EPA Region 5 Records Ctr.
236133

RECORD OF DECISION AMENDMENT
PCB AREAS OPERABLE UNIT
SANGAMO ELECTRIC DUMP/CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE
CARTERVILLE, ILLINOIS

MAY 2007

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V
CHICAGO, ILLINOIS

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Appendix A Responsiveness Summary

Declaration for the Record of Decision Amendment
Crab Orchard National Wildlife Refuge
PCB Areas Operable Unit

A. SITE NAME AND LOCATION

Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (US DOI)
Carterville, Illinois (EPA ID: IL8143609487)

B. STATEMENT OF BASIS AND PURPOSE

This decision document amends U.S. Environmental Protection Agency's (U.S. EPA's) selected remedial actions for contaminated groundwater at the PCB Areas Operable Unit (PCB OU) within the Sangamo Dump/Crab Orchard National Wildlife Refuge Superfund Site ("Site"), which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative record for this Site. The State of Illinois concurs with the revised remedies identified in this amendment. This ROD Amendment will become part of the Administrative Record file to comply with NCP 300.825(a)(2).

C. ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in the August 1, 1990 Record of Decision (ROD) and the June 23, 2000 Explanation of Significant Differences (ESD) for the PCB OU, as modified by this ROD Amendment, may present an imminent and substantial endangerment to public health, welfare, or the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

Overall Site Cleanup Strategy

The Crab Orchard National Wildlife Refuge (Refuge) is currently divided into seven Operable Units (OUs). These OUs are:

- Metals Areas (Metals) OU
- PCB Areas OU
- Explosives/Munitions Manufacturing Areas (EMMA) OU
- Miscellaneous Areas (MISCA) OU
- Water Towers OU
- Additional and Uncharacterized Sites (AUS) OU
- Lake Monitoring OU

The OUs are in various phases of cleanup: investigation, remediation, and long-term monitoring. Separate RODs were signed for the Metals OU, PCB OU, and the EMMA OU, on March 30,

1990, August 1, 1990, and February 19, 1997, respectively. A ROD for Site 14 of the MISCA OU was signed on October 30, 2001. Another ROD for Site 36 and other sites within the MISCA OU was signed on September 12, 2002. Separate Explanations of Significant Differences (ESD) were signed for the EMMA OU and the PCB OU on January 11, 2000 and June 23, 2000, respectively.

Remedial and Removal activities are complete for the Metals OU, EMMA OU, Water Towers OUs, and Site 36 of the MISCA OU. Long-term monitoring is being conducted for the Metals OU and the EMMA OU. A major portion of the PCB OU cleanup activities required under the 1990 ROD for the PCB OU was completed in 1997. Cleanup activities for Site 14 of the MISCA OU are in progress. The remedial investigation is in progress for the AUS OU. The Preliminary Screening Assessment for the Lake Monitoring OU was completed on October 9, 2001.

Addressing Principal Threats at the PCB OU

This ROD Amendment modifies the previously selected remedy for Chlorinated Volatile Organic Compound (CVOC) contaminated groundwater at the PCB OU within the Crab Orchard Site. This revision affects the cleanup technology selected in the June 23, 2000 ESD for the PCB OU. This ROD amendment does not affect the soils remedy and other requirements specified in the August 1, 1990 ROD for the PCB OU. The 2000 ESD specified multiphase extraction (MPE) with phytoremediation and monitored natural attenuation as the groundwater remedy to bring the groundwater to drinking water standards.

There are three major groundwater plumes at Sites 32/33 of the PCB OU, identified as follows:

1. **Groundwater Plume near Building I-1-23 (Plume 1)**

2. **Groundwater Plume near Buildings I-1-2/I-1-3 (Plume 2)**

3. **Groundwater Plume beneath the Area 9 Repository (Plume 3)**

This Amendment to the ROD and ESD focuses on Plumes 1 and 3 only. Although Plume 2 was discussed in the proposed plan, in response to safety concerns raised by the U.S. Department of the Interior (DOI), U.S. EPA will issue a separate ROD Amendment for Plume 2 after DOI's concerns have been satisfied.

The revised remedies include the source removal through excavation and off-site disposal, groundwater extraction and treatment, phytoremediation, and through natural attenuation processes. The source material identified as the principal threat is soil and groundwater contaminated with Trichloroethylene (TCE) and other CVOCs.

Major Components of the Revised Remedies

The major components of the revised remedies for Plumes 1 and 3 are:

1. **Plume 1 – Excavation and Off-site Disposal of CVOC-contaminated soil to 1 mg/kg CVOC contour in the Upper Clay unit, Groundwater Extraction and Treatment in the Sand unit beneath the Upper Clay, and Phytoremediation.**

2. **Plume 3 – Phytoremediation and Monitored Natural Attenuation.**

3. **Institutional Controls to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.**

E. ROD AMENDMENT DATA CERTIFICATION CHECK LIST

The following information is included in the Decision Summary of the ROD Amendment. Additional information can be found in the Administrative Record file for this Site.

- Chemicals of concern (Section VIII (f)/Groundwater Contaminant Sources and Plumes/ page 15)
- Past and Current Site Risk (Section X/Page 19)
- Cleanup levels established for chemicals of concern (Section XI/Page 21)
- How source materials constituting principal threats are addressed (XV/Page 34)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater. (Section IX/Page 19)
- Potential land and groundwater use that will be available at the site as result of the Selected remedies (Section XV/Page 34)
- Estimated capital, annual operation, and maintenance (O&M), and total present worth cost estimates, discount rate, and the number of years over which the remedy cost estimates are projected. (Table 1/Page 31; Table 2/Page 33)
- Key factors that led to this ROD Amendment (Section VI/Page 8)

F. STATUTORY DETERMINATIONS

The revised remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial actions, is cost effective, and utilizes permanent solutions and alternate treatment technologies to the maximum extent practicable.

The revised remedy for Plume 1 also satisfies U.S. EPA's statutory preference for treatment as a principal element of the remedies and reduces toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment.

Because the remedies from the 1990 ROD and this ROD Amendment will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that do not allow for unlimited use and unrestricted exposure, statutory review will be conducted within five years

after initiation of the remedial action to ensure that the remedy is, or will be, protective of the human health and the environment.

James E. Cason

Associate Deputy Secretary
Department of the Interior

JUL 10 2007
Date

for Richard C. Karl, Director
Superfund Division
U.S. EPA Region 5

8/7/07
Date

Decision Summary
Record of Decision Amendment for the PCB Areas Operable Unit
Sangamo Electric Dump/Crab Orchard National Wildlife Refuge
Superfund Site (USDOI)
Carterville, Illinois

I. Site Name, Location, and Brief Description

The Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (US DOI) Superfund Site ("Site") (EPA ID# IL8143609487) is located near Marion, Illinois, (Figure 1) primarily within Williamson County, extending into Jackson and Union Counties in Southern Illinois. The Crab Orchard National Wildlife Refuge (the Refuge) consists of approximately 43,500 acres of multiple-use land. The Refuge is used as wildlife refuge and also for recreational, agricultural, and industrial purposes. The Refuge is owned by the U.S. government and currently is administered by the U.S. Fish and Wildlife Service (FWS), a bureau of the Department of the Interior (DOI).

II. Site History and Contamination Problems at the PCB OU

While presently administered by FWS, the Department of Defense (DOD) administered the Refuge during the World War II era in the 1940s. During the DOD administration, portions of the Refuge were leased to industrial tenants, primarily for the purpose of munitions and explosives manufacturing. In 1947, the DOD transferred the Refuge to the DOI. Congress, in passing the law that created the Crab Orchard National Wildlife Refuge, mandated a continuing industrial presence on the Refuge property. While the principal industry at the Refuge was production of explosives, several other industries including Sangamo Weston, Inc., which manufactured PCB capacitors, moved into the Refuge to occupy many of the buildings formerly used by the wartime industries.

Beginning in the late 1970s, DOI, U.S. EPA, and Illinois EPA conducted site investigations that indicated the presence of PCBs, lead, and cadmium in soils within the eastern portions of the Refuge. The Crab Orchard National Wildlife Refuge site was proposed for the National Priorities List (NPL) in 1984 and finalized on the NPL in July 1987. In 1989, a Remedial Investigation/Feasibility Study (RI/FS) Report was completed by FWS and Sangamo Weston, Inc.

During the RI/FS, thirty-three different study sites within the Refuge were investigated. The RI concluded that four of the sites needed remediation because of the presence of PCBs, lead, and cadmium, and that three other sites needed remediation due to the presence of heavy metals such as lead, cadmium, and chromium. U.S. EPA grouped these study sites into two separate operable units, the Metals Areas OU and the PCB Areas OU. The Metals Areas OU included the three study sites which contained heavy metals contamination. The PCB OU included the remaining four study sites that were contaminated with PCBs, lead, and cadmium. These four sites are the Job Corps Landfill (Site17), the Water Tower Landfill (Site28), the Area 9 Landfill (Site 32), and the Area 9 Building Complex (Site 33). In August 1990, U.S. EPA issued a ROD that selected

the remedial action for the PCB OU. In May 1991, a Consent Decree was signed between U.S. EPA, DOI, and Schlumberger Industries Inc. (Schlumberger), a successor corporation to Sangamo Weston, Inc. Under the terms of the Consent Decree, Schlumberger agreed to perform the cleanup set out in the PCB OU ROD.

In September 1991, U.S. EPA entered into a Federal Facilities Agreement (FFA) with the Department of the Interior, Illinois EPA, and the Department of the Army (DA) (collectively referred to as the FFA Parties). The general purpose was to ensure that the environmental impacts associated with past and present activities at the Refuge were thoroughly investigated and appropriate remedial action taken as necessary to protect the public health, welfare and the environment. The FFA Parties have identified seven Operable Units including the PCB Areas Operable Unit that is the focus of this ROD Amendment. During the soil cleanup activities, groundwater monitoring conducted by Schlumberger at the PCB OU detected trichloroethylene (TCE) and other chlorinated solvents at levels above their respective drinking water standards. In June 2000, U.S. EPA issued an Explanation of Significant Differences (ESD) to address the TCE-contaminated groundwater at the PCB OU. This ROD Amendment describes the changes to the cleanup action required in the June 2000 ESD. The U.S. EPA is the lead agency for implementing the cleanup activities required at the PCB OU, including the activities required in the ROD, ESD, and this amendment for the PCB OU. U.S. Department of the Interior (US DOI) and the Illinois EPA are the support agencies at the PCB OU.

More information on the Site History and contamination problems at other operable units are provided in the March 30, 1990 ROD for the Metals OU, August 1990 ROD for the PCB OU, February 1997 ROD for the EMMA OU, October 2001 ROD for the MISCA OU – Site 14, and September 2002 ROD for the MISCA OU – Site 36.

III. Cleanup Remedy Selected in the Record of Decision (August 1990)

In the 1990 ROD for the Crab Orchard Site's PCB OU, the selected remedy included:

1) The excavation of contaminated soil and sediment;

2) Treatment of all excavated soil and sediment contaminated with PCBs in excess of established remediation goals using mobile incineration technology;

3) Stabilization/fixation of residues from incineration and non-incinerated soil and sediment contamination with metals (if determined to be RCRA hazardous because of the metals leachability) to render them non-hazardous;

4) On-site disposal of non-hazardous treated material and untreated residues exceeding the cleanup targets in a landfill meeting the requirements of RCRA Subtitle D and 35 Illinois Administrative Code Part 807;

5) Backfilling, placement of low-permeability caps and closure of areas where contamination is below the excavation criteria or from where contaminated soil and sediment have been excavated; and

6) Environmental monitoring and maintenance during and after remedial construction to ensure the effectiveness of the remedial action.

IV. Remediation Goals Specified in the Record of Decision (August 1990)

The ROD required the four sites to be remediated to the following cleanup levels:

Soil and Sediment Remediation Goals

lead to 450 mg/kg dry soil,
cadmium to 10 mg/kg dry soil,
PCBs in top one foot of soil to 1 mg/kg dry soil,
PCBs in soil below one foot depth to 25 mg/kg dry soil, and
PCBs in sediments to 0.5 mg/kg dry sediments.

The ROD also required that the risk from all of the chemical contaminants present in the soil and sediment above naturally occurring background levels established for the site not exceed an excess cancer risk of one in one million and not exceed concentrations determined to produce any non-cancer chronic health effects.

Groundwater Remediation Goals

Although the ROD, in a discussion of Site 33, Area 9 Building Complex, reported that TCE groundwater contamination was detected in one well at 906 ppb, the ROD did not require groundwater remediation per se. Nor did the ROD formally identify federal or any more stringent State applicable or relevant and appropriate requirements (ARARs) for the groundwater cleanup. Removal of the contaminated surface soils was expected to control the groundwater contamination. The ROD did not presume that the groundwater required treatment, however, the ROD required monitoring of the groundwater at each of the remediated sites during and after construction of the remedial action. The ROD stated that the purpose of the monitoring was to ensure that after completion of the remediation of the contaminated soils and sediments, the remaining risk from all of the contaminants in the groundwater (measured at the source of the contamination) above naturally occurring background levels did not exceed any excess cancer risk or any standard. The ROD also stated that

> "If, at any time, groundwater at the contaminated sites exceeds a 10^{-6} cumulative lifetime cancer risk, or Maximum Contaminant Levels (MCLs) for carcinogens, whichever is more stringent; and MCLs, Maximum Contaminant Level Goals (MCLGs), or a hazard index of 1.0 for noncarcinogens; whichever is more stringent, additional remedial work as determined by U.S. EPA, shall be performed."

Surface Water Remediation Goals

The ROD provides that the surface water in Area 9 will be monitored during and after construction of the remedial action. The results would be evaluated to ensure that after completion of the remedial action for the contaminated soils and sediments, the cumulative risk from all of the contaminants in surface water above naturally occurring background levels established for the site shall not exceed any non-cancer risk of one in one million (10^{-6}) and shall not exceed any non-cancer chronic health effects.

V. Explanation of Significant Differences (June 2000)

The groundwater monitoring activities conducted by Schlumberger, as part of the 1990 ROD requirement, indicated the presence of TCE and other chlorinated solvents at levels far exceeding their respective MCLs at Sites 32/33. Schlumberger conducted a groundwater investigation at Sites 32/33 in 1997 and 1998 and prepared a Groundwater Investigation (GWI) and Focused Feasibility Study Report (FFS) to address groundwater contamination. Although TCE contamination was known to exist at the time of the ROD, the GWI discovered levels of TCE in groundwater as high as 66,000 parts per billion (ppb) or over 10,000 times the MCL of 5 ppb listed in the Safe Drinking Water Act. In addition to the TCE contamination, other chlorinated volatile organic compounds (CVOCs) including tetrachloroethene (PCE), Dichloroethene (DCE), and vinyl chloride were also discovered at levels above their respective MCLs. The GWI identified five separate known and potential CVOC source areas and associated groundwater plumes within the remediated sites 32/33. The June 2000 ESD for the PCB OU selected multiphase extraction (MPE) with limited phytoremediation and monitored natural attenuation as the appropriate remedial technology that was premised on source material removal. The remedy selected in the ESD was based on the assumption that the hydro-geological strata was similar in all of the source areas requiring remediation.

