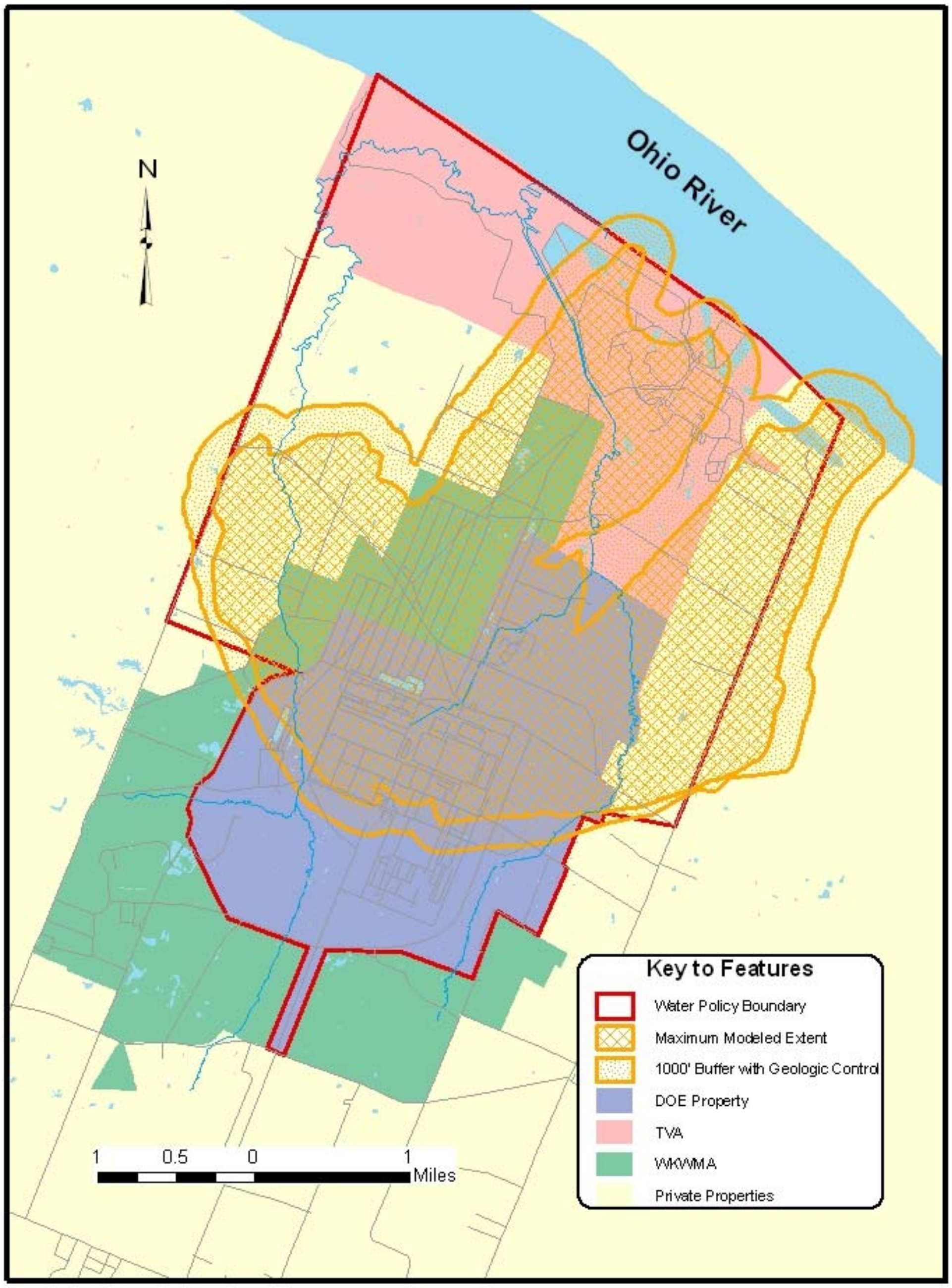
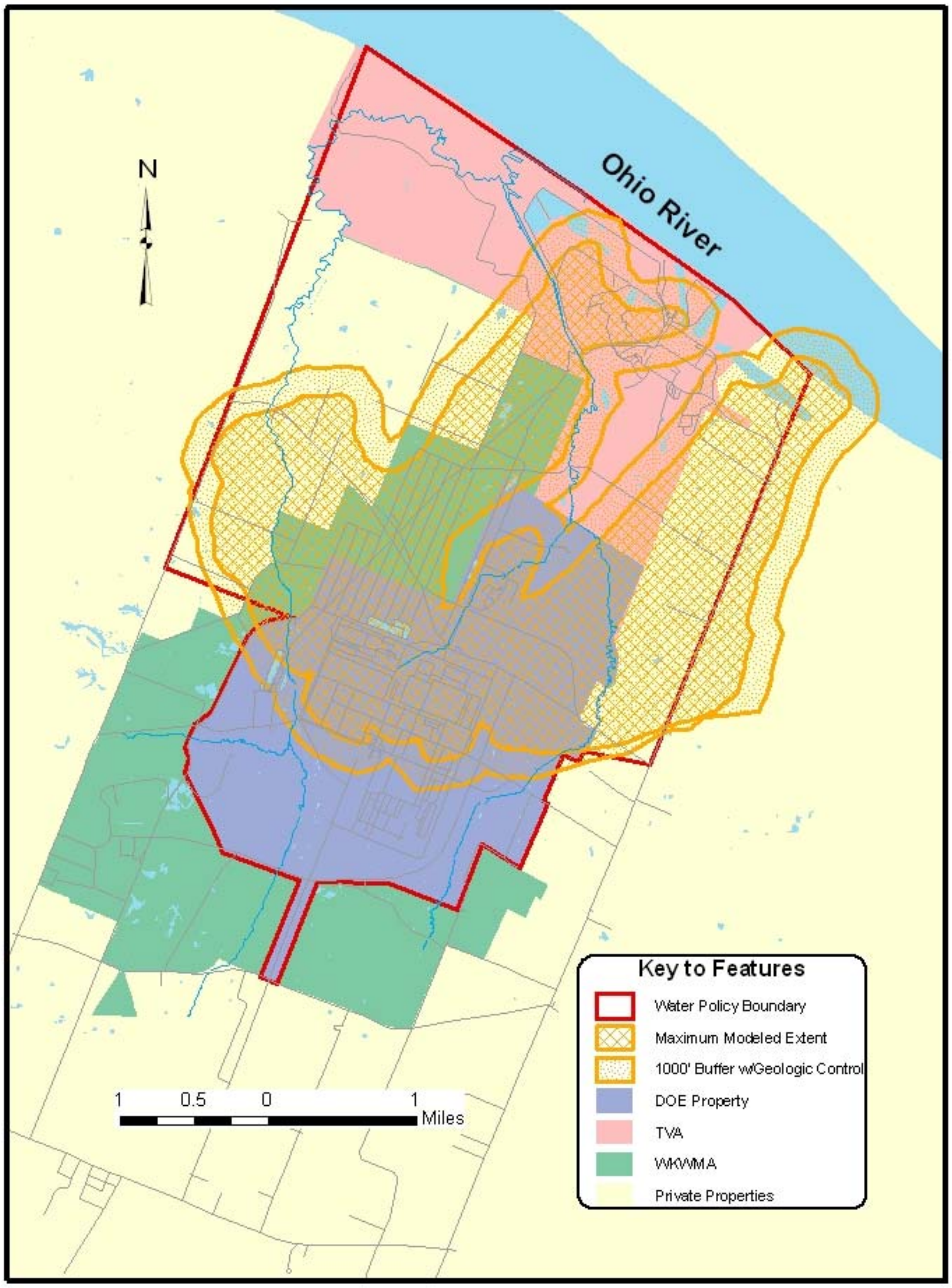


Figure F.5 Predicted Maximum Plume Extent for TCE (5 µg/L) (with 1000 foot buffer) Assuming Source Reductions at C-400, C-720, SWMU 1 and SWMU 4 (including dissolved phase treatment of Southwest Plume) (Scenario 3)



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APPENDIX G. TASK 7
ECONOMIC ANALYSIS OF POTENTIAL PROPERTY ACQUISITION OPTIONS

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ACRONYMS

D	future potential development use
DOE	U.S. Department of Energy
E	existing agricultural farm properties
EE	expanded scope easement
EEL	expanded restrictive easement (lower cost range)
EEU	expanded restrictive easement (upper cost range)
EL	limited scope easement
ELL	limited restrictive easement (lower cost range)
ELU	limited restrictive easement (upper cost range)
L	Lower range of potential costs
P	Property Purchase
PDL	Property purchase using development agriculture land values (lower cost range)
PDU	Property purchase using development agriculture land values (upper cost range)
PEL	Property purchase using existing agricultural land values (lower cost range)
PEU	Property purchase using existing agricultural land values (upper cost range)
PGDP	Paducah Gaseous Diffusion Plant
PTZ	Permeable Treatment Zone
RGA	Regional Gravel Aquifer
SWMU 1	Solid Waste Management Unit 1
SWMU 4	Solid Waste Management Unit 4
TCE	trichloroethene, trichloroethylene ($ClCH{=}Cl_2$)
U	Upper range of potential costs
UCRS	Upper Continental Recharge System
URD	UCRS, RGA, & Dissolved source scenario
URP-PTZ	UCRS, RGE, & Dissolved source scenario with Permeable Treatment Zone

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G.1 INTRODUCTION

The Congressional directive responsible for the initiation of this study states that: "*The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers.*" For this study, the phrase "best interest of the taxpayers" has been interpreted to mean ensuring protection of human health and the environment from exposure to contaminated groundwater in the most cost effective manner possible.

Risks associated with contaminated groundwater can be eliminated or reduced by removal of the contaminants through one or more response actions or by limiting or preventing exposure to contaminated groundwater. For the purpose of this study, four different potential response actions (i.e., scenarios) have been considered: 1) a continuation of the existing pump and treat systems, 2) a reduction of the TCE sources in both the UCRS (95% removal) and the RGA (99% removal) under the C-400 building, 3) implementation of scenario (2) along with a 95% removal of additional TCE sources associated with the C-720 building, SWMU 1 and SWMU 4, and 4) implementation of scenario (3) along with treatment of the dissolved phase of the Southwest plume (inside the restricted area) and the placement of a 14,000 long PTZ along the northern boundary of the restricted area. The estimated costs for implementing each of these options for both 30 year and 100 year time frames have been determined and provided in Appendix D.

None of the evaluated potential response actions will lead to the immediate removal of all contaminated groundwater, even in the event that all sources were immediately removed. This is due to the fact that the existing contaminated plumes extend from the sources to off DOE property. Even if the sources are eliminated, it will take time for the dissolved parts of the plume to dissipate through natural degradation and dilution processes. As a consequence, mitigation of current and potential risks from use of contaminated groundwater requires actions to limit or eliminate exposure. This could be accomplished through restrictive easements or other restrictive agreements (such as the Water Policy) or the fee simple purchase of parcels that currently or may potentially in the future overly contaminated groundwater.

In the short term, the Department of Energy has instituted the Water Policy in which currently impacted private properties have been provided water in exchange for an agreement not to utilize groundwater. This policy is currently estimated to cost $78,000/year. The total Water Policy cost associated with each potential response action was evaluated over a 100 year period by taking into consideration the potential expansion or contraction of the service area that might result from the implementation of each particular response action.

G.2 PROPERTY ACQUISITION OPTIONS

This study evaluates two different property acquisition options to limit or eliminate exposure of humans to contaminated groundwater: 1) outright purchase of property and 2) the use of restrictive easements. The restrictive easement costs have been estimated under an assumption that the current Water Policy will be continued into the future. If discontinued, it is expected that the restrictive easement costs will lie somewhere between the current easement estimates and the current easement estimates plus the costs of the Water Policy.

G.2.1 Cost of the Water Policy

The cost of providing water to those properties currently under the Water Policy is estimated to be approximately $78,000/year. Each year, $27,000 is estimated to be spent in support of monitoring activities associated with the Water Policy while an additional $50,000 is spent on costs associated with administering the Water Policy. Given the fact that it is likely that the monitoring activities would continue, even in the event of the termination of the Water Policy, the total cost of maintaining the current Water Policy was estimated to be $128,000/year (PRS, 2007).

In estimating the total cost of the Water Policy associated with a particular response action, the future costs have been amortized over a 100 year period using a discount rate of 5.05%. In determining the future costs of the Water Policy, it has been assumed that both the water costs and the monitoring costs would increase at an inflation rate of 3%. The analysis also included the costs of any potential increase in the number of Water Policy accounts that might occur as a result of any new additionally impacted properties that might lie beyond the current Water Policy boundary. For the purpose of this analysis, the cost of adding a new account (or property) to the expanded water policy area was estimated to be $14,500 (DOE, 1995).

The future costs of the water policy were not adjusted to take into account the possible subdivision of existing properties as consistent with the explicit language of the Water Policy Action Memorandum (DOE, 2003) which states “Water usage costs caused by increases in ….. subdivision of property would not be reimbursed under this action.” Further, a review of the Water Policy over the last 14 years shows that the number of accounts has remained essentially the same since 1994. Recent conversations with local officials have underscored the conclusion that any significant subdivision of the existing properties in the current Water Policy area or any properties in a potentially expanded Water Policy area is unlikely to occur.

G.2.2 Cost of Property Acquisition Options

Property purchase (P) was assumed to be achieved through a fee simple interest (see Appendix B). Property values were quantified for two major land use classifications: agricultural farm property and rural residential property. Agricultural farm properties were further valued using two different potential land-uses: existing agricultural land use (E) or future potential development use (D). In each case, an upper (U) and lower (L) range of potential costs were considered. This resulted in a total of four different fee simple purchase options: 1) PEL – property purchase using existing agricultural land values (lower cost range), 2) PEU – property purchase using existing agricultural land values (upper cost range), 3) PDL – property purchase using development agricultural land values (lower cost range), and 4) PDU – property purchase using development agricultural land values (upper cost range).

In addition to fee simple purchase, two different easement strategies were also evaluated: limited scope easements (EL) and expanded scope easements (EE). In limited scope easements, it was assumed that restrictions would be placed on the groundwater underlying a property or the surface water running through the property. In expanded scope easements, it was assumed that restrictions would be placed on the groundwater and surface water as well as additional restrictions on the use of the property. As with the fee simple purchase, an upper (U) and lower (L) range of potential easement costs were considered. This resulted in a total of four different restrictive easement options: 1) ELL – limited restrictive easement (lower cost range), 2) ELU – limited restrictive easement (upper cost range), 3) EEL – expanded restrictive easement (lower cost range), and 4) EEU – expanded restrictive easement (upper cost range).

The costs of the different property acquisition strategies have been quantified for each of the four potential response actions by multiplying the unit costs of each property acquisition option (Table C.13 and Table C.16) by either the maximum number of residential properties or the maximum acres of agricultural properties that were potentially affected by each potential response action (Table F.1). (As discussed in Appendix C, costs for acquisition of interests in agricultural property include the values of homes and other buildings.) These results are summarized for each of the four potential response actions in Tables G.1 to G.4.

The total water policy costs associated with each easement option and each potential response action were then calculated by amortizing the annual water policy costs (over a 100 year period) for each option assuming a 3% inflation rate and a discount rate of 5.05%. Annual water policy costs for each option were determined by multiplying the inflated water policy costs for that year by a ratio reflective of the increase or decrease of the potential service area determined using the ratio of the total number of properties impacted for that year to the total number of properties impacted in 2007 (Table F.2). A summary of the composite property acquisition costs are provided in Tables G.5 to G.8.

Table G.1 Costs of Different Property Acquistion Options Associated with P&T Response Action (Scenario 1)

KEY	Property Acquistion Option	Basis	Cost Range	Property Type	Unit Cost $/# or $/ac	Count (#) or acres	Total Cost $
PEL	Fee Simple Purchase	Existing	Lower	Residential	$ 120,293	80	$ 9,623,440
				Agricultural	$ 2,788	3532	$ 9,847,216
						Total:	$ 19,470,656
PEU	Fee Simple Purchase	Existing	Upper	Residential	$ 138,301	80	$ 11,064,080
				Agricultural	$ 3,099	3532	$ 10,945,668
						Total:	$ 22,009,748
PDL	Fee Simple Purchase	Development	Lower	Residential	$ 120,293	80	$ 9,623,440
				Agricultural	$ 6,524	3532	$ 23,042,768
						Total:	$ 32,666,208
PDU	Fee Simple Purchase	Development	Upper	Residential	$ 138,301	80	$ 11,064,080
				Agricultural	$ 7,583	3532	$ 26,783,156
						Total:	$ 37,847,236
ELL	Restrictive Easement	Limited	Lower	Residential	$ 4,001	80	$ 320,080
				Agricultural	$ 472	3532	$ 1,667,104
						Total:	$ 1,987,184
ELU	Restrictive Easement	Limited	Upper	Residential	$ 17,330	80	$ 1,386,400
				Agricultural	$ 872	3532	$ 3,079,904
						Total:	$ 4,466,304
EEL	Restrictive Easement	Expanded	Lower	Residential	$ 16,529	80	$ 1,322,320
				Agricultural	$ 2,589	3532	$ 9,144,348
						Total:	$ 10,466,668
EEU	Restrictive Easement	Expanded	Upper	Residential	$ 38,325	80	$ 3,066,000
				Agricultural	$ 2,789	3532	$ 9,850,748
						Total:	$ 12,916,748

Table G.2 Costs of Different Property Acquistion Options Associated with C400 Response Action (Scenario 2)

KEY	Property Acquistion Option	Basis	Cost Range	Property Type	Unit Cost $/# or $/ac	Count (#) or acres	Total Cost $
PEL	Fee Simple Purchase	Existing	Lower	Residential	$ 120,293	85	$ 10,224,905
				Agricultural	$ 2,788	4370	$ 12,183,560
						Total:	$ 22,408,465
PEU	Fee Simple Purchase	Existing	Upper	Residential	$ 138,301	85	$ 11,755,585
				Agricultural	$ 3,099	4370	$ 13,542,630
						Total:	$ 25,298,215
PDL	Fee Simple Purchase	Development	Lower	Residential	$ 120,293	85	$ 10,224,905
				Agricultural	$ 6,524	4370	$ 28,509,880
						Total:	$ 38,734,785
PDU	Fee Simple Purchase	Development	Upper	Residential	$ 138,301	85	$ 11,755,585
				Agricultural	$ 7,583	4370	$ 33,137,710
						Total:	$ 44,893,295
ELL	Restrictive Easement	Limited	Lower	Residential	$ 4,001	85	$ 340,085
				Agricultural	$ 472	4370	$ 2,062,640
						Total:	$ 2,402,725
ELU	Restrictive Easement	Limited	Upper	Residential	$ 17,330	85	$ 1,473,050
				Agricultural	$ 872	4370	$ 3,810,640
						Total:	$ 5,283,690
EEL	Restrictive Easement	Expanded	Lower	Residential	$ 16,529	85	$ 1,404,965
				Agricultural	$ 2,589	4370	$ 11,313,930
						Total:	$ 12,718,895
EEU	Restrictive Easement	Expanded	Upper	Residential	$ 38,325	85	$ 3,257,625
				Agricultural	$ 2,789	4370	$ 12,187,930
						Total:	$ 15,445,555

Table G.3 Costs of Different Property Acquistion Options Associated with URD Response Action (Scenario 3)

KEY	Property Acquistion Option	Basis	Cost Range	Property Type	Unit Cost $/# or $/ac	Count (#) or acres	Total Cost $
PEL	Fee Simple Purchase	Existing	Lower	Residential	$ 120,293	85	$ 10,224,905
				Agricultural	$ 2,788	4102	$ 11,436,376
						Total:	$ 21,661,281
PEU	Fee Simple Purchase	Existing	Upper	Residential	$ 138,301	85	$ 11,755,585
				Agricultural	$ 3,099	4102	$ 12,712,098
						Total:	$ 24,467,683
PDL	Fee Simple Purchase	Development	Lower	Residential	$ 120,293	85	$ 10,224,905
				Agricultural	$ 6,524	4102	$ 26,761,448
						Total:	$ 36,986,353
PDU	Fee Simple Purchase	Development	Upper	Residential	$ 138,301	85	$ 11,755,585
				Agricultural	$ 7,583	4102	$ 31,105,466
						Total:	$ 42,861,051
ELL	Restrictive Easement	Limited	Lower	Residential	$ 4,001	85	$ 340,085
				Agricultural	$ 472	4102	$ 1,936,144
						Total:	$ 2,276,229
ELU	Restrictive Easement	Limited	Upper	Residential	$ 17,330	85	$ 1,473,050
				Agricultural	$ 872	4102	$ 3,576,944
						Total:	$ 5,049,994
EEL	Restrictive Easement	Expanded	Lower	Residential	$ 16,529	85	$ 1,404,965
				Agricultural	$ 2,589	4102	$ 10,620,078
						Total:	$ 12,025,043
EEU	Restrictive Easement	Expanded	Upper	Residential	$ 38,325	85	$ 3,257,625
				Agricultural	$ 2,789	4102	$ 11,440,478
						Total:	$ 14,698,103

Table G.4 Costs of Different Property Acquistion Options Associated with URD-PTZ Response Action (Scenario 4)

KEY	Property Acquistion Option	Basis	Cost Range	Property Type	Unit Cost $/# or $/ac	Count (#) or acres	Total Cost $
PEL	Fee Simple Purchase	Existing	Lower	Residential	$ 120,293	84	$ 10,104,612
				Agricultural	$ 2,788	4049	$ 11,288,612
						Total:	$ 21,393,224
PEU	Fee Simple Purchase	Existing	Upper	Residential	$ 138,301	84	$ 11,617,284
				Agricultural	$ 3,099	4049	$ 12,547,851
						Total:	$ 24,165,135
PDL	Fee Simple Purchase	Development	Lower	Residential	$ 120,293	84	$ 10,104,612
				Agricultural	$ 6,524	4049	$ 26,415,676
						Total:	$ 36,520,288
PDU	Fee Simple Purchase	Development	Upper	Residential	$ 138,301	84	$ 11,617,284
				Agricultural	$ 7,583	4049	$ 30,703,567
						Total:	$ 42,320,851
ELL	Restrictive Easement	Limited	Lower	Residential	$ 4,001	84	$ 336,084
				Agricultural	$ 472	4049	$ 1,911,128
						Total:	$ 2,247,212
ELU	Restrictive Easement	Limited	Upper	Residential	$ 17,330	84	$ 1,455,720
				Agricultural	$ 872	4049	$ 3,530,728
						Total:	$ 4,986,448
EEL	Restrictive Easement	Expanded	Lower	Residential	$ 16,529	84	$ 1,388,436
				Agricultural	$ 2,589	4049	$ 10,482,861
						Total:	$ 11,871,297
EEU	Restrictive Easement	Expanded	Upper	Residential	$ 38,325	84	$ 3,219,300
				Agricultural	$ 2,789	4049	$ 11,292,661
						Total:	$ 14,511,961

Table G.5 Costs of Different Property Acquistion Options Associated with P&T Response Action (Scenario 1)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 19.5		$ 19.5
PEU	Fee Simple Purchase	Existing	Upper	$ 22.0		$ 22.0
PDL	Fee Simple Purchase	Development	Lower	$ 32.7		$ 32.7
PDU	Fee Simple Purchase	Development	Upper	$ 37.8		$ 37.8
ELL	Restrictive Easement	Limited	Lower	$ 2.0	$ 4.9	$ 6.9
ELU	Restrictive Easement	Limited	Upper	$ 4.5	$ 4.9	$ 9.4
EEL	Restrictive Easement	Expanded	Lower	$ 10.5	$ 4.9	$ 15.4
EEU	Restrictive Easement	Expanded	Upper	$ 12.9	$ 4.9	$ 17.8

Table G.6 Costs of Different Property Acquistion Options Associated with C-400 Response Action (Scenario 2)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 22.4		$ 22.4
PEU	Fee Simple Purchase	Existing	Upper	$ 25.3		$ 25.3
PDL	Fee Simple Purchase	Development	Lower	$ 38.7		$ 38.7
PDU	Fee Simple Purchase	Development	Upper	$ 44.9		$ 44.9
ELL	Restrictive Easement	Limited	Lower	$ 2.4	$ 5.3	$ 7.7
ELU	Restrictive Easement	Limited	Upper	$ 5.2	$ 5.3	$ 10.5
EEL	Restrictive Easement	Expanded	Lower	$ 12.7	$ 5.3	$ 18.0
EEU	Restrictive Easement	Expanded	Upper	$ 15.4	$ 5.3	$ 20.8

Table G.7 Costs of Different Property Acquistion Options Associated with URD Response Action (Scenario 3)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 21.7		$ 21.7
PEU	Fee Simple Purchase	Existing	Upper	$ 24.5		$ 24.5
PDL	Fee Simple Purchase	Development	Lower	$ 37.0		$ 37.0
PDU	Fee Simple Purchase	Development	Upper	$ 42.9		$ 42.9
ELL	Restrictive Easement	Limited	Lower	$ 2.3	$ 5.1	$ 7.4
ELU	Restrictive Easement	Limited	Upper	$ 5.1	$ 5.1	$ 10.2
EEL	Restrictive Easement	Expanded	Lower	$ 12.0	$ 5.1	$ 17.2
EEU	Restrictive Easement	Expanded	Upper	$ 14.7	$ 5.1	$ 19.8

Table G.8 Costs of Different Property Acquistion Options Associated with URD-PTZ Response Action (Scen. 4)						
KEY	Property Acquistion Option	Basis	Cost Range	Acquistion Cost $M	Water Policy Cost $M	Total Cost $M
PEL	Fee Simple Purchase	Existing	Lower	$ 21.4		$ 21.4
PEU	Fee Simple Purchase	Existing	Upper	$ 24.2		$ 24.2
PDL	Fee Simple Purchase	Development	Lower	$ 36.5		$ 36.5
PDU	Fee Simple Purchase	Development	Upper	$ 42.3		$ 42.3
ELL	Restrictive Easement	Limited	Lower	$ 2.3	$ 4.8	$ 7.1
ELU	Restrictive Easement	Limited	Upper	$ 5.0	$ 4.1	$ 9.1
EEL	Restrictive Easement	Expanded	Lower	$ 11.9	$ 4.8	$ 16.7
EEU	Restrictive Easement	Expanded	Upper	$ 14.5	$ 4.8	$ 19.3

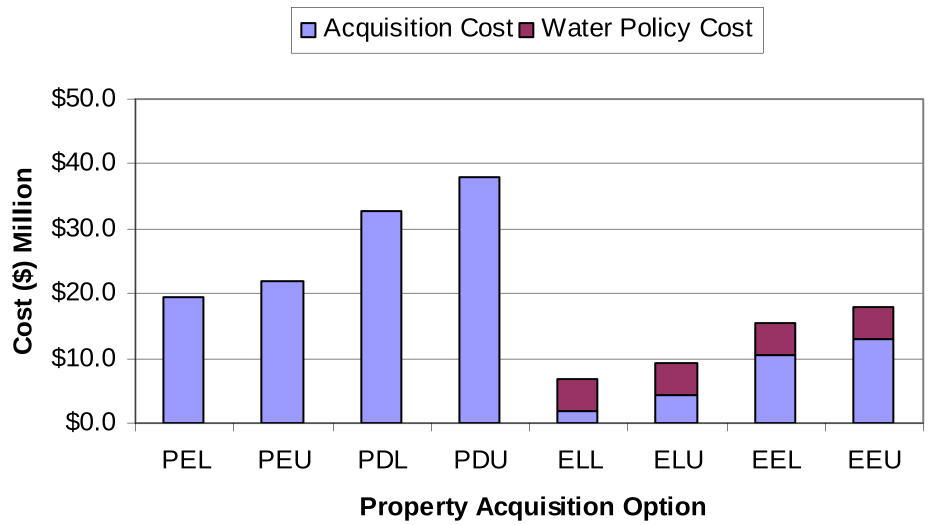

Figure G.1 Range of Property Acquisition Costs for Potential Response Action Scenario 1: P&T (Continuing Pump and Treat) Evaluated Over 100 Years

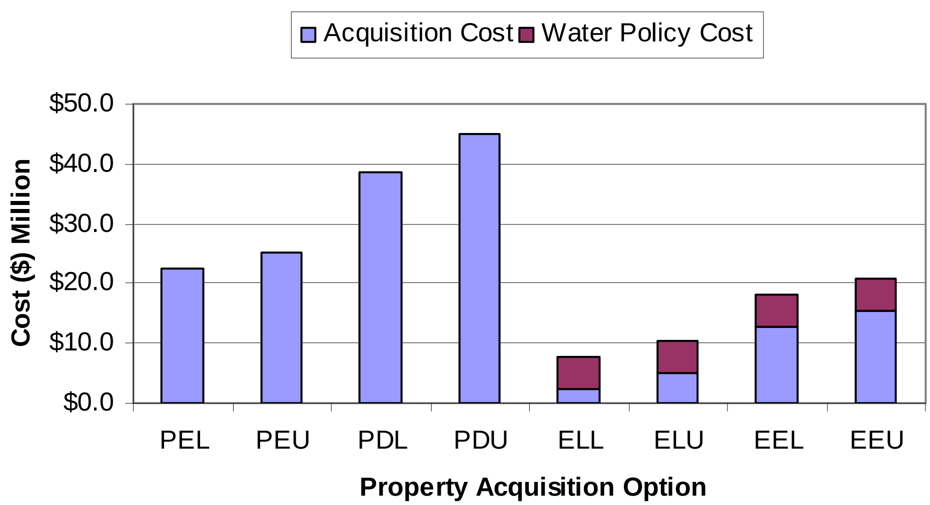

Figure G.2 Range of Property Acquisition Costs for Potential Response Action Scenario 2: C400 (TCE Source Removal at C400 Building) Evaluated Over 100 Years

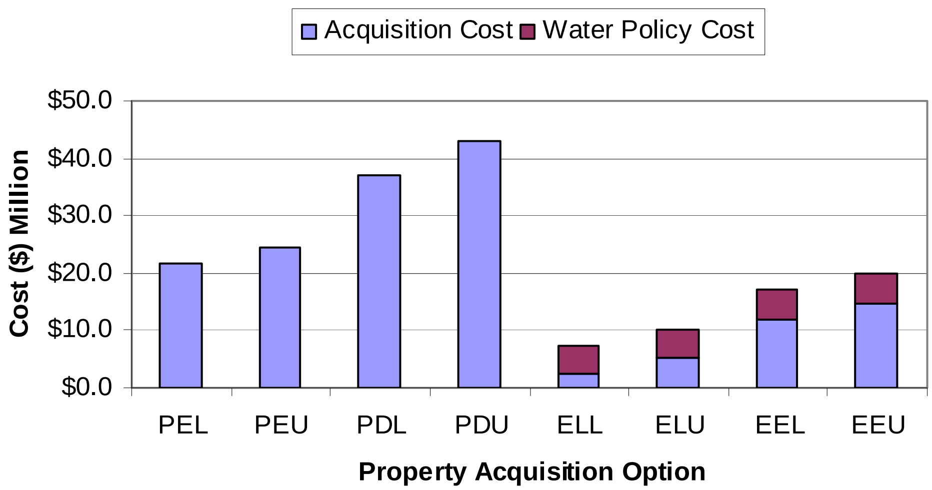

Figure G.3 Range of Property Acquisition Costs for Potential Response Action Scenario 3: URD (TCE Source Removal from URCS, RGA, and Dissolved Phase of Plume associated with C400, C720, SWMU1, and SWMU4) Evaluated Over 100 Years

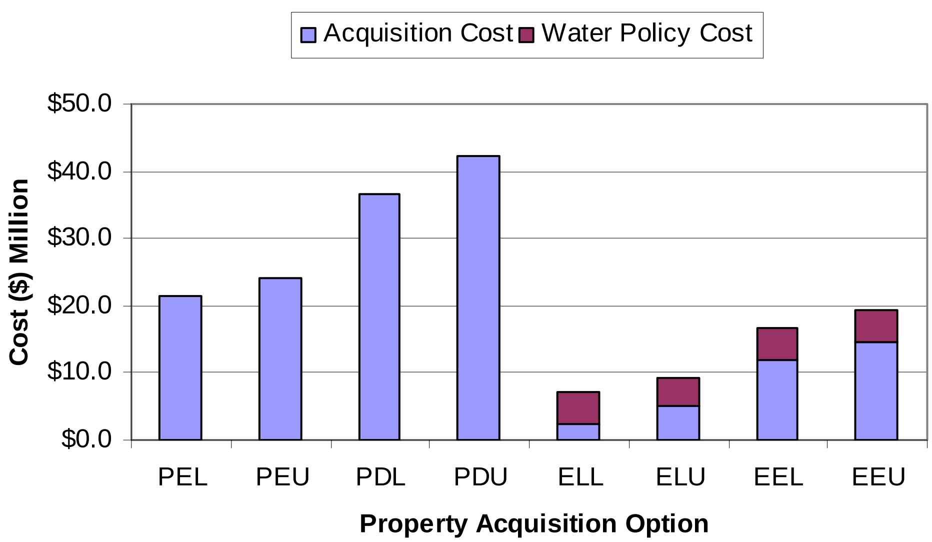

Figure G.4 Range of Property Acquisition Costs for Potential Response Action Scenario 4: URD-PTZ (Scenario 3 plus the addition of a 14,000 foot PTZ along the northern boundary of the PGDP security fence) Evaluated Over 100 Years

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APPENDIX H. TASK 9
PUBLIC INTERACTION

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ACRONYMS

ACT	Active Citizens for Truth
CAB	Paducah Gaseous Diffusion Plant Citizens Advisory Board
DOE	United States Department of Energy
DOE-PPPO	DOE Portsmouth Paducah Project Office
HQ	DOE Headquarters
KRCEE	University of Kentucky – Kentucky Research Consortium for Energy and Environment
PGDP	Paducah Gaseous Diffusion Plant
WKWMA	West Kentucky Wildlife Management Area

H.1 INTRODUCTION

Public Interaction began with the presentation of the draft project Statement of Work to the public for review and comment. (See Attachment H-1 for a copy of the final Statement of Work). The public's comments on the draft Statement of Work are in Attachment H-2.

On April 16, 2006 The Paducah Sun published an article discussing the proposed Statement of Work that had been distributed to the public as well as local/state/federal regulators, politicians and decision-makers. This article is in Attachment H-3.

The first public presentation for the Property Acquisition Project was to the PGDP CAB on June 15, 2006 and addressed the scope, general tasks, and schedule for project completion (Attachment H-4). The question and answer session following the presentation included questions and comments regarding the Statement of Work generated by stakeholders, the CAB, regulators and public officials. Abbreviated meeting minutes for the presentation and follow-up discussions are provided in Attachment H-5.

The DOE-PPPO mailed postcards to PGDP neighbors (Attachment H-6) on June 22, 2006 and issued a media press release (Attachment H-7) announcing the June 29, 2006 "Property Acquisition Study Public Meeting" at the West Kentucky Wildlife Management Area (WKWMA) Clubhouse. The Public Meeting was held at the WKWMA in close proximity to the PGDP and adjoining private and public properties to promote attendance. Attendees were provided an overview presentation (Attachment H-8) of Property Acquisition Project tasks, schedules, and goals by DOE-PPPO and the University of Kentucky-Kentucky Research Consortium for Energy and Environment (KRCEE). Following the presentation, attendees participated in a question and answer session. A list of the questions raised at the Public Meeting is provided in Attachment H-9.

The Paducah Sun published the article "*DOE Neighbors Question Buyout*" on June 30, 2006 summarizing the June 29, 2006 Public Meeting (Attachment H-10). The Courier Journal covered the Public Meeting on July 10, 2006 with publication of the article "*U.S. May Study Buyout around Paducah Plant – Chemicals tainted land's groundwater*" (Attachment H-11).

A draft project report was submitted to DOE on September 15, 2006. Subsequently, a project progress presentation was provided to the PGDP CAB on September 21, 2006. Slides used when introducing the the presentation are provided as Attachment H-12, and the presentation is provided as Attachment H-13. Abbreviated minutes for the September 21, 2006 PGDP CAB meeting are provided in Attachment H-14.

A final draft project report was submitted to DOE on March 16, 2007. A public information briefing was scheduled for March 20, 2007. A public notice was sent out to the citizens in the study area prior to the meeting (Attachment H-15) and a notice was published in the Paduch Sun on March 15, 2007 (Attachment H-16). On March 15, 2007, the Paducah Sun published an atricle which discussed the study (Attachment H-17). Slides used in the presentation are provided as Attachment H-18. Comments received at the meeting are provided in Attachment H-19.

The Paducah Sun published an article on March 21, 2007 summarizing the March 20, 2007 Public Meeting presentations (Attachment H-20). Written comments received during the public comment period ending April 2, 2007 are provided in Attachment H-21.

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ATTACHMENT H-1

STATEMENT OF WORK

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STATEMENT OF WORK
FOR
PROPERTY ACQUISITION STUDY FOR AREAS NEAR THE PADUCAH SITE

May 4, 2006

Statement of Work
for
Property Acquisition Study for Areas near the Paducah Site

Project Mission:

The mission of the project will be to evaluate a range of remedial alternatives, their impact on protection of public health and the environment[1], and their cost of implementation relative to the purchase of properties impacted or potentially impacted by contamination from Paducah Gaseous Diffusion Plant (PGDP). This project will not include any consideration of demolition and disposal (D&D) alternatives for the operating gaseous diffusion plant.

Project Goal:

The primary goal of the project will be to develop relationships between remedial alternatives, compliance with applicable or relevant and appropriate requirements (ARARs), reductions in long-term stewardship (Water Policy and long-term operations and maintenance), and cost impacts that may be afforded through the purchase of properties in the vicinity of the PGDP.

Technical Narrative:

This project will be performed in order to meet the requirements established in Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084), which states:

> "Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers."

