US EPA RECORDS CENTER REGION 5
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FIFTH FIVE-YEAR REVIEW REPORT FOR CRAB ORCHARD NATIONAL WILDLIFE REFUGE SUPERFUND SITE MARION, ILLINOIS

Prepared by

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6/30/2016
Date

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Five-Year Review Report

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List of Acronyms and Abbreviations

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
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
DA	Department of the Army
DOD	Department of Defense
DOI	Department of the Interior
EMMA OU	Explosive/Munitions Manufacturing Areas Operable Unit
ELUC	Environmental Land Use Control
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FWS	United States Fish and Wildlife Service
FYR	Five-Year Review
ICs	Institutional Controls
ITW	Illinois Tool Works
LAKE OU	Lake Monitoring Operable Unit
LUCMOA	Land Use Control Memorandum of Agreement
Metals OU	Metals Areas Operable Unit
MISCA OU	Miscellaneous Areas Operable Unit
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OE	Ordnance and Explosives
OU	Operable Unit
PCB	Polychlorinated biphenyl
PCB OU	PCB Areas Operable Unit
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
Schlumberger	Schlumberger Technology Corporation
SVOC	Semi-Volatile Organic Compound
TTU	Thermal Treatment Unit
UECA	Uniform Environmental Covenant Act
USACE	United States Army Corps of Engineers
UU/UE	Unlimited Use and Unrestricted Exposure
VOC	Volatile Organic Compound

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Executive Summary

The Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund Site (Crab Orchard Site) consists of the following seven Operable Units (OUs):

- OU1 – Metals Areas Operable Unit (Metals OU)
- OU2 – PCB Areas Operable Unit (PCB OU)
- OU3 – Explosive/Munitions Manufacturing Areas Operable Unit (EMMA OU)
- OU4 – Miscellaneous Areas Operable Unit (MISCA OU)
- OU5 – Waters Towers OU
- OU6 – Additional and Uncharacterized Sites Operable Unit (AUS OU)
- OU7 – Lake Monitoring OU (Lake OU)

The following Records of Decision (RODs), Explanation of Significant Differences (ESDs) and ROD Amendments have been issued for four of the OUs which are addressed in this Five Year Review (FYR):

- ROD for the Metals OU (March 1990)
- ROD for the PCB OU (August 1990)
- ROD for the EMMA OU (February 1997)
- ESD for the EMMA OU (January 2000)
- ESD for the PCB OU (June 2000)
- ROD for Site 14 of the MISCA OU (October 2001)
- ROD for Site 36 of the MISCA OU (September 2002)
- ROD Amendment for the PCB OU (August 2007)
- ROD Amendment 2 (Interim Remedy) for the PCB OU (August 2014)

The United Environmental Protection Agency (EPA) did not sign a decision document for the Water Towers OU. The United States Fish and Wildlife Service (FWS) conducted a removal action to remove lead contaminated soil in the vicinity of three water towers and at the Visitors' Center. There is no decision document for the AUS OU since a remedial investigation/feasibility study (RI/FS) is underway. The RI/FS is expected to be complete by 2018. EPA did not sign a decision document for the Lake OU. FWS transferred portions of the Lake OU requiring further RI to the AUS OU. No further action was necessary at the Lake OU. Therefore, the Water Towers OU, AUS OU, and the Lake OU are not addressed in this FYR other than to provide general background information.

The following bullets describe the protectiveness statements for the four OUs of the Crab Orchard Site:

- <u>Metals OU</u>: The remedy at the Metals OU is currently protective of human health and the environment because the soil and sediments at all sites within this OU have been remediated to the cleanup levels selected in the Metals OU ROD. However, in order

for the remedy to be protective in the long-term, the following actions need to be taken: an institutional control (IC) is needed for the Metals Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, the Illinois Environmental Protection Agency (Illinois EPA), and FWS should enter into a Land Use Control Memorandum of Agreement (LUCMOA) consistent with Illinois Uniform Environmental Covenant Act (UECA) to ensure the durability of the ICs and long-term stewardship.

- PCB OU: The remedy at the PCB OU is currently protective of human health and the environment because the Area 9 Repository and the PCB Area Landfill effectively contain the site contamination. The remedial action conducted to date and ongoing/future cleanup activities to address soil and groundwater contamination for Plumes 1, 2, and 3 are expected to mitigate any potential long-term risk including vapor intrusion and restore the groundwater to beneficial use. However, in order for the remedy to be protective in the long-term, the following actions need to be taken: an IC is needed for the PCB Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.
- EMMA OU: The remedies implemented for the EMMA OU are currently protective of human health and the environment. The response actions are effective and requisite land use controls are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.
- MISCA OU: The remedies at the MISCA OU, Sites 14 and 36, are currently protective of human health and the environment because the remedies are completed and ICs are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Sangamo Electric Dump/Crab Orchard National Wildlife Refuge NPL Site		
EPA ID: IL8143609487		
Region: 5	**State:** IL	**City/County:** Carterville

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** No

REVIEW STATUS
Lead agency: EPA
Author name (Federal or State Project Manager): Nanjunda Gowda
Author affiliation: EPA
Review period: 6/17/2015 - 6/15/2016
Date of site inspection: June 17, 2015 and September 09, 2015
Type of review: Statutory
Review number: 5
Triggering action date: 06/30/2011
Due date *(five years after triggering action date)*: 6/30/2016

Five-Year Review Summary Form (continued)

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None

Issues and Recommendations Identified in the Five-Year Review:

OU(s): OU1, OU2, OU3, and OU4	**Issue Category: Institutional Controls**			
	Issue: ICs are needed for the Metals Area and PCB Area landfills and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced.			
	Recommendation: EPA recommends that the FWS update the April 2008 ELUC Plan to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA recommends that EPA, Illinois EPA, and FWS enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 30, 2017

Protectiveness Statement(s)	
Operable Unit: OU1 (Metals OU)	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy at the Metals OU is currently protective of human health and the environment because the soil and sediments at all sites within this OU have been remediated to the cleanup levels selected in the Metals OU ROD. However, in order for the remedy to be protective in the long-term, the following actions need to be taken: an IC is needed for the Metals Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.	

Operable Unit:	*Protectiveness Determination:*
OU2 (PCB OU)	Short-term Protective

Protectiveness Statement:
The remedy at the PCB OU is currently protective of human health and the environment because the Area 9 Repository and the PCB Area Landfill effectively contain the site contamination. The remedial action conducted to date and ongoing/future cleanup activities to address soil and groundwater contamination for Plumes 1, 2, and 3 are expected to mitigate any potential long-term risk including vapor intrusion and restore the groundwater to beneficial use. However, in order for the remedy to be protective in the long-term, the following actions need to be taken: an IC is needed for the PCB Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

Operable Unit:	*Protectiveness Determination:*
OU3 (EMMA OU)	Short-term Protective

Protectiveness Statement:
The remedies implemented for the EMMA OU are currently protective of human health and the environment. The response actions are effective and requisite land use controls are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

Operable Unit:	*Protectiveness Determination:*
OU4 (MISCA OU)	Short-term Protective

Protectiveness Statement:
The remedies at the MISCA OU, Sites 14 and 36, are currently protective of human health and the environment because the remedies are completed and ICs are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

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Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois

Fifth Five-Year Review Report

I. Introduction

EPA Region 5 conducted an FYR of the remedial actions implemented at the Crab Orchard Site in Carterville, Illinois. This review was conducted from June 17, 2015 through June 20, 2016. This report documents the results of the review. The purpose of the FYR is to determine whether the remedies implemented at the Crab Orchard Site are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and identify recommendations to address them.

This review is required by statute. EPA must conduct FYRs consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA and commonly referred to as Superfund) 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.*

This is the fifth FYR for the Crab Orchard Superfund Site. The triggering action for this statutory review is the June 30, 2011 completion date of the previous FYR. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Crab Orchard Site consists of the following seven OUs:

- OU1 – Metals OU
- OU2 – PCB OU
- OU3 – EMMA OU
- OU4 – MISCA OU

- OU5 – Waters Towers OU
- OU6 – AUS OU
- OU7 – Lake OU

This FYR addresses four OUs: Metals, PCB, EMMA and MISCA OUs. The Water Towers, AUS, and Lake OUs are not included because EPA has not issued decision documents for them.

II. Site Chronology

The following table lists the chronology of events for the Crab Orchard Site.

Table 1 Chronology of Events

Date	Event
1984	Crab Orchard Site proposed for NPL
2/86	EPA and FWS entered a Federal Facility Initial Compliance Agreement for the performance of a Remedial Investigation/Feasibility Study (RI/FS)
5/86	RI/FS began at the Crab Orchard Site
7/87	Listed on the NPL as Final
8/88	RI/FS complete
3/30/90	ROD issued for Metals 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	FYR completed for the PCB OU
9/27/01	FYR completed for the Metals Areas OU
10/30/01	ROD issued for MISCA OU – Site 14
9/12/02	ROD issued for MISCA OU – Site 36
9/27/06	Third FYR completed for the Crab Orchard Site
08/07/07	ROD Amendment issued for the PCB OU
06/30/11	Fourth FYR completed for the Crab Orchard Site
08/29/14	ROD Amendment 2 (Interim Remedy) issued for the PCB OU

III. Background

A. Location and Establishment

The Crab Orchard Site is contained in the Crab Orchard National Wildlife Refuge (Refuge) located 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 FWS has operated the Refuge under the authority of the United States Department of the Interior (DOI). The land is used as a wildlife refuge, and also for recreational, agricultural 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 agricultural areas, and restricted access to hunters. The areas that are part of the Superfund investigations are located in the eastern side of the 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 three federal and state listed threatened and endangered species: the Indiana bat, Northern Long Eared bat, and Southeastern Mitosis.

B. World War II Era and Later Industrial Activities

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. 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 that created the Refuge required DOI to continue leasing former wartime industry buildings to industrial tenants. The industrial manufacturing operations have included ammunition and explosives, metal fabrication, plating, and manufacturing of printing inks, fiberglass boats, and electrical components. Over the years these tenants disposed of their waste at several areas within the Refuge. Today, the current industrial tenants must comply with state and federal environmental rules and regulations. 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, EPA placed the Crab Orchard Site on the NPL in July 1987.

C. Remedial Investigation

On February 26, 1986, the FWS and EPA entered into a Federal Facility Initial Compliance Agreement for the performance of an RI/FS. FWS and Sangamo Weston, Inc.

(Sangamo), former industrial tenant at the Refuge, entered into a Cooperative Agreement to conduct the RI/FS at the Crab Orchard Site, which began in 1986 and was completed in August 1988. The RI Report investigated thirty-three study sites, including two background sites. Based on the results of the RI Report, EPA, in consultation with DOI and the 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 such as cadmium, chromium, and lead. These are designated as the Metals OU. The second Proposed Plan addressed four study sites that were primarily contaminated with PCBs, lead, and cadmium. These are designated as the PCB OU.

D. Development of Study Sites and Operable Units

Pursuant to CERCLA Section 120(e), EPA, Illinois EPA, Department of the Army (DA), and DOI entered into a Federal Facility Agreement (FFA) on September 13, 1991 to manage the investigation and cleanups at the Crab Orchard Site. The 33 study sites had different contamination problems caused by different industries in different areas of the Refuge. To accommodate the different cleanup remedies and schedules the FFA partners eventually created a total of seven OUs. Following the designation of the Metals OU and PCB OU, the EMMA OU and the MISCA OU were added to the list of OUs. The EMMA OU included areas physically associated with former DOD explosive/munitions manufacturing and disposal sites at the Crab Orchard Cemetery and Crab Orchard Plant areas within the Refuge. The MISCA OU included those study sites that were proposed in the August 1998 RI Report as needing further investigation. DOI also created a Water Towers 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 added two more OUs, the AUS OU and the Lake OU, for a total of seven OUs at the Crab Orchard Site. The AUS OU was created 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 subsites consolidated into 39 study areas suspected to have contamination due to past disposal practices by several industrial tenants. The Lake OU was created to determine whether Crab Orchard Lake is affected by the past waste disposal activities at the Refuge and, if it is, take appropriate action.

E. Lead Agencies Established for Each OU

DOI is the lead agency responsible for the Metals OU, MISCA OU, PCB OU, Water Towers OU, AUS OU, and Lake OU. The DA is the lead agency for the EMMA OU. The following RODs, ESDs, and ROD Amendments have been issued to date:

- ROD for the Metals OU (March 1990)
- ROD for the PCB OU (August 1990)
- ROD for the EMMA OU (February 1997)
- ESD for the EMMA OU (January 2000)
- ESD for the PCB OU (June 2000)

- ROD for Site 14 of the MISCA OU (October 2001)
- ROD for Site 36 of the MISCA OU (September 2002)
- ROD Amendment for the PCB OU (August 2007)
- ROD Amendment 2 (Interim Remedy) for the PCB OU (August 2014)

EPA signed the RODs for both the Metals OU and PCB OU. EPA and DA signed the ROD for the EMMA OU. EPA and DOI signed the RODs for the MISCA OU and ROD Amendments for the PCB OU.

F. Status of Investigations and Remedial Actions

The remedial actions at the Water Towers OU, Metals OU, EMMA OU, Lake OU, Site 36 of the MISCA OU, and Site 14 of the MICSA OU were completed in August 1993, December 1998, September 2001, October 2001, September 2006, and September 2007, respectively. The remaining two OUs (PCB OU and AUS OU) are in various stages of site investigation and/or remedial activities. The investigations and remedial actions are discussed in detail in Section IV below.

IV. OU 1-7 Remedial Investigations and Remedial Actions

A. Metals OU (OU1)

1. Metals OU Investigation

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

Plating Pond Area (Site 15)
Fire Station Landfill (Site 29)
Old Refuge Shop Area (Site 22)

Figure 2 shows the locations of the above sites.

Site 15 - Plating Pond: Although the 1988 RI confirmed the presence of 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 in the 1970s, to accept liquid waste from a manufacturing operation in Area 7. The pond was approximately 50 feet long and 30 feet wide and, when the RI was conducted, about 4 feet deep and contained an estimated 45,000 gallons of water. 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 of Site 22 indicated contamination in many of the ditches and in 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. 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.

2. Metals OU Remedy Selection

EPA signed the ROD for the Metals OU 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 Resource Conservation and Recovery Act (RCRA) hazardous because of the metals leachability) to render them non-hazardous;
- On-site disposal of non-RCRA hazardous stabilized/fixed 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.

The selected remedy also included ICs to restrict public access to the on-site landfill. In addition, the Metals OU ROD required the three 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.

3. Metals OU Remedy Implementation

Metals OU Remedial Design: The remedial design process for the Metals 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 Metals OU 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.

Metals OU Remedial Action: The Metals OU on-site landfill was constructed in the Northwest corner of the intersection of Ogden and Chamnesstown Roads. On March 30, 1990, the date of the Metals OU ROD issuance, the Illinois solid waste landfill requirements were codified as 35 IAC 807. Subsequently, in September 1990, new Illinois state landfill requirements (i.e., 35 IAC 810 through 815) became effective. 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 Metals OU study sites (i.e., Plating Pond Area, Fire Station Landfill, and the Old Refuge Shop Area) was approximately 36,359 cubic yards as described in more detail below.

Plating Pond: Excavation commenced in February 1996 and was completed in March 1996. Approximately 194 cubic yards of chromium-contaminated soil were excavated from the Plating Pond area, and disposed of in the Metals OU 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 at the Fire Station Landfill 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 Metals OU landfill. Approximately 9,310 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 Metals OU landfill. Approximately 11,980 cubic yards of excavated untreated (non-hazardous) material also was disposed of in the Metals OU 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 Metals OU 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.

In addition, DOI conducted a removal action at Site 22A, which also was part of the MISCA OU. 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 OU Landfill.

4. System Operations/Operation and Maintenance Metals OU (OU1).

Remediated Study Sites: FWS conducted post remediation groundwater monitoring at both the Fire Station Landfill and the Old Refuge Shop areas in 1996, 1997, 1998, 2001, and 2006. The results of the groundwater analysis indicated that the contaminants of concern (cadmium, chromium, cyanide, and lead) for both the Fire Station and Old Refuge Ship sites were below their respective drinking water standards. No further groundwater monitoring is necessary at these sites. Groundwater monitoring wells at the Fire Station Landfill and Old Refuge Shop Sites were decommissioned in 2011.

Metals OU Landfill: FWS is implementing long term operation and maintenance (O&M) activities to ensure that the remedy is maintained for the protection of human health and the environment. Maintenance of the integrity of the remedy is implemented primarily through the annual inspections of the landfill, mowing the landfill and surrounding area, removal of woody vegetation from fence and fence repair.

B. PCB OU (OU2)

1. PCB OU Investigation

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 PCB OU 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 created a

pond as a Job Corps project by damming a ravine running near the site at the landfill. The landfill was used as a dumping area in the 1950s, but was abandoned by 1960. After the significance of the pond's proximity to the landfill became clear, the pond then 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 Landfill and the Building Complex are two adjacent areas with overlapping contamination and 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, Sangamo used some of this area to manufacture power factor capacitors, AC motor run capacitors, and a variety of DC capacitors. The 1988 RI identified soil 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).

Groundwater Contamination at Sites 32/33: In the third quarter of 1997 and in 1998, additional investigation was conducted to determine the nature and extent of contamination in the groundwater in the vicinity of Sites 32/33. The investigation identified the presence of elevated levels of trichloroethylene (TCE) and other chlorinated volatile organic compounds (CVOCs) in the groundwater. Five separate areas that are the sources of the CVOC plumes were identified. The areas include Building I-1-23, Building I-1-2/I-1-3, Building I-1-36A, area beneath the Area 9 Repository, and an area south of the Repository. These five source areas produce three separate groundwater plumes. The Building I-1-23 and I-1-2/I-1-3 source areas each produce a separate plume. The contamination emanating from the area beneath the Repository, Building I-1-36A, and the area south of the Repository merges into a common groundwater plume.

The I-1-23 plume (Plume 1) moves northward and discharges into the West Swale and into the Crab Orchard Lake embayment. The I-1-2/I-1-3 plume (Plume 2) moves westward

toward Highway 148 and discharges into the intermittent stream and marsh area on the east side of the highway; a portion of the Plume 2 moves a relatively short distance eastward into a groundwater stagnation zone contained within Site 33, and does not discharge to surface water. The common plume (Plume 3) formed from the sources at the Repository, I-1-36A, and south of the Repository moves northeastward and discharges into the East Swale.

2. PCB OU Remedy Selection (OU2)

The 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.

The selected remedy also included ICs to restrict public access to the on-site landfill. In addition, the PCB OU 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.

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 applicable or relevant and appropriate federal and state requirements (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.

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 EPA, shall be performed.

In 1991, Schlumberger Industries, Inc., now known as Schlumberger Technology Corporation (Schlumberger) signed a Consent Decree with EPA and DOI. Under the terms of the May 1991 Consent Decree, Schlumberger agreed to perform the cleanup set out in the PCB OU ROD. Although DOI is the lead agency generally for the PCB OU, under the terms of the Consent Decree, EPA is the lead agency responsible for the implementation of the remedial action required under the PCB OU ROD and enforcement of the Consent Decree.

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 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 Scope of Work allowed incinerated soil and sediments to be used as backfill provided they meet all of the cleanup standards. During the initial cleanup 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 other cleanup criteria applied only to material excavated at the four study site between March 1996 and June 1997.

The PCB Scope of Work 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.

ESD for the PCB OU: The 1997-1998 groundwater investigation at Sites 32/33 indicated the presence of three plumes contaminated with TCE above its MCL of 5 ppb. The 1990 PCB OU ROD required that if groundwater contamination exceeded MCLs, EPA shall determine additional remedial action as necessary. On June 23, 2000, EPA signed an Explanation of Significant Differences (ESD), to address groundwater contamination for Plumes 1, 2, and 3 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 (MNA), as the appropriate remedial technology to address the groundwater contamination. 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 was either missing or discontinuous. The absence of the sand layer in the Buildings I-1-2/I-1-3 source area made it difficult to achieve the remedial action objectives using the multiphase extraction technology selected in the June 2000 ESD without further enhancement. EPA subsequently signed two ROD Amendments to address groundwater contamination for Plumes 1, 2, and 3 as described below in this section.

ROD Amendment for the PCB OU: In August 2007, EPA signed an amendment to the 1990 ROD and the 2000 ESD. This ROD Amendment addressed the following groundwater cleanup actions for Plumes 1 and 3 only.

- Plume 1 (Groundwater Plume near Building I-1-23) – Excavation and off-site disposal of CVOC-contaminated soil to 1 mg/kg CVOC contour in the Upper Clay unit, groundwater extraction and treatment in the Sand unit beneath the Upper Clay, and Phytoremediation.
- Plume 3 (Groundwater Plume formed from the sources at the Repository, Building I-1-36A, and south of the Repository) – Phytoremediation and Monitored Natural Attenuation.
- ICs to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.

ROD Amendment 2 (Interim Remedy) for the PCB OU: In August 2014, EPA signed a second amendment to the 1990 ROD and the 2000 ESD. This ROD Amendment was an interim remedy and addressed the following groundwater cleanup actions for Plume 2 only.

- Soil Mixing with Zero Valent Iron (ZVI).
- Short-Term Monitoring to evaluate the effectiveness of the interim remedy.
- ICs to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.

3. PCB OU Remedy Implementation (OU2)

3.1 Remedy Implemented to address the 1990 ROD for the PCB OU

Soil/Sediment remediation: 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.
- A Supplemental Investigation to determine the levels of all other contaminants which could still remain at the site after remediation.

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 was classified as soil and sediment containing PCBs < 25 mg/kg, lead < 450 mg/kg, and cadmium < 10 mg/kg. This category material was used as backfill material in the Area 9 Repository.
- Category 2 material was classified as soil and sediment containing PCBs > 25 mg/kg, lead < 450 mg/kg, and cadmium < 10 mg/kg. This category material was treated in an on-site mobile thermal treatment unit (TTU).
- Category 3 material was classified as soil and sediment containing PCBs > 25 mg/kg, lead > 450 mg/kg, and cadmium > 10 mg/kg.
- Category 4 material was classified as soil and sediment containing PCBs < 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.

PCB OU excavation activities were conducted at the following study sites:

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, 1980 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 East, West and Central Swale areas, 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 155,546 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.

All excavated Category 1 materials were consolidated and placed in the Area 9 Repository. 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. Based on this investigation, Building I-1-23 Annex was demolished, and Building I-1-23 was decontaminated. 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 FWS.

The PCB OU ROD required all soil and sediment contaminated with PCBs greater than 25 mg/kg be thermally treated (incinerated) in an on-site mobile TTU. Mobilization of the TTU started in October 1995. A trial burn test demonstrated that the TTU would achieve the 99.9999% Destruction Reduction Efficiency as required under the Toxic Substances Control Act

(TSCA). EPA then 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. The TTU incinerated 117,145 tons of PCB-contaminated material.

Incinerated materials (soil and sediments) were tested for PCBs, lead and cadmium. All of the incinerated materials met the cleanup criteria for PCBs (< 1 mg/kg). Incinerated (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.

