



**Five-Year Review Report**

**for**

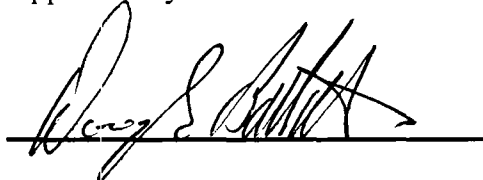
**Crab Orchard National Wildlife Refuge Superfund Site  
Marion, Illinois**

September 2006

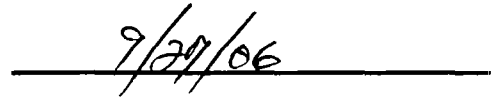
**PREPARED BY:**

**The United States Environmental Protection Agency, Region 5  
Chicago, Illinois**

Approved By:



Date:



*for*

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

# Five-Year Review Report

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## List of Acronyms

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
Army	Department of the Army
AUS OU	Additional and Uncharacterized Sites Operable Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CVOC	Chlorinated Volatile Organic Compound
DOD	Department of Defense
DOI	Department of the Interior
EMMA OU	Explosive/Munitions Manufacturing Areas Operable Unit
FFA	Federal Facility Agreement
FWS	United States Fish and Wildlife Service
LM OU	Lake Monitoring Operable Unit
MA OU	Metals Areas Operable Unit
MISCA OU	Miscellaneous Areas Operable Unit
MCLs	Maximum Contaminant Levels
MMRP	Military Munitions Response Program
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PCB	Polychlorinated biphenyl
PCB OU	PCB Areas Operable Unit
PRP	Potentially Responsible Party
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SVOC	Semi-Volatile Organic Compound
UAO	Unilateral Administrative Order
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WT OU	Towers Operable Unit

## **Executive Summary**

The five-year review of all seven operable units within the Sangamo Electric Dump/ Crab Orchard National Wildlife Refuge NPL Site (also known as Crab Orchard Site) in Carterville, Illinois was completed in August 2006. The site is expected to be protective of human health and the environment. For long-term protectiveness, effective ICs need to be implemented, maintained, and monitored. The following discusses the protectiveness statements for the remedial actions conducted at all seven operable units of the Crab Orchard Site:

MA OU: No lead, cadmium, or chromium-contaminated soil or sediments are present above cleanup levels at any of the remediated sites. The MA OU Landfill is effective in containing the waste and contaminants. The remedial actions at Sites 15, 22, and 29 are expected to be protective of human health and the environment.

PCB OU: No PCB, lead, or cadmium-contaminated soil or sediments above the cleanup levels are present at any of the remediated sites, with the possible exception of some hotspot areas within Sites 32/33 of the PCB OU. Both the Area 9 Repository and the PCB Landfill are effective in containing the waste and contaminants. The remedial action conducted to date and the recommended investigation/possible cleanup of PCB-contaminated soils, if any, in some potential hotspot areas at Sites 32/33 is expected to be protective of human health and the environment. The ROD Amendment to address groundwater contamination is expected to mitigate any potential long-term risk to the building occupants due to soil vapor intrusion of TCE and other chemicals of concern, in addition to bringing the groundwater to beneficial use. Thus the remedies in place and the future groundwater remedies are expected to be protective of human health and the environment.

EMMA OU: The remedial action conducted at the EMMA OU sites COC-3 and COP-4, and the removal action conducted to address unexploded ordnance at the EMMA OU sites, together with the land use controls in place are protective of human health and the environment.

WT OU: The removal actions conducted at three of the water tower areas and at the Visitors Center to remove 450 mg/kg of lead-contaminated are expected to be protective of human health and the environment.

MISCA OU: Site 14: The cleanup activities that are being implemented at Site 14 are expected to be complete in December of 2006. The remedy is expected to be protective of human health and the environment. Site 36: The cleanup activities completed at Site 36 are also expected to be protective of human health and the environment.

AUS OU: Currently, GDOTS is conducting a RI/FS at the AUS OU sites. The RI/FS is expected to be complete by 2010. Based on the recommendations made in the RI/FS report, U.S. EPA will select appropriate remedy, if necessary. Therefore, a protectiveness statement is not made for the AUS OU.

LM OU: Following transfer of portions of the LM OU Sites to AUS OU, no further action was necessary at the LM OU. There is no unacceptable risk to human health and the environment at the LM OU.

Institutional Controls: The FWS is currently implementing and enforcing ICs required under several RODs for the Crab Orchard Site. The protectiveness of the Crab Orchard Site requires implementation and compliance with land and groundwater use restrictions at the Site.

### Five-Year Review Summary Form

<b>SITE IDENTIFICATION</b>		
<b>Site Name:</b> Sangamo Electric Dump/Crab Orchard National Wildlife Refuge NPL Site		
<b>EPA ID:</b> IL8143609487		
<b>Region:</b> 5	<b>State:</b> Illinois	<b>City:</b> Carterville
<b>SITE STATUS</b>		
<b>NPL Status:</b> Final		
<b>Remedial Status:</b> Metals Areas Operable Unit: Complete PCB Areas Operable Unit: Under Construction Explosive/Munitions Manufacturing Areas Operable Unit: Complete Miscellaneous Areas Operable Unit – Site 14: Under Construction Miscellaneous Areas Operable Unit – Site 36: Under Construction Water Tower Areas Operable Unit: Complete Additional and Uncharacterized Sites Operable Unit: Remedial Investigation in progress Lake Monitoring Operable Unit: Complete		
<b>Multiple Operable Units?</b> Yes	<b>Total Number of Operable Units:</b> 7	
<b>Construction Completion date:</b> Metals Areas Operable Unit: 12-29-1998 Explosive/Munitions Manufacturing Areas Operable Unit: 09-27-2001 Water Towers Operable Unit: 08-31-1993 Lake Monitoring Operable Unit: October 9, 2001		
<b>Has site been put into reuse?</b> No		
<b>REVIEW STATUS</b>		
<b>Reviewing Agency:</b> U.S. EPA		
<b>Author name:</b> Nan Gowda		
<b>Author title:</b> Remedial Project Manager	<b>Author affiliation:</b> U.S. EPA	
<b>Review period:</b> January 18, 2006 through August 15, 2006		
<b>Dates of Site Inspection:</b> January 18-19, 2006; January 19, 2006; and February 22, 2006		
<b>Type of review:</b> Statutory		
<b>Review number:</b> 3 (Third)		

## Five-Year Review Summary Form

### Issues:

Based on samples collected by FWS, some hotspot areas with PCB levels above the cleanup criteria may exist within the areas of Sites 32/33.

The groundwater sampling results show that there is need for continued groundwater monitoring to delineate the plumes and determine if natural attenuation is occurring. The discovery of the mine so close to COC-3 and COC-4 is a reason for concern and further investigation at the EMMA OU.

The Draft Land Use Control (LUC) Plan which incorporates and implements the Institutional Controls (ICs) identified in the RODs for the Crab Orchard Site has not yet been finalized.

### Recommendations and Follow-up Actions:

At the PCB OU, U.S. EPA recommends that Schlumberger, as settling defendants, conduct additional investigation to verify the presence of PCBs in the potential hotspot areas identified by FWS, and to remediate such areas, as appropriate, to the cleanup levels specified in the ROD for the PCB OU.

At the EMMA OU, U.S. EPA recommends continued groundwater monitoring at Sites COC-3 and COP-4 to determine the extents of the plumes and whether natural attenuation is occurring.

At the EMMA OU, due to the discovery of the mine, U.S. EPA recommends that a new MMRP investigation, following the CERCLA process, be initiated.

At the Crab Orchard Site, U. S. EPA recommends that the FFA parties work with FWS to finalize the draft LUC Plan.

### Protectiveness Statement:

The site is expected to be protective of human health and the environment. For long-term protectiveness, effective ICs need to be implemented, maintained, and monitored. The following discusses the protectiveness statements for the remedial actions conducted at all seven operable units of the Crab Orchard Site.

MA OU: No lead, cadmium, or chromium-contaminated soil or sediments are present above cleanup levels at any of the remediated sites. The MA OU Landfill is effective in containing the waste and contaminants. The remedial actions at Sites 15, 22, and 29 are expected to be protective of human health and the environment.

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EMMA OU: The remedial action conducted at the EMMA OU sites COC-3 and COP-4, and the removal action conducted to address unexploded ordnance at the EMMA OU sites, together with the land use controls in place are protective of human health and the environment.

WT OU: The removal actions conducted at three of the water tower areas and at the Visitors Center to remove 450 mg/kg of lead-contaminated are expected to be protective of human health and the environment.

MISCA OU: Site 14: The cleanup activities that are being implemented at Site 14 are expected to be complete in December of 2006. The remedy is expected to be protective of human health and the environment. Site 36: The cleanup activities completed at Site 36 are also expected to be protective of human health and the environment.

AUS OU: Currently, GDOTS is conducting a RI/FS at the AUS OU sites. The RI/FS is expected to be complete by 2010. Based on the recommendations made in the RI/FS report, U.S. EPA will select appropriate remedy, if necessary. Therefore, a protectiveness statement is not made for the AUS OU.

LM OU: Following transfer of portions of the LM OU Sites to AUS OU, no further action was necessary at the LM OU. There is no unacceptable risk to human health and the environment at the LM OU.

Institutional Controls: The FWS is currently implementing and enforcing ICs required under several RODs for the Crab Orchard Site. The protectiveness of the Crab Orchard Site requires implementation and compliance with land and groundwater use restrictions at the site.

### Other Comments:

The Army has conducted a five year review of the EMMA OU of the Crab Orchard Site. U.S. EPA is incorporating the five year review conducted by the Army by reference



# **Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois**

## **First Five-Year Review Report**

### **I. Introduction**

EPA Region 5 has conducted a five-year review of the remedial actions implemented at the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge NPL Site (also known as Crab Orchard Site) in Carterville, Illinois. This review was conducted from January 18, 2006 through August 15, 2006. This report documents the results of the review. The purpose of the five-year review is to determine whether the remedies implemented at the site are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify deficiencies found during the review, if any, and identify recommendations to address them.

This review is required by statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121(c), as amended, states:

*If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.*

The NCP part 300.430 (f) (ii) of the Code of Federal Regulations (CFR) states:

*If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

In September 27, 2000, U.S. EPA completed a five-year review of the PCB Areas Operable Unit of the Crab Orchard Site. In September 27, 2001, U.S. EPA completed a five-year review of the Metals Areas Operable Unit of the Crab Orchard Site. This is the first five-year review to include all operable units at the Crab Orchard Site. The Army has conducted the five-year review of the EMMA OU at the Crab Orchard Site. This document incorporates the five-year review conducted by the Army by reference. The triggering action for this statutory review is September 27, 2001, the date upon which the last five-year review was completed. A review is required as contaminants remain at the site above health based levels.

## II Site Chronology

Table 1 lists chronology of events for the Crab Orchard site.

**Table 1 Chronology of Events**

Date	Event
1984	Site proposed for NPL
2/86	U.S. EPA and FWS entered a Federal Facility Initial Compliance Agreement for the performance of an RI/FS
5/86	RI/FS began at the Refuge
7/87	Site NPL designation finalized
8/88	RI/FS complete
3/30/90	ROD issued for Metals Areas OU
8/01/90	ROD issued for PCB OU
5/13/91	Consent Decree signed for PCB OU
9/13/91	Federal Facilities Agreement signature
2/19/97	ROD issued for EMMA OU
1/11/00	ESD for the EMMA OU
6/23/00	ESD for the PCB OU
9/27/00	First Five-Year Review completed for the PCB OU
9/27/01	First Five-Year Review completed for the Metals Areas OU
10/30/01	ROD issued for Miscellaneous Areas OU – Site 14
9/12/02	ROD issued for Miscellaneous Areas OU – Site 36

## III Background

The Crab Orchard National Wildlife Refuge (Refuge) lies near Marion, Carterville and Carbondale, Illinois, primarily within Williamson County, extending into Jackson and Union Counties in southern Illinois. The general location of the Refuge is shown in Figure 1. The Refuge consists of approximately 43,500 acres of multiple-use land. Since 1947, the U.S. Fish and Wildlife Service (FWS) has operated the Refuge under the authority of the U.S. Department of the Interior (DOI). The land is used as a wildlife refuge, and also for recreational, agriculture and industrial purposes. The western end of the Refuge around Crab Orchard Lake is used for recreational purposes while the eastern end is used for manufacturing facilities. Access to the eastern portion is closed to the public, except for limited access to workers at the industrial sites and restricted access to hunters. The study sites which were the focus of the Remedial Investigation (RI) and Feasibility Study (FS) are located in the eastern, closed portion of Refuge. There are twelve lakes, including Crab Orchard Lake located within the Refuge. Although currently not used as such, the 7,000 acre Crab Orchard Lake is a potential drinking water supply source and supports a large population of sport fish. Wetlands are found in some areas adjacent to the lakes. Wildlife on the Refuge includes many game and non-game species. The Refuge has habitat suitable for one endangered species: the Indiana bat.

In the early 1940's, the War Department, the predecessor to the Department of Defense (DOD), used the area at the east end of Crab Orchard Lake, for the manufacturing of bombs, land mines, and explosives. Manufacturing stopped at the end of World War II. The War Assets Department transferred administration of the area to DOI in 1947, with the exception of the ammonia nitrate plant (which was transferred to DOI in 1951) for use as a National Wildlife Refuge. The enacting legislation, which created the Refuge, required DOI to continue leasing former wartime industry buildings to industrial tenants. The industrial manufacturing operations, which continue to the present, included at various times ammunition and explosives, metal fabrication, plating, and manufacturing of printing inks, fiberglass boats, and electrical components. Over the years these tenants have disposed of their waste at several areas within the Refuge.

Tests performed in the eastern portions of the Refuge during the late 1970s and early 1980s indicated that contaminants such as PCBs, lead, and cadmium were present. Based on these findings and the potential threat of these contaminants to human health and the environment, U.S. EPA placed the Crab Orchard Site on the National Priorities List (NPL) in July 1987.

On February 26, 1986, the FWS and U.S. EPA entered into a Federal Facility Initial Compliance Agreement, which required the performance of a Remedial Investigation/Feasibility Study (RI/FS). FWS and Sangamo Weston, Inc, which was one of the former industrial tenants at the Refuge, entered into a Cooperative Agreement to conduct the RI/FS at the Refuge. FWS and Sangamo Weston began the RI/FS of the Refuge in 1986 and completed it in August 1988. The RI Report investigated thirty-three study sites at the Refuge, including two background sites. Based on the results of the RI Report, U.S. EPA, in consultation with DOI and Illinois EPA, made available to the public the draft-final FS Report and two Proposed Plans for remedial action. The first Proposed Plan was for three study sites contaminated primarily with metals. These are designated as the Metals Areas Operable Unit (MA OU). The second Proposed Plan addressed four study sites that were primarily contaminated with PCBs, lead, and cadmium. These are designated as the PCB Areas Operable Unit (PCB OU).

Pursuant to Section 120 (e) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), U.S. EPA, Department of the Army (Army), Illinois EPA, and DOI signed a Federal Facility Agreement (FFA) on September 13, 1991. Because the study sites differ in terms of contamination problems, types of remedies and schedules that may be appropriate, or potentially responsible parties (PRPs), and because site problems are spatially distinct, FFA partners created two additional OUs. These are the Explosive/Munitions Manufacturing Areas Operable Unit (EMMA OU) and the Miscellaneous Areas Operable Unit (MISCA OU). EMMA OU included those areas physically associated with former Department of the Army explosive/munitions manufacturing and disposal sites at the Crab Orchard Cemetery and Crab Orchard Plant areas within the Refuge. MISCA OU included those study sites that were proposed in the August 1998 RI Report as needing further investigation. DOI created a

**Water Towers Areas Operable Unit (WT OU) to remove lead-contaminated soil in the vicinity of three existing water towers and two previous Water Tower areas within the Refuge.**

**In 1997, DOI created two more OUs, the Additional and Uncharacterized Sites Operable Unit (AUS OU) and the Lake Monitoring Operable Unit (LM OU). The purpose of the AUS OU is to investigate any remaining uncharacterized areas within the Refuge that were previously not investigated in the 1988 RI Report and other OU studies. The AUS OU includes 83 sites consolidated into 39 study areas suspected to have contamination due to past disposal practices by several industrial tenants. The purpose of the LM OU is to verify and take appropriate action, if the Crab Orchard Lake is affected by the past waste disposal activities at the Refuge.**

**DOI is the lead agency for the MA OU, MISCA OU, PCB OU, WT OU, AUS OU, and the LM OU. Army is the lead agency for the EMMA OU. Schlumberger Limited (Schlumberger), as a Settling Defendant, signed a Consent Decree (CD) with U.S. EPA and DOI. Under the terms of the CD, Schlumberger agreed to perform the cleanup set out in the Record of Decision (ROD) for the PCB OU. U.S. EPA is the lead agency for the implementation of the remedial action required under the PCB OU ROD and enforcement of the terms of the CD.**

**The WT OU, MA OU, and the EMMA OU were completed in 1993, 1998, and 2001, respectively. The remaining four Operable Units are in various stages of site investigation and/or construction completion.**

**MA OU: The MA OU includes the following three study sites investigated in the 1988 RI Report:**

- Plating Pond Area (also known as Site 15)**
- Fire Station Landfill (also known as Site 29)**
- Old Refuge Shop Area (also known as Site 22)**

**Figure 2 shows the locations of the above sites.**

**Site 15 - Plating Pond: Although the 1988 RI confirmed the presence plating waste in the pond, the RI did not establish the source of the waste. It was probably constructed and used for a few years during the 1970s, to accept liquid waste from a manufacturing operation in Area 7. The pond is approximately 50 feet long and 30 feet wide. Water depth was estimated at 4 feet at the time of the RI, resulting in approximately 45,000 gallons of water in the pond. Sediment sampling from the Plating Pond indicated the presence of chromium, with other organic and inorganic contaminants of less concern found in the sediments, pond water and groundwater. The RI estimated 280 cubic yards of contaminated pond sediment and underlying soil.**

**Site 29 - Fire Station Landfill: The Fire Station Landfill was a dump used by industrial tenants during the 1960s and probably also during the 1950s. It was located on the east side of Route 148, across from the Shop Area, near the former Refuge Fire Station. The Fire Station**

Landfill was L-shaped, with leg dimensions of about 300 feet in the east-west direction and 150 feet in the north-south direction. The width of the legs was estimated at 75 feet, and the thickness of fill was estimated to range from about 2 to 7 feet. The RI (1988) estimated 14,600 cubic yards of contaminated soil. Results of the 1988 RI indicated that the area was contaminated with lead (960 to 2,355 mg/kg), mercury (0.023 to 0.29 mg/kg), and zinc (23 to 929 mg/kg) above background. Results of the groundwater investigation indicated the presence of iron (388 to 4,000 µg/L), manganese (43 to 1,790 µg/L), and selenium (not-detect to 41µg/L total). The dissolved levels of selenium were, however, below its MCL (50µg/L). The primary contaminant of concern was lead.

Site 22 - Old Refuge Shop: The Old Refuge Shop Channel was contaminated with wastes from a plating operation in the former shop area. The channel was contaminated with cadmium, chromium, lead and cyanide from the shop area to Pigeon Creek, a distance of about 4,450 feet. The RI (1988) estimated 5,200 cubic yards of contaminated soil and sediment. Sediments in the drainage channel flowing toward Pigeon Creek were contaminated with cadmium (less than 0.68 mg/kg to 780 mg/kg), chromium (10 to 889 mg/kg), cyanide (130 to 392 mg/kg), and lead (93 to 166 mg/kg). In general, the levels were highest near the drainage sump at the upstream end of the site and decreased downstream. Groundwater in one well showed cadmium (25 µg/L) above its MCL of 5 µg/L.

Additional investigation conducted during remediation indicated the presence of contamination in many of the ditches and the connecting network of an underground storm drain system upgradient of the channel in an area known as the West Shop Area. The boundaries of the Old Refuge Shop Area were extended during remediation to address this upgradient source. This extended portion was named "West Shop Area". Results of the investigation indicated that the sediments in the inlet structures of the storm sewers were contaminated with cadmium (7.8 to 1300 mg/kg) and that the surficial soil in the drainage ditches were contaminated with cadmium levels ranging from 1.5 to 618 mg/kg.

PCB OU: The PCB OU includes the following four study sites that were investigated in the 1988 RI Report:

- Job Corps landfill area (also known as Site 17)
- Water Towers landfill area (also known as Site 28)
- Area 9 landfill (also known as Site 32)
- Area 9 Building Complex (also known as Site 33)

Figure 3 shows the location of the above study sites.

Site 17 - Job Corps Landfill: This landfill was comprised of an inactive abandoned, one-acre landfill originally sited and operated by FWS. The landfill was used by the Refuge tenants to dispose of industrial as well as domestic/household waste and refuse. FWS later constructed an impoundment as a Job Corps project by damming a ravine running near the site at the landfill,

creating a pond. The landfill was used as a dumping area in the 1950s, but was abandoned by 1960. After the significance of the proximity of the pond to the landfill became clear, the pond was largely eliminated by breaching the dam. However, the breach was incomplete, and the size of the pond varied with the seasons, up to 2 acres in size. Results of the RI indicated that the soil and sediments were contaminated with levels of PCBs ranging from 0.8 to 50,000 mg/kg, lead (from 6 to 17,414 mg/kg), and cadmium (from 1 to 57 mg/kg).

**Site 28 - Water Tower landfill:** This landfill is located north of the water tower approximately 1.5 miles east of the intersection of Highway 148 and Ogden Road and 0.1 miles north of Ogden Road. The landfill was abandoned before 1971 after approximately 30 years of intermittent use. The site appears to be diamond shaped, and slopes gradually to the northeast toward a wooded area. The results of the RI indicated that the soil was contaminated with PCBs (from less than 0.01 to 8,900 mg/kg) and lead (from 13 to 4,300 mg/kg).

**Sites 32/33 - Area 9 Landfill and Area 9 Building Complex:** The Area 9 Building Complex and the landfill are two adjacent areas whose extents of contamination overlap each other. These areas are considered to be one contiguous site. The landfill area is an inactive landfill that was reportedly used during the 1950s and early 1960s for the disposal of capacitor manufacturing wastes and other wastes. The Area 9 Building Complex was formerly used by the War Department primarily for explosives and munitions manufacturing during World War II. After the war, the facilities that had been administered by the War Department were then leased to private industries. In 1947, the property was turned over to DOI for administration. From 1946 to 1962, some of this area was utilized by Sangamo Weston, Inc. (Sangamo) to manufacture power factor capacitors, AC motor run capacitors, and a variety of DC capacitors. The results of the RI indicated that the soil was contaminated with lead (from 11 to 20,500 mg/kg) and PCBs (from less than 0.5 to 88,000 mg/kg). Soil in the Building Complex area was contaminated with PCBs (from less than 1 to 120,000 mg/kg). Some of the soil samples in both the landfill and building complex areas also contained chlorinated dibenzo-p-dioxin and dibenzo furan (D/F) isomers (varying from 0/14 to 249 parts per billion).