VI. Basis for the ROD Amendment

Schlumberger conducted a Pre-Design investigation to further characterize the source areas at the PCB OU. The results of the investigation confirmed the presence of three major contamination plumes in the groundwater. These are the plume near the Building I-1-23 area (Plume 1), the plume near the Buildings I-1-2/I-1-3 areas (Plume 2), and the plume under the Area 9 Repository (Plume 3). The investigation concluded that the hydro-geological strata near the Building I-1-23 area consisted of approximately 15 feet of an Upper Sand unit in between an Upper Clay and a Lower Clay unit, whereas near the Buildings I-1-2/I-1-3 Areas, the Upper Sand unit between the Upper and Lower Clay units is either missing or discontinuous. The absence of the sand layer in the Buildings I-1-2/I-1-3 source area makes it difficult to achieve the remedial action objectives using the multiphase extraction technology selected in the June 2000 ESD without further enhancement. Therefore, amendment to the ROD/ESD is necessary. This amendment is limited to Plumes 1 and 3. Due to the need to resolve safety concerns during the cleanup of Plume 2, that plume will be addressed by a separate amendment to the 1990 ROD.

VII. Community Participation

Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substance Pollution Contingency Plan requires public participation in the process of approving a proposed plan ROD amendment. A Proposed Plan for the groundwater remediation at Sites32/33 of the PCB OU at the Crab Orchard National Wildlife Refuge was made available to the public on April 5, 2006. Copies of the Proposed Plan fact sheet were sent to people on the Refuge CERCLA mailing list, and copies of the Proposed Plan, Groundwater Investigation Report, and Focused Feasibility Study Report were placed in the information repositories. The notice of public availability of the Proposed Plan and administrative record, and the notice of public meeting were published in the Southern Illinoisan, and the Marion Daily Republican, the two local newspapers of widest circulation, on April 3, 2006. A public comment period was held from April 5, 2006 to May 5, 2006. U.S. EPA together with the support agencies and partners, U.S. Department of the Interior/Fish and Wildlife Service and Illinois EPA held two separate public sessions on April 19, 2006 to explain its recommended cleanup plan. At this meeting, representatives from U.S. EPA, IEPA, DOI, and Schlumberger answered questions about the remedial alternatives presented in the Proposed Plan. No comments were made. No comments were received during the comment period other than a request to extend the comment period.

In response to a request at the meeting to extend the public comment period, later on followed by an email request, U.S. EPA extended the public comment period to May 19, 2006. U.S. EPA received five comments on the Proposed Plan. The responsiveness summary included in this ROD Amendment addresses these comments.

The Proposed Plan and other CERCLA-related documents for the PCB OU are available for public review at the following repositories:

U.S. Fish and Wildlife Service
Refuge Headquarters
8588 Route 148
Marion, IL 62959
(618) 997-03344, Ext. 361

Morris Library
Southern Illinois University – Carbondale
Carbondale, IL 62901
(618) 453-2818

This ROD Amendment is made part of the Administrative Record file which is located at the FWS Refuge Headquarters listed above.

VIII. Site Characteristics

a. Site Setting

The Crab Orchard National Wildlife Refuge is located in Southern Illinois, just south and west of the city of Marion. The Refuge consists of approximately 43,500 acres of land primarily within Williamson County, extending west and south into Jackson, Union, and Johnson Counties. Crab Orchard Lake is the largest of several lakes within the Refuge. The western portion of the Refuge around Crab Orchard Lake is open to public use for recreational purposes, while the eastern portion of the Refuge is a wildlife sanctuary that is closed to general public access. Land around the eastern portions of Crab Orchard Lake is also used for industrial purposes. The construction of Crab Orchard Lake was completed in 1940 as part of the Crab Orchard Project for Land Utilization. The dam that impounds the waters of Crab Orchard Creek and its tributaries, creating Crab Orchard Lake reservoir, is located at the extreme western end of the lake and has a spillway elevation of 405 feet M.S.L. Crab Orchard Lake is approximately 9 miles long and varies in width from approximately 1.5 miles in the west near the dam to approximately 0.5 mile in the eastern end. The resulting surface area of the lake is 6,965 acres with a watershed drainage area of 72,525 acre-feet. The average water depth varies over the area of Crab Orchard Lake from approximately 2 to 9 feet with a maximum depth of 30 feet. The majority of the northern boundary of the PCB OU area terminates at a bay on Crab Orchard Lake.

b. Site Geology:

(1) Unconsolidated Sediment

The site is underlain by Recent and Quaternary unconsolidated deposits ranging from 30 to 100 feet thick. The unconsolidated deposits consist of the following units, listed in order from the ground surface downward.

Upper Clay: The Upper Clay occurs from the ground surface to depths of approximately 25 feet bgs (below ground surface) beneath most of the site, but thins to approximately 15 feet in the north near Crab Orchard Lake. The Upper Clay consists of weakly bedded, mottled brown and gray silty clays and clayey silts, with occasional silty sand seams and lenses. Many boring logs indicate structure within the Upper Clay, including laminar bedding or alternating 2- to 3-inch beds of finer and coarser material within the clay and silt, especially in the lower half of the unit beneath the Area 9 Repository. Vertical to sub-vertical fractures have been observed throughout this unit. The calculated hydraulic conductivity of this unit is on the order of 10^{-4} to 10^{-6} cm/s (centimeter per second), which is consistent with a silt or loess. The general composition and structure of the Upper Clay indicates that it is a weathered loess deposit, possibly underlain in some locations by slackwater lake deposits.

Upper Sand: The Upper Sand occurs at elevations between approximately 380 feet and 400 feet above mean sea level (MSL) and varies in thickness from 1 to 2 feet in the southern part of the site to approximately 20 feet in the western part and 15 feet in the northwestern part. The Upper Sand is possibly absent in the southeastern and central portions of the site, where the Lower Clay

rises above approximately 400 feet MSL. Composition of the Upper Sand ranges from a clayey sand to a well-graded sand. In some locations, fine layering within the Upper Sand is noted in the boring logs, and there is a general coarsening downward sequence at most locations. This unit is consistent with either a glacio-lacustrine or a glacial outwash deposit.

Lower Clay: The Lower Clay occurs between elevations of approximately 340 feet MSL and 410 feet MSL, with the higher elevations in the southern and south-central portions of the site. The upper surface of the Lower Clay unit is eroded to form hills and valleys, with upper surface elevations varying from 380 feet to 410 feet MSL. This unit ranges in composition from a silty clay to a clayey silt and contains a trace to little fine sand and angular gravel. The gravel content includes fragments of weathered sandstone and coal. The Lower Clay has a very uniform color and texture with no depositional structures noted. Vertical to sub-vertical fracturing is common at the top of the Lower Clay. At some drilling locations, sandy interbedding was noted within the upper 20 feet of the Lower Clay. These sand lenses appear to be discontinuous and are not present beneath much of the site. The Lower Clay is representative of Illinoisan glacial till.

Lower Sand: The Lower Sand, where present, occurs immediately above the bedrock surface. The top of the Lower Sand occurs at approximately 340 to 350 feet MSL. This unit ranges from 10 to 20 feet thick in the northern portion of the site beneath Crab Orchard Lake to approximately 2 feet thick in the southwestern portion and is not present in the southern and southeastern portions where the bedrock surface rises above approximately 350 feet MSL. The Lower Sand is consistently logged as silty sand, and is consistent with a glacial outwash deposit.

(2) Site Bedrock

The bedrock surface below Williamson County consists of Pennsylvanian rocks. These rocks are predominantly weak shales, but include thin (less than 25 feet thick) limestones, sandstones, and coal beds. The Pennsylvanian rocks generally have low porosity and permeability and yield small amounts of water through interconnected pores, fractures, and joints.

Bedrock encountered during groundwater investigations at the PCB OU was described as gray fine-grained micaceous sandstone, and drilling logs indicate that it is competent and well cemented. The sandstone has been identified as a part of the Carbondale Formation.

Topographically, the top of the bedrock surface slopes to the north and west toward Crab Orchard Lake. Bedrock elevations range from approximately 400 feet MSL in the southern and southeastern portions of the site to approximately 320 to 340 feet MSL in the northern and western portions of the site, respectively.

(3) Geology in VOC Source Areas

Although the geology encountered at each individual VOC source area can generally be described as above, each source area has distinct geologic features, as summarized below.

Building I-1-2/I-1-3 Area

Bedrock is very shallow in this area, generally within 30 feet of the ground surface near Building I-1-2, sloping downward to the north, east, and west.

The Lower Sand unit does not exist in this area due to the shallow bedrock.

The Upper Sand unit does not exist in northern, western, and southern portions of this area. The Upper Sand pinches out against the Lower Clay where the Lower Clay rises above approximately 405 feet MSL

The easternmost extent of the Upper Sand unit at this VOC source area is near the western side of Building I-1-2, and the unit thickens to approximately 20 feet to the west near Highway 148.

Building I-1-23 Area

The Upper and Lower Sand units are both present in this area. Bedrock occurs at approximately 100 feet bgs.

The upper surface of the Lower Clay unit appears to have an incised channel running from south to north through the source area.

The Upper Sand varies in thickness from 7 feet on the edges of the channel in the Lower Clay to nearly 20 feet in the center. The Upper Sand also appears to thin to the south of the Building I-1-23 Area.

Area 9 Repository

The Repository fill material ranges in thickness up to approximately 35 feet and is underlain by the Upper Clay unit.

Bedrock occurs at approximately 100 feet below original ground surface beneath the Repository.

The Upper Sand unit is not present beneath the Area 9 Repository.

The lower portions of the Upper Clay unit at the Repository indicate lacustrine features such as finely banded silts and clays, varves, and occasional sandy lenses.

Building I-1-36A Area

The Upper Sand unit is present beneath the entire Building I-1-36A area, and ranges in thickness from 8 to 18 feet.

The Upper Sand unit appears to thin slightly to the north.

South of Area 9 Repository

The Upper Sand unit appears to be continuous beginning approximately 250 feet south of the Repository and continuing to the south, and is not continuous to the north toward the Repository.

The Upper Sand unit thins to the west.

The Lower Clay surface rises in elevation from south to north to approximately 390 feet MSL in the north.

Lacustrine features are common in the lower portion of the Upper Clay unit in this location.

c. Groundwater Flow:

(1) Regional Hydrogeology

Regionally, the shallowest groundwater occurs within the unconsolidated glacio-lacustrine deposits that mantle the bedrock surface throughout much of Southern Illinois. Groundwater is often encountered within 20 feet of the ground surface. Shallow groundwater contours are a subdued reflection of the ground surface topography, with groundwater flowing from areas of high ground surface elevation to discharge areas at lower elevations, such as streambeds or lakes.

Water-bearing sand and gravel units within the glacial and lacustrine deposits of Southern Illinois are common but are generally thin. Groundwater yields from these units are not adequate for municipal supplies. In areas within the vicinity of the site, some thin scattered sand and gravel deposits provide adequate yield for farm and domestic water supplies.

The water-yielding characteristics of the Pennsylvanian bedrock are highly variable. In Williamson County, sandstone aquifer yields are adequate for domestic supplies throughout most of the county. The groundwater in these rocks becomes highly mineralized with depth, and production wells are rarely installed more than 200 to 300 feet into the bedrock. Domestic supplies from the sandstone aquifers are easily obtained at depths ranging from 50 to 80 feet.

(2) Groundwater Occurrence and Flow at the PCB OU

Generally, the groundwater table at the site is a subdued reflection of the topography, with flow northward toward Crab Orchard Lake. Groundwater flow within the clay units has a significant downward component, except in locations of groundwater discharge near surface water, while flow within the sand units is predominantly horizontal.

Upper Sand/Upper Clay

Groundwater is generally encountered from 1 foot to 15 feet bgs in the Upper Clay unit at the site. The one exception is beneath the Area 9 Repository, where groundwater occurs approximately 21 to 25 feet below the top of the Repository (approximately 1 to 5 feet below the

original pre-Repository ground surface elevation). Groundwater elevations at most monitoring well locations fluctuate approximately 3 to 8 feet during the year.

Shallow groundwater beneath the site generally flows northward toward Crab Orchard Lake but is affected locally by surface water drainage ways and by the Area 9 Repository. In the Building I-1-2 area, shallow groundwater flows radially away from a local groundwater high. A majority of the groundwater flow from this area is easterly, toward the East Swale, and westerly, toward the Heron Flats impoundment area located west of Highway 148. Horizontal hydraulic gradients in the Building I-1-2 area range from 0.003 to 0.006.

In the Building I-1-23 area, groundwater flows primarily northward toward Crab Orchard Lake, with a lesser component of flow to the northeast toward the Area 9 Repository. A groundwater mound is present beneath the Area 9 Repository. This causes shallow groundwater to flow to the east toward the Center Swale (located immediately adjacent to the Repository) and to the north toward Crab Orchard Lake. Horizontal hydraulic gradients in the Building I-1-23 area range from 0.004 to 0.006. Horizontal hydraulic gradients at the Area 9 Repository range from 0.01 to 0.02.

Lower Sand Unit

Groundwater in the Lower Sand unit flows to the north toward Crab Orchard Lake. The horizontal hydraulic gradient in the Lower Sand ranges from 0.0004 to 0.0005.

Over most of the site, the piezometric head in the Lower Sand is generally 1 to 3 feet lower than the head in the Upper Sand, indicating a downward potential. However, near Crab Orchard Lake, this is reversed, indicating an upward potential as groundwater discharges to the lake.

Groundwater Hydraulic Characteristics

In the Upper Clay, the calculated hydraulic conductivities range from 1.4×10^{-6} to 7.7×10^{-4} cm/s, with a geometric mean of 4.6×10^{-5} cm/s. These conductivity values are consistent with values reported for silt and loess of 10^{-7} to 10^{-3}cm/s.

In the Upper Sand, the calculated hydraulic conductivities range from 1.3×10^{-5} cm/s to 4.4×10^{-3} cm/s, with a geometric mean of 3.0×10^{-4} cm/s. These conductivity values are consistent with values reported for a silty sand or fine sand.

Hydraulic tests of sand seams within the Lower Clay showed consistent hydraulic conductivity values on the order of 10^{-6} cm/s. The calculated hydraulic conductivity for these sand lenses is an order of magnitude below the range expected for a silty sand and is generally more consistent with that of a glacial till.

In the Lower Sand, calculated hydraulic conductivities generally range from 9.4×10^{-4} to 4.1×10^{-3} cm/s, with a geometric mean of 1.9×10^{-3} cm/s. These values fall within the observed range for a silty sand of 10^{-5} to 10^{-2} cm/s documented in literature.