The PCB OU Scope of Work required that all untreated soil or sediment and any incinerator ash from the TTU 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 incinerated 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 PCB OU 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 OU landfill in the Northwest corner of the intersection of Ogden and Chamnesstown roads. At the time of the ROD signature, August 1, 1990, the Illinois solid waste landfill requirements were codified as 35 IAC 807. Subsequently, in September 1990, new Illinois state landfill requirements (i.e., 35 IAC 810 through 815) became effective. Schlumberger complied 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 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 incinerated 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 incinerated material were also taken to ensure that the cleanup objectives (PCBs < 1 mg/kg) were met.

In August 2004, in response to EPA's 2001 FYR recommendations, Schlumberger removed a total of 1473 tons of PCB-contaminated surface soil from the Central Swale area. In response to EPA's 2006 FYR Recommendations, Schlumberger conducted additional removal action to address residual PCB-contaminated soil and sediment in 15 locations at Sites 32/33. A total of 31,055 tons of soil containing PCBs were removed, transported, and disposed off-site in secure landfills. The majority of the sites required the excavation of small areas consisting of several hundred to several thousand square feet of material. Areas of TSCA-level (>50 ppm) PCB-contaminated soil were typically discrete areas that were not previously remediated. The Tree Stand Area (TSA), which is located in the southeastern portion of the facility, east of

Building I-1-3, was an exception to the overall pattern of PCB residual and hot spot contamination. The TSA as originally defined was actually a cluster of discrete soil piles of predominately lower-level PCB contamination. However, the soil on the northern side of the area was found to be highly contaminated, and the discrete piles were apparently placed on, and possibly mixed with those highly contaminated soils. The plan to delineate each site in a systematic manner using lateral and vertical samples to determine the extent of contamination resulted in the systematic discovery of a rather extensive area of PCB-contaminated soil. Upon completion of the excavation activities, Schlumberger collected confirmation and verification samples that indicated that these areas have been remediated to the cleanup levels specified in the ROD for the PCB OU.

3.2 Remedy Implemented to address the 2007 ROD Amendment for the PCB OU

The ROD Amendment required the excavation and off-site disposal of CVOC-contaminated soil in the Upper Clay unit, groundwater extraction and treatment of Plume 1 in the Upper Sand unit beneath the Upper Clay unit, and Phytoremediation of both Plumes 1 and 3. The Rod Amendment also required ICs to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.

Plume 1 excavation activities near Building I-1-23 began in June 2010 and were completed in October 2010. Within the identified phytoremediation areas for groundwater Plume 1 and Plume 3, a total of 2,675 seedlings and trees were planted, including 150 sycamore seedlings, 700 cottonwood seedlings, 875 willow seedlings, and 700 poplar seedlings. The FWS has already implemented and is enforcing the required ICs to prohibit the installation of potable water wells. A groundwater pump and treat system was installed in 2011 to remove dissolved VOC source mass from the Upper Sand unit (Plume 1). Currently, the groundwater extraction and treatment is in progress.

In 2012, an additional excavation was completed in the area known as the 1960s ditch, located within the Plume 1 area. The excavation was focused on the removal of PCB and VOC-contaminated soil.

The June 2015 O&M Plan for Plumes 1 and 3 documents the operation, maintenance, and performance monitoring and evaluation to be performed for the Plumes 1 and 3 remedies.

3.3 Interim Remedy to address the 2014 ROD Amendment 2 for the PCB OU

EPA anticipates cleanup activities to begin in October 2016. The soil mixing component of the interim remedy consists of mixing the soil with a mixture of clay and ZVI to treat the soil and groundwater within the treatment zones from three feet below grade until hard and competent bedrock is reached. In addition to treating the soil, introduction of the ZVI mixture into the saturated zone will also treat groundwater in the source areas.

The Short-Term Monitoring (STM) component of the remedy incudes groundwater monitoring to detect changes in concentrations of contaminants in groundwater. The STM will evaluate the effectiveness of the interim groundwater cleanup measure and also serve as input to help identify any further appropriate final remedial actions.

The ICs component of the interim remedy will prohibit the installation of production wells until groundwater is restored to drinking water standards. EPA, Illinois EPA, and FWS anticipate entering into a LUCMOA consistent with the Illinois UECA to ensure the durability of the ICs for Plume 2.

4. System Operations/Operation and Maintenance PCB OU (OU2)

4.1 PCB OU Remediated Sites

Pump and Treat (P&T) system: The P&T system installed in 2011 is designed to remove dissolved VOC source mass from the Upper Sand Unit of Plume 1. Contaminated groundwater pumped from the Upper Sand Unit will be treated prior to discharge to the sanitary sewer. The effluent will be monitored to ensure that the treated groundwater does not exceed applicable discharge criteria.

The P&T system contains two interior sections, a process room and a control room separated by a partition wall. The process room is where the water treatment system components have been placed. All equipment in this room meets explosion proof standards. The control room houses the electrical circuit panel and system control panel.

The P&T system includes an extraction well screened within the Upper Sand Unit from 23 to 43 feet below ground surface. The extraction well is constructed of 6-inch diameter stainless steel well casing and stainless steel wire-wound well screen. A 4-inch diameter submersible electric pump is installed within the well screen interval at 34 feet below ground surface. The pump is rated for a flow rate ranging from 5 to 10 gallons per minute with a maximum discharge pressure of 60 pounds per square inch.

The P&T system is equipped with a set of dual high-capacity particulate filters (bag filters) in parallel that remove particles suspended in process water and dual 400-pound liquid carbon adsorption vessels in series to treat additional contaminants from the water prior to discharging to the sanitary sewer.

Contaminated groundwater extracted out of the wells through the submersible pump is directed through the bag filters to remove suspended particles. After the bag filters, the water is forced into the bottom of the first carbon adsorption vessel. The water is then forced up through the carbon and ejected out the top of the first tank and into the bottom of the second carbon adsorption vessel. Next the water is forced up through the carbon in the second tank. The treated water then runs through a totalizing flow meter and is finally discharged to a sanitary sewer.

Schlumberger conducts the preventive maintenance and servicing of the P&T system as specified in the June 2015 O&M Plan of Plumes 1 and 3. The preventive maintenance includes inspection of the pump and electrical connections, flow meters, plumbing, and other fittings. The servicing of the system includes changing bag filters as needed and servicing of the spent carbon in the carbon adsorption vessels.

Phytoremediation: Four phytoremediation areas (Areas A, B, C, and D) were installed in 2010, covering approximately 2.2 acres (Figure 5). VOC concentrations were measured from monitoring wells during the baseline sampling event, and eight subsequent quarterly sampling events were completed between July 2011 and April 2012. Concentration were monitored from upgradient and downgradient monitoring wells for phytoremediation planting in Areas A and B. Since October 2012, Schlumberger is conducting groundwater monitoring in these areas semiannually.

Surface Water: At the Site 32 area, three drainage swales (eastern, central, and western) receive storm water runoff from Sites 32and 33. Surface water is present in the eastern swale for only a few days after large storm events, and surface water in central and western swales is present for a few weeks after large events. The swales are not readily accessible to Site 33 industrial workers and FWS restricts recreational use of the areas. Since there is no significant contaminant source remaining in Sites 32 and 33 surface soil, the occasional surface water present in the swales does not pose a significant source of exposure. Therefore, no further surface water monitoring is necessary at these drainage swales.

There is no flowing or permanent body of surface 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.

Groundwater: As part of an approved Final O&M Plan for the PCB OU (September 1995 - Revision 2), Schlumberger conducted short-term groundwater monitoring at the remediated study sites. These remediated sites included Sites 17, 28, and 32/33. The purpose of the short-term monitoring was 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. Based on past results of groundwater monitoring at the Job Corps Landfill site (Site 17) and Water Tower Landfill Site (Site 28), no VOCs, SVOCs, PCBs/pesticides were detected in any of the monitoring wells. Therefore, no further groundwater monitoring is being conducted at Sites 17 and 28.

Groundwater monitoring at Sites 32/33 is conducted as part of the performance monitoring for the Plumes 1 and 3. For Plume 1, a baseline sampling event was performed in March 2011, and four quarterly monitoring events were conducted from July 2011 to April 2012. Following one year of quarterly sampling, the frequency was adjusted to semiannually with the October 2012 monitoring event. A total of 33 monitoring well (Figure 3-1) are part of the long-

term monitoring (LTM) network, screened within the Upper Clay, Upper Sand, Intermediate Sand, or Lower Sand units.

The performance wells include plume wells, boundary wells, and sentinel wells. Plume wells are located within the source area exhibiting VOC concentrations above MCLs. Boundary wells are monitoring wells cross gradient or downgradient of the contaminant plume. The sentinel wells are located between the contaminant plume and the downgradient receptor (Crab Orchard Lake). In addition, there are two background wells located upgradient of the Plume 1 and 3 source areas. Well designations for the 33 monitoring wells in the LTM network are presented in Table 3.

4.2 PCB Areas Landfill

Schlumberger, in coordination with FWS, is implementing long term O&M activities to ensure that the remedy is maintained for the protection of human health and the environment. Maintenance of the integrity of the remedy is implemented primarily through the annual inspections of the landfill, mowing the landfill and surrounding area, removal of woody vegetation from fence and fence repair.

C. EMMA OU (OU3)

The EMMA OU consisted of fifteen sites. Ten of these sites (COC-1 through COC-10) were located within the Crab Orchard Cemetery (COC) area. Four of the sites (COP-1 through COP-4) were located within the Crab Orchard Plant (COP) area. One other site was located in the explosives compounds storage bunker area. An RI/FS completed in 1997 by the United Army Corps of Engineers (USACE), on behalf of the DA, resulted in EPA and DA signing a ROD for the EMMA OU in February 19, 1997. The ROD determined that no further action was required at twelve of the fifteen EMMA OU sites, and that cleanup actions were required at two sites (COC-3 and COP-4). The ROD deferred selecting a remedy for the site COC-4 so that an ecological risk could be further evaluated at the site. Based on the results of the ecological risk conducted at the site COC-4, EPA and the DA signed an ESD in January 2000 requiring no further action at Site COC-4.

The DA completed the cleanup activities at the EMMA OU Sites in September 2001. In addition, DA also removed ordnance and explosives (OE) and unexploded ordnance (UXO) at Sites COC-1, COC-4, COC-5, COC-6, and COC-15 from June 2000 to November 2000. The objective was to safely locate, identify, and dispose of all OE and non-OE related scrap greater than one square inch in size to a depth of one foot. The total area cleared was approximately 7.8 acres. A total of 21,000 pounds of OU scrap and 1,800 pounds of non-OE scrap were recovered, inspected, and transferred off-site.

In June 2016, the USACE, on behalf of the DA completed the FYR of the EMMA OU sites within the Crab Orchard Site. This FYR incorporates the FYR Report for the EMMA OU by reference as Attachment C. Please see Attachment C for the details of the EMMA OU (OU3) Investigation, Remedy Selection, Remedy Implementation, and O&M.

D. MISCA OU (OU4)

1. Investigation. The MISC OU included the following 20 study sites that were investigated in the 1988 RI Report:

Site 14 is an approximately 3.5-acre site located in the northern part of Area 8. Soil and groundwater were contaminated primarily with benzene, toluene, ethylbenzene, xylene, and methylene chloride. The groundwater contamination exceeded 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, 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 the AUS OU. Another MISCA OU site (Site 34) was investigated as part of the Lake OU. Figure 4 shows the general locations of the MISCA OU sites 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 steam house 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 drainage way that flows northward through the center of Area 7.

Site 20, the D Area South Drainage Channel, is a segment of a drainage way 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.

2. Remedy Selection MISCA (OU4)

MISCA OU Site 14: 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 specified ICs to prohibit installation of potable water wells 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 MISCA OU 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

MISCA OU Site 36: 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.

All other sites within the MISCA OU: The ROD for Site 36 and other sites within the MISCA OU 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, 11, 11A, 12, 13, 18, 20, 21, 24, 25, 26, 27, 30, 31, and 35. A human health risk assessment was not conducted at Sites 10 and 16, since a completed exposure pathway does not exist at these sites. The ICs to prevent access to Sites 10 and 16 are included in the ELUC Plan as described in Chapter VI, Section F.8 of this report. FWS has taken steps to implement these ICs.

3. Remedy Implementation MISCA OU (OU4)

MISCA OU Site 14: Under the terms of a Unilateral Administrative Order issued by EPA on August 30, 2001, Illinois Tool Works, Inc. (ITW), successor to Diagraph Corporation, conducted cleanup activities at Site 14 of the MISCA OU. The ITW cleaned up the soil contamination at Site 14 to levels based on 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, and meet UU/UE. Therefore, no ICs are required at Site 14.

The cleanup activities began in December 2006 and were completed in May 2007. Approximately 26,280 tons of soil contaminated primarily with ethylbenzene, benzene, xylene, and benzene were excavated, and disposed of at an off-site facility. Groundwater monitoring of wells located within and downgradient of the site began in September 2007. ITW conducted four quarterly, two semi-annual, and one annual groundwater monitoring at a total of 13 wells. No contaminants of concern were detected in any of these monitoring events. The groundwater at this site is restored to drinking water standards and no further monitoring is necessary at this site. The monitoring wells at Site 14 were decommissioned in June 2011.

MISCA OU Site 36: The cleanup activities began in May 2005 and were completed in July 2006. All above and below ground Waste Water Treatment Plant (WWTP) structures were removed. Approximately 38,230 cubic yards of sludge, sediment, and soil were excavated, and disposed of at an off-site facility. Approximately 21,400 gallons of water from the contaminated area were disposed of at the WWTP in Marion, Illinois. Approximately 668,400 gallons that met the State of Illinois Class I Groundwater Standards were released into existing clean drainage channels. Approximately 49,440 cubic yards of material were excavated and backfilled to establish grade to match the existing terrain. The excavated areas meet the UU/UE requirements and therefore, no ICs are required at Site 36.

E. Water Towers OU (OU5)

The interiors and exteriors of three of the water towers within 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.

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.

F. AUS OU (OU6)

1. Investigation: 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 Areas 11/12. Other sites investigated within the AUS OU include Areas 4, 6, 7, 8, 9, 10, and 13.

The Area 2 sites encompass approximately 550 acres of currently active industrial operations. The Areas 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.

The General Dynamics Ordnance and Tactical Systems (GDOTS) signed an Administrative Order on Consent (AOC) with 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. The RI/FS is expected to be complete by 2018. The RI report, which was completed in March 2015, evaluated the potential risk to indoor workers, outdoor workers, excavation workers, and recreational users. These evaluated site use scenarios present an unacceptable risk to human health. The most common risk pathway is the excavation worker scenario, resulting from volatile contaminants partitioning from soil and/or groundwater within the AUS OU. The April 2008 ELUC plan effectively restricts access to all of the contaminated areas within the AUS OU. Refuge Law Enforcement Officers have been provided with the ELUC Plan. They are briefed at least annually regarding the Plan restrictions. The Law Enforcement Officers conduct patrols of all areas of the Refuge during normal work times and on days and times when workers/public are not typically present. GDOTS maintains armed security with video surveillance and roving patrols for their active sites.

Based on the observations of the Refuge Law Enforcement Officers, there is no evidence of use of the site for indoor worker, outdoor worker, excavation worker, and recreational purposes. There is no evidence of trespassers at any of the contaminated sites.

G. Lake OU (OU7)

Between October 1999 and July 2000, DOI conducted a preliminary screening analysis for the Lake OU, by collecting surface water, sediment, and fish specimen samples in the Crab Orchard Lake. The purpose of the investigation was to gather sufficient information to determine if releases to Crab Orchard Lake pose a potential threat to human health or the environment and to determine if a remedial investigation was warranted. DOI completed a Preliminary Screening Analysis Report for the Lake OU on October 9, 2001. Based on the conclusions of this report, DOI transferred portions of the Lake OU requiring further remedial investigation to the AUS OU. No further action is necessary at the Lake OU.

V. Progress Since the Last Five-Year Review

Protective Determinations/Statements from the 2011 FYR Report:

The Crab Orchard Site is expected to be protective of human health and the environment. For long-term protectiveness, effective ICs have been implemented, maintained, and monitored by FWS. The following are the protectiveness statements from the 2011 FYR Report for the Crab Orchard Site:

- Metals OU: No lead, cadmium, or chromium-contaminated soil or sediments are present above cleanup levels at any of the remediated sites with the exception of a portion of Site 22 that is now part of the AUS OU. The Metals OU Landfill is effective in containing the waste and contaminants. With the exception of the unremediated portion of Site 22, 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 one hotspot area near the 1960 drainage ditch area 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. Following completion of the site investigation, EPA will issue a ROD Amendment to address groundwater contamination for Plume 2. The remedial action conducted to date and ongoing/future cleanup activities to address soil and groundwater contamination for Plumes 1, 2, and 3 are 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.

- Water Towers OU: The removal actions conducted at three of the Water Tower areas and at the Visitors Center to remove lead-contaminated soil are expected to be protective of human health and the environment.
- MISCA OU: The remedial actions conducted at Sites 14 and 36 are 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 2018. Based on the recommendations made in the RI/FS report, EPA will select appropriate remedies, if necessary. Therefore, a protectiveness statement is not made for the AUS OU.
- Lake OU: Following transfer of portions of the Lake OU Sites to AUS OU, no further action was necessary at the Lake OU. There is no unacceptable risk to human health and the environment at the Lake OU.
- Institutional Controls: The FWS has completed an ELUC Plan which identifies all ICs required under RODs for the Metals OU, PCB OU, EMMA OU, and MISCA OU. The FWS is implementing, maintaining, reporting and enforcing, these land use controls. To ensure the remedy continues to function as intended, FWS will update the ELUC Plan to include long-term stewardship procedures.

Issues and Recommendations from the 2011 FYR:

Issues:

At the EMMA OU, the groundwater sampling results show a need for continued groundwater monitoring to delineate the plumes and determine if natural attenuation is occurring. This groundwater sampling need 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 an undetonated mine is a reason for concern and further investigation. The mine was successfully detonated in place and no longer poses a threat.

Recommendations:

1. EPA recommends that the FWS update the ELUC Plan to include an inspection schedule, a checklist for each area to document the long-term stewardship procedures, and a requirement to provide EPA and IEPA an annual certification that ICs remain in place and are effective.

2. At the EMMA OU, the groundwater sampling results show a need for continued groundwater monitoring to delineate the plumes and determine if natural attenuation is occurring. This groundwater sampling need currently does not affect protectiveness; however, it may affect future protectiveness, if groundwater is not restored to MCLs. Also, at the EMMA OU, the discovery of an undetonated mine is a reason for concern

and further investigation. The mine was successfully detonated in place and no longer poses a threat.

Follow-up Actions:

1. EPA, Illinois EPA, and FWS are in discussions with regard to entering into a Land Use Control Memorandum of Agreement (LUCMOA) consistent with the Illinois Uniform Environmental Covenant Act to ensure the durability of the ICs at the Crab Orchard Site. EPA anticipates that the LUCMOA will be signed by September 30 2017.

2. At the EMMA OU, the purpose of the continued groundwater monitoring at Sites COC-3 and COP-4 is to ensure that the contaminated groundwater does not migrate off-site and not to determine if MNA is occurring. The DA will continue groundwater monitoring to ensure that there is no contaminant migration in the groundwater.

3. At the EMMA OU, the undetonated mine discovered in 2006 was identified in an area south of Sites COC-3 and COP-4, and not within the established boundaries of the EMMA OU. There was no additional OE uncovered. The mine was successfully detonated in place and no longer poses a threat.

Remedy Implementation Activities since 2011:

A. PCB OU: As described in Chapter IV, Section B.3.2 and 4.1, a groundwater pump and treat system was installed in 2011 to remove dissolved VOC source mass from the Upper Clay unit. The system is in operation since 2011 and Schlumberger is currently conducting semi-annual and annual monitoring of the LTM network.

In 2012, an additional excavation to a depth of 15 feet below ground surface was completed in an area known as the 1960s ditch, located within the Plume 1 area. The excavation was focused on the removal of PCB- and CVOC-contaminated soil. Approximately, 3,858 tons of contaminated soil were excavated and disposed off-site.

As described in Chapter IV, Section B.2 of this report, in August 2012, EPA signed ROD Amendment 2 to the 1990 ROD and 2000 ESD for the PCB OU. As described in Chapter IV, Section B.3.3 of this report, Schlumberger is in the process of implementing the cleanup action required under this ROD Amendment 2 to address groundwater contamination at Plume 2.

In July 2015, Schlumberger initiated a Plume 3 Pilot Study to evaluate in situ chemical oxidation (ISCO) using potassium permanganate to treat elevated concentrations of CVOCs in Plume 3 groundwater. The purpose of the pilot study is to evaluate the technical feasibility of ISCO applied through hydraulic fracturing injection and assess its ability to reduce the CVOC mass as a supplement to the current groundwater remedy.

A total of 16,500 and 6,600 lbs of potassium permanganate were injected into the Upper Clay and Upper Sand units, respectively, through four injection points in July 2015, with fractures initiated every three feet vertically across the targeted zones. Seven performance monitoring wells were established to assess the results through monitoring approximately 1, 3, 6, and 9 months following injections. The final monitoring event is scheduled to occur in May 2016, and a report on the results is anticipated in the summer of 2016.

In February 2016, EPA approved a November 2015 Technical Memorandum – PCB OU Risk Assessment - submitted by Schlumberger. This memorandum documented that there is no unacceptable risk to human health and the environment due to soil, sediment, or surface water at the PCB OU.

B. MISCA OU – Site 14: As described in Chapter IV, Section D.3 of this report, groundwater at Site 14 is restored to drinking water standards and no further monitoring is necessary. The monitoring wells at Site 14 were decommissioned in June 2011.

C. MISCA OU – Site 36: As described in Chapter IV, Section D.3, FWS conducted groundwater monitoring of eight wells at the site from August 2014 to May 2015. Based on the results of the monitoring, groundwater at Site 36 is not impacted and no further monitoring is necessary. FWS is currently in the process of decommissioning Site 36 related monitoring wells by September 2016.

Institutional Controls

ICs are non-engineered instruments, such as administrative and legal controls that help to minimize the potential for 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 UU/UE.

FWS has prepared an ELUC Plan (Attachment B) which identifies all ICs required under RODs signed for the Metals OU, PCB OU, EMMA OU, and MISCA OU at the Crab Orchard Site. FWS is responsible for implementing, maintaining, reporting on, and enforcing ICs and land use controls. The ICs at the Crab Orchard Site consist of ELUCs which are defined as follow (from the ELUC Plan, pgs. 1-2, Appendix B): "...the term "Environmental Land Use Control" or "ELUC" means a restriction or control that limits exposure to contaminated media (e.g., soils, surface water, groundwater, etc.) arising from the need to protect human health and/or the environment at any site within the NPL Site. ELUCs may be necessary when contamination is first discovered, when CERCLA response actions are ongoing, or when some amount of contamination remains on-site as part of a CERCLA remedy. The term includes controls on access (e.g., engineered barriers, such as caps, and non-engineered mechanisms, such as fences or signs). Additionally, the term encompasses both affirmative measures to achieve the desired control (e.g., security patrols) and prohibitive directives (e.g., no drilling of drinking water wells)."

A summary of the implemented and planned ICs for the Crab Orchard Site is listed in the

table and are further discussed below. Maps showing areas in which the ICs apply are included in the ELUC Plan (Appendix B).

Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Landfill (Figure 6)	Yes	Yes	Metals Area and PCB Area Landfills	Restrict public access.	ICs are planned. Planned date of completion -- 9/30/2017.
Surface soil	Yes	Yes	Sites COC-3 and COP-4 of the EMMA OU	Prohibit subgrade activities.	ELUC Plan dated April 2008
Surface Soil	Yes	Yes	Site 10 and Site 16 of the MISCA OU	Restrict human access	ELUC Plan dated April 2008
Groundwater	Yes	Yes	Sites 32/33 of the PCB OU	Prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards	ELUC Plan dated April 2008

Current Compliance: The remedies selected for the Metals OU, PCB OU, the MISCA OU for Site 14, and MISCA OU for Site 36 appear to be functioning as intended. Based on the Site inspections and data reviewed, no inappropriate land or groundwater uses were observed. EPA is not aware of site or media uses which are inconsistent with the stated objectives of the ICs and cleanup goals. Access to the property is limited due to use of fencing and continued presence there since much of the Site is used as a National Wildlife Refuge. However, long-term protectiveness at the Site requires continued compliance with use restrictions to assure that the remedy continues to function as intended.

The RODS for both the Metals OU and PCB OU required public access control to the on-site landfills for the Metals OU and PCB OU. Both the landfills are located side by side within a fenced area posted with signs restricting access to the public.

The ROD Amendments for the PCB OU required ICs to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards. These ICs are included in the April 2008 ELUC plan and are being enforced by FWS. EPA, Illinois EPA, and FWS anticipate entering into a LUCMOA consistent with the Illinois UECA to ensure the durability of all required ICs.

The ROD for MISCA OU Site 36 required ICs to prohibit installation of potable water wells until groundwater is restored to MCLs. Based on the results of the monitoring, groundwater at Site 36 is not impacted. Therefore, no ICs are necessary at Site 36.

The ROD for MISCA OU Site 14 required ICs to prohibit installation of potable water wells until groundwater is restored to MCLs. The ROD for Site 14 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. ITW cleaned up the soil contamination to levels based on EPA's generic soil screening levels to meet UU/UE. Also, the groundwater at Site 14 has been restored to MCLs. Therefore, no ICs are required at Site 14.

Human health risk assessments were not conducted at Sites 10 and 16, since completed exposure pathways do not exist at these sites. The ICs to restrict access to Sites 10 and 16 are included in the ELUC Plan.

Long-term Stewardship: EPA, Illinois EPA, and FWS are currently in the process of entering into a LUCMOA consistent with the Illinois UECA to ensure the durability of ICs at the Site. The LUCMOA which is expected to be signed by September 2017 will ensure that effective ICs are maintained, monitored and enforced and that the remedies continue to function as intended with regard to ICs.

VI. Five Year Review Process

A. Administrative Components. The FYR for the Sangamo Electric/Crab Orchard National Wildlife Refuge Superfund Site was led by Nanjunda Gowda, Remedial Project Manager for the Sangamo Electric/Crab Orchard National Wildlife Refuge. The following team members assisted in the review:

- Paul Lake, Illinois EPA
- Mike Coffey, FWS
- Chuck Beasley, FWS
- Quyet La, USACE
- Monica Schneider, CH2M

The review, which began on June 17, 2016, consisted of the following components.

- Community Notification and Involvement

- Document Review
- Data Review
- Site Inspection, and
- Five-Year Review Report Development and Review

B. Community Notification and Involvement: Activities to involve the community in the five-year process were initiated with a meeting in April 2016 between Nanjunda Gowda and Cheryl Allen, EPA's community involvement coordinator for the Crab Orchard Site. A notice was published in the local newspaper, "Southern Illinoisan" on April 24, 2016, stating that there was a five-year review and inviting the public to submit their comments to EPA. The results of the review and the report will be made available at the Site information repository located at U.S. Fish and Wildlife Service, 450 West De Young, Suite 201, Marion, Illinois 62959; and at Southern Illinois University – Carbondale, Morris Library, Carbondale, Illinois 62901.

C. Document Review. This FYR included a review of all relevant documents (see Attachment A) and site inspections of the Metals OU, PCB OU, EMMA OU, and MISCA OU.

D. Data Review. A review of records and monitoring reports through March 2016 indicates the following:

1. Metals OU

Groundwater, Surface Water, and Leachate Monitoring Results

Fire Station Landfill and Old Refuge Shop Sites: No groundwater samples were collected for the Fire Station Landfill and the Old Refuge Shop sites as part of this review because cleanup standards established in the Metals OU ROD have been met. The results of past groundwater monitoring analysis conducted in 1996, 1997, 1998, 2001, and 2006 indicated that the contaminants of concern (cadmium, chromium, cyanide, and lead) at both the Fire Station Landfill and the Old Refuge Shop sites were below their respective drinking water standards. Monitoring wells at both the Fire Station Landfill and West Refuge Shop were decommissioned in 2011.

Metals Areas Landfill: No groundwater samples were collected for the Metal Area Landfill as part of this review because the cleanup standards have been met. Based on the results of the past groundwater monitoring and the 2011 FYR Report, concentrations of all metals in the groundwater for which MCLs/Illinois Class I Groundwater Standards are established were below those standards. Leachate samples (Table 2) collected in February 2016 at the Metals Area Landfill were analyzed for metals. 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. No further leachate or groundwater monitoring is necessary at the Metals Areas Landfill. Landfill monitoring wells were decommissioned in May 2016.

2. PCB OU

Based on the November 2015 Technical Memorandum – PCB OU Risk Assessment – there is no unacceptable risk to human health and the environment due to soil, sediment, or surface water at the PCB OU. The cleanup actions have met UU/UE.

2.1 PCB OU Groundwater Monitoring Results

Area 9 Building Complex and Area 9 Landfill (Sites 32/33): As described in Chapter IV.B.4.1 of this report, a total of 33 monitoring wells, including two background wells (Table 3) are associated with the Plumes 1 and 3. Schlumberger conducted a baseline sampling event of the LTM network in March 2011 and four quarterly monitoring from July 2011 to April 2012. Since October 2012, Schlumberger is conducting semiannual monitoring of the LTM network.

The purpose of the LTM network for Plume 1 (Figure 3-1) is for evaluating the progress and effectiveness of the P&T remedy selected in the PCB OU ROD Amendment in achieving the remedial action objectives (RAOs). Plume 1 monitoring network includes a total of 10 wells screened within the Upper Sand, Lower Sand, and Intermediate Sand units. Based on the groundwater analytical results, four wells (33MWC-30, 33MWC-50, 33MWC-52, and 33MWC-53) screened in the Upper Sand unit were observed exceeding the MCLs in the October 2014 and April 2015 sampling events. Levels of TCE decreased significantly from 6,300 ppb (March 2011) to 3,300 ppb (April 2015) in the plume monitoring well 33MWC-33, located approximately 600 feet downgradient of the pump and treat system extraction well EW-1 (Figure 3-1) and roughly 800 feet hydraulically downgradient of the excavation area. Levels of other contaminants including cis-1,2-DCE, vinyl chloride, and trans-1,1-DCE have remained stable since the baseline monitoring event. The plume well 33MWC-53, located adjacent to Building I-1-23 and near the Plume 1 source area soil excavation, is approximately 250 feet upgradient from the extraction well EW-1. Levels of TCE in 33MWC-50 have fluctuated from 92 µg/L in the baseline event to 2,600 µg/L in January 2012 to 140 µg/L in April 2015. Levels of TCE (240 µg/L), and cis-1,2-DCE (2900 µg/L) in the plume monitoring well 33MWC-30 (downgradient well in the direction of the groundwater flow toward the Crab Orchard Lake) remained stable since the baseline monitoring event. Levels of TCE in the plume monitoring well 33MWC-52, located along the western edge of Plume1, remained relatively stable since the baseline monitoring event. Concentrations ranged from 8.3 µg/L (April 2012) to 14 µg/L (January 2012), decreasing to 9.2 µg/L in the April event.

The purpose of the LTM network for Plume 3 (Figure 3-1) is for evaluating the progress and effectiveness of the MNA remedy selected in the PCB OU ROD Amendment in achieving the RAOs. Plume 3 groundwater samples were collected from 20 monitoring wells and two background monitoring wells and analyzed for select VOCs, consisting of cis-1,2-DCE, PCE, TCE, trans-1,2-DCE, and vinyl chloride. Select Plume 3 monitoring wells and background monitoring wells were also analyzed for MNA parameters. The levels of TCE in the plume monitoring well 33MWC- 09 remained stable with some variance, from 30,000 µg/L to 23,000 µg/L between the baseline and the April 2015 monitoring events. Cis-1,2-DCE, PCE, and vinyl

chloride have been detected in the monitoring well exceeding MCLs, with levels remaining relatively stable between the baseline and the April 2015 events, indicating that reductive dechlorination is occurring. No VOCs have been detected above MCLs in the sentinel well 33MWC-18 (hydraulically downgradient form the repository, screened within the Upper Clay unit).

The highest levels of TCE and cis-1,2-DCE detected between the baseline monitoring event and the April 2015 event from monitoring wells screened in the Upper Sand unit were in plume monitoring wells 33MWC-27, 33MWC-47, 33MWC-49, 33MWC-56, and 33MWC-64. Levels of the chemicals have decreased with some variance form the baseline sampling event to the April 2015 monitoring event.

VOC concentrations in 33MWC-60 located downgradient of the Area 9 Repository have remained fairly consistent since March 2011. PCE concentrations range from 98to 270 µg/L and have been above 150 µg/L since October 2012. TCE concentrations range from 46 to 67 µg/L, with the lowest concentration observed in October 2014. No VOCs have been detected exceeding MCLs in sentinel well 33MWC-66 (both screened within the Upper Sand unit).

The select VOCs analyzed for in October 2014 and April 2015 have generally not been detected in monitoring wells screened within the Lower Sand unit and have not been detected above MCLs for VOCs currently analyzed.

2.2 PCB OU Monitored Natural Attenuation

Groundwater samples were collected from select Plume 3 monitoring wells and the background monitoring wells and analyzed for MNA parameters. The MNA evaluation has shown that there has been degradation of the more highly chlorinated COCs (PCE and TCE) as indicated by the presence of the daughter products, even though geochemical conditions within Plume 3 are not optimal for biologically mitigated reductive dechlorination. Natural attenuation is a long-term process with the goal of controlling the plume and may take many years to reach the cleanup goals.

As described in Chapter V, Schlumberger has initiated a Plume 3 Pilot Study to evaluate the technical feasibility of ISCO applied through hydraulic fracturing and assess its ability to reduce the CVOC mass as a supplement to the current MNA remedy.

2.3 PCB OU Phytoremediation

Concentrations of VOCs were monitored in upgradient and downgradient wells for phytoremediation planting areas A and B (Figure 5). The VOC data collected between March 2011 and April 2015 indicate that TCE degradation and a parallel increase in a primary degradation product, cis-1,2-DCE are preceding across Area A. At Area B, the downgradient well (33MWC-18) is not impacted by TCE or degradation products, although concentrations are significant in the upgradient well (33MWC-09).

The depth to groundwater levels in monitoring wells and piezometers in the vicinity of the phytoremediation areas indicate that this part of the remedy for Plumes 1 and 3 is functioning as intended; that is shallow groundwater is being captured before entering swales and Crab Orchard Lake.

2.4 PCB OU Surface Water Monitoring Results

Area 9 Building Complex and Area 9 Landfill (Sites 32/33): At Site 32 area, three drainage swales (eastern, central, and western) receive storm water runoff from Sites 32and 33. Surface water is present in the eastern swale for only a few days after large storm events, and surface water in central and western swales is present for a few weeks after large events. The swales are not readily accessible to Site 33 industrial workers and FWS restricts recreational use of the areas. Since there is no significant contaminant source remaining in Sites 32 and 33 surface soil, the occasional surface water present in the swales does not pose a significant source of exposure. The ongoing remedial action to address groundwater contamination is expected to mitigate any further degradation of the groundwater and surface water discharging to the Crab Orchard Lake. No further surface water monitoring is necessary at these drainage swales.

2.5 PCB Areas Landfill Leachate and Groundwater Monitoring Results

No groundwater samples were collected as part of this FYR. Based on the results of the past groundwater monitoring and the 2011 FYR Report, concentrations of all metals in the groundwater for which MCLs/Illinois Class I Groundwater Standards are established were below those standards. Leachate samples (Table 2) collected in March 2016 at the PCB Areas Landfill were analyzed for metals. 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. No further leachate or groundwater monitoring is necessary at the PCB Areas Landfill.

2.6 Pump and Treat System Operation

Based on the information presented in the Fourth Annual Monitoring Report for the Plume 1, the P&T System has consistently recovered TCE and other CVOCs from the Upper Sand unit, meeting the performance objectives. Continued operation of the P&T system will result in the recovery of additional contaminant mass and contribute to the attainment of remedy performance objectives.

3. EMMA OU

The USACE, on behalf of the DA, has conducted the FYR of the EMMA OU sites within the Crab Orchard Site. This FYR incorporates the FYR Report for the EMMA OU by reference as attachment C. Please see Attachment C for discussion of the EMMA OU Data Review.

4. MISCA OU

Site 14: Monitoring for groundwater for Site 14 ended in 2010 when it was determined that the cleanup standards established in the MISCA OU ROD have been met. Following completion of the source control portion of the remedial action selected in the ROD for the MISCA OU – Site 14, ITW conducted four quarterly samplings, two semi-annual samplings and an annual sampling of 13 groundwater monitoring wells at Site 14. The last annual groundwater monitoring was conducted in July 2010. Contaminants of concern (benzene, toluene, ethylbenzene, xylene, and methylene chloride) have not been detected in any of the monitoring wells. Groundwater cleanup objectives have been met and the remedial action at Site 14 is complete. The monitoring wells at Site 14 were decommissioned in June 2011.

Site 36: The FWS conducted groundwater monitoring of eight wells at the site from August 2014 to May 2015. Selection of COCs for groundwater sampling at Site 36 was based on COCs detected in soil. The groundwater monitoring data show that there has been no exceedances of groundwater standards at Site 36 in the downgradient wells. Based on the results of the Groundwater Monitoring Report for Site 36 of the MISCA OU, 2014-2015, the groundwater at Site 36 is not impacted and no further groundwater monitoring is required. FWS is in the process of decommissioning Site 36 related monitoring wells by September 2016.

E. Site Inspection: A site inspection was conducted on June 17, 2015. Nanjunda Gowda (EPA), Paul Lake (Illinois EPA), Chuck Beasley and Mike Coffey (FWS), and Quyet La (USACE) took part in the inspection. The purpose of the inspection was to assess the protectiveness of the remedies for Sites COC-3 and COP-4 of the EMMA OU. Conditions during the inspections were favorable with mild temperatures and no precipitation. The June 17, 2015 inspection of the EMMA OU found that at Sites COC-3 and COP-4 were in good condition with no signs of erosion and the grass was thick and healthy. The sites were within fenced areas which limits any exposures.

A second site inspection was conducted on September 9, 2015. Nanjunda Gowda (EPA), Paul Lake (Illinois EPA), Chuck Beasley (FWS), Cathy Barnett (CH2M), and Monica Schneider (CH2M) took part in the site inspection. The purpose of the inspection was to assess the protectiveness of the remedies selected for Site 22 of the Metals OU, Site 14 and 36 of the MISCA OU, and Sites 32/33 of the PCB OU. Conditions during the inspections were favorable with mild temperatures and no precipitation. A summary of the September 9, 2015 inspection is provided below.

1. Metals Areas OU, Metals Area Landfill: The Old Refuge Shop Area (Site 22) and the Metals Area Landfill sites were inspected. There were no signs of erosion in the Old Refuge Shop Area. The landfill cap at the Metals Area landfill 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 when they are discovered.

2. PCB OU, PCB Areas Landfill, Area 9 Repository: The Area 9 Building Complex/Landfill, Area 9 Repository, drainage swales leading to the lake, and the PCB Landfill were inspected. There were no signs of erosion of the backfilled areas in any of these 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. As part of the maintenance, FWS personnel in coordination with Schlumberger will address any erosion problems at the repository when they are discovered.

3. MISCA OU: Both Sites 14 and 36 are generally in good condition with no erosion problems.

No interviews were conducted as part of this FYR.

VII. Technical Assessment

A. Metals Areas OU

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

- The Metals OU landfill is located within a fenced area 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 Land Use Control Plan.
- There were no noticeable erosions problems at the landfill. The Metals OU landfill cover system has been effective in isolating waste and contaminants as supported by leachate and groundwater concentrations.
- 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 Metals OU. Based on the results of past groundwater monitoring, no contaminant concentrations (cadmium, chromium, cyanide, and lead) were detected above their respective drinking water standards. 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. Concentrations of all metals in the leachate were well below the allowable based on the 1994 Groundwater Impact Assessment for the Metals Area 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?
Answer: Yes.

- **Changes in Standards:** This FYR 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?
Answer: No.

B. PCB OU

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

- 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. ICs to prohibit the installation of potable wells are in place and enforced by FWS. There is no unacceptable risk to human health and the environment due to soil, sediment, or surface water at the PCB OU.

- 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 were consolidated and backfilled in the remediated landfill site with at least 2-foot of clean soil, now known as the Area 9 Repository. The landfill is located in a closed area which is fenced and posted with signs restricting access to the public. Leachate elevations levels at the landfill are well within the maximum allowed

level. There were no noticeable erosion problems at the landfill. The landfill cover system has been effective in isolating waste and contaminants as supported leachate and groundwater concentrations. Concentrations in the leachate and groundwater are well within acceptable concentrations indicating no adverse impacts. The landfill is generally in good condition.

- The selected remedies for Plumes 1 and 3 continue to be effective to control the plumes and reduce COC concentrations.

- Plume 1: The P&T System has consistently recovered TCE and other CVOCs from the Upper Sand unit, meeting the performance objectives. Continued operation of the P&T system will result in the recovery of additional contaminant mass and contribute to the attainment of remedy performance objectives.

- Plume 3: Natural attenuation is a long-term process with the goal of controlling the plume and it may take many years to reach the cleanup goals. The MNA evaluation has shown that degradation of the more highly chlorinated COCs (PCE and TCE) is occurring, as indicated by the presence of the daughter products, even though geochemical conditions within Plume 3 are not optimal for biologically mediated reductive dechlorination. Schlumberger has initiated a Plume 3 Pilot Study to evaluate the technical feasibility of ISCO applied through hydraulic fracturing and assess its ability to reduce the CVOC mass as a supplement to the current MNA remedy.

- Plumes 1 and 3: Depth to water level measurements and root zone depths demonstrate that phytoplantations are already contributing to uptake of VOCs in shallow groundwater.

- Institutional controls: The ICs have been maintained with the land use controls implemented to prohibit production wells at the Site.

- Plume 2: Schlumberger is in the process of implementing the interim remedy for addressing groundwater contamination for Plume 2. The cleanup action is expected to be complete in the middle of 2017.

- 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. ICs prohibit the installation of potable water wells at the site. The FWS has incorporated these restrictions into the Land Use Control Plan. FWS is implementing, maintaining, and enforcing these land use controls. There is no unacceptable risk to human health and the environment.

- Indoor air samples collected at Buildings I-1-2 and I-1-3 (Plume 2), and Building I-1-23 (Plume 1) 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 both of the ROD Amendments 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.

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?
Answer: Yes.

Changes in the risk assessment methodologies since the time of the ROD, ESD, ROD Amendment, and ROD Amendment 2 do not call into question the protectiveness of the remedies since all contaminants of concern, including PCBs, lead, and cadmium will be remediated to below cleanup levels at the remediated sites. The November 2015 Technical Memorandum (PCB OU Risk Assessment) documents that there is no unacceptable risk to human health and the environment due to soil, sediment, or surface water at the PCB OU.

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

The remedies are working as intended.

C. EMMA OU

The USACE, on behalf of the DA, conducted the FYR of the EMMA OU sites within the Crab Orchard Site. This FYR incorporates the FYR Report for the EMMA OU by reference as Attachment C. Additional details are provided in Attachment C.

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

All contaminants of concern (nitro aromatic compounds, lead, and RDX/HMX) have been removed at Sites -3 and COP-4 to comply with the requirements of the 1997 ROD for the EMMA OU. In addition, the DA conducted removal activities to address unexploded ordnance at 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. The soil covers at the COC-3 and COP-4 sites have thick vegetation and show no signs erosion. The groundwater monitoring has been maintained to insure that the contaminated groundwater does not migrate off-site. The sites are in fenced areas and are inaccessible to the public. ICs to prohibit the installation of potable wells at the EMMA OU sites are in place and enforced by FWS.

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?
Answer: Yes.

The exposure assumptions, toxicity data, cleanup levels, and 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?
Answer: No.

The remedies are working as intended.

D. MISCA OU – Site 14

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

Excavation and off-site disposal of soil contaminated with benzene, ethylbenzene, toluene, xylene, methylene chloride, chromium, and lead are complete. Groundwater cleanup objectives are met at Site 14 and no further action or monitoring is necessary at Site 14.

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?
Answer: Yes.

The exposure assumptions, toxicity data, and the remedial action objectives used at the time of the remedy selection are still valid. As described in Chapter IV, Section D.3 of this report, ITW cleaned up the soil contamination at Site 14 to levels much more stringent than the levels required under the ROD for the MISCA OU - Site 14. There is no unacceptable risk to human health and the environment at Site 14.

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

E. MISCA OU – Site 36

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

The major components of the remedy at Site 36 which included the demolition of the existing wastewater treatment plant, excavation, and off–site disposal of contaminated material from the

east pond, primary and secondary lagoons, and the Upper Dove Creek are complete. No further action at Sites 22A and no action at the remaining MISCA OU sites are necessary. ICs to prevent access to Sites 10 and 16, and ICs to prohibit the installation of potable water wells at Site 36 are in place and enforced by FWS. Groundwater cleanup objectives are met at Site 14 and no further action or monitoring is necessary at Site 14.

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?
Answer: Yes.

The exposure assumptions, toxicity data, cleanup levels, and the remedial action objectives used at the remedy selection are still valid.

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

VIII. Issues

In order to ensure that the remedies continue to function as intended and to be protective in the long-term, two issues are identified: ICs are needed for the Metals Area and PCB Area landfills; long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced.

IX. Recommendations and Follow-up Actions

EPA recommends that the FWS update the April 2008 ELUC Plan to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA recommends that EPA, Illinois EPA, and FWS enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

X. Protectiveness Statements

The following bullets describe the protectiveness statements for each of the four operable units (OUs) of the Crab Orchard Site:

- Metals OU: The remedy at the Metals OU is currently protective of human health and the environment because the soil and sediments at all sites within this OU have been remediated to the cleanup levels selected in the Metals OU ROD. However, in order for the remedy to be protective in the long-term, the following actions need to be taken: an IC is needed for the Metals Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the

Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

- PCB OU: The remedy at the PCB OU is currently protective of human health and the environment because the Area 9 Repository and the PCB Area Landfill effectively contain the site contamination. The remedial action conducted to date and ongoing/future cleanup activities to address soil and groundwater contamination for Plumes 1, 2, and 3 are expected to mitigate any potential long-term risk including vapor intrusion and restore the groundwater to beneficial use. However, in order for the remedy to be protective in the long-term, the following actions need to be taken: an IC is needed for the PCB Area landfill; and long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.
- EMMA OU: The remedies implemented for the EMMA OU are currently protective of human health and the environment. The response actions are effective and requisite land use controls are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.
- MISCA OU: The remedies at the MISCA OU, Sites 14 and 36, are currently protective of human health and the environment because the remedies are completed and ICs are in place. However, in order for the remedies to be protective in the long-term, the following action needs to be taken: long-term stewardship procedures should be developed and implemented to ensure that implemented ICs are effective and properly maintained, monitored, and enforced. The April 2008 ELUC Plan should be updated to include all ICs relating to the Metals OU, PCB OU, EMMA OU, and the MISCA OU. EPA, Illinois EPA, and FWS should enter into a LUCMOA consistent with Illinois UECA to ensure the durability of the ICs and long-term stewardship.