Consistent with these requirements, the following tasks shall be performed.

Task 1: Identification of property overlying and immediately adjacent to the contaminated groundwater plumes and the potential surface water contaminant pathways near the Paducah facility. This task will consider results of Task 4 when identifying properties. This task will entail development of graphical presentations and narrative describing the methods used to identify property and the task results.

Task 2: Delineation of approaches for either property purchase, or obtaining options to purchase, the properties identified in Task 1. This task will entail development of narrative describing the approaches and the methods used to select the approach. The approaches will include but not be limited to consideration of immediate transfer in fee simple, as well as consideration of acquisition of interests in a manner other than immediate transfer of title in fee simple. This would include identification and cost of other legal mechanisms preventing use of groundwater, such as purchase of property subject to life estates or other mechanisms to allow for near-term occupation of property, with eventual transfer of full title to the Department of Energy in the future; implementation of deed restrictions of water usage, and purchase of water or mineral "rights."

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[1] For this project, the definition of "protection of public health and the environment" will be consistent with the U.S. Environmental Protection Agency acceptable risk range of 10^{-4} to 10^{-6} and a hazard quotient less than 1.

Task 3: Development of cost estimates to acquire interests in property based upon the approaches developed for purchasing the property/options as part of Task 2. This task will entail development of narrative describing the methods used to develop cost estimates and the presentation of the resulting estimates.

Task 4: Completion of sensitivity analyses to determine groundwater flow paths that might result upon cessation of enrichment operations in order to determine whether properties affected by contaminant migration could differ in the future. This task will entail development of narrative describing the methods used to complete the sensitivity analyses and graphical presentations of analyses results.

Task 5: Identification of current remedial action assumptions for sources contributing contamination to groundwater and surface water migration pathways and changes in the assumptions that could result from implementation of sustainable restrictions of human exposure to contaminated media (i.e., groundwater, sediment, and surface water). This task will entail compiling lists of remedial action assumptions previously detailed in Groundwater and Surface Water Operable Unit decision and planning documents. Examples of documents to consider are as follows:

- *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1857&D1; July 2000 and DOE/OR/07-1857&D2; August 2001),
- *Remedial Investigation/Feasibility Study Workplan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1812&D1; September 1999),
- *Work Plan for the Burial Ground Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2179&D2; December 2005),
- *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/06-1351&D1; July 1995), and
- *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant Paducah, Kentucky* (DOE/OR/07-2150&D3; February 2005).

Additionally, the current planned and alternative end states described in *Paducah Gaseous Diffusion Plant End State Vision Document* (DOE/OR/07-2119&D2/R3; July 2005) and the presentations of future actions in *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Annual Revision–FY 2005* (DOE/OR/1849&D1) will be incorporated into the lists to determine potential actions for specific source areas. These lists will include cost estimates provided in the various decision documents. For actions without cost estimates in decision documents, qualitative estimates will be derived using generally available information. This task will result in the development of narrative describing the sources of information, methods, and the resulting remedial action assumption lists.

Task 6: Identification of conditions necessary to render property acquisition cost-effective while still ensuring protection for human health and the environment. This task will include analyses of whether property purchase would be necessary to achieve protectiveness based on current cleanup assumptions or whether changes in cleanup assumptions and approaches would be necessary to render property acquisition appropriate cost-effective, and protective. This task will result in the development of narrative describing the methods used to complete this task and the results of the analyses.

Task 7: Completion of an economic analysis of the potential purchase options. This task will integrate the information developed in the earlier tasks and consider the overall cost of a property/options purchase versus the ongoing expense of providing water to affected residents, long-term surveillance, and maintenance, and versus the cost of future cleanup actions under current cleanup assumptions and prospective alternative scenarios developed as part of this project. Due to limitations in remedial cost information (see Task 5), this task will result in the development of a narrative describing the methods used to complete the analysis and matrices and/or graphical presentations depicting the conclusions from the analysis.

Task 8: Public interaction support. This task will include preparation of presentations describing the methods and results of the Property Acquisition Study. Although it is anticipated that personnel from the Department of Energy will be the lead presenters at any meeting, participation of technical representatives should be anticipated. Planning at minimum will be for delivery of 3 presentations to be used at Citizen Advisory Board meetings (May, July, and September 2006) and 2 presentations to be used at Public Information Briefings (June and October 2006). Drafts and finals of briefing materials will be prepared, with the draft materials to be available for review two weeks prior to the meeting time.

Task 9: Reporting. This task will include the preparation and electronic delivery of biweekly progress reports, management interaction with the Department of Energy lead technical contact, and preparation of a draft and final report. In addition, this task includes development of a detailed project schedule with an October 31, 2006 completion date. The weekly progress reports will be due no later than Wednesday at noon, and a one-half hour follow-up phone call should be scheduled for 4 pm eastern time. The draft and final report shall consist of a main text and attachments developed through completion of Tasks 1 through 8. In addition, the report shall include an Executive Summary. The detailed project schedule shall be included in the project proposal.

Deliverable Schedule:

Deliverable	Anticipated Due Date[a]	Number of Copies	Recipient
Project Schedule	To be included with project proposal	Electronic delivery only	Richard Bonczek
Report Outline	To be included with project proposal	Electronic delivery only	Richard Bonczek
Progress Report	Weekly after project kickoff	Electronic delivery only	Richard Bonczek
First CAB presentation	May 2006	Electronic delivery as PowerPoint file	Richard Bonczek
Second CAB presentation	July 2006	Electronic delivery as PowerPoint file	Richard Bonczek
Third CAB presentation	September 2006	Electronic delivery as PowerPoint file	Richard Bonczek
First Public Information presentation	June 2006	Electronic delivery as Power Point file	Richard Bonczek
Second Public Information presentation	October 2006	Electronic delivery as PowerPoint file	Richard Bonczek
Draft Report	September 15, 2006	Electronic delivery as PDF and 5 paper copies	Richard Bonczek
Final Report	October 31, 2006	Electronic delivery as PDF and 10 paper copies	Richard Bonczek

[a] Dates were developed assuming a May 8, 2006 start. If start is delayed, then these dates will be adjusted.

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ATTACHMENT H-2

CITIZENS ADVISORY BOARD COMMENTS ON STATEMENT OF WORK

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Review Summary for Comments Received on

Statement of Work for Property Acquisition Study for Areas Near the Paducah Site

Comments Received from CAB via email from Rhonda Smith dated May 2, 2006:

CAB – "Project Mission: The mission of the project will be to evaluate the impact on protection of public health and environment, and the cost of implementation relative to the purchase of properties impacted or potentially impacted by contamination from PGDP. This study is not to evaluate remedial alternatives of D&D. It is to study the option of land acquisition and its different scenarios."

RESPONSE – The study does not consider D&D alternatives. The options studied will consider different "types of acquisition" and determination of the impact of acquisition types on cleanup scenarios contained in earlier decision documents. The following statement was added to the SOW to clarify this issue. "This project will not include any consideration of demolition and disposal (D&D) alternatives for the operating gaseous diffusion plant."

CAB – "Project Goal: The primary goal of the project will be to develop scenarios for land acquisition and how the cost of continued remediation, long-term surveillance, and maintenance is in the best interest of the TAXPAYERS."

RESPONSE –The Project Goal statement was not changed in the revised SOW because the Project Goal needed to be specific to support proposal preparation. However, please note that the statement made in the comment is included in the quote from the Bill presented in the SOW's Technical Narrative as follows, "Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the <u>cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers</u>."

CAB – "Task 1: Include properties that have been identified as adversely affected by past actions of stewards for PGDP/DOE properties. To include perimeter properties not adjacent to plant. Not limited to adjacent but inclusive of So. Illinois border properties and properties in proximity up to a 10 mile radius with a minimum of 5 miles. No other facilities within the DOE complex are in such close proximity to residential areas. Most other locations did land acquisition activities in advance to minimize health hazards. Savannah River site is approximately 298,000 acres/310 sq. miles. Oak Ridge is approximately 65,000 acres. These areas may give you an indication of what size area could be adversely affected."

RESPONSE – DOE is required to ensure that the study is consistent with the bill, and consideration of impacts at distances listed in this comment would exceed the requirements in the Bill. Therefore, the properties considered by this project will be limited to those in, or possibly near the boundary of, the Water Policy box. No change was made to the SOW based upon this comment.

CAB – "Task 2: Sentence 3 - The approaches will include but not be limited to consideration of acquisition of interests in a manner including immediate transfer of title in fee simple."

RESPONSE – Sentence was revised to include explicit consideration of immediate transfer of title in fee simple. The revised sentence is as follows, "The approaches will include but not be limited to consideration of immediate transfer in fee simple, as well as consideration of acquisition of interests in a manner other than immediate transfer of title in fee simple."

CAB – “Task 3: Sentence 1 - Development of cost estimates using normal appreciated land values and terms to acquire interests in property based upon the approaches developed for purchasing the property/options as part of Task 2. This may mean relocating an extended area as described in comment for Task 1 above. All property owners being reviewed should be treated with dignity at all times. If for some reason they don’t want to be interviewed…the KRCEE should use all other available resources to secure information to make informed decisions. Some of these landowners are elderly and don’t need to be discomforted by this study or its participants.”

RESPONSE – Public briefings are anticipated as part of the study, and at those meetings all members of the public will be treated with respect; however, DOE does not anticipate visiting residences to interview individuals as part of this study. DOE commits to working with KRCEE to ensure that they consider all available resources when developing cost estimates for property acquisition. No change was made to the SOW in response to this comment.

Comments Received Verbally at CAB Meeting of April 20, 2006:

CAB Meeting – Concerning the number of briefings: The project should include regular contact and briefing of the CAB. A third CAB presentation mid-way through the project should be considered.”

RESPONSE – A third briefing was added to the schedule as recommended in this comment.

CAB Meeting – Concerning land acquisition costs compared to remedial action costs: DOE should not be allowed to leave a mess and simply buy the property. DOE needs to consider if remediation is in the best interests of the taxpayer not if property purchase is in the best interest of the taxpayer.

RESPONSE – Completion of this study is not meant to imply that the scope of the cleanup will be reduced. Consistent with the CERCLA process and the FFA, the information developed by this project will be used to support future decisions. No change made in the SOW in response to this comment. DOE will be sure to include this point in future briefings to the CAB and public.

CAB Meeting – Concerning project history: PACRO was the organization that started Congress thinking about this study However, PACRO was more interested in development of a master plan, which would include consideration of property reuse, and presented this to the CAB in March 2004. DOE has put a different twist on the original plan through the issuance of this SOW by aligning the study with the CERCLA process.

RESPONSE – DOE is required to ensure that the study is consistent with the bill, and development of a master reuse plan would exceed the requirements in the Bill. Therefore, the development of such a plan cannot be included in this study. No change was made to the SOW based upon this comment.

CAB Meeting – EPA is internally looking at the study and would consider any land acquisition strategy as a form of institutional control. EPA would still expect progress on groundwater cleanup.

RESPONSE – DOE anticipates including the results of the study in future decision-making consistent with the CERCLA process and the FFA. No change was made to the SOW based upon this comment.

CAB Meeting – Regarding property value: Contaminant releases have devalued the property; therefore, values determined now are less than they would have been in the past. Why can’t DOE leave the property owners alone?

RESPONSE – DOE is required to complete the study. The need to consider land devaluation due to contaminant release will be addressed by the study. Later CAB and Public Briefings will address the methods used to develop land values. No change was made to the SOW based upon this comment.

CAB Meeting – Regarding using KRCEE for the study: What is the value of the contract?

RESPONSE – DOE will set the contract price following finalization of the SOW and as part of proposal acceptance. The funding level was not set in the Bill. No change was made to the SOW based upon this comment.

CAB Meeting – Regarding comments from the Commonwealth of Kentucky: The Commonwealth provided comments in writing on the SOW (see below). Is DOE going to respond in writing and issue a new SOW?

RESPONSE – DOE has received and reviewed the Commonwealth’s comments. A written response summary will be included in the Public Interaction Appendix to the Land Acquisition Study report. DOE will be sure to include this appendix in the report outline due from the contractor at project kick-off. A revised SOW that considers comments will be issued. No change was made to the SOW based upon this comment.

CAB Meeting – EPA asked if studies of this type had been done at other DOE sites.

RESPONSE – The report will consider land acquisition studies done at other sites. No change was made to the SOW based upon this comment.

CAB Meeting – Concerning the review period: The review period for the SOW is too short.

RESPONSE – DOE needs to get the study underway and is hesitant to increase the review period. DOE will accept comments on the SOW through April 28. No change was made to the SOW based upon this comment.

CAB Meeting – What properties will be evaluated as part of the study?

RESPONSE – Consistent with the Bill, the study will consider all land above the groundwater plumes. No change was made to the SOW based upon this comment.

CAB Meeting – There is uncertainty in the size of the plume. Is DOE certain that all affected properties will be included?

RESPONSE – To ensure that all affected properties are included, the study will include properties above and near the plume boundaries. Later CAB and Public Briefings will discuss the methods used for the study. No change was made to the SOW based upon this comment.

CAB Meeting – ACT members will not participate in this study.

RESPONSE – Noted. No change was made to the SOW based upon this comment.

CAB Meeting – Currently, there a lawsuit against the plant. How will the study address lawsuit issues?

RESPONSE – The study will not attempt to address specifically any issues related to the lawsuit. No change was made to the SOW based upon this comment.

CAB Meeting – Not sure there is such a negative impact from completing the study. Some plant neighbors might be interested in the study results.

RESPONSE – DOE believes that the study will provide information valuable in decision-making. No change was made to the SOW based upon this comment.

Comments Received from Kentucky Division of Waste Management:

KYDWM – "Project Goals: The Draft SOW indicates that reductions in long-term stewardship should be considered for balancing the trade-offs with regards to purchasing properties in the vicinity of the PGDP. Comment: The draft SOW should endeavor to establish meaningful and true cost estimates for long-term stewardship so as to provide for realistic costs for balancing the trade-off. Also, it is very likely that under a remedy that would include DOE ownership of these properties that there would be long-term costs associated with some level of on-going monitoring, annual or 5-year reviews, etc."

RESPONSE - The project will include costs for long-term stewardship, including surveillance and reporting. These estimates will be taken from the previous decision documents because development of new estimates is outside the scope of the project. However, the report will note the uncertainties associated with the costs for long-term stewardship. Please note that long-term monitoring and access controls are included in the remedies to be considered in Task 5. No change was made to the SOW based upon this comment.

KYDWM – "Task 4 speaks to a sensitivity analysis to be conducted to determine the likelihood for changes in groundwater flow paths upon plant shutdown. Comment: Any decision documents moving forward should include contingencies for potential ground-truthing activities that may be necessary to ensure that the conclusions of the sensitivity analyses are accurate."

RESPONSE – DOE agrees that conditions at the PGDP may change in the future due to plant shut-down and believes that all models will need to consider these changes when/if used in decision-making. The sensitivity analyses are being performed to ensure that all properties that might be affected by changing hydrological conditions are included in the study. No change was made to the SOW in response to this comment.

KYDWM – "Tasks 5 and 6 speak to the need to review current cleanup assumptions and how they might be affected by property acquisition. Comment: Are the current cleanup assumptions those established in the 2003 Letter-of-Intent? Additionally, the Draft SOW indicates that a number of existing documents will be evaluated as part of the study; including the Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, August 2001. The FS included considerations for source areas and the dissolved phase portions of the plume. It did not give any considerations to institutional controls or property acquisitions. That said, if the Department pursues property acquisition it should be evaluated as an element of the overall cleanup process, including groundwater cleanup. In particular, 40 CFR 300.430 (a)(iii)(D) should be considered by the Department when formulating remedial alternatives that include institutional controls.

Ed. The referenced citation is as follows:

"(D) EPA expects to use institutional controls such as water use and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls may be used during the conduct of the remedial investigation/ feasibility study (RI/FS) and implementation of the remedial action and, where necessary, as a component of the completed remedy. The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy."

RESPONSE - The cleanup assumptions to be used in the study are found the references listed in the SOW. Note that the Letter of Intent is an appendix to the PGDP Site Management Plan; therefore, the cleanup assumptions in the Letter of Intent will be part of the study. DOE recognizes the importance of integrating institutional controls with other potential remedial actions. The information developed during the planned project will be used in future decision-making as suggested in the comment. No change was made to the SOW in response to this comment.

KYDWM – "General Comment: If at the conclusion of the study the Department determines to move forward with further consideration of property acquisition as part of the overall remedy for the site, then the process should be formulated within the CERCLA framework to include stakeholder involvement. It should be noted that any ecological concerns must be addressed within the framework of the CERCLA process as well."

RESPONSE – Material in comment will be considered as part of follow-up activities during remedy selection. No change to SOW made in response to comment.

Comment Received from Bill Tanner on April 20, 2006:

Bill Tanner – "A buyout plan should never be forced. To use buyout as a reason for reduced levels of cleanup is immoral."

RESPONSE – Completion of this study is not meant to imply that the scope of the cleanup will be reduced. No change made in the SOW in response to this comment. DOE will be sure to include this point in future briefings to the CAB and public.

Comment from John Razor, Sr. Vice President Shaw E&I (currently Program Manager for Paducah Remediation Services) in email dated April 6, 2006:

John Razor – "Bill at your request I have reviewed the SOW for the property acquisition near PGDP. I feel the SOW is well written and should generally provide the contractor a good understanding of what the needs of the Department are. The only area that I think needs consideration is the meaning of 'protection of public health and the environment.' While it is unclear what Congress meant precisely, I think that clear direction from the Department is essential to getting the work product that is desired. This will be critical in defining the remedial action goals to which comparison is made in tasks 5, 6, and 7."

RESPONSE – A footnote defining "protection of public health and the environment" was added to the SOW's Project Mission. This footnote states "For this project, the definition of "protection of public health and the environment" will be consistent with the U.S. Environmental Protection Agency acceptable risk range of 10-4 to 10-6 and a hazard quotient less than 1."

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ATTACHMENT H-3

PADUCAH SUN ARTICLE APRIL 16, 2006

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Neighbors of plant again hear talk of DOE land buyouts

By **Joe Walker** jwalker@paducahsun.com--*270.575.8656*

Sunday, April 16, 2006

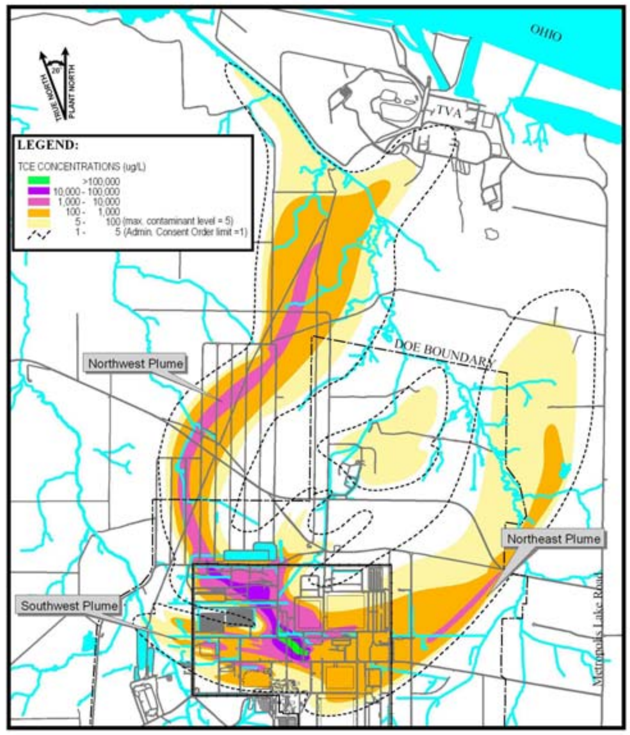
Linda Long doubts the federal government could possibly offer her and her neighbors enough money to give up the land they love, even if it is contaminated from past practices at the Paducah Gaseous Diffusion Plant.

"I can't imagine Congress appropriating enough money to adequately compensate us if we had to move," Long said. "It would be hard to find someplace else to go that would be suitable."

Long, who lives on Ogden Landing Road just north of the plant, is a charter member of a decade-old citizen's board that advises the Department of Energy on cleanup issues. Board members have been asked for quick feedback on a feasibility study for buying the land or taking purchase options, if owners are interested. The board will meet again Thursday.

Although it is unclear how much the property is worth, economic development officials estimated four years ago that such a buyout would cost $15 million.

The final report is tentatively scheduled for release this fall, following two presentations before the board and two public meetings to discuss needed changes.



U.S. Department of Energy
The Department of Energy is studying whether to offer to buy land containing three large plumes of trichloroethylene-contaminated groundwater that flow north of the Paducah Gaseous Diffusion Plant, shown in the lower center of this map. TCE concentrations range from 1 to more than 100,000 parts per billion. The federal drinking water limit is 5 parts per billion, or five drops in a large swimming pool.

Board members were notified this month that DOE plans to hire the Kentucky Research Consortium for Energy and Environment, located at the University of Kentucky, to do the study.

Congress required DOE to consider acquiring some or all of the 9,500 acres containing an estimated 10 billion gallons of contaminated groundwater flowing from the plant to the Ohio River. The study will determine if the purchase "is in the best interest of taxpayers.

Besides pumping and treating groundwater and cleaning up contamination, DOE spends $70,000 to $100,000 a year providing municipal water to 121 homes and businesses in the polluted area. Long has received free water since traces of trichloroethylene contamination were found in her well in 1988. TCE, once liberally used as a degreaser at the plant, is the chief groundwater pollutant.

Despite the problem, Long has no desire to move. “I have a sentimental attraction to where I live, on a farm where I was born in 1932,” she said.

Her great-grandmother was the daughter of Bishop Boldry, whose family moved here from Tennessee in the 1850s and founded Harmony Baptist Church. Boldry School Road, which runs north off Ogden Landing Road, was named after the family, she said.

Many of the plant’s neighbors are descendants of the family “and have an attachment to where they live,” Long said.

“That’s why so many people in Grahamville are related to the Boldrys and the Longs,” she said. “I’ve talked to some of the people, and they feel the same way.”

Long said she’s biased because her family lost land to the government during World War II for the Kentucky Ordnance Works, just west of the plant.

The report is to consider methods of buying the land while allowing residents to continue living on the property for now but eventually transferring full title to DOE. Another possibility is implementing deed restrictions on water usage, and buying purchase of water or mineral rights.

The study sprang from an advisory board recommendation in March 2004. Federal legislation followed last fall, pushed by the Kentucky delegation.

Advisory board member John Anderson said the work is less comprehensive than what was proposed by the Paducah Area Community Reuse Organization, an economic development group that he directs. PACRO had called for an independent study of various uses of the plant once it closes starting in 2010, including the buyout scenario.

Anderson said he is encouraged because Sen. Mitch McConnell, R-Louisville, who led the land-study legislation, also pushed successful legislation in the late 1990s creating the Clark’s River National Wildlife Refuge.

“People in Clark’s River Bottom got paid fairly, and those who didn’t want to move were allowed to stay there with life estates,” he said. “There was no taking of land.”

Ruby English, who has lived on Metropolis Lake Road near the plant for 35 years, said she doesn’t put much stock in the study because DOE has been unable to clean up the groundwater.

“If I offered to sell you my farm, and I told you it was contaminated, would you buy it?” she asked.

She is among about 135 people owning 82 pieces of land who joined a 1997 federal lawsuit alleging former plant contractors poisoned and devalued their land.

The suit remains before the U.S. 6th Circuit Court of Appeals after being dismissed in Paducah in early 2004.

All staff photographs are available for purchase.
Please call 270-575-8682 or 270-575-8683.

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ATTACHMENT H-4

PGDP CITIZENS ADVISORY BOARD MEETING PRESENTATION

JUNE 15, 2006

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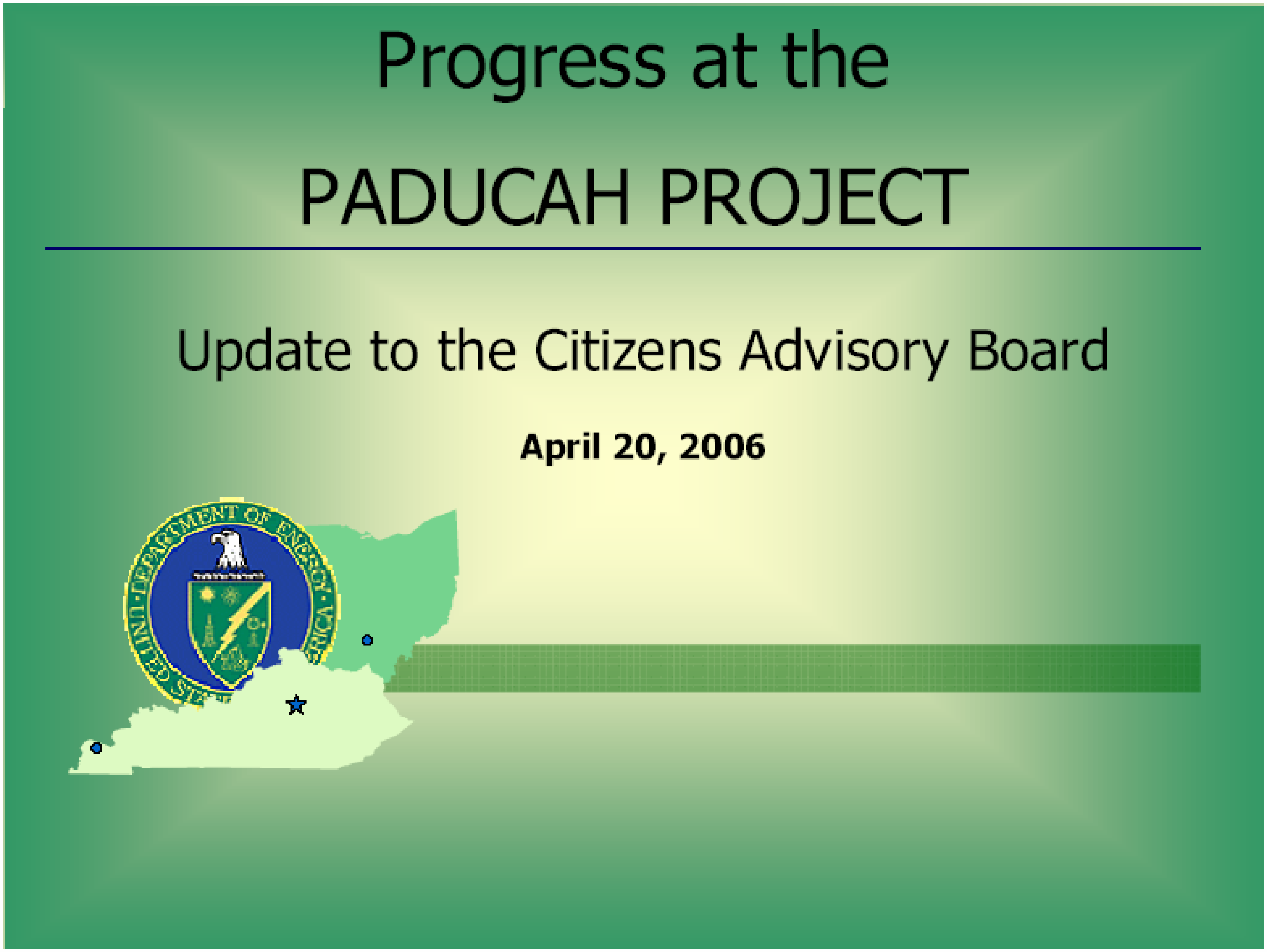
Progress at the
PADUCAH PROJECT
Update to the Citizens Advisory Board
April 20, 2006
DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

Property Acquisition Study

Background

- The study is being conducted at the direction of Congress in accordance with 2006 Energy and Water Development Appropriations Act

  "Within the funds provided the Department shall undertake a study to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and the environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of the taxpayers."

- A Statement of Work (SOW) was developed with the participation of the Kentucky Research Consortium for Energy and Environment (KRCEE) located at the University of Kentucky

- The SOW was sent for review and input to stakeholders (public and regulatory agencies) on April 5

Property Acquisition Study

Plans

- After revision of SOW based on review and input from stakeholders, DOE expects to award a grant to KRCEE to perform the study
- Per current SOW, KRCEE will:
  - Identify properties overlying and adjacent to groundwater plumes and along creeks
  - Delineate approaches and costs to acquire property or interests in property that result in protection of human health and the environment
  - Identify current remedial action assumptions (taken from reports such as Feasibility Study for the Groundwater Operable Unit)
  - Compare costs of acquisition against costs of cleanup under current remedial action assumptions

Property Acquisition Study

Alternatives to be considered within the land purchase study

- Option to purchase property with allowance for near-term occupation by current owner (e.g., life estates)
- Implementation of deed restrictions on groundwater usage with no title transfer
- Purchase of water or mineral "rights"

Performing the Study will not affect the current Water Policy

The selection of specific cleanup actions made following the completion of the Study will be in accordance with applicable law and agreements, including public participation

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ATTACHMENT H-5

PGDP CITIZENS ADVISORY BOARD

ABBREVIATED MINUTES JUNE 15, 2006

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Working for the future

Paducah Gaseous Diffusion Plant CITIZENS ADVISORY BOARD

PADUCAH GASEOUS DIFFUSION PLANT CITIZENS ADVISORY BOARD

111 Memorial Drive • Paducah, Kentucky 42001 • (270) 554-3004 • paducahcab@bellsouth.net • www.pgdpcab.org

Paducah Gaseous Diffusion Plant Citizens Advisory Board Meeting Minutes
June 15, 2006

The Citizens Advisory Board (CAB) met at the CAB office in Paducah, Kentucky, June 15, 2006, at 6 p.m.

Board members present: John Anderson, Allen Burnett, Judy Clayton, Shirley Lanier, Bobby Lee, Linda Long, Elton Priddy, Jim Smart, Rhonda Smith and James Tidwell

Board member absent: Chad Kerley, Janet Miller and John Russell

***Ex Officio* members and related regulatory agency employees present:** Brian Begley, Brian Baker and Bill Clark, Kentucky Division of Waste Management; Tim Kreher, Kentucky Department of Fish and Wildlife Resources; David Williams and Debbie Vaughn-Wright, Environmental Protection Agency

Deputy Designated Federal Official present: Rachel Blumenfeld

DOE Federal Coordinator present: Jeff Snook

DOE-related employees present: Rich Bonczek, Jeannie Brandstetter, Yvette Cantrell, Bryan Clayton, Kim Crenshaw, Ken Davis, Bruce Gardner, Guy Griswald, Steve Hampson, Steve Kay, Reinhard Knerr, Jim McVey, Lindell Ormsbee, Bruce Phillips, Pat Presley, Mike Spry, Joe Tarantino, Barry Tilden, and John Volpe

Four members of the public attended the meeting.

PGDP Property Acquisition Study *Attachment 3*

Ormsbee provided a presentation on the Paducah Gaseous Diffusion Plant Property Acquisition Study. Questions and answers (paraphrased) appear below.

Questions/comments	Answers
Mr. Williams – In task #5, I interpret that to mean changing the points of compliance.	**Mr. Ormsbee** – We interpret that as looking at the remediation options that have been identified in the Feasibility Study for the Groundwater Operable Unit. For each option, we will be looking at what the concentration would be at specific points and what additional institutional controls would be necessary to protect the public if that option were to be implemented.
Mr. Williams – In the discussion of the point of compliance for the Southwest Plume, which was used for calculations of remedial action to reach the mcl of that point of compliance, you would be moving that point of compliance because you bring the property into the DOE. The people would be moved out of the area of the plume, therefore, they would not be exposed. In the discussions for reuse of the property, these points of compliance are only good if it remains DOE property. Once reuse is discussed, it is a whole new ballgame. People, industries and reuse are brought back in with the transfer of DOE property. It would be a short-term solution. For long-term to be achieved, the property would need to be acquisitioned to an entity such as for a golf course.	**Mr. Ormsbee** – We will be looking at analysis of concentrations at various points from the property to the fence and points beyond that. We are not considering moving the points of compliance. We are looking at cost breakdowns and analysis and the scope of the study is not related to the consideration of regulatory issues with regards of compliance or point movement. We are mainly looking at costing out institutional controls options with regard to remediation options that have been already laid out in the groundwater operable unit strategies.

Mr. Williams –I want to point out that the EPA HQ Federal Facilities Remediation Office, the Federal Facilities Enforcement Office, as well as our lawyers are digesting this. This issue is not new to EPA. It is an issue that we have gone around on with various federal facilities and projects for years. The question is if I never sell this property then that means I do not have to remediate the plume and the answer is no. You still have to remediate the plume. This is just a land use control.	**Ms. Blumenfeld** – We were directed by Congress to do the study. **Mr. Ormsbee** – We are looking to stay on the right side of the regulatory issue fence. We are not looking at that issue. We recognize there are implications here, but that is not KRCEE's responsibility to address that.
Ms. Lee – Will potential future reuse of the site impact remediation strategies and are you going to make those considerations when you do the analysis? To the community, that is an important component.	**Mr. Ormsbee** – We do recognize that there could be some potential reuse of the property. We will look at the property acquisition options that might allow that to occur. We are going to try to look at a wide range of remediation options and different property acquisition options that will include information that will provide some insight to that answer but it is not finalized at this point. We are looking at different options to acquire the property.
Mr. Williams – As a case in point, for instance, with a private property holder, it is very difficult to enforce a restriction on drilling a well as it is right now. However, if DOE were to take possession of that property and then transfer it again, they could put in place in the deed of transfer longer restrictions.	**Mr. Ormsbee** – Yes, that would restrict that type of drilling to take place.
Ms. Smith – In task #1, on June 29, will you have a graphic depiction of what areas or property will be considered in the study.	**Mr. Ormsbee** – We do not intend on picking individual properties. We will be looking at clusters of properties. Based on the preliminary analysis, we are starting with the Water Policy area as a possible suite of properties that could be impacted. The plume is currently identified to be included in the study and that could move either direction east or west. It may pick up a buffer east of Metropolis Lake Road. We are looking at non-DOE property including TVA property and the Wildlife Management Area around 9,000 acres.
Ms. Smith – My concern is for the public to be knowledgeable and to generate interest. Will you be advertising the location, such as a one-page ad?	**Mr. Ormsbee** – It will be publicized but I do not know the size if the ad. **Ms. Blumenfeld** – It is not usually a full page.

Ms. Long – Some of the people that live around me do not take the paper. A letter needs to be mailed to all the people that could be affected.	**Mr. Ormsbee** – It is intended that all property owners that will be impacted by the results of the preliminary analysis will be contacted individually. **Ms. Blumenfeld** – The public property records will be used to obtain contact.
Ms. Smith – In addition to the possibility of a one-page ad, in there anything this Board can do to help publicize the meeting? We could share half of the expense for the ad.	**Mr. Ormsbee** – We would be glad to partner with the CAB to help publicize the meeting. **Ms. Blumenfeld** – She asked Bonczek to work with Smith, Ormsbee, and Snook to coordinate the publicity of the meeting.
Ms. Lee – Is there a way to get some of the information in GIS format for mapping that the CAB is doing in order to communicate with the public. Is the information and software available to the public?	**Mr. Ormsbee** – The maps will be generated by a GIS system. The product is being developed for DOE so it would be their call on who the maps would be shared with. **Ms. Blumenfeld** - We would look at sharing information. Sometimes there is proprietary information that has to do with the software license, but our intent is to support your mapping efforts. **Mr. Ormsbee** – All of the software used is GIS. **Mr. Williams** – It is my understanding that McCracken County does not currently have the property boundaries in GIS format. **Ms. Ormsbee** – We have some GIS coverages that identify all of the parcels from the Engineering Office. We already have a preliminary data set and are working on additional coverage to the east of Metropolis Lake Road. We are also communicating with the Property Valuation Administration (PVA) office to pull all of the information together.
Mr. Kreher – In task #3, what are the development of cost estimates based upon? Will they be based on the average value acre of farmland sold in Kentucky over the past year ?	**Mr. Ormsbee** – We are trying to be more geographically specific than that. That is why we are in contact with the PVA office to get an idea of property value specific to this locale around the facility and range of cost relative to specific land use issues.
Mr. Kreher – Acquiring a group of property is supposed to be a cost efficient practice. If you are assuming that the land could be purchased, for example, for \$2500 an acre but one of the property owners in that group will not accept	**Mr. Ormsbee** – We will look at fair market value for the properties and conduct some sensitivity analysis on those perimeters to look at some ranges beyond that to get an idea of the potential impact of those types of variables.

ATTACHMENT H-6

DOE PUBLIC MEETING ANNOUNCEMENT

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You are invited to a DOE public meeting….to discuss the start of a Congressionally directed U.S. Department of Energy (DOE) study on potential property acquisition above the plumes of contaminated groundwater near the Paducah Gaseous Diffusion Plant. DOE has tasked the Kentucky Research Consortium for Energy and Environment (KRCEE) to conduct the study. Meeting topics include project scope and methodology for the study. A report on the results is due to DOE in Fall 2006.

DOE public meeting time and location:

Thursday, June 29, 2006
6:30 p.m. to 8:00 p.m.
at the West Kentucky Wildlife Management Area Clubhouse
10535 Ogden Landing Road
(2.6 miles west of Grahamville)

Directions: From Paducah: 7 miles from I-24, exit 4, west on US 60. At Future City, turn north onto KY 996 for 3.6 miles. Turn west on KY 358 for 2.6. If you need special accommodations to attend this meeting or have questions, please call 270/441-5023.

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ATTACHMENT H-7

DOE PUBLIC MEETING PRESS RELAEASE

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DOE NEWS

NEWS MEDIA CONTACTS:
Laura Schachter, DOE Public Affairs, 859/219-4010 June 22, 2006

News Media Advisory

ENERGY DEPARTMENT TO HOST PUBLIC MEETING JUNE 29TH TO BEGIN A STUDY OF POTENTIAL PROPERTY PURCHASE NEAR THE PADUCAH GASEOUS DIFFUSION PLANT

WHO: Officials from the U.S. Department of Energy and the Kentucky Research Consortium for Energy and Environment.