U.S. EPA signed the ROD for the PCB OU at the Crab Orchard Site on August 1, 1990. The four study sites totaled approximately fifty acres. Cleanup activities for PCBs, lead, and cadmium-contaminated soil meeting the requirements of the ROD were completed in July 1997. Approximately 117,000 tons of PCB-contaminated soils were incinerated. Incinerator ash containing hazardous levels of lead and cadmium were stabilized and disposed of in an on-site engineered landfill. Further investigation at the site indicated the presence of elevated levels of chlorinated solvents including trichloroethylene in groundwater at the site. On June 23, 2001, U.S. EPA issued an Explanation of Significant Differences (ESD) to the PCB OU ROD to address the groundwater contamination at the site. The ESD selected multi-phase extraction of chlorinated solvents, with limited phytoremediation and monitored natural attenuation as the remedial technology. The remedy selected in the ESD was based on the assumption that the hydro-geological strata were similar in all of the source areas requiring remediation.

Schlumberger conducted a Pre-Design investigation to further characterize the source areas at the PCB OU. The investigation concluded that the hydro-geological strata near the Building I-1-23 contaminant source 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. U.S. EPA is currently in the process of issuing an amendment to the ROD and ESD for the PCB OU.

EMMA OU: The Army has conducted the five-year review of the EMMA OU sites within the Crab Orchard Site. This document incorporates the Five-year Review Report for the EMMA OU by reference.

MISCA OU:

Site 14 is an approximately 3.5-acre site located in the northern part of Area 8. Soil and groundwater are contaminated primarily with benzene, toluene, ethylbenzene, xylene, and methylene chloride. The groundwater contamination exceeds MCLs for these constituents.

Site 36 was the site of the Refuge Wastewater Treatment Plant and is located north of Crab Orchard Lake and west of Route 148. The site covers about 47 acres; the facility occupied about one-third of the site. Site 36 included the wastewater treatment structures, the former sludge drying beds, two unused ponds, two sewage lagoons that were in use, the surrounding grounds, and ditches leading away from the site. The site is primarily grass-covered with some wooded areas. The site's primary contaminants were PCBs, cadmium, and chromium.

Remaining MISCA OU sites: In addition to Sites 14 and 36, the MISCA OU consists of eighteen sites (Sites 7, 7A, 8, 9, 10, 11A, 12, 16, 20, 21, 22A, 24, 25, 26, 27, 30, 31, and 35). Sites 13 and 18 which were originally listed under this OU are now included under AUS OU. Another MISCA OU site (Site 34) was investigated as part of LM OU. Figure 4 shows the general locations of the MISCA OU sites and summarized below:

Site 7, the D Area Southeast Drainage Channel, is in industrial area referred to as the D Area. The channel discharges into Crab Orchard Lake.

Site 7A, the D Area North Lawn, is in the same industrial area as Site 7. Barrels of chemicals were reportedly dumped at this site.

Site 8, the D Area Southwest Drainage Channel, is a segment of a perennial stream in the same industrial area as Sites 7 and 7A.

**Site 9, the P Area Northwest Drainage, is a segment of a perennial stream channel near an industrial area referred to as the P Area.**

**Site 10, the Waterworks North Drainage, is in the same stream as Site 9, only further downstream. It is upstream of the former Refuge Waterworks.**

**Site 11, the P Area Southeast Drainage, is a segment of a perennial stream channel near an industrial area.**

**Site 11A, P Area North, is within the industrial area known as the P Area. This site is near an abandoned L-shaped covered walkway, a loading dock, and a steamhouse with a concrete pit.**

**Site 12, the Area 8 Impoundment, is located within a dry, circular impoundment, in a former industrial area referred to as Area 8.**

**Site 16, the Area 7 Industrial Park, includes portions of a building complex designated on the Refuge as Area 7 and portions of the drainageway that flows northward through the center of Area 7.**

**Site 20, the D Area South Drainage Channel, is a segment of a drainageway in an industrial area referred to as the D Area.**

**Site 21, the Southeast Corner Field, was identified as a possible former dumping area.**

**Site 22A, the Former Post Treating Facility, was part of the maintenance yard in Area 4 and may have been a former wood-treating facility.**

**Site 24, the Pepsi Plant West Drainage Ditch, is located near a Pepsi-Cola Bottling Company building.**

**Site 25, Crab Orchard Creek at the Marion Landfill, is located near the former Marion municipal landfill.**

**Site 26, Crab Orchard Creek below the Marion Sewage Treatment Plant, is downstream of Site 25. The Marion Sewage Treatment Plant discharges to Crab Orchard Creek.**

**Site 27, the Crab Orchard Creek Dredge Area, is a segment of Crab Orchard Creek, in an area dredged a number of years ago. It is also located downstream of the Marion Sewage Treatment Plant.**



Site 30, the Munitions Control Site, is in a low-lying area surrounding bunkers that have been used for munitions storage. This site was used as a control (background) site for the 1988 Refuge-wide RI, referred to in this document as the 1988 RI.

Site 31, the Refuge Control Site, is on the north side of the Refuge, near the current Refuge Maintenance Shop. This site was also used as a control (background) site for the 1988 RI.

Site 35, the Area 9 Waterway, is located in a depression in an agricultural field east of Area 9. The lack of vegetation in the depression, observed during the 1988 RI, suggested possible contamination.

Water Towers OU: The interiors and exteriors of the three of the water towers within in the Crab Orchard Site were sandblasted and repainted on numerous occasions during the 1980s and as recently as 1991. Sandblasting sand, paint chips, and paint debris generated from sandblasting, cleaning procedures and repainting activities were not collected and were allowed to accumulate on the surrounding ground. Later investigations discovered that previously used paint was lead based, and the surficial debris and surrounding soils were found to contain elevated lead concentrations.

In addition, during the course of scheduled renovations in 1993 and construction at the proposed Visitors Center (former Refuge fire station) of the Crab Orchard National Wildlife Refuge, FWS discovered that the exterior of the main building had been painted in the past using a paint with high lead content. Further investigation revealed that the wood siding and surrounding soil at the Visitors Center of the Crab Orchard National Wildlife Refuge were contaminated with lead.

AUS OU: In September 2001, DOI issued a draft final Preliminary Assessment/Site Inspection report for the AUS OU, in which 31 sites were proposed for remedial investigation. The 31 sites are located throughout the current and former industrial areas on the Refuge, as well as in locations not within defined industrial areas. The two major groups of AUS OU sites where hazardous substance releases are located are in Area 2 and Area 11/12.

The Area 2 sites encompass approximately 550 acres of currently active industrial operations. The Area 11/12 sites encompass approximately 300 acres of former industrial facilities. AUS OU sites in Areas 4, 6, 7, 8, 9, 10, and 13 encompass approximately 1500 acres, including active and inactive industrial manufacturing, storage and waste disposal areas. As documented in the PA/SI report, the principal contaminants at the AUS OU sites include trichloroethylene ("TCE"), tetrachloroethylene ("PCE"), semi-volatile organic compounds ("SVOCs"), polyaromatic hydrocarbons (PAHs), explosive related compounds, pesticides, and metals.

LM OU: DOI completed a Preliminary Screening Analysis (PSA) Report for the Lake Monitoring OU on October 9, 2001. Based on the conclusions of this report, DOI transferred

portions of the LM OU requiring further remedial investigation to the AUS OU. No further action is necessary at the LM OU.

#### **IV Remedial Actions**

##### **1. Metals Areas OU (OU1)**

##### **A. Remedy Selection (OU1)**

The U.S. EPA signed the ROD for the MA OU at the Crab Orchard Site on March 30, 1990. The selected remedy included:

- Excavation of contaminated soil and sediments;
- Treatment by stabilization/fixation of all excavated soil and sediment contaminated with metals (if determined to be RCRA hazardous because of the metals leachability) to render them non-hazardous;
- On-site disposal of non-RCRA hazardous stabilized/fixated 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; and
- Environmental monitoring during and after remedial construction to ensure the effectiveness of the remedial action.

In addition, the ROD required the four sites to be remediated to the following cleanup levels:

- Lead to 450 mg/kg dry soil at the Fire Station Landfill
- Cadmium to 10 mg/kg dry soil at the Old Refuge Shop
- Chromium to background levels at the Plating Pond; (background levels for chromium established at 30.7 mg/kg)
- Old Refuge Shop: Risk from all of the chemical contaminants present above naturally occurring background levels 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.
- Discharge standards for the pond water (Plating Pond) and for water from the drainage stream (Old Refuge Shop Area) will be established to comply with the effluent standards and water quality standards of the Clean Water Act and State requirements.
- Old Refuge Shop and Fire Station Landfill: Groundwater shall be monitored during and after remediation of the sites. The monitoring results shall be evaluated to assure that after completion of the remediation of the contaminated soils and sediments, the risk from all of the contaminants in the groundwater above naturally occurring background levels shall not exceed an excess cancer risk of one in one million ( $10^{-6}$ ) and shall not exceed any non-cancer chronic health effects.

## B. Remedy Implementation (OU1)

The remedial design process for the MA OU was started in October 1990 and completed in March 1993 by FWS. As part of the remedial design and during remedial implementation activities, several site investigations and studies were conducted. These investigations included the following:

- Quantification Investigation to delineate extent, quantify the volumes of material requiring excavation, and to determine background concentrations of metals in the soils at the Refuge.
- Treatability Study to identify appropriate treatment processes to render the hazardous waste materials non-hazardous by Toxicity Characteristic Leaching Procedure.
- Disposal Site Investigation to obtain the data necessary for the design of the landfill and groundwater monitoring system.
- Groundwater Impact Assessment to confirm that the landfill would not have an adverse impact on groundwater.
- West Shop Area investigation to determine the extent of contamination in the storm sewers, drainage, and a suspected source beyond and upstream of the boundaries of the Old Refuge Shop Channel.

The USACE, on behalf of DOI, awarded the contract to Heritage Remediation (Heritage) for implementation of the remedial action at the Metals Areas Operable Unit. Heritage began the construction activities on May 12, 1994 and completed the construction of the on-site landfill disposal cell in August 1994. In accordance with the design, on-site clay soil was used for the three-foot thick clay liner. The leachate collection system, composite liner, and layer of select fill material were constructed. During the remedial investigation activities of the Miscellaneous Areas OU in early 1994, dioxin and pentachlorophenol-contaminated soil was detected within the Old Refuge Shop site. Heritage refused to work with dioxin-contaminated soil at the Old Refuge Shop area. Their contract was subsequently terminated in August 1994. No waste material was placed in the cell at that time. The landfill cell was seeded to help prevent erosion, and left till the following year. In February 1995, USACE awarded the remaining portion of the work to a new contractor, R&R International. R&R International began the construction activities in August 1995 and completed in September 1996.

The following summarizes the sediment and soil excavation activities:

Plating Pond: In February and March of 1996, approximately, 194 cubic yards of chromium-contaminated soil were excavated from the Plating Pond area and disposed of in the on-site landfill. Confirmatory samples were taken to ensure that cleanup levels were met. The excavated area was restored to a pond. Grading and seeding were completed in August 1996.

Fire Station Landfill: Excavation commenced in November 1995 and was completed in March 1996. Approximately, 552 cubic yards of lead contaminated material (determined to be

RCRA hazardous because of metals leachability) was excavated, stabilized to render it non-hazardous, and disposed of in the on-site landfill. Approximately, 9310 cubic yards of excavated untreated (non-hazardous) material was also disposed of in the on-site landfill. Confirmatory samples were taken to ensure that cleanup levels were met. The excavated area was backfilled with clean soil. Grading and seeding were completed in July 1996.

**Old Refuge Shop:** Excavation commenced in August 1995 and was completed in December 1995. The contaminants of concern included cadmium, chromium, lead, and cyanide. Approximately, 10,635 cubic yards of contaminated material (determined to be RCRA hazardous because of metals leachability) was excavated, stabilized to render it non-hazardous, and disposed of in the on-site landfill. Approximately, 11,980 cubic yards of excavated untreated (non-hazardous) material was also disposed of in the on-site landfill. Confirmatory samples were taken to ensure that cleanup levels were met. The excavated areas were backfilled with clean soil. Grading and seeding were completed in July 1996.

**West Shop Area:** Prior to remediating the soil and sediments at the West Shop Area, the storm water system was cleaned by vacuum methods and flushed. Subsequently, this system was sealed closed. Excavation commenced in January 1996 and was completed in March 1996. The contaminants of concern included cadmium, chromium, lead, and cyanide. Approximately 1,621 cubic yards of contaminated material (determined to be RCRA hazardous because of metals leachability) was excavated, stabilized to render it non-hazardous, and disposed of in the on-site landfill. Approximately, 2,067 cubic yards of untreated (non-hazardous) material was disposed of in the on-site landfill. Confirmatory samples were taken to ensure that cleanup levels were met. Excavated areas were backfilled with clean soil. Grading and seeding were completed in June 1996.

The ROD required the disposal of nonhazardous stabilized/fixated material and untreated residues exceeding the cleanup targets in an on-site landfill meeting the requirements of RCRA Subtitle D and 35 Illinois Administrative Code Part 807. The on-site landfill was constructed in the Northwest corner of the intersection of Ogden and Fishpond Roads. At the time of the ROD signature, March 30, 1990, the Illinois solid waste landfill requirements were codified as 35 IAC 807. Subsequently, Illinois State promulgated new landfill requirements (i.e., 35 IAC 810 through 815). FWS complied with substantive requirements of this newly promulgated requirement by conducting a Groundwater Impact Assessment of the Metals Areas Landfill. The landfill construction commenced in May 1994 and was completed in September 1996. The total volume of treated and untreated (non-hazardous) material from the three study sites (i.e., Plating Pond Area, Fire Station Landfill, and the Old Refuge Shop Area) was approximately 36,359 cubic yards.

In addition, DOI conducted a removal action at Site 22A, which was part of the Miscellaneous Areas Operable Unit. Under this removal action, approximately 6,400 cubic yards of dioxin/furan and pentachlorophenol-contaminated soil was excavated from Site 22A and disposed of in the Metals Areas Landfill.

## **C. System Operations/Operation and Maintenance (OU1)**

### **Remediated Study Sites**

FWS has been conducting periodic inspections of the remediated sites to verify the condition of vegetation and identify erosion damage to the remediated sites. In 1998, FWS took corrective action to repair gullies, place protective erosion matting, and install water flow checks at the eastern part of the Old Refuge Shop Channel.

FWS conducted groundwater monitoring at both the Fire Station Landfill and the Old Refuge Shop areas during the time frame of 1996 - 1998. The monitoring results were evaluated to assure that after completion of the remediation of the contaminated soils and sediments, the risk from all of the contaminants in the groundwater above naturally occurring background levels do not exceed an excess cancer risk of one in one million ( $10^{-6}$ ) and do not exceed any non-cancer chronic health effects. The last groundwater sampling effort occurred in April 2006 in preparation for this five-year review.

### **Metals Areas Landfill**

FWS is implementing long term O&M activities to ensure that the components of the remedy which require maintenance for proper functioning are maintained for the protection of human health and the environment. Maintenance of the integrity of the remedy is implemented primarily through the quarterly and annual inspections of the landfill, and implementation of required maintenance identified during inspections. O&M requirements include:

- **Landfill Cover:** Quarterly visual inspection and minor repairs as necessary of the landfill cover.
- **Earthwork:** Quarterly inspection for surface diversions upgradient of the landfill.
- **Mowing:** Twice yearly mowing of the landfill and surrounding areas.
- **Erosion Damage:** Quarterly visual inspections for erosion damage to the landfill and repairs as necessary.
- **Animal Barrier:** Quarterly inspections to verify that no borrowing or digging has occurred into the top of the landfill.
- **Settlement/Subsidence:** Quarterly visual inspection of the entire landfill and perimeter for excessive settlement.
- **Quarterly inspection of the vegetation within the landfill limits; repairs, as necessary, including removal of deep rooted or woody vegetation, and revegetation of any bare areas.**
- **Drainage Ditch/Outlets Repair:** Quarterly inspection of the landfill drainage ditches.
- **Site Fencing:** Quarterly inspection to ensure that the fencing has not been damaged.
- **Leachate Collection Piping:** Cleaning of the leachate collection piping on an annual basis.

## **2. PCB Areas OU (OU2)**

### **A. Remedy Selection (OU2)**

The U.S. EPA signed the ROD for the PCB OU at the Crab Orchard Site on August 1, 1990. The selected remedy included:

- Excavation of contaminated soil and sediments;
- Treatment of all excavated soil and sediments contaminated with PCBs in excess of established remediation goals using mobile incineration technology; or using in situ vitrification (ISV) technology, if a demonstration is made that ISV can meet or exceed the performance standards established for incineration technology.
- Stabilization/fixation of residues from incineration and non-incinerated soil and sediment contaminated with metals (if determined to be RCRA hazardous because of the metals leachability) to render them nonhazardous;
- On-site disposal of nonhazardous 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;
- 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
- Environmental monitoring and maintenance during and after remedial construction to ensure the effectiveness of the remedial action.

In addition, 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.
- 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 and shall not exceed concentrations determined to produce any non-cancer chronic health effects.
- In addition to being treated to levels protective of wildlife and of human health by direct contact, the PCB- and lead-contaminated soils and sediments shall be treated to a level that is protective of the groundwater. The soil remediation goal shall be established at levels that will not allow leaching to the groundwater and create groundwater contamination in exceedance of the groundwater remediation goals.

### Groundwater Remediation Goals

- Monitoring of the groundwater at each of the remediated sites during and after construction of the remedial action.
- Evaluate the monitoring results to assure that after completion of the remediation of the contaminated soils and sediments, 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 study sites, exceeds a  $10^{-6}$  cumulative life-time cancer risk, or 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 Remediation Goals

- The surface water of the Job Corps Pond shall be monitored during and after construction of the remedial action, if appropriate. (i.e., if the pond continued to exist after remediation). Any surface water (if the pond continued to exist after remediation) at this site will be monitored and the results will be evaluated to assure that after completion of the remedial action of 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 must not exceed an excess cancer risk of one in one million ( $10^{-6}$ ) and must not exceed any non-cancer chronic health effects. In addition, after the remedial action is complete, the water in the Job Corps pond (if the pond continued to exist after remediation) must show no degradation and must meet all chemical-specific ARARs established for the site.
- The surface water at Area 9 will also be monitored during and after construction of the remedial action. The results will be evaluated to assure 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 an excess cancer risk of one in one million ( $10^{-6}$ ) and shall not exceed any non-cancer chronic health effects. In addition, after construction, of the remedial action, the water in the Area 9 Embayment of Crab Orchard Lake must show no degradation and must meet all chemical-specific ARARs for this site.

Schlumberger chose to use the mobile incineration technology instead of the ISV technology for treating the PCB-contaminated soil and sediments at the PCB OU.

### Other Cleanup Criteria

The Scope of Work (SOW) for the PCB OU allowed that if the excavation is more than two feet deep and above the water table, untreated soils and sediments containing less than 25 mg/kg PCBs, which otherwise meet the cleanup standards, may be consolidated as backfill in the excavated areas if those materials will be covered with at least 12 inches of clean soil. Also, the SOW allowed incinerated soil and sediments to be used as backfill provided they meet all of the cleanup standards. During the remedial activities, FWS requested that such untreated soil and sediments be consolidated and backfilled in one area near the Area 9 landfill rather than leaving them in the various excavation trenches at the four study sites. Schlumberger, at the request of FWS, excavated all untreated material (i.e., soil with PCBs from 1.0 mg/kg to 25 mg/kg) from the four study sites of the PCB OU. The excavated material was later consolidated and backfilled in the Area 9 Repository, the location of which was approved by FWS.

The SOW required that the PCB-contaminated material be treated in an on-site mobile incinerator to obtain 99.9999% destruction removal efficiency of the PCBs and other organic co-contaminants, to obtain 99.9% combustion efficiency, and to allow no more than 1 mg/kg PCBs in the ash.

### **B. Remedy Implementation (OU2)**

The remedial design process for the PCB OU was started in May 14, 1991 and completed by Schlumberger on September 26, 1995. Prior to the remedial design, several site/laboratory investigations were conducted. These investigations included the following:

- Site investigation which delineated the full lateral and vertical extent of contamination at the Job Corps Landfill, Water Tower Landfill, Area 9 Landfill and Building Complex areas.
- Treatability study which confirmed the use of mobile incineration as a viable technology in meeting the established performance standards.
- Treatability study which confirmed the use of stabilization technology as a viable technology in stabilizing the metals-contaminated material at the site.
- Landfill Siting Assessment which led to locating the PCB landfill site adjacent to the Metals Areas landfill site.
- Building I-1-23 Investigation which led to the demolition of the Building I-1-23 Annex and decontamination of the Building I-1-23.
- Supplemental Investigation which determined the levels of all other contaminants which could still remain at the site after remediation. The results of this investigation were used by Schlumberger in completing a Baseline Final Effective Risk Assessment which met the established soil and groundwater remediation goals.

Based on the Pre-Design Contamination Delineation Report, Schlumberger classified the material to be excavated in each of the study sites into the following four different categories



Category 1 material (soil and sediments) was classified as containing PCBs  $\leq 25$  mg/kg, lead  $\leq 450$  mg/kg, and cadmium  $\leq 10$  mg/kg. This category material was used as backfill material in the Area 9 Repository.

Category 2 material (soil and sediments) was classified as containing PCBs  $> 25$  mg/kg, lead  $\leq 450$  mg/kg, and cadmium  $\leq 10$  mg/kg. This category material was treated in an on-site mobile thermal treatment unit (TTU).

Category 3 material (soil and sediments) was classified as containing PCBs  $> 25$  mg/kg, lead  $> 450$  mg/kg, and cadmium  $> 10$  mg/kg.

Category 4 material (soil and sediments) was classified as containing PCBs  $\leq 25$  mg/kg, lead  $> 450$  mg/kg, and cadmium  $> 10$  mg/kg. During remediation activities, both categories 3 and 4 were combined and treated in a TTU. The incinerated ash was stabilized, as necessary to render them non-hazardous. This treated material was disposed of in an on-site landfill.