XI. Next Review

The next review will be conducted within five years of the completion of this FYR report and will address all OUs at the site.

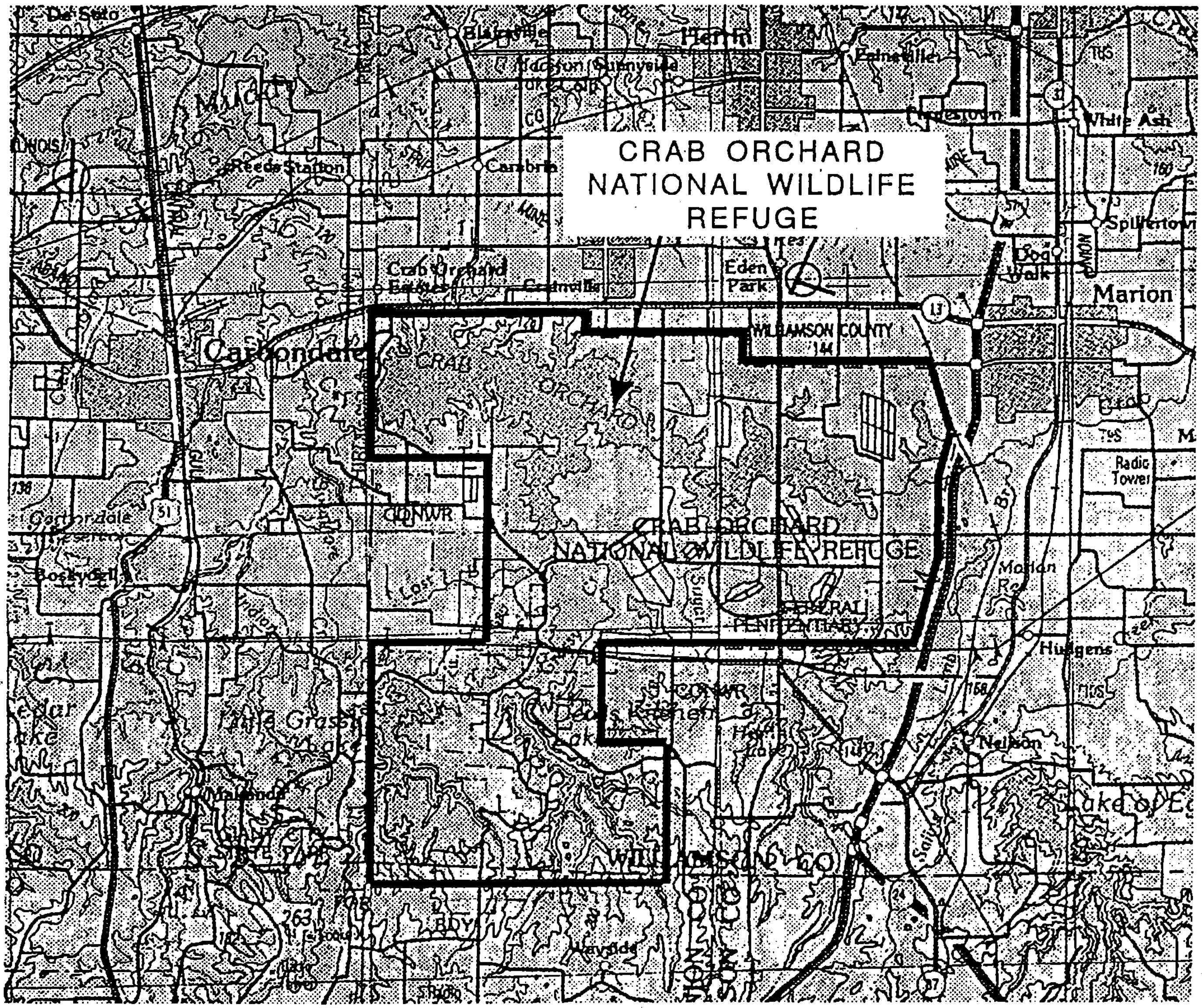
XII. Other Comments

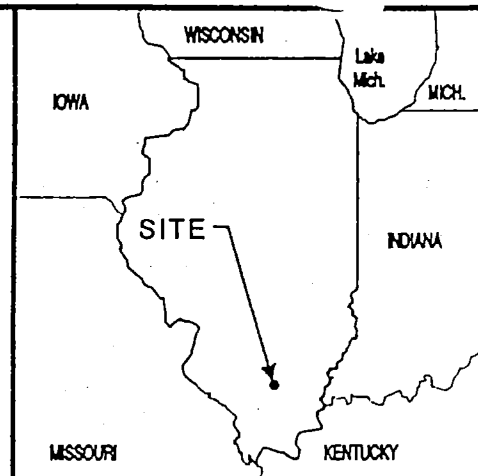
The USACE, on behalf of the DA, has conducted the FYR of the EMMA OU sites within the Crab Orchard Site. This document incorporates the FYR Report for the EMMA OU by reference.

Attachment A

List of Documents Reviewed

1. Remedial Investigation Report by O'Brien and Gere (August 1988)
2. Feasibility Study Report by O'Brien and Gere (August 1989)
3. Record of Decision for the Metals Areas Operable Unit (March 30, 1990)
4. Record of Decision for the PCB Areas Operable Unit (PCBOU) (August 1990)
5. Consent Decree for the PCBOU(May 1991)
6. Federal Facilities Agreement (September 1991)
7. Pre-Design Contamination Delineation Report for the PCBOU (April 1993)
8. Final Operation and Maintenance Plan (September 1995)
9. Solidification and Stabilization Work Plan for the PCBOU (September 1996)
10. Groundwater and Surface Water Monitoring Report for PCBOU (February 1997)
11. Closeout Report for the Metals Areas Operable Unit (February 1997)
12. Record of Decision for the EMMA OU (February 1997)
13. Draft Final Closeout Report for the PCBOU (March 1998)
14. Groundwater Investigation Report and Focused Feasibility Study (January 2000)
15. Explanation of Significant Differences for the EMMA OU (January 2000)
16. Explanation of Significant Differences for the PCB OU (June 2000)
17. FYR Report for the PCB OU (September 2000)
18. Preliminary Screening Analysis Report for the Lake OU (April 2001)
19. FYR Report for the Metals OU (September 2001)
20. Record of Decision for the MISCA OU – Site 14 (October 2001)
21. Record of Decision for the MISCA OU – Site 36 (September 2002)
22. Final Revised Closure Report for the Water Towers Operable Unit (June 2004)
23. Documentation Report for Center Swale Sediment Removal Action (January 2005)
24. Post Remedial Action Monitoring Report for the Metals Areas Operable Unit (May 2006)
25. Third FYR Report (September 2006)
26. Interim Remedial Action Report for Site 36 of the MISCA OU (September 2006)
27. ROD Amendment for the PCB OU dated August 2007
28. Final ELUC Plan for Crab Orchard National Wildlife Refuge NPL Site (FWS April 2008)
29. Interim Remedial Action Completion Report for Site 14 of the MISCA OU (September 2009)





VICINITY MAP

SOURCE:
PADUCAH
1 X 2 QUADRANGLE
GEOLOGICAL SURVEY
1987

FIGURE 1

NOTE:
1. REFUGE BOUNDARY LOCATION APPROXIMATE.

SITE PLAN

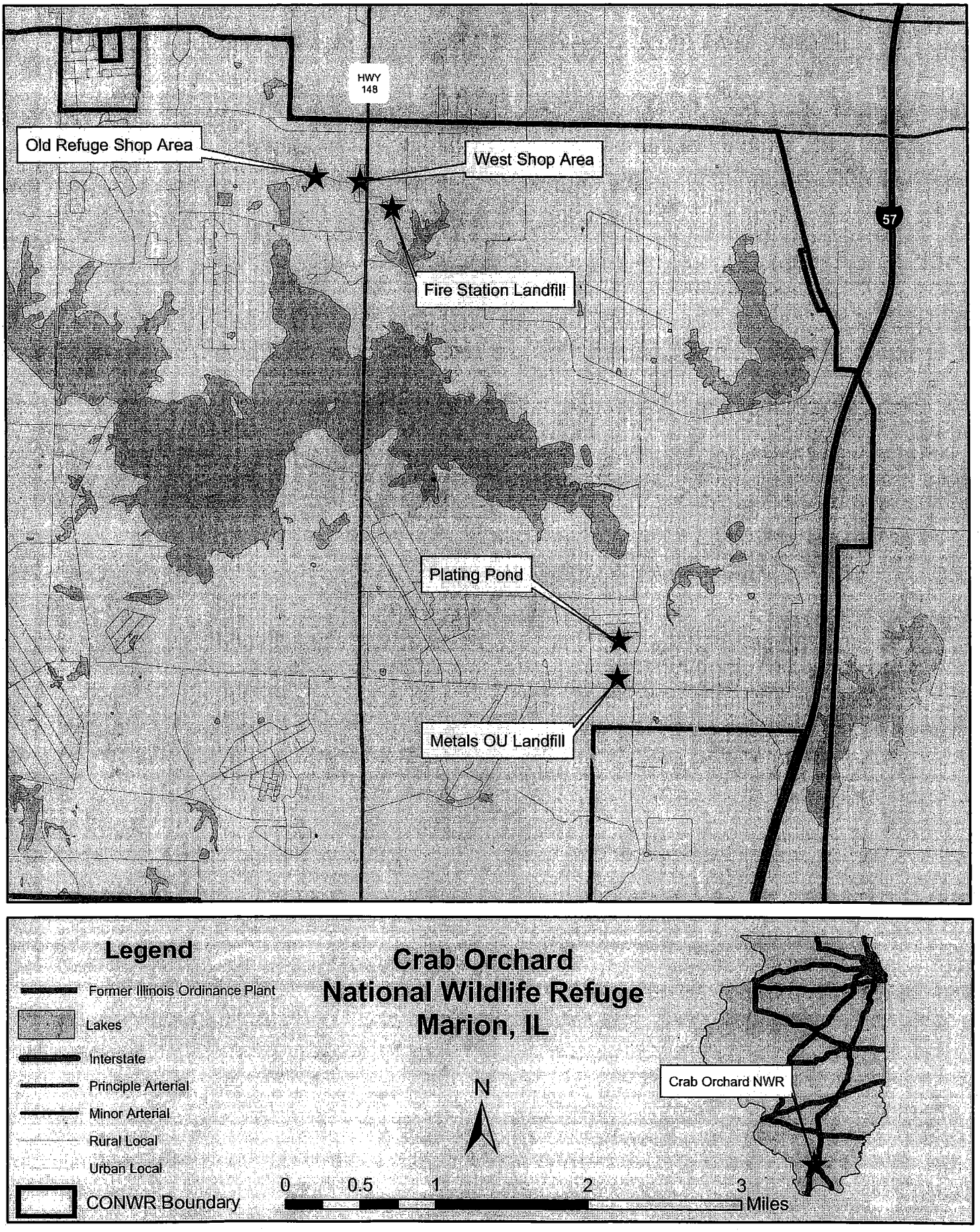
3 0 3

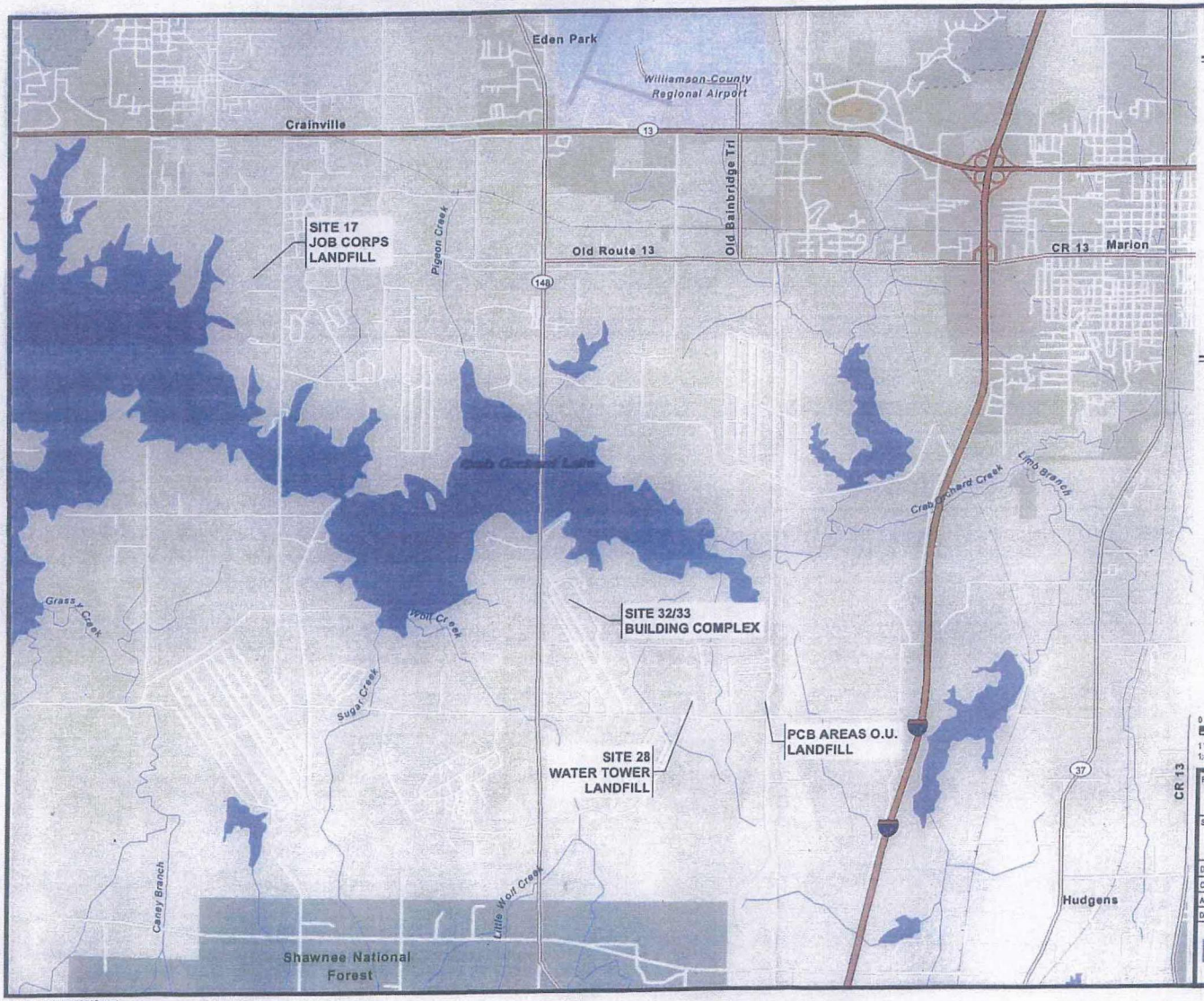
SCALE IN MILES

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

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

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





LEGEND

NOTES

1. MAP DATA FROM ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI).

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PROJECT: CRAB ORCHARD NWR - PCB O.U. WILLIAMSON COUNTY, ILLINOIS			
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APPROVED BY: MARTIN S	DATE PRINTED:	FIGURE 3	
DATE: JANUARY 2011			

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744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923 53708-8923
Phone: 608-831-4444
Fax: 608-831-3334

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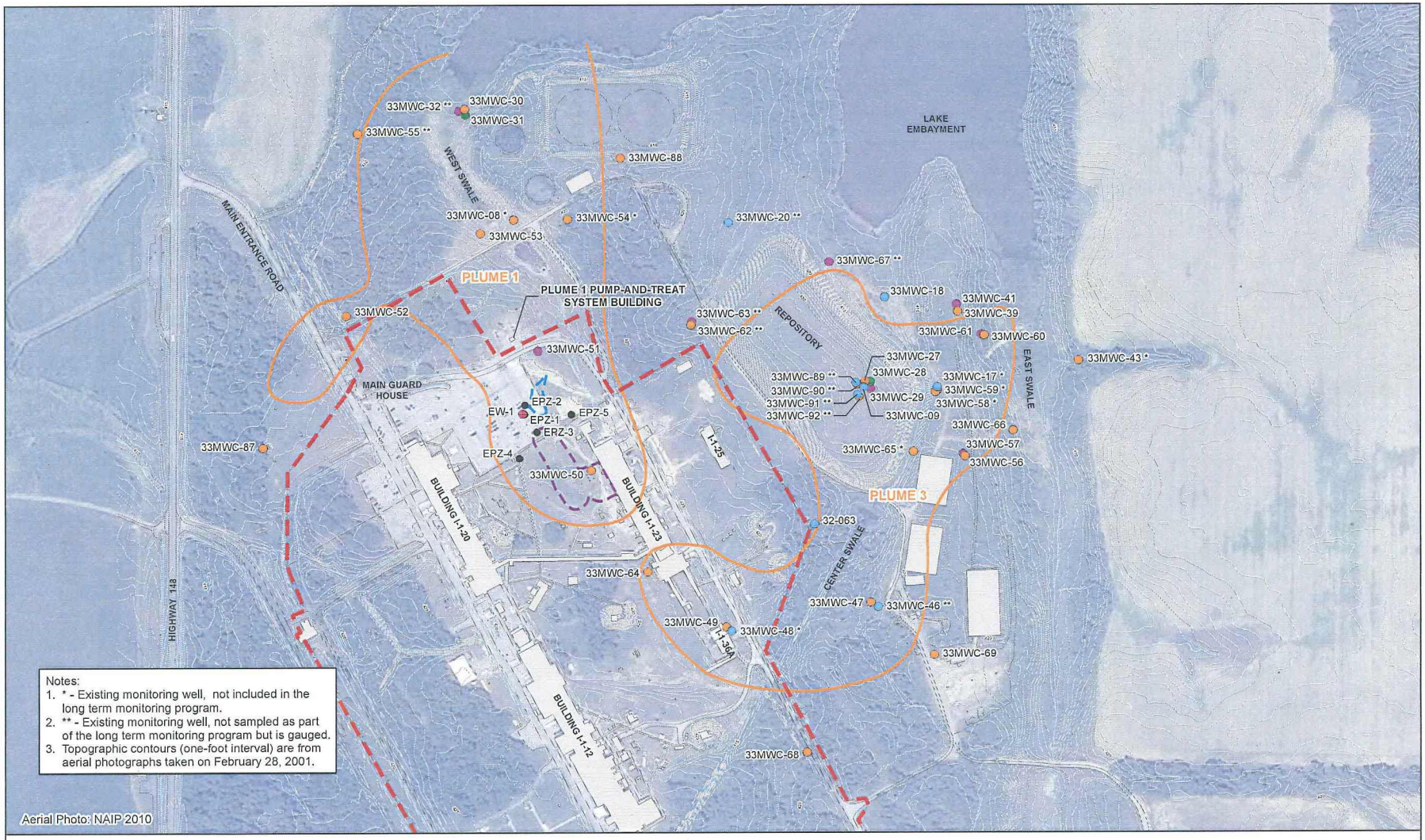

Notes:
1. * - Existing monitoring well, not included in the long term monitoring program.
2. ** - Existing monitoring well, not sampled as part of the long term monitoring program but is gauged.
3. Topographic contours (one-foot interval) are from aerial photographs taken on February 28, 2001.

N

0 150 300 Feet

LEGEND

- Industrial Area Boundary
- Buildings
- Surface Water
- Topographic Contour (Index)
- Topographic Contour (Intermediate)

Monitoring Well Locations
Type of Well, Unit Screened

- Existing Monitoring Well, Upper Clay
- Existing Monitoring Well, Upper Sand
- Existing Monitoring Well, Intermediate Sand
- Existing Monitoring Well, Lower Sand
- Extraction Well
- Piezometer
- Plume Extents
- Approximate Plume 1 Excavation Area
- 1960s Drainage Ditch Excavation Area

FIGURE 3-1
Plume 1 and 3 Monitoring Well Network and Plume 1 Pump-and-Treat System
Fourth Annual Monitoring Report for Plumes 1 and 3
Crab Orchard National Wildlife Refuge
Marion, Illinois

ch2m

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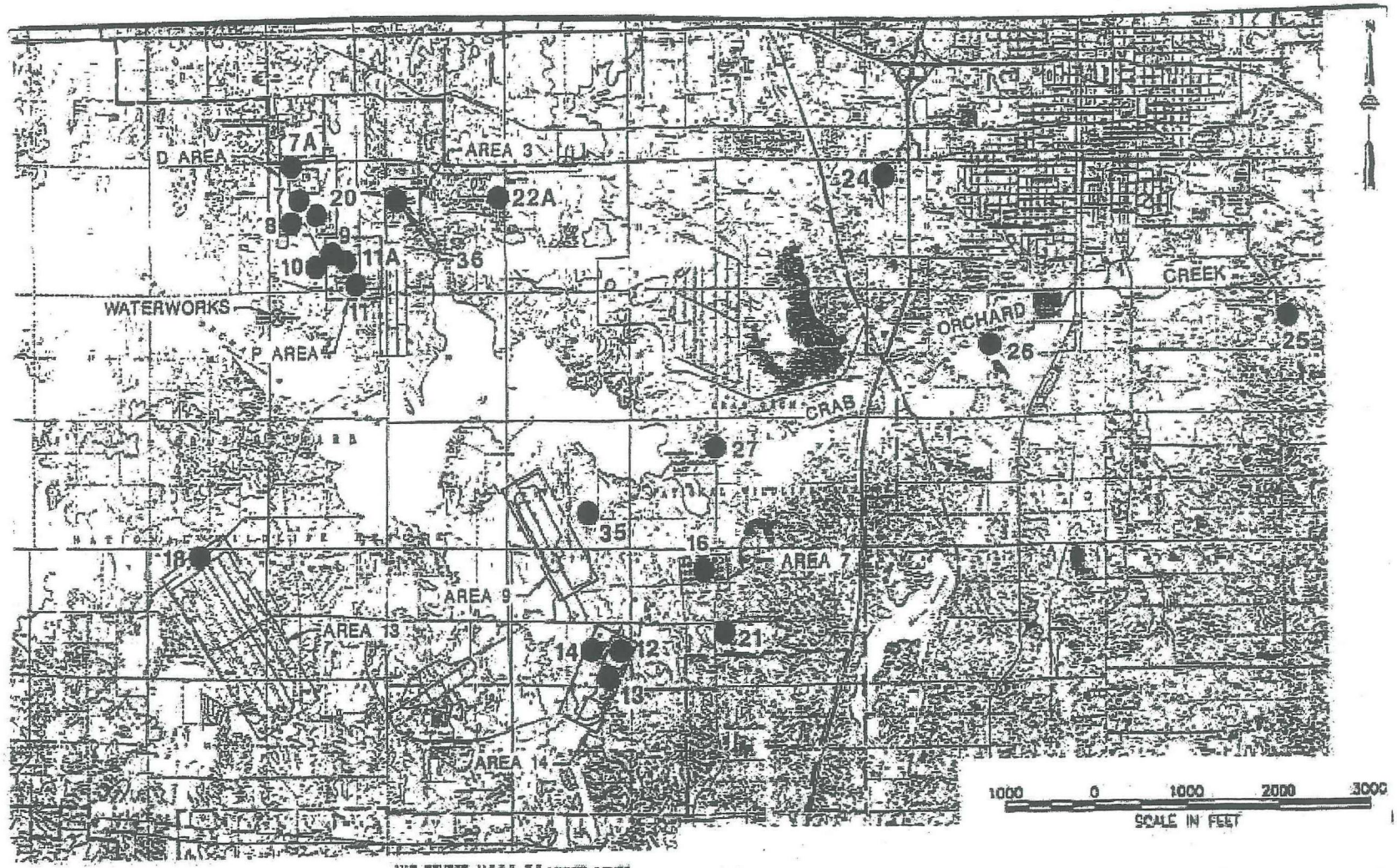