WHAT: The U.S. Department of Energy will host a Public Meeting to discuss the start of a Congressionally directed U.S. Department of Energy (DOE) study on potential property acquisition above the plumes of contaminated groundwater near the Paducah Gaseous Diffusion Plant. DOE has tasked the Kentucky Research Consortium for Energy and Environment (KRCEE) to conduct the study. Meeting topics include the project scope and methodology KRCEE will use for the study. A report on the results is due to DOE in Fall 2006.

WHEN: Thursday, June 29, 2006, from 6:30 p.m. to 8:00 p.m.

WHERE: Clubhouse at the West Kentucky Wildlife Management Area, 10535 Ogden Landing Road (KY 358), 2.6 miles west of Grahamville, KY

Directions: From Paducah: Take US 60 to Future City. Turn north onto KY 996 for 3.6 miles. Turn west on KY 358 for 2.6 miles

-DOE-

R-06-023

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ATTACHMENT H-8

DOE PUBLIC MEETING PRESENTATION JUNE 29, 2006

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U.S. Department of Energy

Portsmouth/Paducah Project Office

PGDP Property Acquisition Study

PGDP Public Informational Meeting
June 29, 2006

Presented by
Richard Bonczek, PhD
U.S. Department of Energy, Portsmouth/Paducah Project Office (PPPO)
and
Lindell Ormsbee, PhD, Director
Kentucky Research Consortium for Energy and Environment (KRCEE)

Background

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

2

Background

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

"Within the funds provided the Department shall undertake a ***study of the potential purchase of property or options to purchase property***

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

3

Background

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located ***above the plume of contaminated groundwater*** *near the facility site.*

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

4

Background

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate ***protection of human health and environment from exposure to contaminated groundwater***

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

5

Background

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the ***best interest of taxpayers****."*

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

6

Overview of Project Tasks

- Identify properties that overlie contaminated groundwater or are along Bayou and Little Bayou Creeks.
- Evaluate approaches and estimate costs to acquire property or interests in property associated with contaminated groundwater or along creeks.
- Identify cleanup assumptions presented in earlier reports.
- Develop costs for acquisition options and cleanup options and compare these costs.

7

Examples of Property Interests Being Evaluated

- Outright purchase of land.
- Purchase of property in a manner that allows the current owner to stay on the property as long as they live.
- Purchase the right to place deed restrictions on groundwater usage without purchase of land.

Such options could prevent use of contaminated groundwater.

8

Key Points

- Performing the Study will not take away any commitments made under the current Water Policy.
- The Study's report will not be a decision document.
- The selection of specific future cleanup actions and development of decision documents will be in accordance with applicable law and agreements, which require public participation and regulatory approval.
- The information developed by the Study will be available for use in future decision documents.
- Details concerning property acquisition, if any, would appear in the future decision documents.

9

Project Team

- Kentucky Research Consortium for Energy and Environment
- University of Kentucky College of Law
- University of Kentucky College of Agriculture
- University of Kentucky College of Engineering

10

Key Points

- **Performing the Study will not take away any commitments made under the current Water Policy.**
- **The Study's report will not be a decision document.**
- **The selection of specific future cleanup actions and development of decision documents will be in accordance with applicable law and agreements, which require public participation and regulatory approval.**
- **The information developed by the Study will be available for use in future decision documents.**
- **Details concerning property acquisition, if any, would appear in the future decision documents.**

11

Project Tasks

- **Identify properties above contaminated groundwater plumes or are along creeks**
  - Properties will be evaluated as a group rather than individually
  - Initially consider those properties within the Water Policy area
  - Examples of types of property
    - Federal
    - State
    - Private

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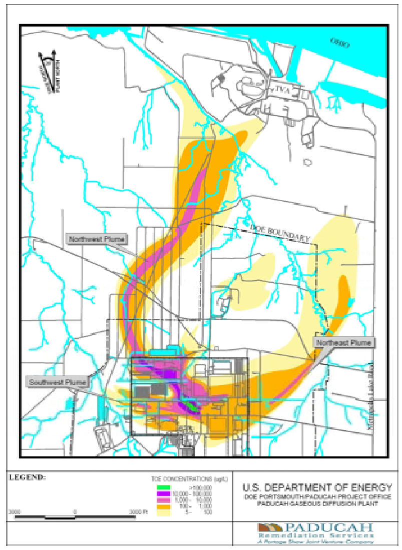
TCE Plumes at PGDP

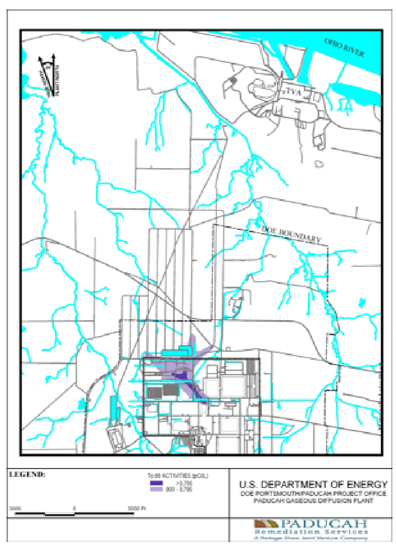
Area Where TCE Contamination Exceeds the Maximum Contaminant Level (MCL)



13

Tc-99 Plumes at PGDP

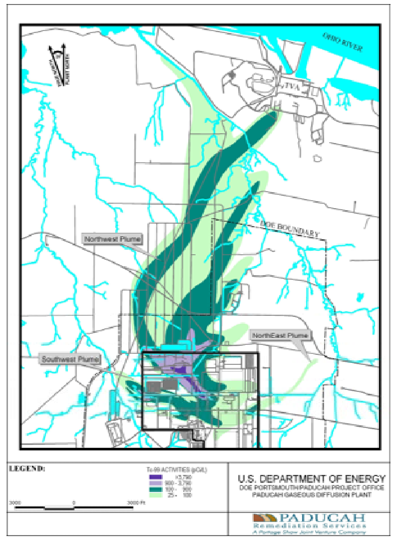
Area Where Tc-99 Contamination Exceeds the Maximum Contaminant Level (MCL)



14

Tc-99 Plumes at PGDP

Area Where Tc-99 Contamination Has Been Detected Above 25 pCi/L



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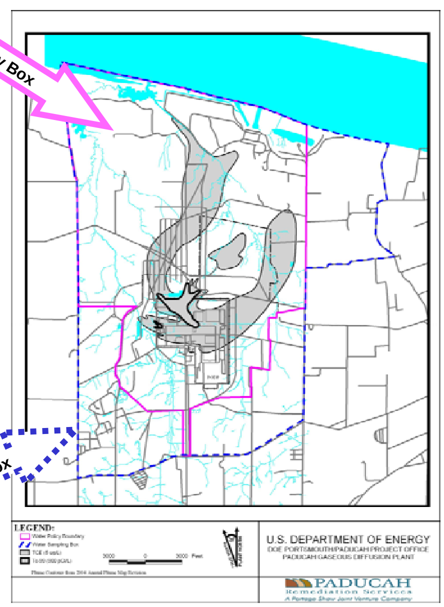
Water Policy Area

Implemented in June 1994.

- Provides municipal water to residences in the Water Policy Box.
- Owners agree not to use groundwater.
- Agreements are renewed every 5 years.

Water Policy Box



Water Sampling Box

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Project Tasks

- **Identify property acquisition options**
  - Fee simple (Outright purchase of title)
  - Life estates (Buy title; owner stays on property)
  - Easements (Purchase restrictions on use)
- **Determine property acquisition costs**
  - Properties will be evaluated as a group rather than individually
  - Fair market value (consider sales of comparable properties in all of McCracken County)
  - Best possible and expected future use
  - Follow appropriate federal guidelines

17

Project Tasks

- **Catalogue a range of proposed remedial options and select a subset of options for evaluation**
  - Groundwater Operable Unit Studies
  - Surface Water Operable Unit Studies
  - Burial Ground Operable Unit Studies
- **Evaluate and predict how groundwater plumes may change over time using groundwater modeling**
  - Changes in water use at the plant
  - Potential effect from clean-up actions
  - Potential effect from community use of groundwater
  - Natural phenomena

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Project Tasks

- **For each selected remedial option, identify which properties would need to be acquired to protect human health and the environment**
- **Complete an economic analysis of the potential property acquisition options**
  - – Determine cost of selected remedial options
  - – Determine cost of property acquisition options
  - – Total and compare costs

19

Project Tasks

- **Public interaction support**
  - – Four presentations for CAB
    - (June, August, October, and November)
  - – Two presentations for public
    - (June and October)
- **Reporting**
  - – Draft report due to DOE on September 15, 2006
  - – Final report due to DOE on October 31, 2006

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Upcoming Activities

- August 15 – Update Due to DOE-HQ
- August 17 – Update to CAB
- September 15 – Draft Report Due to PPPO
- October 19 – Present Draft Results to CAB
- October – Second Public Informational Meeting
- October 31 – Final Report Due to PPPO
- November 16 – Present Results to CAB
- November 19 – Report Due to Congress

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Contacts

Please send your comments or questions to:

- **Dave Dollins**
  - Email: Dave.Dollins@lex.doe.gov
  - Phone: 270/441-6819
- **Rich Bonczek**
  - Email: Rich.Bonczek@lex.doe.gov
  - Phone: 859/219-4008
- **Laura Schachter**
  - Email: Laura.Schachter@lex.doe.gov
  - Phone: 859/219-4010

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PGDP Property Acquisition Study

Questions and Comments

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ATTACHMENT H-9

DOE PUBLIC MEETING QUESTIONS

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Date	Type	Topic	Question/Comment	Questioner
6/29/2006	W	Basis for Study	Do you have the right to buyout the properties? Is it a law?-Q6	Not available.
6/29/2006	W	Basis for Study	Does the lawsuit we have going on have any bearing on this study? Q-6	Not available.
6/29/2006	W	Basis for Study	Who started all these studys (sic) and went to Congress to ask for these studys (sic)? Q-6	Not available.
6/29/2006	W	Basis for Study	Why did Congress "mandate" this study? What Congressional Committee(s) facilitated this proposal? Q-7	Not available.
6/29/2006	W	Basis for Study	What year did DOE first consider property acquisition as part of the cleanup of PGDP? Q-7	Not available.
6/29/2006	W	Basis for Study	Don't you think it is a waste of taxpayers money to study the studies that has already been done by DOE? Q19	Not available.
6/29/2006	W	Basis for Study	Why does the study compare purchase costs vs cleanup costs? These are separate issues and would advise KY and EPA regulators to watch that DOE doesn't allow property purchase to reduce scope of offsite GW cleanup.	Not available.
6/29/2006	W	Future Property Use	Once acquired will DOE hold the property in perpetuity or will DOE ultimately transfer their interest to another party?	Not available.
6/29/2006	W	Future Property Use	Would you give a life estate to someone 35 years old with a life expectancy of 80 years? Q-7	Not available.

Date	Type	Topic	Question/Comment	Questioner
6/29/2006	W	Future Property Use	Explain what happens when the owner dies, what about the children to inherit the property? Q19	Not available.
6/29/2006	W	Future Property Use	Should we continue to make improvements to our land and homes?	Not available.
6/29/2006	W	Future Property Use	How would a life estate effect (sic) someone who rents property.	Not available.
6/28/2006	P	General	Please explain what the study is about?	Joyce Bender joyce.bender@ky.gov Nature Preserves and Natural Areas Branch Manager Kentucky State Nature Preserves Commission 801 Schenkel Lane Frankfort, KY 40601 T: 502/573-2886 F: 502/573-2355
6/28/2006	P	General	Lives in Arkansas. Owns Property. Please get her information	Jennie Curtis 'jecurtis@sbcglobal.net'
7/7/2006	P	General	Property owner was out of town and received meeting notice when returned. Please explain the study?	Ms. Robbie Anderson Metropolis Lake Road West Paducah, KY 270/488-2377
6/29/2006	W	Maps/Models	How do you make maps? Groundwater modeling what and how water sampling boxes (where)?	Not available.
6/29/2006	W	Maps/Models	What is the number of residential drinking-water wells that are contaminated? Q-7	Not available.
6/29/2006	W	Maps/Models	Lives close to the plant. Wants to know if he is included-does not think his wells are contaminated	Malcolm Beardsley 9775 McCaw Road West Paducah, KY 42086
6/29/2006	W	Maps/Models	How confident are you with the location of the TCE plume? Could it be larger than the maps indicate?	Not available.
6/29/2006	W	Maps/Models	If the contamination plume underlies 5 acres of my 90-acre farm, how much land will I lose?	Not available.
6/29/2006	W	Maps/Models	If my house is 1200 feet from the plume, will you leave me alone?	Not available.

Date	Type	Topic	Question/Comment	Questioner
6/29/2006	W	Previous Studies	Has a health study been done of the area? If yes, what were the results and who did the study? What does the study cover? If there are no health risks, why buy the property?	Joey Wray 6355 Metropolis Lake Road West Paducah, KY 42086 270/559-7915
6/29/2006	W	Previous Studies	Why has a health study of this area not been done?	Not available.
6/29/2006	W	Site Cleanup	If & When & Where has a plume ever been conquered & eliminated? How?	Not available.
6/29/2006	W	Study Basis	Who asked for this study from the Advisory Board?	Not available.
6/29/2006	W	Study Methods/Report	My main concern is that you use a fair and impartial appraiser to assess land value and buildings.	Not available.
6/29/2006	W	Study Methods/Report	Will the table of comments to DOE be attached to the study include the responses by UK & DOE tonight?	Not available.
6/29/2006	W	Study Methods/Report	Please describe the types of legal instruments that could potentially be used under this studies easement option.	Not available.
6/29/2006	W	Study Methods/Report	Are you aware the University of Siberia has done a study of this plant and published a book?	Al Puckett 270/462-3210
6/29/2006	W	Study Methods/Report	What are the changes made in the working project scope from comments received by the public and regulators? How many comments did DOE receive and how can the public get a copy of these comments?	Not available.
6/29/2006	W	Study Methods/Report	What DOE information will this study by Mr. Ormsbee be given? (KRCEE) to do the study? Q-19	Not available.
6/29/2006	W	Study Methods/Report	Will there be any door to door activity? Is so, will identification of workers be made known?	Not available.
6/29/2006	W	Study Methods/Report	How does this study consider any planning McCracken County may be doing for future land use?	Not available.
6/29/2006	W	Study Methods/Report	Can we get a copy of the audio tape of the meeting?	Not available.
6/29/2006	W	Study Methods/Report	You have 9500 acres to buy and $15 million to buy it. That is only $1578.74 per acre. This is well below the market value of some property. Cost of cleanup is well over $1 billion.	Not available.
6/29/2006	W	Study Methods/Report	How will we get a copy of the report for copying?	Not available.

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ATTACHMENT H-10

PADUCAH SUN ARTICLE JUNE 30, 2006

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By Jaclyn Brenning
The Paducah Sun

GILBERTSVILLE, Ky. — Sharon Noffsinger of Muhlenberg County has spent every Fourth of July at the Kentucky Dam Village State Resort Park campground for more than 40 years. Katie, her black and white rat terrier, has been coming for three.

Katie goes everywhere with Noffsinger and the

Attractions 1D

grandchildren. She goes on walks in the park and sleeps in the air-conditioned camper. And she tags along in the family boat to watch the shower of fireworks over Kentucky Lake.

"She's a great little dog," Noffsinger said, scratching between the terrier's ears Thursday afternoon. "You should really see her try to go fishing with us."

Noffsinger is one of about 220 guests in the campground over the holiday weekend.

Her first trip meant sleeping in a truck bed with a tarp stretched over it as a tent. Next was a real tent, then a used RV and finally a new RV.

Please see HOLIDAY / 12A

DOE neighbors question buyout

■ Contaminated water *attracts study of possible property purchases.*

By Joe Walker
Sun Business Editor
jwalker@paducahsun.com

Glenda Wray shook her head at the idea of a $300,000 study to help the federal government decide whether to offer to buy contaminated land around the Paducah Gaseous Diffusion Plant.

"We don't want to sell our property," she said, "and we don't want somebody else taking it to resell for industry."

She and her son, Joey Wray, both residents of Metropolis Lake Road just east of the plant, were among about 80 people who attended a Department of Energy meeting Thursday night to discuss the congressionally mandated study. The meeting was held immediately behind the plant in the West Kentucky Wildlife Management Area clubhouse, whose well is contaminated and capped.

Many in attendance were among the 121 plant-neighboring households and businesses who have received free municipal water from DOE since 1994 because of an es-

Please see WATER / 11A

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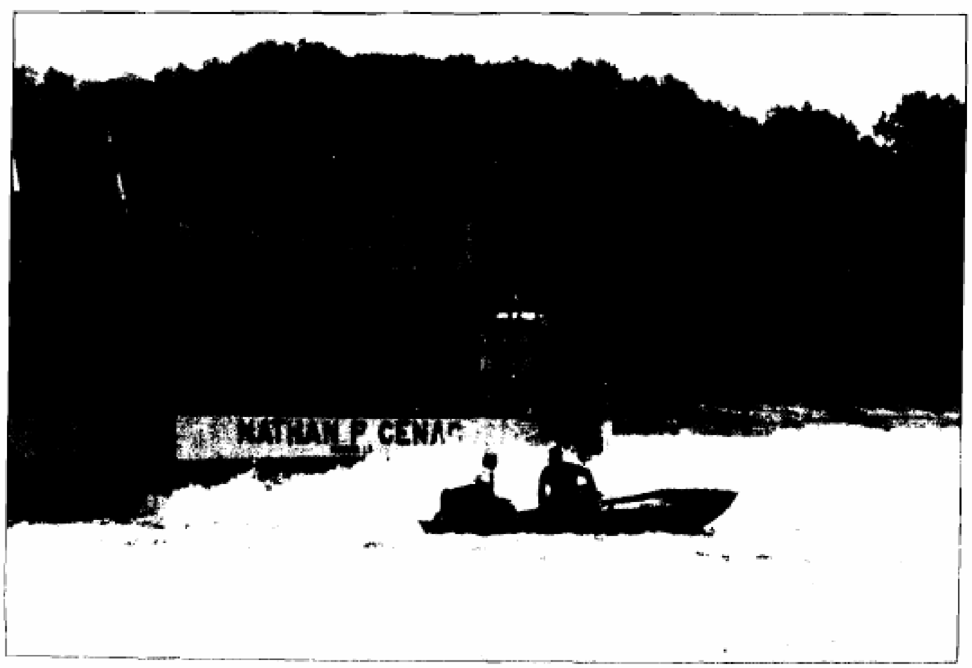

Photo by Jeff Yates

Close quarters: Two men continue fishing after their small boat is rocked by the wake of the

Contamination near plant ...

Continued from 1A

timated 10 billion gallons of contaminated groundwater. The area is 60 to 120 feet deep, flows from the plant to the Ohio River and chiefly contains trichloroethylene once liberally used by plant workers as a degreaser.

"It's another example to me of a waste of money," Joey Wray said. "They keep saying there's no health risk from it. If there's no health risk, why bother?"

The Wrays were among about 135 people owning 82 pieces of land who joined a 1997 federal lawsuit alleging former plant contractors poisoned and devalued their land. The suit remains before the U.S. 6th Circuit Court of Appeals after being dismissed in Paducah in early 2004.

Joey Wray said his and his mother's wells were sealed by DOE in return for getting free municipal water. He said they were told their wells are contaminated, but have never seen information to verify that.

Vicki Jurka of Golconda, Ill., asked how many private wells near the plant are contaminated above drinking water standards. DOE's Rich Bonczek said he was not sure, but that information would be made available to residents.

Afterward, Jurka said she understands there are five contaminated wells, but has asked for six years and never received an official answer. A member of the watchdog group Active Citizens for Truth, she is concerned about radioactive substances being in vegetables near the uranium enrichment factory.

The meeting kicked off the study, which sprang from a plant citizens' advisory board recommendation in March 2004. DOE has hired the University of Kentucky-based Kentucky Research Consortium for Energy and Environment to do the work. A draft report is due Sept. 15 and a final report Oct. 31. Another public meeting will be held in October.

Bill Murphie, who oversees DOE cleanup work at the plant, said the study will determine the cost-efficiency of a buyout but will not make recommendations. "Purchasing property like this is kind of an extraordinary measure ... The default is to not do that."

But the groundwater contamination "doesn't speak well of DOE's past practices," he said. The area is one of the largest in the nation, Murphie said, adding that the study will help DOE decide long-term cleanup options.

Consortium director Lindell Ormsbee said his group will evaluate a range of land-cleanup alternatives in terms of cost and protecting public health and the environment. The information will be used by DOE in meeting the federal legislation, which requires studying whether a buyout "is in the best interests of taxpayers."

Ormsbee said the study will focus on land under which U-shaped contaminated groundwater flows. Radioactive technetium, another pollutant, is mainly confined to the plant grounds, he said.

Public and private land will be evaluated in blocks at fair market value as compared with other property in McCracken County. Among the options considered will be outright purchase, buying the land but allowing residents to stay, or purchasing easements.

Ragland bond set at $1 million

Associated Press

LEXINGTON, Ky. — A man accused of murdering a University of Kentucky football player must post a $1 million bond to be released pending his second trial, a judge ruled Thursday.

Shane Ragland, accused of shooting Trent DiGiuro in 1994, sought a lower bond. Fayette Circuit Judge Thomas Clark also stipulated that Ragland pay for an electronic monitoring program and refrain from drugs.

ATTACHMENT H-11

LOUISVILLE COURIER-JOURNAL ARTICLE JULY 10, 2006

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courier-journal.com
The Courier-Journal | Louisville, Kentucky

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Sunday, July 10, 2005

U.S. may study buyout around Paducah plant

Chemicals tainted land's groundwater

By James R. Carroll
The Courier-Journal

KEVIL, Ky. -- Ronald Lamb was outraged and demanded government compensation after discovering in 1994 that his water well had been tainted by pollution from the nearby Paducah Gaseous Diffusion Plant.

Now, Lamb said he's intrigued by a measure before Congress calling for the government to study buying the properties of families whose homes and farms sit on top of a plume of groundwater contaminated by degreasing solvents and radioactive chemicals.

"At one time I would not have sold, but if the price was right I would listen," said Lamb, a mechanic who unsuccessfully sued over the pollution. "I hope they don't think they will get it for nothing."

It's not clear how much Lamb and other owners of about 120 homes sitting above 10 billion gallons of contaminated groundwater might get, or how ongoing cleanup efforts would be affected.

But in 2002, local economic development officials estimated such a buyout would cost about $15 million.

The department is being asked to look into the purchases as a way of saving the government money, according to language inserted by Sen. Mitch McConnell, R-Ky., into the $31.2 billion spending bill for energy and water projects.

"It sounds to me like cut and run," Steve Ellis, vice president of the citizens group Taxpayers for Common Sense, said of how a buyout might affect the cleanup. "I don't think buying people out is the solution."

Tony Hatton, assistant director of the Kentucky Division of Waste Management, which oversees the environmental cleanup at the Paducah plant, said he couldn't see how the federal government would view buying the land as "fitting into any type of remedy" for getting rid of the contamination.

State officials would expect to be brought into the decision and discussions about its effect on the cleanup, Hatton said.

McConnell, who has said he supports the ongoing cleanup, said a study could answer important questions about what would happen to those efforts if the government buys the land.

The measure passed the Senate 92-3 on July 1 and now goes to a conference with the House, which did not include a similar provision.

Limiting liability?

The contaminated groundwater plume, discovered in 1988, is under about 9,500 acres. It contains the solvent trichloroethylene and radioactive technetium-99, both of which originated in the plant, which produces fuel for nuclear power stations.

Some critics say a buyout would limit the government's future liability for cleaning up the contamination. Other critics wonder what taxpayers have to show for the $178 million spent on various studies and experimental antipollution technologies, some of which were tried and then abandoned.

"As far as any major results, there aren't any," said Mark Donham, an environmentalist who was the former chairman of the citizens' advisory board that oversaw the plant's cleanup.

But Jim Smart, an associate engineering professor at the University of Kentucky's campus in Paducah who also serves on the advisory board, said it has taken time to evaluate different technologies and to properly study and map the contamination.

"Maybe looking back, the money could have been spent wiser, but that's hindsight," he said.

The Energy Department for about a decade has been paying the West McCracken Water District about $65,000 a year to provide free municipal water to homes whose well water was tainted by the pollution.

How long a buyout study would take and what would happen to the land after the government bought it is unclear.

Energy Department spokeswoman Laura Schachter said everything the study would cover hasn't been worked out yet, but part of its scope would be "does this effectively help with reducing risks to people and to the environment?"

Using the land

Some local officials think a buyout would clear the way for local industrial development on the land. But others doubt any company would be attracted to an area dotted with chemical and radioactive contamination.

Schachter insisted her agency is not giving up on the cleanup. She acknowledged the department has talked about studying a buyout, but "later down the line."

"We'll follow the will of Congress," Schachter said of McConnell's request for the study.

Ken Wheeler, chairman of the Greater Paducah Economic Development Council, said the buyout issue originated with the Paducah Area Community Reuse Organization, a federally funded panel looking to offset job losses at the plant and its eventual closing.

In a telephone interview, Wheeler suggested the private property might be consolidated for a more appropriate use. The reuse group in the past has suggested using sites at and around the plant for an industrial park or manufacturing.

Wheeler said he thought the cleanup would continue, regardless of the study's findings.

"The study is to decide on a course of action and assess the interests of the owners," he said.

McConnell learned of preliminary conversations on a buyout late last year and sent a letter to the Energy Department in December asking about the implications of purchasing property near the plant.

Among other things, McConnell wanted to know why the buyout was being looked at as an option for dealing with the contamination, whether such a purchase would save money that could be used for other cleanup projects, and whether buying land over the plume might affect cleanup commitments

"While I understand this proposal may allow (the Energy Department) to reduce its cleanup efforts off-site, I am concerned that this approach may be used as a rationale to discontinue efforts to clean the source of the contamination at the plant site," McConnell wrote to Paul Golan, then the Energy Department's acting assistant secretary for environmental management.

Neighbors

Although a buyout is only conceptual, it would involve about 120 families from the Heath-Grahamville area whose homes or land sit over the plume.

"If the money's right, I'll sell anything," said Christopher Johnson, who is raising a family on 10 acres and says he likes rural living. "But they will have to dish out some dollars for me to leave."

But others question whether a buyout could lead to the government using eminent domain to force families off their land.

Bill Tanner, superintendent of the West McCracken Water District and a former member of the citizens' advisory board, doubted the site would appeal to any industry unrelated to nuclear activities or the plant cleanup.

"You're not going to get a General Motors to come in there," Tanner said.

Donham said the key will be establishing a fair market value for the property.

"How do you value two decades or more of living in a toxic environment, having family members getting ill, and seeing the value and heritage of your property go downhill?" he asked. "Yet the government won't compensate for this, and I foresee a lot of bitterness if the government tries to take this property on the cheap."

The reporters can be contacted at jmalone@courier-journal.com and jcarroll@courier-journal.com

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ATTACHMENT H-12

INTRODUCTION TO CAB PRESENTATION SEPTEMBER 21, 2006

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Land Acquisition Study

- The Land Acquisition Study is being conducted in response to a Congressional Directive and is not an independent DOE initiative.
  – KRCEE selected to conduct this study.
- The Land Acquisition Study is not a decision document
  – Will result in data and information that will be considered in future cleanup decisions at the PGDP.
- Any future cleanup decisions at the PGDP would be made in accordance with applicable law, would provide for public participation, and would have to comply with standards to ensure the protectiveness of future cleanup actions.
- DOE intends to continue working with the local community and the CAB to address concerns.
- DOE remains committed to protective cleanup at the PGDP.

- DOE has not yet reviewed or evaluated the technical basis or results of the study.
- The purpose of this presentation is for KRCEE to provide the CAB with an overview of its work to date.

ATTACHMENT H-13

CAB PRESENTATION SEPTEMBER 21, 2006

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PGDP Property Acquisition Study

CAB Presentation

September 21, 2006

Presented by Lindell Ormsbee,
Director; Kentucky Research Consortium for Energy and Environment (KRCEE)

Agenda

- Project Goals
- Project Task Status
  - Potential Remedial Action Alternative Analysis
  - Groundwater Modeling
  - Property Acquisition Potential Options
  - Property Acquisition Potential Costs
  - Economic Analysis
- Future Activities

2

Project Goals

- **The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.**

  "Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers."

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

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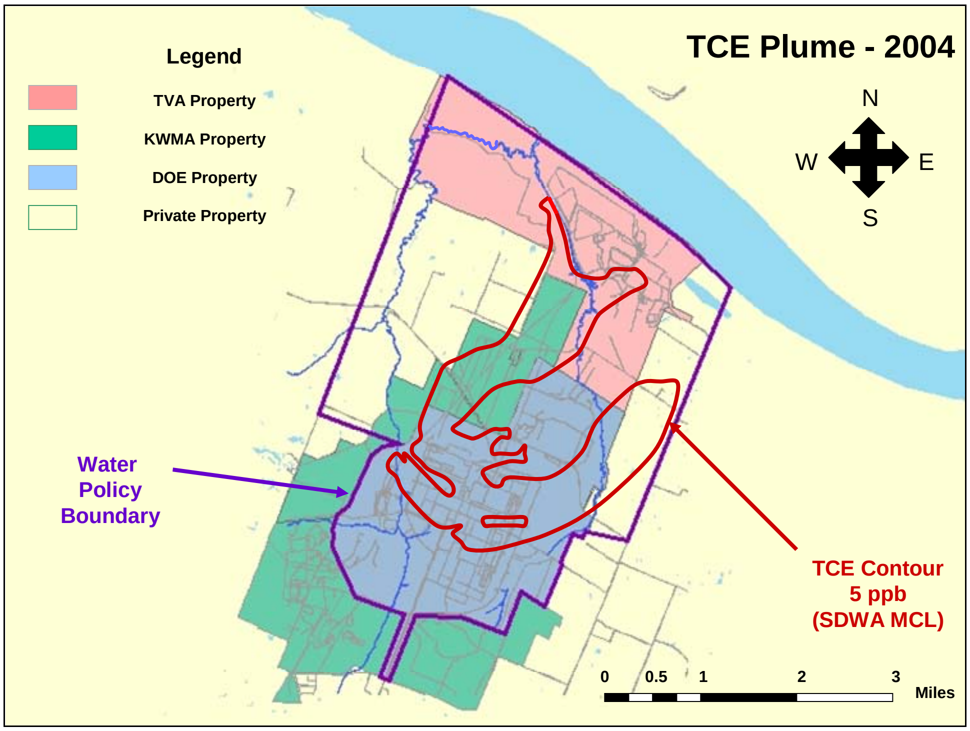
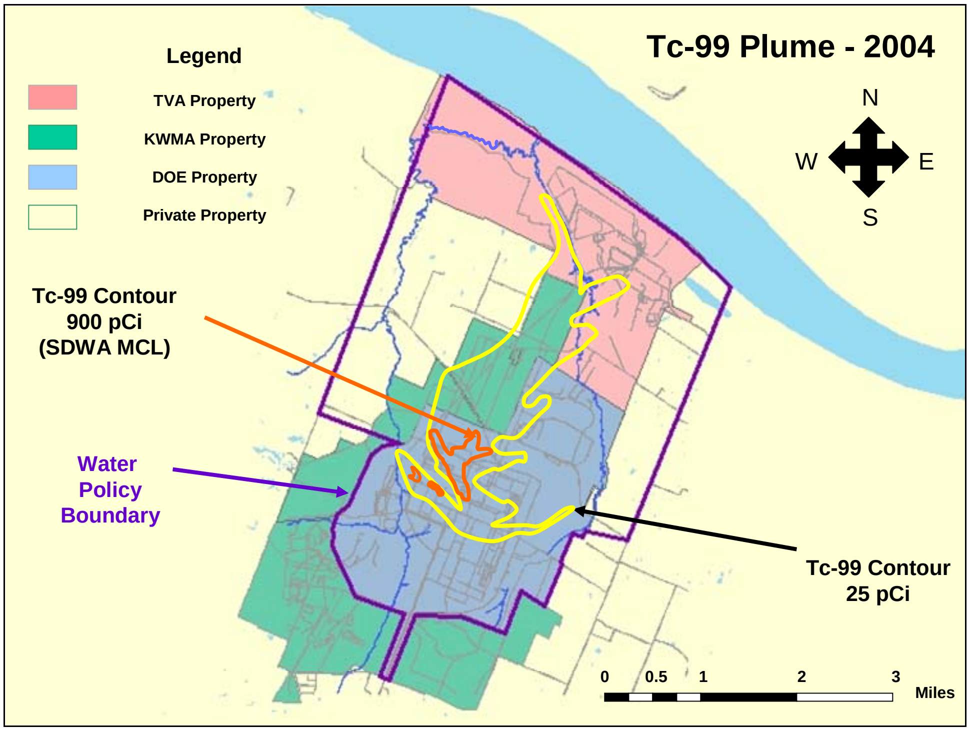
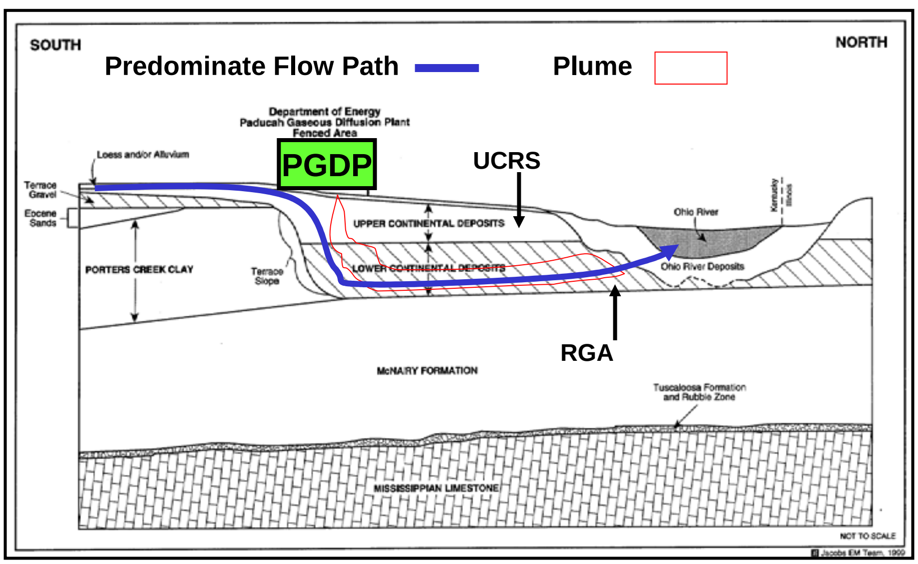




Conceptual Site Model



Sources of Groundwater Contamination

- **Primary source is a source in the UCRS**
- **Secondary source is a source in the RGA (DNAPL)**
- **TCE Source Areas**
  - **C-400 Building area**
  - **SWMU 4 C-747 Burial Ground**
  - **SWMU 1 Former Oil Landfarm**
  - **C-720 Building area**
- **^{99}Tc Source Area**
  - **C-400 Building area**

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Potential Remedial Action Option Analysis

- **Based on remedial action options taken from the most recent groundwater feasibility study (FS)**
- **Options considered are:**
  - **No Action**
  - **Existing Pump and Treat**
    - **Continuation of existing pump and treat systems**
  - **Treat UCRS (Primary) Sources**
    - **Remove 95% of TCE found in soil down to 45 ft below surface (UCRS)**
  - **Treat RGA (Secondary) Sources**
    - **Remove 99% of TCE found in high concentration areas (i.e., DNAPL) in the Regional Gravel Aquifer (RGA)**
  - **Combination of Treating UCRS and RGA Sources and the Plumes**
    - **Remove 95% TCE from UCRS and 99% from RGA DNAPL**
    - **Reduce TCE concentrations in the plumes (on and off DOE property)**
- **Estimated costs of each remedial action option were developed using information from the FS**

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Groundwater Modeling

- Each potential remedial action technology was evaluated using the current DOE Models
- Goals are to determine under each remedial alternative scenario:
  - Potential extent of plume migration
  - Changes in plume over time
- 100-year period was modeled

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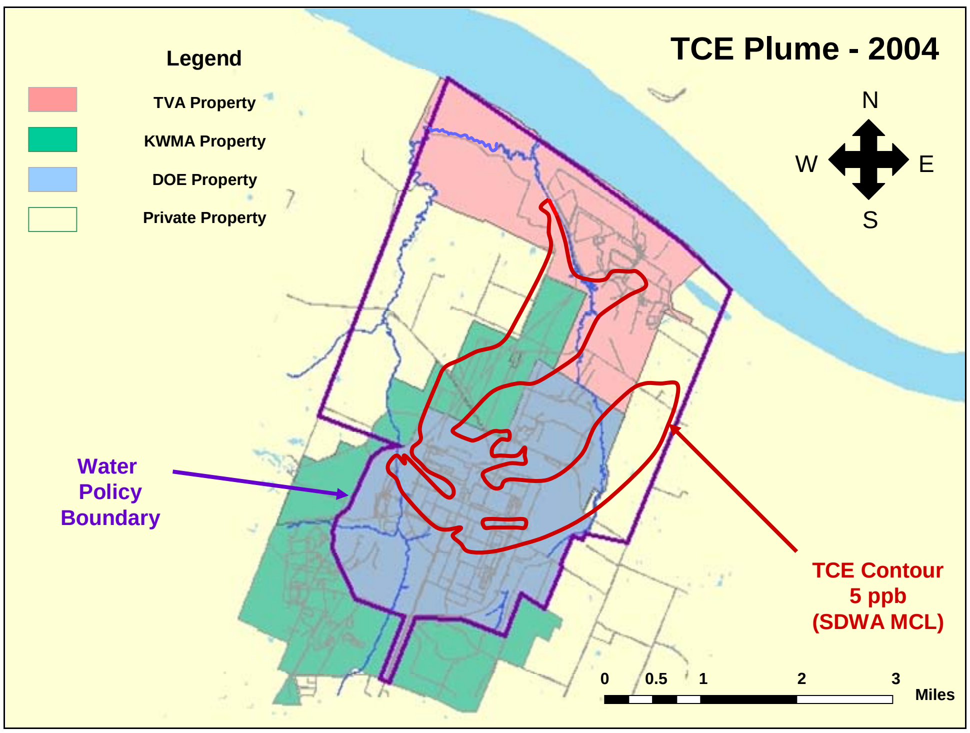