Vertical Flow

Vertical gradients are downward over most of the site, including at each of the identified VOC source areas. However, upward gradients are present near Crab Orchard Lake, where groundwater discharge to the lake is occurring. There are also vertical upward gradients immediately below and adjacent to the lower reaches of the swales and intermittent streams (where the swales and streams approach larger surface water bodies), where groundwater is discharging to surface water. One exception is the area downgradient to the west of Building I-1-2. At this location, there is still a downward component of groundwater flow, which suggests that the discharge area is still further to the west, near Heron Flats, on the western side of Highway 148.

d. Surface Water:

Surface water drainageways are present at several locations at the site. In the southwestern portion of the site, an intermittent stream that appears to originate near Buildings I-1-2/I-1-3 flows westerly toward Highway 148, passes beneath Highway 148 through a culvert pipe, and discharges into the Heron Flats impoundment area on the western side of the highway. The Center Swale originates on the eastern side of the main building complex and runs northeasterly along the eastern and southern sides of the Area 9 Repository before discharging to Crab Orchard Lake. The West Swale runs northward from the vicinity of Building I-1-23 and discharges to Crab Orchard Lake. The East Swale runs northward along the entire eastern boundary of the site and discharges to Crab Orchard Lake. The swales and the intermittent stream are often dry in their upper reaches, except following rainfall events. The lower reaches appear to be receiving groundwater inflow and are flowing over much of the year.

e. Groundwater/Surface Water Relationship:

Although often there is no standing or flowing water in the surface water drainageways at the site, the sediment in the lower reaches of the swales is often moist. This may indicate that groundwater is discharging to the lower reaches of the swales but at a rate that will not result in flowing water. It appears that the lower reaches of the swales and the intermittent stream are zones of groundwater discharge during most, if not all, of the year.

f. Groundwater Contaminant Sources and Plumes:

Volatile organic compounds, particularly PCE; TCE; cis-1,2-DCE; and vinyl chloride, make up the majority of the constituents detected in groundwater. Petroleum-related VOCs (e.g., benzene and toluene) have also been detected sporadically across the site. In addition, several less soluble chlorinated organic compounds (trichlorobenzene and dichlorobenzene) have been detected in groundwater samples from the VOC source areas near Buildings I-1-2 and I-1-23, and in the vicinity of Building I-1-36A.

VOC plumes within the Upper Sand unit extend from 500 feet to over 1,000 feet downgradient from each of the primary source areas. The distribution of VOCs in the groundwater plumes at the site is controlled largely by the hydraulic gradients in the shallow flow system; however, the

transport of VOCs from the source areas is also dependent on the geology. In areas where the Upper Sand unit is not present or is discontinuous, VOCs have been transported shorter distances than in areas where the Upper Sand is continuous.

The contaminants in groundwater are dominated by chlorinated solvents, especially TCE, DCE, and PCE. Of these contaminants, TCE is present at the highest concentrations over most of the site. Contaminants occur mainly within the Upper Clay and Upper Sand units; groundwater within the underlying Lower Clay and Lower Sand units generally shows nondetectable concentrations. The conceptual model for transport of contaminants at the site is that VOC source residuals are slowly releasing dissolved VOCs into the groundwater; the dissolved VOCs then migrate vertically downward from the source units (which are predominantly within the Upper Clay) through the Upper Clay into the Upper Sand unit. The high permeability of the Upper Sand unit relative to the Lower Clay unit results in groundwater flow that is primarily horizontal. Although there is a significant downward gradient from the Upper Sand to the Lower Sand over much of the site, the low permeability of the Lower Clay confining unit restricts the downward flow of groundwater and contaminants to the Lower Sand unit.

The permeable Upper Sand unit is the primary pathway for lateral contaminant migration in groundwater at the site. TCE and related compounds occur in groundwater plumes that extend up to 1,000 feet or more from the source areas in the Upper Sand unit. The general absence of contaminants in the Lower Sand unit indicates that, despite the existence of relatively strong downward gradients over portions of the site, contaminants have not reached the Lower Sand. Investigation data indicate that natural attenuation processes likely are responsible for limiting the migration of contaminants into the Lower Clay and the Lower Sand units.

g. Descriptions of Individual Plumes

Buildings I-1-2/I-1-3

Based on the soil chemistry data, there appear to be two separate, but nearby, VOC source areas in the Building I-1-2 area. One source area is located directly east of Building I-1-2, just south of the former location of a manufacturing building. The second source is located just east of Building I-1-3, north of the former building. The two source areas, although separate, form one plume to the east and one plume to the west of the combined Buildings I-1-2/I-1-3 area.

These two plumes of VOCs extend downgradient to the east and west of the Buildings I-1-2/I-1-3 source areas. The orientations of these plumes are consistent with the groundwater flow pattern in the area. Transport of contaminants to the north and south appears to be very limited in extent. A groundwater divide effectively splits the groundwater flow at the source areas to the east and west. In addition, the Upper Sand unit appears to be absent to the north and to the east of Buildings I-1-2/I-1-3. This also contributes to the limited groundwater flow from the Buildings I-1-2/I-1-3 source areas to the north or south.

The primary VOC constituents detected in groundwater wells nearest to the Building I-1-2 source area are TCE and DCE. However, a tentatively identified compound (TIC), 1,1,2-trichloro-1,2,2-trifluoroethane (Freon113), has also been detected in groundwater in this source

area. In addition, historical data indicate the presence of significant concentrations (on the order of 10 to 100 ppb) of trichloro-, dichloro-, and monochloro-benzenes. These compounds have low water solubility (19 ppm to 500 ppm) compared to TCE (1,100 ppm) and DCE (6,400 ppm), and are generally restricted to the immediate source area.

Investigation data indicate the importance of the Upper Clay as the primary source of VOCs leaching downward into the Upper Sand unit in this area, although the Upper Sand is not present throughout this source area. Downgradient to the west, groundwater within the Upper Clay contains low to nondetectable VOC concentrations, while groundwater from the Upper Sand in the same location contains significant VOC concentrations. The data indicate that, while the highest VOC concentrations occur within the shallow fine-grained sediment (Upper Clay) in the source area, lateral transport of VOCs occurs primarily within the Upper Sand, and downgradient areas of the Upper Clay are not impacted.

The VOC plume to the west of Building I-1-2 is of a greater extent, and contains higher VOC concentrations, than the plume to the east. The difference in VOC distribution is explained by the geology in this local area. The Upper Sand thickens to the west, which allows significant transport of contaminants, but appears to be discontinuous to the east, which limits lateral transport in that direction. As a result, the VOC plume to the east extends only approximately 800 feet downgradient toward the East Swale, while to the west total VOC concentrations on the order of 2,000 ppb persist more than 1,300 feet downgradient of the source area. Transport of VOCs to the west is toward the intermittent stream and low-lying area on the east side of Highway 148. However, no significant concentrations of VOCs have been detected in groundwater at the low-lying area near the highway.

Building I-1-23

Concentrations of VOCs on the order of 3,000 ppb extend in the groundwater plume from the Building I-1-23 source area northward (downgradient) to Crab Orchard Lake. Similar to the Building I-1-2 source area, the primary VOC constituents detected in groundwater nearest to this source area are PCE, TCE, and DCE; however, significant concentrations of chlorobenzene, and much lower concentrations of trichlorobenzene, have also been detected at the Building I-1-23 source area. As in the Building I-1-2 plume, trichloro- and monochloro-benzenes have not been detected in the plume originating at the Building I-1-23 area.

The vertical distribution of VOCs within the Building I-1-23 source area saturated zone is very similar to that observed in the Building I-1-2 source area. Shallow groundwater within the Upper Clay unit shows total VOC concentrations one order of magnitude higher than the groundwater at the same location within the Upper Sand. Unlike the Building I-1-2 area, however, total VOC concentrations in the Upper Sand and the Upper Clay in the groundwater near Crab Orchard Lake are very similar. This is the result of upward vertical gradients in the immediate vicinity of Crab Orchard Lake that cause upward movement of impacted groundwater from the Upper Sand, through the Upper Clay, and discharge to the West Swale and to Crab Orchard Lake.

Area 9 Repository

A plume of VOCs extends eastward from beneath the Area 9 Repository toward the Center and East Swales, and some migration of VOCs has occurred to the north toward Crab Orchard Lake. The distribution of contaminants emanating from soil beneath the Area 9 Repository is explained by the local water table configurations and by the geology. A groundwater mound is present beneath the Repository during much of the year, causing groundwater to flow both to the north toward Crab Orchard Lake and to the east toward the Center and East Swales. The thin and clay-rich nature of the Upper Sand beneath the Repository greatly reduces (by adsorption) the transport of VOCs away from the source area, particularly to the north where the deposit becomes very clayey. The transport of VOCs that does occur is primarily to the east, where the Upper Sand is thicker and of lower clay content. Therefore, it is believed that the Area 9 Repository plume discharges to the Center and East Swales.

The primary VOC constituents detected include PCE, TCE, and DCE. Few to no trichloro-, dichloro-, or monochloro-benzenes have been detected in groundwater at the Area 9 Repository. Concentrations of PCE and its degradation products are highest within the source area. TCE, DCE, and vinyl chloride are transported downgradient of the source area, but unlike the VOC plumes from the other source areas at the site, the concentrations of these compounds generally decrease in downgradient locations. The decrease of biodegradation products in the downgradient areas of the plume is the result of relatively low groundwater flow velocities in the vicinity of the Area 9 Repository. Low flow velocity limits the transport of PCE source material downgradient, thus reducing concentrations of biodegradation products in these areas.

Only low to non-detected concentrations of VOCs have been detected in the Upper Sand to the northeast of the Area 9 Repository. Variations in groundwater chemistry at this location appear to be the result of variations in the groundwater flow direction and possibly seasonal water table fluctuations. No VOCs have been detected in the Upper Sand east of the East Swale, and only a trace of TCE has been detected at the water table well at the same location. The groundwater chemistry data, in addition to the upward hydraulic gradients, indicate that groundwater flowing east from the Area 9 Repository is discharging to the East Swale. No significant groundwater contamination extends east of the East Swale.

Building I-1-36A

The primary VOC constituents detected in groundwater in the vicinity of Building I-1-36A are PCE, TCE, and DCE. Low concentrations of several dichlorobenzene compounds have also been detected. VOCs in groundwater in the area of Building I-1-36A form a plume, which extends first easterly toward the Center Swale, where it merges with a plume originating south of the Area 9 Repository, and then north and eastward toward the East Swale and Crab Orchard Lake. Here, the VOC plume from the direction of BuildingI-1-36A merges with the Area 9 Repository plume to the east of the Repository. Eastward transport of VOCs from the area of Building I-1-36A is aided by intermittent recharge from the Center Swale. Near Building I-1-36A, there is also a northerly component to the flow system that causes low VOC concentrations at the perimeter of the Building I-1-36A plume to merge with the Building I-1-23 plume. The western extent of VOC concentrations in groundwater in the area upgradient of

Building I-1-36A is uncertain; however, the presence of low concentrations of dichlorobenzenes in the shallow groundwater on the western side of BuildingI-1-36A suggests that the source area is nearby.

South Side, Area 9 Repository

A plume, designated the South Side plume, appears to originate from a separate source area located to the south of the Area 9 Repository and to the east of the Center Swale.

The primary VOC constituents within this plume are PCE, TCE, and DCE, similar to the other site source areas. Unlike the other source areas, trichloro-, dichloro-, and monochloro-benzenes were not detected in the groundwater samples. However, carbon tetrachloride (CTET) was detected within the Upper Sand unit. Like the chlorobenzene compounds, CTET is relatively insoluble in water. Its presence in groundwater at these locations and its absence elsewhere at the site indicates that this plume has a separate source area located near the southern side of the Area 9 Repository.

The South Side plume merges with the Building I-1-36A plume (from the west) and extends to the northeast toward the eastern side of the Area 9 Repository, following the trend of the Center Swale. Here it merges with the Area 9 Repository plume. The combined VOC plume is then transported to the east and north, where it emerges as surface water in the East Swale, which then flows into Crab Orchard Lake.

IX. Current and Future Site and Resource Uses

The Crab Orchard National Wildlife Refuge consists of approximately 43,500 acres of multiple use land. The refuge is used as wildlife refuge and also for recreational, agricultural, and industrial purposes. The Area 9 Landfill (Site 32) and the Area 9 Building Complex (Site 33) are located in an industrial area. Access is limited to employees working in the Area 9 Building complex and to refuge personnel. This area is expected to remain as an industrial area in the foreseeable future. The groundwater contamination emanating from the sites, however, extends beyond the designated industrial area in to the Crab Orchard Lake, which is a recreational area.

EPA generally defers to State Groundwater Classifications for current or future groundwater uses. Although the groundwater is not used currently for drinking water purposes, the contaminated aquifer at Sites 32/33 has been classified by the State of Illinois as a Class I Potable Resource Groundwater in accordance with Illinois Administrative Code, Title 35, Part 620, Subpart B (Section 620.210). Accordingly, Illinois EPA and U.S. EPA affirm the need to protect the potential future beneficial use of the Sites 32/33 Class I Potable Resource Groundwater by virtue of the remedies contained in this ROD Amendment.

X. Past and Current Site Risks

PCBs, lead, and cadmium were the contaminants of concern at four sites (Job Corps Landfill, Water Tower Landfill, Area 9 Landfill, and Area 9 Building Complex) within the PCB OU. These contaminants posed an unacceptable risk to human health and the environment, including

wildlife at the refuge. The 1990 ROD for the PCB OU describes in detail the site risks due to the contaminants of concern for each of these sites. The ROD also established remediation goals for soil, sediment, groundwater, and surface water, and required that following remediation, a risk assessment be conducted as noted below:

> Soil and Sediment: Risk assessment to ensure that the risk from all of the chemical contaminants present above naturally occurring background levels established for the Site in the soil and sediment shall not exceed an excess cancer risk of one in one million (10^{-6}) and shall not exceed concentrations determined to produce any non-cancer chronic health effects.
>
> Groundwater: Risk assessment to ensure that the risk from all of the contaminants in the groundwater (measured at the source of contamination) above naturally occurring background levels shall not exceed any excess human health risk or any standard. If at any time, groundwater at any of the remediated sites exceeds a 10^{-6} cumulative life-time cancer risk, or maximum contaminant levels (MCLs) for carcinogens, whichever is more stringent; and MCLs, maximum contaminant level goals (MCLGs), or a hazard index of 1.0; whichever is more stringent, for non-carcinogens, additional remedial work as determined by U.S. EPA shall be performed.
>
> Surface Water at Area 9: Risk assessment to ensure that the cumulative risk from all of the contaminants in the surface water above naturally occurring background levels established for the site in the soil and sediment shall not exceed an excess cancer risk of one in one million (10^{-6}) and shall not exceed any non-cancer chronic health effects.

Under the terms of the May 1991 Consent Decree, Schlumberger undertook the cleanup activities at these sites. In 1997, approximately 117,145 tons of PCB-contaminated soils were incinerated in an on-site mobile incinerator. PCB-contaminated soil/sediments with levels less than 25 mg/kg were consolidated and backfilled in an on-site repository at Site 32. Lead and cadmium contaminated soil were rendered non-hazardous, and disposed of in an on-site landfill at the refuge. Monitoring activities conducted by Schlumberger following the remedial action indicated the presence of TCE and other chlorinated solvents in the groundwater at Sites 32/33 at levels significantly higher than their respective MCLs. Groundwater at this site is State of Illinois Class I Potable Groundwater Resource and is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Currently, there is no risk to human health, because presently the groundwater is not being used for drinking water. Future use of the groundwater at Sites 32/33 as a drinking water resource would pose unacceptable risk, however.

Periodic air monitoring inside nearby buildings currently used by General Dynamics Ordnance and Tactical Systems (GDOTS) and indoor air samples collected by Schlumberger at Buildings I-1-2, I-1-3, and I-1-23 have shown that concentrations of VOCs inside these buildings are well within permissible environmental exposure standards adopted by Occupational Safety and Health Standards (OSHA). Implementation of the selected remedies would help mitigate any potential long-term risk to the building occupants due to soil vapor intrusion of TCE and other chemicals of concern from soil vapor intrusion. After completion of the remedial activities identified in

this ROD Amendment, a site-specific risk assessment will be conducted to ensure that all other requirements in the 1990 ROD are met.