REFUGE BOUNDARY

SITE LOCATION

MAP SOURCE: U.S.G.S. 7.5 MINUTE SERIES QUADRANGLE MAPS MARION, IL, 1968, PHOTOREVISED 1980, AND CRAB ORCHARD LAKE, IL, 1968, PHOTOREVISED 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

Notes:
1. Topographic contours (one-foot interval) are from aerial photographs taken on February 28, 2001.
2. Groundwater elevations were measured October 28, 2014

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0 100 200 Feet

LEGEND
- Piezometer Location
- Plume Extents
- Phytoremediation Area
- Buildings
- Industrial Area Boundary
- Surface Water
- Topographic Contour (Index)
- Topographic Contour (Intermediate)

FIGURE 5
Phytoremediation Areas and Piezometer Locations
Fourth Annual Monitoring Report for Plumes 1 and 3
Crab Orchard National Wildlife Refuge
Marion, Illinois

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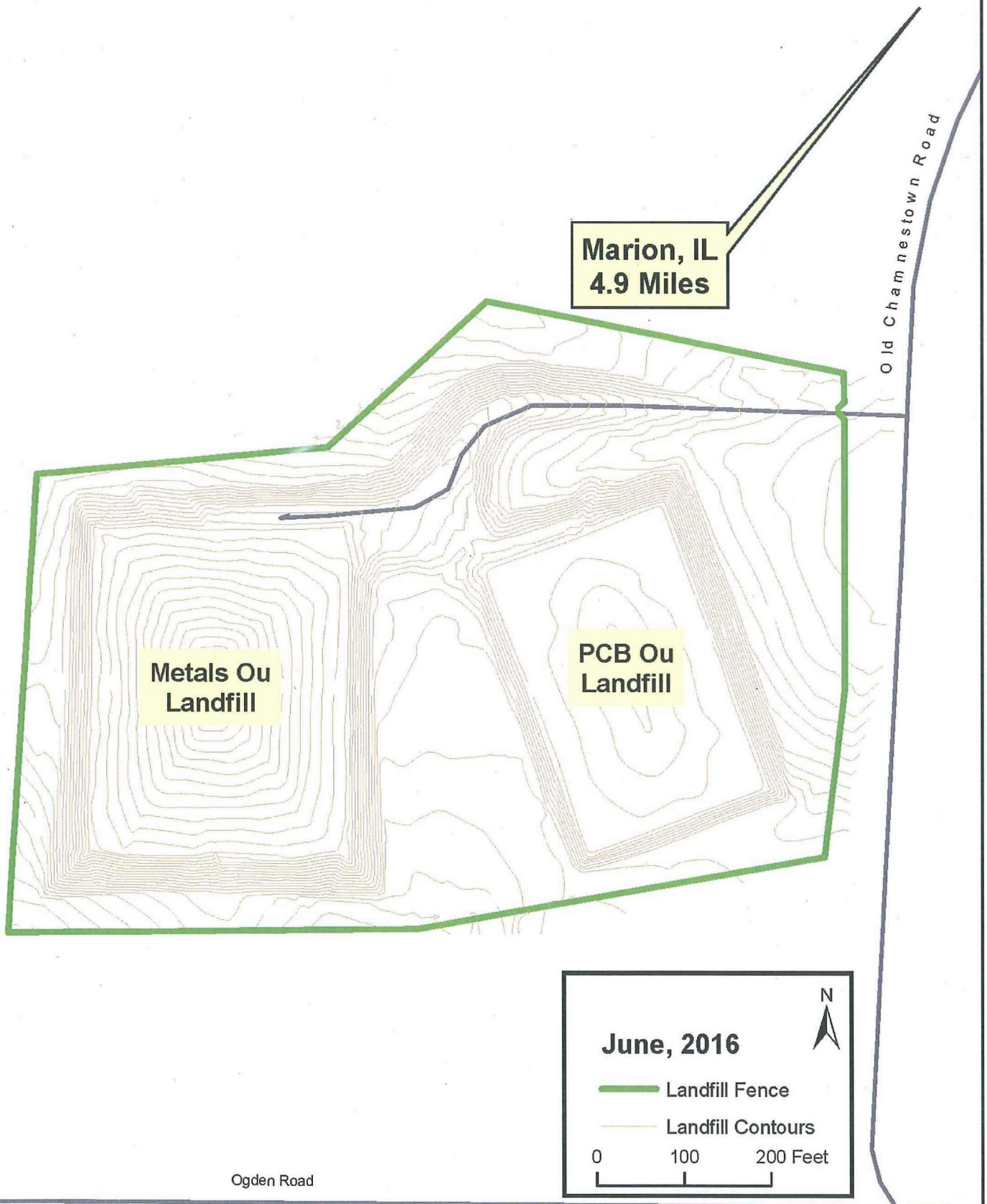
Figure 6



Location of Metals OU and PCB OU Landfills
Crab Orchard National Wildlife Refuge
Marion, Illinois

Table 2 Metals Area and PCB OU Area Landfills Leachate Results (2016)

Compounds	Metals Leachate	PCB OU Leachate
Date	02/16/16	04/18/16
Inorganics (ug/L) - Total		
Aluminum	**280**	NA
Antimony	ND	NA
Arsenic	ND	NA
Barium	**14.2**	NA
Beryllium	ND	NA
Boron	ND	NA
Cadmium	ND	**1.5 J**
Calcium	**25100**	NA
Chromium	ND	**2.5 J**
Cobalt	ND	NA
Copper	ND	NA
Cyanide, total	ND	NA
Cyanide, weak acid	ND	NA
Iron	501	NA
Lead	ND	NA
Magnesium	**4150**	NA
Manganese	**42.4**	NA
Mercury	ND	NA
Nickel	ND	NA
Potassium	**10100**	NA
Selenium	ND	NA
Silver	ND	NA
Sodium	**2290**	NA
Thallium	ND	NA
Vanadium	ND	NA
Zinc	ND	NA
Inorganics (ug/L) - Dissolved		
Cadmium	NA	ND
Chromium	NA	ND
Volatile Organic Compounds (ug/L)		
cis-1,2-Dichloroethene	NA	ND
Tetrachloroethene	NA	ND
Trichloroethene	NA	ND
Vinyl chloride	NA	ND
Polychlorinated Biphenyls (PCBs) (ug/L)		
PCBs, Total	NA	ND

NA = Not Analyzed
ND = Not Detected
J = Estimated

TABLE 3

Plumes 1 and 3 2015 Monitoring Well Network

Fourth Annual Monitoring Report for Plumes 1 and 3

Crab Orchard National Wildlife Refuge, Marion, Illinois

Well ID	Current Designation	Unit Screened	Water-Level Measurement	Water-Quality Field Parameters[a]	Analytical Parameters VOCs	MNA[b]
Plume 1 Wells						
33MWC-30	Plume	Upper Sand	X		X	
33MWC-31	Sentinel	Intermediate Sand	X		X	
33MWC-32	Sentinel	Lower Sand	X			
33MWC-50	Plume	Upper Sand	X		X	
33MWC-51	Boundary	Lower Sand	X		X	
33MWC-52	Plume	Upper Sand	X		X	
33MWC-53	Plume	Upper Sand	X		X	
33MWC-55	Boundary	Upper Sand	X			
33MWC-87	Boundary	Upper Sand	X		X	
33MWC-88	Boundary	Upper Sand	X		X	
Plume 3 Wells						
32-063	Boundary	Upper Clay	X		X	
33MWC-09	Plume	Upper Clay	X	X	X	X
33MWC-18	Sentinel	Upper Clay	X	X	X	X
33MWC-20	Boundary	Upper Clay	X			
33MWC-27	Plume	Upper Sand	X	X	X	X
33MWC-28	Boundary	Intermediate Sand	X		X	
33MWC-29	Boundary	Lower Sand	X	X	X	
33MWC-39	Sentinel	Upper Sand	X	X	X	X
33MWC-41	Sentinel	Lower Sand	X		X	
33MWC-46	Boundary	Upper Clay	X			
33MWC-47	Plume	Upper Sand	X	X	X	X
33MWC-49	Plume	Upper Sand	X	X	X	X
33MWC-56	Plume	Upper Sand	X	X	X	X
33MWC-57	Boundary	Lower Sand	X		X	
33MWC-60	Plume	Upper Sand	X	X	X	X
33MWC-61	Sentinel/ Boundary	Lower Sand	X		X	
33MWC-62	Boundary	Upper Sand	X			
33MWC-63	Boundary	Lower Sand	X			
33MWC-64[d]	Plume	Upper Sand	X	X	X	X
33MWC-66[c]	Boundary	Upper Sand	X	X	X	X
33MWC-67	Boundary	Lower Sand	X			
Background Wells						
33MWC-68	Background	Upper Sand	X	X	X	X
33MWC-69[c]	Background	Upper Sand	X	X	X	X

Notes:

[a]Water-quality field parameters include measurements of oxidation-reduction potential, dissolved oxygen, pH, specific conductance, temperature, and turbidity.

[b]MNA parameters include field analysis for carbon dioxide and dissolved iron, and laboratory analysis for dissolved gases, total organic carbon, total inorganic carbon, select metals (iron and manganese), alkalinity, chloride and sulfate, nitrite + nitrate, and nitrate.

[c]MNA parameters were sampled during October 2014 event only.

[d]33MWC-64 will be sampled as part of the long-term monitoring events if there is a time during daylight hours when the well is accessible.

Designation Definitions:

Plume Well = A groundwater monitoring well exhibiting VOC concentrations above the maximum contaminant levels.

Sentinel Well = A groundwater monitoring well situated between the contaminant plume and the downgradient receptor (Crab Orchard Lake).

Boundary Well = A groundwater monitoring well cross-gradient or upgradient of the contaminant plume; may also include wells screened in the Upper Clay above an area of contamination confined in the Upper Sand or wells screened in the Lower Sand beneath an area of contamination confined in the Upper Sand.

Background Well = A groundwater monitoring located upgradient of the Plume 1 and 3 source areas.

MNA = monitored natural attenuation

VOC = volatile organic compound

FINAL

ENVIRONMENTAL LAND USE CONTROL PLAN

Crab Orchard National Wildlife Refuge NPL Site
Marion, Illinois

U.S. Fish & Wildlife Service
Crab Orchard National Wildlife Refuge
Marion, Illinois

April 2008

FINAL

STAND-ALONE SECTION FOR FIELD AND CONSTRUCTION PERSONNEL ENVIRONMENTAL LAND USE CONTROL PLAN

Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois
April 2008

I. Purpose and Instructions

Purpose

Because of past industry at the Refuge, there is some remaining contamination that results in various land use controls (LUCs) to some areas within the former Illinois Ordnance Plant (IOP).[1] These LUCs apply to all individuals conducting field and construction work on the Refuge. The purpose of this stand-alone section is to provide these personnel with a method for quickly and accurately identifying potential site restrictions. Note that this section contains information designed to be used, if necessary, as a stand-alone document, separate from the remaining body of the Environmental Land Use Control Plan (Plan). However, the source Plan should be checked periodically for updates.

Instructions

There are two IOP-wide restrictions: (1) the installation of production water wells is prohibited and (2) residential use and camping are prohibited. Exceptions to the IOP-wide restrictions will be enumerated in future versions of this Plan, as appropriate. Some sites may have restrictions in addition to the IOP-wide restrictions including, for example, digging restrictions. To determine if a site in question has any additional restrictions, follow these instructions:

- find the site on the following Overview Map of the former IOP;
- if the site in question has additional restrictions, the site will be outlined on the Overview Map and shown with a reference to review an associated figure (also included in the stand-alone section), which will include a summary of additional restrictions; and,
- if the site in question is not shown on the Overview Map, only the two IOP-wide restrictions (noted above) apply.

II. Personal Protective Equipment Guidelines

Until the nature and extent of contamination has been fully delineated throughout the entire site and appropriate final remedies are in place, interim guidelines for personal protective equipment (PPE) at various areas throughout the Refuge are necessary in an order to protect human health from potential exposure to site-related contamination. PPE guidelines are also shown on the figures.

[1] There are on-going investigations at most of the sites and additional information may be available. CERCLA staff can be contacted for up-to-date information. Also, this is a list of sites requiring use restrictions and is not to be considered a complete inventory of all CERCLA sites on the Refuge.

III. Agency and Facility Points-of-Contact

Illinois Environmental Protection Agency

Name:	Paul Lake
Address:	1021 North Grand Avenue, East P.O. Box 19276 Springfield, IL 62702
Phone:	(217) 785-7728
Fax:	(217) 782-3258
E-mail:	epa4170@epa.state.il.us

U.S. Environmental Protection Agency

Name:	Nanjunda Gowda
Address:	77 West Jackson Boulevard, SRF-5J Chicago, IL 60604-3590
Phone:	(312) 353-9236
Fax:	(312) 353-8426
E-mail:	gowda.nanjunda@epamail.epa.gov

Crab Orchard National Wildlife Refuge

Name:	Dennis Pinigis CERCLA Program Manager
Address:	8588 Route 148 Marion, IL 62959
Phone:	(618) 997-3344
Fax:	(618) 998-0674
E-mail:	dennis_pinigis@fws.gov

Name:	Dan Frisk Refuge Manager
Address:	8588 Route 148 Marion, IL 62959
Phone:	(618) 997-3344
Fax:	(618) 997-8961
E-mail:	dan_frisk@fws.gov

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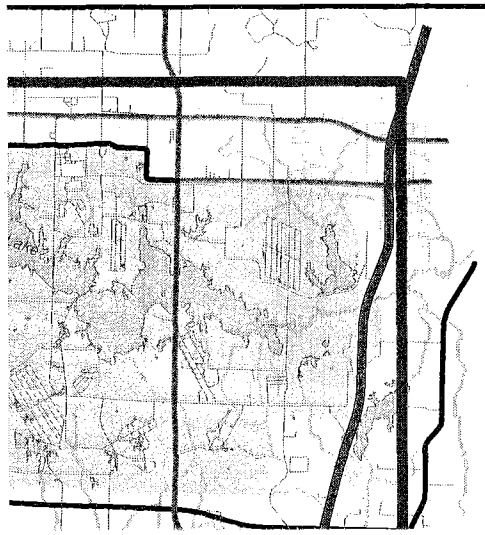

Figure 14-1
Figure 3-5
Figure 3-2
Figure 6-1
Figure 3-3
Figure 3-1
Figure 5-1
Figure 3-4
Figure 4-1
Figure 17-1
Figure 17-1
Crab Orchard Lake
Figure 10-1
Figure 10-2
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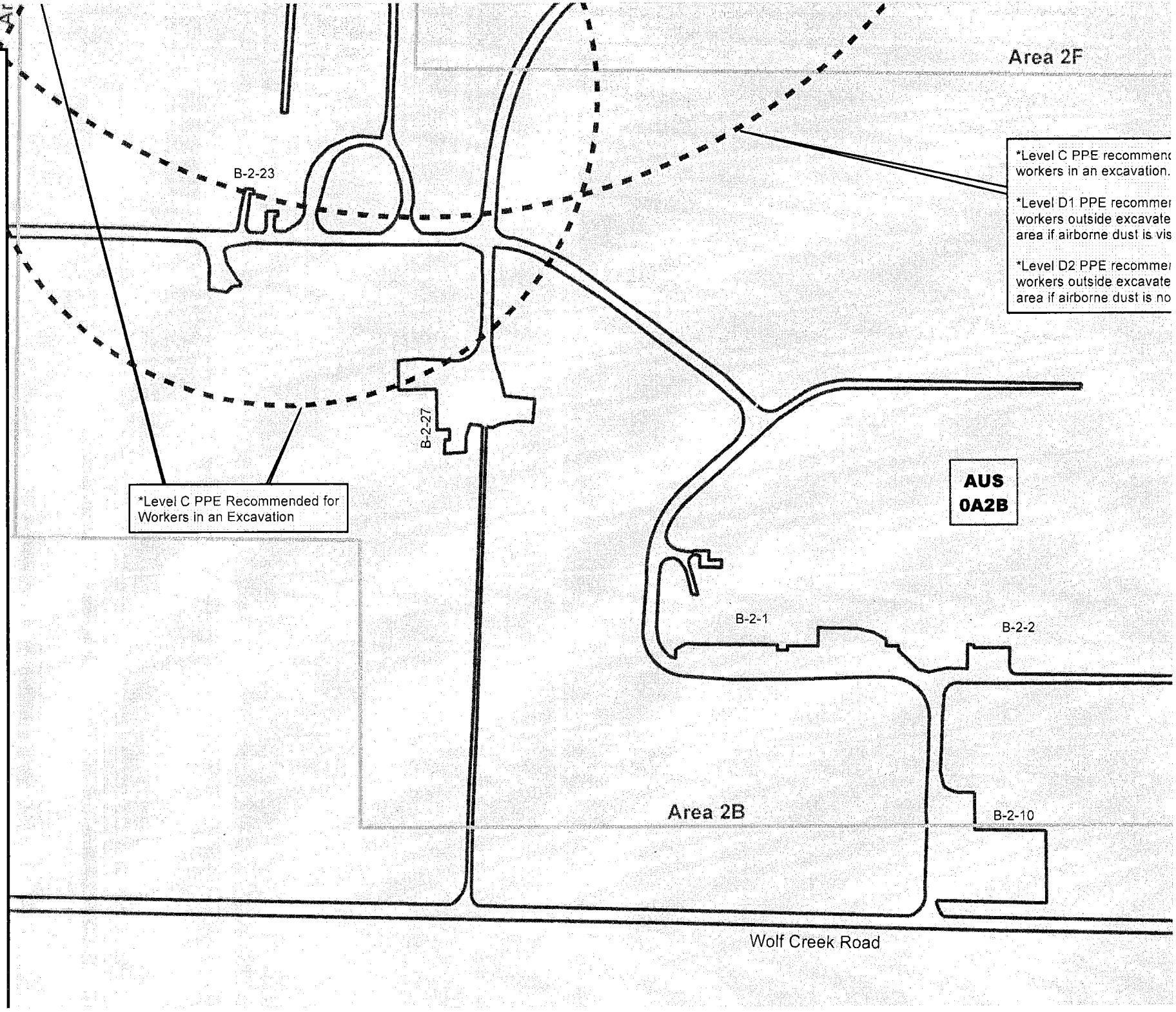

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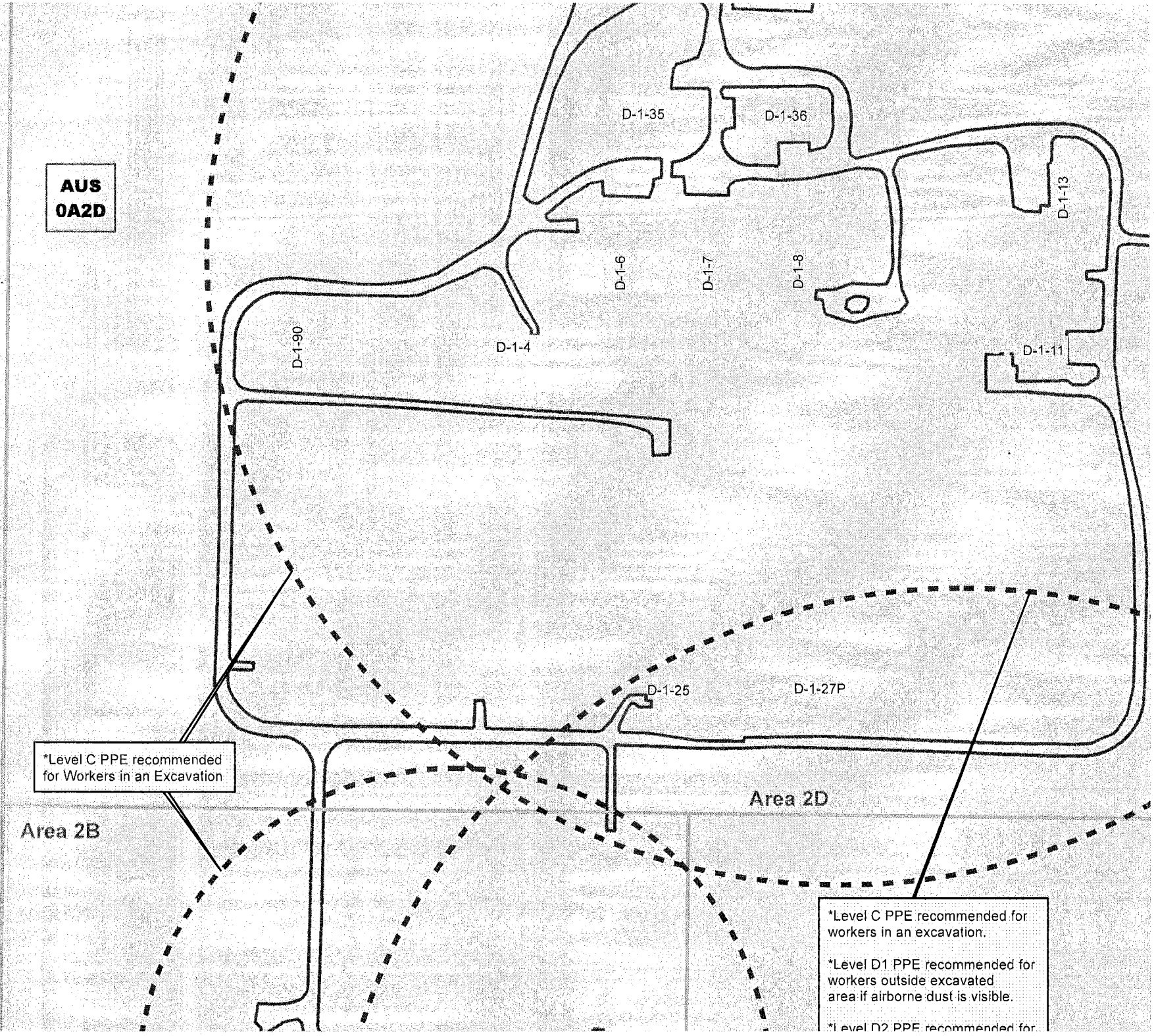