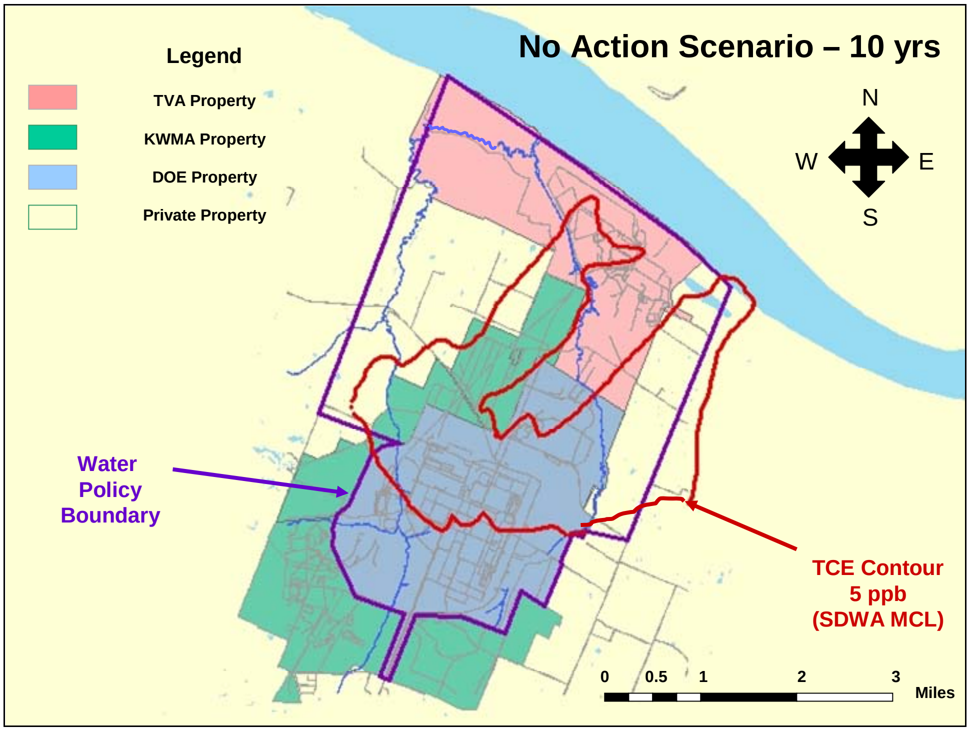
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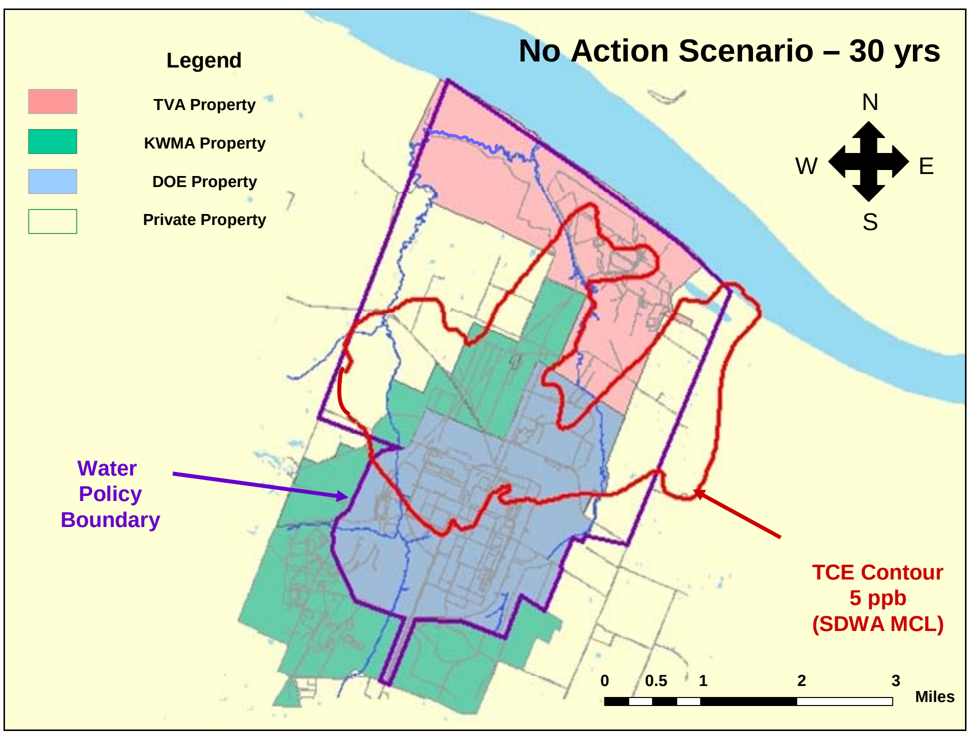
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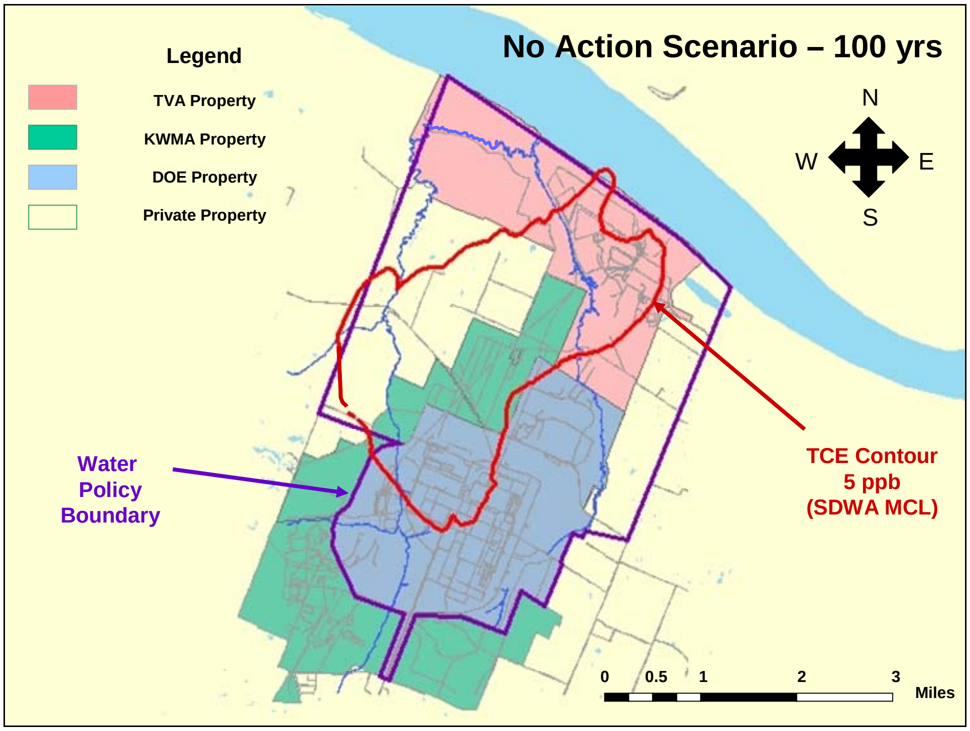
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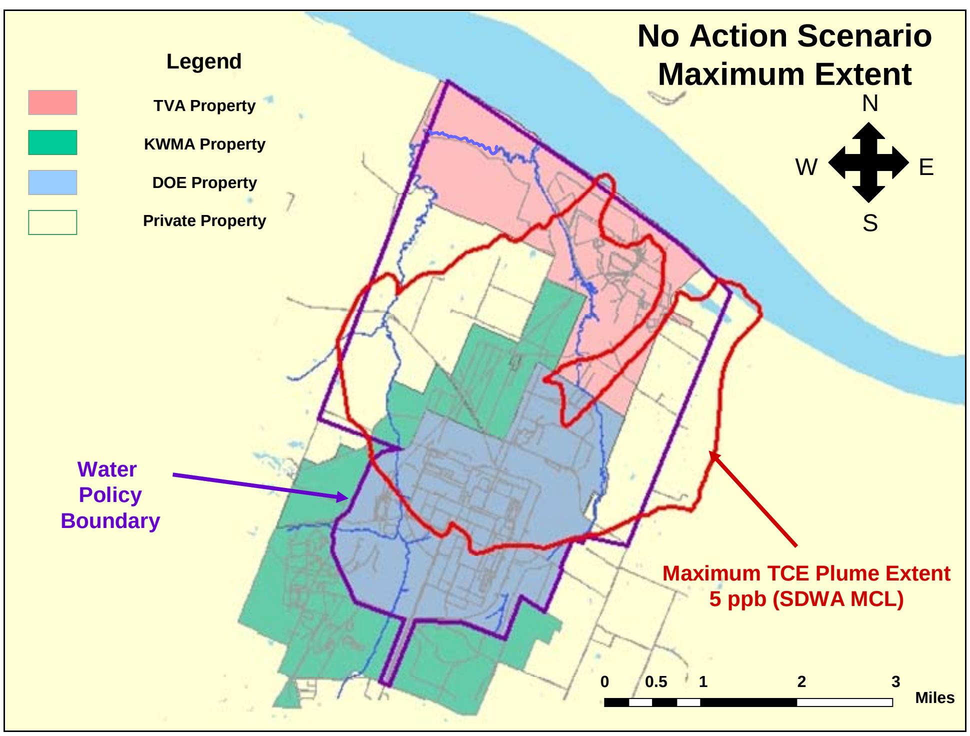
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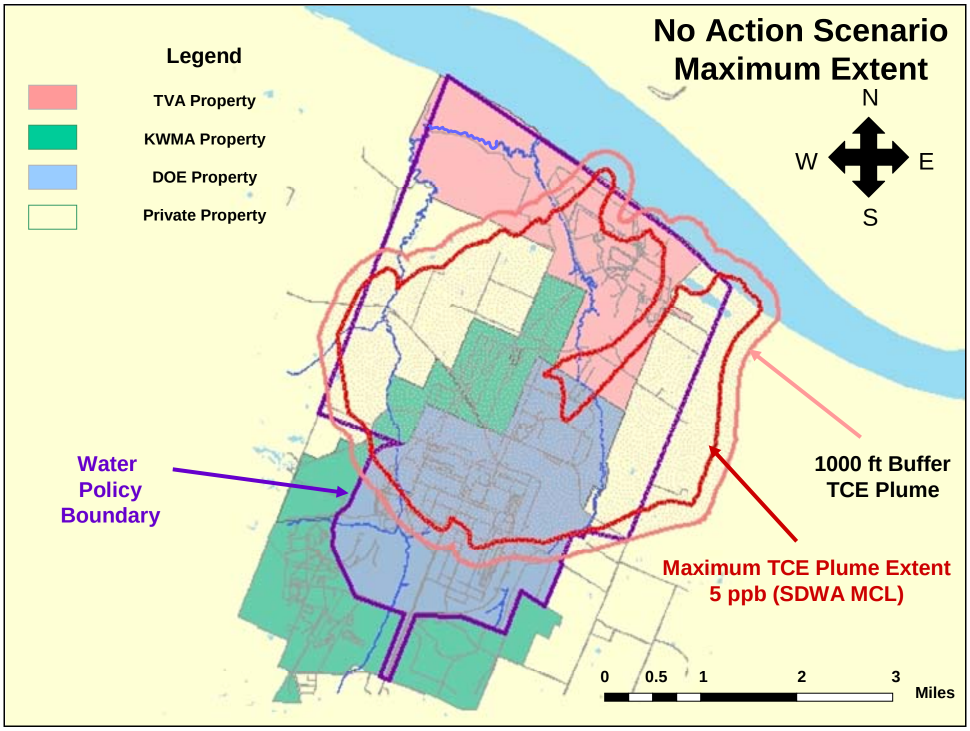
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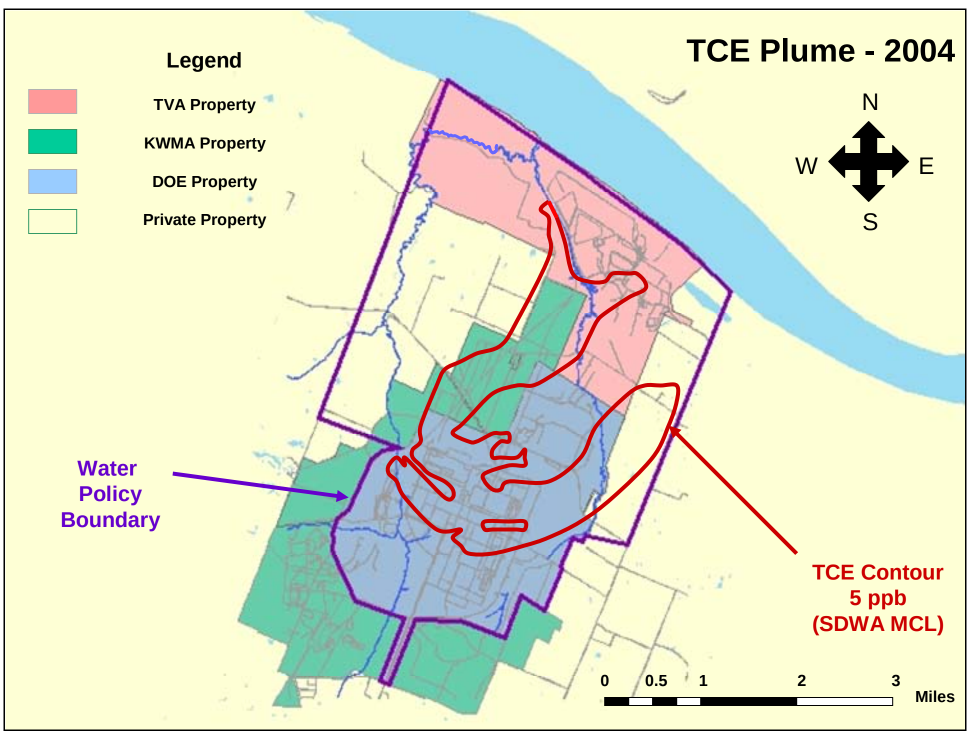
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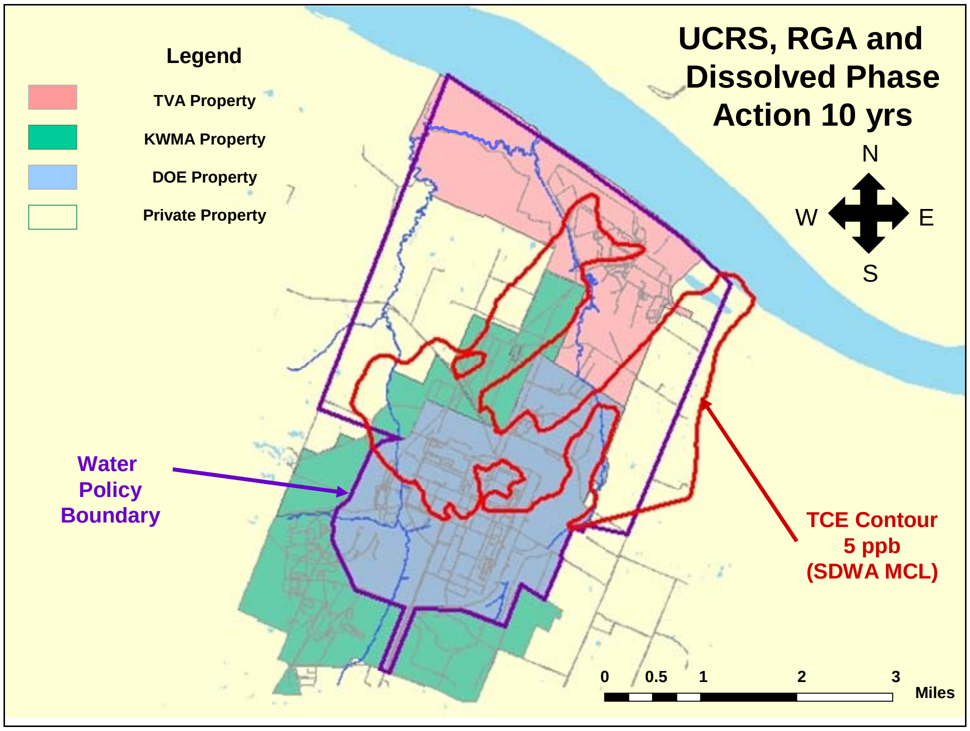
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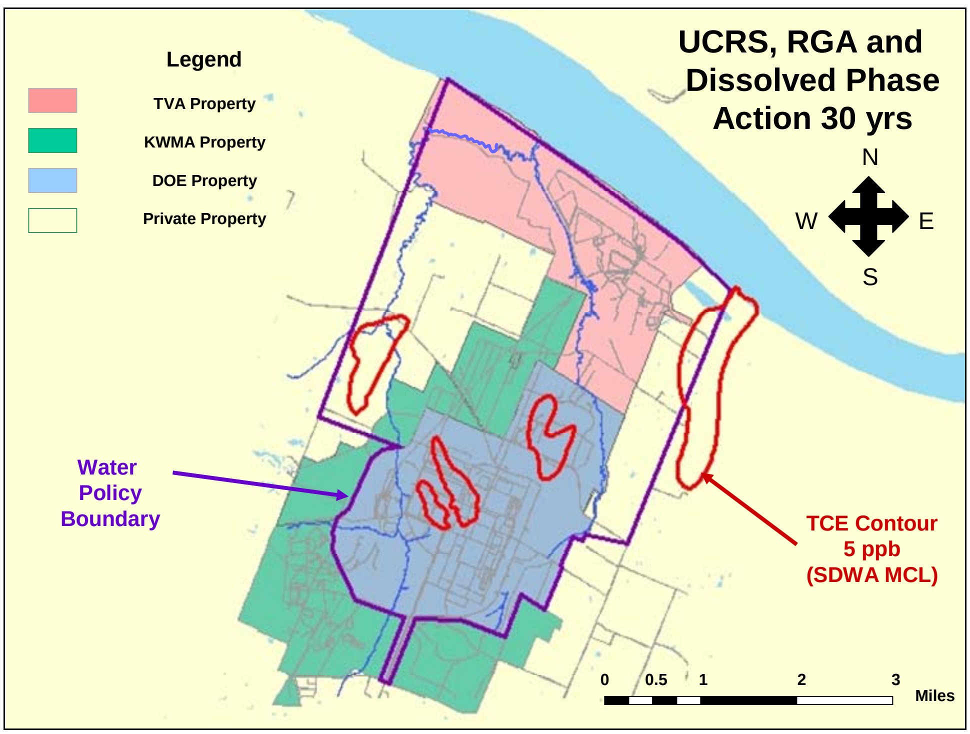
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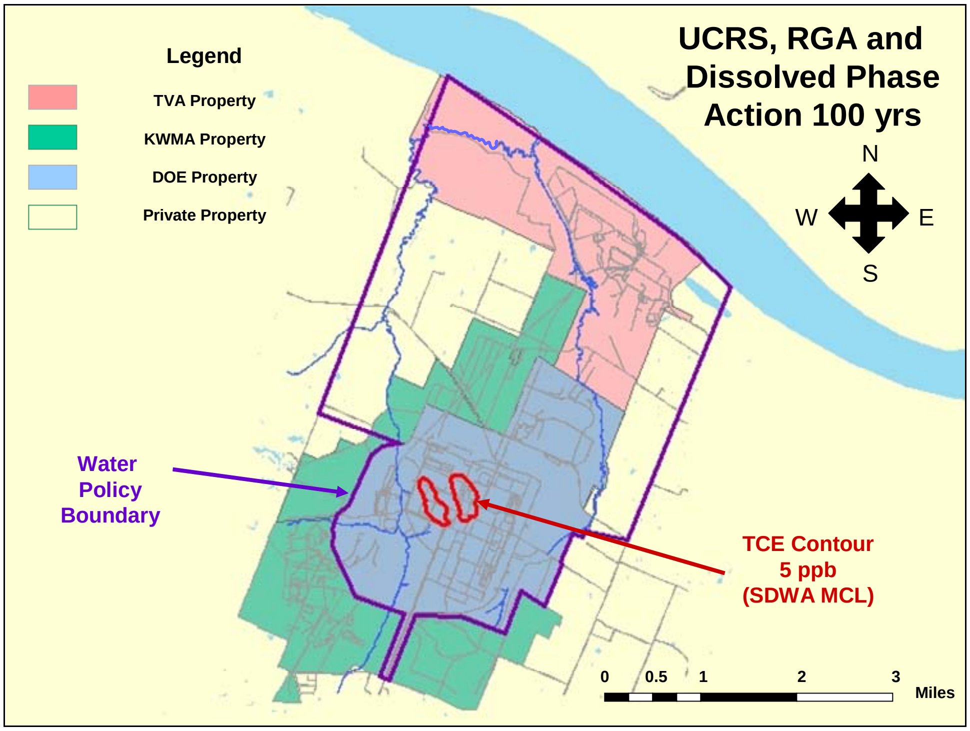
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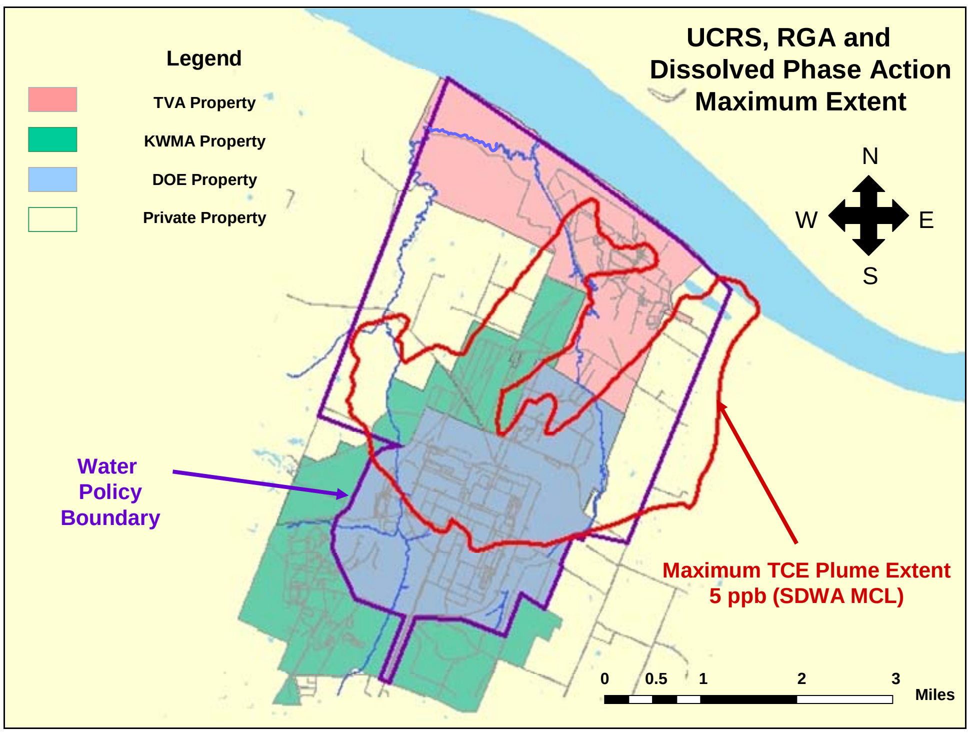
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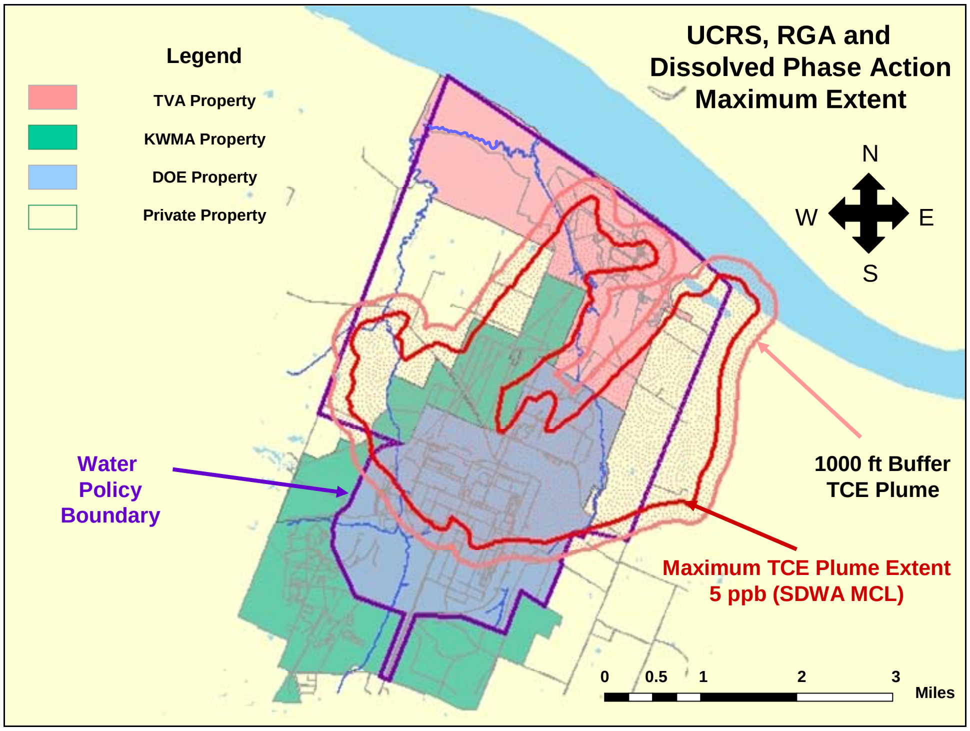
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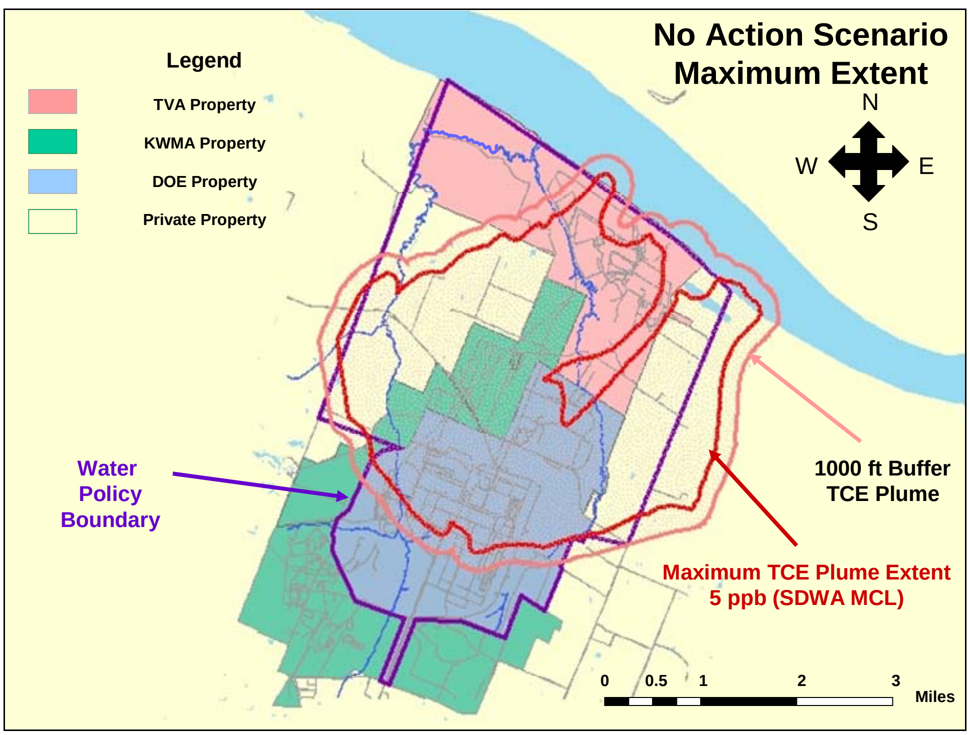
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Summary of Potentially Impacted Private Properties

- Based on conservative estimates of maximum plume extent
- Assumes if any portion of a property is impacted, then entire property is selected for purchase or easement
- Maximum Extent Without Buffer
  - Approximately 3300 acres for all options
- Maximum Extent With Buffer
  - Approximately 4400 acres for all options

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Property Acquisition Potential Options

- **Goal is to identify different ways properties or interests in properties might be purchased in Kentucky**
- **Compiled by UK College of Law**
- **Identified ways include:**
  - **Fee simple ownership (Buy property outright)**
  - **Easements (Restrict use of the property) – several types**
    - **Limited scope easements**
      - **Restrict use of groundwater and/or surface water**
      - **Continuation of water policy**
    - **Expanded scope easements**
      - **Limit use of land, including use of groundwater and/or surface water**
      - **Continuation of water policy**

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Property Acquisition Potential Costs

- **Federal and state properties not considered**
- **Properties being evaluated as a group (mass appraisal)**
- **Fair market value estimates obtained using:**
  - **Assumes willing buyers and sellers**
  - **Sales of comparable properties in McCracken County**
  - **Easements based on similar state and federal programs**
- **Appropriate federal guidelines**
  - ***Uniform Appraisal Standards for Federal Land Acquisitions***
    - **Provides standards for use in appraising properties taken for federal land use**
  - **Highest value and best use**
    - ***"The reasonably probable use that produces the highest property value"***

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Property Acquisition Potential Costs

- **Examined five remedial actions**
- **Properties impacted based on maximum potential plume extent**
- **Property costs determined based on:**
  - **Agricultural property**
  - **Rural residential property**

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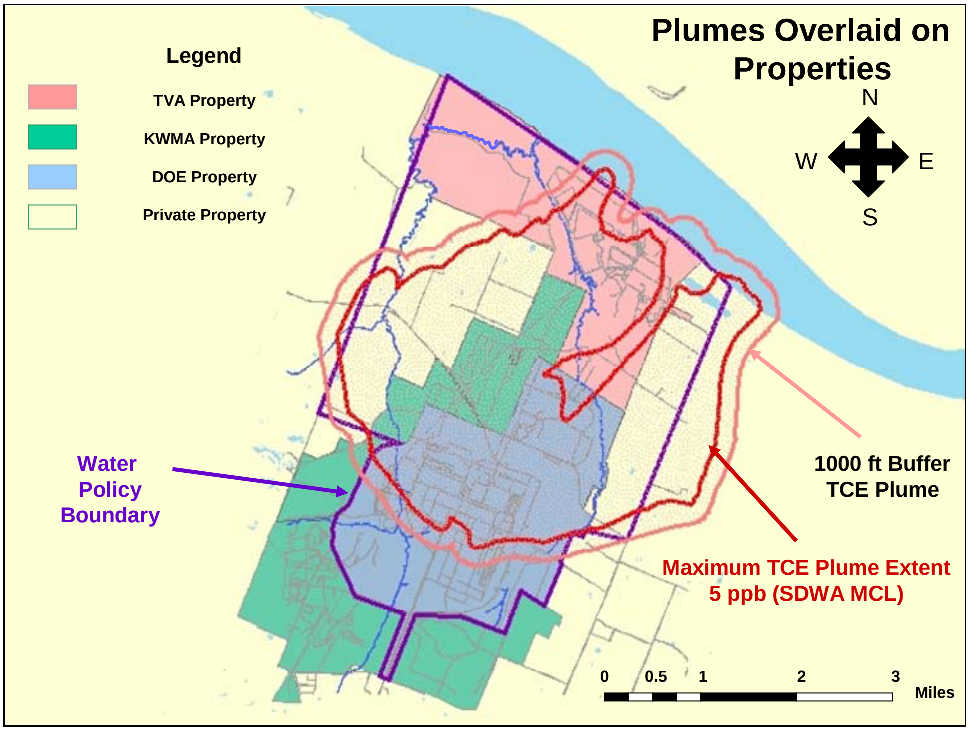

Preliminary Cost Estimate Ranges

- Property acquisition costs
  - Fee Simple - $19 M to $47 M
  - Easements - $2 M to $16 M
- Remediation costs
  - No Action (without long-term stewardship cost) - $0 M
  - Pump and Treat - $68 M
  - Primary (UCRS) Source Action - $28 M to $380 M
  - Secondary (RGA) Source Action - $15 M to $175 M
  - Primary and Secondary Source and Dissolved Phase Action - $208 M to $853 M

All remediation costs are based on a 30-year evaluation period

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Overview of Study

- Consistent with the Congressional Directive:
  - Identified purchase options
  - Identified maximum extent of the area overlying the plume
  - Developed costs of remedial action options
  - Developed costs of property acquisition options
- Draft report under review
- Any policy decisions would consider additional information:
  - No specific actions being taken
  - No specific policy decisions being made

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Future Activities

- Review of draft report started September 15
- Future Briefings/Meetings
  - Public Presentation #2
  - CAB Briefing #3

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ATTACHMENT H-14

CITIZENS ADVISORY BOARD ABREVIATED MINUTES

SEPTEMBER 21, 2006

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PADUCAH GASEOUS DIFFUSION PLANT
CITIZENS ADVISORY BOARD

111 Memorial Drive • Paducah, Kentucky 42001 • (270) 554-3004 • PaducahCAB@bellsouth.net • www.pgdpcab.org

Paducah Gaseous Diffusion Plant Citizens Advisory Board Meeting Minutes

September 21, 2006

The Citizens Advisory Board (CAB) met at the CAB office in Paducah, Kentucky, September 21, 2006, at 6 p.m. The meeting adjourned at 10:10 p.m.

Board members present: Allen Burnett, Bobby Lee, Linda Long, Janet Miller, John Russell, Jim Smart, Rhonda Smith and James Tidwell

Board members absent: John Anderson, Judy Clayton, Shirley Lanier, and Elton Priddy

***Ex Officio* members and related regulatory agency employees present:** Bill Clark, Jon Maybriar, and Tony Hatton, Kentucky Division of Waste Management; Tim Kreher, Kentucky Department of Fish and Wildlife Resources; David Williams and Debbie Vaughn-Wright, Environmental Protection Agency; Steve Hampson and John Volpe, Radiation Health Branch

Deputy Designated Federal Official: Reinhard Knerr

Portsmouth/Paducah Chief Operating Officer: Rachel Blumenfeld

DOE Federal Coordinator present: David Dollins

DOE-related employees present: David Ashburn, Rich Bonczek, Jeannie Brandstetter, Tracey Brindley, Yvette Cantrell, Paul Corpstein, Kim Crenshaw, Bruce Gardner, Stephen Gohn, Guy Griswold, Mitch Hicks, Steve Kay, Matt La Barge, Steve Manning, Doug Moore, John Morgan, Lindell Ormsbee, Bruce Phillips, John Razor, and Scott Smith

Eight members of the public attended the meeting.

Land Acquisition Study Update

Dr. Ormsbee provided a presentation on the Land Acquisition Study to the Board. Questions and answers (paraphrased) appear below.

Questions/Comments	Answers
Russell: Was the statement "Remove 95% of TCE found in soil down to 45 feet below surface" a target taken from an existing document?	**Ormsbee:** Those numbers came from the D1 Groundwater Operable Unit Feasibility Study that looked at possible technologies and the potential remediation percent reduction that could be achieved with those different technologies.
Russell: It was asked earlier if there were goals or targets for the C-400 project and it was said that the technology would be used until an isotope is hit and quit. This doesn't suggest that.	**Blumenfeld:** What Ormsbee is talking about is a FS document KRCEE was directed to in their statement of work to identify potential remedial options. The C-400 ROD identifies an asymptotic condition as how to operate.
Russell: Then this option was abandoned.	**Blumenfeld:** I wouldn't say abandoned. That is specifically what happened for the C-400 ROD.
Burnett: Were any sensitivity studies done on treatment efficiencies or are all the values taken from the documents?	**Ormsbee:** Only the efficiencies in the documents were used.
Lee: Explain the ranges on the remediation costs on why there is such a large variation.	**Ormsbee:** That is related to the type of technology used in the D1 documents. Some of the D2 documents did not spell out the prescribed technologies.
Williams: The implemented cost of property versus remediation would need to include the sufficient rewriting of all of the environmental laws that we are currently operating under.	**Ormsbee:** That assumes that the remediation option that is looked at is not meeting the associated CERCLA requirements. The one looked at is hitting targets of reducing TCE at the property boundary within 10 years and the property fence within 15 years. If a remediation strategy was implemented right now that meets targets at the boundary and fence line in a short time frame, there is still material out there beyond the fence that will dissipate over time.
Williams: Current environmental laws would only regard property acquisition as a land use control which would be an additive cost to those remediation costs,	**Ormsbee:** Correct.

not in lieu of.	
Smith: Do you know when the public presentation will be scheduled?	**Ormsbee:** Not at this time. **Blumenfeld:** Early or mid-winter, depending on the internal review. It is a preliminary document.
Burnett: At what point will the CAB see the actual document?	**Blumenfeld:** When we get the final draft but before the report is finalized, after internal DOE process including headquarters, that draft will be available to the CAB. We have made the commitment to make the document available to the public and include comments in the appendix with the final report that actually goes to Congress. I am not sure of the timeframe.
Burnett: The CAB would like to review the document and incorporate comments before public review.	**Blumenfeld:** I will take the request under advisement and give the CAB an answer next month.
Smart: The point that Williams made should be clear in the report; it seems the thought process is just to buy the land and forget remediation.	**Ormsbee:** We are well aware of that.