Job Corps Landfill Area: Excavation commenced in April 1996 and was completed in August 1996. Excavated material consisted of approximately 6,275 cubic yards of Category 1, 1,980 cubic yards of Category 2, and 2,600 cubic yards of Category 3 material.

Water Tower Landfill: Excavation commenced in March 1996; and was completed in April 1996. Excavated material consisted of approximately 512 cubic yards of category 1 and 471 cubic yards of Category 3 material.

Area 9 Landfill and Building Complex: Excavation commenced in December 1995 and was completed in June 1997. Areas of excavation consisted of West and East Drainage swale area, Area 9 Landfill, Industrial Building Complex, and the Lake Embayment Area. Excavated material in all except the Lake Embayment area consisted of approximately 51,505 cubic yards of category 1, 55,546 cubic yards of category 2, and 4,624 cubic yards of categories 3 and 4 materials. The excavated material in the Lake Embayment Area consisted of approximately 53,918 cubic yards of category 1 material.

Excavated Category 1 soils and sediments were taken to the Area 9 Repository for consolidation in one location. Excavated Category 2, 3, and 4 materials were transported to the TTU Feed Storage Building and later thermally treated.

Building I-1-23: An additional investigation was conducted to complete the characterization of the extent of PCB contamination within Building I-1-23 and the annex building attached to it. This investigation and the subsequent clean up action (demolition of Building I-1-23 Annex and decontamination of Building I-1-23) were not required by the ROD. The demolished material including Annex ceiling and appurtenances, masonry walls, floors, and foundation were disposed of in the Area 9 Repository as category 1 material.

**Underground Storage Tanks (USTs) Removal:** Excavation and removal of four underground storage tanks located immediately north of the Building I-1-23 was performed in August 1996. Contaminants of concern for these UST removals were Benzene, Toluene, Ethylbenzene, Xylene, lead, and carcinogenic and non-carcinogenic poly nuclear aromatics. Excavation of contaminated soil continued until contaminant levels in soil were below the remediation goals established by Illinois Administration Code 731. After removal, the USTs were cleaned and transported for recycling at Gary's Metal in Carbondale, Illinois. Contaminated soil was disposed of at the Evotech-Illinois Litchfield-Hillsboro Landfill. Approximately 4,800 gallons of diesel contaminated water were disposed of at the St. Louis Municipal wastewater treatment plant. Approximately 100 gallons of diesel tank bottom sludge and less than 50 gallons of gasoline tank bottom sludge were disposed of at Northstar Environmental in Tennessee. After the soil sample analytical results indicated that all of the contaminated material had been removed from each excavation, Schlumberger submitted a Corrective Action Completion Report to Illinois EPA. The Illinois EPA reviewed the Corrective Action Completion Report and in its February 17, 1999 letter granted a no further remediation determination to the U.S. Fish and Wildlife Service.

The ROD required all soil and sediment contaminated with PCBs greater than 25 mg/kg be thermally treated in an on-site mobile TTU. Mobilization of the TTU started in October 1995. A Mini-burn test was conducted in June 1996 and a Trial Burn Test was conducted in September 1996. Purpose of the Trial Burn Test was to demonstrate that the TTU would achieve the 99.9999% Destruction Reduction Efficiency as required under the Toxic Substances Control Act (TSCA). Based on the results of the Trial Burn Test, U.S. EPA issued Final Operating Parameters for operating the TTU in December of 1996. Under these operating conditions, thermal treatment of PCB-contaminated material was completed in June 1997. A total of 117,145 tons of PCB-contaminated material was thermally treated.

Thermally treated materials (soil and sediments) were tested for PCBs, lead and cadmium. All of the thermally treated materials met the cleanup criteria for PCB (< 1 mg/kg). Thermally treated (category 2) materials which met the cleanup criteria for PCBs (< 1 mg/kg), lead (< 450 mg/kg), and cadmium (< 10 mg/kg) were disposed of in the Area 9 Repository as backfill material. Thermally treated (category 3 and 4) materials were sent through the stabilization process before being tested for TCLP lead and TCLP cadmium to verify that the material was rendered non-hazardous. All non-hazardous thermally treated category 3 and 4 materials were disposed of in the on-site landfill.

The SOW required that all untreated soil or sediment and any incinerator ash found to be RCRA characteristic be remediated using stabilization/fixation technologies in order to render it non-hazardous. A total of 7,786 cubic yards of thermally treated category 3 and 4 material were stabilized using a pug mill in accordance with the Solidification/Stabilization Plan for all areas in the PCB OU (Revision 1) September 1996.

The ROD required the disposal of nonhazardous treated material and untreated residues exceeding the cleanup targets in an on-site landfill meeting the requirements of RCRA Subtitle D and 35 Illinois Administrative Code Part 807. The landfill was constructed adjacent to the Metals Areas Operable Unit landfill in the Northwest corner of the intersection of Ogden and Fishpond roads. At the time of the ROD signature, August 1, 1990, the Illinois solid waste landfill requirements were codified as 35 IAC 807. Subsequently, Illinois State promulgated new landfill requirements (i.e., 35 IAC 810 through 815). Schlumberger decided to comply with the new IAC standards to the extent practicable. Schlumberger conducted a Hydrogeologic Impact Assessment for the PCB Area Landfill. This assessment was later accepted by Illinois EPA and conveyed to U.S. EPA in its May 12, 1995 letter. The landfill construction began on October 3, 1995 and was completed on July 23, 1996. All of the thermally treated category 3 and 4 materials were landfilled. The closure activities for the landfill commenced on June 23, 1997 and completed on July 25, 1997.

Prior to backfilling with clean soil, confirmatory samples were taken at all the excavated areas to ensure that the revised cleanup objectives (PCBs < 1 mg/kg; lead <450 mg/kg; cadmium <10 mg/kg) were met. Confirmative samples of the thermally treated material were also taken to ensure that the cleanup objectives (PCBs < 1 mg/kg) were met.

On June 23, 2000, U.S. EPA issued an Explanation of Significant Differences (ESD) to address groundwater contamination at Sites 32/33 of the PCB OU. The ESD selected multi-phase extraction of chlorinated solvent contaminated groundwater, with limited phytoremediation and monitored natural attenuation, as the appropriate remedial technology to address the groundwater contamination. As stated earlier, because of the difficulties in achieving the remedial action objectives using multiphase extraction technology, U.S. EPA is in the process of issuing a ROD Amendment. This ROD Amendment to the PCB OU is expected to be issued in December 2006.

### **C. System Operations/Operation and Maintenance (OU2)**

#### **Remediated Sites**

Groundwater: As part of an approved Final Operations and Maintenance (O&M) Plan for the PCB OU (September 1995 - Revision 2), Schlumberger is conducting short-term groundwater monitoring at the remediated study sites on a bi-annual basis. The purpose is to ensure the effectiveness of the remedial action by establishing that the source removal from the contaminated study sites has been sufficient to halt any contribution to groundwater contamination and stabilize or abate, if necessary, existing conditions. If, at any time following completion of the remedy, groundwater at any of the remediated study sites exceeds any of the remediation goals identified in the ROD, U.S. EPA would determine additional remedial measures as necessary.

**Surface Water:** There is no flowing or permanent body of water at either the Water Tower Landfill Site or the Job Corps Landfill site. The Job Corps Pond was demolished as part of the remediation. Therefore, no surface water monitoring is necessary at these two study sites. Surface water monitoring on a bi-annual basis is required at the remaining two remediated study sites (Area 9 Building Complex/Landfill). The purpose is to ensure that the excavation of soil and sediment from the contaminated study sites does not adversely impact surface water, and to measure the effectiveness of the remedial action. The SOW stated that if, after completion of the excavation and backfilling of the contaminated study sites, surface water exceeds any of the surface water remediation goals, or ARARs due to transport of contaminants from the study sites, the need for additional remedial work shall be evaluated. Because U.S. EPA is currently in the process of issuing an amendment to the ROD for the PCB OU to address groundwater contamination, no surface water monitoring is presently being conducted by Schlumberger. Surface monitoring, however, will resume during the groundwater remedy implementation phase.

### **PCB Areas Landfill**

Schlumberger, in coordination with FWS, is also maintaining the PCB OU landfill cover, monitoring the collection and removal of leachate from the landfill, and conducting groundwater monitoring of upgradient and downgradient wells pertaining to the PCB OU Landfill.

The O&M requirements include:

- **Landfill Cover:** Monthly visual inspection and minor repairs as necessary of the landfill cover.
- **Earthwork:** Monthly inspection for surface diversions upgradient of the landfill.
- **Mowing:** Twice yearly mowing of the landfill and surrounding areas.
- **Erosion Damage:** Monthly visual inspections for erosion damage to the landfill and repairs as necessary.
- **Animal Barrier:** Quarterly inspections to verify that no borrowing or digging has occurred into the top of the landfill.
- **Settlement/Subsidence:** Monthly visual inspection of the entire landfill and perimeter for excessive settlement.
- **Quarterly inspection of the vegetation within the landfill limits; repairs, as necessary, including removal of deep rooted or woody vegetation, and revegetation of any bare areas.**
- **Drainage Ditch/Outlets Repair:** Quarterly inspection of the landfill drainage ditches and the perimeter system pipe outlets.
- **Site Fencing:** Quarterly inspection to ensure that the fencing has not been damaged.
- **Leachate Collection Piping:** Cleaning of the leachate collection piping on an annual basis.

### 3. EMMA OU (OU3)

The Army has conducted the five-year review of the EMMA OU sites within the Crab Orchard Site. This document incorporates the Five-year Review Report for the EMMA OU by reference.

### 4. MISCA OU (OU4)

#### A. Remedy Selection (OU4)

##### Site 14

The U.S. EPA and DOI signed a ROD for Site 14 of the MISCA OU on October 30, 2001. The major components of the selected remedy included the excavation, removal, and off-site disposal of soil contaminated with Benzene, Ethylbenzene, Toluene, Xylene, Methylene Chloride, Lead, and Chromium. The ROD also specified Institutional Controls (ICs) to prohibit installation of potable water wells until groundwater is restored to MCLs. ROD also included the groundwater at Site 14 until groundwater is restored to MCLs. The ROD also specified ICs to be implemented for worker protection, if a risk assessment to be conducted following remediation indicated unacceptable risk to site workers or construction workers at the site. The following table shows the cleanup levels for the contaminants of concern:

Cleanup Levels for Site 14		
Contaminant	Soil Cleanup level (mg/kg)	MCLs/State of Illinois Class I Groundwater Standards (mg/L)
Benzene	0.09	0.005
Ethylbenzene	100	0.7
Toluene	11*	1
Xylene	292*	10
Methylene Chloride	4.4*	0.005
Chromium	52	N/A
Lead	400	N/A

\* This indicates that the cleanup level is considered interim

Under the terms of a Unilateral Administrative Order (UAO) issued by U.S. EPA on August 30, 2001, Illinois Tool Works, Inc. (ITW), successor to Diagraph Corporation, is conducting cleanup activities at Site 14 of the MISCA OU. The ITW decided to cleanup the soil contamination to levels based on U.S. EPA's generic soil screening guidance (OSWER 9355.4-24 March 2001). These cleanup levels for ethylbenzene (13 mg/kg), benzene (0.03 mg/kg), methylene chloride (0.03 mg/kg), and xylene (190 mg/kg) are more conservative than the levels required under the ROD. The cleanup activities, which include the excavation, removal, and off-site disposal of volatile organic compounds (VOCs), lead, and chromium-contaminated soil, are expected to be completed by December 2006.

## Site 36

The U.S. EPA and DOI signed a ROD for Site 36 and other sites within the MISCA OU on September 12, 2002. The major components of the selected remedy for Site 36 included the demolition of the wastewater treatment plant and disposal of the material in an off-site permitted landfill; excavation and off-site disposal of contaminated material from the east pond, Primary and Secondary Lagoons, and the Upper Dove Creek. Soil and sludge with PCB concentrations above 50 mg/kg were required to be disposed of in a landfill under the Toxic Substances Control Act (TSCA). In addition, the ROD required groundwater monitoring and ICs to prohibit installation of potable water wells until the groundwater is restored to MCLs/State of Illinois Class I Groundwater Standards.

The DOI's contractor, Pangea Group, began the construction activities in May 2005. Remedial Project Managers of U.S. EPA, Illinois EPA, and FWS completed a site inspection of Site 36 in July 2006. As part of the remedial action, DOI removed all above ground and below ground Waste Water Treatment Plant (WWTP) features. Removal and off-site disposal of contaminated surface water, sludge, soils and sediment has been accomplished. The remedial phase is virtually complete as of September 2006. All that remains to be done is to grade some minor erosional areas and to oversee certain areas where vegetation has not established itself well. FWS is in the process of submitting a remedial action completion report in September 2006.

## All other sites within the MISCA OU

The ROD for Site 36 specified ICs to restrict human access at Sites 10 and 16. The ROD specified No Further Action at Site 22A, and No Action at other MISCA OU sites including Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 13, 18, 20, 21, 24, 25, 26, 27, 30, 31, and 35. The ICs to prevent access to Sites 10 and 16 are included in a Land Use Control (LUC) Plan prepared by FWS. FWS has taken steps to implement these ICs.

### **5. WT OU (OU5)**

Surface debris and surrounding soils at three water towers and at the Visitors' Center were contaminated with elevated levels of lead. Early action to remove approximately 2,200 cubic yards of lead contaminated soil was completed by DOI in May 1993. This action included excavation and off-site disposal of soil and debris with lead contamination exceeding 450 mg/kg.

### **6. AUS OU (OU6)**

The General Dynamics Ordnance and Tactical Systems (GDOTS) signed an Administrative Order on Consent (AOC) with U.S. EPA, DOI, and Illinois EPA on December 27, 2003. Under the terms of this AOC, GDOTS is currently conducting an RI/FS at the AUS OU of the Crab Orchard Site.

## **7. LM OU (OU7)**

The preliminary screening analysis of the LM OU was completed in October 9, 2001. Based on the conclusions of this screening analysis report, DOI transferred portions of the LM OU requiring further remedial investigation to the AUS OU. Therefore, no further action is necessary at the LM OU.

## **V. Five-Year Review Process**

### **A. Administrative Components**

The five-year review for the Sangamo Electric/Crab Orchard National Wildlife Refuge Superfund Site was led by Nan Gowda, Remedial Project Manager for the Sangamo Electric/Crab Orchard National Wildlife Refuge. The following team members assisted in the review:

- Paul Lake, Remedial Project Manager, Illinois EPA
- Dennis Pinigis, CERCLA Project Coordinator, U.S. Fish & Wildlife Service
- Elaine L. Moore, AUS OU Coordinator, U.S. Fish & Wildlife Service
- Chuck Beasley, U.S. Fish and Wildlife Service
- Karen Rabek, U.S. Army Corps of Engineers
- Eric Gredell, RMT, Contractor for Schlumberger

### **B. Document Review**

This five-year review included a review of all relevant documents (see Attachment A), interview with FWS representatives, and site inspections. This completed report is available in the information repository. Notice of its completion will be placed in the local newspaper and local contacts will be notified by letter.

### **C. Interviews**

The following individuals were contacted as part of the five-year review:

- Dennis Pinigis, CERCLA Project Manager, Fish and Wildlife Service
- Chuck Beasley, Fish Wildlife Service (Interviewed April 26, 2000)

### **D. Site Inspection**

Site inspections were conducted on January 18<sup>th</sup> and 19<sup>th</sup> of 2006, and on February 22<sup>nd</sup> 2006. Representatives of U.S. EPA, Illinois EPA, FWS, DA, and Schlumberger took part in site inspection on January 18, 2006. Representatives from U.S. EPA, Illinois EPA, and Army took

part in the site inspection on January 19, 2006, and representatives from U.S. EPA and FWS took part in the site inspection on February 22, 2006. Site inspections included remediated sites pertaining to MA OU, PCB OU, EMMA OU, and MISCA OU, Metals Areas Landfill, PCB Areas Landfill, and the Area 9 Repository. Conditions during the inspections were favorable with mild temperatures and no precipitation.

**Metals Areas OU:** Fire Station Landfill site (Site 29), Old Refuge Shop Area (Site 22), Plating Pond Area (Site 15), and the Metals Area Landfill were inspected. There were no signs of erosion in any of the remediated sites. The landfill cap was generally found to be in good condition. The vegetative cover was thorough and abundant, with no distressed areas, trees or shrubs. No noticeable depressions, excessive cracks, leachate seeps, odors, or other indications of distress were noted. No intrusive activities were noted on the cover system and no landfill waste or other contaminants were exposed or appeared to be exposed. As part of the maintenance, FWS personnel will address any erosion problems at the Metals Areas Landfill. Mr. Beasley stated that the leachate levels are checked on a quarterly basis and leachate removed as necessary.

**PCB OU:** Job Corps Landfill, Water Towers Landfill, Area 9 Building Complex/Landfill, Area 9 Repository, drainage swales leading to the lake, and the PCB OU Landfill were inspected. There were no signs of erosion of the backfilled areas in any of the remediated sites. The landfill cap was generally found to be in good condition. The vegetative cover was thorough and abundant, with no distressed areas, trees or shrubs. No noticeable depressions, excessive cracks, leachate seeps, odors, or other indications of distress were noted. No intrusive activities were noted on the cover system and no landfill waste or other contaminants were exposed. The fence which surrounds both the PCB and the Metals Areas Landfills is in good shape. All monitoring wells were in good condition. No intrusive activities were noted and no waste material or other contaminants were exposed or appeared to be exposed.

The Area 9 Repository is generally in good condition, with the exception of some minor erosion problems. As part of the maintenance, FWS personnel in coordination with Schlumberger will address any erosion problems at the repository.

The East, West, and Center drainage swales appeared to be in good condition with little or no noticeable erosion problems. Mr. Pinigis and Mr. Beasley stated that FWS had collected soil samples in several areas upgradient of these swales. The analytical results indicated PCB levels above the cleanup criteria in those areas.

**WT OU:** Inspections of the remediated Water Tower Area Sites did not indicate any signs of erosion of the backfilled areas.

**MISCA OU - Site 36:** Although not part of this five-year review, U.S. EPA, Illinois EPA, and FWS, and Pangea Group made a final site inspection of Site 36 as part of the construction completion. Although U.S. EPA has not reviewed a Draft Remedial Action



Completion Report for Site 36, all cleanup activities appear to be complete with the exception of some noticeable erosion problems. FWS is currently working with Pangea Group to address any erosion issues at the site.

#### **E. Risk Information Review**

The following standards were identified as applicable or relevant and appropriate requirements (ARARs) in both the RODs for the Metals Areas OU and the PCB OU. They were reviewed for changes that could affect protectiveness:

##### Surface Water Discharge

- Clean Water Act: 40 CFR Parts 122.41 and 122.44

##### Excavation of Soil and Sediment

- Resource Conservation and Recovery Act (RCRA), Subtitle C: 40 CFR 262.34; 264, Subparts B, C, G, I, J, and L; 40 CFR 268; and any more stringent State of Illinois equivalent provisions of 35 IAC Part 724)
- Clean Air Act: 40 CFR 50.6 and 50.12

##### Stabilization/Fixation

- RCRA Subtitle C: 40 CFR 268; 40 CFR Subparts I, J, L or X; and must meet any more stringent regulatory design standards of the State of Illinois 35 IAC 724
- Clean Air Act: 40 CFR 50.6 and 50.12

##### Disposal or Decontamination of Equipment

- RCRA Subtitle C: 40 CFR 264.114; and must meet any more stringent regulatory decontamination or disposal standards of the State of Illinois 35 IAC 724

##### Industrial Landfill or Caps

- RCRA Subtitle D: 40 CFR 241, Subpart B and must meet any more stringent technical regulations of the State of Illinois 35 IAC Part 807.

##### Backfill Excavation

- Clean Air Act: 40 CFR 50.6

### **Monitoring and Maintenance**

- RCRA Subtitle C: 40 CFR Subpart F
- RCRA Subtitle D: 40 CFR 241.204; and must meet any more stringent technical regulations of the State of Illinois 35 IAC 807

### **Personal Protection**

- Occupational Safety and Health Act (OSHA): 29 CFR 1910.120 and Subparts C, D, E, and P

### **Location Specific ARARs**

- Crab Orchard Enabling Legislation (16 U.S.C. 666f and g)
- National Wildlife Refuge Administration Act (16 U.S.C. 668 dd)
- Eagle Protection Act of 1940 (16 U.S.C. 668a)
- Migratory Bird Treaty Act of 1918 (16U.S.C. 703-711)

In addition, the following standards were identified as ARARs for the PCB Areas OU only:

### **Excavation of Soil and Sediment**

- Toxic Substances Control Act: 40 CFR 761.79

### **Incineration of Soil and Sediment**

- Toxic Substances Control Act: 40 CFR 761.60 (a) (4) (I) and (d); and 40CFR 761.70
- RCRA Subtitle C: 40 CFR Subpart O; 40 CFR 262.22, 262.34, and 264, Subparts B,C, I, J, and L); and 40 CFR 268.
- Clean Air Act: 40 CFR 50.6 and 50.12

### **Disposal or Decontamination of Equipment**

- Toxic Substances Control Act: 40 CFR 761.79

### **Location Specific ARARs**

- Eagle Protection Act of 1940 (16 U.S.C. 668a)
- Migratory Bird Treaty Act of 1918 (16U.S.C. 703-711)

Standards for the contaminants of concern have not become more stringent since the signing of the RODs in 1990, except for Illinois State's new landfill regulations 35 IAC 810

through 815, which superseded 35 IAC 807. These changes do not affect the protectiveness, because both DOI and Schlumberger voluntarily designed and constructed the Metals Area Landfill and the PCB Area Landfill by complying with the State of Illinois' newly promulgated landfill requirements 35 IAC 810 through 815.

There were no changes in either the Chemical-Specific or Action Specific ARARs.

The following standards were identified as applicable or relevant and appropriate requirements (ARARs) in the EMMA OU. They were reviewed for changes that could affect protectiveness:

Excavation

- 40 CFR 264.114

Generation of Hazardous Waste

- 40 CFR 61 Subpart M
- 40 CFR Part 262
- 40 CFR Part 261 Subpart C

Illinois Special Waste Requirements

- 35 IAC Part 808 and 35 IAC 809

Offsite Transport

- 40 CFR Part 262 Subpart C
- 40 CFR Parts a71 though 179
- 40 CFR Part 263
- 40 CFR Parts 107, 171-177

Worker Safety (OSHSA)

- 40 CFR 1910.120

Illinois Discharge Limitations

- 35 IAC 309
- 35 IAC 307
- 35 IAC 302

### Location Specific ARARs

- RCRA 40 CFR 264.18
- Executive Order 11990 – Protection of Wetlands
- Supbart 404, Clean Water Act (40 CFR 230)
- Endangered Species Act (16 USC 1531, 50 CFR 200, 50 CFR 402)
- Migratory Bird Act (16 CFR Chapter 7)
- The Archaeological and Historic Preservation Act (16 USC 469)
- National Wildlife Refuge System Administration Act. (16 USC 668, 50 CFR 27)
- Human Skeleton Remains Protection Act (Illinois revised statues 1989)
- Crab Orchard National Wildlife Refuge Creation (61 Stat. 770 dated Aug. 5, 1947)

There were no changes to any of the requirements listed above.