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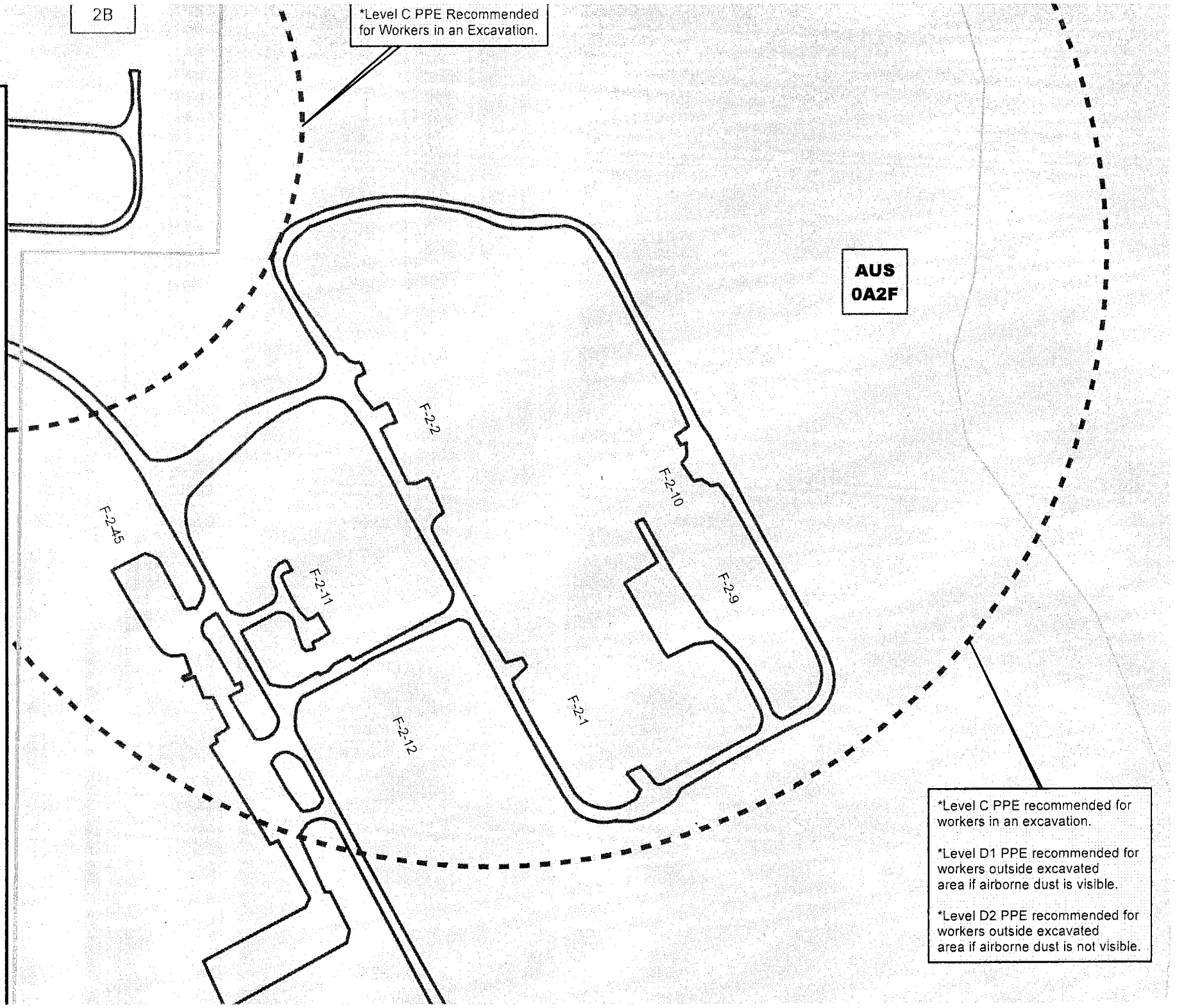

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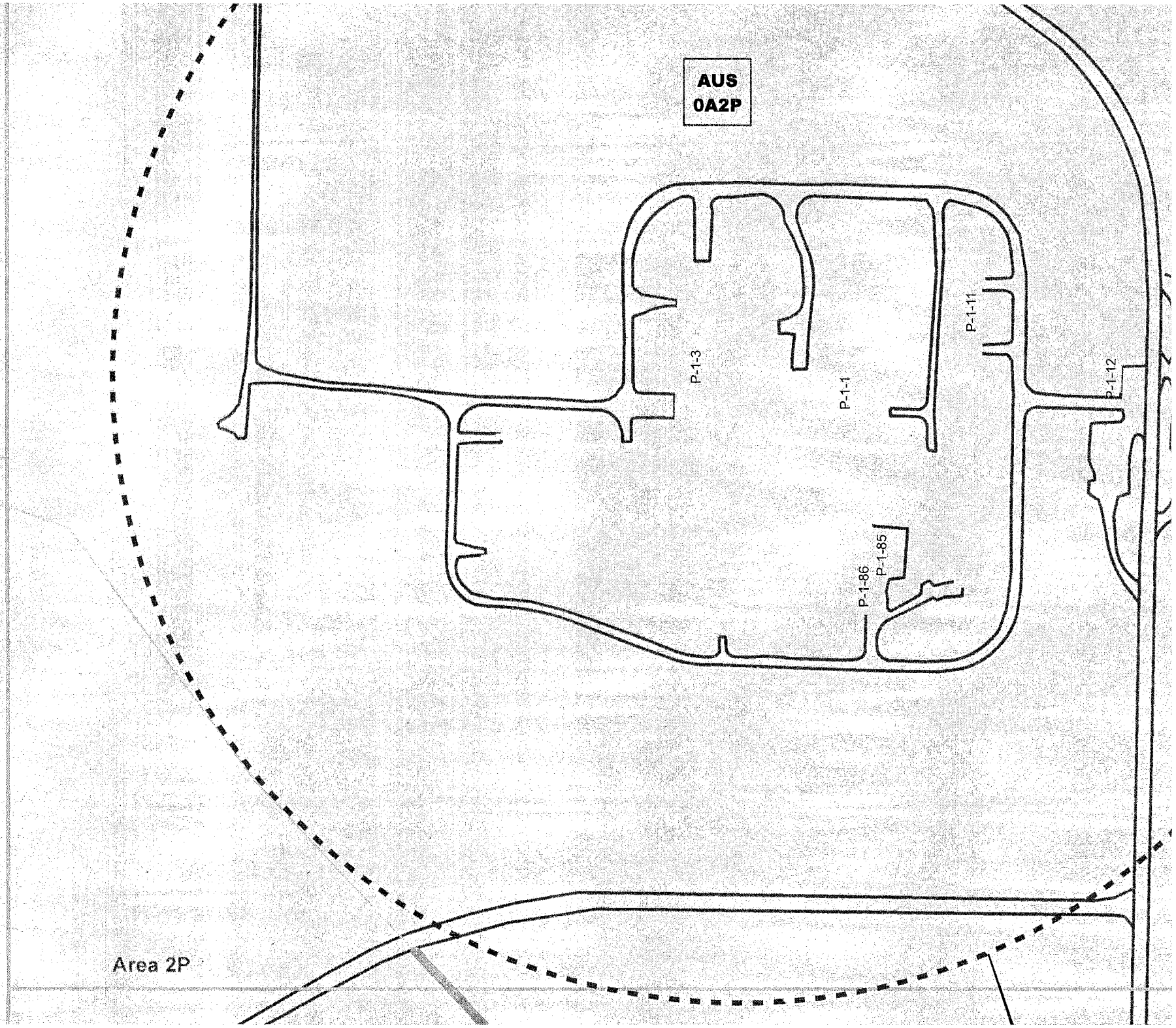

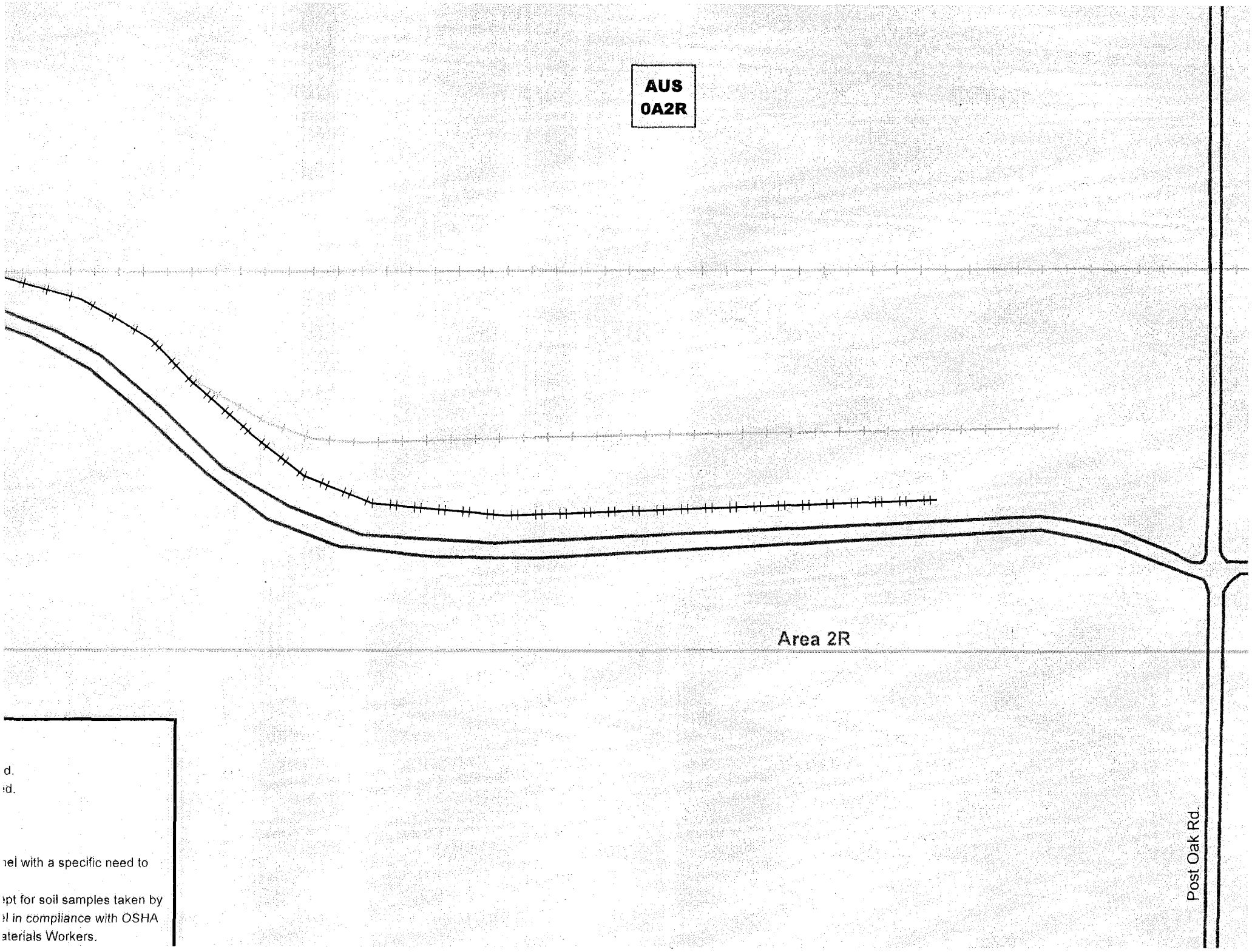

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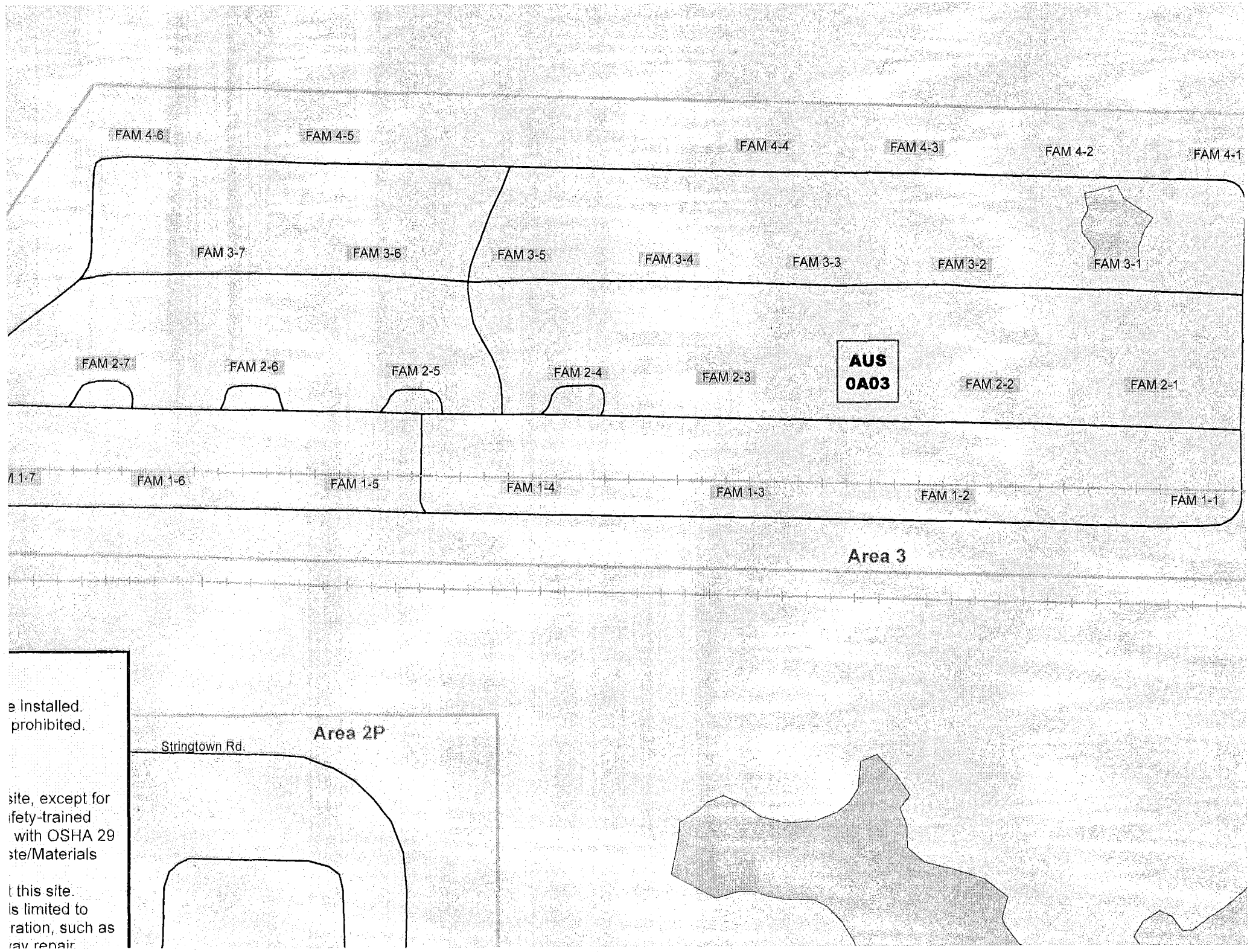

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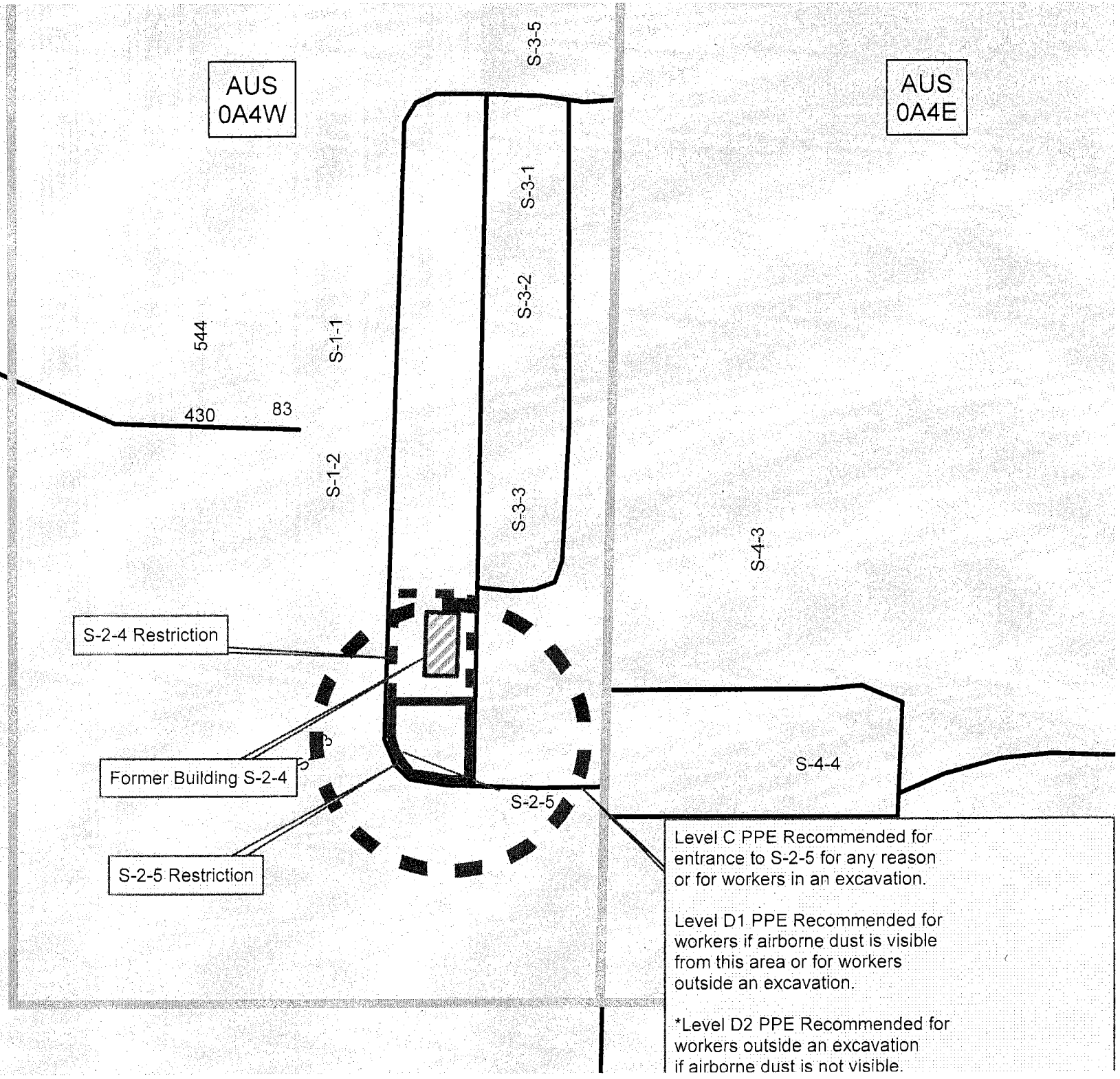

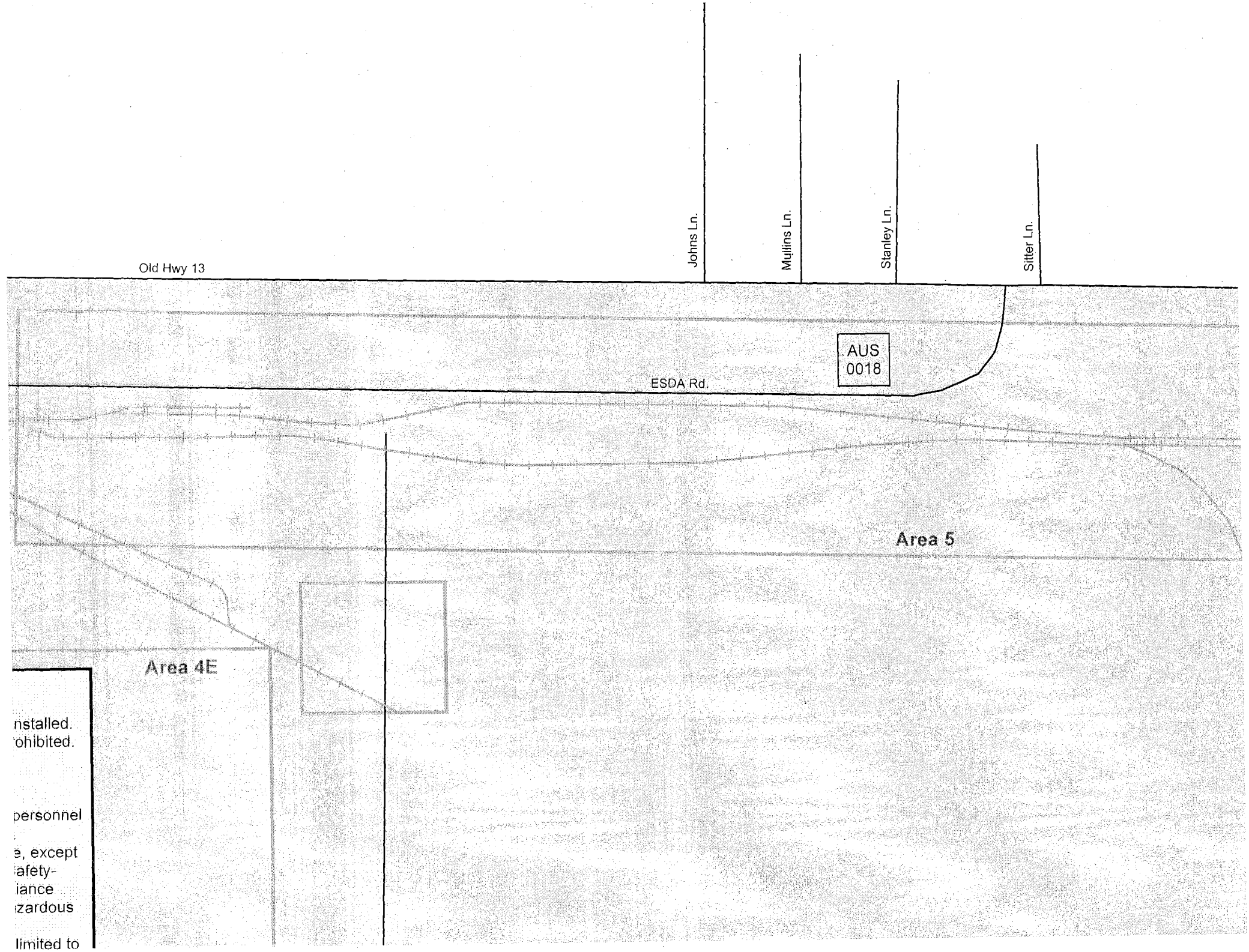

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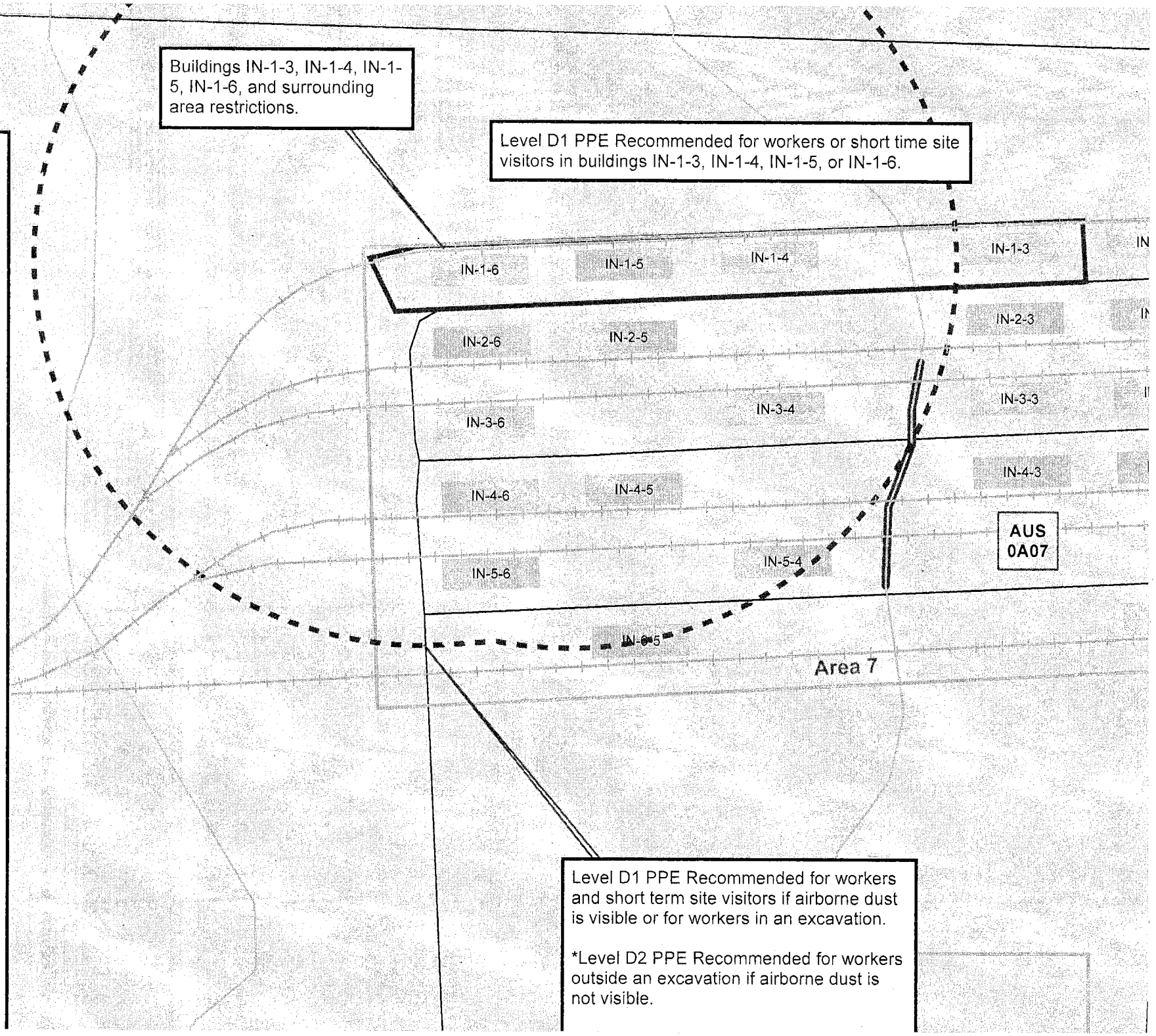