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ATTACHMENT H-15

THE PADUCAH SUN ARTICLE

MARCH 15, 2007

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DOE not seeking landowner buyout

■ **Agency will** *discuss year-long study pertaining to contaminated groundwater.*

By Joe Walker
Sun Business Editor
jwalker@paducahsun.com

The Department of Energy has no plans to buy land above a massive area of contaminated groundwater near the Paducah Gaseous Diffusion Plant, but Joey Wray says many of his neighbors wouldn't be interested even if an offer were made.

"Most of us wouldn't be for it," said Wray, who lives at 6355 Metropolis Lake Road. "The reason is most of us have lived here our entire lives. It's our home, our parents' home and our grandparents' home."

He also wonders why DOE is even considering a buyout if the contamination is no longer a threat. Since 1994, the government has provided free municipal water to 121 plant-neighboring households and businesses because of an estimated 10 billion gallons of contaminated groundwater. The area is 60 to 120 feet deep, flows from the uranium-enrichment plant to the Ohio River and contains trichloroethylene, once liberally used by the factory as a degreaser.

Wray and his mom, Glenda Wray, shared those opinions at a DOE public meeting last June, and they plan to attend a follow-up meeting at 6 p.m. Tuesday at the

BARKLEY THIELEMAN/The Sun

This well monitors groundwater on Glenda Wray's property on Metropolis Lake Road.

Please see **DOE** / 10A

DOE not proposing buyout of landowners

Continued from 1A

Heath High School auditorium. DOE officials will reveal the findings of a year-long study that included land acquisition among the alternatives for dealing with the contamination.

DOE is not offering to buy land, spokeswoman Laura Schachter said. Instead, the findings and public comments will be submitted to Congress April 16 because the study was mandated by lawmakers, she said.

"I think the department is really sensitive to the fact there is anxiety and interest," Schachter said. "But no decision has been made (to buy land)."

The study contains cost estimates and spells out ways to buy land or land interests, she said. "It's really bringing together all this information and presenting it under a set of parameters and possibilities, but it isn't a recommendation."

Schachter said most of the comments have been from people who merely want to understand the buyout options. If buying land were truly an option, it probably would be considered as part of the overall cleanup work at the plant as governed by federal laws, she said.

Federal legislation sponsored by Sen. Mitch McConnell required DOE to study whether a buyout is in taxpayers' best interests. Work focused on land under which contaminated groundwater flows in a horseshoe-shaped plume away from the plant. Another pollutant, radioactive technetium, is present but in much less quantity than the degreaser.

DOE evaluated public and private land in blocks at fair market value as compared with other property in McCracken County. Among the options considered were outright purchase, buying the land but allowing residents to stay, or purchasing easements.

Wray said those who might want to sell generally don't have sentimental attachments to the land. They include owners who bought property more recently for redevelopment or other uses, he said.

"There are definitely some who would be interested in selling," Wray said. "I'm not faulting them at all."

Wray's family wells were among those sealed by DOE in return for free municipal water. Monitoring wells on their farmland continue to test for contamination.

The Wrays were among about 135 people owning 82 pieces of land who joined a 1997 federal lawsuit alleging former plant contractors poisoned and devalued their land. The suit remains before the U.S. 6th Circuit Court of Appeals after being dismissed in Paducah in early 2004.

Although it is unclear how much the property is worth, economic development officials estimated five years ago that such a buyout would cost $15 million.

In addition to pumping and treating groundwater, DOE spends $70,000 to $100,000 a year providing free water. No technique has been discovered to effectively clean up the groundwater, but DOE will try to remove the chief source of the pollution by using in-ground electrodes to evaporate the degreaser from beneath a plant cleaning building. That work is expected to start next winter and will take about nine months.

ATTACHMENT H-16

DOE PUBLIC MEETING ANNOUNCEMENT

MARCH 15, 2007

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You are invited to a DOE public meeting…

….to learn more about the results of a study prepared for the U.S. Department of Energy (DOE) regarding property acquisition of land located above the plumes of contaminated groundwater near the Paducah Gaseous Diffusion Plant.

Meeting time and location:

Tuesday, March 20, 2007
6:00 p.m. to 8:00 p.m.
Heath High School Auditorium
4330 Metropolis Lake Road
West Paducah, KY 42086

Directions: From Paducah: 7 miles from I-24, exit 4, west on US 60. Turn right, proceed 0.5 miles on KY-996 . If you need special accommodations to attend this meeting or have questions, please call 270/441-6800

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ATTACHMENT H-17

DOE PUBLIC MEETING ANNOUNCEMENT IN THE PADUCAH SUN

MARCH 18, 2007

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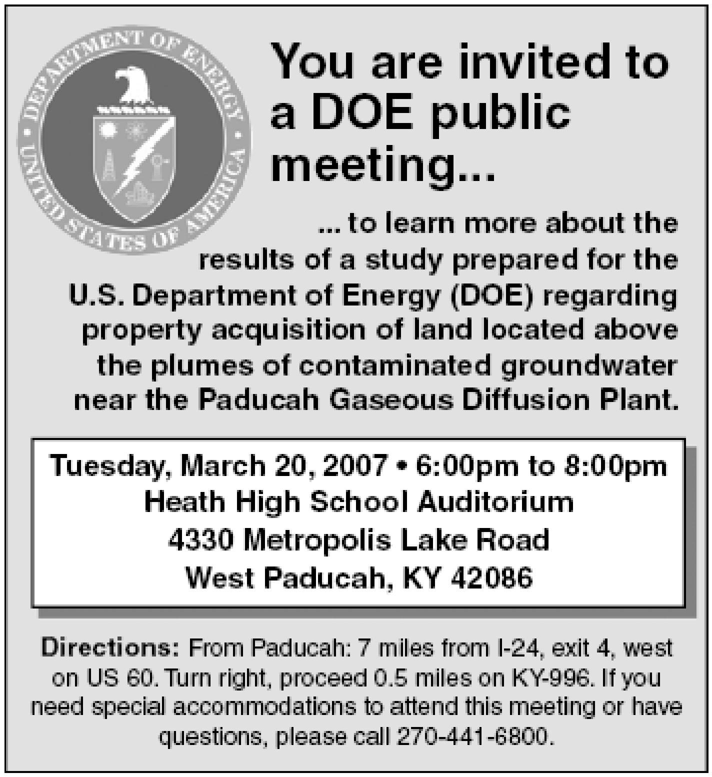

Ad appeared in the Paducah Sun on March 18, 2007 and West Kentucky News on March 15, 2007

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ATTACHMENT H-18

DOE PUBLIC MEETING PRESENTATION MARCH 20, 2007

This attachment includes copies of PowerPoint presentations that were presented at the public meeting on March 20, 2007. The attachment includes a copy of a presentation by Mr. Bill Murphie, which summarized the progress that has been made at the PGDP, and a copy of a presentation by Dr. Richard Bonzeck, which summarized the results of the Land Acquisition Study.

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Clean-up Progress at the Paducah Gaseous Diffusion Plant

William Murphie

March 20, 2007

EM Environmental Management

safety ❖ performance ❖ cleanup ❖ closure

1

Site Environmental Challenges

Contaminated soils/sediments

Legacy Waste

Tc-99 plume

Burial Grounds

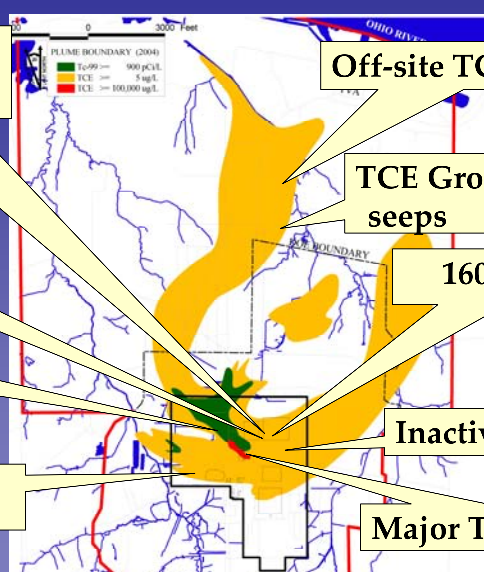
Off-site TCE plumes

TCE Groundwater seeps

160 DMSAs

Inactive Facilities

Major TCE source



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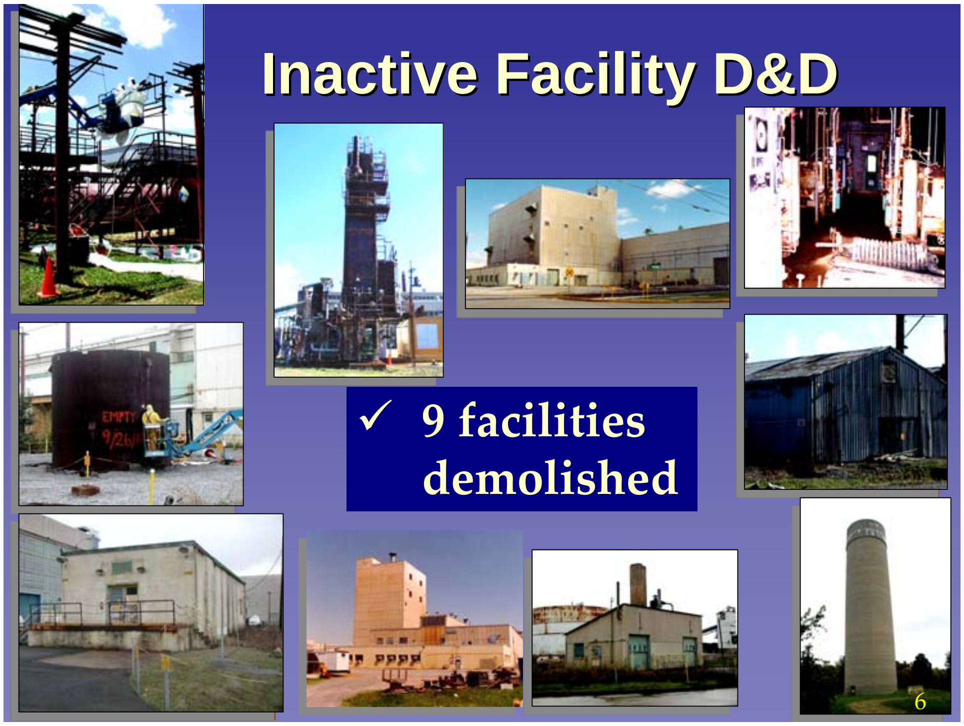
2

Site Clean-up Goals

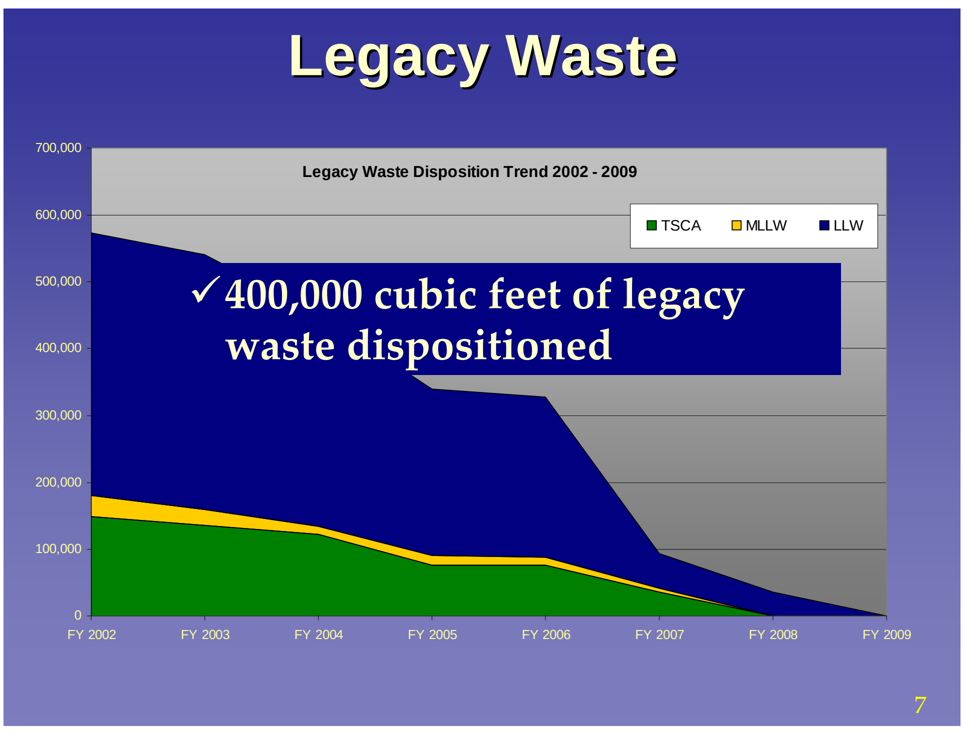
- All Scrap Metal removed from site
- All 17 excess facilities gone/stabilized
- Mixed, TSCA, low-level waste gone
- DMSAs gone
- Off-site risk mitigated
- Major groundwater sources removed

PROGRESS


✓Completed removal of 31,500 tons of contaminated scrap metal
5



Inactive Facility D&D
EMPTY
9/26/
✓ 9 facilities demolished
6



Legacy Waste
Legacy Waste Disposition Trend 2002 - 2009
TSCA
MLLW
LLW
✓400,000 cubic feet of legacy waste dispositioned
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
FY 2002
FY 2003
FY 2004
FY 2005
FY 2006
FY 2007
FY 2008
FY 2009
7

DMSAs

✓ **All outside DMSAs complete**

61% DMSA materials removed

8

Interim Solutions to Mitigate Off-site Risk

- Established the Water Policy Box
- Hard piped and remediated portions of the North South Diversion Ditch
- Operation of the Northeast and Northwest Pump and Treat
- C-400 ROD
- Environmental Monitoring

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U.S. Department of Energy

Portsmouth/Paducah Project Office

Paducah Land Acquisition Study

Public Informational Briefing

Heath High School

March 20, 2007

Richard Bonczek, PhD

Environmental Management
safety ◆ performance ◆ cleanup ◆ closure

www.em.doe.gov

Background

The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.

"Within the funds provided the Department shall undertake a ***study of the potential purchase of property or options to purchase property***

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

Background

The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.

*"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located **above the plume of contaminated groundwater** near the facility site.*

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

Background

The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.

*"Within the funds provided the Department shall undertake a study of the potential purchase of property or options to purchase property that is located above the plume of contaminated groundwater near the facility site. The study shall evaluate the adequate **protection of human health and environment from exposure to contaminated groundwater***

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

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Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

Background

The study is being conducted in accordance with a Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act.

The report provides information regarding land acquisition options under various cleanup scenarios.

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The report is not a decision document.

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

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7

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The report is not a decision document.

The information in the report may be used in future decision documents, as appropriate.

Energy and Water Development Appropriation Bill, 2006 (Senate Report 109-084)

Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

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8

Background

Tasks Completed

Project Team

- **Kentucky Research Consortium for Energy and Environment**
- **University of Kentucky College of Law**
- **University of Kentucky College of Agriculture**
- **University of Kentucky College of Engineering**

Background

Tasks Completed

- **Identified property that is over or could be over contaminated groundwater.**
- Delineated ways to purchase property or interests in property.
- Developed general cost estimates for property or interests in property.
- Summarized assumptions for potential remedial actions that could address contaminated groundwater and sources.
- Modeled where contaminated groundwater might migrate to in the future and identified potentially impacted properties.
- Identified conditions that make property acquisition cost-effective while ensuring protection for human health and the environment.
- Completed an economic analysis.

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Background

Tasks Completed

DOE is providing a draft of the report for Public Review as part of this Public Meeting.

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safety ✧ performance ✧ cleanup ✧ closure
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Public comments, which will be incorporated into the revised report, are due April 3, 2007

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The final draft of the report is due to Congress on April 16, 2007.

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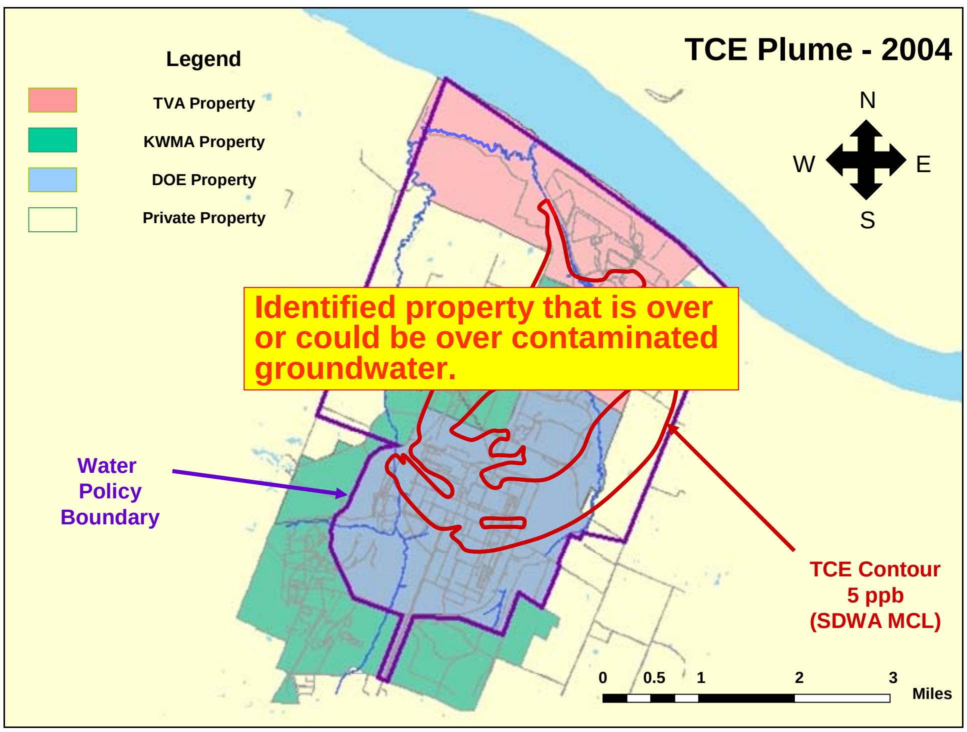
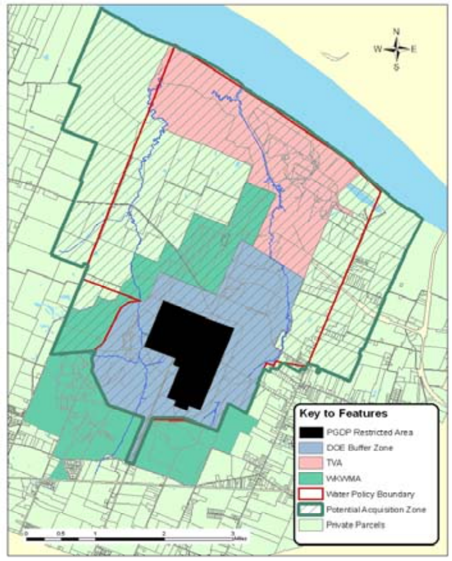


Identified property that is over or could be over contaminated groundwater

Ownership Characteristics in the Area Impacted or Potentially Impacted by Contaminated Groundwater		
Ownership	**Number of Parcels**	**Area (Acres)**
DOE	1	3,556
TVA (Shawnee Power Plant)	1	2,669
Kentucky (West Kentucky Wildlife Mgt. Area)	2	1,290
Private Property Farm Rural Residential	165 64 101	6,054 5,783 271
Total	169	13,568



Delineated ways to purchase property or interests in property

Considered:

- Fee Simple
- Life Estate
- Leasehold
- Concurrent Estates
- Nonpossessory – Future Interests
- Option to Purchase
- License
- Easement
- Real Covenants/ Equitable Servitudes

Chosen for Evaluation:

- Fee Simple
- Easement
  - Limited
  - Expanded

Developed general cost estimates for property or interests in property

Range of Estimated Per Unit Acquisition Costs to DOE* for Fee Simple Purchase of Properties Based on: (1) Tax Valuation and (2) Sales Valuation			
Parcel Type	**Units**	**Estimated Range of Acquisition Costs Per Parcel or Per Acre (Averaged over Area)**	
		Upper Estimate	**Lower Estimate**
Residential	Per Parcel	$138,301	$120,293
Farm:			
Fair Market Value	Per acre	$3,099	$2,788
Development Value	Per acre	$7,583	$6,524

* Values shown include legal costs.

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Developed general cost estimates for property or interests in property

Limited scope easement includes restrictions on the use of groundwater underlying a property or the surface water running through the property.

Range … for		
Eas…		
		Farm: …mated Cost …er Acre
Limited Scope Restrictions		
Upper Estimate	$17,330	$872
Lower Estimate	$4,001	$472
Expanded Scope Restrictions		
Upper Estimate	$38,325	$2,789
Lower Estimate	$16,529	$2,589

* Values shown include legal costs.

EM Environmental Management safety ❖ performance ❖ cleanup ❖ closure 4/4/2007 Rev 1 www.em.doe.gov 24

Developed general cost estimates for property or interests in property

Expanded scope easement includes restrictions on the use of groundwater underlying a property or the surface water running through the property *and,* potentially, a prohibition on the construction of subsurface structures (i.e., swimming pools, septic systems, ponds and the like).

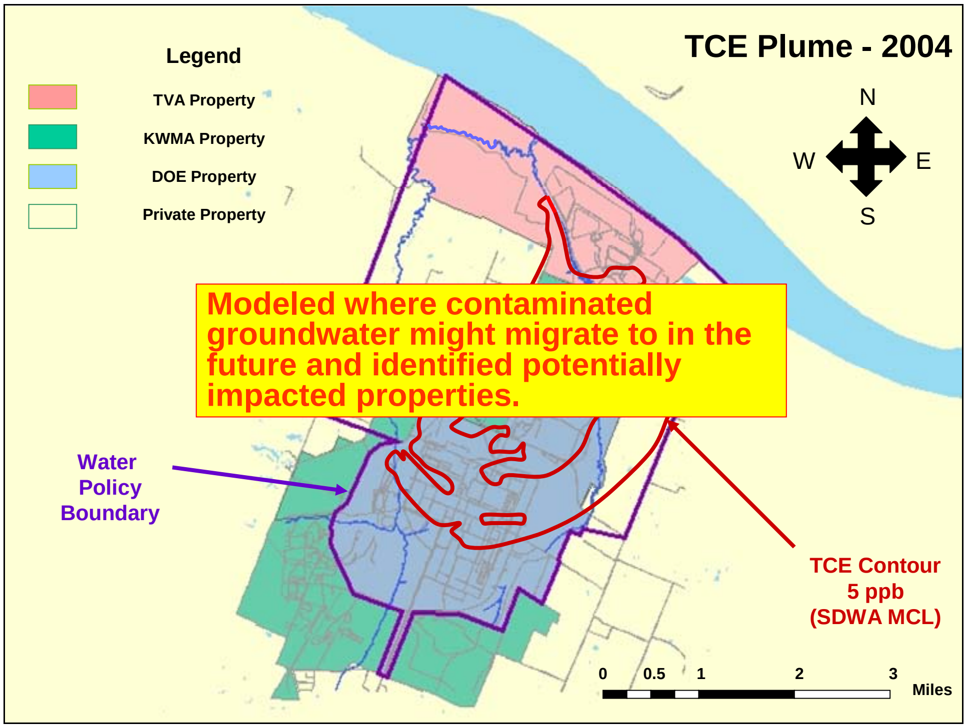
		: d Cost cre
Limited		
		2
		2
Expanded Scope Restrictions		
Upper Estimate	$38,325	$2,789
Lower Estimate	$16,529	$2,589

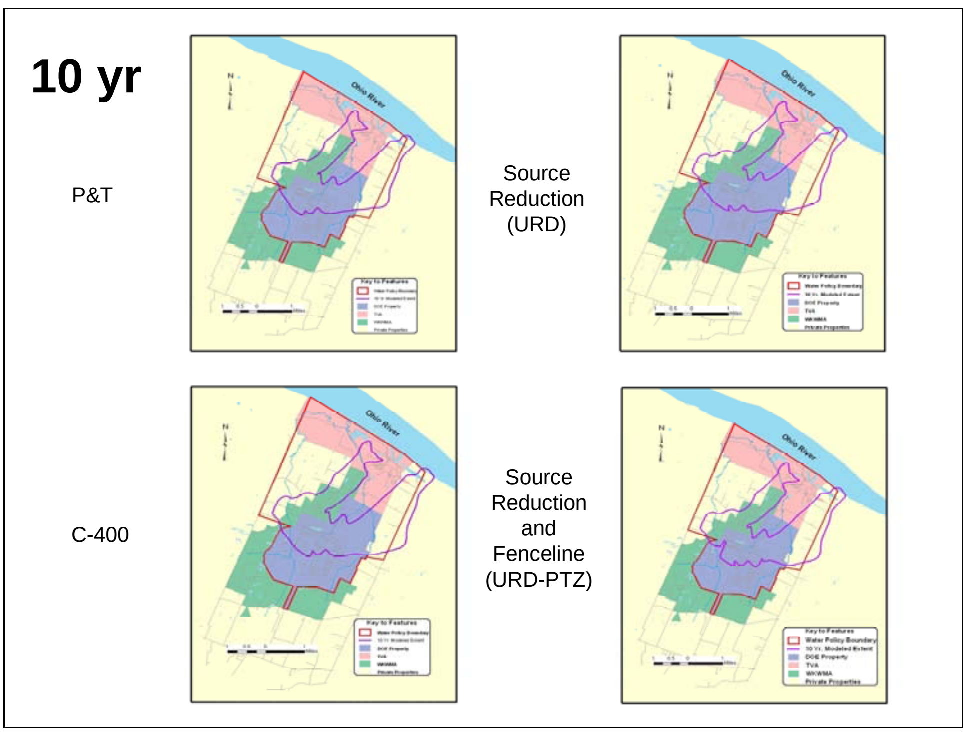
* Values shown include legal costs.

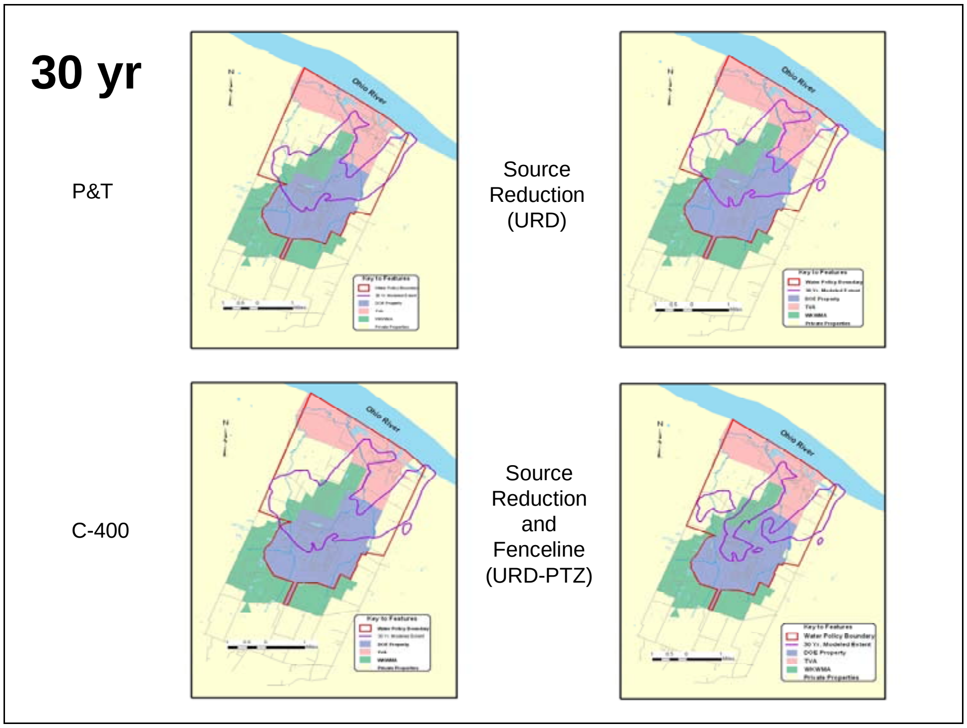
Summarized assumptions for potential remedial actions that could address contaminated groundwater and sources

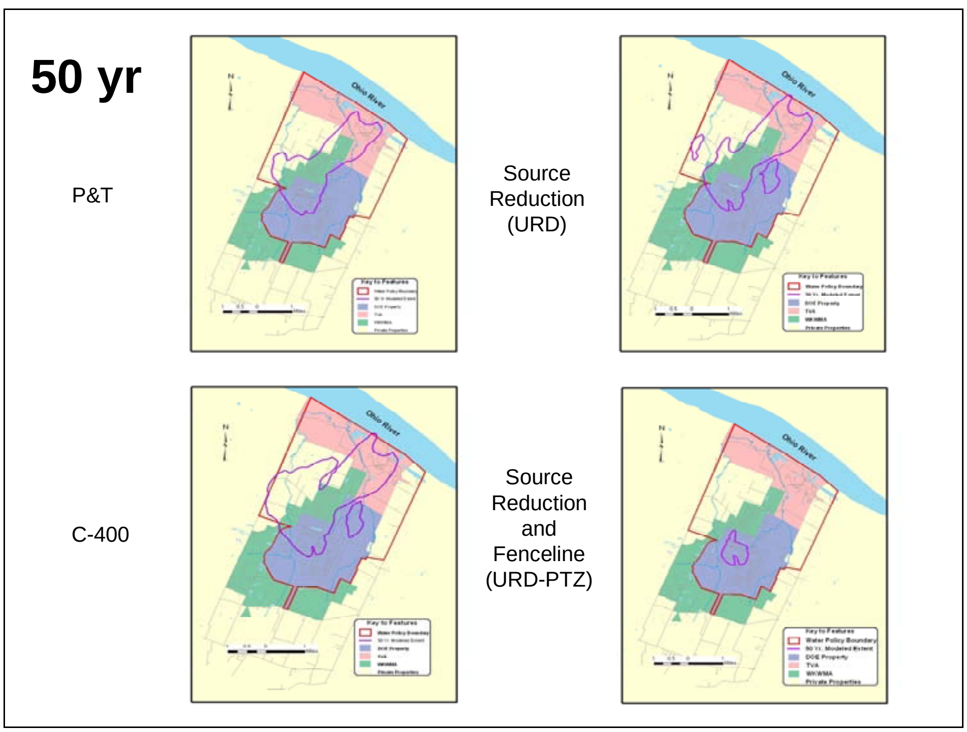
- Continuation of existing pump and treat action (P&T)
- Source … 400 buildin…
- Source … urces and tre… D)
- Source reduction for all sources, treatment of Southwest Plume, and plume containment (URD-PTZ)

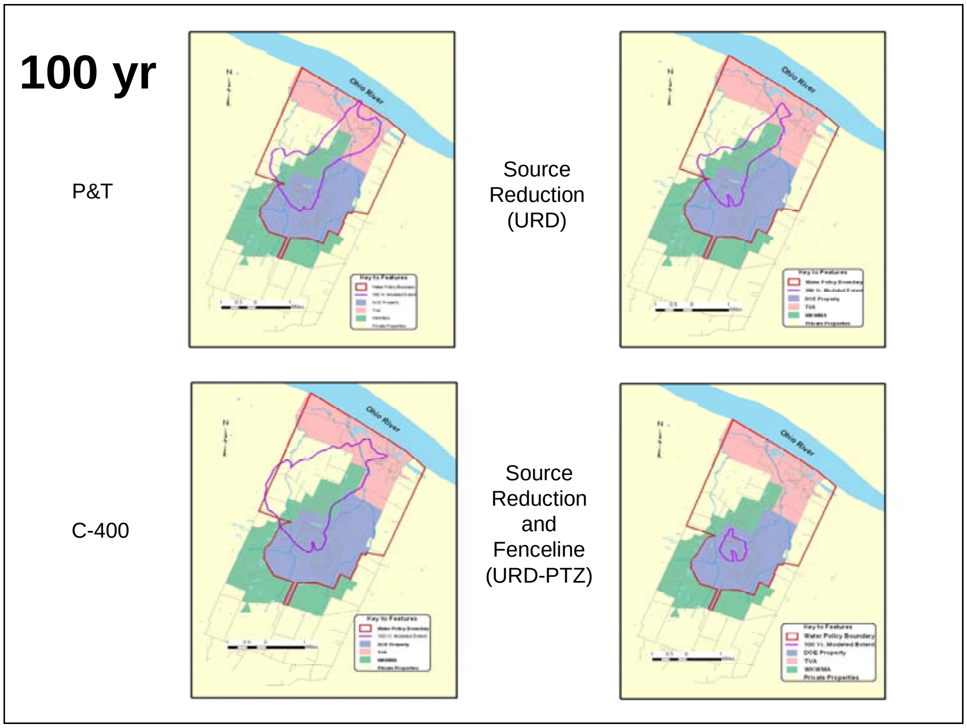
These four scenarios are examples used to examine the potential effect of remedial actions on plume migration in the future.

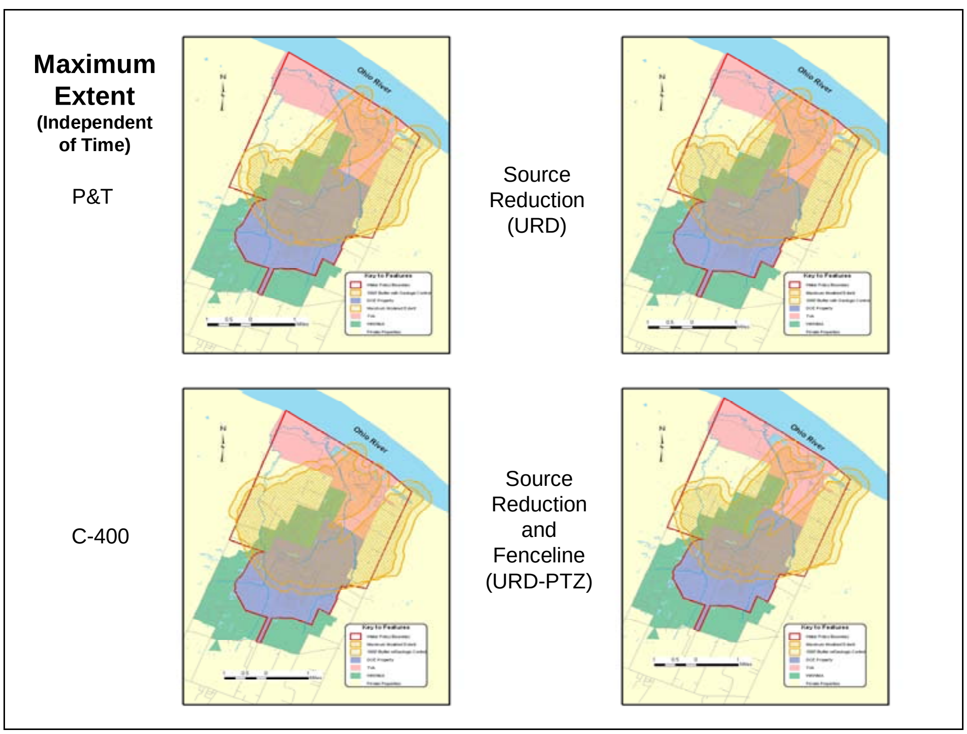

TCE Plume - 2004
Legend
TVA Property
KWMA Property
DOE Property
Private Property
N
W
E
S
Modeled where contaminated groundwater might migrate to in the future and identified potentially impacted properties.
Water Policy Boundary
TCE Contour 5 ppb (SDWA MCL)
0 0.5 1 2 3
Miles


10 yr
P&T
Source Reduction (URD)
C-400
Source Reduction and Fenceline (URD-PTZ)


30 yr
P&T
Source Reduction (URD)
C-400
Source Reduction and Fenceline (URD-PTZ)
Ohio River


50 yr
P&T
Source Reduction (URD)
C-400
Source Reduction and Fenceline (URD-PTZ)
Ohio River


100 yr
P&T
Source Reduction (URD)
C-400
Source Reduction and Fenceline (URD-PTZ)
Ohio River


Maximum Extent
(Independent of Time)
P&T
Source Reduction (URD)
C-400
Source Reduction and Fenceline (URD-PTZ)
Ohio River

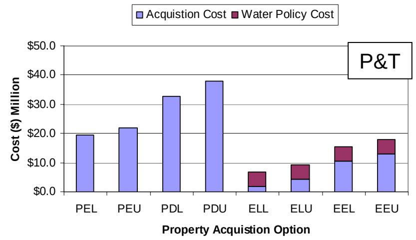
Modeled where contaminated groundwater might migrate and identified potentially impacted properties

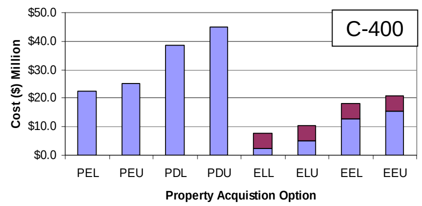
Maximum Potential Property Impact for Each Potential Remedial Action (over 100-years modeled)			
Scenario	**ID**	**Agricultural Parcels (acres)**	**Residential Parcels (number)**
1	**P&T**	3531	80
2	**C-400**	4370	85
3	**URD**	4102	85
4	**URD-PTZ**	4049	84

Completed an economic analysis

Key

- PEL – Fee Simple Purchase, Existing Condition, Lower Estimate
- PEU – Fee Simple Purchase, Existing Condition, Upper Estimate
- PDL – Fee Simple Purchase, Development, Lower Estimate
- PDU – Fee Simple Purchase, Development, Upper Estimate
- ELL – Limited Easement, Lower Estimate
- ELU – Limited Easement, Upper Estimate
- EEL – Expanded Easement, Lower Estimate
- EEU – Expanded Easement, Upper Estimate





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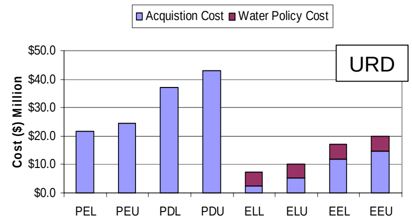
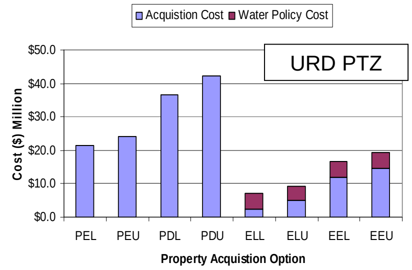
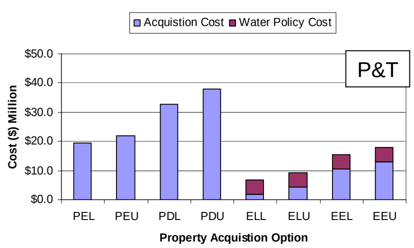
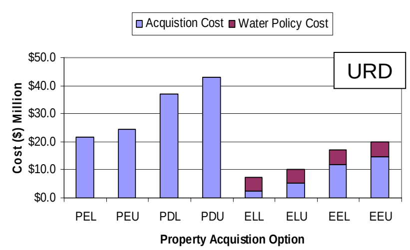
- PDL – Fee Simple Purchase, Development, Lower Estimate
- PDU – Fee Simple Purchase, Development, Upper Estimate
- ELL – Limited Easement, Lower Estimate
- ELU – Limited Easement, Upper Estimate
- EEL – Expanded Easement, Lower Estimate
- EEU – Expanded Easement, Upper Estimate

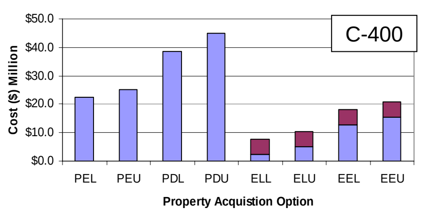


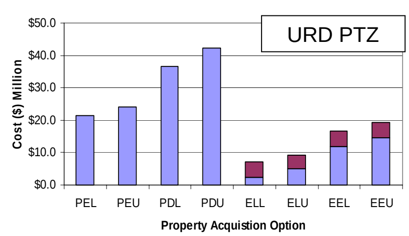


Completed an economic analysis









General Observations

- Fee simple property purchase is significantly more expensive than the combined cost of the Water Policy with a limited or expanded easement.
- When compared between potential remedial actions, the costs for property acquisition (purchase or easement) are essentially equal.
  - The cost of property acquisition to limit exposure to contaminated groundwater does not depend on the effectiveness of the remedial action over time.