Chemicals of concern for this ROD Amendment are Trichloroethylene (TCE), Tetrachloroethene (PCE), Dichloroethene (DCE), Vinyl chloride, and any other chlorinated volatile organic compounds which are found in groundwater above their respective MCLs. The highest reported TCE concentration in groundwater is 66,000 ppb. Highest reported TCE concentration in soil is 44 mg/kg.

XI. Remedial Action Objectives

40 CFR 300.430(a)(1)(iii)(F) of the National Contingency Plan (NCP) states:

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."

The Remedial Action Objectives are as follows:

- Restore contaminated groundwater at Sites 32/33 to Drinking Water Standards to the extent practicable;
- Reduce or control, to the extent practicable, the impact of subsurface sources of volatile organic compounds on the groundwater quality.

XII. Description of Remedial Alternatives

As stated earlier, there are three distinct groundwater contamination areas namely, the Building I-1-23 Area (Plume 1), Buildings I-1-2/I-1-3 Areas (Plume 2), and the Area 9 Repository (Plume 3). Plume 2 will be addressed by a separate ROD Amendment. All alternatives, with the exception of the No Action alternative include groundwater monitoring. The following includes a brief description of various components of the remedial alternatives considered for this ROD Amendment.

Groundwater Extraction and Treatment component of the remedial alternatives includes the pumping and treating of groundwater in the Upper Sand aquifer.

Permeable Reactive Barrier (PRB) component of the remedial alternatives includes the construction of a continuous barrier consisting of a mixture of zero-valent iron (ZVI) and sand immediately downgradient of the CVOC plume. The reactive zone of the PRB containing the ZVI would be placed across the full depth of the Upper Sand unit, from the top of the lower clay to the bottom of the Upper Clay. As the groundwater flows through the PRB under natural gradients, the dissolved VOCs would be destroyed by chemical reactions with the ZVI.

Multiphase Extraction with Pneumatic Fracturing component of the remedial alternatives includes multiphase extraction (MPE) wells with enhancement by pneumatic fracturing to treat the VOC sources within the Upper Clay unit. The Upper Sand unit would also be treated with MPE wells. MPE is an in-situ technology that uses a high-vacuum pump(s) to extract liquid and vapor simultaneously from the subsurface through the extraction wells.

Phytoremediation component of alternatives includes planting of phreatophytic trees, including cottonwood, poplar, or willow, near the lake for phytoremediation of the shallow groundwater.

Engineered Wetland component of the alternatives includes a constructed engineered wetland treatment zone within a portion of the existing Crab Orchard Lake bay to intercept the VOC-impacted groundwater where it currently discharges into the bay, and to treat the discharging groundwater and surface water runoff that passes through the drainage swales to reduce VOC concentrations to non-detectable levels before water enters the main body of the lake.

Alternative concentration limits (ACLs) component are used in lieu of drinking water standards. ACLs will be established by developing baseline groundwater quality levels for the shallow aquifer near the groundwater/surface water interface within the plume discharge area, and then employing an analytical method to determine what level of groundwater contamination would constitute a statistically significant increase in VOC concentrations at selected points of compliance for groundwater quality. If future groundwater monitoring confirms a statistically significant increase in the contaminant concentrations, the need for further remedial action would be evaluated.

In-Situ Reductive Dechlorination includes the addition of a substrate into the source area soil and groundwater to stimulate the in-situ destruction of VOCs in both the Upper Sand and Upper Clay through biological reductive dechlorination.

Electrical Resistive Heating (ERH) technology is a thermally enhanced soil vapor extraction (SVE) technique that targets both contaminated soil and groundwater. This alternative involves the use of electrical current transmitted through the contaminated soil zones in the Upper Clay and Upper Sand, using a large number of metal electrodes to heat the groundwater to the boiling point, with removal of the resulting steam and hot soil vapor using a soil vapor extraction system, and processing/treatment of the extracted steam/water/vapor for removal of VOCs.

Monitored Natural Attenuation component of the remedial alternatives includes regular periodic monitoring of groundwater and surface water to assess the attenuation of contaminant plumes via natural chemical, physical, and biological processes. The monitoring data are evaluated to determine if the groundwater contaminant plumes are stable or receding, and to determine the rate of change of the VOC concentrations.

Institutional Controls component of the remedial alternatives prohibits the installation of potable water wells until the groundwater is restored to the drinking water standards.

The following remedial alternatives are in addition to the ANo Action@ alternative which is required under NCP to establish a baseline for comparison of the effectiveness of the remedial

alternatives. The "No Action" alternative is considered ineffective at achieving the remedial action objectives of bringing the groundwater to beneficial uses or to reduce/control the impact of subsurface sources of the VOCs on the groundwater quality. The alternatives are numbered to correspond with numbers in the FFS Report.

Groundwater Plume near Building I-1-23 (Plume 1)

- Alternative A1 - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Groundwater Extraction and Treatment, Phytoremediation, and Institutional Controls

- Alternative A2 - Excavation (within 1 mg/kg CVOC contour in the Upper Clay unit), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls

- Alternative B - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Permeable Reactive Barrier, Phytoremediation and Institutional Control

- Alternative C - Multiphase Extraction with Pneumatic Fracturing, Groundwater Extraction and Treatment, Phytoremediation and Institutional Control

- Alternative D - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative E - Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative F - Excavation (within 10 mg/kg CVOC contour in the Upper Clay unit), In-Situ Reductive Dechlorination, Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

- Alternative G - Electrical Resistive Heating in source areas within an estimated 1 mg/kg CVOC zones through the full depth of Upper Clay and Upper Sand units, Phytoremediation, and Institutional Controls

Groundwater Plume near Building I-1-2/I-1-3 (Plume 2)

- Alternative A - Limited Excavation, Multiphase Extraction with Pneumatic Fracturing, and Institutional Controls

- Alternative B - Permeable Reactive Barrier and Institutional Controls

- Alternative C - Alternate Concentration Limits and Institutional Controls

- Alternative D - Excavation (within the 10 mg/kg VOC contour), Alternate Concentration Limits, and Institutional Controls

- Alternative E - Excavation (within the 10 mg/kg VOC contour), In-Situ Reductive Dechlorination with Pneumatic Fracturing, Alternate Concentration Limits, and Institutional Controls

- Alternative F - Electric Resistive Heating (within 10 mg/kg CVOC contour) and Institutional Controls

Groundwater Plume beneath the Area 9 Repository (Plume 3)

- Alternative A - Phytoremediation and Monitored Natural Attenuation

- Alternative B - Phytoremediation and Alternative Concentration Limits

XIII. Applicable or Relevant and Appropriate Requirements (ARARs)

The following federal and state ARARs apply to one or more of the remedial alternatives for the groundwater at Sites 32/33:

1. Chemical-specific ARARs

   - 40 CFR 141 - MCLs promulgated under the Safe Drinking Water Act.

   - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.405, General Prohibition Against Violations of the Groundwater Quality Standards: No person shall cause, threaten or allow the release of any contaminant to groundwater so as to cause a groundwater quality standard to be exceeded.

   - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.410, Class I Groundwater Quality Standards.

   - 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.450, Alternative Groundwater Quality Standards: Applies to any chemical constituent within a Groundwater Management Zone. Following completion of corrective action allows alternate groundwater standards equal to the concentration of contaminants determined by groundwater monitoring, if such concentrations exceed the appropriate groundwater quality standards and to the extent practicable, the exceedances have been minimized and beneficial use has been returned.

   - 40 CFR 122.41 and 122.44 - Clean Water Act: If any ditch water from Sites 32/33 must be discharged to a surface water body during site preparation, the discharge shall meet the effluent standards and

prohibitions and water quality standards established under Sections 301, 302, 303, 307, 318, and 405 of the Clean Water Act.

- 35 IAC Part 302, Subpart B – General Use Water Quality Standards, specifically Part 302.208 – Numeric Standards for Chemical Constituents, and Part 302.1210 – Other Toxic Substances.

2. Action Specific ARARs

- 35 IAC Part 304, Subpart A – General Effluent Standards, specifically Parts 304.102 and 304.105 to 141 – For discharges to waters of the state.
- 35 IAC Part 305 – Monitoring and Reporting, specifically Parts 305.102 to 103 - For discharges to waters of the state.
- 35 IAC Part 306, Subpart A – Systems Reliability, specifically Part 306.102
- 35 IAC Part 309, Subpart A – NPDES Permits – Substantive requirements pertinent to construction and operation of contaminated groundwater treatment or pretreatment works and to point source discharges to waters of the state.
- 35 IAC Part 620 – Groundwater Quality, Subpart D, Section 620.250, Groundwater Management Zone (GMZ): Allows the establishment of a GMZ, a three dimensional region containing groundwater managed to mitigate impairment caused by the release of contaminants from a site; requires corrective action in a timely and appropriate manner approved by Illinois EPA.
- 40 CFR 262.34; and 264, Subparts B, C, I, J, and L - Resource Conservation and Recovery Act (RCRA), Subtitle C - Excavated material which is RCRA hazardous will be handled and stored in accordance with the substantive technical standards applicable to generators of hazardous waste and for owners and operators of hazardous waste and for owners an operators of hazardous waste storage facilities.
- 40 CFR 268 – Excavated material which is RCRA hazardous will be handled and stored in accordance with the land disposal restrictions
- 40 CFR 264, Subpart G – The excavation activities, when completed, shall meet the closure performance standards for clean closure.
- 35 IAC Part 724 design requirements – The excavation and storage activities must also meet any more stringent State of Illinois regulations.
- 40 CFR 761.65 - Clean Air Act – During excavation the national ambient air quality standards (NAAQS) for particulate matter and lead shall not be exceeded.
- 35 IAC Subtitle B – Air Pollution, Part 201 – Substantive permitting requirements under Parts 201.141, .143, .152-.165, .207-.210, .261-.265, .282-.283, .310-.312 for construction or modification of an emission source.
- 35 IAC 704 – UIC Permit Program; 35 IAC Part 730 – Underground Injection Control Operating requirements – Substantive permitting

requirements for underground injection of hazardous liquids (Class IV UIC well) or non-hazardous fluid (Class V UIC well). Injection of contaminated fluid into underground sources of drinking water in excess of any primary drinking water regulations is prohibited. 35 IAC Part 724.124(c) exempts Class IV wells (hazardous) from this prohibition on RCRA and CERCLA sites; however, no exemption exists for Class V wells.

- 35 IAC Part 722 – Standards Applicable to Generators of Hazardous Waste – If solid waste (defined per 35 IAC Part 721.102) is generated, the generator must determine if that waste is hazardous.
- 35 IAC Subtitle G – Waste Disposal, specifically Parts 724 and 728 – If hazardous waste is present on a site, pertinent requirements of hazardous waste treatment, storage, and disposal under 35 IAC Subtitle G (Waste Disposal) must be followed.
- 35 IAC Part 808 – Special Waste Classifications – Generators of a waste must classify the waste. A special waste (defined per Section 3.45 of Illinois Environmental Protection Act) determination is required under 35 IAC Part 808.12. Management of special waste must be in accordance with 35 IAC Subtitle G (Waste Disposal), including 35 IAC Part 809 (Special Waste Hauling) and 35 IAC Part 810 (Solid Waste Disposal).
- 40 CFR 264.114 – RCRA, Subtitle C – During remediation and closure all equipment, structure, and soils that are used on /with RCRA hazardous material must be properly decontaminated or disposed of.
- 35 IAC Part 724 – Decontamination of equipment, structures, and soils that are used on/with RCRA hazardous materials must meet any more stringent regulatory decontamination or disposal standards of the State of Illinois.
- 40 CFR 50.6 – During backfilling activities the NAAQS for particulate matter shall not be exceeded.
- 40 CFR 264, Subpart F – RCRA Subtitle C – Groundwater monitoring for the remediated sites shall be in accordance with the groundwater monitoring requirements of RCRA.
- 29 CFR 1910.120 and 1926, Subparts C, D, E, and P – Occupational Safety and Health Act (OSHA) – During all remedial activities the requirements of OSHA for the training and safety of workers will be observed.

3. <u>Location Specific ARARs</u>

- National Wildlife Refuge Administration Act (16 USC 668dd).
- Fish and Wildlife Coordination Act (16 USC 661-666).
- Migratory Bird Treaty Act of 1918 (16 USC 703-711, as amended.
- Endangered Species Act – 16 USCA Sections 1531 to 1544.
- Archeological and Historic Preservation Act – 16 USCA Sect. 469
- Native American Graves Protection and Repatriation Act – PL 101-601

XIV. Evaluation of Alternatives

a. Evaluation Criteria

U.S. EPA's evaluation of remedial alternatives is based on the nine criteria set forth in the National Contingency Plan (NCP), 40 CFR Part 300. These criteria are described below.

A remedial alternative is judged first in terms of the threshold criteria of protecting human health and the environment and complying with Applicable or Relevant and Appropriate Requirements (ARARs). If a proposed remedy meets these two criteria, it is then evaluated against the balancing and modifying criteria in order to arrive at a final recommended alternative.

Threshold Criteria

1. Overall protection of human health and the environment: U.S. EPA determines whether an alternative adequately protects human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site.

2. Compliance with ARARs: U.S. EPA evaluates whether an alternative attains applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility citing laws or provides grounds for invoking a waiver.

Balancing Criteria

3. Long-term effectiveness and permanence: U.S. EPA considers the ability of an alternative to maintain protection of human health and the environment over time, and the reliability of such protection.

4. Reduction of contaminant toxicity, mobility, or volume through treatment: U.S. EPA evaluates the degree to which an alternative uses treatment to address the principal threats posed by the site.

5. Short-term effectiveness: U.S. EPA considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. Implementability: U.S. EPA considers the technical and administrative feasibility of implementing the alternative, such as relative availability of goods and services.

7. Cost: U.S. EPA estimates an alternative's capital and O&M costs and calculates the present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollars.

Modifying Criteria

8. State acceptance: U.S. EPA considers any concerns the state has raised with respect to the preferred alternative, other alternatives or with ARARs or ARAR waivers.

9. Community Acceptance: U.S. EPA considers which components of the alternatives interested persons in the community support, have reservations about, or oppose.

b. Application of the Evaluation Criteria to the Cleanup Alternatives

As part of the evaluation process, each alternative is evaluated against the nine criteria outlined above. The ROD Amendment briefly summarizes the outcome of this evaluation with the goal of identifying the alternative that best meets the nine criteria. This ROD Amendment evaluates cleanup alternatives for Plumes 1 and 3 only. Evaluation of Cleanup alternatives for Plume 2 will be made in a separate ROD Amendment.

Groundwater Plume near Building I-1-23 (Plume 1)

1. Overall Protection of Human Health and the Environment:

All of the alternatives, with the exception of the ANo Action@ alternative include Phytoremediation and Institutional Controls to prohibit the installation of potable water wells until groundwater is restored to the drinking water standards, will provide overall protection of human health and the environment.

Alternative A2 provides the most assurance that human health and the environment will continue to be protected over the duration of the remedy and beyond. Under Alternative A2, Excavation (within 1 mg/kg CVOC contour in the Upper Clay), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls, the bulk of the soil contamination, including NAPL mass, in the Upper Clay will be removed. The groundwater extraction and treatment system will consist of extraction wells (or a single well, if sufficient) installed to capture groundwater contamination in the Upper Sand unit and an above groundwater treatment system to remove and treat contaminants from the extracted groundwater. At the downgradient edge of the plume, Poplar Trees or Eastern Cottonwood trees representing the Phytoremediation component of the remedy will be planted to capture any residual groundwater contamination near the lake. As the final component of the remedy, Institutional Controls will be used to prevent future use of groundwater at the site until groundwater is restored to drinking water standards.