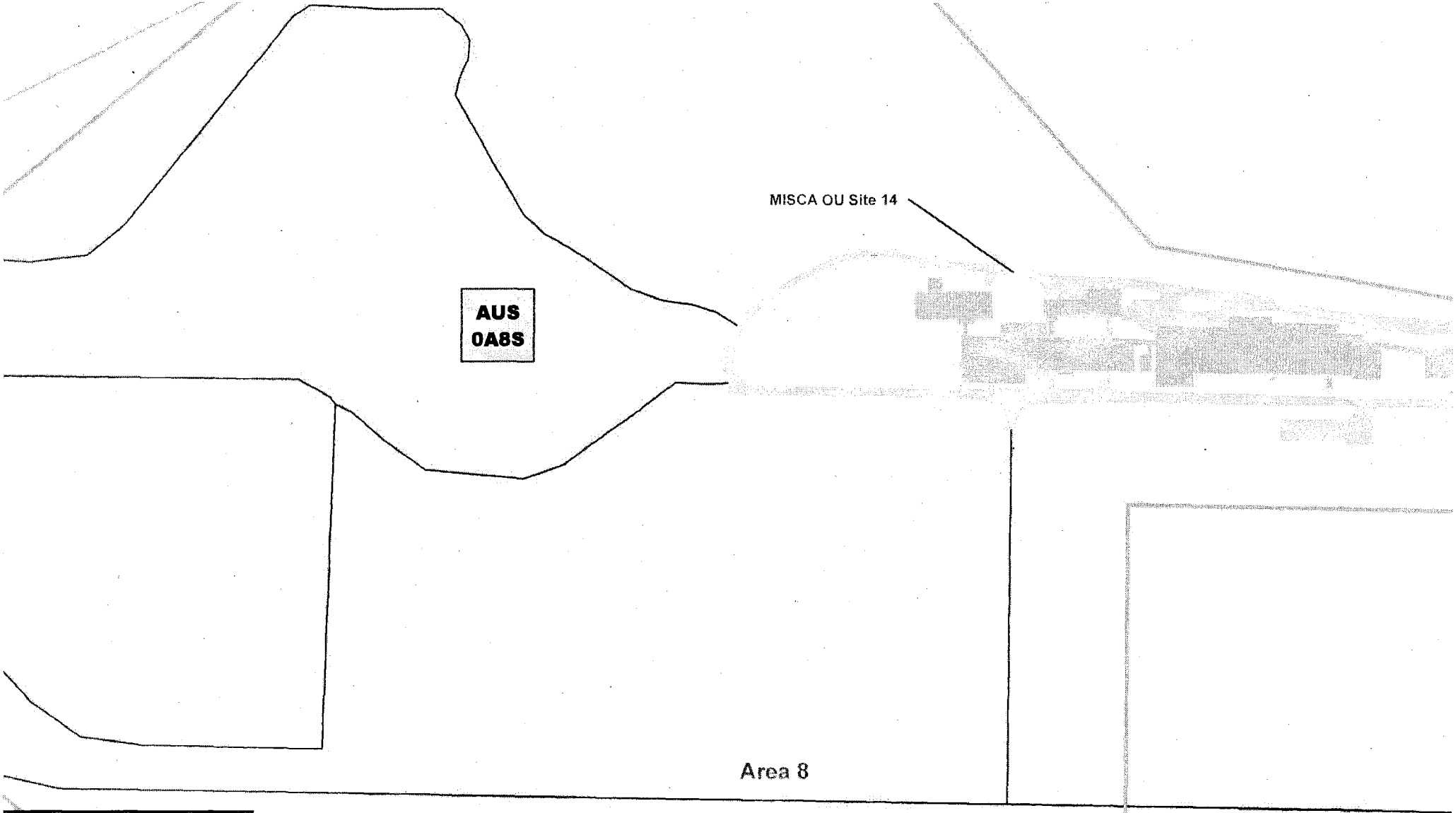

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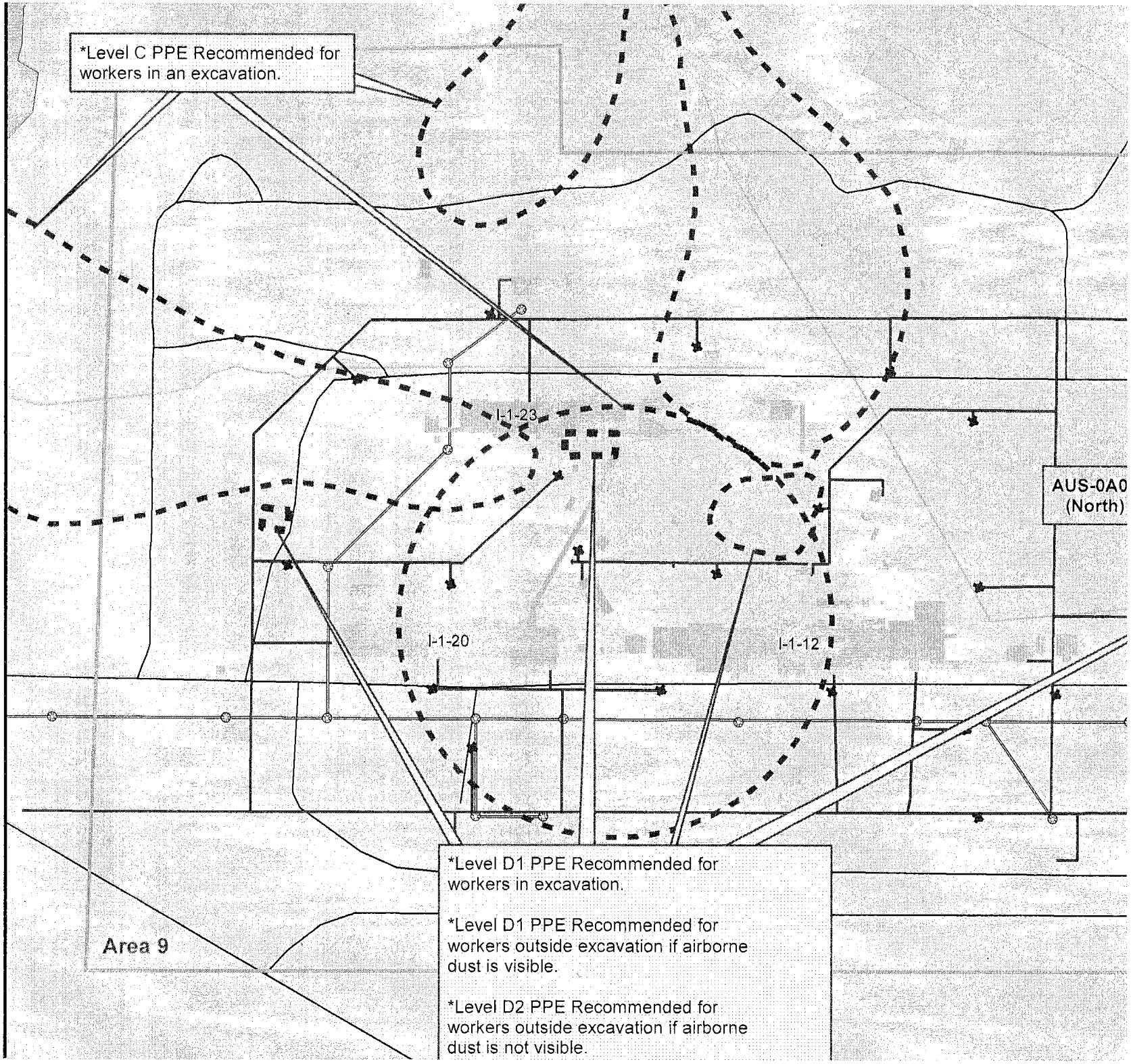

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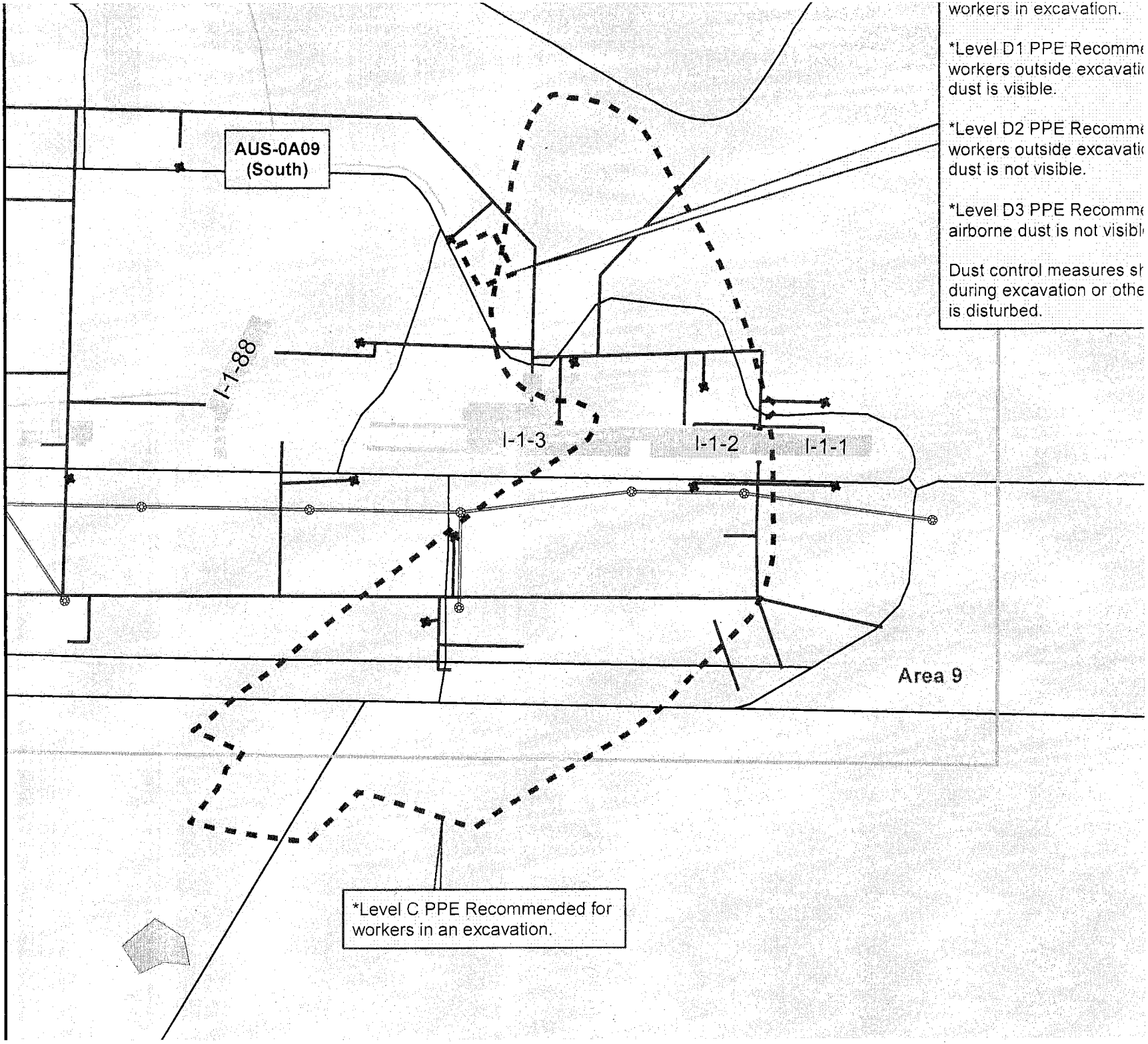

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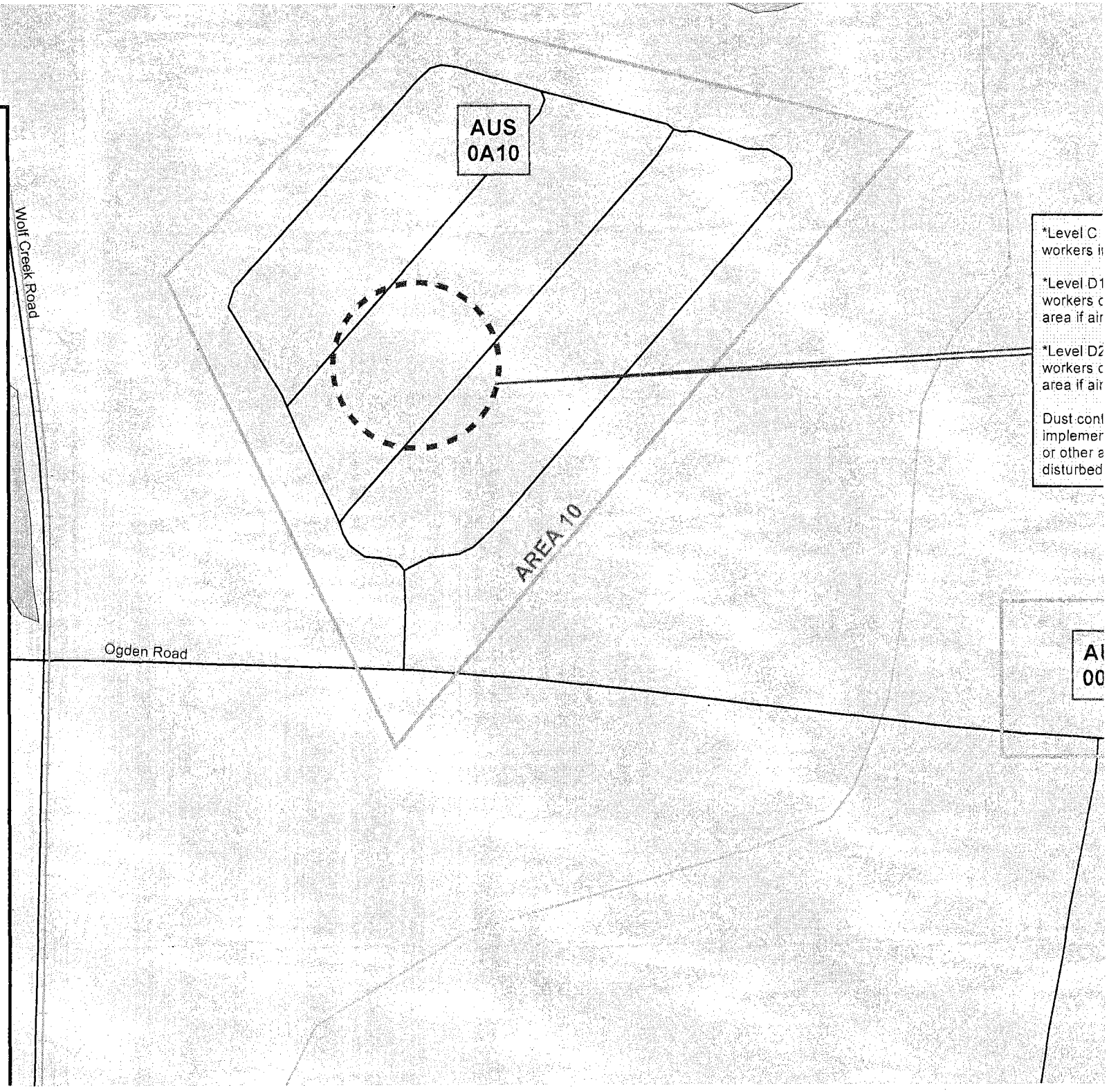

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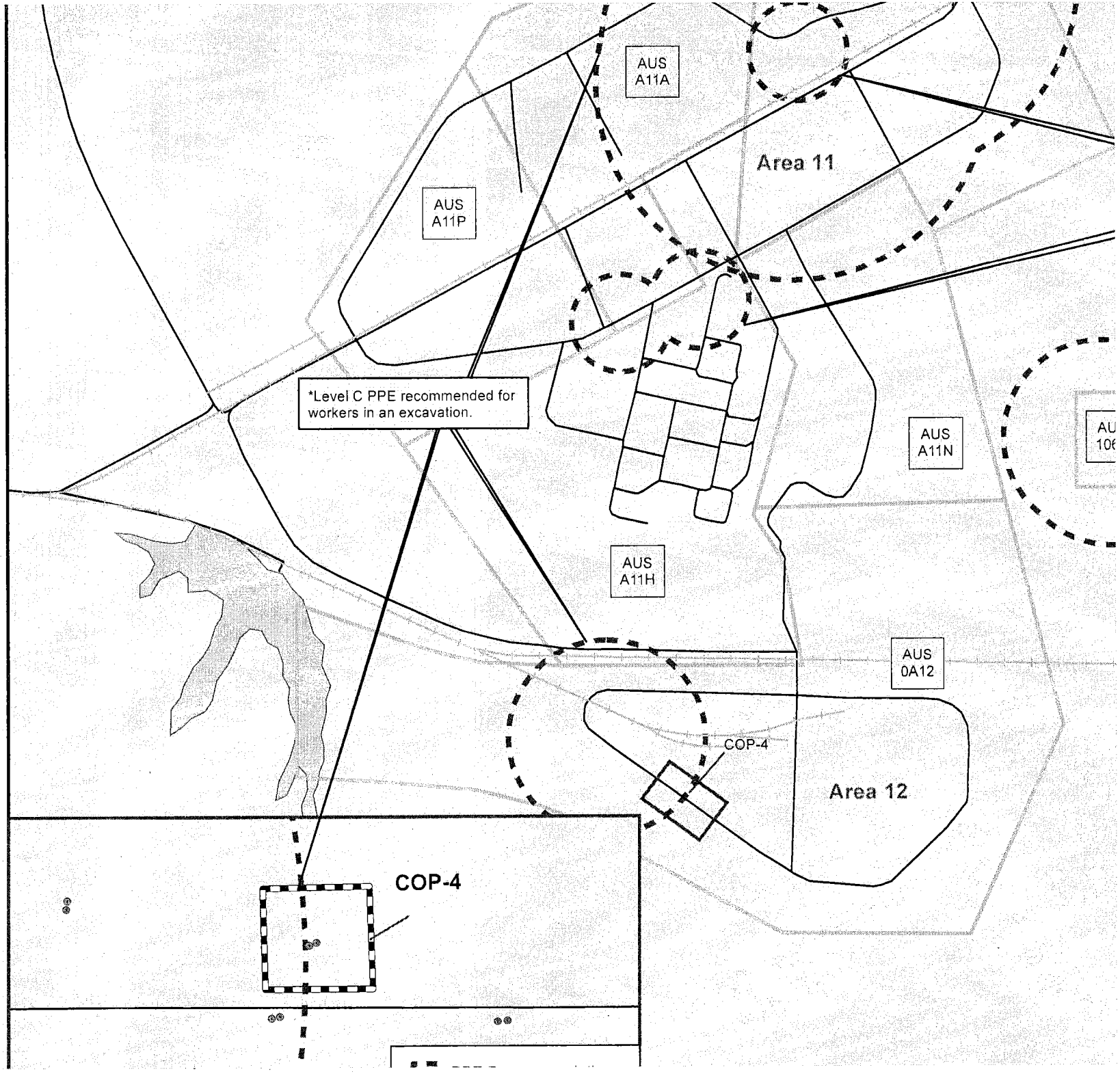