Future Use of the Results of the Study

The Land Acquisition Study gives DOE a tool that can be used in future decision documents to:

1) evaluate the cost effectiveness of potential institutional controls.
2) evaluate the cost effectiveness of potential remedial actions.

Upcoming Activities

- March 20 – Public Information Briefing
- April 3 – Comments Due
- April 13 – Final Report to DOE-HQ
- April 16 – Final Report to Congress

EM Environmental Management
safety ❖ performance ❖ cleanup ❖ closure
4/4/2007 Rev 1 www.em.doe.gov 39

Contacts

Please send your comments or questions to:

- Rich Bonczek
  - Email: Rich.Bonczek@lex.doe.gov
  - Phone: 859/219-4008
- Laura Schachter
  - Email: Laura.Schachter@lex.doe.gov
  - Phone: 859/219-4010
- Mitch Hicks
  - Email: Mitch.Hicks@lex.doe.gov
  - Phone: 270/441-6829

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ATTACHMENT H-19

COMMENTS RECEIVED AT PUBLIC MEETING

This attachment contains the comments received at the public meeting on March 20, 2007. These include 1) a list of the attendees at the meeting, 2) a list of questions asked by citizens, 3) a summary of statements made by citizens attending the meeting, 4) a copy of a letter dated March 17, 2007 along with six attachments that was submitted by Ruby English.

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U.S DEPARTMENT OF ENERGY PUBLIC MEETING
LAND ACQUISITION STUDY RESULTS MARCH 20, 2007 PADUCAH, KENTUCKY

NAME	MAILING ADDRESS	PHONE	Add name to mailing List?
Paul Long	9620 Ogden Landing Rd West Paducah	488-3573	
Robbie Long	✓	✓	
Russ Tilford	3950 Hobbs Kevil KY 42053	462-2592	
Burgess Robertson	8935 Gipson Rd West Paducah, Ky 42086	488-3703	
Linda Long	10625 Ogden Landing Rd. Kevil KY 42053	462-3446	
Don Catlin	6340 Bethel Ch Rd Kevil	462-3571	
Jim Coope	5360 Metropolis Lake Rd West Paducah, Ky 42086	488-2447	

U.S DEPARTMENT OF ENERGY PUBLIC MEETING
LAND ACQUISITION STUDY RESULTS MARCH 20, 2007 PADUCAH, KENTUCKY

NAME	MAILING ADDRESS	PHONE	Add name to mailing List?
Dianna Long			
Ruby English	6715 Metropolis Lake Rd. West Paducah, Ky 42086	488-3225	✓
David Dollins			
Shirley Pollard	10945 Ogden Landing Rd	462-3815	✓
Bobbie Ford	7040 Metropolis Lake RD	488-3933	✓
[illegible] Campbell	10005 Cratzer	488-3369	
Ruth Cooper Dietzel	9345 Bradford Ln	488-5966	
Cynthia Zvonar	DOE		
[illegible] Rafferty	P.O. Box 358 Wyatt, Mo. 63882	573-675-3211	✓

U.S DEPARTMENT OF ENERGY PUBLIC MEETING
LAND ACQUISITION STUDY RESULTS MARCH 20, 2007 PADUCAH, KENTUCKY

NAME	MAILING ADDRESS	PHONE	Add name to mailing List?
Harry W. Mattingly	8455 Shawnee Ln West Paducah KY	(270) 488 3879	
Rita Beames	159 Longview Drive Paducah, Ky 42001	270-534-9309	Yes
KENNETH GLASS	5915 METROPOLIS LAKE Rd WEST PADUCAH 42086	488-2166	YES
Glenda Wray	6155 Met. LK RD W. Pad Ky 42086	488-3470	Yes
Jerry Wray	6355 Metropolis Lake Road 42086	488-2178	Yes
Joe Walker	Box 2300 Paducah Ky 42002-2300	575-8656	Yes
William & Vinci Ford	7020 metropolis Lk Rd	488-3019	Yes
William & Vinci Ford	8425 metropolis Lk Rd	488-3014	Yes
russell McCallister	DOE / PPPO	553 219-4012	No

U.S DEPARTMENT OF ENERGY PUBLIC MEETING
LAND ACQUISITION STUDY RESULTS MARCH 20, 2007 PADUCAH, KENTUCKY

NAME	MAILING ADDRESS	PHONE	Add name to mailing List?
Charles & Vicki Jackson	RT3 Box 265A, Golconda, IL 62938	—	—
Charles H. Shaw	9540 McCAW RD West Pad. Ky 42086		
OSBBY WALKER	5955 MET. LAKE RD		
Larry Adams	9050 Gipson Rd.	—	—
Lynn Simmons	11765 Ogden Landing Rd.		
Gary Vanderpool	7060 Old Cuttersville Rd	—	—
Gary Buckingham	6515 Metropolis Lk Rd West Paducah	488-3696	✓
Tommy Vace	10835 Ogden Lnd. Rd KEVIL	462-3072	
Jim Grief	10770 Ogden Landing Rd KEVIL	744-8920	
Alice F. Dick	6465 Bobby Sch. RD	488-2218	

Questions Received at the Public Meeting
(Specific answers were provided to each question during the meeting)

1. How will DUF6 and GNEP activities affect the groundwater plumes?

2. Why didn't the overhead show the Tc^{99} plume? The Tc^{99} is a lot more mobile than indicated.

3. How saleable is property within the Water Policy Box?

4. Why wasn't the property assessed as heavy industrial that is zoned heavy industrial?

5. After this study goes to Congress, what is their most "probable" response?

6. Does the "proposed" recycling plant affect the buyout of property?

7. If easement expanded was used would the property have to be rezoned to have public septic system use? In other words would this be just a way for the city to take over the county.

8. I was told from employees at Shawnee that the plume hit the Ohio River 5 years ago. I know there are several monitoring wells on Shawnee property. The plume map is not correct.

9. My property is in heavy industrial area next to Shawnee Steam Plant. My property is work much more than the price you showed per acre.

10. If this new plant comes to West Paducah where is the 580 acres they want to buy?

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Verbal Public Comments at Land Acquisition Study Meeting
March 20, 2007

Comment 1:

Audience Member: I've worked for the last week on this coming up and thought tonight whenever that I got here well we were going to learn something different. Well I hadn't. The only thing I learned was the same thing that has been over and over and over. You know, 37 years ago I moved out to this area. My husband had just got a job on the game reserve. We thought we were really going to take off and do something with our lives. Well those 37 years have put him in the grave. We got a youngest son. We don't know how much longer before he'll be there because his brain is dying. I see a lot of you people here that I know that have medical problems. I have medical problems and then to learn tonight that they are not going to do anything to clean up or anything. They say that they are. They've had since 1988 to start cleaning up these plumes. We are no closer to the plumes being cleanup now than it was in 1988. Our property is contaminated. In order for us to sell it we have to declare that we are sitting on contaminated plumes. You can't get anything out of it and then, to go and be averaged out at $3,000 and something dollars as a fair market value. That would be fine if our property was in good health, but it's not, and then to learn that where some of these have already been put down as heavy industrial. Well there not being treated as heavy industrial and our precious city and county commissioners have put it out as residential out there. Well it's not residential. They went back in 2003 and they changed that to heavy industrial down Metropolis Lake Road, and that is on the record. So you know, I think that some of these people are getting shafted. And it's not that I'm standing up here and I got an axe to grind, because I really got an axe to grind if I wanted to grind it. I'm just tired of people being run over in this area. And you know all of you other people you come in from other places. You all don't live out here. Come and live in our houses. Come and live in our spots. Get out there for 35 years and drink and walk over the stuff that we've walked through. Then you go back and you bring your families. Would you Steve build a house out here and bring your family down here to live knowing what contamination is out here. Be honest I know you wouldn't. You, Lindell , Mr. Murphie, none of you all.

I appreciate that and I'll take you at you're word that you are sincere. I', m not saying that your not o.k., but I've got 11 acres that I'll sell you.

And that was just being joking I just thought, a fair price. Seriously in all seriousness I do know that some of it is trying to be cleaned up, but Mr. Murphie, you know as well as I do that the meetings we sit at month after month. After all of the presentations that have been made, all of the other things that have been done, you can not sit there and tell me in all honesty, 100%, that things will be cleaned up because you know as well as I do that the research that I've done as far as the Tce 99 and the other volatiles and things that are in this northeast plume, you know it's going to take years and years if they ever get cleaned up because there is no known technology that is available that can clean those up

Comment 2:

Audience member: I live on Metropolis lake road. I'm married to William Ford. And I want to know what they think how many people in this room are going to live to be 100. None of us. We need something done now. All of us that live on Metropolis Lake Road there's, I would say 80% all have cancer of one kind of another. In May of last year I was given 1 year to live. I'm still here, but I don't know if I'm going to live to see any of this progress done. My husband is going to still be around and I would like to see something done so I would know that he would be safe after I'm gone. That's all we ask is for someone to give us a definite response to this. The government up there, they don't know what we live in. When they had the 911 the government steps in and does all this for them. Well we are in desperate need for this also. They do not care about the little people. They care about their money which we give to the government and we pay our taxes and we pay or dues to everyone, even to the Good Lord. That's all we ask. For some kind of resolution. Soon, not 15, 20 or 100 years from now.

Comment 3:

Audience Member: One thing I would like to address is the fundamental fairness in the way that this was approached to the community with the draft document. People came tonight not knowing what was going to be presented and was asked to address just the overview. No one knows what the text actually says. It's very important that people know what the text says and I would encourage everyone to respond to the text when they read their disc.

The question I asked a while ago that I don't believe was appropriately answered was the salability of the property. There are a number of people in the neighborhood that I have spoken with, I don't live in the neighborhood, that I have spoken with them. A lot of them know me because I've tested their vegetables and they've had real estate appraisers come to their property and pretty much tell them that their property cannot be sold, that there are all kinds of disclosures that are necessary. Active Citizens for Truth has been given documents that are appraisals that show indeed there is verbiage on these appraisals that talk about groundwater contamination and so forth and so a lot of these people in good conscience just myself having spoken with them, in good conscience, couldn't sell their property to someone that might bring their children or grandchildren on to that property and raise them. Some of these people have had soil and water and other things tests themselves and had shown this property to be contaminated. We've had people come in Active Citizen for Truth and ask, well I've have been growing a garden for years, but maybe my grandchildren shouldn't be eating it because of the contamination. Maybe my grandchildren shouldn't be playing in this contaminated dirt and I don't think this has been reflected to Congress and I believe it is up the community to make sure Congress know this.

Ruby English
6715 Metropolis Lake Road
West Paducah KY 42086
Phone: 270/488-3225
E-mail: renglish@brtc.net

March 17, 2007

Honorable Peter J. Visclosky, Chair, etal
Subcommittee on Energy and Water Development
Room 2362-B
Rayburn House Office Building
Washington DC 20515

RE: Senate Report 109-084:
Study of Property Acquisition of Land Located above the Plumes Of Contaminated Groundwater Near the Paducah Gaseous Diffusion Plant, 5600 Hobbs Road, West Paducah, KY 42086

Dear Sir:

My name is Ruby English. I reside at 6715 Metropolis Lake Road, West Paducah, KY 42086. I along with my husband Earnest Ray, now deceased as of February 12, 2006, and our two sons, Tony and Larry English have lived at this address for over 35 years. My property consists of almost eleven acres with one field between my property and Department of Energy (DOE) property, which sits at the back and to the east of the C746-U Landfill and approximately two miles across field from the Paducah Gaseous Diffusion Plant.

In the Congressional Directive to DOE in the 2006 Energy and Water Development Appropriations Act, your committee directed DOE to do a study of my property along with other property in regards to sitting over the Northeast Plume and Northwest Plume. This study was to "evaluate the adequate protection of human health and environment from exposure to contaminated groundwater and consider whether such purchase, when taking into account the cost of remediation, long-term surveillance, and maintenance, is in the best interest of taxpayers" unquote. Sir, I am a taxpayer along with other families who are United State citizen's and have been living on top of these plumes for over 50 years, paying tax dollars for companies and federal agencies that were allowed to dump hazardous waste down drains, through the air, and operate in a shroud of secrecy. When you talk about best interest of tax payers dollars, then we need to consider the enormous amount of monies that the tax payers have paid for clean-up of contaminated groundwater at the Paducah Gaseous Diffusion Plant, which cannot be cleaned up. Let's talk about the $300,000 the University of Kentucky received to do this study which shows there was never any intention to buy private property that the PGDP contaminated. The Paducah Sun reported on March 15, 2007, DOE spokesperson, Laura Schachter stated "the study was only done because it was mandated by lawmakers in Congress."[1] So you see monies are not being wasted on the residents, but millions have been wasted by the DOE to contractors knowing there was not an effective technology that would clean-up contaminated groundwater. We did not know until 1988 of the contamination, when my late husband along with the Health Department Official inspected and tested a well at the request of a private landowner and found her well along with others to be contaminated and unusable. In 1999 maps of the Northeast and Northwest contaminated plumes appeared in the Courier Journal along with locations of radiation spots even out into the residential community.

GROUNDWATER CONTAMINATION: The Northeast Plume is 1,000 feet wide and 120 feet deep, contaminated with trichloroethylene (TCE), technetium-99 (TC-99), radionuclides, heavy metals, transuranics and several contaminants of concerns that according to DOE in their Feasibility Study were released from the PGDP, and describes how the groundwater became contaminated and flows downwind from the facility to the Ohio River. Over the last thirteen years several technologies have been tried without success in removing the contamination. All of the technologies that have been tried have cost millions of taxpayer dollars. These plumes extend beyond the PGDP property. Little Bayou Creek which is contaminated runs through private property (Warren Smith) into Big Bayou Creek to the Ohio River. Currently, the nearest neighbor is approximately ½ mile from the plant. All that separates this neighbor's property from DOE property is

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[1] Laura Schachter, DOE spokesperson, Paducah Sun Newspaper.

Little Bayou Creek, where on the DOE side mounds of proposed contaminated soil have been found that was dredged from Little Bayou Creek in earlier years when hazardous contaminants were so intense and will be tested by the Department of Energy. The Paducah Sun Newspaper on March 18, 2007 reported Reinhard Knerr, lead manager of DOE for cleanup at the Paducah Gaseous Diffusion Plant, that these contaminated mounds would be tested extensively.[2] TCE is the source of the Northeast Plume groundwater contamination according to DOE and the soil is heavy with PCB's and contaminants that are also in the groundwater.

SOIL CONTAMINATION: In addition, soil contamination is very widespread around the PGDP. Residents own farms, raise crops, grow gardens, not knowing the hazardous pollutants the cooling towers were releasing out into the atmosphere was being distributed back onto private property into the soil and vegetation. Most of these residents still turn their soil under to raise gardens, crops, setting the stage for soil contamination. Soil is an exposure pathway and can become polluted when a dangerous contaminating substance reaches the top soil. An exposure pathway describes how a contaminant travels from its source to an individual. A complete exposure pathway consists of the starting place of the release, how it is released, how it travels, a point of possible individual contact, and a path the exposure took. The pathway that humans are exposed to by these contaminants are by the food they eat out of their gardens, the air they breathe, the water they drink from their wells, the baths they take when a day's work is done, and the soil and vegetation they handle on their property. I do know there is concrete rubble, which came out of buildings contaminated with contaminates and used as liners on creek banks and ponds, and also rusted uranium barrels sitting out in the open, just waiting for a criticality to occur. Because of sites like these it is no wonder the total amount of contaminated soils have yet to be determined, as characterization of the soil is not yet completed. However, it was pointed out that approximately 200 acres of soils is still affected by the remaining pollution in a presentation at a Citizen's Advisory Board Meeting and to the public. The soil is highly loaded with PCB's, which were land farmed or poured out on land and disked under in the earlier years.

In March of 2005, I had the soil in my garden and yard tested by the Kentucky Division of Waste Management, to find out if my property was

[2] Reinhard Knerr, DOE lead manager for clean-up: Paducah Sun Newspaper.

okay to raise a garden for myself and my family to eat. My property is high in Arsenic at 17.9 mg/kg and Thallium 5.3 mg/kg. Because of such a high concentration in private property soil they retested the soil in June, 2005 as a precaution and found it still high.[3] According to Albert Westerman (EPPC DEP DES), in an e-mail he said regarding the soil results his advice was and I quote: "Based on a percentage of the total amount they would normally consume from their garden, they should consume no more than 0.8% of the vegetables grown in the garden or 0.3% of the total vegetables they might consume over the year. Obviously, these percentages are so low that basically we are saying do not eat your produce grown in this garden. You can grow it for looks but do not eat it. This recommendation is based on a cancer risk of one in one million." unquote.[4] A DOE map shows a well on a private farm was tested and thallium was found.[5] This location is approximately ¼ mile across from my property upwind. So you see even my property and groundwater is contaminated with hazardous pollutants that are not good for consumption whether it is in small or large amounts.

<u>HEALTH ISSUES:</u> If you go around the plant to over 600 households that surround this facility you will find enormous health problems. Workers, ex-workers and their families are being compensated for their illnesses which they contracted while working at the Paducah Gaseous Diffusion Plant, while the residents residing around this plant are left in the wind suffering with their illnesses and family deaths caused by the contamination and releases from this plant. The illnesses surrounding this plant consists of brain tumors, lung cancer, stomach cancer, thyroid cancer, colon cancer, birth defects, diabetes, brain cells dying, Crohn's disease, blood disorders, high blood pressure, heart trouble, kidney cancer, throat cancer, lymphoma, and I could go on with many more. I know and believe this because it is happening and has happened in my own immediate family. I and my family suffer some of the above illnesses along with many other residents and their families. My youngest son has heavy metal poisoning of manganese, arsenic, mercury, aluminum, cadmium and lead, which is causing his brain cells to die and not be replaced. My oldest son has a blood disorder and chronic diarrhea that keeps him from being able to obtain health insurance. My husband worked as a conservation officer for the KY Dept. of Fish and

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[3] English's garden and yard samples tested.

[4] Al Westerman: (EPPC DEP DES), regarding results of soil samples.

[5] DOE Map: Tested for thallium.

Wildlife. He would wash off in the creeks in the summer, because of the heat and the dirt when he would mow and disk the ground for planting. These waters were purple and yellow, and he saw fish that would be dead and floating on top of the water. He died last year from rheumatoid arthritis and heart failure with his stints collapsing. He was in such poor condition he was not able to undergo heart surgery, so he died. I had thyroid and colon cancer, diabetes, high blood pressure, and nerve damage. So you see I know something about the suffering that these families are going through, because I live it every day of my life. The damage to property and neighbor's health was done years ago before the contamination was found. The clean-up process has been slow and ineffective.

In conclusion, the severity of the contamination is very deep, and to clean-up the groundwater and soil completely will be very costly to the Department of Energy. There is no known technology available to clean-up the soil or the groundwater contamination. Health problems will continue to increase due to the time span it takes for diseases to materialize following exposure to contaminants released from this plant in previous years. The dormant years for these contaminates can be from ten to thirty years or more before health problems begin to surface. Will the Department of Energy be successful in cleaning up the contamination, protecting the environment, and the public from further harm? That remains to be seen.

Thank you for letting me have this opportunity to respond to the study regarding property acquisition of land located above the plumes of contaminated groundwater near the Paducah Gaseous Diffusion Plant located in West Paducah, KY. You may not believe my story, but it is true because I live it every day of the year.

Sincerely,

Ruby English

Ruby English,
Concerned neighbor and
ACT Chair

Attachments:

NOTES

1. DOE not seeking landowner buyout: Paducah Sun Newspaper: mailto:jwalker@paducahsun.com.
2. Reducing the DOE dirt: Paducah Sun Newspaper: mailto:jwalker@paducahsun.com.
3. English's Garden soil samples:
4. Dr. Al Westerman: (EPPC DEP DES).
5. DOE Map: Thallium found
6. Northeast Plume Map.

The Paducah Sun

DOE not seeking landowner buyout

Agency will discuss year-long study pertaining to contaminated groundwater.

By Joe Walker jwalker@paducahsun.com--270.575.8656

Thursday, March 15, 2007

The Department of Energy has no plans to buy land above a massive area of contaminated groundwater near the Paducah Gaseous Diffusion Plant, but Joey Wray says many of his neighbors wouldn't be interested even if an offer were made.

"Most of us wouldn't be for it," said Wray, who lives at 6355 Metropolis Lake Road. "The reason is most of us have lived here our entire lives. It's our home, our parents' home and our grandparents' home."

He also wonders why DOE is even considering a buyout if the contamination is no longer a threat. Since 1994, the government has provided free municipal water to 121 plant-neighboring households and businesses because of an estimated 10 billion gallons of contaminated groundwater. The area is 60 to 120 feet deep, flows from the uranium-enrichment plant to the Ohio River and contains trichloroethylene, once liberally used by the factory as a degreaser.

Wray and his mom, Glenda Wray,

Frequently Answered Questions

shared those opinions at a DOE public meeting last June, and they plan to attend a follow-up meeting at 6 p.m. Tuesday at the Heath High School auditorium. DOE officials will reveal the findings of a year-long study that included land acquisition among the alternatives for dealing with the contamination.

BARKLEY THIELEMAN The Sun
This well monitors groundwater on Glenda Wray's property on Metropolis Lake Road.

DOE is not offering to buy land, spokeswoman Laura Schachter said. Instead, the findings and public comments will be submitted to Congress April 16 because the study was mandated by lawmakers, she said.

"I think the department is really sensitive to the fact there is anxiety and interest," Schachter said. "But no decision has been made (to buy land)."

The study contains cost estimates and spells out ways to buy land or land interests, she said. "It's really bringing together all this information and presenting it under a set of parameters and possibilities, but it isn't a recommendation."

Schachter said most of the comments have been from people who merely want to understand the buyout options. If buying land were truly an option, it probably would be considered as part of the overall cleanup work at the plant as governed by federal laws, she said.

Federal legislation sponsored by Sen. Mitch McConnell required DOE to study whether a buyout is in taxpayers' best interests. Work focused on land under which contaminated groundwater flows in a horseshoe-shaped plume away from the plant. Another pollutant, radioactive technetium, is present but in much less quantity than the degreaser.

DOE evaluated public and private land in blocks at fair market value as compared with other property in McCracken County. Among the options considered were outright purchase, buying the land but allowing residents to stay, or purchasing easements.

Wray said those who might want to sell generally don't have sentimental attachments to the land. They include owners who bought property more recently for redevelopment or other uses, he said.

"There are definitely some who would be interested in selling," Wray said. "I'm not faulting them at all."

Wray's family wells were among those sealed by DOE in return for free municipal water. Monitoring wells on their farmland continue to test for contamination.

The Wrays were among about 135 people owning 82 pieces of land who joined a 1997 federal lawsuit alleging former plant contractors poisoned and devalued their land. The suit remains before the U.S. 6th Circuit Court of Appeals after being dismissed in Paducah in early 2004.

Although it is unclear how much the property is worth, economic development officials estimated five years ago that such a buyout would cost $15 million.

In addition to pumping and treating groundwater, DOE spends $70,000 to $100,000 a year providing free water. No technique has been discovered to effectively clean up the groundwater, but DOE will try to remove the chief source of the pollution by using in-ground electrodes to evaporate the degreaser from beneath a plant cleaning building. That work is expected to start next winter and will take about nine months.

The Paducah Sun

Reducing the DOE dirt

Testing, removal of nearby contaminated soil promised

By **Joe Walker** jwalker@paducahsun.com--*270.575.8656*

Sunday, March 18, 2007

The Department of Energy plans to extensively test contaminated dirt piles in the West Kentucky Wildlife Management Area and remove those piles that might pose a health risk.

"We're trying to be as aggressive as we possibly can to get out in the field," said Reinhard Knerr, DOE lead manager for cleanup at the Paducah Gaseous Diffusion Plant. "We don't think there are any immediate health threats, but these are in areas open to field trials and other activities."

The overgrown dirt mounds, dumped from creek dredging many years ago, were cordoned off after DOE technicians surveyed 30 miles of creeks and ditches around the plant late last year. Using handheld devices to sweep for low-level radiation, workers put rope and signs around five to eight miles of dirt and concrete rubble piles.

"It just doesn't make sense to us to have all these areas roped off and have to maintain five to eight miles of chain and postings," Knerr said.

There are 99 soil piles in the management area around the plant, plus

Frequently Answered Questions

51 concrete rubble piles in the same area as well as on nearby Tennessee Valley Authority land and several miles away in the Ballard Wildlife Management Area.

Knerr said some rubble piles were trucked to the Ballard County area and placed for erosion control until the 1970s at the request of state Fish & Wildlife managers. Although there is "not a clear understanding" that plant workers hauled the piles, they apparently came from plant demolition projects, he said.

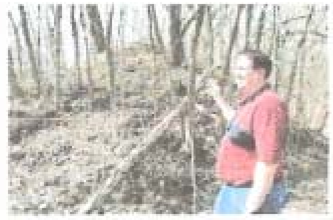
"We would have surveyed them (for radiation), but survey equipment back then wasn't as sensitive as it is now, and regulations weren't as stringent as they are today," Knerr said.

He said some piles previously were moved back to the plant after scanning showed somewhat elevated levels of radiation. All of the piles outside the plant will be retested, Knerr said.

Many of the dirt piles date back to the 1960s and 1970s, based on the size of trees growing on them, and are adjacent to creeks that run through the plant, he said.

DOE submitted a sampling and analysis plan Feb. 9 to the U.S. Environmental Protection Agency and Kentucky waste-management and radiation-control regulators. The work will determine the extent and depth of uranium, heavy metal and polychlorinated biphenyl (PCB) contamination.

Assuming regulators agree, testing will start late this month on the east side of the plant where several mounds were discovered in November near a horse trail. Knerr said the area is remote and very overgrown in summer months, making the piles hard to see.



Jim Ethridge Paducah Remediation Services Reinhard Knerr, Department of Energy lead manager for cleanup, points to the highest contaminated dirt pile (12 feet) near the Paducah Gaseous Diffusion Plant. It will be among the first to be tested and, if needed, removed.

Jim Ethridge Paducah Remediation Services DeNuke worker Will Guy uses a global positioning system computer that will log thousands of sampling results from dirt pile field tests.

"That area has the greatest potential for elevated levels of PCBs, heavy metals and uranium," he said.

Jim Ethridge/Paducah Remediation Services Justin Sunderland of Department of Energy subcontractor DeNuke Services uses a detector to sweep the ground for radiation. The yellow satellite-positioning equipment on his back automatically plots the exact location of the test.

Although the Kentucky Division of Waste Management sought minor changes in the plan, DOE is cleared to start work, said Tony Hatton, assistant division director. Hatton said he understands that EPA and the Kentucky Radiation Control Branch have some concerns about which regulatory authority should govern the work, but he expects those to be resolved.

During the first phase, more than 700 field samples and more than 200 lab samples will be taken from each of three sites on the east side. Knerr said workers will bore from the top of the piles down to two feet below the base. For the tallest, 12-foot pile, that means going 14 feet deep.

DOE wants to follow sampling by quickly removing dirt that poses unacceptable risk, Knerr said.

"We want to make sure we use our taxpayers' dollar effectively," he said. "We think there's going to be a large percentage of material that can go into the plant landfill."

Any soil with elevated PCBs will have to be sent to an approved disposal facility elsewhere, Knerr said.

Hatton said DOE is self-regulated regarding low-level radioactive materials that go into the landfill, but state regulations bar the landfill from receiving anything with more than 49 parts per million of PCBs. That is roughly equivalent to 49 drops of ink in a 40-gallon drum of water.

"Ultimately it's DOE's responsibility to sample the soil and be sure it meets all the criteria that allow them to place the soil in the landfill," he said, adding that getting rid of contaminated soil is preferable to managing it in place, Hatton said.

Soil removal is tentatively slated to begin in May, depending on regulatory approval, Knerr said.

Subsequent testing will involve (1) other areas east of the plant and three soil piles near a ditch that runs from the center of the plant into the management area, (2) dirt piles west of the plant, and (3) rubble piles. Portable satellite equipment will automatically plot the thousands of samples made by reading a position every second.

Knerr said sampling is expected to last through October, "but we hope to beat that schedule. The thickness of summer vegetation will be a real challenge."

EPA expressed concern in December that previous cleanup investigation at the plant had not found the piles, especially considering their size, number and close proximity to the plant fence. Plant heavy equipment operator Chris Naas reminded DOE officials last month that he told federal investigators several years ago about having excavated the dirt, but he thought he was ignored.

There are limited dredging records, and both DOE and regulators knew about some of the soil and rubble piles, Knerr said. "I think what wasn't understood was the number of piles and that they had a potential for elevated contamination."

ruby english

From:	<Brian.Begley@ky.gov>
To:	<renglish@brtc.net>
Sent:	Wednesday, June 01, 2005 11:17 AM
Subject:	Your garden soil sample update

Ms. English,
I just received Dr. Westerman's response to a question I posed regarding the amount of vegetables that was safe to eat from your garden. His response is below. It appears that the consumption amount is so low ("no more than 0.3% of the total vegetables they might consume over the year") that we are suggesting that you do not eat the produce that is grown from your garden.

I again apologize for the delay in getting out your explanation letter. My goal is that it will go out in the mail today. I am still willing to send you an electronic copy of the letter with the two summary tables I created so you can see the results once it gets approved. Feel free to call with any questions. The phone numbers of the two state experts I consulted are located in the last paragraph of the letter. You can contact them for a more detailed explanation if you like.

Brian D. Begley, P.G.
KY Division of Waste Management
(502) 564-6716 ext. 669
brian.begley@ky.gov

Brian,
Unfortunately, that is almost an impossible question to answer because you really are asking how many potatoes, carrots or batches of lettuce can they eat out of their garden, and we would need to know exactly how much of each vegetable is grown rather then relying on national averages as we did in the assessment. Based on a percentage of the total amount they would normally consume from their garden, they should consume no more than 0.8% of the vegetables grown in the garden or 0.3% of the total vegetables they might consume over the year.
Obviously, these percentages are so low that basically we are saying do not eat your produce grown in this garden. You can grow it for looks but do not eat it. This recommendation is based on a cancer risk of one in one million. -Al

-----Original Message-----
From: Begley, Brian (EPPC DEP DWM)
Sent: Tuesday, May 31, 2005 11:47 AM
To: Westerman, Albert (EPPC DEP DES)
Subject: RE: PGDP Garden Soil Results and Question
Sensitivity: Private

Al,
I have one final question regarding the soil results and your response to the results. In your response you suggest that the family limit their consumption of vegetables being grown in their garden. How much should the residents limit their vegetable intake from their garden. Based on the 40% assumption what should we tell the resident is a safe amount to eat? If we tell the resident to limit their intake of garden vegetables then what amount do we tell them.
Thanks,
Brian

Brian D. Begley, P.G.
KY Division of Waste Management
(502) 564-6716 ext. 669
brian.begley@ky.gov

6/1/2005

Sample ID 030503

Sample ID 060503

Analyte	03/16/05 Sample Garden Soil (mg/kg)	Background	Region 9 PRGs Residential Soil (mg/kg)	06/03/05 Sample English Garden (mg/kg)
Mercury	0.036 B	0.2	23	0.015 BN
Arsenic	17.9	12	0.39	13.8
Lead	28.4	36	400	25.6
Selenium	ND	0.8	390	0.54 B
Thallium	5.3	0.21	5.2	2.9
Uranium	ND	4.653	16	ND N
Aluminum	8230 N	13000	76000	7970 N
Antimony	ND N	0.21	31	ND N
Barium	114	200	5400	94.3
Beryllium	0.83	0.67	150	0.79
Boron	6.5 B		16000	4.7 B
Cadmium	ND	0.21	37	ND N
Calcium	1500	200000		1500
Chromium	17.5	16	100000	13.7
Cobalt	10.5	14	900	9.7
Copper	8.6	19	3100	8.2
Iron	23100 N*	28000	23000	16800 N
Magnesium	952	7700		955
Manganese	1580 N	1500		1570 N
Molybdenum	0.89 B		390	0.59 B
Nickel	7.6	21	1600	7.6
Potassium	658	1300		646
Silicon	971 N			1300
Silver	ND	2.3	390	ND
Sodium	31.6 B	320		40.6 B
Vanadium	43.6	38	78	33.2
Zinc	36.6	65	23000	35.1

Table 1

B = Estimated Result. Result is less than the reporting limit

N = Spiked analyte recovery is outside the stated control limits.

Sample ID 060504

06/03/05 Sample English Yard (mg/kg)
0.060 B
9.9
32.3
1.3
3.3
ND
13800 N
ND N
162
0.76
5.7 B
ND
1440
18
7.6
16.7
20800
2040
632 N
0.84 B
14.1
1260
675
ND
39.1
31.6
93.8

Property values	Increasing	[x] Stable	Declining	Tenant	150+ High 50+	Multi-family
Demand/supply	Shortage	[x] In balance	Over supply	[x] Vacant (0-5%)	Predominant	Commercial 25
Marketing time	Under 3 mos.	[x] 3-6 mos.	Over 6 mos.	Vacant (over 5%)	85 25	Vacant 35

Note: Race and the racial composition of the neighborhood are not appraisal factors.

Neighborhood boundaries and characteristics: North: Ohio River, West: Bethel Church Road, South: Highway 60, East: Metropolis Lake Road.

Factors that affect the marketability of the properties in the neighborhood (proximity to employment and amenities, employment stability, appeal to market, etc.):

Market conditions in the subject neighborhood (including support for the above conclusions related to the trend of property values, demand/supply, and marketing time — such as data on competitive properties for sale in the neighborhood, description of the prevalence of sales and financing concessions, etc.): Conventional financing readily available at 5.00-6.00% fixed interest rates; 15 & 30 year terms; 0-1% origination fee; 0-1% discount points. FHA/VA financing also available at 5.00-6.00% fixed interest rates, 15 & 30 year terms; 0-1% origination fee; 0-1% discount points. Discounts, buydowns, concessions, not prevalent in this market area.

Project information for PUDs (If applicable)-- Is the developer/builder in control of the Home Owners' Association (HOA)? Yes [x] No

Approximate total number of units in the subject project N/A. Approximate total number of units for sale in the subject project N/A.

Describe common elements and recreational facilities: N/A

Dimensions see attached legal description and plat;

Site Area — Corner Lot Yes [x] No

Specific zoning classification and description M-H, Heavy Industrial Zone

Zoning compliance [x] Legal Legal nonconforming (Grandfathered use) Illegal No zoning

Highest & best use as improved [x] Present use Other use (explain)

Topography level
Size average to large
Shape irregular
Drainage appears adequate
View
Landscaping
Driveway Surface
Apparent Easements

Utilities	Public	Other	Off-site Improvements	Type	Public	Private
Electricity	[x]		Street	asphalt	[x]	
Gas			Curb/Gutter	none		
Water	[x]		Sidewalk	none		
Sanitary Sewer		septic	Street lights	none		
Storm Sewer			Alley	none		

FEMA Special Flood Hazard Area Yes [x] No
FEMA Zone C Map Date 6-04-80
FEMA Map No. 210151 0020 B

Comments (apparent adverse easements, encroachments, special assessments, slide areas, illegal or legal nonconforming zoning, use, etc.): No adverse easements or encroachments were observed at the site or on the plat. It is assumed that none exist.