The modeling simulations show that Alternatives A2 and G would bring groundwater to beneficial use in approximately 40 and 75 years, respectively. All other alternatives would take more than 200 years to bring groundwater to beneficial use.

2. Compliance with ARARs:

Alternatives A1, A2, B, C and G, would meet the ARARs identified in this ROD Amendment. Alternate concentration limits (ACLs) would have to be established for Alternatives D, E, and F.

By excavating most of the contaminated soil in the Upper Clay unit, Alternative A2 will remove approximately 97% of the NAPLs in the Upper Clay. Based on groundwater modeling results, NAPLs in the Upper Sand unit will be removed within 11 years of groundwater extraction and treatment and the remaining NAPLs in the Upper Clay unit will be removed within 14 years after excavation of the contaminated soil. Groundwater will be restored to drinking water standards in approximately 40 years.

Based on the calculations presented in Appendix B of the FFS Report, the NAPL and sorbed VOC mass in the Upper Sand would be fully removed within approximately three years after the start of ERH treatment (Alternative G), and the NAPL and sorbed VOC mass in the Upper Clay would be fully removed in approximately 65 years from the start of treatment. Groundwater standards would be met over the entire plume area within approximately 75 years.

3. Long-Term Effectiveness and Permanence

All of the alternatives, with the exception of the No Action alternative, include Phytoremediation or Phytoremediation with Engineered Wetland as a component of the remedy. Phytoremediation will be effective in achieving limited long-term effectiveness by reducing the volume of contaminated groundwater and the mass of chlorinated VOCs discharging to the Crab Orchard Lake or other surface water locations. Alternatives A1, A2, B, C, D, F, and G which include excavation and/or groundwater treatment as components of the remedy, will provide long-term effectiveness and permanence.

Although all of these alternatives provide long-term effectiveness and permanence, the remediation benefits will not be permanent until all of the NAPL mass had been removed from the Upper Clay by natural processes which will take approximately 14 years for Alternative A2, 65 years for Alternative G, and more than 200 years for Alternatives A1, B, C, D, and E.

Alternative A2 provides the greatest degree of long-term effectiveness and permanence since most of the source material including NAPL mass will be removed in the Upper Clay unit and groundwater extraction and treatment in the Upper Sand unit will restore the groundwater to drinking water standards in approximately 40 years. Alternative G would restore the groundwater to beneficial use in approximately 75 years.

4. Reduction of toxicity, mobility, and volume through treatment:

All of the alternatives are capable of achieving some reduction in the toxicity, mobility and volume of contamination through treatment. Alternatives A1, A2, and C provide greater reduction in mobility of VOCs than the other alternatives, by focusing the groundwater extraction within the main source area. Groundwater extraction under these three alternatives would also provide capture and removal of dissolved VOCs over a broader area than the in-situ groundwater treatment zone provided by the permeable reactive barrier (PRB) in Alternative B, thereby providing greater reduction in both volume and mobility of VOCs over time than the PRB. Alternative A1, however, will not reduce VOC mobility, if the extraction wells stopped operation within 11 years (short-term option), due to the expected rebound of the VOC plume.

Alternative A2 would provide removal or destruction of more of the VOC source mass in a shorter time than the other alternatives. Alternatives B, D, F, and G would do little to reduce the mobility of the VOC source mass that would remain after completing the "active" phase of the source area remediation.

Because Alternatives A2, C, F, and G are expected to remove or destroy more VOCs than other alternatives, they would also provide greater reduction of VOC toxicity. However, under Alternatives B and F, there is potential that if the PRB (Alternative B) or the in situ biodegradation (Alternative F) does not provide complete destruction of the VOCs, breakdown products such as vinyl chloride that have higher toxicity than the parent compounds may be present in the groundwater at some locations.

5. Short-Term Effectiveness:

The Alternatives that include source area soil excavation and off-site disposal as a component of the remedial action (Alternatives A1, A2, B, D, and F) would present a higher level of potential exposure of construction workers to VOCs during implementation of the alternative than the alternatives that do not include soil excavation (Alternatives C, E, and G). There would also be a slightly increased risk of exposure of the general public to VOCs during transport of the soil for disposal. Alternative B would have recurring potential for adverse exposures during replacement of the PRB, which has been assumed to be required every 20 years.

Potential exposures to steam, hot water, hot soil vapor, condensate containing concentrated VOCs, and electrical hazards during operation of the ERH system (Alternative G) would result in greater potential short-term exposures to remediation workers and employees working in nearby buildings. Proper design of the ERH system and taking proper health and safety precautions, however, would eliminate these concerns. The design may include air monitoring inside nearby buildings to address the issue of VOC vapors that may not be fully captured by the ERH system and which may migrate beneath and into the buildings during implementation. Air monitoring instruments (e.g., Photoacoustic multigas analyzer) would be placed inside buildings and samples collected at regular intervals throughout the duration of the remediation. If VOCs are detected above their pre-determined action levels, the ERH system could be designed to automatically shut down and/or to evacuate the occupants of the building. To prevent adverse impact to building instrumentation, operations of safety, the ERH system would includes isolation transformers that prevent the uncontrolled flow of electricity outside of the electrode arrangement. Thus it is physically impossible for electricity to enter the nearby building electrical system via the existing building grounding grid.

All of the alternatives include some form of phytoremediation as a component of the work. The vegetation provided for phytoremediation would not reach its peak groundwater remediation effectiveness until roughly three years after planting.

Alternatives A1, A2, and C would provide more rapid short-term improvement in groundwater quality downgradient of the VOC source area than the other alternatives, due to the groundwater extraction component of the alternatives.

6. Implementability:

Alternatives A1, A2, C, and F are readily implementable relative to all other alternatives. The soil excavation component in several of the alternatives (Alternatives A1, A2, B, D, and F) is expected to be implementable, despite the presence of several existing underground utilities. The successful completion of the PCB soil excavations in 1996 demonstrate that the existing utilities in this area can be avoided during excavation work. Alternative B would have considerable uncertainty regarding the constructability of the PRB at this location, however, owing to the depth and thickness of the Upper Sand unit. The extent of these construction challenges would not be known until additional pilot soil borings were completed during pre-design fieldwork. Existing buried utilities in the location of the PRB would also present an impediment to construction. PRB is a patented technology available from limited number of contractors with patent implementation rights and a site use license and fee are required. Pneumatic fracturing of the clay under Alternate C, certain types and methods of bio-substrate addition as included under Alternative F, and the use of ERH technology under Alternative G are also patented technologies offered by limited number of vendors with patent implementation rights. Under Alternative G, air monitoring inside nearby buildings during implementation may be needed to ensure that VOC vapors are not migrating beneath and into the buildings. A high level of coordination with GDOTS is needed to ensure that the implementation of the ERH system would not unreasonably interfere with GDOTS' ongoing activities at the site.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 1.

Table 1
Summary of Estimated Costs for Each Alternative for Plume 1

	Total Capital Cost	Total Cost	Total Present Worth Cost
A1	$830,000	$5,182,000	$3,719,000
A2	$2,747,000	$5,688,000	$4,914,000
B	$2,276,000	$5,836,000	$4,415,000
C	$1,319,000	$5,809,000	$4,352,000
D	$1,074,000	$3,062,000	$2,391,000
E	$706,000	$2,740,000	$2,046,000
F	$1,410,000	$3,564,000	$2,908,000
G	$2,930,000	$4,322,000	$3,837,000

(Total present worth value is for a 30-year period and an annual discount rate of 3.2 %)

Alternative E has the lowest total present worth cost and Alternative A2 has the highest. This is because Alternative E includes no removal of source material and limited operation and maintenance costs while alternatives A1 and A2 include a much longer projected period of operation and maintenance costs. Alternative G has the highest capital costs. Although Alternative A2 is more expensive than other alternatives, based on the groundwater modeling results, it brings the groundwater to MCLs and State of Illinois Class I Groundwater standards in the shortest timeframe of about 40 years when compared with other alternatives which would take more than 100 years.

8. State Acceptance:

The Illinois EPA has provided support to U.S. EPA throughout the re-evaluation process. The Illinois EPA concurs with the selected remedy.

9. Community Acceptance:

U.S. EPA received five written/email comments, including comments from Schlumberger and GDOTS. Three of the comments received were supportive of U.S. EPA's preferred remedies. Of the remaining two, Schlumberger commented on U.S. EPA's preferred remedies. GDOTS expressed concerns regarding the preferred remedy's potential impact on GDOTS' operations and health and safety of its employees. The responsiveness summary included in this ROD Amendment addresses these comments.

Groundwater Plume beneath the Area 9 Repository (Plume 3)

1. Overall Protection of Human Health and the Environment:

Both Alternatives A and B include Phytoremediation and Institutional Controls to prohibit installation of potable water wells until groundwater is restored to drinking water standards. Both alternatives are protective of human health and the environment.

2. Compliance with ARARs:

The time frame to bring groundwater to drinking water standards is through natural attenuation process and would take longer than 100 years. Alternate Concentration limits have to be established for Alternative B. Compliance with the surface water quality standards will be enhanced by the phytoremediation that is included as a component of both alternatives.

3. Long-Term Effectiveness and permanence:

Alternatives A and B are both expected to supplement the existing effective natural attenuation processes by planting additional treatment of shallow groundwater in low lying areas at the Center and East Swales that receive the discharge of the merged groundwater plumes on the eastern side of the Repository. Both alternatives would provide the same degree of long-term

effectiveness and permanence through the natural attenuation process, phytoremediation, and institutional controls.

4. Reduction of toxicity, mobility, and volume through treatment:

Both alternatives would provide the same degree of reduction in the toxicity, mobility, and volume of the site contaminants by allowing natural processes to breakdown the contamination into harmless by products. The phytoremediation component of both these alternatives would provide further reduction in volume, mobility, and toxicity through phytoremediation of the VOCs by the trees and prairie grasses.

5. Short-Term Effectiveness:

Both alternatives present a very low short- or long-term risk to the community, workers, and the environment during implementation. The existing natural attenuation process is effectively controlling the VOC source area impacts. Therefore, the time required for the vegetation planted for phytoremediation to reach maturity will not impair the short-term effectiveness.

6. Implementability:

The Phytoremediation component of both Alternatives A and B is readily implementable.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 2.

Table 2
Summary of Estimated Costs for Each Alternative for Plume 3

	Total Capital Cost	Total Cost	Total Present Worth Cost
Alternative A	$199,400	$1,854,800	$1,322,400
Alternative B	$174,800	$1,708,300	$1,210,300

(Total present worth value is for a 30-year period and an annual discount rate of 3.2 %)

8. State Acceptance:

The Illinois EPA has provided support to U.S. EPA throughout the re-evaluation process. The Illinois EPA concurs with the selected remedy.

9. Community Acceptance:

U.S. EPA received five written/email comments, from both the public and potentially responsible parties at the Crab Orchard Site. The responsiveness summary included in this ROD Amendment addresses these comments.

XV. The Selected Remedy

Groundwater Plume near Building I-1-23 (Plume 1)

The Selected remedy for the Groundwater Plume near Building I-1-23 (Plume 1) is Alternative A2, which includes Excavation (within 1 mg/kg CVOC contour in the Upper Clay unit) and Off-site Disposal of CVOC-contaminated soil, Groundwater extraction and Treatment in the Sand unit beneath the Upper Clay, Phytoremediation, and Institutional Controls.

The selected remedy was preferred over other alternatives because it is expected to bring the groundwater to MCLs within a relatively shorter time frame of approximately 40 years with a short-term pump and treat duration of only 11 years. Based on the FFS Report, the total present worth cost of this alternative is $4,914,000. Although other alternatives cost less than the selected remedy, based on groundwater modeling results, the time frame for all other alternatives to bring the groundwater to the drinking water standards is longer than 100 years, unless these alternatives included a long-term pump and treatment technology.

Excavation and off-site disposal of VOC-contaminated material to the 1 mg/kg VOC contour in the Upper Clay unit would remove most of the NAPLs in the Upper Clay unit. After the excavation component of the remedy is complete, additional soil and groundwater samples at Plume 1 are collected to establish new baseline conditions at the site. The new data collected will be input into the groundwater model to arrive at a more refined timeframe for bringing groundwater to MCLs. An extraction well system will be designed and installed to remove dissolved VOC source mass from the Upper Sand unit. Groundwater extraction will continue for a period of approximately 11 years at which point all the NAPL mass is expected to be removed in the Upper Sand unit. It is expected that the rate of VOC mass removal closely matches the predictions made based on the results of the new groundwater modeling simulations. Five years after the extraction system is in place, U.S. EPA will evaluate the progress of VOC mass removal in the Upper Sand unit. If it is determined that it would take a significantly longer time frame than that predicted by the groundwater model to remove NAPL mass in the Upper Sand unit, U.S. EPA will reevaluate the cleanup action at this plume area and may stop further extraction of groundwater in the Upper Sand unit and consider issuing a technical impracticality waiver.

Phytoremediation component of this selected remedy includes the planting of phreatophytic trees, including poplar, willow, or Eastern Cottonwood trees near the lake for phytoremediation of the shallow groundwater. These trees uptake TCE and degrade it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Final selection of the species of trees to be used should be made during the remedial design phase. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake or other surface water locations by slowing down or reversing shallow groundwater flow toward the drainage swales and the lake, and by the uptake of dissolved CVOCs. Institutional Controls will prohibit the installation of potable water wells until the groundwater is restored to drinking water standards. Based on the FFS Report, the total present worth cost of the remedy is $4,914,000.

Groundwater Plume beneath the Area 9 Repository (Plume 3)

The Selected remedy for the Groundwater Plume beneath the Area 9 Repository (Plume 3) is Alternative A, which includes Phytoremediation, Monitored Natural Attenuation, and Institutional Controls.

Phytoremediation component of this selected remedy includes the planting of phreatophytic trees, including poplar, willow, or Eastern Cottonwood trees near the lake for phytoremediation of the shallow groundwater. These trees uptake TCE and degrade it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Final selection of the species of trees to be used should be made during the remedial design phase. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake or other surface water locations by slowing down or reversing shallow groundwater flow toward the drainage swales and the lake, and by the uptake of dissolved CVOCs. Institutional Controls prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

Based on existing data, the Area 9 Repository plume is being degraded by natural processes. Also, the Area 9 plume is not migrating very far downgradient of the source area. Concentrations of total VOCs in groundwater beneath the Repository (>35,000 μg/L) are being reduced to 10 to 30 μg/L within a distance of about 200 feet along the groundwater flow path. Therefore, the natural attenuation process together with phytoremediation and institutional controls will provide the necessary protection of human health and the environment with the assurance that ongoing monitoring can be used to evaluate the success of this alternative. There was no significant difference between Alternatives A and B. However, all of the components of Alternative A (phytoremediation, monitored natural attenuation, and institutional controls) were previously included in U.S. EPA's June 2000 ESD for the PCB OU. Therefore, U.S. EPA has selected Alternative A, which retained the remedial components previously chosen in the ESD. Based on the FFS Report, the total present worth cost of this alternative is $1,322,400.