### **F. Data Review**

A review of records and monitoring reports through July, 2006, indicates the following:

#### **1. Metals Areas OU:**

##### **Soil Remediation (OU1)**

- Approximately, 36,359 cubic yards of metal contaminated soil and sediments were excavated, stabilized as necessary, and disposed in an on-site landfill. An additional 6,400 cubic yards of pentachlorophenol and dioxin contaminated soil from Site 22A, part of the Miscellaneous Areas Operable Unit, was disposed in the landfill.
- Study sites, Sites 22 and 29, are remediated to less than 450 mg/kg lead and 10 mg/kg cadmium. Study site 15 is remediated to less than 30.7 mg/kg chromium.
- The previous West Shop Area investigations and remediation done under the Metals Area Operable Unit were confined mostly to the ditches and sewers surrounding the buildings at the West Shop Area. Except for the former dry cleaning building, the areas immediately surrounding the buildings had not been investigated. These areas along with the rest of the West Shop area are now included as part of the AUS OU RI/FS and no further discussion is made in this report.
- The on-site disposal landfill was constructed in accordance with the substantive requirements of the State of Illinois' newly promulgated landfill requirements 35 IAC 810 through 815.

##### **Groundwater Monitoring Results (OU1)**

###### **Fire Station Landfill (Site 29)**

Groundwater samples collected in April 2006 as part of this five-year review at Site 29 were analyzed for metals. The location of Groundwater Monitoring Wells is shown in Figure 5.

The results of the groundwater sampling are summarized in Table 2. The results show a significant reduction in contaminant levels when compared with the groundwater monitoring results conducted in 1996, 1997, and 1998. Aluminum levels have decreased from 421,000 µg/L in 1996 to 58 µg/L. Barium levels have decreased from 4,590 µg/L in 1996 to 41 µg/L (below its MCL of 2000 µg/L). Beryllium was detected at levels (0.64 to 0.71 µg/L) well below its MCL of 4 µg/L. Chromium levels have decreased from 808 µg/L in 1996 to 2.4 µg/L (below its MCL of 100 µg/L). Lead levels have decreased from 232 µg/L in 1996 to 2.7 µg/L (below its action level of 15 µg/L). Selenium was detected at 4.5 µg/L well below its MCL of 50 µg/L. No Arsenic or lead was detected in any of the monitoring wells at Site 29.

#### **Old Refuge Shop (Site 22)**

Groundwater samples collected in April 2006 as part of this five-year review at Site 22 were analyzed for metals. Groundwater monitoring well locations are shown in Figure 5. The results of the groundwater sampling are summarized in Table 2. The results show a significant reduction in contaminant levels when compared with the groundwater monitoring results conducted in 1996, 1997, and 1998. Aluminum levels have decreased from 308,000 µg/L in 1996 to 4,800 µg/L. Barium levels have decreased from 5,260 µg/L in 1996 to 78 µg/L (below the MCL of 2,000 µg/L). Cadmium levels have decreased from 4.6 ppb in 1997 to 0.97 µg/L (below the MCL of 5 µg/L). Chromium levels have decreased from 491 µg/L in 1996 to 7.6 µg/L (below the MCL of 100 µg/L). Lead levels have decreased from 133 µg/L in 1996 to 5 µg/L (below the action level of 15 µg/L). No arsenic, selenium, or thallium was detected in any of the monitoring wells at Site 29.

#### **Surface Water Monitoring Results at the Plating Pond (Site 15)**

Surface water sample collected in April 2006 as part of this five-year review at the Plating Pond (Site 15) were analyzed for metals. Antimony (3.2 µg/L), Barium (16 µg/L), and Beryllium (0.63 µg/L) were detected at levels well below their respective MCLs.

#### **Metals Areas Landfill Leachate and Groundwater Monitoring (OU1)**

Leachate and groundwater samples collected in May 2006 at the Metals Area Landfill were analyzed for metals. The location of Groundwater Monitoring Wells is shown in Figure 6. The results of the groundwater sampling are summarized in Table 3. Concentrations of all metals in the groundwater for which MCLs/Illinois Class I Groundwater Standards are established were below those standards. Concentrations of all metals in the leachate were well below the allowable levels based on the 1994 Groundwater Impact Assessment for the Metals Area Landfill.

In June 2005, 4-methylphenol and phenol were detected in landfill leachate above the modeled concentrations at which no groundwater impacted is expected. Also, methylene chloride was detected at levels above MCLs/ Illinois Class I Groundwater Standards. Based on

these results, VOCs and SVOCs were added to the analyte list for all leachate sampling for a minimum of two semi-annual sampling events.

## 2. PCB OU:

### Soil Remediation (OU2)

- Approximately, 117,145 tons of PCB-contaminated soil and sediments were incinerated in an on-site thermal treatment unit.
- Approximately, 7,786 cubic yards of PCB, lead, and cadmium-contaminated material were stabilized and disposed of in an on-site landfill.
- About 102,210 cubic yards of PCB-contaminated soil and sediments (< 25 mg/kg) were excavated, consolidated, and backfilled in the Area 9 Repository.
- All four study sites (Sites 17, 28, 32, and 33) are remediated to PCBs < 1 mg/kg, lead < 450 mg/kg, and cadmium < 10 mg/kg.
- Sediments in drainage ditches and the Crab Orchard Lake Embayment are remediated to PCBs < 0.5 mg/kg.
- In August 2004, Schlumberger completed the excavation and off-site disposal of approximately 1,473 tons of PCB-contaminated sediments from the Center Swale at Site 32.

### Groundwater Monitoring Results (OU2)

**Job Corps Landfill (Site 17):** Groundwater samples collected in April 2006 as part of this five-year review at Site 17 were analyzed for VOCs, SVOCs, PCBs/pesticides, and metals. The location of Groundwater Monitoring Wells is shown in Figure 7. The results of the groundwater sampling are summarized in Tables 4 through 7. There were no VOCs, SVOCs, or PCBs/pesticides detected in any of the monitoring wells. Dissolved concentrations of Antimony (2.3 µg/L), Arsenic (0.61 to 2.0 µg/L), Barium (53.6 to 84.3 µg/L), Cadmium (0.24 µg/L), Chromium (0.14 to 13.5 µg/L), Copper (0.19 µg/L), Lead (0.28 µg/L), and Selenium (0.0.24 to 4.1 µg/L) were detected in the groundwater at levels well below their established MCLs or Action levels. In response to the recommendation made in the September 2000 Five-year review of the PCB OU, Schlumberger collected groundwater samples at Site 17 for Dioxin/Furan analysis. No dioxin/furans were detected in the groundwater except for Octa-chlorodibenzo-p-dioxin at levels ranging from 0.092 to 1.1 nanograms per liter. The maximum concentration of 1.1 nanograms per liter is the toxic equivalent of 0.11 picogram per liter of 2,3,7,8 tetrachlorodibenzo-p-dioxin well below its drinking water standard of 30 picograms per liter.

**Water Tower Area Landfill (Site 28):** Groundwater samples collected in April 2006 as part of this five-year review at Site 28 were analyzed for VOCs, SVOCs, PCBs/pesticides, and metals. The location of Groundwater Monitoring Wells is shown in Figure 8. The results of the groundwater sampling are summarized in Tables 4 through 7. There were no VOCs, SVOCs, or PCBs/pesticides detected. Dissolved concentrations of Arsenic (0.75 to 4.0 µg/L), Barium (25 to

92.9 µg/L), Beryllium (0.09 µg/L), Cadmium (0.31 µg/L), Chromium (2.6 to 4.0 µg/L), copper (0.2 µg/L), lead (0.14 to 0.73 µg/L), mercury (0.011 µg/L), and Selenium (0.28 µg/L) were detected in groundwater below their respective MCLs or Action Levels.

**Area 9 Building Complex and Area 9 Landfill (Sites 32/33):** Groundwater at Sites 32/33 is contaminated with TCE and other chlorinated volatile organic compounds (CVOCs) above their respective groundwater and the State of Illinois Class I Groundwater standards. As stated earlier, the U.S. EPA is in the process of issuing a ROD Amendment to the ROD/ESD for the PCB OU. The revised remedies are expected to mitigate further degradation of the groundwater and bring the groundwater to beneficial use. Therefore, no further review of the groundwater contamination is made in this report.

### **Surface Water Monitoring Results (OU2)**

**Area 9 Building Complex and Area 9 Landfill (Sites 32/33):** No surface water samples were collected as part of this five-year review. Based on the analytical results of the samples collected in February 2003, TCE and other CVOCs were detected in the surface water at Sites 32/33. No PCBs or pesticides were detected in the surface water. As stated earlier, the U.S. EPA is in the process of issuing a ROD Amendment to the ROD/ESD for the PCB OU. The revised remedies are expected to mitigate further degradation of the groundwater and surface water discharging to the Crab Orchard Lake. Therefore, no further review of the surface water contamination is made in this report.

### **PCB Areas Landfill Leachate and Groundwater Monitoring Results (OU2):**

Groundwater and leachate samples collected in April 2006 from the PCB OU landfill were analyzed for VOCs, Semi-VOCs, PCBs/Pesticides, and metals. Groundwater Monitoring Well locations are shown in Figure 9. Results of groundwater sampling are summarized in Tables 4 through 7. Results of landfill leachate sampling are summarized in Tables 8 through 11. There were no VOCs, Semi-VOCs, or PCB/Pesticides detected in either the landfill leachate or the groundwater samples. Total concentrations of Arsenic (1.2 µg/L), Barium (45.6 µg/L), Beryllium (0.15 µg/L), and Cadmium (0.06 µg/L) were detected in the leachate samples. Total concentrations of Arsenic (1.5 µg/L), Barium (26.4 to 55.9 µg/L), Beryllium (0.10 µg/L), Cadmium (0.18 to 0.3 µg/L), Chromium (0.64 to 2.7 µg/L), Lead (0.18 µg/L), and Selenium (1.8 to 4.8 µg/L) were detected in the groundwater samples.

## **3. EMMA OU**

The Army has conducted the five-year review of the EMMA OU sites within the Crab Orchard Site. This document incorporates the Five-year Review Report for the EMMA OU by reference.

#### **4. MISCA OU**

**Site 14:** The ITW is in the process of implementing the cleanup activities which include the excavation of chromium, lead, and VOC-contaminated soil at Site 14 of the MISCA OU.

**Site 36:** The DOI's contractor, Pangea Group, began the construction activities in May 2005. Major components of the cleanup activities including the excavation, removal and off-site disposal of contaminated soil, sludge, and sediments, and grading and seeding are complete as of the last inspection made by the Remedial Project Managers of U.S. EPA, Illinois EPA, and FWS.

#### **5. WT OU**

The 450 mg/kg lead cleanup level established for the Water Tower Areas and the Visitors Center is protective of human and the environment. No further action is necessary in the vicinity of any of the Water Towers or the Visitors Center.

#### **6. AUS OU**

The GDOTS is presently conducting a Remedial Investigation at the AUS OU Sites. The RI/FS is expected to be complete by 2010.

#### **7. LM OU**

Based on the conclusions of the preliminary screening analysis, DOI transferred portions of the LM OU requiring further investigation to AUS OU. As stated earlier, GDOTS is conducting a remedial investigation of AUS OU Sites including the sites transferred from LM OU. Therefore, no further action is necessary at the LM OU.

#### **8. Land Use Control/Institutional Controls**

ICs are non-engineered instruments, such as administrative and legal controls that help to minimize the potential to exposure to contamination and that protect the integrity of the remedy. ICs are required to assure long-term protectiveness for any areas which do not allow for unlimited use or unrestricted exposure.

The FWS has prepared a draft LUC Plan for the review and approval of U.S. EPA and Illinois EPA. The draft LUC Plan identifies all ICs specified in the RODs for the MA OU, PCB OU, EMMA OU, and MISCA OU of the Crab Orchard National Wildlife Refuge Superfund Site. Details of the IC implementation and maintenance actions, including periodic inspections of these restricted areas are included in the LUC Plan. Currently, U.S. EPA and Illinois EPA are working with FWS and Army in finalizing the LUC Plan. The FWS is responsible for implementing, maintaining, reporting on, and enforcing the land use controls.



Creation of IC maps are underway which depict the areas where use restrictions are required. The IC maps, once completed, will be publicly available and on EPA's Superfund Data Management System (SDMS) and will serve as an additional IC as an informational control.

### **Summary of Data Review**

#### **1. Metals Areas OU:**

In summary, all contaminants of concern at Sites 15, 22, and 29, including lead, cadmium, and chromium, have been remediated to the cleanup levels required by the ROD for the MA OU. The results of groundwater monitoring indicate a significant reduction in contaminant concentrations in groundwater at the remediated sites. Currently, groundwater at the Crab Orchard National Wildlife Refuge is not being used for drinking water purposes. The remediated sites do not pose any unacceptable risk to human health or the environment. The results of the on-site landfill groundwater monitoring are within the statistical range of background groundwater concentrations.

#### **2. PCB Areas OU:**

In summary, all contaminants of concern (PCB, Lead, and Cadmium) at Sites 17, 28, 32, and 33 have been remediated to the cleanup levels required by the ROD. However, based on recent samples collected by FWS, some hotspot areas with PCBs in excess of the cleanup criteria may exist at Sites 32/33. At the Area 9 Landfill (Site 32), soil and sediments with levels of PCBs, lead, and cadmium less than 25 mg/kg, 450 mg/kg, and 10 mg/kg, respectively are consolidated and backfilled in the remediated landfill site with at least 2-foot of clean soil, now known as the Area 9 Repository. The repository was generally in good condition. U.S. EPA is in the process of issuing a ROD Amendment to the ROD/ESD for the PCB OU to address groundwater contamination at Sites 32/33. Currently, groundwater at the Crab Orchard National Wildlife Refuge is not being used for drinking water purposes. The remediated sites do not pose any unacceptable risk to human health or the environment.

#### **3. EMMA OU**

The Army has conducted the five-year review of the EMMA OU sites within the Crab Orchard Site. This document incorporates the Five-year Review Report for the EMMA OU by reference. In summary, all contaminants of concern (nitroaromatic compounds and lead, RDX/HMX) have been removed at Sites COC-3 and COP-4 to comply with the requirements of the 1997 ROD for the EMMA OU. In addition, the Army conducted removal activities to address unexploded ordnance at the EMMA OU sites. The response included surveying and excavation for unexploded ordnance over 20 acres and reforestation of 83 acres to eliminate intrusive land use activities. Both the remedial and removal activities at the EMMA OU sites are complete.

#### **4. MISCA OU**

All construction activities at Site 36 of the MISCA OU are complete. Cleanup activities at Site 14 of the MISC OU are expected to be complete by December 2006. No further action at Site 22A and no action at the remaining MISCA OU sites are necessary. ICs to prevent access to Sites 10 and 16 have been incorporated into the Land Use Control Plan prepared by FWS.

#### **5. WT OU**

Removal activities conducted at the three water tower areas and at the Visitors Center of the Crab Orchard Site are complete.

#### **6. AUS OU**

GDOTS is conducting a RI/FS at the AUS OU sites. The RI/FS is expected to be completed by 2010.

#### **7. LM OU**

Portions of the LM OU needing remedial investigation were transferred to the AUS OU. No further action is necessary at the LM OU.

#### **8. Land Use Control/Institutional Controls**

The U.S. EPA and Illinois EPA are presently working with FWS and the Army to finalize the draft Land Use Control Plan prepared by the FWS. The ICs required under the RODs for the MA OU, PCB OU, EMMA OU, and MISCA OU have been incorporated into this LUC Plan.

### **VI. Technical Assessment**

The following conclusions support the extent to which the remedies selected in the RODs for the Crab Orchard Site remain protective of human health and environment:

#### **1. Metals Areas OU:**

**Question A: Is the remedy functioning as intended by the decision document? Yes**

- **Implementation of Institutional Controls and Other Measures:** The landfill is located within the closed area, fenced, and posted with signs restricting access to the public. There are no planned changes in land use at the remediated sites. Access to these areas remains closed to the public, except for limited access to workers at the industrial sites and restricted access to hunters. The FWS has incorporated these ICs into the draft LUC Plan which is being reviewed by U.S. EPA and Illinois EPA.

- **Remedial Action Performance:** The landfill cover system has been effective in isolating waste and contaminants as supported by leachate and groundwater concentrations. Concentrations in the leachate and groundwater are within acceptable concentrations indicating no adverse impacts.
- **Operation and Maintenance:** Leachate elevation levels at the MA OU Landfill are well within the maximum allowed level.
- **Opportunities for Optimization:** There has been no significant or consistent detection of volatile organic compounds or semi-volatile organic compounds. Based on these findings, the monitoring program may be altered to eliminate parameters and reduce frequency of monitoring. There were no noticeable erosions problems at the landfill.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid? Yes

- **Changes in Standards:** This five-year review identified Illinois State's new landfill regulations 35 IAC 810 through 815, which had been promulgated since the ROD was signed. However, these changes do not affect the protectiveness, because DOI complied with the substantive requirements of the State of Illinois' newly promulgated landfill requirements 35 IAC 810 through 815.
- **Changes in Exposure Pathways:** No contaminated soil or sediments above cleanup levels remain at the remediated sites. The decrease of contaminant levels in groundwater at the site indicate the remediation is successful in restoring groundwater to its potential beneficial use.
- **Changes in Risk Assessment Methodologies:** Changes in the risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the remedy since all contaminants of concern were removed from the remediated sites:

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? No

## 2. PCB OU:

Question A: Is the remedy functioning as intended by the decision document? Yes

- There are no planned changes in land use at the site. No soil or sediments contaminated with PCBs remain at the remediated sites with the exception of some potential hotspot areas at Sites 32/33.
- Groundwater at Sites 32/33 is contaminated with TCE and other chlorinated solvents above their drinking water standards. U.S. EPA is in the process of issuing a ROD Amendment to address the groundwater contamination. Currently, there is no risk to human health, because presently the groundwater is not being used for drinking water. 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 specified in the ROD Amendment is expected to mitigate any potential long-term risk to the building occupants due to soil vapor intrusion of TCE and other chemicals of concern.

- The landfill cover system has been effective in isolating waste and contaminants. As previously discussed, leachate levels at the PCB Area Landfill are consistently below allowable levels. There were no noticeable erosion problems at the landfill.
- The Area 9 Repository has been effective in isolating waste and contaminants. There were no noticeable erosion problems at the Area 9 Repository.

**Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid? Yes**

- Changes in the risk assessment methodologies since the time of the ROD do not call into question the protectiveness of the remedy since all contaminants of concern, including PCBs, lead, and cadmium were remediated to below cleanup levels at the remediated sites. Schlumberger will, however, conduct a post-remediation site-specific risk assessment using U.S. EPA's most recent risk assessment guidance. This risk assessment is a requirement in the ROD and will be conducted after the implementation of the remedies to address groundwater contamination.

**Question C: Has any other information come to light that could call into question the protectiveness of the remedy? Yes**

- Based on the analytical results of samples collected by FWS, potential hotspot areas with PCB levels in excess of the cleanup criteria may be present at Sites 32/33. Further sampling at these potential hotspot areas is necessary to confirm the presence of contamination and to conduct further cleanup. Any additional source removal at these potential hotspot areas, if necessary, is expected to be protective of human health and the environment.

### **3. EMMA OU**

The Army has conducted the five-year review of the EMMA OU sites within the Crab Orchard Site. This document incorporates the Five-year Review Report for the EMMA OU by reference.

**Question A: Is the remedy functioning as intended by the decision document? Yes, the removal actions have all been successful. The quarterly and annual groundwater monitoring has been maintained. The soil covers are in good shape and the sites are in fenced areas and are inaccessible to public.**

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Yes, the remedial action objectives are still valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? No

The remedies are working as intended. However, in March 2006, a biologist with FWS found a mine south of sites COC-3 and COC-4. The mine was a live, explosively loaded, M-21 Anti-Tank mine, unfuzed. It was detonated in place in April 2006. This mine was located across the road from one of the sites that underwent a UXO removal action. It is likely that the mine was associated with kickout from the World War II era open burn/open detonation site. Due to the discovery of the mine, the U.S. Army Corps of Engineers (USACE) recommends that a new Military Munitions Response Program (MMRP) investigation, following the CERCLA process, be initiated.

#### **4. MISCA OU – Site 14**

Question A: Is the remedy functioning as intended by the decision document? Remedy has not yet been implemented.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid? Remedy has not yet been implemented.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy? Remedy has not yet been implemented.

- Currently, ITW is in the process of implementing the cleanup action at Site 14 of the MISCA OU. The ITW has volunteered to cleanup the soil contamination to levels based on U.S. EPA's generic soil screening guidance (OSWER 9355.4-24 March 2001). These cleanup levels are more stringent than the levels specified in the ROD for Site 14. The cleanup activities are expected to be completed in December 2006. The remedy is expected to be protective of human health and the environment.

#### **5. MISCA OU – Site 36**

Question A: Is the remedy functioning as intended by the decision document? Yes

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid? Yes

**Question C: Has any other information come to light that could call into question the protectiveness of the remedy?** No

- Although U.S. EPA has not reviewed the Remedial Action Completion Report for Site 36 of the MISCA OU, cleanup activities are complete with the exception of a few minor erosion issues. The implemented remedy is expected to be protective of human health and the environment.

## **6. WT OU**

**Question A: Is the remedy functioning as intended by the decision document?** Yes

**Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?** Yes

**Question C: Has any other information come to light that could call into question the protectiveness of the remedy?** No

Removal action conducted to remove lead-contaminated soil at the three water tower areas and the Visitors Center are protective of human health and the environment.

## **7. AUS OU**

**Question A: Is the remedy functioning as intended by the decision document?** No remedy has yet been selected. AUS OU sites are currently being investigated to determine the nature and extent of contamination.

**Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?** No remedy has yet been selected. AUS OU sites are currently being investigated to determine the nature and extent of contamination

**Question C: Has any other information come to light that could call into question the protectiveness of the remedy?** No

The GDOTS is currently conducting a RI/FS at the AUS OU to determine the nature and extent of contamination at the sites, and to determine if any of the AUS OU sites are posing an unacceptable risk to human health and the environment. The RI/FS is expected to be complete by 2010, at which time cleanup actions, if necessary, will be selected in accordance with CERCLA process.