GENERAL DESCRIPTION	EXTERIOR DESCRIPTION	FOUNDATION	BASEMENT	INSULATION
No. of Units	Foundation	Slab	Area Sq. Ft. n/a	Roof
No. of Stories	Exterior Walls	Crawl Space	% Finished	Ceiling
Type (Det./Att.)	Roof Surface	Basement	Ceiling	Walls
Design (Style)	Gutters & Dwnspts.	Sump Pump	Walls	Floor
Existing/Proposed	Window Type	Dampness	Floor	None
Age (Yrs.)	Storm/Screens	Settlement	Outside Entry	Unknown [x]
Effective Age (Yrs.)	Manufactured House	Infestation		

ROOMS	Foyer	Living	Dining	Kitchen	Den	Family Rm.	Rec. Rm.	Bedrooms	# Baths	Laundry	Other	Area Sq.Ft.
Basement												
Level 1												
Level 2												

Finished area above grade contains: Rooms; Bedroom(s); Bath(s); Square Feet of Gross Living Area

INTERIOR	HEATING	KITCHEN EQUIP.	ATTIC	AMENITIES	CAR STORAGE
Floors	Type	Refrigerator	None	Fireplace(s) #	None
Walls	Fuel	Range/Oven	Stairs	Patio	Garage # of Cars
Trim/Finish	Condition	Disposal	Drop Stair	Deck	Attached
Bath Floor	COOLING	Dishwasher	Scuttle	Porch	Detached
Bath Wainscot	Central	Fan/Hood	Floor	Fence	Built-In
Doors	Other	Microwave	Heated	Pool	Carport
	Condition	Washer/Dryer	Finished		Driveway

Additional features (special energy efficient items, etc.):

Condition of the improvements, depreciation (physical, functional, and external), repairs needed, quality of construction, remodeling/additions, etc.:

Adverse environmental conditions (such as, but not limited to, hazardous wastes, toxic substances, etc.) present in the improvements, on the site, or in the immediate vicinity of the subject property: Site is located inside area of investigation for ground water contamination created by the U.S.E.C. Gaseous Diffusion Plant, see map; U.S.E.C. has connected subject site to city water.

Freddie Mac Form 70 6-93 — MCS, a Division of ACI Development (800) 854-7703 — Page 1 of 2 — Fannie Mae Form 1004 6-93

approximate
Ellis L Farm

Department of Energy
Public Meeting

Heath High School

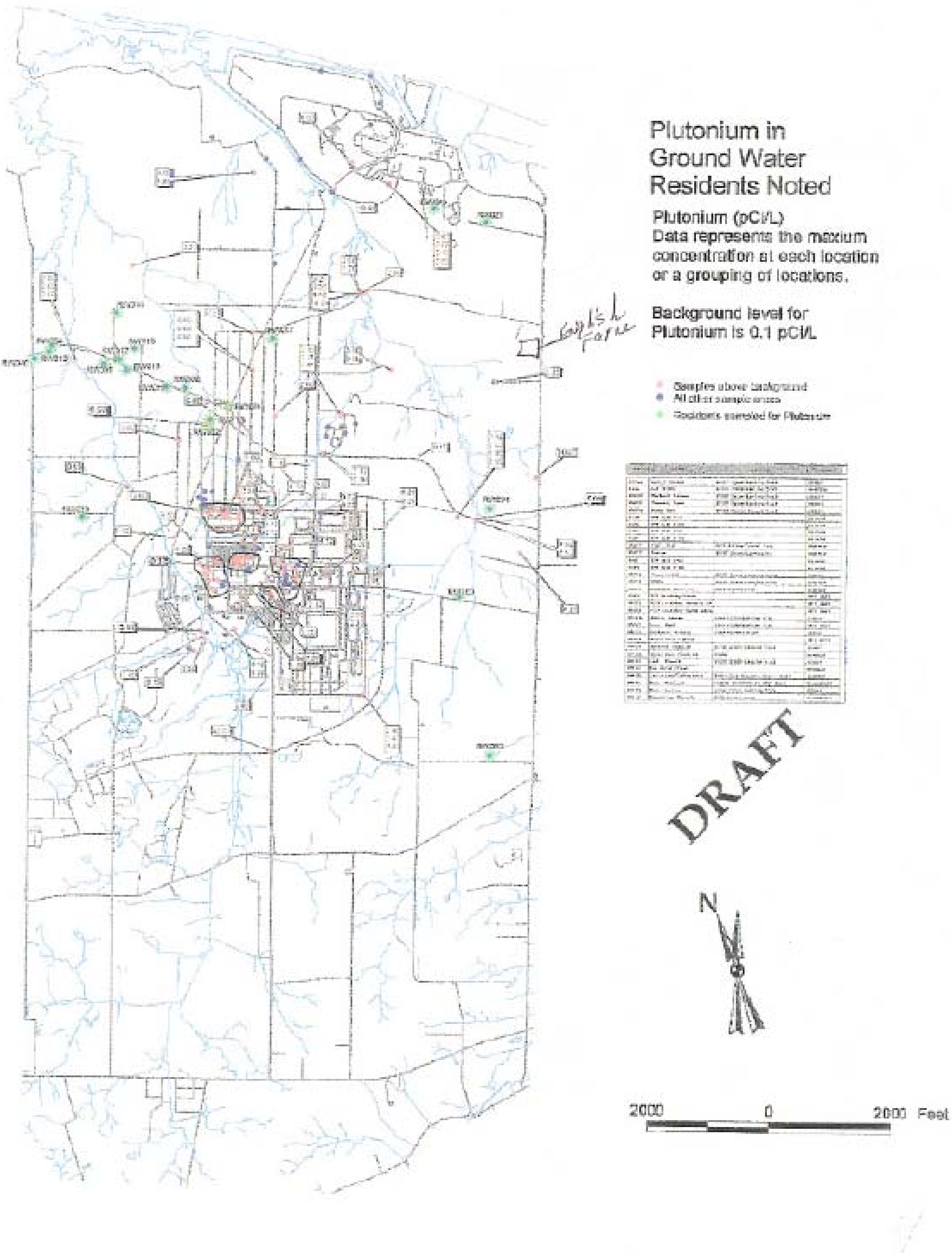
October 5, 2000

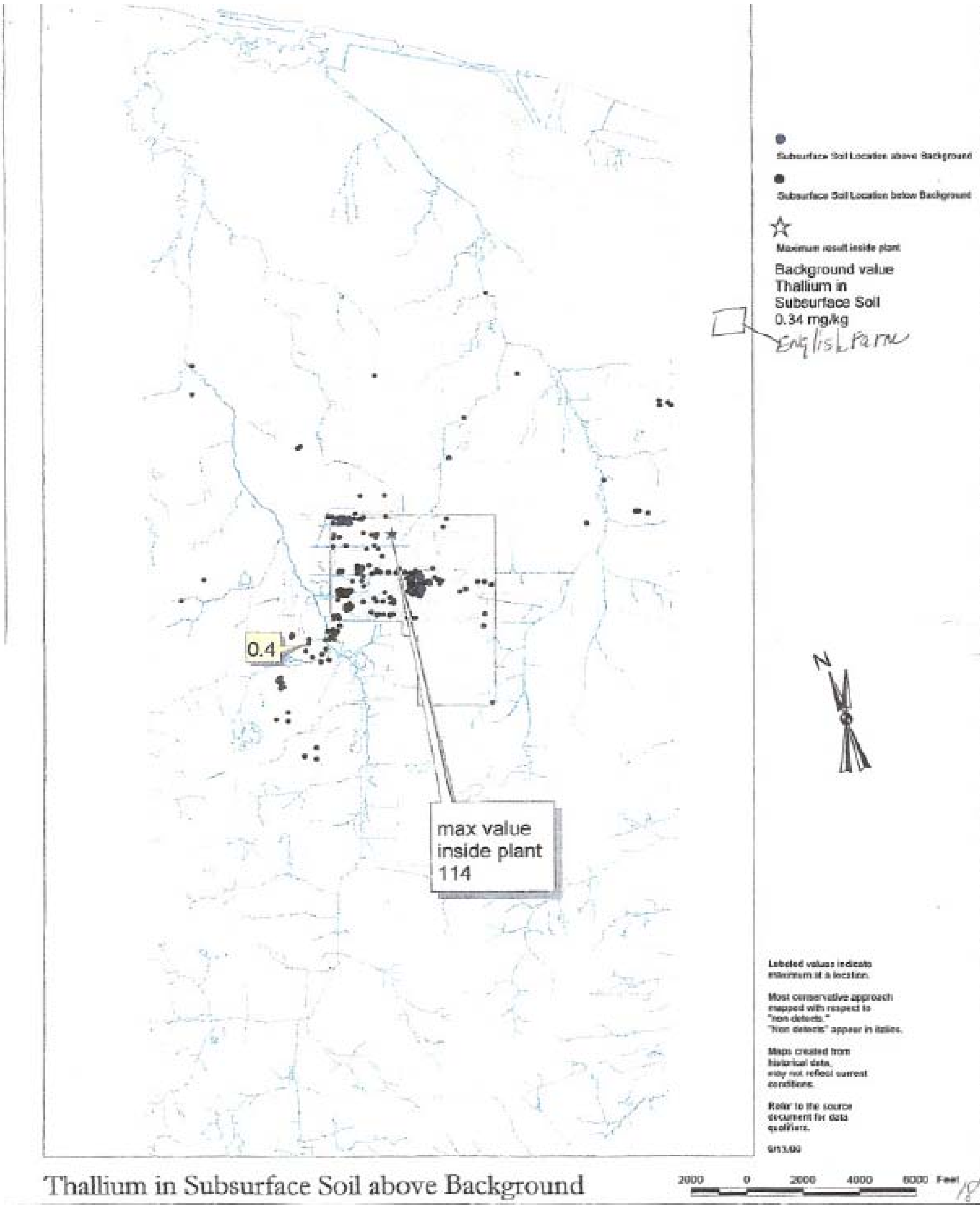
7:30 p.m.

Enclosed are 29 DRAFT and four Final maps produced using data collected during an 11-year period. Each map reflects sampling taken for various radioactive isotopes (including plutonium) and beryllium. Sampling data for the past 11 years is included on each map.

Questions about these maps or the public meeting should be directed to Bechtel Jacobs Company, Public Affairs, 270-441-5023.

Documents from which all data were collected are available in the U.S. Department of Energy's Environmental Information Center, located at 175 Freedom Blvd., Kevil, KY 42053. Hours are from 7:30 a.m. to 4:30 p.m. Monday through Friday (except on Federal holidays) and by appointment. Please phone 270-462-2550.


Plutonium in
Ground Water
Residents Noted
Plutonium (pCi/L)
Data represents the maxium
concentration at each location
or a grouping of locations.
Background level for
Plutonium is 0.1 pCi/L
Samples above background
All other sample areas
Residents sampled for Plutonium
DRAFT
N
2000
0
2000 Feet



Thallium in Subsurface Soil above Background

Working for the future

Paducah Gaseous Diffusion Plant
CITIZENS ADVISORY BOARD

PADUCAH GASEOUS DIFFUSION PLANT
CITIZENS ADVISORY BOARD

111 Memorial Drive • Paducah, Kentucky 42001 • (270) 554-3004 • padssab@apex.net www.oakridge.doe.gov/pgdpssab

October 30, 2002

Subject: Proposed Recommendation from Paducah Gaseous Diffusion Plant (PGDP) Citizens Advisory Board - Compensation for Landowners

Dear PGDP Neighbor:

Enclosed is a proposed recommendation from the PGDP Citizens Advisory Board Community Concerns Subcommittee. The subcommittee, which deals with residential contamination issues, has prepared the proposed recommendation and wants to hear from you.

Please complete the enclosed questionnaire and mail it in the return-addressed, postage-paid envelope as soon as possible to enable the subcommittee to better represent the community's position on the proposed recommendation.

If you have any questions or need additional information, the Board meets monthly or you can contact the office at (270) 554-3004. Thank you for your prompt cooperation.

Sincerely,

Craig Rhodes

Craig Rhodes
Community Concerns Subcommittee

CR:ll
LTR-PAD/CAB-LL-02-0022

Enclosures: 1. Proposed recommendation
2. Questionnaire

c/encs: D. Dollins, DOE-PAD
P. Halsey, DOE-ORO
M. Kemp, CAB
W. D. Seaborg, DOE-PAD
S. Young, BJC
File-EMEF-DMC-PAD-RC

PADUCAH GASEOUS DIFFUSION PLANT
CITIZENS ADVISORY BOARD

111 Memorial Drive · Paducah, Kentucky 42001 · (270) 554-3004 · paducab@apex.net www.oakridge.doe.gov/pgdpssab

Proposed Recommendation 02-02

Submitted for Discussion by Community Concerns Subcommittee August 15, 2002

Title: Compensation for Landowners

Background:
Operations at the Paducah Gaseous Diffusion Plant have led to contamination in the area around the plant. Past evidence shows that private wells and land have been contaminated.

Concern:
Contamination may have diminished the value of some nearby private property.

Recommendation:
There are well-defined areas of contamination, underground and on the surface and some of these areas of contamination are unquestionably linked to operations at the Paducah Gaseous Diffusion Plant (i.e., groundwater plumes). Therefore, the Department of Energy (DOE) should take the initiative to compensate landowners where there is loss of value. We recommend that DOE develop a plan, subject to approval by the Citizens Advisory Board and the public, to retain the services of several property appraisers who will assess damage and property value. DOE should then offer to pay landowners in the affected area for damage. This payment would not prevent additional claims by individuals for personal injury or property damage that is currently unknown.[1]

[1] The intent of distributing this proposed recommendation to the affected citizens around the plant is to receive their input on this proposed recommendation. The intent of the proposed recommendation is to allow landowners who owned groundwater wells that have been closed due to contamination from the plant to collect damages from the loss of use of that resource without waiving any other rights to use all legal means to seek compensation for other damages they may have suffered. We believe that people who have lost the use of their wells should be compensated for that loss, but that such compensation should not result in that party losing their right to seek compensation for other damages, such as health problems, loss of land values, and other possible losses. Thus, this proposed recommendation is to be narrowly construed to only apply to groundwater contamination which has resulted in the loss of use of that resource.

PADUCAH GASEOUS DIFFUSION PLANT
CITIZENS ADVISORY BOARD

111 Memorial Drive • Paducah, Kentucky 42001 • (270) 554-3004 • padcab@apex.net www.oakridge.doe.gov/pgdpcab

COMMUNITY CONCERNS SUBCOMMITTEE QUESTIONNAIRE

I have read the Paducah Gaseous Diffusion Plant Citizens Advisory Board Community Concerns subcommittee proposed recommendation on compensation for landowners and:

(Please check one)

_______ I agree with the recommendation and wish for the subcommittee to proceed with the recommendation to the Department of Energy.

______ I disagree with the recommendation and do not wish for the subcommittee to proceed with the recommendation to the Department of Energy.

Comments:

____

____

____

____

Please complete and mail in the enclosed return-addressed, postage-paid envelope as soon as possible. Thank you.

PGDP Citizens Advisory Board
Community Concerns Subcommittee

Fact Sheet
Proposed Recommendation for Compensation of Landowners

- 98 Water Policy participants were mailed a copy of the proposed recommendation and a questionnaire, that is to be filled out and returned to the CAB.
- 28 responses have been received to date.
- All responses received are in agreement with the proposed recommendation.
- A compilation of all comments will be provided at the January 2003 Board meeting.

February 23, 2004

Dave Dollins
Paducah Operations Oversight Group
United States Department of Energy
P.O. Box 1410
Paducah, KY 42002

Public Comment in the matter of:
Draft Risk-Based End State Vision and Variance Report for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2119&DO/R2-Secondary Document)

Comment Period Ends:
February 20, 2004 (extended)

Please include the following comments as part of the permanent file.

Charles Jurka
RT 3, Box 265A
Golconda, IL 62938

Charles Jurka

Vicki Jurka
RT 3, Box 265A
Golconda, IL 62938

Vicki Jurka

Comments:

The landowners, through the PGDP Water Policy, have entered into an agreement to abandon the use of groundwater while purchasing municipal water at DOEs expense. This agreement has a five-year life with variable renewal options. Since its inception, with one exception (landowner refusal), this removal action has performed effectively; meeting the goal of reducing "risks to residents, from exposure to" contaminated "groundwater."

Under the risk-based end state proposal "enhanced institutional controls.. would supersede (annul or replace) the current PGDP Water Policy." One of the proposed institutional controls takes the form of a legal agreement; placing "enforceable restrictions on groundwater." This type of legal agreement would be limited in duration through the law of perpetuity as well as subject to legal interpretation. Another proposal calls for the aquisition "of rights from surrounding property owners and directly implements (ing) restrictions on groundwater and property use." This proposal enjoins the property owner to abstain from using their groundwater and/or property in exchange for an undetermined sum of money. Under the principles of mutual benefit both parties would automatically benefit from this buyer/seller agreement. But through this approach, the landowner realizes a lesser, more undesireable, benefit when relinquishing not only property right but municipal water payments as well.

DOE and its contractors contaminated the landowners groundwater; destroying a self-sufficient economical option for landowner water-production. DOE then ameliorated this harm, through the Water Policy, by paying the costs associated with a new source of "clean" water. The extensive and expansive degree of groundwater contamination, under the current proposed remedial actions, will remain for many generations to come. In all likelihood, legal instruments will not bridge this generational span. The inherent failures of both current and risk-based proposals necessitates the exploration of other options. The most fail-safe, long-range, cost-effective option is the purchase and subsequent DOE control of "realestate" from all Water Policy landowners.

Pages 143-147: Hazard 1, V-1.2 through V-1.5: This draft document makes claims that the only "variance in risk between the current planned end state and the RBES is the amount of time necessary to achieve MCLs." We disagree. The decision making process (scope, cost, schedule, etc.) fails to consider the progression of the curently identified groundwater plumes and the potential impact on landowners , residing out side the Water Policy boundries, who still rely on groundwater sources. It also fails to address the importance of the element of time respecting the migration of unremediated contaminants beyond current Water Policy boundries and/or into the deeper aquifer (McNairy). It should be apparent that the proposed institutional controls will not ameliorate the risk for future generations.

Barriers:

* (143) We endorse the regulators position for "source actions to reduce contaminant concentrations."
* (143) We reject "technical impractability waivers."
* (144) We disagree with calling the fenceline "point of exposure." It would be better identified as the source of all exposures.
* (144-5) After 50 years of dumping by DOE and its contractors, source actions are necessary.

Page 148: Hazard 2, V-2.1: The RBES fails to consider the hazard posed from eating "ecological receptors" after they have been exposed to long-lived PCBs in their environment.

Page 150: Hazard 3, V-3.1: Burial grounds are inconsistent with re-industrialization.

Pages 40 and 142 through 159: Hazard 5: Hazard area 5 includes closed and operating landfills. There are three (P), not two, closed landfills in this industrialized landfill area. These landfills are leaking.They are closer to the residential receptor than any other PGDP/DOE facility. They sit atop a seismically active area. By their very nature, they pose both current and future risk. The operating landfill (C-746-U) is the primary disposal option for legacy waste, in storage at DMSAs, at PGDP. The potential for future expansion of this landfill is great: ongoing EM, proposed D&D, as well as DUF-6 conversion activities drive this concern. These landfills are a contentious community issue. "Table 5.1 Variance Report by Hazard Area" completely ignores these hazards.

Page 12 (para. above 2.1.2): This paragraph requires clarification.

Page 44 (risk levels): Fig.4.1a2 is referenced but does not appear in this draft document (our copy). This appears to be an important reference when determining exposure pathways.

Page 1: "Once finalized, this report will provide information that can be used to establish clearly articulated and technically achievable cleanup goals for

PGDP..." It is our hope that the final document will achieve these goals; as the draft document fails miserably.

Generally:

* This draft document fails to address radiological risk.
* Anticipated recreational use for areas outside the fence is inconsistent with a McCracken County zoning ordinance .
* This draft document makes contradictory statements (eg: pg ES-3, 1st set * #3, 2nd set *#7, off-site/on-site disposal).
* During D&D the NE plume treatment system may be dismantled/removed (pg.5)
* 24% of the population living around PGDP still rely on groundwater (pg.27
* The timeline for this document, including but not limited to production, notification, availability, and review, was insufficient. This hurried approach generated a poorly prepared document containing many errors (including noticeable omissions).
* The intended use of this document is poorly understood by the public and others; DOE calls it a "living document" with a fast approaching "final" version due date.

Thank you

ATTACHMENT H-20

ARTICLE IN THE PADUCAH SUN

MARCH 21, 2007

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LANCE DENNEE/The Sun
Property owners from the Heath area watch a Department of Energy presentation at Heath High School on Tuesday.

DOE: Land around plant could cost up to $54 million

By **Joe Walker** jwalker@paducahsun.com--*270.575.8656*
Wednesday, March 21, 2007

A new Department of Energy study shows it would cost taxpayers at least $30 million to buy land affected or threatened by groundwater contamination from the Paducah Gaseous Diffusion Plant.

The cost would rise to about $54 million if commercial-development value of farmland were considered rather than market value.

Although DOE hasn't offered to buy land, Alice Dick would gladly sell. Her well on Boldry School Road north of the plant was the first to be found contaminated in 1988 with trichloroethylene (TCE), a degreaser heavily used at the factory for decades.

She now has cancer and believes drinking the water was a factor. If the government doesn't buy it, the land will be hard to sell because of the pollution, she said.

"I'd give anything if they would buy me out because I'm right in the middle of the contamination," Dick said.

She was among about 50 people who attended a public meeting Tuesday night at Heath High School to hear the results of the study, mandated by 2006 legislation sponsored by Sen. Mitch McConnell, R-Louisville. Instead of offering to buy land, DOE is accepting public comments until April 3 to go into a final report to Congress due April 16.

DOE officials called the findings a tool for future cleanup decisions and said individual land appraisals would be done if the department decides to buy land. Bill Murphie, head of the DOE project office including Paducah, said $120 million is being spent annually in cleanup work, "but there is no silver bullet" to cleanse the groundwater.

The study found that:

101 residential parcels covering 271 acres and 64 parcels of farmland spanning 5,783 acres are or could be above about 10 billion gallons of contaminated groundwater flowing northeasterly from the plant to the Ohio River.

It would cost an average of around $130,000 to buy 3-acre residential parcels. Acquisition costs of farmland range from $2,800 to $3,100 per acre based on fair market value and from $6,500 to $7,600 per acre based on commercial-development value. Averaging the low and high ranges, it would cost about $13 million to buy residential land and between $17 million to $41 million to buy farmland, depending on whether fair market or development value is used.

Limited-scope easements, restricting groundwater or surface water use, range from $472 to $872 per acre for farms and from $4,000 to $17,300 for residential parcels. Expanded-scope easements — including water-use restrictions and a possible ban on building in-ground swimming pools, septic systems and ponds — range from $2,600 to $2,800 per acre for farms and from $16,500 to $38,400 for residential parcels.

DOE currently spends about $78,000 a year to provide free municipal water to about 100 homes and businesses north of the plant that are above or near the contamination. Buying land is "significantly more expensive" than the combined cost of providing the water with a limited or expanded easement, the report said.

The study estimated the cost and potential effectiveness of 12 methods to reduce the toxicity, volume and mobility of groundwater contamination. The study then estimated how much land would be needed using four combinations of those methods to cleanup the water.

DOE modeled the potential spread of contamination over periods of 30 and 100 years and determined the cleanup cost ranged from $9.6 million to $151.4 million, depending on the extent of the work. In all cases the spread was projected to be only slightly outside the free-water area, bounded by Metropolis Lake Road, the Ohio River and Bethel Church Road. The property-acquisition area was determined by adding a 1,000-foot buffer around the fringe of the contaminated groundwater.

Gary Mattingly, who lives at 8455 Shawnee Lane east of the plant, said he worries that the groundwater eventually will reach his land. He has wells on his property, which is 1,000 to 1,200 feet east of Metropolis Lake Road in an area that modeling shows could eventually be affected by the pollution.

"I'm just concerned about the health risks for my family," he said, adding that he will pass the property on to his children. "I'm not necessarily interested in selling, but I need to know how much more value I should put into my home."

Among the cleanup methods considered in the study were continued pumping and treating of groundwater as well as using in-ground electrodes to evaporate TCE from beneath a cleaning building in the center of the plant. Pumping and treating is ongoing, and use of the electrodes is expected to start within a year.

The building is considered the primary source of TCE. Another pollutant, radioactive technetium, is present in groundwater but in much less quantity than the degreaser.

All staff photographs are available for purchase.
Please call 270-575-8682 or 270-575-8683.

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ATTACHMENT H-21

WRITTEN COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD (ENDING APRIL 3, 2007)

This attachment contains the written comments received during the public comment period, ending April 3, 2007. These include 1) a copy of a letter from Fay Buckingham, 2) a copy of a letter from the Kentucky Department of Fish and Wildlife Resources, and 3) a copy of a fax from Ruby English containing landowners reply to the Property Acquisition along with 11 accompanying exhibits.

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From: fbuckingham [mailto:fbuckingham@brtc.net]
Sent: Friday, March 30, 2007 3:37 PM
To: Schachter, Laura
Subject: Department of Energy

Department of Energy

Property Acquisition Study

Paducah Gaseous Diffusion Plant

Paducah, Ky.

Lady, Gentlemen or whomever it may concern:

I have read the report that was presented to us at the March 20 meeting.

I'm not sure I totally understand its content, but I am sure of one thing. There's a lot of taxpayer money being spent to save the taxpayers money, probably at our expense. I think most of us are taxpayers as well, & we are the "injured parties".

Does anyone have any figures to determine what our property values would have been, had we not had the contamination, compared to the value today? The last I heard, no one was manufacturing land, so the appreciable value should only rise. Mr. Murphie stated at the meeting, that the properties in this community have appreciated - that's very true, except in the contaminated area. He also stated that he would not have a problem with his family living in one of these homes, well if anyone believes that, remember the oceanfront property in Arizona.

Considering the long range damage to us and our children, I feel there should be equitable compensation, or buy out, soon. Sure we're concerned with 30 years from now, but some of us are at the age we don't need to be held in limbo for another 10 years. We need this fiasco over with. I personally, do not wish to leave my daughter a contaminated piece of crap. No, money can't buy sentimental value, (my parents bought this property in the 50's). I raised my daughter here, there are many good memories, but the government messed it up and it will be ruined 'til Jesus comes.

This report is going to Congress, well whoop-ti-de. They can't even keep their stuff honest, so what are we to expect from them? More talk, more prolonged debate? Since there's no real accountability in government, I suppose this will get kicked about a few more years. In the meantime we, don't know if we should try to sell, at a considerable loss, go ahead with plans to build an apartment building ,subdivision, or is everyone going to be afraid to live there.

I guess we're still paying Japan for WW2 destruction, and that was war, the enemy, where is the balance? Oh, I almost forgot, we are getting our water bill paid, what an expense compared to other government spending.. One of the options, being considered,

will not allow swimming pools or septic tanks. I assume we are to go to the woods, or drive 8 miles to the sewers.

I'm old, uneducated and perhaps don't comprehend all that's being considered, but I do recognize gobbledegoop when I hear it.

Fay Buckingham

6515 Metropolis Lake Road

West Paducah, Ky 42086

270 488 3696 or 270 462 8313

KENTUCKY COMMERCE CABINET
KENTUCKY DEPARTMENT OF FISH & WILDLIFE RESOURCES

Ernie Fletcher
Governor

#1 Sportsman's Lane
Frankfort, Kentucky 40601
Phone (502) 564-3400
1-800-858-1549
Fax (502) 564-0506
fw.ky.gov

George Ward
Secretary

Dr. Jonathan W. Gassett
Commissioner

March 30, 2007

Mr. Rich Bonczek
U.S. Dept. of Energy
Portsmouth/Paducah Project Office
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

Dear Mr. Bonczek:

The Kentucky Department of Fish and Wildlife Resources (KDFWR) appreciates the opportunity to comment on the "Property Acquisition Study for Areas near the Paducah Gaseous Diffusion Plant, Paducah, Kentucky" draft report. The KDFWR has a long history of cooperating with the U.S. Department of Energy (DOE) to manage publicly owned lands around the Paducah Gaseous Diffusion Plant (PGDP). The West Kentucky Wildlife Management Area (WKWMA) was established to provide wildlife-related recreational opportunities while also being protective of human and environmental health.

The cost analyses presented in the land acquisition study seemed to compare only the direct costs of fee simple land purchase versus extended deed restrictions. The report failed to consider that future costs of contamination reduction may be decreased if affected lands were owned by either the DOE or KDFWR. It is also our understanding that many private landowners surrounding the PGDP/WKWMA complex have expressed concern that their property has been devalued due to existing groundwater contamination and proximity to possible surface contamination on and around the PGDP.

It is KDFWR's opinion that a fee simple purchase of private lands surrounding the PGDP/WKWMA complex, with subsequent joint management responsibilities by DOE and/or KDFWR, would reduce long-term residential exposure to existing contaminant sources. In addition, fee simple purchase from willing private sellers may alleviate area residents' concerns of land devaluation by paying fair market values without consideration of known or potential contamination issues. Lands acquired could also be managed for public recreation while allowing greater access oversight than private land.

Rich Bonczek
March 30, 2007
Page Two

We hope you will consider the above comments during your critical assessment of the Property Acquisition Study. If you would like to discuss this issue further, please do not hesitate to contact me at (502) 564-7109.

Sincerely,

Dr. Jonathan Gassett
Commissioner

JWG/MSC/njm

Fax Cover Sheet

6715 Metropolis Lake Road
West Paducah, KY 42086
270/488-3225
270/488-3225

Send to: U.S. Department of Energy	From: Ruby English
Attention: Richard Bonczek, PhD & Laura Schachter	Date: April 1, 2007
Office Location: Lexington, KY	Office Location:
Fax Number: 859-219-4098	Phone Number: 270/488-3225

- ☐ Urgent
- ☐ Reply ASAP
- ☐ Please comment
- ☐ Please Review
- ☐ For your Information

Total pages, including cover: 23

Comments:

This needs to be added to the response I turned in at the meeting of March 20, 2007, at Heath High School meeting to Laura.

This is to be incorporated into the Paducah Land Acquisition Study.

Thank you

Landowners reply to Property Acquisition Study for Areas near the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, March, 2007 draft document.

THE COMPENSATION TO THE LANDOWNER CAN BE AS LOW AS $1.00 (C.3.4).

COMMENT: 3.1 PROPERTY ANALYSIS
3.2 PROPERTY PURCHASE ANALYSIS
3.3.1 UNIT COSTS for PROPERTY PURCHASE

Since 1994, enabled by the "Action Memorandum for the PGDP Water Policy", DOE has entered into "licensing agreements" with property owners within the "Water Policy Box" (BOX). This process would ordinarily require direct knowledge of the contracting landowners' interest in the impacted real estate. The ground work for these agreements is not evident in this document. The "study" instead relies on secondary information for development of the purchase analysis. Secondary information fails to reflect the value of small business operations or landlord-tenant contract within the "BOX."

COMMENT: 3.2 PROPERTY PURCHASE ANALYSIS
B.2.1.1 THE FEE SIMPLE
3.3.2 UNIT COSTS FOR PROPERTY EASEMENTS

Kentucky recognizes fee simple interest in real estate best described as surface land including groundwater rights. Kentucky also recognizes separate fee simple interest in subsurface rights, or the rights to minerals underlying the real estate. Both interests are recorded using the same geographical description and both bear the same parcel index number (Exhibit-1). In this instance, the acquisition of both interests is necessary.

The purchase of both limited and/or expansive easements similarly will require legal agreements with owners of real estate (e.g. well drilling, wastewater systems, ponds) as well as with owners of mineral rights (e.g. exploration wells, extraction activities). Accordingly, the action of one party could purportedly breach a non-offending party's agreement, compelling the innocent party to seek relief by defending their own agreement while pursuing enforcement of the breach.

3.3.2 COMMENT: 3.3.2 UNIT COST FOR PROPERTY EASEMENT
B.2.3.3 EASEMENTS
B.2.3.4 REAL COVENANTS AND EQUITABLE SERVITUDES

Discover what the U.S. Department of Energy and the U.S. Environmental Protection Agency say about institutional controls (i.e. easements, covenants, servitudes, etc.):

- "The institutional controls currently used at EM sites have never been shown to be reliable for more than a few decades and their utilization presents serious risks for future generations of Americans." (Exhibit-2).

- "A deed restriction against well drilling that cannot be guaranteed to apply to all subsequent owners of the property may not be appropriate for restricting use of a site at which well drilling would result in exposure to hazardous contaminants for a 100-year period." (Exhibit-3).

Page Two

- "When a Superfund site is remediated to background or non-detect levels, contamination at the site presumably poses no further risk to public health or the environment. In contrast, when institutional controls are a major part of the remedy, residual contaminants on-site or in migrating groundwater, surface water, or airborne dust may still cause harm." (Exhibit-4).

EPA states that the definition of institutional controls is not always clear. Since 1952, the Department of Energy has been allowed to contaminate the entire community surrounding the Paducah Gaseous Diffusion Plant causing groundwater contamination and many health problems. Because of contaminates released from this plant the Department of Energy should be held accountable le by the same laws and cleanup requirements that the private sector is held accountable by.

COMMENT: 3.4 IDENTIFICATION OF REMEDIAL ACTION ASSUMPTIONS
D.5.2 PRIMARY SOURCE AREA-VAPOR EXTRACTION
D.5.3 PRIMARY SOURCE AREAS-DIRECT HEATING TECHNOLOGY
D.5.5 SECONDARY SOURCE AREA-STEAM EXTRACTION TECHNOLOGY
D.5.6 SECONDARY SOURCE AREA-PUMP-AND-TREAT TECHNOLOGY
D.5.8 DISSOLVED PHASE PLUME AREA-PUMP-AND-TREAT TECHNOLOGY

Contaminates characterized at PGDP include, but are not limited to, volatiles such as TCE, PCBS, metals, and radionuclides:

- Filtration treatment of the gaseous stream omitted, while using many of the referenced technologies, is completely inadequate for treatment of the complex mixtures of contaminants released. In particular, filtration does not capture the radionuclides, which are then released back into the environment.

- The pump-and-treat system for the northeast groundwater plume uses a PGDP/USEC cooling tower to "air strip" contaminants entrained in the plume. That contaminated water not only contains TCE, heavy metals, chemicals, PCBs, radionuclides, dioxin, but other complex mixtures as well. Many of the toxic and hazardous contaminants removed from the groundwater via this "technology" are released to air and back into the residential community surrounding PGDP.

- Natural attenuation allows TCE to degrade to the more toxic chemical vinyl chloride, a known human carcinogen.

COMMENT: 3.6 ASSESSMENT OF EXTENT OF PROPERTY ACQUISITION NEEDED
APPENDIX F (generally)

Who – is – kidding – who?

Eloquent requests for Congressional funding to protect the health of residents immediate to PGDP are delivered on a near annual basis. Huge amounts of money is allocated. Studies abound, Removal actions (dumping their junk on others) "make it pretty and seem nice and clean." Congress should be as enraged as we are!

Page Three

WE WANT YOU TO KNOW WE ARE SICK AND DYING OUT HERE AND NO RELIEF IS IN SIGHT.

- No exposure assessment exists for the residential public residing within any radius of PGDP.
- Cancer in the community is extensive. Many complicated health conditions are undiagnosed or misdiagnosed. Many residents have multiple adverse health conditions.
- Residential soil is contaminated with transuranics such as plutonium, neptunium, and americium. (Exhibit-5).
- Residential soil is contaminated many times background by Technetium-99. (Exhibit-6).
- Residential soil is contaminated many times background with the rarely referenced (PGDP) Thorium-230. (Exhibit-7).
- Groundwater in residential areas is contaminated with plutonium. (Exhibit-8).
- Technetium-99 is in groundwater in the northeast sector as well as the northwest sector. (Exhibit-9).
- Plutonium contaminates residential garden vegetables several times background at PGDP. Literature suggests an airborne source. (Exhibit-10).
- The ATSDR Health Assessment for Paducah (6. References; ATSDR) lacks human health data. Even worker health data was not available at the time the document was published. Confidence in the document is very low.
- Independent hair analysis results from a qualified physician and laboratory suggest a greater exposure for the resident than for the worker. Exhibit-11 shows the results from 29 year resident, never employed in an industrial situation, and the results from a 20 year PGDP employee who does not reside in this community. (Exhibit-11).
- Funding for human health testing in this community apparently does not exist. Phone calls seeking relief are not returned. Funding is available for testing the contaminant burden of aquatic, biota, and wildlife. Risk to human health via the food chain and other media remains hypothetical without invasive human health testing.
- Apparently, human health risk does not fall under the scope of the PGDP CAB…or so they've been cautioned.

PGDP data in general points to environmental transport pathways (groundwater, soil, air) and details environmental and biological accumulation and transformation that can lead to human exposure. Until body burden assessments (costing approximately $5,000 each) are performed the actual human dose of PGDP contaminants is not evident and the resultant biological alteration or health-effect remains unknown. Without remediation of the site the cycle will continue not only as it currently exists but with the additional contaminant burden from the DUG-6 Conversion Facility, once it goes on-line. And if that is not enough, the acceptance of the Global Nuclear Energy Partnership (GNEP) proposal for Paducah will certainly "Ice the Cake" with another lifetime plus of exposure to the same or similar contaminants…toxic and hazardous as they are.

COMMENT: B.2.1.4 CONCURRENT ESTATES

Lacking direct knowledge as to the type and extent of concurrent estates within "The Water Policy Box", DOE improperly deems them "unsuitable…for purposes of acquisition of property interests."

Appendix B (generally)

- Be aware that Region IV (U.S.EPA) policy for institutional controls is much less stringent than for example policy within Regions V and X. Perhaps experience has resulted in stricter controls.