Institutional Controls

Area 9 Landfill (Site 32) and the Area 9 Building Complex (Site 33) are located in an industrial area within the refuge. These areas are expected to remain as industrial areas in the foreseeable future. Groundwater at this site is State of Illinois Class I Potable Groundwater Resource and is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Quality Standards.

Currently, there is no risk to human health, because presently the groundwater is not being used for drinking water. Groundwater at the site is a potential future source of drinking water as designated by the State of Illinois Groundwater Classification. Institutional controls are necessary to prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

The Crab Orchard National Wildlife Refuge is owned by the U.S. Government and currently is administered by FWS. FWS is currently finalizing a Land Use Control (LUC) Plan which incorporates institutional controls required under the records of decisions signed for all operable units within the Crab Orchard Site. The FWS is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. DOI shall submit a LUC Plan, as a Primary Document under the FFA, to U.S. EPA for review and approval in accordance with the review and approval schedule in the FFA, that shall contain implementation and maintenance actions, including periodic inspections. FWS will incorporate the Institutional Controls (Figure 2) to prohibit the installation of potable water wells until groundwater is restored to drinking water standards into its LUC Plan.

XVI. Statutory Determinations

Under CERCLA §121and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a permanent element a bias against off-site disposal of untreated wastes. The following sections discuss how the revised remedies meet these statutory requirements.

A. Protection of Human Health and the Environment

The revised remedy for Plume 1 includes excavation of contaminated materials in the Upper Clay unit, groundwater extraction and treatment in the Upper Sand unit, Phytoremediation and Institutional Controls to prohibit installation of potable water wells at the site until groundwater is restored to the drinking waters standards will provide protection of human health and the environment. Groundwater at this site is classified as State of Illinois Class I Potable Groundwater Resource. Through excavation in the Upper Clay unit, most of the TCE contaminated material including most of NAPL mass is removed. Based on the groundwater model predictions, groundwater extraction and treatment in the Upper Sand unit will remove all of the NAPL mass in approximately 10 years. The remaining NAPL mass in the Upper Clay unit would be removed in 14 years. Groundwater would be restored to drinking water standards within a timeframe of approximately 40 years. In addition, this will also significantly reduce any potential long-term risk due to soil vapor intrusion of TCE and other VOCs to the occupants of nearby buildings.

The revised remedy for Plume 3 includes Monitored Natural Attenuation, Phytoremediation, and Institutional Controls to prohibit the installation of potable water wells until groundwater is restored to drinking water standards. The natural attenuation processes at this VOC source area, together with the additional treatment of shallow groundwater in low lying areas at the Center and East Swales through phytoremediation, and Institutional Controls will provide protection of human health and the environment.

There are no short-term threats associated with the revised remedies for Plumes 1 and 3 that cannot be readily controlled.

B. Compliance with ARARs

The selected remedies for groundwater remediation would meet the ARARs presented in the following sections through the removal/treatment of principal threat wastes at Plume 1 and through monitored natural attenuation at Plume 3. This ROD Amendment will not affect other ARARs selected in the 1990 ROD for the PCB Areas Operable Unit.

1. Chemical Specific ARARs

Safe Drinking Water Act: MCLs (40 CFR 141) are relevant an appropriate for site groundwater. The groundwater at these sites are not currently being used as a source of drinking water, but the aquifer at these sites could potentially be used as a drinking water source in the future.

40 CFR 122.41 and 122.44 - Clean Water Act: If ditch water from Sites 32/33 must be discharged to surface water body during site preparation, the discharge shall meet the effluent standards and prohibitions and water quality standards established under Sections 301, 302, 303, 307, 318, and 405 of the Clean Water Act.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.405, General Prohibitions Against Violations of the Groundwater Quality Standards – Exceedances of Illinois' Class I Groundwater Quality Standards are impetus for corrective action. Undertaking the recommended remedial alternatives in this ROD amendment will correct these violations.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.410 Illinois Class I Groundwater Standards - Since the Illinois Class I Groundwater Quality Standards for the contaminants of concern are the same as MCLs, Illinois groundwater standards would be met.

Illinois Groundwater Quality Standards: 35 IAC Part 620, Subpart D, Section 620.450, Alternative Groundwater Quality Standards apply to any chemical constituent within a Groundwater Management Zone. Following completion of corrective action the U.S. EPA may allow the responsible party to petition the State of Illinois to obtain alternate groundwater standards equal to the concentration of contaminants determined by groundwater monitoring. This is to be allowed only if such concentrations exceed the appropriate groundwater quality standards and to the extent practicable, the exceedances have been minimized and beneficial use has been returned.

General Use Water Quality Standards: 35 IAC Part 302, Subpart B, Section 302.208 – Numeric Standards for Chemical Constituents and Part 302.1210 – Other Toxic Substances. Surface water standards are applicable, if site-related chemicals impact surface water in area drainage swales or lakes.

2. Action Specific ARARs:

40 CFR 50.6 and 50.12 – Clean Air Act: During excavation and backfilling activities the National Ambient Air Quality Standards (NAAQS) for particulate matter shall not be exceeded.

40 CFR 262.34 and 264, Subparts B, C, I, J, and L – RCRA Subtitle C: - Excavated material which is RCRA hazardous will be handled and stored in accordance with the substantive technical standards applicable to generators of hazardous waste and for owners and operators of hazardous waste storage facilities.

40 CFR 264, Subpart G: – The excavation activities, when completed, shall meet the closure performance standards for clean closure.

40 CFR 264.114 RCRA Subtitle C: During remediation and closure all equipment, structures, and soils that are used on/with RCRA hazardous materials must be properly decontaminated or disposed of. Decontamination of equipment, structures, and soils that are used on/with RCRA hazardous materials must meet any more stringent regulatory decontamination or disposal standards of the State of Illinois (35 IAC Part 724).

40 CFR 264 Subpart F: Groundwater monitoring for the remediated sites shall be in accordance with the groundwater monitoring requirements of 40 CFR 264 Subpart F.

40 CFR 268: Excavated material which is RCRA hazardous will be handled and stored in accordance with the land disposal restrictions. The excavation and storage activities must also meet any more stringent State of Illinois equivalent provisions (35 IAC Part 724 requirements)

40 CFR 761.65 Toxic Substances Control Act: Excavated material which contains PCBs at concentrations of 50 parts per million will be handled and stored in accordance with the requirements of 40 CFR 761.65.

35 IAC Subtitle B Part 201: Air Pollution – Substantive permitting requirements under Parts 201.141, .143, .152-.165, .207-.210, .261-.265, .282-.283, .310-.312 for construction or modification of an emission source.

35 IAC Part 304, Subpart A, Parts 304.102 and 304.105 to 304.141: General Effluent Standards for discharges to waters of the state.

35 IAC Parts 305.102 to 305.103: Monitoring and Reporting for discharges to waters of the state.

35 IAC Part 306, Subpart A: Systems Reliability – Part 306.102

35 IAC Part 309, Subpart A: NPDES Permits - Substantive requirements pertinent to construction and operation of contaminated groundwater treatment or pretreatment works and to point source discharges to waters of the state.

35 IAC Part 620, Subpart D, Section 620.250: Establishing a GMZ, a three dimensional region containing groundwater managed to mitigate impairment caused by the release of contaminants at Sites 32/33, allows remediation to proceed without the State of Illinois taking enforcement action for the violation. Requires corrective action in a timely and appropriate manner approved by Illinois EPA.

35 IAC Part 722: Standards Applicable to Generators of Hazardous Waste – If solid waste (defined per 35 IAC Part 721.102) is generated, the generator must determine if that waste is a hazardous waste.

35 IAC Subtitle G, Parts 724 and 728: Waste Disposal - If hazardous waste is present on a site, pertinent requirements of hazardous waste treatment, storage, and disposal under 35 IAC Subtitle G (Waste Disposal) must be followed.

40 CFR 761.65: Clean Air Act – During excavation the national ambient air quality standards (NAAQS) for particulate matter shall not be exceeded.

35 IAC Part 808: Special Waste Classifications – Generators of a waste must classify the waste. A special waste (defined per Section 3.45 of Illinois Environmental Protection Act) determination is required under 35 IAC Part 808.12. Management of special waste must be in accordance with 35 IAC Subtitle G (Waste Disposal), including 35 IAC Part 809 (Special Waste Hauling) and 35 IAC Part 810 (Solid Waste Disposal).

29 CFR 1910.120 and 1926, Subparts C, D, E, and P: Occupational Safety and Health Act (OSHA) – During all remedial activities the requirements of OSHA for the training and safety of workers will be observed.

3. Location Specific ARARs

National Wildlife Refuge Administration Act (16 U.S.C. 668dd): This law is applicable to areas designated as part of the National Wildlife Refuge System. It requires that remedial action that takes place at Sites 32/33 be compatible with the established purposes of the Refuge.

Endangered Species Act – 16 USCA Sections 1531 to 1544: This law is applicable, if endangered species or critical habitat is present at Sites 32/33.

Archeological and Historic Preservation Act – 16 USCA Sect. 469: This law is applicable to any archeological or historical artifact uncovered during remedial activities.

Native American Graves Protection and Repatriation Act – PL 101-601: This law is applicable, if Native American or cultural items are found during remedial activities.

Migratory Bird Treaty Act of 1918 (16 USC 703-711)

Fish and Wildlife Coordination Act (16 USC 661-666)

C. Cost Effectiveness

In U.S. EPA's judgment, the revised remedy is cost-effective and meets all other requirements of CERCLA. Section 300.430(f)(1)(ii)(D) of the NCP requires U.S. EPA to evaluate the cost-effectiveness by comparing all of the alternatives which meet the threshold criteria (overall protection of human health and the environment and compliance with ARARs), against three additional balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall Effectiveness is then compared to cost to determine whether a remedy is cost effective. For Plume 1, the revised remedy was chosen over other alternatives, because groundwater would be restored to beneficial use within the shortest timeframe under this remedy. The estimated present worth cost for the revised remedies for Plumes 1 and 3 are $4,914,000 and $1,322,400, respectively. The selected remedy for Plume 1 would bring the groundwater to beneficial use within the shortest timeframe of approximately 40 years compared with all other alternatives which would take significantly longer timeframes.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the maximum extent practicable.

U.S. EPA has determined that the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be practicably utilized at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, U.S. EPA has determined that the revised remedies provide the best balance of trade-offs in terms of the nine criteria, while also considering the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and State and community acceptance.

The revised remedy for Plume 1 includes excavation, off-site disposal of VOC-contaminated soil in the Upper Clay unit and extraction and treatment of VOC-contaminated groundwater in the Sand unit below the Upper Clay. Based on modeling results, the revised remedy brings groundwater to beneficial use within the shortest timeframe of approximately 40 years when compared with other remedial alternatives.

The phytoremediation component of the revised remedies for Plumes 1 and 3 would also provide treatment by taking-up TCE and degrading it to several known metabolic products, including trichloroethanol, trichloroacetic acid, and dichloroacetic acid. Phytoremediation will reduce the volume of contaminated groundwater and the mass of CVOCs discharging to Crab Orchard Lake.

E. Preference for Treatment as a Principal Element

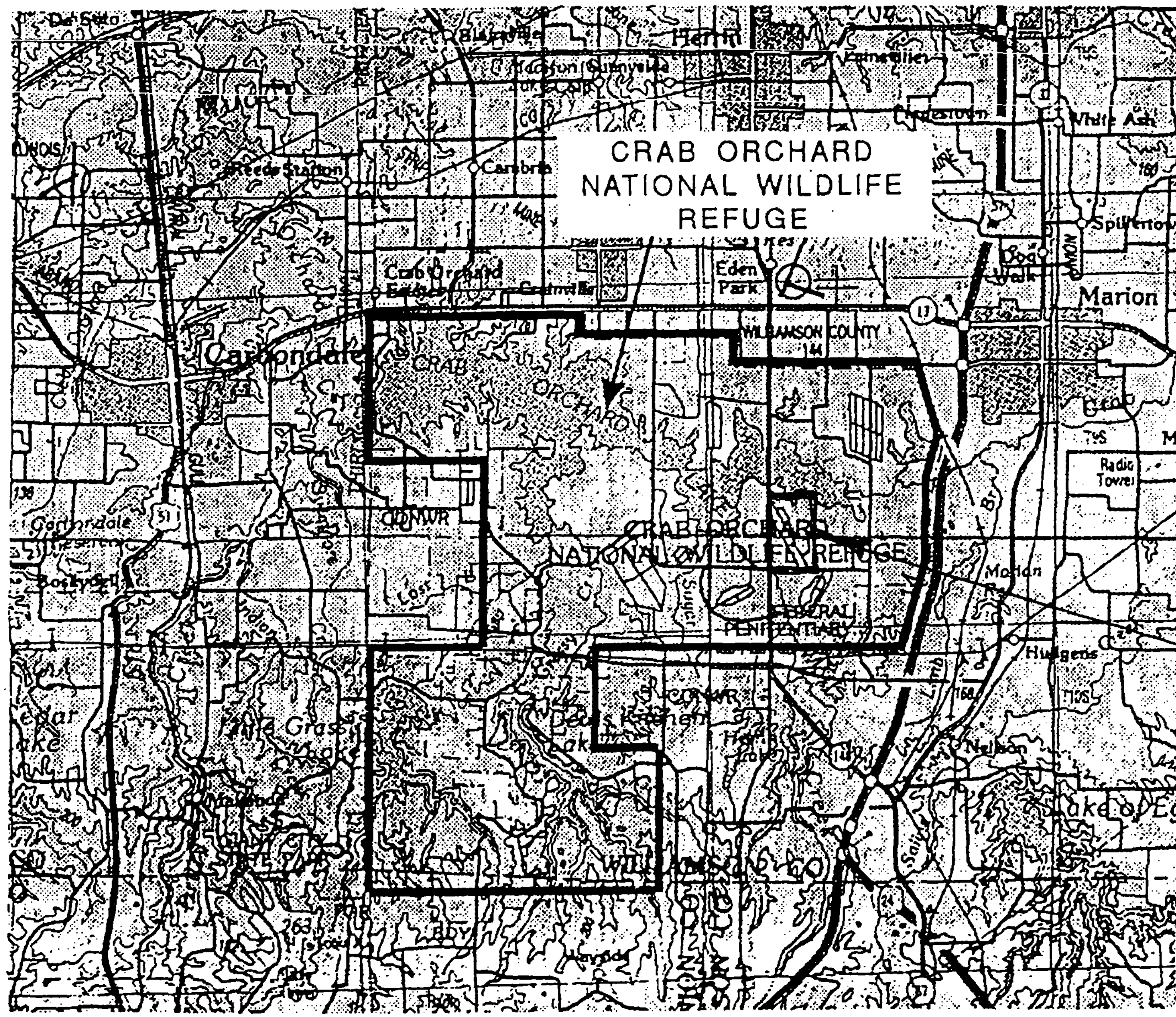
The revised remedy for Plume 1 treats the VOC-contaminated groundwater through extraction, treatment and discharge. By utilizing treatment, the statutory preference for remedies that employ treatment as a principal element is satisfied.