## **8. LM OU**

Based on the Preliminary Screening Analysis conducted by the FWS, portions of the LM OU needing further investigation were transferred to the AUS OU, and therefore, no cleanup action is required at the LM OU.

### **VII. Issues**

At the PCB OU, based on the analytical results of samples collected by FWS, potential hotspot areas with PCBs levels in excess of the cleanup criteria may be present at Sites 32/33. This issue would affect both short-term and long-term protectiveness, if PCBs levels were to be present in the hotspot areas above cleanup levels. This issue is not sufficient to warrant a finding of not protective as long as corrective actions are taken.

At the EMMA OU, the groundwater sampling results show that there is need for continued groundwater monitoring to delineate the plumes and determine if natural attenuation is occurring. This issue currently does not affect protectiveness, however, it may affect future protectiveness, if groundwater is not restored to MCLs.

At the EMMA OU, the discovery of the mine so close to the sites COC-3 and COC-4 is a reason for concern and further investigation. Since the mine was successfully detonated in place, this issue does not affect protectiveness either currently or in the future.

Land use restrictions are required to implement the ICs identified in the RODs for the MA OU, PCB OU, EMMA OU, and the MISCA OU. These ICs include the maintenance of the landfill caps, access restrictions, and to prohibit the installation of potable water wells until groundwater is restored to drinking water standards. The FWS has prepared a draft LUC Plan which incorporates the ICs for all of the OUs for the Crab Orchard Site. The LUC Plan has not yet been finalized. This issue does not currently affect protectiveness, but may affect future protectiveness, if the ICs are not implemented and enforced.

### **VIII. Recommendations and Follow-up Actions**

At the PCB OU, U.S. EPA recommends that Schlumberger, as settling defendants, conduct additional investigation to verify the presence of PCBs in the hotspot areas identified by FWS before June 30, 2007, and to remediate such area, as appropriate, to the cleanup levels specified in the ROD for the PCB OU.

At the EMMA OU, U.S. EPA recommends continued groundwater monitoring at Sites COC-3 and COP-4 to determine the extents of the plumes and whether natural attenuation is occurring.

At the EMMA OU, due to the discovery of the mine, U.S. EPA recommends that a new MMRP investigation, following the CERCLA process, be initiated before June 2007.

**Land Use Restrictions** are required to prohibit interference with the landfill caps, restrict access and prohibit groundwater use at portions of the Crab Orchard Site. The FWS has prepared a draft Land Use Control Plan which incorporates the ICs identified in the RODs for the MA OU, PCB OU, EMMA OU, and the MISCA OU. The U.S. EPA recommends that the FFA parties work with FWS in finalizing the LUC Plan before June 30, 2007.

The above follow up actions are expected to be protective of human health and the environment in the long-term.

#### **IX. Protectiveness Statements**

The site is expected to be protective of human health and the environment. For long-term protectiveness, effective ICs need to be implemented, maintained, and monitored. The following discusses the protectiveness statements for the remedial actions conducted at all seven operable units of the Crab Orchard Site:

- **MA OU:** No lead, cadmium, or chromium-contaminated soil or sediments are present above cleanup levels at any of the remediated sites. The MA OU Landfill is effective in containing the waste and contaminants. The remedial actions at Sites 15, 22, and 29 are expected to be protective of human health and the environment.
- **PCB OU:** No PCB, lead, or cadmium-contaminated soil or sediments above the cleanup levels are present at any of the remediated sites, with the exception of potential hotspot areas within Sites 32/33 of the PCB OU. Both the Area 9 Repository and the PCB Landfill are effective in containing the waste and contaminants. The remedial action conducted to date and the recommended investigation/possible cleanup of PCB-contaminated soils, if any, in some potential hotspot areas at Sites 32/33 is expected to be protective of human health and the environment. The ROD Amendment to address groundwater contamination is expected to mitigate any potential long-term risk to the building occupants due to soil vapor intrusion of TCE and other chemicals of concern, in addition to bringing the groundwater to beneficial use. Thus the remedies in place and the future groundwater remedies are expected to be protective of human health and the environment.
- **EMMA OU:** The remedial action conducted at the EMMA OU sites COC-3 and COP-4, and the removal action conducted to address unexploded ordnance at the EMMA OU sites, together with the land use controls in place are protective of human health and the environment.
- **WT OU:** The removal actions conducted at three of the water tower areas and at the Visitors Center to remove 450 mg/kg of lead-contaminated are expected to be protective of human health and the environment.



- MISCA OU: Site 14: The cleanup activities that are being implemented at Site 14 are expected to be complete in December of 2006. The remedy is expected to be protective of human health and the environment. Site 36: The cleanup activities completed at Site 36 are also expected to be protective of human health and the environment.
- AUS OU: Currently, GDOTS is conducting a RI/FS at the AUS OU sites. The RI/FS is expected to be complete by 2010. Based on the recommendations made in the RI/FS report, U.S. EPA will select appropriate remedy, if necessary. Therefore, a protectiveness statement is not made for the AUS OU.
- LM OU: Following transfer of portions of the LM OU Sites to AUS OU, no further action was necessary at the LM OU. There is no unacceptable risk to human health and the environment at the LM OU.
- Institutional Controls: The FWS is currently implementing and enforcing ICs required under several RODs for the Crab Orchard Site. The protectiveness of the Crab Orchard Site requires implementation and compliance with land and groundwater use restrictions at the Site.

#### **X. Next Review**

This is a statutory site that requires on going five-year reviews. The next review will be conducted within five years of the completion of this five-year report and will address all OUs at the site.

#### **XI. Other Comments**

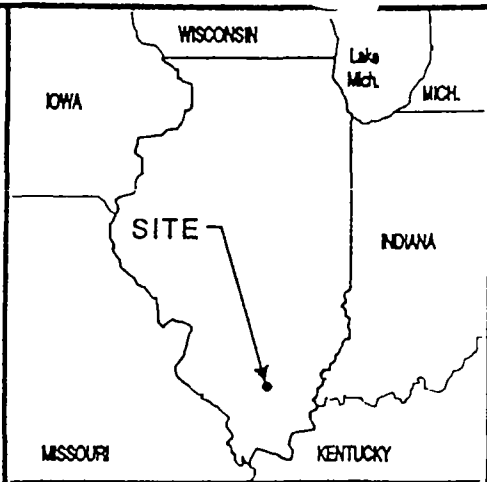
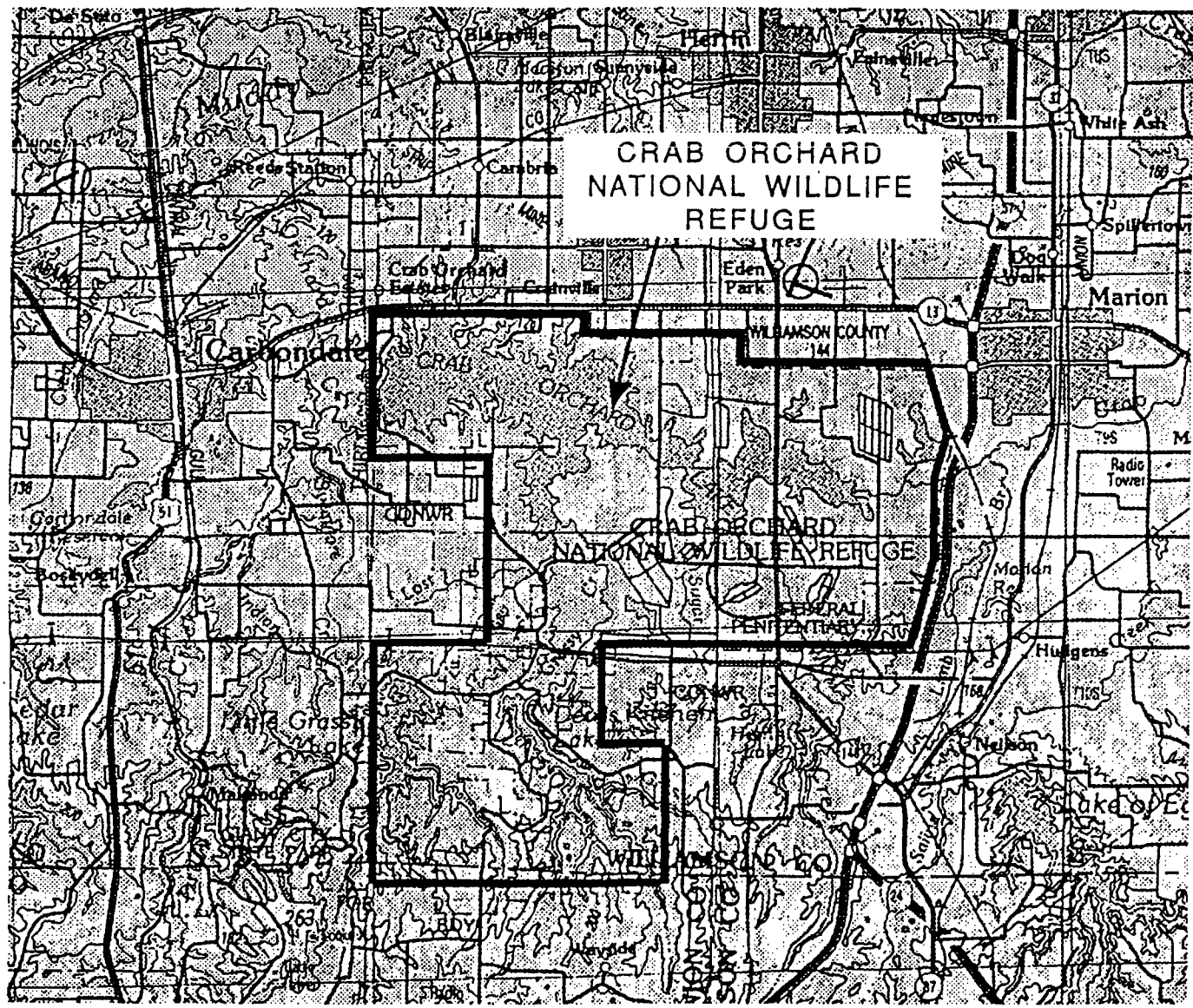
The Army has conducted a five year review of the EMMA OU of the Crab Orchard Site. U.S. EPA is incorporating the five year review conducted by the Army by reference.

## **Attachment A**

### **List of Documents Reviewed**

(All documents pertain to Crab Orchard National Wildlife Refuge Superfund Site)

**Remedial Investigation Report by O'Brien and Gere (August 1988)**  
**Feasibility Study Report by O'Brien and Gere (August 1989)**  
**Record of Decision for the Metals Areas Operable Unit (March 30, 1990)**  
**Record of Decision for the PCB Areas Operable Unit (PCBOU) (August 1990)**  
**Consent Decree for the PCBOU (May 1991)**  
**Federal Facilities Agreement (September 1991)**  
**Pre-Design Contamination Delineation Report for the PCBOU (April 1993)**  
**Final Operation and Maintenance Plan (September 1995)**  
**Solidification and Stabilization Work Plan for the PCBOU (September 1996)**  
**Groundwater and Surface Water Monitoring Report for PCBOU (February 1997)**  
**Closeout Report for the Metals Areas Operable Unit (February 1997)**  
**Record of Decision for the EMMA OU (February 1997)**  
**Draft Final Closeout Report for the PCBOU (March 1998)**  
**Groundwater Investigation Report and Focused Feasibility Study (January 2000)**  
**Explanation of Significant Differences for the EMMA OU (January 2000)**  
**Explanation of Significant Differences for the PCB OU (June 2000)**  
**Five-Year Review Report for the PCB OU (September 2000)**  
**Preliminary Screening Analysis Report for the LM OU (April 2001)**  
**Five-Year Review Report for the MA OU (September 2001)**  
**Record of Decision for the MISCA OU – Site 14 (October 2001)**  
**Record of Decision for the MISCA OU – Site 36 (September 2002)**  
**Final Revised Closure Report for the Water Towers Operable Unit (June 2004)**  
**Documentation Report for Center Swale Sediment Removal Action (January 2005)**  
**Post Remedial Action Monitoring Report for the Metals Areas Operable Unit (May 2006)**



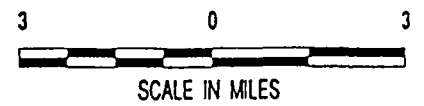
VICINITY MAP

SOURCE:  
 PADUCAH  
 1 X 2 QUADRANGLE  
 GEOLOGICAL SURVEY  
 1987

FIGURE 1

NOTE:  
 1. REFUGE BOUNDARY  
 LOCATION APPROXIMATE.

SITE PLAN

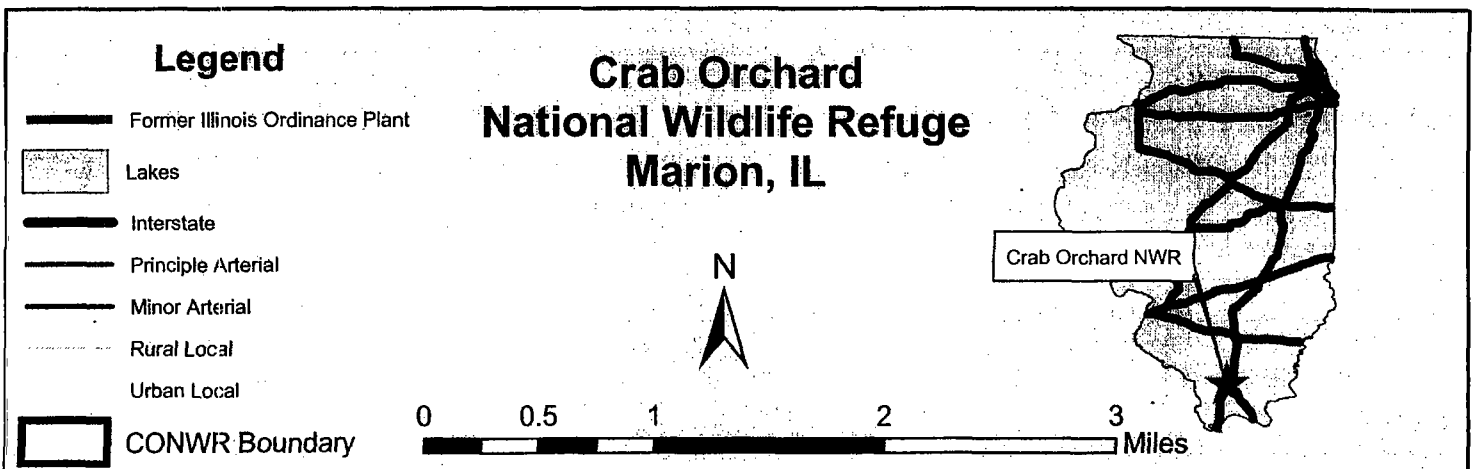
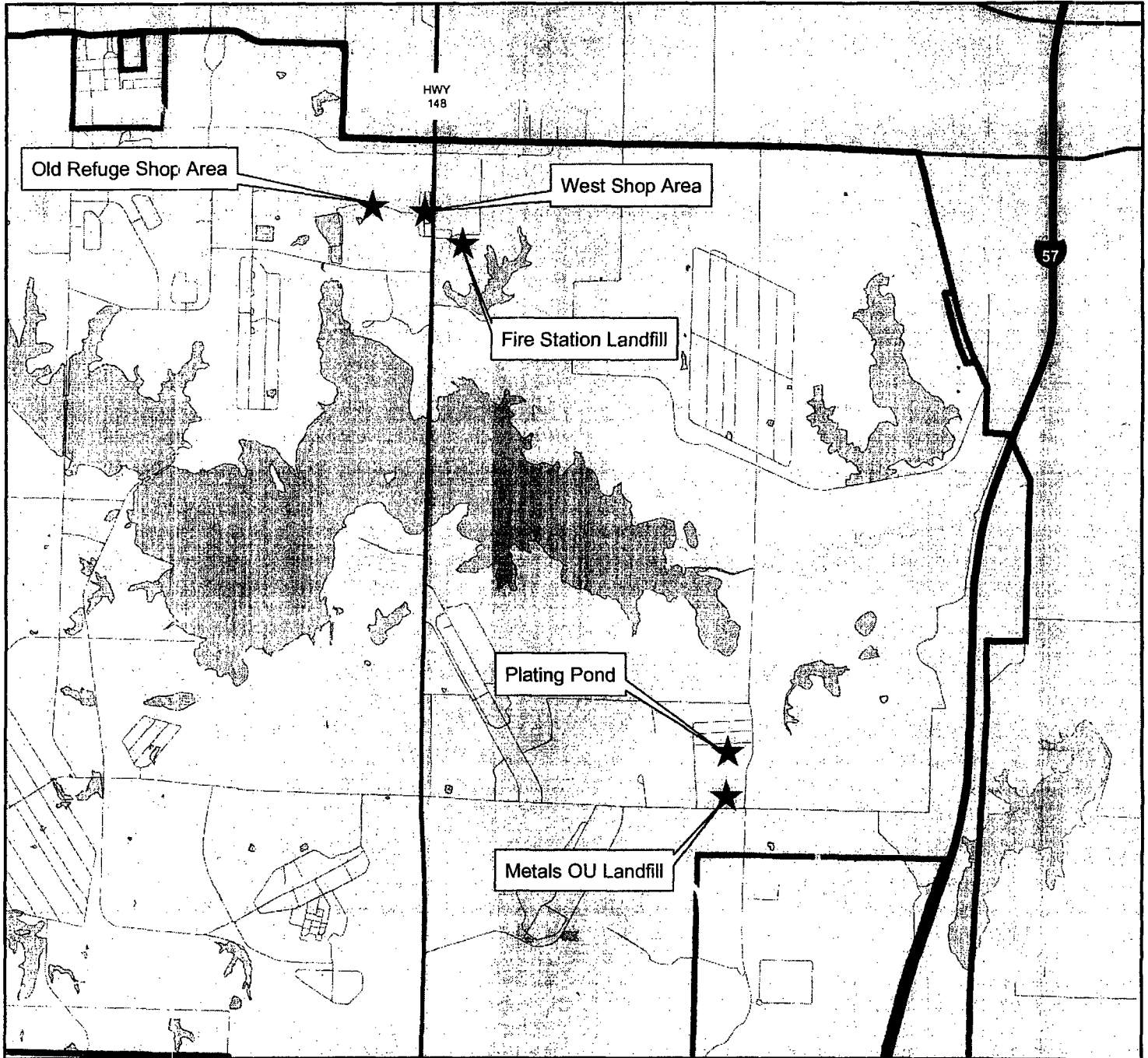


CLIENT/PROJECT		W-C/CRAB ORCHARD RI/IL	
DRAWN	CHECKED	REVIEWED	DATE
TPK	WGB	WGB	2-23-94

TITLE		REFUGE LOCATION MAP	
SCALE	FILE NAME	JOB NO.	DWG NO.
AS SHOWN	8168109	933-8168	

TITLE		REFUGE LOCATION MAP	
SCALE	FILE NAME	JOB NO.	DWG NO.
AS SHOWN	8168109	933-8168	

**Figure 2** Location of the Plating Pond, Fire Station Landfill, Old Refuge Shop, and the Metals OU Landfill.



DWG. NO.: 408696-B-C02  
 PROJ. NO.: 408689  
 DRAFT. CHCK. BY: J. HUBBARD  
 ENGR. CHCK. BY: B. PRICE  
 DATE LAST REV.:  
 DRAWN BY: reptils  
 STARTING DATE: 6/13/94  
 DRAWN BY: reptils  
 408689C02 BOARD