- When considering the failure of Institutional Controls the Rocky Flats CAB points to the PGDP Water Policy failure that "allowed a renter to use contaminated groundwater over a period of 11 years." Apparently, a similar failure also occurred at Oak Ridge when a "deed restriction along with improper monitoring allowed drilling of new wells for irrigation (gold course).

COMMENT: B.2.3.3 EASEMENTS

The statutory language for a conservation easement in Kentucky is not only "overly broad" but in this case stretched beyond belief. It is obvious the intent of this type of easement is to protect and conserve necessary or aesthetically valuable assets. It is a far reach to anticipate this language could restrict the use of <u>contaminated</u> groundwater or development <u>on severely environmentally degraded land</u> as is found at and near PGDP. A hazardous waste easement is better suited for this situation.

COMMENT: C.3.4 ESTIMATED VALUE OF EASEMENTS

Environmental and Economic effects go hand-in-hand.

Economic loss to the landowner can take many forms once unobservable contamination within groundwater plumes becomes "visible" through the recording of institutional controls. This is particularly true at Paducah where highly detailed and widely disseminated reports, as well as numerous newspaper articles about the groundwater contamination, further prejudice the property and its owners.

- Insurance underwriters are often reluctant to provide coverage for properties subject to environmental covenants. Individuals fortunate enough to procure coverage will surely be subjected to more restrictive polices as well as higher cost.

- Property owners denied coverage due to the recording of institutional controls can become both bankrupt and homeless through a singe event (e.g. fire, tornado).

Page Five

- In a competitive real estate market the marketability and value of encumbered and contaminated property is reduced.

Environmental covenants not only diminish value for the landowner but for the lender as well:

- While a landowner may receive a degree of compensation for the loss of value to property due to the imposition of the institutional control, a lending institution will not.

- In the event a current lender finds it necessary to foreclose on a property, now under covenant, the diminution of value will become evident.

- When a subordination agreement runs with the covenant, the consent of the lender may become a necessary step in the implementation of the institutional control.
- A lending institution might annul a mortgage or other agreement once and environmental covenant is attached to property records.
- A landowner's ability to re-mortgage will be restricted once the property becomes subject to institutional controls. The ability to shop around for the best price may be eliminated entirely.
- Once a parcel of land becomes the subject of an estate (or divorce situation) an heir wishing to keep the property, that may already be his primary residence, may not be able to settle the estate (divorce settlement) with other heirs (spouse) if a mortgage is unattainable.

Environmental covenants pose similar problems for municipalities as well:

- A municipality may experience difficulties when foreclosing on a tax-lien.
- Conversely, depending on the nature of the legal instrument(s), foreclosure could eclipse or destroy the institutional control.

As is evident, institutional controls can encumber not only the landowners but others as well.

COMMENT: H.1 INTRODUCTION

The June, 2006 "property Acquisition Study Public Meeting" was well attended, attracting a near overflow crowd. At the close of the meeting a large number of those in attendance, left the meeting verbally stating "they would never attend another one of these meeting." Obviously they were true to their word as the March 20, 2007 meeting for the draft document was poorly attended.

FUNDAMENTAL FAIRNESS ISSUES ABOUND FOR BOTH MEETINGS.

Page Six

COMMENT: Generally

One cannot determine whether the landowners' ability to contract at will, will not be superceded by the governments power to exercise authority in order to expunge their obligation to remediate contaminated groundwater plumes at PGDP. Thus the community asks Congress to consider the use of:

- Institutional controls when an owners interest in property supercedes their concern for health.
- Direct purchase by DOE or its agent where the owners concern for health supercedes their desire to retain contaminated-unhealthy property.
- Life estates for persons too ill or aged to undergo relocation.

A simple survey sent to landowners' within the "Water Policy Box" could have discovered the extent of public interest in relinquishing real estate or other interest in real estate, while greatly enhancing this document.

The Congress should be made aware a class-action lawsuit regarding private property contamination is currently active in the courts.

RESIDENTS OF THE WATER POLICY BOUNDARY

NAME:	HOUSEHOLD ILLINESS
Ruby English	Cancer, Thyroid & Colon
Tony D. English	Brain cells dying Heavy metal poisoning
Mary Hall	a
Phyllis J Robertson	
Freda Bobo	
Robbie Anderson	
Paul Long	
Robbie Long	
Linda Long	
A.B. Puckett	
Mr & Mrs. Donald Gatt	

RESIDENTS OF THE WATER POLICY BOUNDARY

NAME: | **HOUSEHOLD ILLINESS**

Angela Jenkins

Buck Jenkins

[illegible]

Sandra English

EXAMPLE–not Kentucky

PUBLIC NOTICE
TAX DEED NOTICE

TAX DEED NO.

FILED
February 8,

TAKE NOTICE

TO:

This is NOTICE of the filing of the Petition for Tax Deed on the following described property:

All the minerals underlying the Southeast Quarter of the Southeast Quarter, in Section Three (3), and also the Northwest Quarter of the Northeast Quarter and the East half of the Northwest Quarter, in Section Ten (10), all in Township ( ) South, Range ( ) East of the Third Principal Meridian, situated in the County of

Parcel Index Number 05-4- -001-001, 05-4- -001-003 and 05-4- -001-004

On June 18, at 10:00 a.m. the Petitioner intends to make application for an order on the petition that a Tax Deed be issued. The real estate was sold on July 17, for general taxes of the year The period of redemption will expire June 8, at 4:00 PM.

PUBLIC NOTICE
TAX DEED NOTICE

TAX DEED NO.

FILED
February 8,

EX-1

EM U.S. Department of Energy
Office of Environmental Management

BACKGROUND INFORMATION FOR THE USE OF INSTITUTIONAL CONTROLS ON DOE ENVIRONMENTAL MANAGEMENT SITES

I Definitions

"Institutional controls" in this context are non-engineering legal mechanisms for restricting the use of land, groundwater, and surface water; for limiting access to the site; and for warning persons about the presence of hazards. In Environmental Management's (EM) current practice, institutional controls include deed notices, easements, covenants and equitable servitudes, and zoning and other regulatory programs. Institutional controls, as that term is used here, do not include, but are often used in conjunction with "physical controls" such as engineered and/or natural barriers, signage, fencing or other physical structures designed to prevent human intrusions or dispersal by natural forces of radioactive and/or chemically hazardous wastes and contamination.

II Use of Institutional Controls

Over the last several years, remediation of the EM sites has begun to "mature," with planning for future uses, better information about conditions at each site, better understanding of the capabilities and limitations of existing clean-up technology, and increased participation by local stakeholders. There is general agreement that no currently available technologies exist to render radioactive substances harmless and that some non-radioactive contaminants will remain toxic for the indefinite future. Both kinds of contamination will remain or will be disposed of as wastes on-site or elsewhere in EM or commercial locations. This decision led to considerations of increased reliance on institutional controls in order to restrict the use of contaminated sites and disposal areas, to limit human exposure, and prevent disturbance of the contaminants. Such reliance would require that the controls perform effectively for as long as the wastes and contamination remain hazardous, which in some cases is many thousands of years.

Wastes and contaminants in soil and ground water are left in place for one or more reasons: 1) technology to remove the waste and/or contamination does not exist, 2) cleanup might result in spreading waste and/or contamination more widely or present unacceptable risks to workers, 3) removal is viewed as unacceptably expensive, or 4) complete removal is not required for planned future uses. While EM is currently making decisions to leave wastes and/or contamination in place at some sites only because removal would be too costly, such a decision requires comparing the life-cycle costs of monitoring and enforcing institutional controls with the cost for cleanup of the site.

The institutional controls currently used at EM sites have never been shown to be reliable for more than a few decades and their utilization presents serious risks for future generations of Americans. Those risks, even though they may not be monetizable, must be articulated and set off against any savings from leaving contaminants in place. To be of any use, the accounting described here must precede or accompany planning for cleanup of a site. The methodology for such an accounting must not employ discount rates that have the effect of eliminating future risks and costs from consideration.

Current EPA and DOE guidance calls on decision makers to consider institutional controls for sites that cannot or will not be cleaned up for unrestricted use and to specify controls in planning for the cleanup of such sites. However, the guidance assumes that institutional controls will prove effective over the long term at sites conveyed to non-federal entities and at those retained by EM. This assumption is not justified. For example:

- Deed notices contemplate only voluntary compliance.
- Easements and covenants may not be enforceable under widely varying state laws.
- Notices and use restrictions depend on state law-based recording systems, which often fail for various reasons.
- Zoning restrictions can change over time as a function of local political processes.

Furthermore, such institutional controls may not apply to lands that remain in federal ownership. Even continued ownership of contaminated lands or disposal sites by the federal government is no guarantee of protection, since long-term protection depends on good record keeping, the commitment and expertise of land managers, and stable funding for surveillance, monitoring, and maintenance.

III Criteria for Evaluating Physical and Institutional Controls

Reliance on physical and institutional controls raises five broad concerns, and such controls can be evaluated based on the following:

1) *Durability.* The fundamental requirement for physical and institutional controls is that they remain effective over long periods of time, or that they be easily renewable on a periodic basis. Experience to date provides few grounds for confidence that either physical or institutional controls are reliably effective beyond a few decades.

2) *Communication to successive owners and users.* The existence of physical and institutional controls must be communicated to future generations if they are to remain effective. To assure notice of controls and restrictions and to maximize compliance, there must be at a minimum a chain of conveyances containing notice of the remaining hazards and restrictions from one land owner and/or user to the next.

3) *Stewardship.* An "infrastructure" of expertise in the understanding and management of contaminated sites, the use of physical and institutional controls, and the ability to deal with both routine and unexpected problems must be maintained over time.

4) *Communication with affected persons.* It is not enough for land owners and

users to know about existing physical and institutional controls; persons who might be affected by the failure of such controls must be aware of their existence and of any contingency plans for protection of workers and the public. To facilitate public awareness, records of such controls and other information related to the location, and types and extent of wastes and contamination must be available to and accessible by the public in federal, state, and local locations.

5) *Enforcement*. An institutional control or land-use restriction is worth little if it can be ignored with impunity; conversely, a robust system of enforcement will go a long way to ensuring its long-term effectiveness. A broad range of potential enforcers and overlapping/redundant requirements are keys to the success of institutional controls and land use restrictions.

6) *Monitoring, and repair*. Over the very long periods of time involving long-term stewardship, it will be essential to monitor the continuing effectiveness of both physical and institutional controls; when failures are found or anticipated, repair or replacement will be essential. The monitoring, repair, and replacement functions require a stable source of funding over long periods of time. We are at the very earliest stages in developing the institutions and their responsibilities for monitoring, repair, and replacement.

7) *Funding*. The availability of a secure, long-term funding source is essential to ensure that stewardship activities can be successfully taken.

Last Updated 07/11/2001 (mhp)

NOT MEASUREMENT SENSITIVE

DOE G 454.1-1
10-14-05

Institutional Controls Implementation Guide for Use with DOE P 454.1, *Use of Institutional Controls*

[This Guide describes suggested nonmandatory approaches for meeting requirements. Guides are not requirements documents and are not to be construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.]

U.S. Department of Energy
Washington, D.C.

AVAILABLE ONLINE AT:
www.directives.doe.gov

INITIATED BY:
Office of Environment, Safety and Health

EX-3

**INSTITUTIONAL CONTROLS
AT SUPERFUND SITES:**

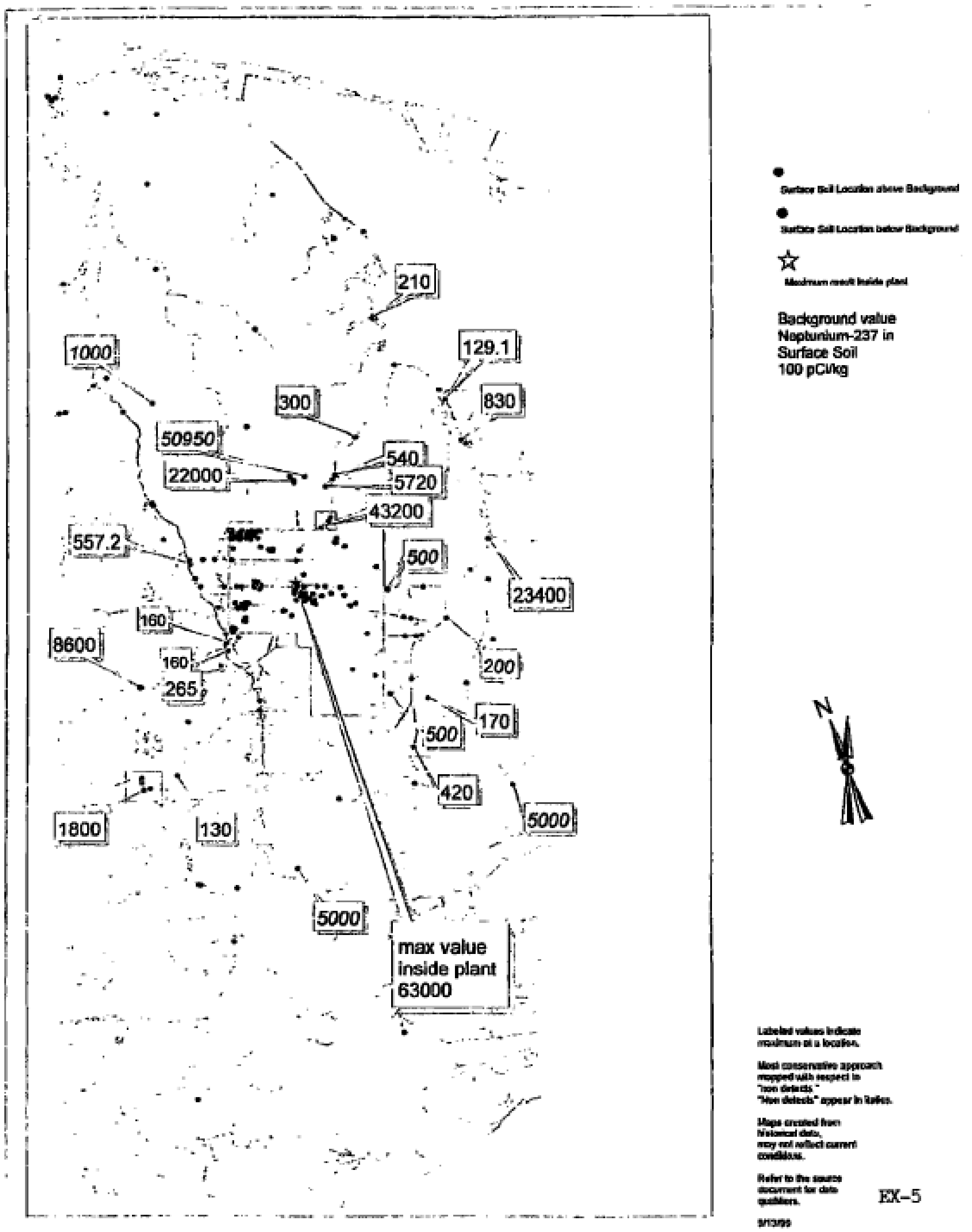
**A PRELIMINARY ASSESSMENT OF
THEIR EFFICACY AND
PUBLIC ACCEPTABILITY**

Mary R. English
David L. Feldman
Robert Inerfeld
James Lumley

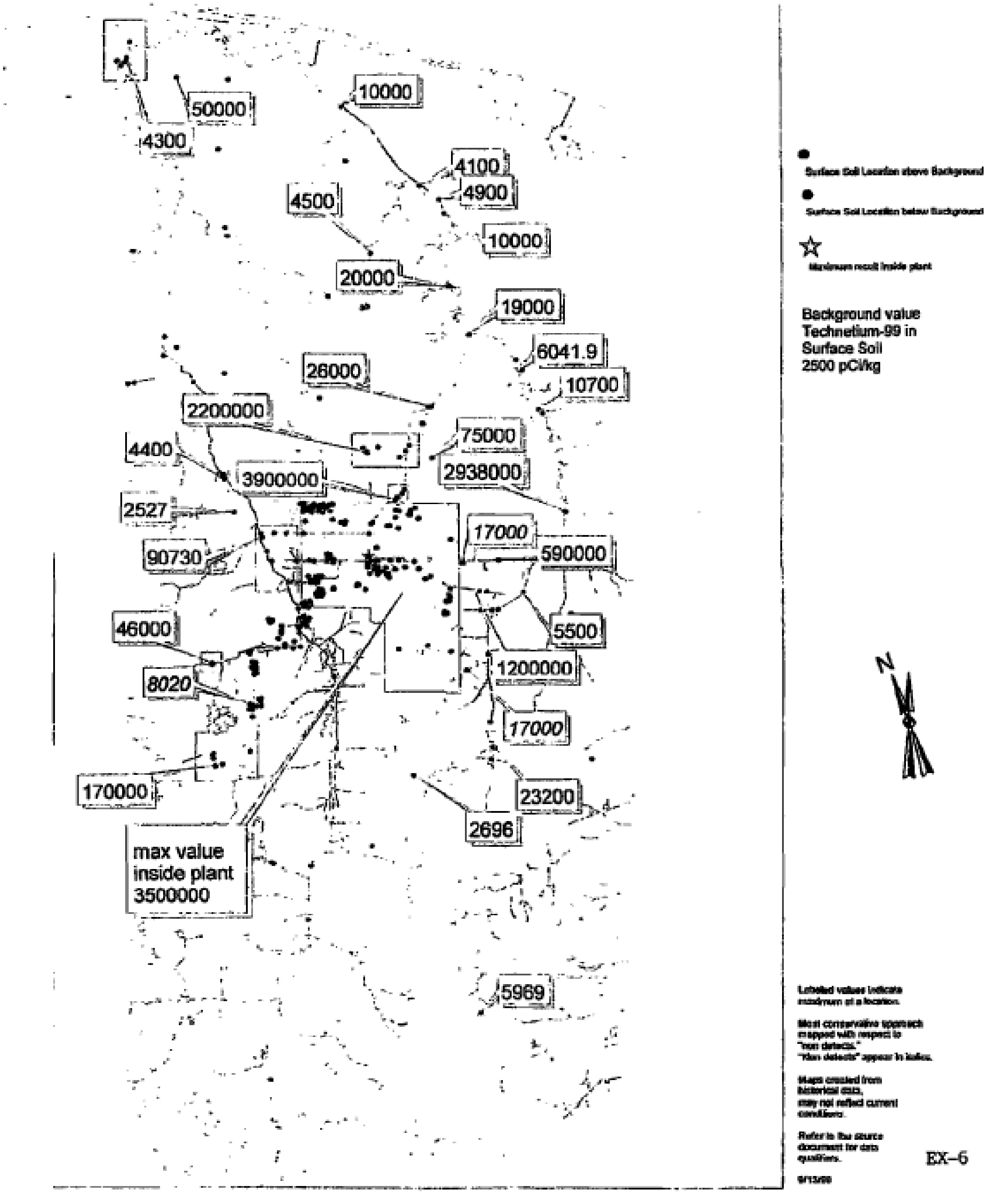
July 1997

Questions and comments on this report should be directed to Dr. Mary R. English or Dr. David L. Feldman at the Energy, Environment, and Resources Center, 600 Henley Street, Suite 311, University of Tennessee, Knoxville, TN 37996-4134, phone 423-974-4251, fax 423-974-1838, *menglish@utk.edu* or *feldman@utk.edu*.

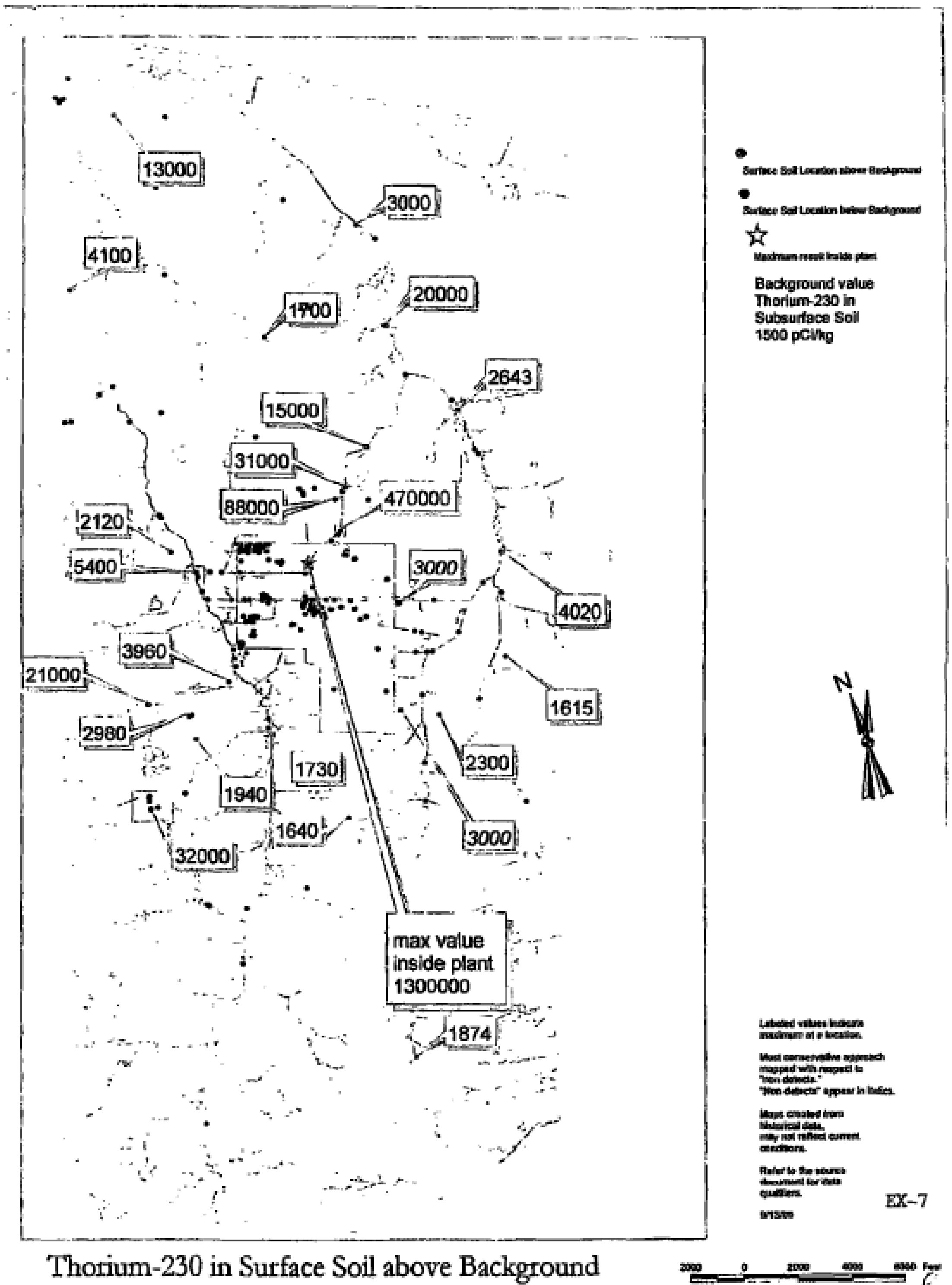
EX-4



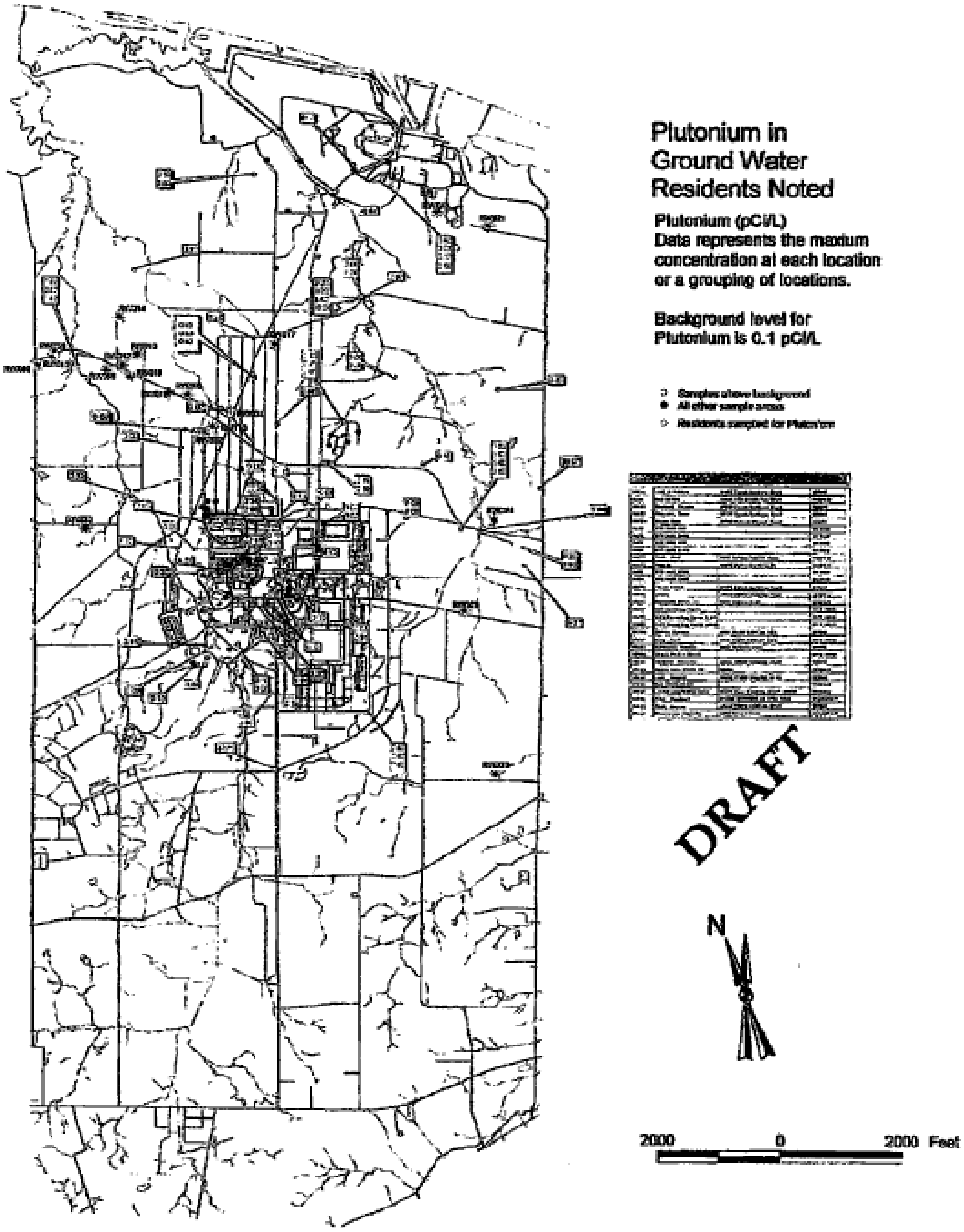
Neptunium-237 in Surface Soil above Background



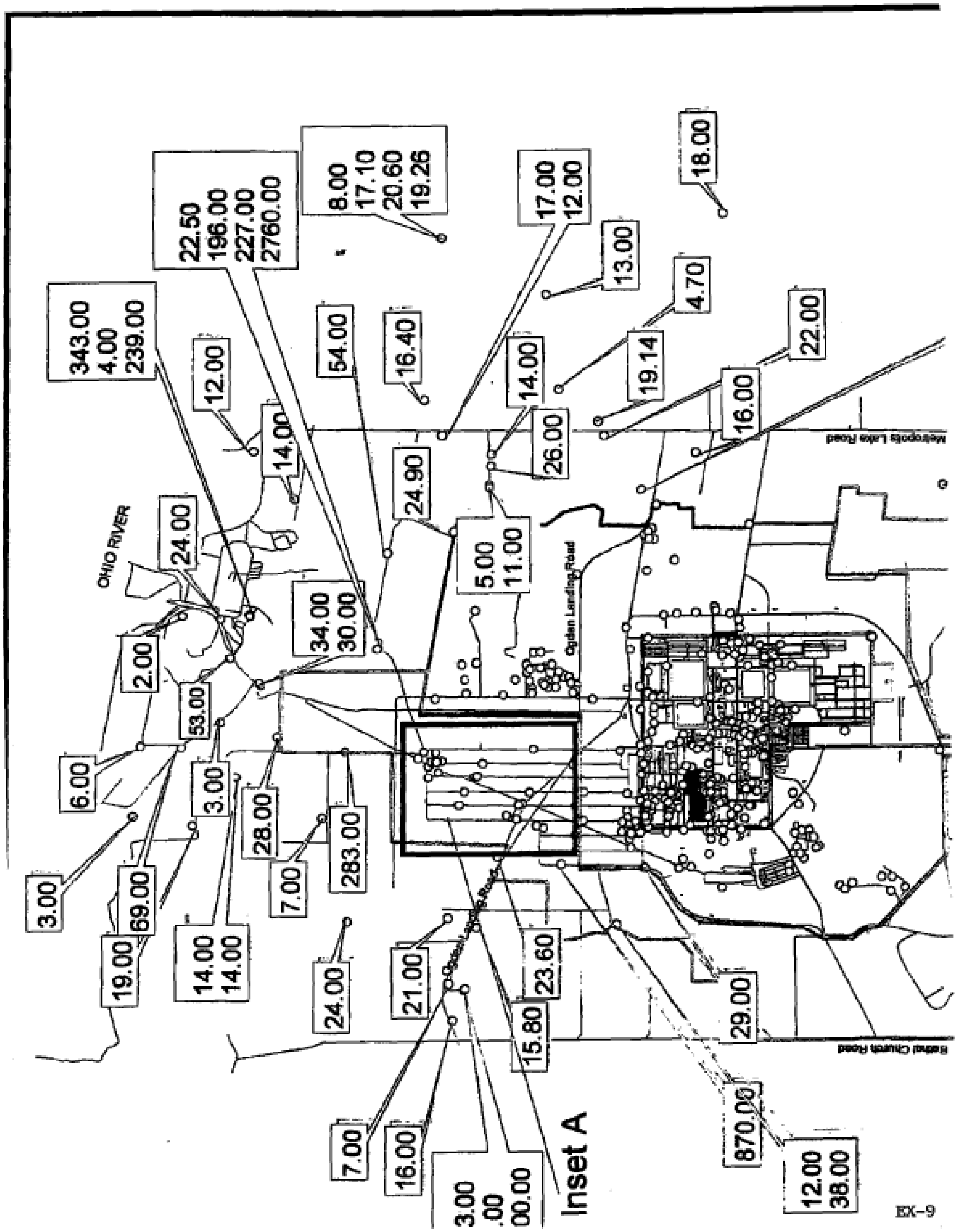
Technetium-99 in Surface Soil above Background

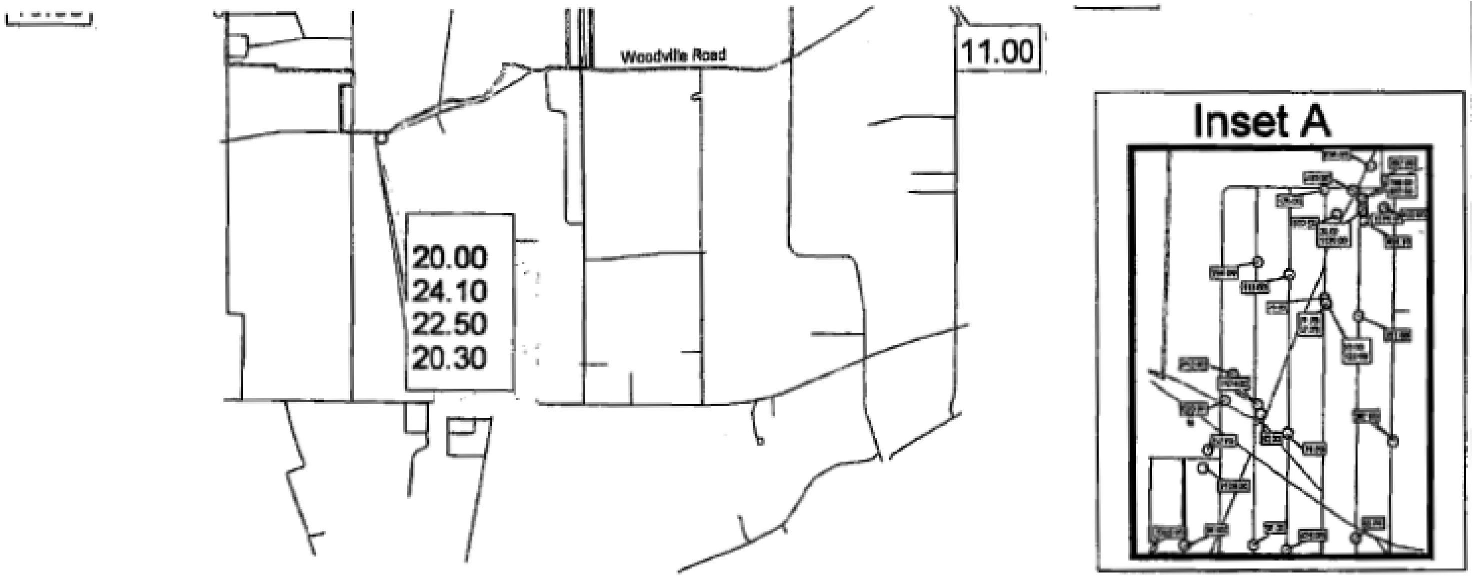


Thorium-230 in Surface Soil above Background


Plutonium in Ground Water Residents Noted
Plutonium (pCi/L)
Data represents the medium concentration at each location or a grouping of locations.
Background level for Plutonium is 0.1 pCi/L
Samples above background
All other sample areas
DRAFT
N
2000
0
2000 Feet

EX-8


OHIO RIVER
Metropolis Lake Road
Ogden Landing Road
Bethel Church Road
Inset A
EX-9



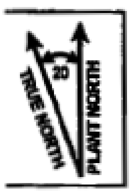
LEGEND

Groundwater Sample (pCi/L)

Streams
Roads
DOE Property Boundary
PGDP Property Boundary
WKWMA Property Boundary

The values plotted are maximum values at that location. Some samples were collected in close proximity to others; therefore they may appear as the same location on the map. Each data result is from a separate location.

Approved 10/18/01
Date



0 3000 6000 Feet

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS,
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
BECHTEL JACOBS COMPANY, LLC

CDM Federal Services Inc.

Paducah OREIS Data
Groundwater - Technetium-99 Detects

FIGURE No. C5bc90002sk023.apr
DATE 08-31-01

EX-9

HAIR ELEMENTS

DOCTOR'S DATA Inc

POTENTIALLY TOXIC ELEMENTS

TOXIC ELEMENTS	RESULT µg/g	REFERENCE RANGE	PERCENTILE 68th 95th
Aluminum	5	< 12	
Antimony	0.15	< 0.08	
Arsenic	0.52	< 0.12	
Beryllium	< 0.01	< 0.02	
Bismuth	0.013	< 0.08	
Cadmium	0.12	< 0.15	
Lead	1.2	< 2	
Mercury	0.06	< 1.1	
Platinum	< 0.003	< 0.005	
Thallium	< 0.001	< 0.01	
Thorium	< 0.001	< 0.005	
Uranium	0.008	< 0.06	
Nickel	0.17	< 0.4	
Silver	0.61	< 0.1	
Tin	0.09	< 0.3	
Titanium	1.4	< 1	
Total Toxic Representation			

ESSENTIAL AND OTHER ELEMENTS

ELEMENTS	RESULT µg/g	REFERENCE RANGE	PERCENTILE 2.5th 16th 50th 84th 97.5th
Calcium	344	375- 1100	
Magnesium	48	40- 140	
Sodium	290	24- 180	
Potassium	190	20- 80	
Copper	8.3	9- 26	
Zinc	140	120- 200	
Manganese	2	0.2- 0.65	
Chromium	0.36	0.2- 0.45	
Vanadium	0.064	0.018- 0.065	
Molybdenum	0.048	0.04- 0.1	
Boron	7.3	0.7- 4	
Iodine	6	0.25- 1.3	
Lithium	0.012	0.008- 0.04	
Phosphorus	310	250- 400	
Selenium	2.2	0.95- 1.7	
Strontium	0.75	1- 6	
Sulfur	47100	42000- 49000	
Barium	0.45	0.5- 3	
Cobalt	0.015	0.013- 0.05	
Iron	10	5.8- 14	
Germanium	0.026	0.045- 0.065	
Rubidium	0.085	0.03- 0.25	
Zirconium	0.089	0.04- 1	

SPECIMEN DATA

COMMENTS:

Date Collected: 3/7/2000

Date Received: 3/10/2000

Date Completed: 3/11/2000

Methodology: ICP-MS

Sample Size: .212 g

Sample Type: Pubic

Hair Color:

Treatment:

Shampoo:

3/24/2000

RATIOS

ELEMENTS	RATIOS	EXPECTED RANGE
Ca/Mg	7.11	4- 30
Ca/P	1.11	0.8- 8
Na/K	1.58	0.5- 10
Zn/Cu	17.2	4- 20
Zn/Cd	> 999	> 800

LABORATORY DIRECTOR: [illegible] • CLIA ID NO. [illegible] • MEDICARE PROVIDER NO. [illegible] • TAX ID NO. [illegible]
MAILING ADDRESS: P.O. Box 111, West Chicago, IL 60186-0111 • STREET ADDRESS: [illegible], St. Charles, IL [illegible]
TELEPHONE: 630.377.8139 • FASCIMILE: [illegible] • [illegible]@doctorsdata.com • www.doctorsdata.com

resident-EX-11

DOCTOR'S DATA

POTENTIALLY TOXIC ELEMENTS

TOXIC ELEMENTS	RESULT µg/g	REFERENCE RANGE	PERCENTILE 68th 95th
Aluminum	6.6	< 7.0	

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