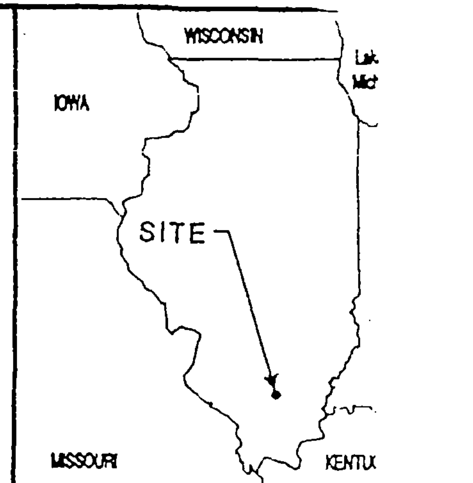
F. Five-Year Review Requirements

Because the remedies selected under this ROD Amendment and the August 1990 ROD for the PCB OU will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years of construction completion for the remedial action. The statutory review will be conducted to ensure that the remedies are, or will be, protective of human health and the environment.

XVII. Documentation of Changes from Proposed Plan

The Proposed Plan for the Amendment to the 1990 ROD for the PCB OU was released for public comment in April 2006. That Proposed Plan addressed Plume 1, Plume 2, and Plume 3. In response to a comments from U.S. Department of Interior, U.S. EPA decided to issue a separate ROD Amendment for Plume 2 to ensure that the Department of Interior's concerns were satisfied. U.S. EPA reviewed all comments submitted during the public comment period. U.S. EPA had determined that no significant changes to the remedies for Plume 1 and Plume 3, as originally identified in the Proposed Plan, were necessary or appropriate.





VICINITY MAP

SOURCE:
PADUCAH
1 X 2 QUADRANGLE
GEOLOGICAL SURVEY
1987

PCB OU

FIGURE 1

NOTE:
1. REFUGE BOUNDARY LOCATION APPROXIMATE.

SITE PLAN

3 0 3

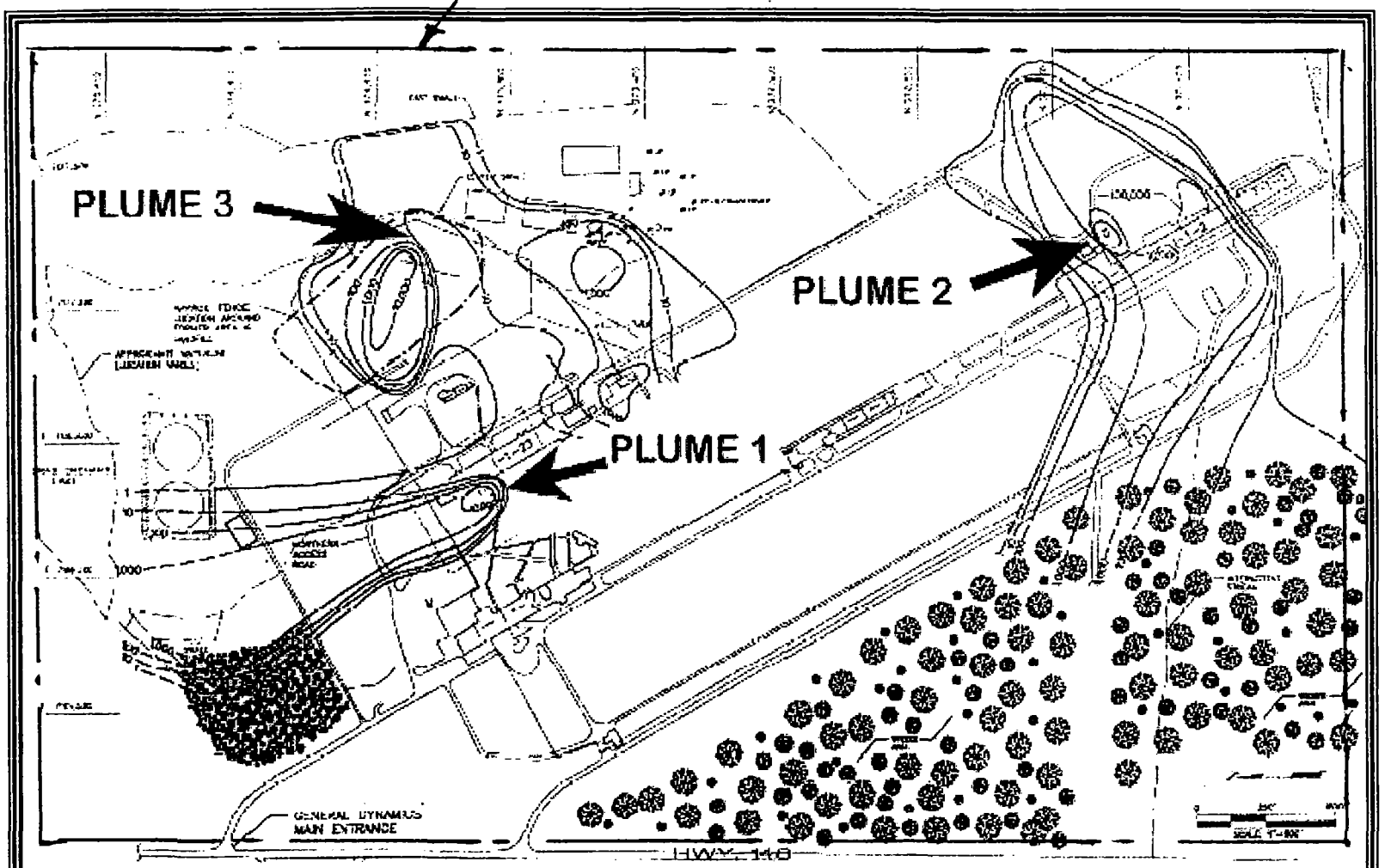
SCALE IN MILES

CLIENT/PROJECT		TITLE
W-C/CRAB ORCHARD RI/IL		REFUGE LOCATION MAP

DRAWN	CHECKED	REVIEWED	DATE	SCALE	FILE NAME	JOB NO.	DWG NO.	FIGURE
TPK	WGB	WGB	2-23-94	AS SHOWN	8168109	933-8168		~~1-1~~

Limits of Land Use Control

Prohibit Installation of Potable Water Wells
until groundwater is restored to drinking water standards.



Plume location at the Crab Orchard Wildlife Superfund Site

Figure 2

APPENDIX A

RESPONSIVENESS SUMMARY FOR THE AMENDMENT TO THE RECORD OF DECISION FOR THE PCB AREAS OPERABLE UNIT CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE

This Responsiveness Summary summarizes the public comments U.S. EPA received regarding the Proposed Plan for the Amendment to the Record of Decision (August 1990) and the Explanation of Significant Differences (ESD) dated June 23, 2000 and U.S. EPA's responses to those comments. The Proposed Plan was released to the public on April 5, 2006, and the public comment period ran from April 5, 2006 through May 19, 2006.

The United States Environmental Protection Agency (U.S. EPA) received a total of five (5) public comments during the public comment period. Copies of all the comments received are included in the Administrative Record for the Site. U.S. EPA carefully considered all comments prior to selecting the remedies documented in the ROD Amendment.

Three of the commenters expressed support for the remedies selected by U.S. EPA. The remaining two commenters including Schlumberger Limited (Schlumberger) and General Dynamics Ordnance and Tactical Systems (GDOTS) submitted letters with detailed comments on the preferred remedies identified in the Proposed Plan. These comments fell within several different categories: basis for asserting the potential future groundwater use for drinking water purposes, uncertainty in estimating timeframes for bringing groundwater to drinking water standards, use of Alternative concentration limits, technical impracticality waiver, use of innovative technologies, evaluation of remedial alternatives using the nine criteria set forth in the NCP, and safety issues in implementing the remedy for Plume 2. This Responsiveness Summary does not repeat verbatim each individual comment. Rather, the comments are summarized and grouped by the type of issue raised. Comments regarding Plume 2 are not discussed because although the Proposed Plan discussed Plume 2, this amendment will not select a remedy for Plume 2. A separate ROD amendment later will be issued for Plume 2.

Comments from GDOTS:

GDOTS expressed concerns regarding the preferred remedy's potential impacts on GDOTS business operations, the efficacy of shoring and side slope support for excavation and the possibility that unexploded ordnance may be present. GDOTS' concerns are summarized below.

Plume 1

- Physical disruption during excavation, earth vibration (during shoring/sheet pile installation, excavation/well and piping installation, and backfill compaction) including destinations of underground utilities;
- Potential future subsidence of backfill and as a result of "heaving" sand (where the Upper Sand is exposed) during excavation;
- Disruption to operations during construction and operation of the treatment building;

- Future subsidence due to settlement resulting from long-term dewatering; and
- Security issues pertaining to having non-GDOTS personnel in proximity to GDOTS' energetic operations (this is also an issue for the Plume 2 area)

In addition, GDOTS raised the following:

- As described above, the associated volume of removed soil as described in the FS confirms that the excavations will have vertical side slopes. Although much of these excavations will be in cohesive soils, the proposed depths will require shoring or sheet piles to prevent unstable side slopes. Additionally, much of the excavated areas include fill from the earlier PCB excavations, which will be unstable if steep slopes are proposed. Alternatively, the side slopes should be inclined at least 2:1, which would require expansion of the overall footprint; and,
- GDOTS also is concerned that DOD may not have yet investigated whether unexploded ordnance is present in the areas where excavation activities are going to occur. The history of the munitions manufacturing operations at these affected areas predates GDOTS use of this site.

GDOTS requested that U.S. EPA respond to each of these technical issues to mitigate safety concerns and to ensure that there is no interruption in GDOTS business operations at the site.

U.S. EPA's Response: Most of the conditions that underlie the concerns raised by GDOTS' issues also existed during Schlumberger Limited's (Schlumberger) excavation and construction work in 1996-1997 as part of the PCB OU cleanup activities. Throughout the nearly two-year effort, Schlumberger worked cooperatively with Olin Corporation/Primex Technologies, predecessors to GDOTS, to minimize disruptions to business operations and ensure plant security. During construction of the contaminated material storage buildings, incineration unit and the water treatment building, the high level of cooperation between Schlumberger and Olin Corporation/Primex Technologies prevented disruption to business operations. Schlumberger's contractors took appropriate engineering measures and were able to excavate to depths exceeding 18 feet without disrupting normal business operations. Schlumberger will prepare a remedial action implementation plan (RAIP) which will address in greater detail these engineering issues raised by GDOT. The RAIP will determine the appropriateness of providing shoring or sheet piles, the design of the side slopes for the excavation areas, as necessary, and will address any other issues raised by GDOTS regarding the implementation of the selected remedy. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup work.

Security Measures

Schlumberger and Olin Corporation/Primex Technologies also cooperated on security issues during the 1996-1997 PCB OU cleanup activities and again during the later groundwater investigation at the site to allow specified non-GDOTS personnel access to the potentially contaminated areas near Buildings I-1-23, I-1-2, I-1-3, and I-1-36. Since GDOTS took over the operations at the Crab Orchard Site, Schlumberger and its contractors collected air monitoring samples inside Buildings I-1-2 and I-1-3 which are currently being used by GDOTS for

warehousing raw materials and/or finished products. U.S. EPA, Illinois EPA, and FWS personnel have entered these buildings for inspection without encountering significant security issues. U.S. EPA appreciates the coordination extended to the agency staff and Schlumberger's contractor staff on numerous occasions.

U.S. EPA expects that a limited number of contractor personnel, vendors, and workers would be allowed access for performing the cleanup activities. The security screening of these non-GDOTS personnel will be resolved during the remedial design phase prior to the actual start of remedial action. These access issues and security issues are important yet manageable matters.

In addition, GDOTS itself is performing a Remedial Investigation at a number of sites/locations within many areas currently occupied by GDOTS. U.S. EPA believes that access and security issues for workers are similar to both activities.

Unexploded Ordnance

Throughout the potentially contaminated areas, Schlumberger's contractors have installed numerous monitoring wells and geoprobes without any major issues and did not encounter unexploded ordnance (UXO). Prior to start of the cleanup work, however, U.S. EPA will confirm with the Department of the Army (Army) that there are no unexploded ordnances at or near all areas needing remediation. If the Army indicates that there may be UXOs in any of the affected areas, U.S. EPA will require the Army to identify and remove the UXOs before the remedy is implemented. The necessity to demolish certain unused buildings on the eastern side of Building I-1-3 will be determined during the remedial design phase. If necessary, these buildings would be demolished as part of the remedial action.

As explained above, the RAIP will address the security issues raised by GDOTS. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup work.

Schlumberger and its consultants will determine the appropriateness of providing shoring or sheet piles, and design the side slopes for the excavation areas, as necessary, and will prepare a remedial action implementation plan (RAIP) which will address all issues relating to the cleanup activities, including issues raised by GDOTS. U.S. EPA will review and approve the RAIP to ensure that GDOTS' concerns are adequately addressed prior to the start of actual cleanup activities.

Comments from Schlumberger:

Schlumberger's Comment: The selected remedy must be based on site-specific conditions and risk and assertion that the groundwater will be used in the future for drinking water does not reflect site specific factors.

U.S. EPA's Response: U.S. EPA generally defers to State Groundwater Classifications for current or future groundwater uses. The contaminated aquifer at Sites 32/33 of the PCB OU,

however, has been classified by the State of Illinois as a Class I Potable Resource Groundwater in accordance with Illinois Administrative Code, Title 35, Part 620, Subpart B (Section 620.210). The definition of "resource groundwater" is found in the Illinois Groundwater Protection Act, "a resource groundwater means a groundwater that is presently being or in the future capable of being put to beneficial use" (415 Illinois Compiled Statutes (ILCS) 55/3(j)).

The Illinois Pollution Control Board (IPCB) states in its Final Opinion and Order on Section 620.210, "the Board believes that among the most necessary facets of the State's groundwater protection program is the need to protect all drinkable water at a drinkable level. Similarly, the Board does not believe that current actual use should be the sole control of whether potable groundwater is afforded the same protection necessary to maintain potability; we simply cannot allow the sullying of a resource that future generation may need." The IPCB's opinion comports well with the NCP's expectation to return usable groundwaters to their beneficial uses wherever practicable (40 CFR 300.430(a)(1)(iii)(F)). Accordingly, Illinois EPA and U. S. EPA affirm the need to protect the potential future beneficial use of the Sites 32/33 Class I Potable Resource Groundwater by virtue of the remedies contained in this ROD Amendment. Therefore, MCLs are relevant and appropriate for the groundwater remediation at the site.

Groundwater at this site is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Use of the groundwater at Sites 32/33 of the PCB OU as a drinking water resource is a reasonably anticipated future use and would pose unacceptable risk.

Schlumberger's Comment: The proposed plan presents an estimate of time that each alternative would take to remediate each source area as if that time were a specific value that is known with a high degree of accuracy.

Schlumberger contends that the time projections in the FFS - Rev. 3 were created through use of the groundwater model developed for the site. The modeling estimates include a large degree of uncertainty. As discussed in Section 7 of the FFS - Rev. 3, "...[s]imulations of the remedial alternatives for each CVOC source area and plume "should be considered as a 'semiquantitative' evaluation, and predicted concentrations should be considered in a relative, rather than an absolute, sense." The estimates of the length of time needed to remediate each area rely on estimates of the source mass (and particularly the mass of non-aqueous phase liquids, or "NAPL"), its form (residual coatings, blebs, ganglia, or pools), the location of the source (in permeable sands, low permeability clays, etc.), biodegradation rates, and groundwater flow rates. These parameters have substantial variability over a site such as the PCB Operable Unit, and are almost never known with a high degree of certainty.