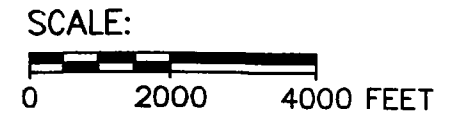
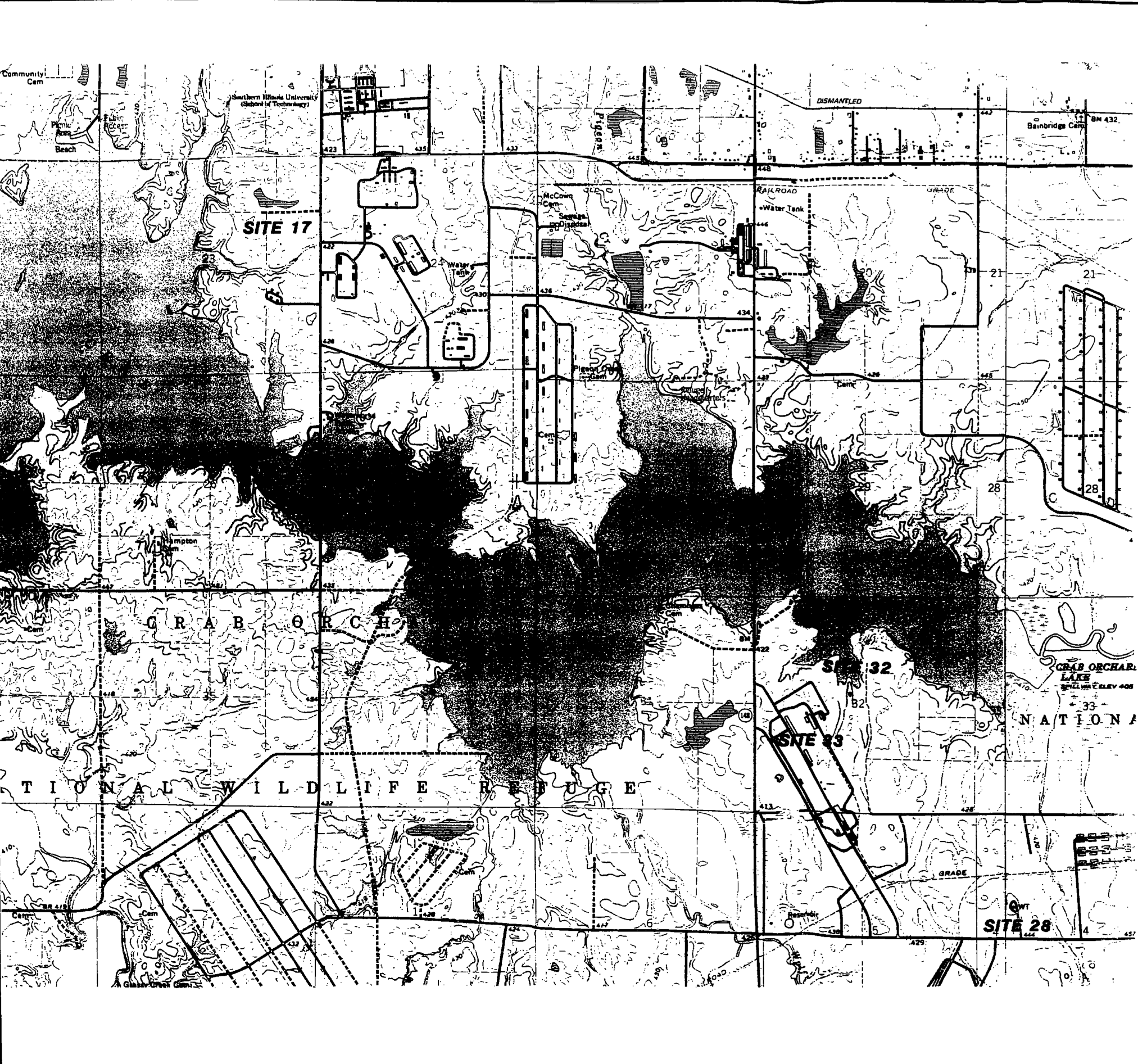
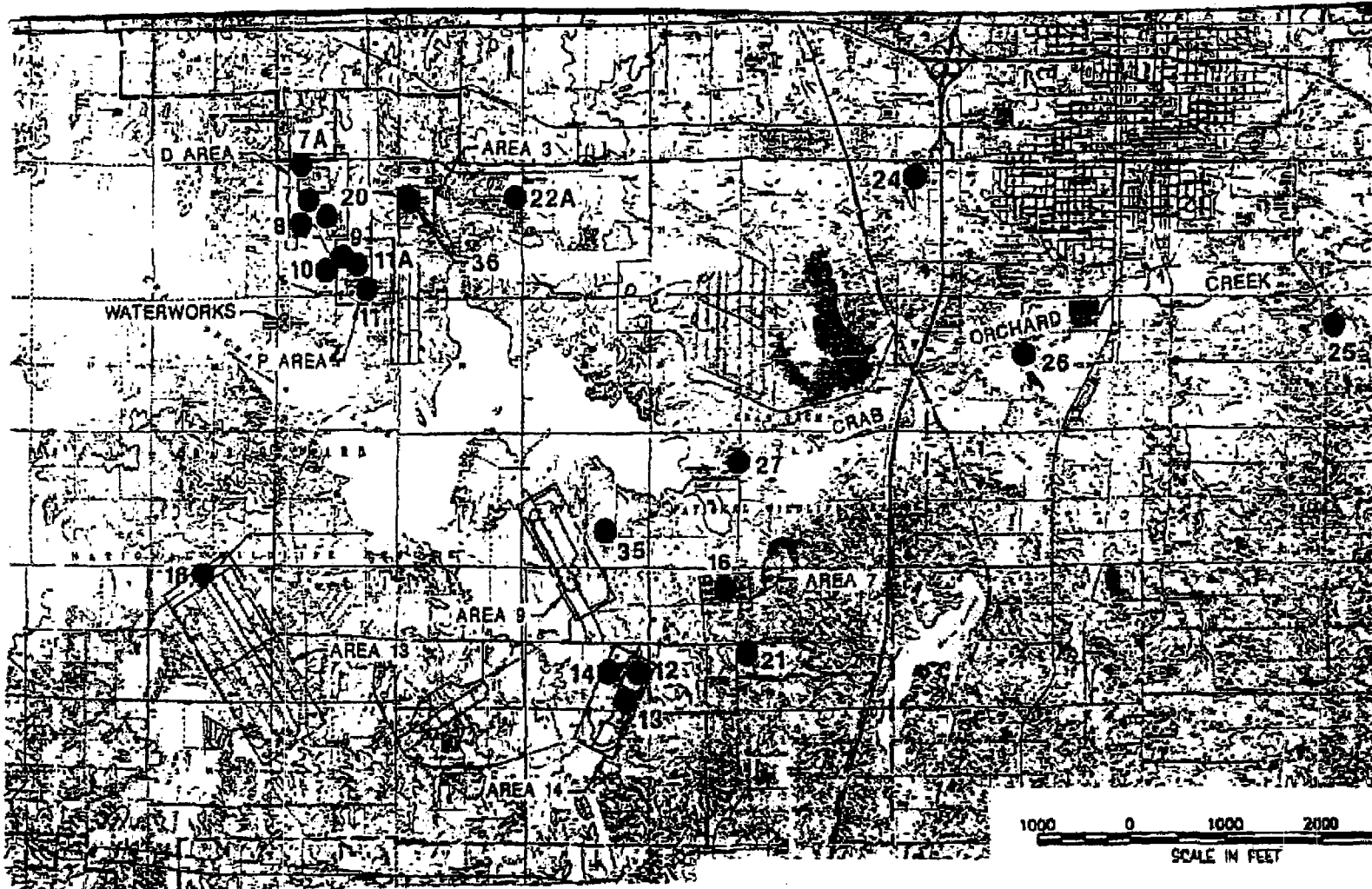


FIGURE 3

PCB AREAS OPERABLE UNIT

CRAB ORCHARD  
 WILDLIFE REFUGE  
 MARION, ILLINOIS





--- REFUGE BOUNDARY  
 ● SITE LOCATION

MAP SOURCE: U.S.G.S. 7.5 MINUTE SERIES  
 QUADRANGLE MAPS MARION, ILL.  
 1964, PHOTOENLARGED 1990, AND  
 CRAB ORCHARD LAKE, ILL. 1964,  
 PHOTOENLARGED 1978.

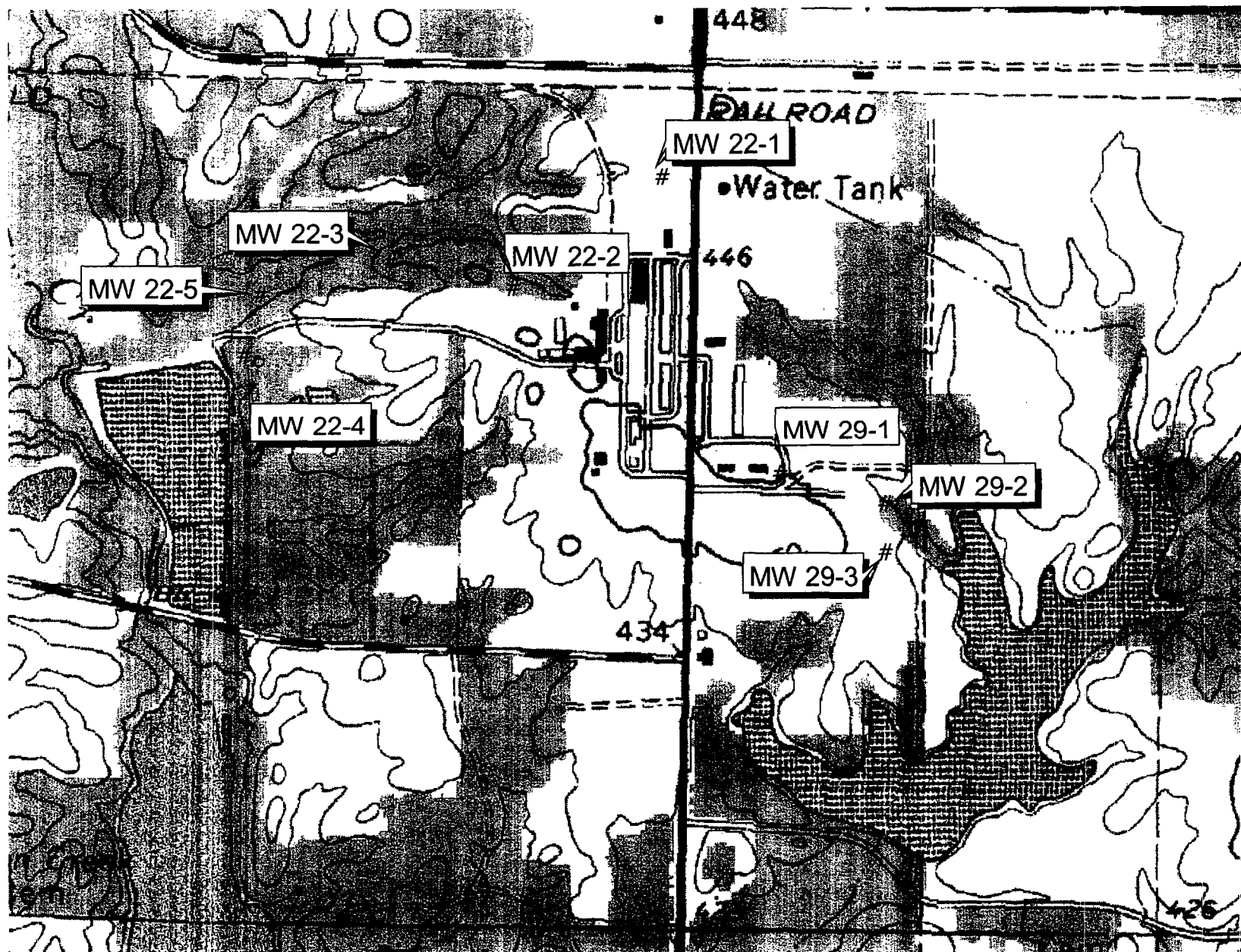
NOTE: SITE 34 IS CRAB ORCHARD LAKE.

Sites 30 and 31 are control (background) sites and therefore are not shown on this figure.

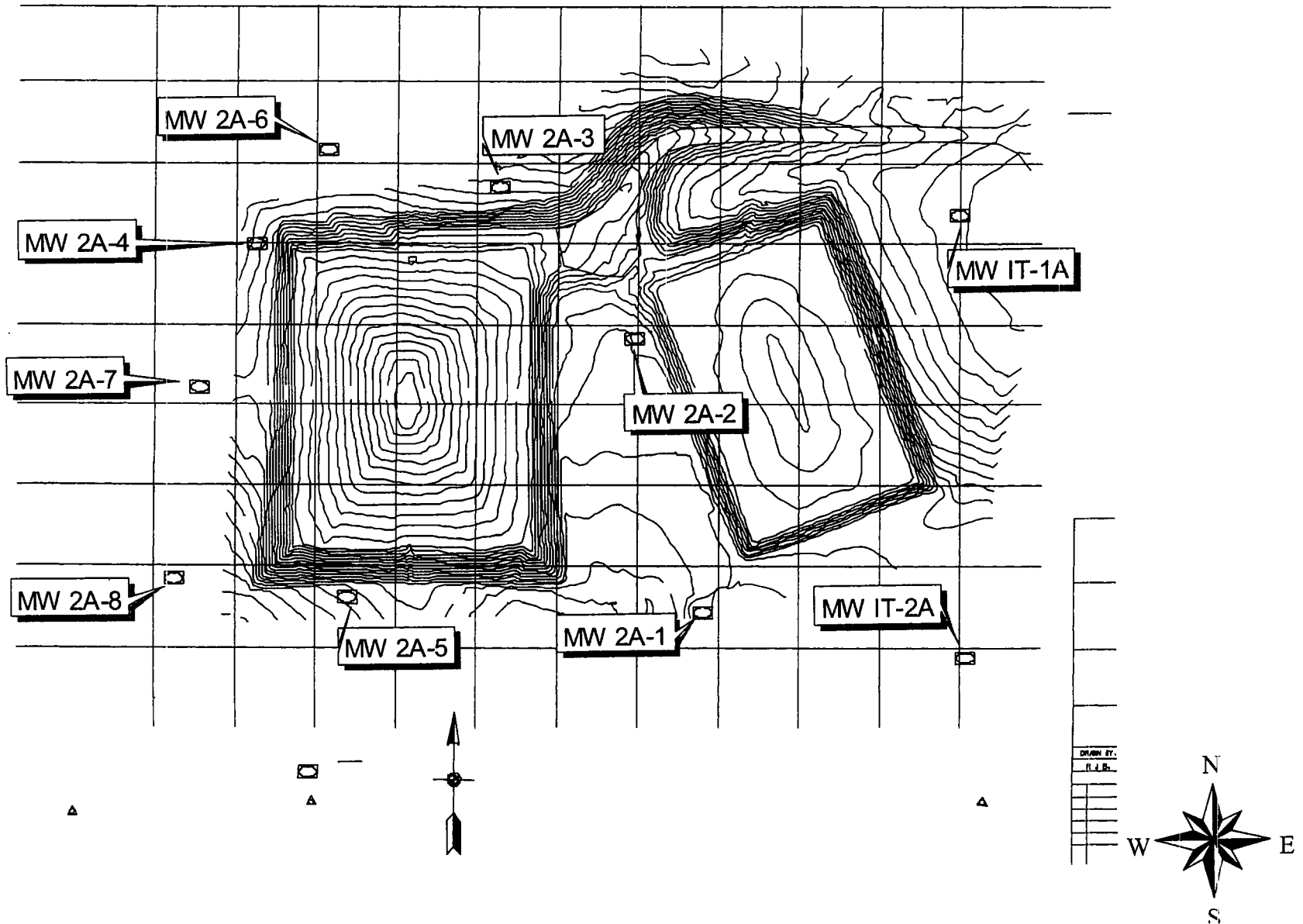
Miscellaneous Areas Operable Unit	FIG. NO. 4
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U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION, MISSOURI DISTRICT, JEFFERSON CITY, MISSOURI

**Figure 5. Location of Fire Station and Old Refuge Shop Groundwater Monitoring Wells.**



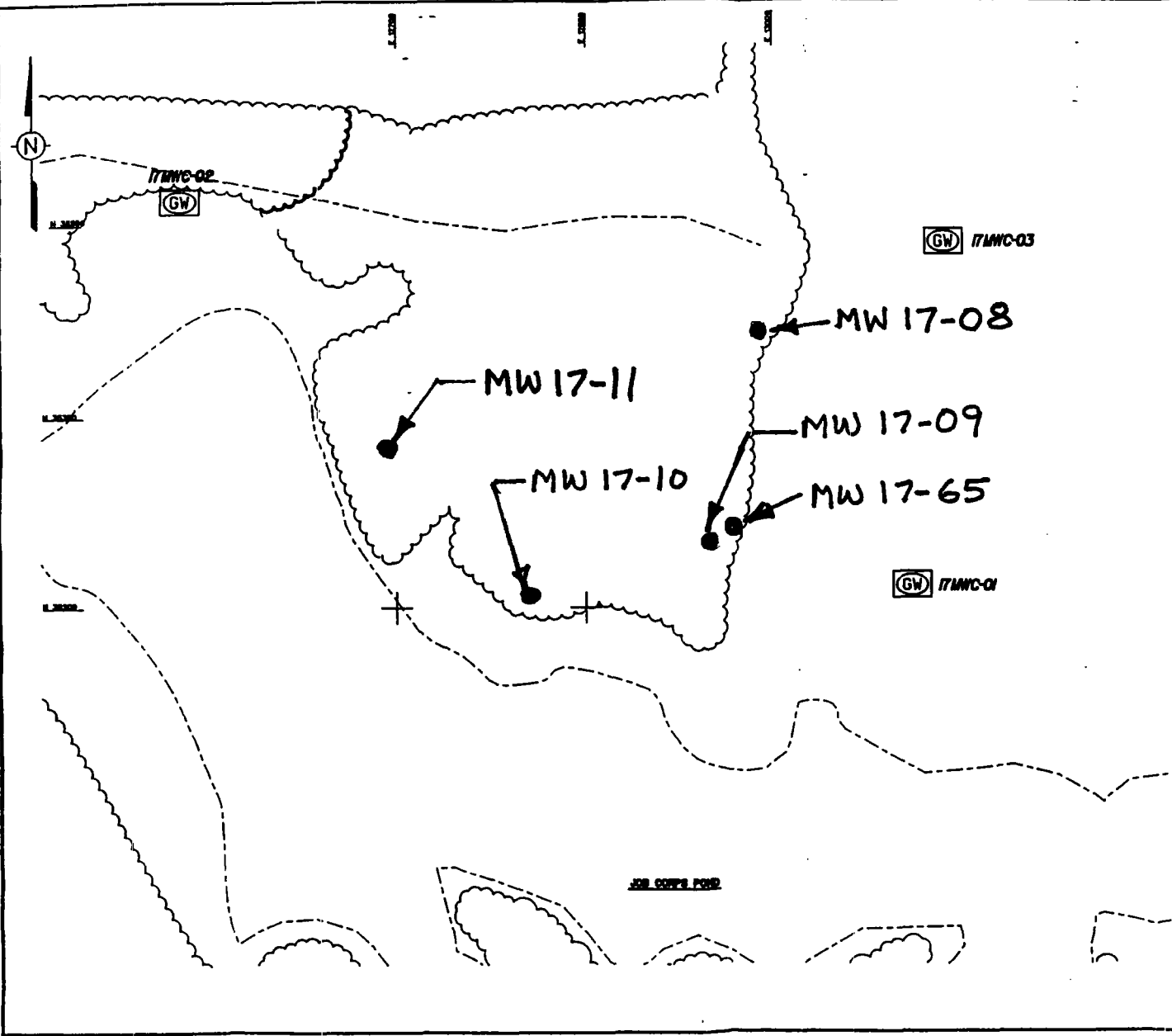
# Figure 6 - Location of Metals Area Landfill Groundwater Monitoring Wells.





STARTING DATE: 10/07/84  
 DRAWN BY: G. PACHECO  
 DATE LAST REV.:  
 DRAWN BY:  
 DRAFT. CHCK. BY: S. MAYES  
 ENGR. CHCK. BY: S. MAYES  
 INITIATION: S. MAYES  
 PROJ. MGR.: D. BURTON  
 DWS. NO.: 4066863L0-02  
 PROJ. NO.: 406686

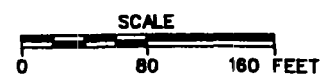
10/07/84 CP  
 4066863L0-02



**LEGEND:**

COMPLIANCE MONITORING WELL  
 EXISTING TREE LINE  
**PRE-REMEDIALTION MONITORING WELL**

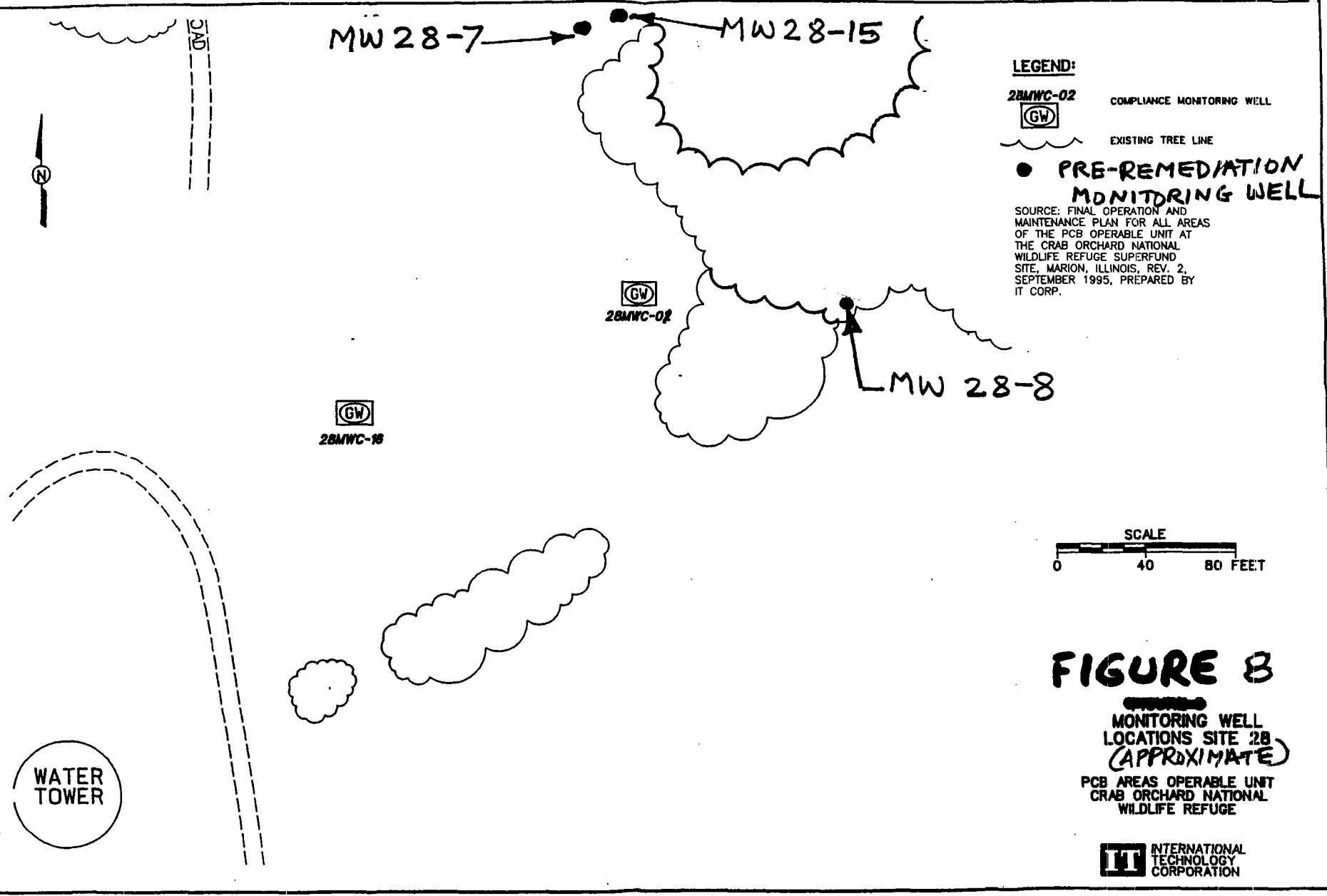
SOURCE: FINAL OPERATION AND MAINTENANCE PLAN FOR ALL AREAS OF THE PCB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE, MARION, ILLINOIS, REV. 2, SEPTEMBER 1995, PREPARED BY IT CORP.



**FIGURE 7**  
~~FIGURE 9~~  
 MONITORING WELL LOCATIONS SITE 17  
 PCB AREAS OPERABLE UNIT  
 CRAB ORCHARD NATIONAL WILDLIFE REFUGE



12/07/84 GP  
 FILENAME: 408882E.D43  
 STARTING DATE: 06/77/84  
 DRAWN BY: G. PARECO  
 DATE LAST REV.:  
 DRAWN BY:  
 DRAFT. CHECK. BY: G.P.  
 ENGR. CHECK. BY: S. HAYES  
 INITIATOR: S. HAYES  
 PROJ. NO.: 408882E.D43  
 DWG. NO.: 408882E.D43  
 PROJ. NO.: 408882E



**LEGEND:**

28MWC-02  
 (GW) COMPLIANCE MONITORING WELL

EXISTING TREE LINE

● PRE-REMEDICATION MONITORING WELL

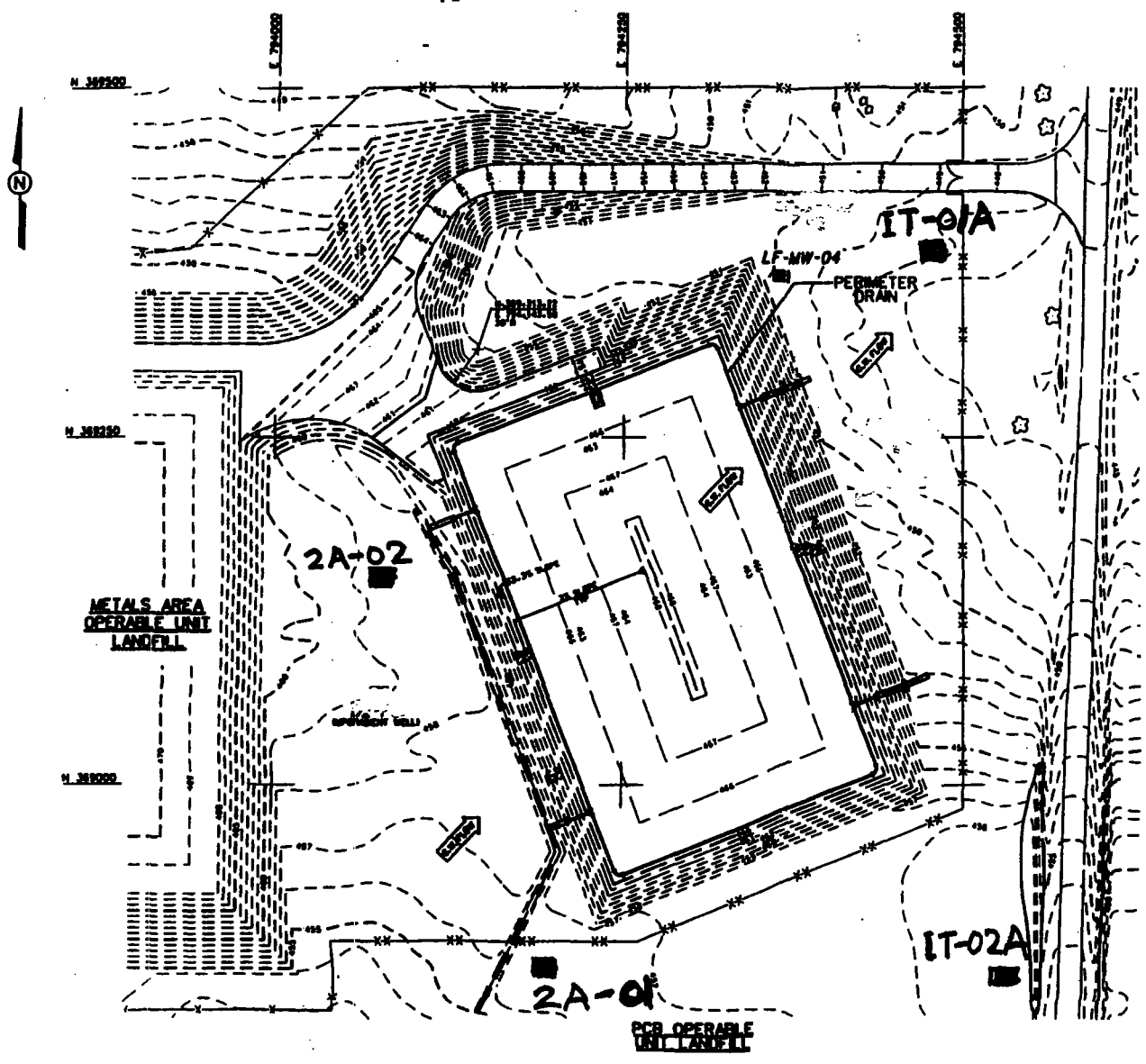
SOURCE: FINAL OPERATION AND MAINTENANCE PLAN FOR ALL AREAS OF THE PCB OPERABLE UNIT AT THE CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE, MARION, ILLINOIS, REV. 2, SEPTEMBER 1995, PREPARED BY IT CORP.

SCALE  
 0 40 80 FEET

**FIGURE 8**  
 MONITORING WELL LOCATIONS SITE 28 (APPROXIMATE)  
 PCB AREAS OPERABLE UNIT  
 CRAB ORCHARD NATIONAL WILDLIFE REFUGE

STARTING DATE: 10/7/84  
 DRAWN BY: G. PACHCO  
 DATE LAST REV.: 1/85  
 DRAFT: CHOL BY: C.A.  
 CHECK: CHOL BY: S. HAYES  
 INITIATOR: S. HAYES  
 ENG. NO.: 408684  
 PROJ. NO.: 408684

4/17/95 DJM  
 FILENAME: 408684-04-4



**LEGEND:**

- COMPLIANCE GROUNDWATER MONITORING POINT
- EXISTING TREE LINE
- GROUNDWATER FLOW DIRECTION

SOURCE: FINAL OPERATION AND MAINTENANCE PLAN FOR ALL AREAS OF THE PCB OPERABLE UNIT AT THE CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE, MARION, ILLINOIS, REV. 2, SEPTEMBER 1995, PREPARED BY IT CORP.



**FIGURE-9**  
**FIGURE-4**  
 MONITORING WELL SAMPLING LOCATIONS AT PCBOU LANDFILL

PCB AREAS OPERABLE UNIT  
 CRAB ORCHARD NATIONAL  
 WILDLIFE REFUGE

INTERNATIONAL TECHNOLOGY CORPORATION

REVISED

Table 2 Groundwater Monitoring Results for the Old Refuge Shop Area and Fire Station Landfill Sites (April 2006)  
 Surface Water Monitoring Results for the Plating Pond Site (May 2006)

Monitoring Well	RA-22-1	RA-22-2	RA-22-2 Duplicate	RA-22-3	RA-22-4	RA-22-5	RA-29-1	RA-29-2	RA-29-3	Plating Pond
Date	04/26/06	04/27/06	04/27/06	04/28/06	04/28/06	04/28/06	04/26/06	04/26/06	04/27/06	04/27/06
Inorganics (ug/l)										
Aluminum	230	900	1000	4800	260	3100	41	50	58	230
Antimony	3.9	7.7	8.8	3.7	3	10	5.4	5.2	4.5	3.2
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	42	36	36	78	55	47	65	26	41	16
Beryllium	1	0.72	0.75	0.86	0.26	0.3	0.81	0.71	0.64	0.63
Cadmium	ND	0.71	ND	ND	ND	0.97	ND	ND	ND	ND
Calcium	120000	43000	42000	120000	68000	15000	70000	120000	32000	3300
Chromium	ND	7.6	7.1	11	1.5	4.9	2.6	1.4	2.4	ND
Cobalt	1.6	ND	ND	5	8.7	3.6	ND	ND	ND	ND
Copper	ND	6.4	11	6.9	8.7	7.7	ND	ND	ND	ND
Cyanide, Total	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	460	1000	1000	11000	4700	5700	ND	ND	45	1700
Lead	ND	ND	ND	3.1	5	ND	ND	ND	2.7	ND
Magnesium	62000	26000	25000	99000	37000	3400	25000	65000	16000	2200
Manganese	690	17	14	2800	4900	600	10	2.1	2.6	93
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	5.7	13	13	19	14	11	ND	ND	2.2	ND
Potassium	1800	550	560	2600	980	800	1200	1100	860	1700
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	4.5	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	310000	83000	79000	110000	120000	20000	130000	97000	67000	1000
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	1.8	3	2.7	16	ND	9.8	1.3	2.2	ND	ND
Zinc	ND	ND	ND	14	ND	13	ND	ND	ND	ND

Table 3 Metals Area Landfill Leachate and Groundwater Monitoring Results (May 2006)

	Leachate	IT-01A	IT-02A	MW-2A1	MW-2A2	MW-2A3	MW-2A3 Duplicate	MW-2A4	MW-2A5	MW-2A6	MW-2A7	MW-2A8
Date	05/02/06	05/03/06	05/03/06	05/04/06	05/03/06	05/03/06	05/03/06	05/03/06	05/03/06	05/04/06	05/04/06	05/04/06
Inorganics (ug/l)												
Aluminum	2500	20	24	24	21	330	330	20	62	62	100	330
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	24	56	30	30	54	31	31	58	35	43	48	31
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	14000	38000	55000	90000	59000	13000	13000	79000	62000	49000	26000	13000
Chromium	2.6	2.2	2.1	ND	ND	5.2	4.3	6.7	ND	ND	1.7	4.3
Cobalt	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	2.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide, Total	ND	ND	ND	ND	2.1	ND	ND	ND	2.1	ND	3.8	ND
Iron	2000	ND	ND	ND	ND	250	300	ND	ND	ND	56	300
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	2400	17000	33000	35000	22000	7000	7000	39000	21000	20000	13000	7000
Manganese	61	3.1	52	16	ND	2.6	2.7	ND	0.72	0.85	5.4	2.7
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	8.9	3.4	ND	ND	ND	3.3	3	ND	ND	ND	2.2	3
Potassium	1900	530	830	520	490	350	340	3200	440	220	530	340
Selenium	ND	ND	ND	6.6	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	11000	32000	26000	41000	28000	16000	16000	89000	38000	21000	43000	16000
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	4.9	ND	ND	ND	1.2	ND	ND	1.7	1	ND	ND	ND
Zinc	60	6.7	ND	ND	ND	ND	ND	7.4	ND	ND	ND	ND

MONITORING WELL SAMPLES  
VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006 246118-001 <b>SITE 17</b>	27-APR-2006 246118-002 <b>SITE 17</b>	27-APR-2006 246118-003 <b>SITE 17</b>	25-APR-2006 246052-004 <b>SITE 28</b>	25-APR-2006 246052-005 <b>SITE 28</b>	26-APR-2006 246083-002 <b>PCB OU LANDFILL</b>
1,1,1-TRICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-TETRACHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-TRICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-DICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DIBROMO-3-CHLOROPROPANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DIBROMOETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROPROPANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-BUTANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2-HEXANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-METHYL-2-PENTANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
ACETONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
BENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
BROMOCHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
BROMODICHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
BROMOFORM	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
BROMOMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CARBON DISULFIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CARBON TETRACHLORIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CHLORODIBROMOMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROFORM	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
CIS-1,2-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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01-APR-2006 to 01-MAY-2006

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**TABLE 4**

MONITORING WELL SAMPLES  
VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006	27-APR-2006	27-APR-2006	25-APR-2006	25-APR-2006	26-APR-2006
		246118-001	246118-002	246118-003	246052-004	246052-005	246083-002
CIS-1,3-DICHLOROPROPENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
ETHYLBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
METHYLENE CHLORIDE	UG/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
STYRENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TETRACHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TOLUENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TRANS-1,2-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TRANS-1,3-DICHLOROPROPENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TRICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
VINYL CHLORIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
XYLENE, TOTAL	UG/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

MONITORING WELL SAMPLES  
VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006 246083-001	25-APR-2006 246052-006	26-APR-2006 246083-004	26-APR-2006 246083-003
1,1,1-TRICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-TETRACHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-TRICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,1-DICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,1-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DIBROMO-3-CHLOROPROPANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DIBROMOETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,2-DICHLOROPROPANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,3-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
1,4-DICHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
2-BUTANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0
2-HEXANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0
4-METHYL-2-PENTANONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0
ACETONE	UG/L	< 5.0	< 5.0	< 5.0	< 5.0
BENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
BROMOCHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
BROMODICHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
BROMOFORM	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
BROMOMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CARBON DISULFIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CARBON TETRACHLORIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CHLORODIBROMOMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROFORM	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CHLOROMETHANE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
CIS-1,2-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0

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TABLE 4



MONITORING WELL SAMPLES  
VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006	25-APR-2006	26-APR-2006	26-APR-2006
		246083-001	246052-006	246083-004	246083-003
CIS-1,3-DICHLOROPROPENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
ETHYLBENZENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
METHYLENE CHLORIDE	UG/L	< 2.0	< 2.0	< 2.0	< 2.0
STYRENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
TETRACHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
TOLUENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
TRANS-1,2-DICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
TRANS-1,3-DICHLOROPROPENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
TRICHLOROETHENE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
VINYL CHLORIDE	UG/L	< 1.0	< 1.0	< 1.0	< 1.0
XYLENE, TOTAL	UG/L	< 1.0	< 1	< 1.0	< 1.0

MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006 246118-001	27-APR-2006 246118-002	27-APR-2006 246118-003	25-APR-2006 246052-004	25-APR-2006 246052-005	26-APR-2006 246083-002
2,2'-OXYBIS(1-CHLOROPROPANE)	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2,4,5-TRICHLOROPHENOL	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
2,4,6-TRICHLOROPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2,4-DICHLOROPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2,4-DIMETHYLPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2,4-DINITROPHENOL	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
2,4-DINITROTOLUENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2,6-DINITROTOLUENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2-CHLORONAPHTHALENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2-CHLOROPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2-METHYLNAPHTHALENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2-METHYLPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
2-NITROANILINE	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
2-NITROPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
3,3'-DICHLOROBENZIDINE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
3-NITROANILINE	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
4,6-DINITRO-2-METHYLPHENOL	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
4-BROMOPHENYL-PHENYLETHER	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
4-CHLORO-3-METHYLPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
4-CHLOROANILINE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
4-CHLOROPHENYL-PHENYLETHER	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
4-METHYLPHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
4-NITROANILINE	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
4-NITROPHENOL	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
ACENAPHTHENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
ACENAPHTHYLENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
ANTHRACENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BENZO (A) ANTHRACENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BENZO (A) PYRENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10

MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006	27-APR-2006	27-APR-2006	25-APR-2006	25-APR-2006	26-APR-2006
		246118-001	246118-002	246118-003	246052-004	246052-005	246083-002
BENZO (B) FLUORANTHENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BENZO (G, H, I) PERYLENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BENZO (K) FLUORANTHENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BIS (2-CHLOROETHOXY) METHANE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BIS (2-CHLOROETHYL) ETHER	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BIS (2-ETHYLHEXYL) PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
BUTYLBENZYL PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
CARBAZOLE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
CHRYSENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DI-N-BUTYL PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DI-N-OCTYL PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DIBENZ (A, H) ANTHRACENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DIBENZOFURAN	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DIETHYL PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
DIMETHYL PHTHALATE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
FLUORANTHENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
FLUORENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
HEXACHLOROBENZENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
HEXACHLOROBUTADIENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
HEXACHLOROCYCLOPENTADIENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
HEXACHLOROETHANE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
INDENO (1, 2, 3-CD) PYRENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
ISOPHORONE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
N-NITROSODI-N-PROPYLAMINE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
N-NITROSODIPHENYLAMINE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
NAPHTHALENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
NITROBENZENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
PENTACHLOROPHENOL	UG/L	< 29	< 25	< 23	< 25	< 26	< 25
PHENANTHRENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10

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MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006 246118-001	27-APR-2006 246118-002	27-APR-2006 246118-003	25-APR-2006 246052-004	25-APR-2006 246052-005	26-APR-2006 246083-002
PHENOL	UG/L	< 11	< 10	< 9	< 10	< 10	< 10
PYRENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10

MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006	25-APR-2006	26-APR-2006	26-APR-2006
		246083-001	246052-006	246083-004	246083-003
2,2'-OXYBIS (1-CHLOROPROPANE)	UG/L	< 10	< 10	< 10	< 10
2,4,5-TRICHLOROPHENOL	UG/L	< 25	< 25	< 25	< 26
2,4,6-TRICHLOROPHENOL	UG/L	< 10	< 10	< 10	< 10
2,4-DICHLOROPHENOL	UG/L	< 10	< 10	< 10	< 10
2,4-DIMETHYLPHENOL	UG/L	< 10	< 10	< 10	< 10
2,4-DINITROPHENOL	UG/L	< 25	< 25	< 25	< 26
2,4-DINITROTOLUENE	UG/L	< 10	< 10	< 10	< 10
2,6-DINITROTOLUENE	UG/L	< 10	< 10	< 10	< 10
2-CHLORONAPHTHALENE	UG/L	< 10	< 10	< 10	< 10
2-CHLOROPHENOL	UG/L	< 10	< 10	< 10	< 10
2-METHYLNAPHTHALENE	UG/L	< 10	< 10	< 10	< 10
2-METHYLPHENOL	UG/L	< 10	< 10	< 10	< 10
2-NITROANILINE	UG/L	< 25	< 25	< 25	< 26
2-NITROPHENOL	UG/L	< 10	< 10	< 10	< 10
3,3'-DICHLORO BENZIDINE	UG/L	< 10	< 10	< 10	< 10
3-NITROANILINE	UG/L	< 25	< 25	< 25	< 26
4,6-DINITRO-2-METHYLPHENOL	UG/L	< 25	< 25	< 25	< 26
4-BROMOPHENYL-PHENYLETHER	UG/L	< 10	< 10	< 10	< 10
4-CHLORO-3-METHYLPHENOL	UG/L	< 10	< 10	< 10	< 10
4-CHLOROANILINE	UG/L	< 10	< 10	< 10	< 10
4-CHLOROPHENYL-PHENYLETHER	UG/L	< 10	< 10	< 10	< 10
4-METHYLPHENOL	UG/L	< 10	< 10	< 10	< 10
4-NITROANILINE	UG/L	< 25	< 25	< 25	< 26
4-NITROPHENOL	UG/L	< 25	< 25	< 25	< 26
ACENAPHTHENE	UG/L	< 10	< 10	< 10	< 10
ACENAPHTHYLENE	UG/L	< 10	< 10	< 10	< 10
ANTHRACENE	UG/L	< 10	< 10	< 10	< 10
BENZO (A) ANTHRACENE	UG/L	< 10	< 10	< 10	< 10
BENZO (A) PYRENE	UG/L	< 10	< 10	< 10	< 10

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MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006 246083-001	25-APR-2006 246052-006	26-APR-2006 246083-004	26-APR-2006 246083-003
BENZO (B) FLUORANTHENE	UG/L	< 10	< 10	< 10	< 10
BENZO (G, H, I) PERYLENE	UG/L	< 10	< 10	< 10	< 10
BENZO (K) FLUORANTHENE	UG/L	< 10	< 10	< 10	< 10
BIS (2-CHLOROETHOXY) METHANE	UG/L	< 10	< 10	< 10	< 10
BIS (2-CHLOROETHYL) ETHER	UG/L	< 10	< 10	< 10	< 10
BIS (2-ETHYLHEXYL) PHTHALATE	UG/L	< 10	< 10	< 10	< 10
BUTYLBENZYLPHTHALATE	UG/L	< 10	< 10	< 10	< 10
CARBAZOLE	UG/L	< 10	< 10	< 10	< 10
CHRYSENE	UG/L	< 10	< 10	< 10	< 10
DI-N-BUTYLPHTHALATE	UG/L	< 10	< 10	< 10	< 10
DI-N-OCTYLPHTHALATE	UG/L	< 10	< 10	< 10	< 10
DIBENZ (A, H) ANTHRACENE	UG/L	< 10	< 10	< 10	< 10
DIBENZOPURAN	UG/L	< 10	< 10	< 10	< 10
DIETHYLPHTHALATE	UG/L	< 10	< 10	< 10	< 10
DIMETHYLPHTHALATE	UG/L	< 10	< 10	< 10	< 10
FLUORANTHENE	UG/L	< 10	< 10	< 10	< 10
FLUORENE	UG/L	< 10	< 10	< 10	< 10
HEXACHLOROBENZENE	UG/L	< 10	< 10	< 10	< 10
HEXACHLOROBUTADIENE	UG/L	< 10	< 10	< 10	< 10
HEXACHLOROCYCLOPENTADIENE	UG/L	< 10	< 10	< 10	< 10
HEXACHLOROETHANE	UG/L	< 10	< 10	< 10	< 10
INDENO (1, 2, 3-CD) PYRENE	UG/L	< 10	< 10	< 10	< 10
ISOPHORONE	UG/L	< 10	< 10	< 10	< 10
N-NITROSODI-N-PROPYLAMINE	UG/L	< 10	< 10	< 10	< 10
N-NITROSODIPHENYLAMINE	UG/L	< 10	< 10	< 10	< 10
NAPHTHALENE	UG/L	< 10	< 10	< 10	< 10
NITROBENZENE	UG/L	< 10	< 10	< 10	< 10
PENTACHLOROPHENOL	UG/L	< 25 *	< 25 *	< 25 *	< 26 *
PHENANTHRENE	UG/L	< 10	< 10	< 10	< 10

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MONITORING WELL SAMPLES  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006	25-APR-2006	26-APR-2006	26-APR-2006
		246083-001	246052-006	246083-004	246083-003
PHENOL	UG/L	< 10	< 10	< 10	< 10
PYRENE	UG/L	< 10	< 10	< 10	< 10

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TABLE 5

MONITORING WELL SAMPLES  
PESTICIDES AND PCBS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006 246118-001	27-APR-2006 246118-002	27-APR-2006 246118-003	25-APR-2006 246052-004	25-APR-2006 246052-005	26-APR-2006 246083-002
4,4'-DDD	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
4,4'-DDE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
4,4'-DDT	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ALDRIN	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ALPHA-BHC	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ALPHA-CHLORDANE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
AROCLOR-1016	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1221	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1232	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1242	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1248	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1254	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
AROCLOR-1260	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
BETA-BHC	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
DELTA-BHC	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
DIELDRIN	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ENDOSULFAN I	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ENDOSULFAN II	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ENDOSULFAN SULFATE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
ENDRIN	UG/L	< 0.055 *	< 0.056 *	< 0.050 *	< 0.053	< 0.052	< 0.056
ENDRIN ALDEHYDE	UG/L	< 0.055 *	< 0.056 *	< 0.050 *	< 0.053	< 0.052	< 0.056
ENDRIN KETONE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
GAMMA-BHC (LINDANE)	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
GAMMA-CHLORDANE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
HEPTACHLOR	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
HEPTACHLOR EPOXIDE	UG/L	< 0.055	< 0.056	< 0.050	< 0.053	< 0.052	< 0.056
METHOXYCHLOR	UG/L	< 0.11	< 0.11	< 0.10	< 0.11	< 0.10	< 0.11
TOXAPHENE	UG/L	< 0.55	< 0.56	< 0.50	< 0.53	< 0.52	< 0.56
1,2,4-TRICHLORO BENZENE	UG/L	< 11	< 10	< 9	< 10	< 10	< 10