Schlumberger contends that the time projections include too much uncertainty to support the conclusions in the Proposed Plan and there is a possibility that none of the alternatives would ever attain MCLs. Based on uncertain ability of the various alternatives to remove NAPL mass and reduce groundwater concentrations to specified level, Schlumberger contends that the differences among the remedial alternatives are likely minor, and the predicted shorter remediation period based on the projections in the FFS cannot justify a significantly greater remediation effort or cost. Schlumberger also commented that the bulk of the estimated time to

move from levels which would provide full protection of human health and the environment at this site (e.g., 30 to 40 ppb) to much lower levels (MCLs) that are not relevant and appropriate for this site.

U.S. EPA's Response: Generally at groundwater remediation sites, the timeframes to bring the groundwater to the desired cleanup levels are based on site-specific groundwater modeling results. These modeling results nearly always have some degree of uncertainty and are estimates only. U.S. EPA agrees that there are uncertainties in the groundwater modeling conducted by Schlumberger with regard to several factors including actual mass of NAPL residuals, the form of NAPL, and the achievable removal effectiveness of various remedial alternatives. The timeframes and predicted concentrations discussed in the ROD Amendment are based on modeling results and are considered in a relative, rather than an absolute sense.

It is possible that some or most of the NAPL may already have been removed. During the PCB remedial action in 1996, a large volume of PCB-contaminated soil within the TCE source area was remediated. Schlumberger did not adjust its model to reflect that possibility but made reasonable, yet conservative, assumptions in calibrating the transport model to represent the source areas. Appendix B of the Focused Feasibility Study (FFS) Report (Rev. 3) discusses the rationale for the assumptions made in the calibration of the groundwater model. Based on the iterative process of calibration of the model to measure concentrations in the plume, constant-concentration nodes were set at 20,000 μg/L TCE for the Upper Clay and Upper Sand units at the Building I-1-23 area and the Repository. For Buildings I-1-2/I-1-3 source areas, constant concentration nodes were set at 100,000 μg/L TCE in the Upper Clay, and 30,000 μg/L TCE in the Upper portion of the Lower Clay. Page B-5 (Appendix B) of the FFS Report states that these constant-concentration values were chosen based on the adjustments made during calibration to reproduce the observed concentrations in the aquifer, and do not take into account removal of source materials during the PCB remedial action in 1996. The report further states that the calibration of the transport model to measured values that exist in the aquifer is considered appropriate and representative of a system that is in quasi-equilibrium with the remaining source area TCE residuals. U.S. EPA believes that the FFS prepared by Schlumberger used reasonable, yet conservative assumptions in its input to the groundwater model.

As stated earlier, MCLs are relevant and appropriate for the groundwater remediation at the site. U.S. EPA disagrees with Schlumberger's contention that the differences among the remedial alternatives are likely minor and that the predicted shorter remediation period based on the projections in the FFS cannot be used to justify a significantly greater remediation effort or cost. Based on the modeling results, there are significant differences in timeframes between Alternative A2 (approximately 40 years) and all of the other alternatives (approximately 75 years for Alternative G and more than 200 years for all other alternatives) for Plume 1. In addition, as stated in Section 7.3.1 of the FFS Report, because of the broad effect of groundwater extraction, the effects of uncertainties (e.g., uncertainties in the modeling, in the effectiveness of groundwater extraction, and in the location and quantity of source material) on the projections of groundwater quality over time are expected to be relatively small compared to the effects of uncertainties on some other remedial alternatives. The effects of uncertainties associated with Alternative A2, which includes both excavation and groundwater extraction and treatment are

relatively small when compared with other alternatives which do not include groundwater extraction.

One of the remedial action objectives is to restore groundwater to drinking water standards to the extent practicable. Alternative A2 for Plume 1 is expected to meet this objective within an estimated timeframe of 40 years, respectively, when compared to most of the other alternatives which take more than 200 years to achieve the same objective.

Schlumberger's Comment: ACLs may be used if the conditions of CERCLA Section 121(d)(2)(B)(ii) are met and cleanup to MCLs or other protective levels is not practicable. If these statutory criteria for ACLs, including a finding that active restoration of the ground water to MCLs or non-zero MCLGs is deemed not to be practicable, documentation of these conditions for the ACL is sufficient and additional documentation of a waiver of the MCL or MCLG is not necessary.

U.S. EPA's Response: Although the alternatives that include ACLs are viable remedial alternatives, U.S. EPA chose Alternative A2 over alternatives that use ACLs, because modeling predicts that active restoration of the groundwater to MCLs is practicable. Under Alternative A2, excavation to 1 mg/kg VOC contour in the Upper Clay unit is expected to remove most of the VOCs, including NAPLs. Based on the model predictions, groundwater extraction and treatment in the upper sand unit would remove all of the NAPLs in approximately 10 years. Remaining NAPLs in the Upper Clay unit would be removed in approximately 14 years. Groundwater would be restored to MCLs in about 40 years.

U.S. EPA agrees with Schlumberger that ARAR waivers are not necessary where ACLs are used. The ROD Amendment corrects this inaccuracy.

Schlumberger's Comment: If MCLs continue to be used as ARARs, U.S. EPA should provide a technical impracticability waiver of the MCLs as authorized by the NCP and EPA guidance.

U.S. EPA's Response: U.S. EPA acknowledges that the presence of NAPLs in the source area presents significant limitations on the potential effectiveness of remedial alternatives and results in lengthy time periods required to achieve groundwater cleanup standards. Based on the groundwater modeling results, the time required to achieve groundwater cleanup standards for most of the alternatives (with the exception of Alternatives 2 and G for Plume 1) is more than 200 years. However, U.S. EPA believes that where the contaminated groundwater is not currently used or an alternate water source is readily available, <u>and</u> there is no near-term future need for the resource, it is appropriate to consider a longer time frame for achieving restoration cleanup levels. For the Crab Orchard Site, the timeframe of 40 years for Plumes 1 to restore the groundwater to beneficial use is considered reasonable. Technical Impracticality Waiver at this site is not currently being considered since restoration of the groundwater to MCLs is not impracticable.

Schlumberger's Comment: Schlumberger suggests that the ROD Amendment include a language that would allow further consideration of innovative technologies.

U.S. EPA's Response: U.S. EPA is receptive to viable innovative technologies as long as Schlumberger demonstrates that such new technologies are appropriate for this site. Additional language in the ROD Amendment is not necessary.

Schlumberger's Comment: For Plume 1, Schlumberger suggests the selection of either Alternative F or even Alternative A1 at a substantially lower cost and with correspondingly greater cost-effectiveness.

U.S. EPA's Response: Both Alternatives A1 and F involve the excavation of contaminated soil in the Upper Clay unit to only 10 mg/kg VOC contour. Although Alternatives A1 and F cost 21% and 40%, respectively, less than Alternative A2, these alternatives would leave a substantial mass of VOCs and NAPLs remaining in the Upper Clay resulting in this alternatives taking more than 250 years to restore the groundwater to MCLs which are relevant and appropriate requirements for this site. Alternative A2 would restore the groundwater to MCLs throughout the plume area within a timeframe of about 40 years. As stated earlier, the effects of uncertainties associated with Alternative A2 which includes both excavation and groundwater extraction and treatment are relatively small when compared with Alternative F. U.S. EPA is justified in selecting Alternative A2 over Alternatives A1 and F.

Schlumberger's Comment: Comments on Evaluation Criteria for Plume 1

U.S. EPA's Response: Schlumberger's comments are based on its assertion that there is no basis to bring groundwater to MCLs, uncertainties in the predicted concentrations and timeframes, and its assertion that ACLs, rather than MCLs are relevant and appropriate.

As stated earlier, MCLs are relevant and appropriate for the groundwater remediation at this site. For Alternative 2 that includes both excavation and groundwater extraction and treatment, the effects of uncertainties on the projections of groundwater quality are relatively small when compared with other alternatives which do not include groundwater extraction.

Schlumberger commented that some of the comparisons made in the Evaluation of Alternatives Section of the Proposed Plan are either incorrect or misleading in its opinion. In order to address their concerns, U.S. EPA has revised the section on the Evaluation of Alternatives. This is reflected in the Evaluation of Alternatives Section of the ROD Amendment.

Schlumberger's Comment: The Proposed Plan includes an element that nullifies even the purported benefits of Alternative A2. As noted above, under the Proposed Plan, U.S. EPA will re-evaluate in five years whether removal of the CVOC mass (particularly NAPL) from the Upper Sand zone will take significantly longer than 11 years. If it will, U.S. EPA may halt further groundwater extraction at the five-year point and issue a technical impracticability waiver. If this occurs, active remediation of the Upper Sand will cease as soon as the pump-and-treat system is shut off. Substantial amounts of CVOC source mass would remain in the Upper Sand, and TCE concentrations would persist, perhaps for many decades, throughout the plume at levels potentially several orders of magnitude greater than MCLs. Conversely, under Alternative F, the TCE concentrations in groundwater near the lake are predicted to approach the MCL after 30 to 40 years, with concentrations throughout the plume continuing to decrease gradually as the

CVOC source mass that may remain in the Upper Clay is depleted. Given the possibility (or even the likelihood) of a technical impracticability waiver after five years, Alternative A2 could leave the aquifer worse off than under Alternative F. The bio-substrate periodically injected into the Upper Sand up to a 5-year period under Alternative F would continue to provide active biological treatment of the remaining CVOC source mass long after the injections ceased.

U.S. EPA's Response: U.S. EPA will evaluate the progress of the remedy in achieving groundwater remediation five years after the start of the groundwater extraction and treatment. U.S. EPA's willingness to evaluate the progress does not automatically mean that a TI waiver is imminent. Depending on its evaluation, U.S. EPA may recommend additional enhancement to the chosen remedy or continuing the groundwater extraction process beyond the 11 years originally predicted by the model results or consider TI waiver, if appropriate. We disagree with Schlumberger's assertion that Alternative A2 could leave the aquifer worse off than under Alternative F. Because of the excavation (to 1 mg/kg VOC contour) component of the remedy for Alternative A2, almost all of the NAPL mass in the Upper Clay unit would be removed during the excavation phase in the Upper Clay unit and the remaining NAPL mass in the Upper Clay unit would be removed in approximately 14 years, whereas for Alternative F (excavation to 10 mg/kg only) the model predicts that it would take approximately 250 years to remove all of the NAPL mass from the Upper Clay unit. Please note that uncertainties associated with remedies that include groundwater extraction are relatively small compared with other alternatives such as Alternative F. Even if it took substantially longer timeframe than 14 years to remove the principal threat (NAPL mass in the Upper Clay Unit) and longer than 10 years to remove all of the NAPL in the Upper Sand unit, Alternative A2 is still the better remedial alternative than either Alternatives A1 or F.

Schlumberger's Comment: The Proposed Plan indicates on Page 20 that "Alternatives A1 and A2 provide the greatest likelihood that the mobility of the contaminants would be reduced because any groundwater contamination remaining after source removal would be captured by groundwater extraction wells." This statement is incorrect. The extraction well that would pump groundwater from the Upper Sand unit following the Upper Clay excavation would capture contaminants (VOCs) only within the hydraulic capture zone of the well. The extraction well would be located within the Building 1-1-23 source area. The VOCs in the groundwater plume outside of the capture zone would not be captured by the extraction system.

U.S. EPA's Response: Based on the Groundwater flow modeling, a single vertical extraction well screened in the confined Upper Sand unit at the location of the highest VOC concentrations in the source area would effectively cut off and remove dissolved VOCs migrating from the source area in groundwater. A single well is expected to establish a hydraulic capture zone of approximately 900 feet wide at the source area well location. The number and location of the extraction wells (if more than one well is needed) will be established during the remedial design phase to ensure that groundwater contamination remaining after source removal would be effectively captured.

Schlumberger's Comment: Alternative F would cost 40% less than Alternative A2, and Alternative A1 would cost 24% less than Alternative A2. Alternative A2 requires the excavation and offsite disposal of significantly more contaminated soil than Alternative F or Alternative Al, but does not provide any greater protection of human health and the environment at this site (i.e.,

any greater reduction of site-specific risks) than either Alternative F or Alternative Al. Because Alternatives F and A1 provide protection of health and the environment, achievement of ARARs, long-term effectiveness, short-term effectiveness, and implementability at substantially lower costs than Alternative A2, no basis exists under CERCLA or the NCP to require expenditure of the higher cost of Alternative A2, and selection of Alternative A2 would be arbitrary and capricious.

U.S. EPA's Response: As stated earlier, groundwater at this site is contaminated with TCE and other chlorinated solvents well above MCLs and Illinois Class I Groundwater Standards. Future use of the groundwater at Sites 32/33 of the PCB OU as a drinking water resource would pose unacceptable risk. Alternative A2 would bring the groundwater to MCLs within an estimated timeframe of 40 years, while Alternatives A1 and F would take longer than 250 years. Hence the higher cost for Alternative A2 is justified by the more reasonable remediation timeframe.

Schlumberger's Comment: On page 11, the Proposed Plan states: "Concentrations of VOCs on the order of 66,000 ppb extend in the groundwater plume from the Building 1-1-23 source area northward (downgradient) to Crab Orchard Lake." This statement is incorrect. VOC concentrations at the noted concentration range have only been detected in the immediate VOC source area. VOC concentrations observed in groundwater samples from monitoring wells outside the immediate source area are substantially lower than the indicated concentration range.

U.S. EPA's Response: The ROD Amendment addresses this concern by stating that concentrations of VOCs on the order of 3,000 ppb extend in the groundwater plume from Building I-1-23 source area northward to Crab Orchard Lake.

Schlumberger's Comment: The FWS has expressed a preference for Eastern Cottonwood as the tree species that best suits the requirements of the Refuge, rather than poplars. Final selection of the species of trees to be used should be made during the remedial design phase, rather than specified in a ROD Amendment.

U.S. EPA's Response: The ROD Amendment addresses this concern by including Eastern Cottonwood as one of the tree species under the Phytoremediation component of the remedy.

Schlumberger's Comment: The Proposed Plan presumes that a sufficient number of additional soil and groundwater samples can be collected (presumably from the Upper Sand unit) to allow use of the existing groundwater model to develop "a more accurate time frame" to reach MCLs at all locations. The key factors that will affect the actual time required to reach MCLs are the amount of VOC source mass that remains in the Upper Sand and the effectiveness of VOC source mass removal from the Upper Clay. As demonstrated by the results of the many soil and groundwater samples that have been collected in the Building 1-1-23 source area, the ability to develop an accurate estimate of the actual amount of VOC source mass remaining from such sampling is extremely difficult (if not impossible), given the physical conditions at this source area. It is unlikely that the additional sampling required by the Proposed Plan will allow the development of remediation time frame estimates that are any more accurate than the estimates already provided in the FFS - Rev. 3. The accuracy of the groundwater model in projecting the total time required to reach MCLs will still primarily depend on the accuracy of the estimate of

total VOC source mass remaining – and little, if any, improvement in the accuracy of that mass estimate is likely to be provided by the required additional soil and groundwater sampling. Therefore, there is no technical basis for requiring the additional burdens and costs of this future sampling.

U.S. EPA's Response: Following completion of the excavation component of the remedy, confirmative samples will be taken to verify that the cleanup criteria are met. In addition, groundwater samples are needed to establish baseline conditions prior to the start of any groundwater extraction and treatment. Collection of these samples is required as part of the remediation. If there are no significant differences between the new data collected and the previous data input into the groundwater model, no further modeling may be necessary. The data obtained from the future groundwater sampling will be used to ultimately determine the progress of the remedy.