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MONITORING WELL SAMPLES  
PESTICIDES AND PCBs  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	33MMC-09	33MMC-17	33MMC-28	33MMC-39
		26-APR-2006	25-APR-2006	24-APR-2006	24-APR-2006	24-APR-2006	26-APR-2006
		246083-001	246052-006	246052-001	246052-003	246052-002	246083-006
4,4'-DDD	UG/L	< 0.051	< 0.048				
4,4'-DDE	UG/L	< 0.051	< 0.048				
4,4'-DDT	UG/L	< 0.051	< 0.048				
ALDRIN	UG/L	< 0.051	< 0.048				
ALPHA-BHC	UG/L	< 0.051	< 0.048				
ALPHA-CHLORDANE	UG/L	< 0.051	< 0.048				
AROCLOR-1016	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1221	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1232	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1242	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1248	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1254	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
AROCLOR-1260	UG/L	< 0.51	< 0.48	< 0.49	< 0.50	< 0.48	< 0.51
BETA-BHC	UG/L	< 0.051	< 0.048				
DELTA-BHC	UG/L	< 0.051	< 0.048				
DIELDRIN	UG/L	< 0.051	< 0.048				
ENDOSULFAN I	UG/L	< 0.051	< 0.048				
ENDOSULFAN II	UG/L	< 0.051	< 0.048				
ENDOSULFAN SULFATE	UG/L	< 0.051	< 0.048				
ENDRIN	UG/L	< 0.051	< 0.048				
ENDRIN ALDEHYDE	UG/L	< 0.051	< 0.048				
ENDRIN KETONE	UG/L	< 0.051	< 0.048				
GAMMA-BHC (LINDANE)	UG/L	< 0.051	< 0.048				
GAMMA-CHLORDANE	UG/L	< 0.051	< 0.048				
HEPTACHLOR	UG/L	< 0.051	< 0.048				
HEPTACHLOR EPOXIDE	UG/L	< 0.051	< 0.048				
METHOXYCHLOR	UG/L	< 0.10	< 0.096				
TOXAPHENE	UG/L	< 0.51	< 0.48				
1,2,4-TRICHLORO BENZENE	UG/L	< 10	< 10				

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MONITORING WELL SAMPLES  
PESTICIDES AND PCBS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	IT-01A	IT-02A
		26-APR-2006 246083-004	26-APR-2006 246083-003
4,4'-DDD	UG/L	< 0.051	< 0.061
4,4'-DDE	UG/L	< 0.051	< 0.061
4,4'-DDT	UG/L	< 0.051	< 0.061
ALDRIN	UG/L	< 0.051	< 0.061
ALPHA-BHC	UG/L	< 0.051	< 0.061
ALPHA-CHLORDANE	UG/L	< 0.051	< 0.061
AROCLOR-1016	UG/L	< 0.51	< 0.61
AROCLOR-1221	UG/L	< 0.51	< 0.61
AROCLOR-1232	UG/L	< 0.51	< 0.61
AROCLOR-1242	UG/L	< 0.51	< 0.61
AROCLOR-1248	UG/L	< 0.51	< 0.61
AROCLOR-1254	UG/L	< 0.51	< 0.61
AROCLOR-1260	UG/L	< 0.51	< 0.61
BETA-BHC	UG/L	< 0.051	< 0.061
DELTA-BHC	UG/L	< 0.051	< 0.061
DIELDRIN	UG/L	< 0.051	< 0.061
ENDOSULFAN I	UG/L	< 0.051	< 0.061
ENDOSULFAN II	UG/L	< 0.051	< 0.061
ENDOSULFAN SULFATE	UG/L	< 0.051	< 0.061
ENDRIN	UG/L	< 0.051	< 0.061
ENDRIN ALDEHYDE	UG/L	< 0.051	< 0.061
ENDRIN KETONE	UG/L	< 0.051	< 0.061
GAMMA-BHC (LINDANE)	UG/L	< 0.051	< 0.061
GAMMA-CHLORDANE	UG/L	< 0.051	< 0.061
HEPTACHLOR	UG/L	< 0.051	< 0.061
HEPTACHLOR EPOXIDE	UG/L	< 0.051	< 0.061
METHOXYCHLOR	UG/L	< 0.10	< 0.12
TOXAPHENE	UG/L	< 0.51	< 0.61
1,2,4-TRICHLOROBENZENE	UG/L	< 10	< 10

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MONITORING WELL SAMPLES  
METALS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01	17MWC-02	17MWC-03	28-16	28MWC-01	2A-01
		27-APR-2006 246118-001	27-APR-2006 246118-002	27-APR-2006 246118-003	25-APR-2006 246052-004	25-APR-2006 246052-005	26-APR-2006 246083-002
ALUMINUM, DISSOLVED	UG/L	239	22.6 B	161 B	12.9 B	17.8 B	
ALUMINUM, TOTAL	UG/L						59.7 B
ANTIMONY, DISSOLVED	UG/L	< 60.0	2.3 B	< 60.0	0.040 B	< 60.0	
ANTIMONY, TOTAL	UG/L						< 60.0
ARSENIC, DISSOLVED	UG/L	1.7 B	0.61 B	2.0 B	4.0 B	0.75 B	
ARSENIC, TOTAL	UG/L						1.5 B
BARIUM, DISSOLVED	UG/L	53.6 B	71.6 B	84.3 B	92.9 B	25.0 B	
BARIUM, TOTAL	UG/L						26.4 B
BERYLLIUM, DISSOLVED	UG/L	0.060 B	0.090 B	0.040 B	0.080 B	0.090 B	
BERYLLIUM, TOTAL	UG/L						0.10 B
CADMIUM, DISSOLVED	UG/L	0.24 B	0.24 B	0.17 B	0.31 B	< 5.0	
CADMIUM, TOTAL	UG/L	0.080 B	0.41 B	< 5.0	0.69 B	0.62 B	0.30 B
CALCIUM, DISSOLVED	UG/L	10100	84900	17500	40800	71800	
CALCIUM, TOTAL	UG/L						74800
CHROMIUM, DISSOLVED	UG/L	5.0 B	13.5	0.14 B	4.0 B	2.6 B	
CHROMIUM, TOTAL	UG/L						0.84 B
COBALT, DISSOLVED	UG/L	3.8 B	1.7 B	2.9 B	0.53 B	1.0 B	
COBALT, TOTAL	UG/L						0.28 B
COPPER, DISSOLVED	UG/L	0.19 B	< 25.0	0.78 B	0.20 B	< 25.0	
COPPER, TOTAL	UG/L						< 25.0
IRON, DISSOLVED	UG/L	262	31.1 B	127	< 100	4.4 B	
IRON, TOTAL	UG/L						< 100
LEAD, DISSOLVED	UG/L	< 5.0	< 5.0	0.28 B	0.14 B	0.73 B	
LEAD, TOTAL	UG/L	2.7 B	5.0	32.4	< 5.0	< 5.0	< 5.0
MAGNESIUM, DISSOLVED	UG/L	4400 B	37700	6890	14800	26800	
MAGNESIUM, TOTAL	UG/L						29500
MANGANESE, DISSOLVED	UG/L	11.3 B	21.7	268	0.83 B	0.68 B	
MANGANESE, TOTAL	UG/L						3.6 B
MERCURY, DISSOLVED	UG/L	0.0098 B	< 0.20	< 0.20	< 0.20	0.011 B	

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MONITORING WELL SAMPLES  
METALS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	17MWC-01		17MWC-02		17MWC-03		28-16		28MWC-01		2A-01	
		27-APR-2006	246118-001	27-APR-2006	246118-002	27-APR-2006	246118-003	25-APR-2006	246052-004	25-APR-2006	246052-005	26-APR-2006	246083-002
MERCURY, TOTAL	UG/L											<	0.20
NICKEL, DISSOLVED	UG/L	8.3	B	18.3	B	5.8	B	5.0	B	0.60	B		
NICKEL, TOTAL	UG/L											0.50	B
POTASSIUM, DISSOLVED	UG/L	552	B	1910	B	1260	B	884	B	393	B		
POTASSIUM, TOTAL	UG/L											539	B
SELENIUM, DISSOLVED	UG/L	0.24	B*	4.1	B*	1.4	B*	0.28	B*	<	10.0	*	
SELENIUM, TOTAL	UG/L											4.7	B*
SILVER, DISSOLVED	UG/L	<	10.0	<	10.0	0.040	B	0.21	B	0.24	B		
SILVER, TOTAL	UG/L											<	10.0
SODIUM, DISSOLVED	UG/L	33600		152000		59000		41500		28200			
SODIUM, TOTAL	UG/L												37200
THALLIUM, DISSOLVED	UG/L	<	10.0	<	10.0	<	10.0	<	10.0	<	10.0		
THALLIUM, TOTAL	UG/L											<	10.0
VANADIUM, DISSOLVED	UG/L	0.17	B	0.89	B	0.44	B	0.91	B	0.88	B		
VANADIUM, TOTAL	UG/L											1.5	B
ZINC, DISSOLVED	UG/L	15.4	B	10.3	B	16.9	B	4.8	B	2.3	B		
ZINC, TOTAL	UG/L											1.7	B

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MONITORING WELL SAMPLES  
METALS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006 246083-001	25-APR-2006 246052-006	26-APR-2006 246083-004	26-APR-2006 246083-003
ALUMINUM, DISSOLVED	UG/L				
ALUMINUM, TOTAL	UG/L	20.0 B	13.8 B	41.6 B	43.6 B
ANTIMONY, DISSOLVED	UG/L				
ANTIMONY, TOTAL	UG/L	< 60.0	0.010 B	< 60.0	< 60.0
ARSENIC, DISSOLVED	UG/L				
ARSENIC, TOTAL	UG/L	< 10.0	2.1 B	0.10 B	< 10.0
BARIUM, DISSOLVED	UG/L				
BARIUM, TOTAL	UG/L	28.4 B	55.9 B	53.2 B	31.9 B
BERYLLIUM, DISSOLVED	UG/L				
BERYLLIUM, TOTAL	UG/L	0.10 B	0.060 B	0.050 B	0.080 B
CADMIUM, DISSOLVED	UG/L				
CADMIUM, TOTAL	UG/L	0.18 B	< 5.0	0.22 B	< 5.0
CALCIUM, DISSOLVED	UG/L				
CALCIUM, TOTAL	UG/L	76900	59500	30900	57700
CHROMIUM, DISSOLVED	UG/L				
CHROMIUM, TOTAL	UG/L	1.8 B	0.64 B	2.7 B	2.5 B
COBALT, DISSOLVED	UG/L				
COBALT, TOTAL	UG/L	0.62 B	0.59 B	0.16 B	0.31 B
COPPER, DISSOLVED	UG/L				
COPPER, TOTAL	UG/L	0.14 B	< 25.0	0.31 B	< 25.0
IRON, DISSOLVED	UG/L				
IRON, TOTAL	UG/L	< 100	< 100	58.3 B	< 100
LEAD, DISSOLVED	UG/L				
LEAD, TOTAL	UG/L	< 5.0	< 5.0	0.17 B	0.18 B
MAGNESIUM, DISSOLVED	UG/L				
MAGNESIUM, TOTAL	UG/L	30300	22300	14300	35300
MANGANESE, DISSOLVED	UG/L				
MANGANESE, TOTAL	UG/L	3.4 B	< 15.0	0.64 B	3.7 B
MERCURY, DISSOLVED	UG/L				

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TABLE 7

MONITORING WELL SAMPLES  
METALS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	2A-01 DUP	2A-02	IT-01A	IT-02A
		26-APR-2006 246083-001	25-APR-2006 246052-006	26-APR-2006 246083-004	26-APR-2006 246083-003
MERCURY, TOTAL	UG/L	< 0.20	< 0.20	< 0.20	< 0.20
NICKEL, DISSOLVED	UG/L				
NICKEL, TOTAL	UG/L	2.2 B	0.77 B	3.8 B	0.69 B
POTASSIUM, DISSOLVED	UG/L				
POTASSIUM, TOTAL	UG/L	547 B	523 B	573 B	903 B
SELENIUM, DISSOLVED	UG/L				
SELENIUM, TOTAL	UG/L	4.8 B*	3.0 B*	< 10.0 *	1.8 B*
SILVER, DISSOLVED	UG/L				
SILVER, TOTAL	UG/L	0.18 B	0.47 B	0.24 B	0.50 B
SODIUM, DISSOLVED	UG/L				
SODIUM, TOTAL	UG/L	37900	28300	31100	27000
THALLIUM, DISSOLVED	UG/L				
THALLIUM, TOTAL	UG/L	< 10.0	< 10.0	1.0 B	< 10.0
VANADIUM, DISSOLVED	UG/L				
VANADIUM, TOTAL	UG/L	1.1 B	1.9 B	0.37 B	0.61 B
ZINC, DISSOLVED	UG/L				
ZINC, TOTAL	UG/L	5.6 B	3.7 B	8.2 B	0.84 B

LEACHATE  
 VOLATILE ORGANIC COMPOUNDS  
 APRIL 2006  
 CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE	
		26-APR-2006	246083-005
1,1,1-TRICHLOROETHANE	UG/L	<	1.0
1,1,2,2-TETRACHLOROETHANE	UG/L	<	1.0
1,1,2-TRICHLOROETHANE	UG/L	<	1.0
1,1-DICHLOROETHANE	UG/L	<	1.0
1,1-DICHLOROETHENE	UG/L	<	1.0
1,2-DIBROMO-3-CHLOROPROPANE	UG/L	<	1.0
1,2-DIBROMOETHANE	UG/L	<	1.0
1,2-DICHLOROBENZENE	UG/L	<	1.0
1,2-DICHLOROETHANE	UG/L	<	1.0
1,2-DICHLOROPROPANE	UG/L	<	1.0
1,3-DICHLOROBENZENE	UG/L	<	1.0
1,4-DICHLOROBENZENE	UG/L	<	1.0
2-BUTANONE	UG/L	<	5.0
2-HEXANONE	UG/L	<	5.0
4-METHYL-2-PENTANONE	UG/L	<	5.0
ACETONE	UG/L	<	5.0
BENZENE	UG/L	<	1.0
BROMOCHLOROMETHANE	UG/L	<	1.0
BROMODICHLOROMETHANE	UG/L	<	1.0
BROMOFORM	UG/L	<	1.0
BROMOMETHANE	UG/L	<	1.0
CARBON DISULFIDE	UG/L	<	1.0
CARBON TETRACHLORIDE	UG/L	<	1.0
CHLOROBENZENE	UG/L	<	1.0
CHLORODIBROMOMETHANE	UG/L	<	1.0
CHLOROETHANE	UG/L	<	1.0
CHLOROFORM	UG/L	<	1.0
CHLOROMETHANE	UG/L	<	1.0
CIS-1,2-DICHLOROETHENE	UG/L	<	1.0

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LEACHATE  
VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE 26-APR-2006 246083-005
CIS-1,3-DICHLOROPROPENE	UG/L	< 1.0
ETHYLBENZENE	UG/L	< 1.0
METHYLENE CHLORIDE	UG/L	< 2.0
STYRENE	UG/L	< 1.0
TETRACHLOROETHENE	UG/L	< 1.0
TOLUENE	UG/L	< 1.0
TRANS-1,2-DICHLOROETHENE	UG/L	< 1.0
TRANS-1,3-DICHLOROPROPENE	UG/L	< 1.0
TRICHLOROETHENE	UG/L	< 1.0
VINYL CHLORIDE	UG/L	< 1.0
XYLENE, TOTAL	UG/L	< 1.0



LEACHATE  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE	
		26-APR-2006	246083-005
2,2'-OXYBIS(1-CHLOROPROPANE)	UG/L	<	9
2,4,5-TRICHLOROPHENOL	UG/L	<	23
2,4,6-TRICHLOROPHENOL	UG/L	<	9
2,4-DICHLOROPHENOL	UG/L	<	9
2,4-DIMETHYLPHENOL	UG/L	<	9
2,4-DINITROPHENOL	UG/L	<	23
2,4-DINITROTOLUENE	UG/L	<	9
2,6-DINITROTOLUENE	UG/L	<	9
2-CHLORONAPHTHALENE	UG/L	<	9
2-CHLOROPHENOL	UG/L	<	9
2-METHYLNAPHTHALENE	UG/L	<	9
2-METHYLPHENOL	UG/L	<	9
2-NITROANILINE	UG/L	<	23
2-NITROPHENOL	UG/L	<	9
3,3'-DICHLOROBENZIDINE	UG/L	<	9
3-NITROANILINE	UG/L	<	23
4,6-DINITRO-2-METHYLPHENOL	UG/L	<	23
4-BROMOPHENYL-PHENYLETHER	UG/L	<	9
4-CHLORO-3-METHYLPHENOL	UG/L	<	9
4-CHLOROANILINE	UG/L	<	9
4-CHLOROPHENYL-PHENYLETHER	UG/L	<	9
4-METHYLPHENOL	UG/L	<	9
4-NITROANILINE	UG/L	<	23
4-NITROPHENOL	UG/L	<	23
ACENAPHTHENE	UG/L	<	9
ACENAPHTHYLENE	UG/L	<	9
ANTHRACENE	UG/L	<	9
BENZO (A) ANTHRACENE	UG/L	<	9
BENZO (A) PYRENE	UG/L	<	9

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LEACHATE  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE 26-APR-2006 246083-005
BENZO(B) FLUORANTHENE	UG/L	< 9
BENZO(G, H, I) PERYLENE	UG/L	< 9
BENZO(K) FLUORANTHENE	UG/L	< 9
BIS(2-CHLOROETHOXY) METHANE	UG/L	< 9
BIS(2-CHLOROETHYL) ETHER	UG/L	< 9
BIS(2-ETHYLHEXYL) PHTHALATE	UG/L	< 9
BUTYLBENZYLPHTHALATE	UG/L	< 9
CARBAZOLE	UG/L	< 9
CHRYSENE	UG/L	< 9
DI-N-BUTYLPHTHALATE	UG/L	< 9
DI-N-OCTYLPHTHALATE	UG/L	< 9
DIBENZ(A, H) ANTHRACENE	UG/L	< 9
DIBENZOFURAN	UG/L	< 9
DIETHYLPHTHALATE	UG/L	< 9
DIMETHYLPHTHALATE	UG/L	< 9
FLUORANTHENE	UG/L	< 9
FLUORENE	UG/L	< 9
HEXACHLOROBENZENE	UG/L	< 9
HEXACHLOROBUTADIENE	UG/L	< 9
HEXACHLOROCYCLOPENTADIENE	UG/L	< 9
HEXACHLOROETHANE	UG/L	< 9
INDENO(1, 2, 3-CD) PYRENE	UG/L	< 9
ISOPHORONE	UG/L	< 9
N-NITROSODI-N-PROPYLAMINE	UG/L	< 9
N-NITROSODIPHENYLAMINE	UG/L	< 9
NAPHTHALENE	UG/L	< 9
NITROBENZENE	UG/L	< 9
PENTACHLOROPHENOL	UG/L	< 23
PHENANTHRENE	UG/L	< 9

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LEACHATE  
SEMI-VOLATILE ORGANIC COMPOUNDS  
APRIL 2006  
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE 26-APR-2006 246083-005
PHENOL	UG/L	< 9
PYRENE	UG/L	< 9

LEACHATE  
 PESTICIDES AND PCBS  
 APRIL 2006  
 CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE	
		26-APR-2006	246083-005
4,4'-DDD	UG/L	<	0.051
4,4'-DDE	UG/L	<	0.051
4,4'-DDT	UG/L	<	0.051
ALDRIN	UG/L	<	0.051
ALPHA-BHC	UG/L	<	0.051
ALPHA-CHLORDANE	UG/L	<	0.051
AROCLOR-1016	UG/L	<	0.51
AROCLOR-1221	UG/L	<	0.51
AROCLOR-1232	UG/L	<	0.51
AROCLOR-1242	UG/L	<	0.51
AROCLOR-1248	UG/L	<	0.51
AROCLOR-1254	UG/L	<	0.51
AROCLOR-1260	UG/L	<	0.51
BETA-BHC	UG/L	<	0.051
DELTA-BHC	UG/L	<	0.051
DIELDRIN	UG/L	<	0.051
ENDOSULFAN I	UG/L	<	0.051
ENDOSULFAN II	UG/L	<	0.051
ENDOSULFAN SULFATE	UG/L	<	0.051
ENDRIN	UG/L	<	0.051
ENDRIN ALDEHYDE	UG/L	<	0.051
ENDRIN KETONE	UG/L	<	0.051
GAMMA-BHC (LINDANE)	UG/L	<	0.051
GAMMA-CHLORDANE	UG/L	<	0.051
HEPTACHLOR	UG/L	<	0.051
HEPTACHLOR EPOXIDE	UG/L	<	0.051
METHOXYCHLOR	UG/L	<	0.10
TOXAPHENE	UG/L	<	0.51
1,2,4-TRICHLOROBENZENE	UG/L	<	9

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LEACHATE  
 METALS  
 APRIL 2006  
 CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PARAMETER	UNITS	LEACHATE	
		26-APR-2006	246083-005
ALUMINUM, TOTAL	UG/L	77.2	B
ANTIMONY, TOTAL	UG/L	0.40	B
ARSENIC, TOTAL	UG/L	1.2	B
BARIUM, TOTAL	UG/L	45.6	B
BERYLLIUM, TOTAL	UG/L	0.15	B
CADMIUM, TOTAL	UG/L	0.060	B
CALCIUM, TOTAL	UG/L	469000	
CHROMIUM, TOTAL	UG/L	< 10.0	B
COBALT, TOTAL	UG/L	0.18	B
COPPER, TOTAL	UG/L	4.7	B
IRON, TOTAL	UG/L	254	
LEAD, TOTAL	UG/L	< 5.0	
MAGNESIUM, TOTAL	UG/L	154000	
MANGANESE, TOTAL	UG/L	574	
MERCURY, TOTAL	UG/L	< 0.20	
NICKEL, TOTAL	UG/L	1.6	B
POTASSIUM, TOTAL	UG/L	16100	
SELENIUM, TOTAL	UG/L	< 10.0	*
SILVER, TOTAL	UG/L	0.16	B
SODIUM, TOTAL	UG/L	497000	
THALLIUM, TOTAL	UG/L	< 10.0	
VANADIUM, TOTAL	UG/L	1.3	B
ZINC, TOTAL	UG/L	< 20.0	

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 TABLE II