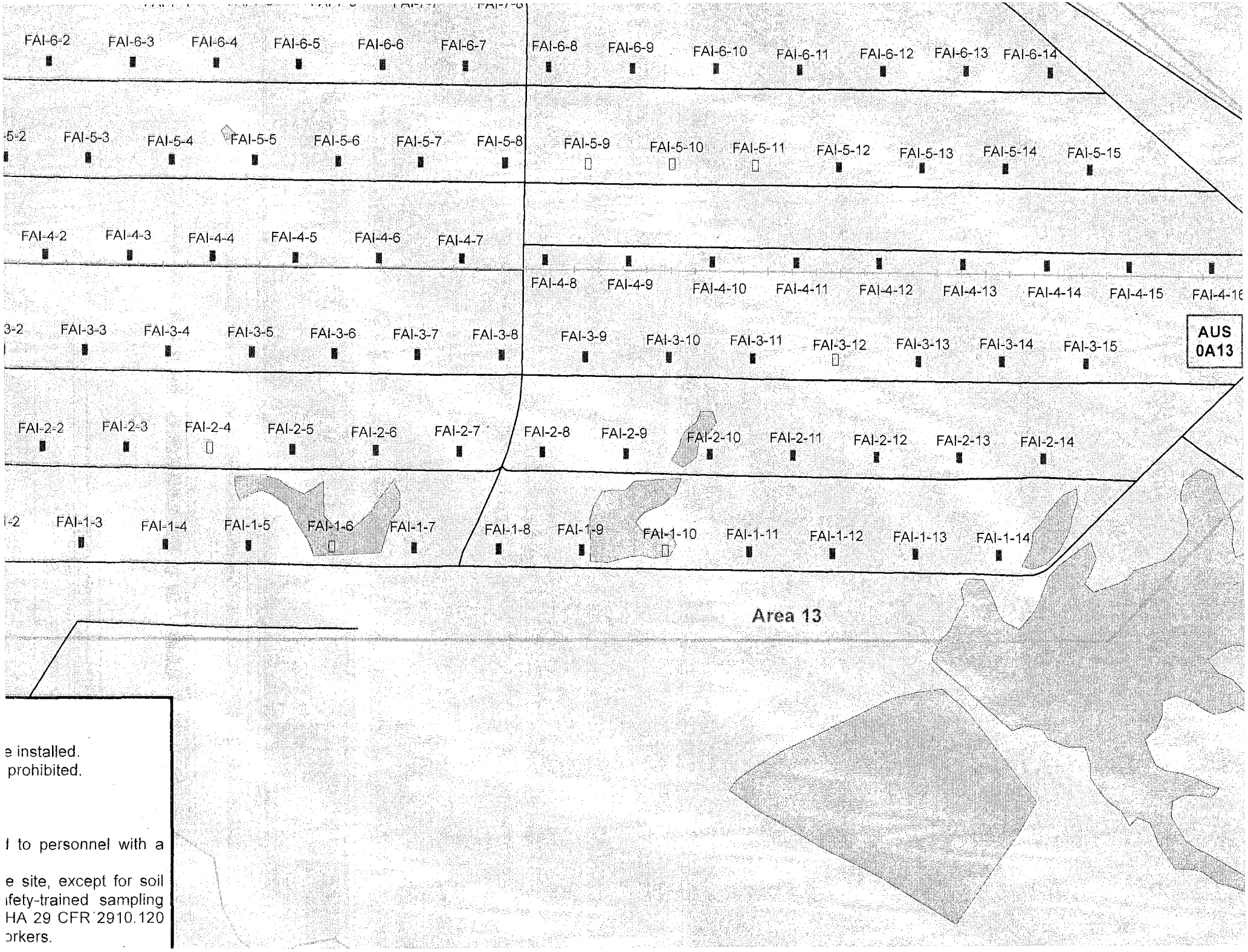

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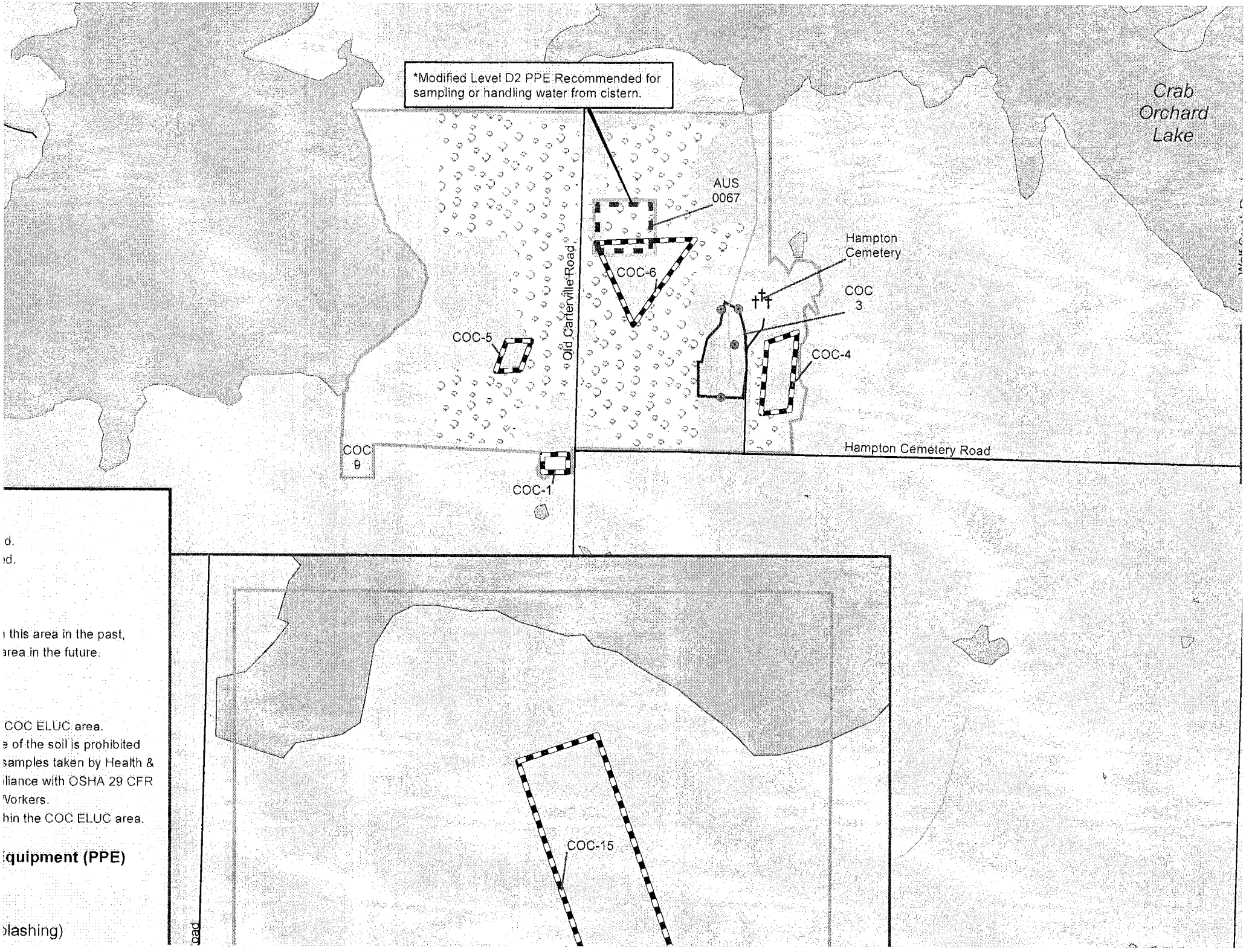

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FINAL

ENVIRONMENTAL LAND USE CONTROL PLAN

Crab Orchard National Wildlife Refuge NPL Site
Marion, Illinois

U.S. Fish & Wildlife Service
Crab Orchard National Wildlife Refuge
Marion, Illinois

April 2008

FINAL
ENVIRONMENTAL LAND USE CONTROL PLAN

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FINAL
ENVIRONMENTAL LAND USE CONTROL PLAN

I. BACKGROUND

A number of environmental investigative and remediation activities have been undertaken at the National Priority List (NPL) Site known as the Sangamo Dump/Crab Orchard National Wildlife Refuge (CONWR or Refuge), Carterville, Illinois (Site) pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §9601 *et. seq.*, and the National Contingency Plan (NCP), 40 C.F.R. Part 300. The Refuge is administered by the U. S. Department of the Interior (DOI), Fish and Wildlife Service (FWS). These investigative activities have revealed and may in the future reveal certain areas of environmental contamination, where hazardous substances, hazardous wastes or hazardous constituents, or their derivatives were released into the environment as a result of activities conducted over the history of the facility. The Site does not include the entire refuge, but only sites within the area of the former Illinois Ordnance Plant (IOP).[1] Such sites may generally be categorized as follows:

1. Those that have been fully investigated and specific remedy(ies) previously implemented (the Metals Areas Operable Unit (MAOU), the Explosives/Munitions Manufacturing Operable Unit (EMMA OU), Sites 14, 22A and 36 of the Miscellaneous Areas Operable Unit (MISCA OU), the Water Towers Operable Unit (WTOU), and most of the PCB [polychlorinated-biphenyl] Areas Operable Unit (PCB OU).

2. Those that have been fully investigated and remedy(ies) have been selected but have not yet been implemented;

3. Those that have been fully investigated but final remedy selection decisions have not yet been made;

4. Those in need of further investigative activities before the appropriate final remedy(ies) can be selected and implemented (the AUS OU); and,

5. Those sites which have been investigated and for which it has been determined that no active remedy is needed (most of the MISCA OU).

II. DEFINITIONS

For the purposes of this document, the term "Environmental Land Use Control" or "ELUC" means a restriction or control that limits exposure to contaminated media (e.g., soils, surface water, groundwater, etc.) arising from the need to protect human health and/or the environment at any site within the NPL Site. ELUCs may be necessary when contamination is first discovered, when CERCLA response actions are ongoing, or when some amount of contamination remains on-site as part of a CERCLA remedy. The term includes controls on access (e.g., engineered barriers, such as caps, and non-engineered mechanisms, such as fences

[1] Note that upper-case "Site" (when not used as a proper name, such as Site 36) refers to the NPL Site as defined in the first paragraph. Lower-case "site" refers to one of the sites within the NPL Site (listed in Attachment A).

or signs). Additionally, the term encompasses both affirmative measures to achieve the desired control (e.g., security patrols) and prohibitive directives (e.g., no drilling of drinking water wells).

III. APPLICABILITY

This Plan applies to each site for which remedial action has been determined to be necessary following investigative activities conducted in accordance with CERCLA and the NCP, and has not been or will not be remediated to allow for unrestricted use. The provisions of the Plan also temporarily apply to sites currently under investigation, such as the AUS OU sites.

Note that for sites under investigation, in accordance with the NCP and EPA guidance, the site-wide and site-specific ELUCs will not be considered when conducting Baseline Risk Assessments (BRAs). See further discussion in Appendix B.

Due to factors arising from federal ownership of real property, this Plan along with remedy decision documents (e.g. Record of Decision (ROD)) will be deemed to fulfill ELUC recording requirements until such time a property interest in any site with ELUCs on CONWR is transferred out of federal ownership. At the time of such transfer, all ELUC requirements that apply to that site will be articulated in land transfer documents (e.g. deed) that must be observed by the new owner. Additional detail about written requirements for future property conveyances is provided in Section VIII.

IV. PURPOSE

By adopting this plan, the FWS intends to accomplish the following specific objectives:

1. To implement a process to ensure appropriate long-term maintenance of those ELUCs that have already or may be selected as part of the chosen remedy for any site on CONWR and documented in a remedy decision document by elevating the general level of awareness among CONWR personnel, tenants, and visitors regarding the ELUCs;

2. To implement a process for the FWS to periodically advise the U.S. Environmental Protection Agency (USEPA) and the Illinois Environmental Protection Agency (IEPA) representatives of the continued maintenance of ELUCs at CONWR and of any planned changes in land use impacting any site remedy that includes ELUCs based on the assumption that land usage would be controlled, (e.g., restricted to industrial use);

3. To implement procedures for integrating all site remedies that include ELUCs into the Crab Orchard National Wildlife Refuge land use planning process;

4. To satisfy FWS' obligation to comply with those ELUCs deemed necessary by FWS in consultation with USEPA or IEPA as part of a selected remedy and provided for in a remedy selection document (e.g. ROD), until such time as FWS, USEPA and IEPA

determine that those ELUCs are no longer necessary for the protection of human health and the environment;

5. To satisfy FWS's obligations as land manager and steward of CONWR, to implement temporary ELUCs during the pendency of ongoing CERCLA investigations (e.g. Remedial Investigation/Feasibility Study), prior to implementation of a remedy pursuant to a remedy selection document (e.g. ROD).

In accordance with the NCP and EPA risk assessment guidance, the site-wide and site-specific ELUCs will not be considered when conducting a Baseline Risk Assessment (BRA) for any site at CONWR.

V. ATTACHMENTS

The following two attachments are part of this Plan as further specified below:

1. The CONWR site listing (Attachment A) for those presently known sites covered under the terms of this Plan. Attachment A will be updated annually by FWS to reflect any additions or deletions of sites as may hereafter be agreed to by the Parties. Copies of each annual update will be promptly distributed to USEPA and IEPA. If no site additions or deletions have been made during the previous year, then no updated attachment will be prepared or distributed for that period.

2. Attachment B, the CONWR Environmental Land Use Control Implementation Plan (ELUCIP). This Plan includes background information for all the sites and a discussion of the screening values used to assess whether sites may pose unacceptable risk without land use controls. The ELUCIP includes IOP-wide ELUCs prohibiting residential use and the installation of potable wells in the upper aquifer. The ELUCIP also includes individual Environmental Land Use Control Implementation Plans ("site ELUCIPs") for all known sites to be covered under the terms of this Plan. Each site ELUCIP: (1) identifies the site's location by reference to the facility's land use plan or by other means sufficient to enable the Parties to readily locate the site; (2) includes the basis for the ELUC, if needed (chemical results from previous investigations); (3) identifies both the ELUC objective for the site being addressed as well as those particular ELUCs to be relied upon to achieve the objective; (3) specifies what must be done in order to implement and maintain the specific ELUCs required for the site; and (5) contains a cross-reference to whatever decision document(s) apply to the site. As future decisions involving ELUCs are made at sites on CONWR, these sites will become covered under this Plan and listed in Attachment A, and a new ELUCIP appropriate to each such newly covered site will be added to Attachment B. In conjunction with the CONWR Comprehensive Conservation Plan (CCP), these plans should serve as a central ELUC reference source to assist CONWR personnel with completing periodic site inspections, review, and certifications required under Paragraph VI of this Plan.

VI. SITE INSPECTION/REVIEW/CERTIFICATION

Within thirty (30) days of finalizing the ELUC Plan attachments identified in Section V or sixty (60) days after execution of this Plan, whichever occurs first, CONWR shall initiate the following specific actions:

1. Conduct the first of annual visual inspections of all sites with site ELUCIPs included in Attachment A to this Plan. These inspections will be for the purposes of verifying all necessary ELUCs have been implemented and are being properly maintained. The CONWR Superfund Manager will be responsible for: (1) ensuring all required inspections are performed; (2) providing USEPA and IEPA with thirty (30) days advance notice of, and opportunity to participate in, the annual inspection conducted each calendar year; (3) notifying USEPA and IEPA of any deficiencies noted within thirty (30) days, and; (4) ensuring that corrective measures are undertaken as soon as practicable to correct any such deficiency(ies) with timely notification to USEPA and IEPA detailing corrective actions taken or providing a timetable outlining future corrective actions. Note that some sites do not need ELUCs besides the global restrictions on potable wells and residential use identified in Attachment B.

2. Whenever a five-year review is preformed, FWS will coincide an ELUC certification inspection with the review, and then restart the annual clock at that time.

3. Prepare and forward an annual report to USEPA and IEPA signed by the CONWR Superfund Manager or the CONWR Refuge Manager certifying the continued retention of all implemented ELUCs associated with those Sites identified in Attachment A to this Plan (as last updated). The first annual report will be due within 90 days of initiating the annual inspections.

VII. AGENCY COORDINATION

CONWR agrees to implement the following agency coordination procedures:

1. Except under circumstances reasonably determined by the FWS to be an emergency, FWS shall provide at least sixty (60) days notice prior to implementation of any Land Use Change (as defined in Section VII.3.) at any site subject to ELUCs. The FWS will provide notification of any such change to USEPA and IEPA. If USEPA or IEPA has program authority over particular ELUC(s) within affected site(s), FWS will seek concurrence from either USEPA or IEPA with a FWS determination as to whether the contemplated change will prompt a re-evaluation of the selected remedy that includes specific ELUC(s) to ensure continued protection of human health and the environment.

2. Except in the case of an emergency where FWS personnel reasonably believe it is not practicable to give notice to USEPA and IEPA prior to implementation of a Land Use Change, any Land Use Change that will not be implemented until USEPA or IEPA

have been given requisite notice and comment period of 30 days, consistent with Section VII.3 below. Each notification must include:

a. An evaluation of whether the anticipated Land Use Change will negatively impact the effectiveness of the selected site remedy, including the effectiveness of existing ELUCs;

b. An evaluation of the potential need for additional CERCLA response action(s), which may include additional ELUC(s), resulting from implementation of the anticipated Land Use Change; and,

c. A proposal for changes to the remedy decision document (e.g. ROD) that would result in changes to the selected site remedy.

3. Upon being notified by CONWR of an anticipated Land Use Change at a site, USEPA or IEPA or both shall evaluate the information provided pursuant to paragraph 2 above, and may provide comments within 30 days to such Land Use Change.

Any of the following will constitute a Land Use Change:

a. Any change in land use that is not consistent with the exposure assumptions for human health and/or ecological receptors upon which site risks to human health and the environment are based, as well as the specific remedy, including specific ELUCs, implemented at the site to address human and ecological risks identified during the BRA;

b. Site activities that disrupt or otherwise reduce the effectiveness of the implemented ELUC as part of a selected remedy. Examples include excavation at a landfill, groundwater pumping impacting a groundwater pump and treat system, a construction project impacting ecological habitat protected by the remedy, removal of a fence that is part of the ELUC, unlocking of a gate when the lock is required by the ELUC, or removal of warning signs that are part of the ELUC, or,

c. Any site activity that will negate the need for the specific ELUC(s) implemented at the site.

4. Upon discovery, FWS will immediately notify USEPA and IEPA of any Land Use Change at any site with an implemented ELUC which has not been previously reviewed and concurred in by USEPA or IEPA. Such notifications will provide all pertinent information as to the nature and extent of the change and describe any measures implemented or to be implemented (to include a timetable for future completion) to reduce or prevent human health or ecological impacts.

A list of the appropriate agency and facility points-of-contact is included in the Stand-Alone Section for Field and Construction Personnel at the beginning of this ELUC Plan.

VIII. FUTURE PROPERTY CONVEYANCE

After CERCLA response actions memorialized in the remedy selection document (e.g. ROD), including those that include ELUC(s), have been implemented at a particular site within CONWR, FWS may choose to transfer a property interest in that site to a non-PRP agency, private person or entity. Should the decision be made to transfer a property interest in such site to any other non-PRP agency, private person or entity, either title to, or an easement or right of way in, any site on CONWR with an existing ELUC(s), then the FWS shall ensure:

1. The written instrument (e.g. deed) transferring a property interest contains a covenant pursuant to CERCLA §120(h) that "all remedial action necessary to protect human health and the environment with respect to any such substance remaining on the property has been taken before the date of such transfer."

2. USEPA and IEPA are provided with notice at least sixty (60) days prior to any such intended conveyance. Such notice must: (1) indicate the mechanism(s) to be used to reasonably ensure any ELUC(s) will be the maintained by the transferee after the conveyance has occurred; and (2) include an assurance that CONWR has recorded in the land records that the transfer of the property interest includes the ELUC(s) (e.g. in the form of a deed restriction).

3. Any ELUC(s) included as part of the transfer of a property interest is/are reviewed and incorporated into those documents transferring the property interest and copies of such documents are recorded in the land records as required by applicable federal requirements (CERCLA §120(h)) and state law.

4. Each transferee is given adequate notice of past releases of hazardous substances in accordance with CERCLA §120(h) and 40 CFR §373 as well as existing site condition(s) and agrees to maintain any ELUCs contained as part of the property interest that has been transferred. The notice will indicate that if the ELUCs are not maintained, risk based scenarios based on the ELUCs may no longer be valid.

The planned transfer of any site with ELUCs to a public or private entity may prompt USEPA or IEPA to re-evaluate the continued appropriateness of any previously agreed upon ELUC(s) based upon the level of assurance provided that all necessary ELUCs will be adequately maintained.

IX. CHANGE IN APPLICABLE REGULATIONS OR CONTAMINANT CONCENTRATIONS

The FWS may propose the removal of any site from coverage under the terms of this Plan if either: (i) a post-remedy implementation increase to applicable federal or state risk-based cleanup regulations that may affect the cleanup goals in a remedy decision document (e.g. ROD),

or (ii) a reduction in previously documented contaminant concentration levels that may affect selected remedy (e.g. reduce or eliminate the need for ELUCs). FWS will consult with both USEPA and IEPA regarding any change in the ongoing need for ELUCs as part of a selected remedy articulated in a remedy selection document (e.g. ROD) prior to consideration of potentially removing a site from the ELUC Plan.

The FWS may propose changes to ELUCs for sites covered under this Plan if either: (i) a post-remedy implementation strengthening of applicable federal or state risk-based cleanup regulations that may result in stricter cleanup goals, or (ii) an increase in previously documented contaminant concentration levels that may result in the need for additional CERCLA response action(s) (e.g. affect the need for and type of ELUCs). FWS will consult with both USEPA and IEPA regarding these types of changes that may ultimately affect remedy decisions.

FINAL

ATTACHMENT A

CONWR SITE LISTING

Crab Orchard National Wildlife Refuge NPL Site
Marion, Illinois

U.S. Fish & Wildlife Service
Crab Orchard National Wildlife Refuge
Marion, Illinois

April 2008

- **METALS AREA OPERABLE UNIT** (MAOU)
  - Site 15 – Plating Pond
  - Site 22 – Old Refuge Shop Channel
  - Site 29 – Fire Station Landfill

- **PCB AREAS OPERABLE UNIT** (PCB OU)
  - Site 17 – Job Corps Landfill
  - Site 28 – Water Tower Landfill
  - Site 32 – Area 9 Landfill
  - Site 33 – Area 9 Building Complex

- **EXPLOSIVES/MUNITIONS MANUFACTURING OPERABLE UNIT** (EMMA OU)
  - COC-1
  - COC-2
  - COC-3
  - COC-4
  - COC-5
  - COC-6
  - COC-7
  - COC-8
  - COC-9
  - COC-10
  - COP-1
  - COP-2
  - COP-3
  - COP-4
  - BUNKER 1-3

- **MISCELLANEOUS AREAS OPERABLE UNIT** (MISCA OU)
  - Site 7 – D Area Southeast Drainage Channel
  - Site 7A – D Area North Lawn
  - Site 8 – D Area Southwest Drainage Channel
  - Site 9 – P Area Northwest Drainage Channel
  - Site 10 – Waterworks North Drainage Channel
  - Site 11 – P Area Southeast Drainage
  - Site 11A – P Area North
  - Site 12 – Area 8 Impoundment
  - Site 13 – Area 8 change House
  - Site 14 – Area 8 Solvent Storage Drainage Ditch
  - Site 16 – Area 7 Industrial Site
  - Site 18 – Area 13 Loading Platform
  - Site 20 – D Area South Drainage Channel
  - Site 21 – Southeast Corner Field
  - Site 22A – Former Post Treating Facility
  - Site 24 – Pepsi Plant West Drainage Ditch
  - Site 25 – Crab Orchard Creek at Marion Landfill

- Site 26 – Crab Orchard Creek Below Marion Sewage
- Site 27 – Crab Orchard Creek Below I-51 Dredge Area
- Site 30 – Munitions Control Site
- Site 31 – Refuge Control Site
- Site 34 – Crab Orchard Lake
- Site 35 – Area 9 East Waterway
- Site 36 – Refuge Wastewater Treatment Plant

- **WATER TOWERS OPERABLE UNIT** (WTOU)
  - Water Tower No. 1
  - Water Tower No. 2
  - Water Tower No. 3
  - Water Tower No. 4
  - Cedar Point Water Tower
  - Visitor Center

- **ADDITIONAL AND UNCHARACAERIZED SITES OPERABLE UNIT** (AUS OU)
  - AUS-0A2B Booster Loading Line
  - AUS-0A2D Detonator Loading Line
  - AUS-0A2F Fuse Loading Line
  - AUS-0A2P Artillery Primer Loading Line
  - AUS-0A2R Railroad Spur
  - AUS-0A03 Finished Ammunition – Group I
  - AUS-0A4E East Shop Area
  - AUS-0A4W West Shop Area
  - AUS-0A06 Ammonium Nitrate High Explosive & Smokeless Powder Storage Area
  - AUS-0A07 Inert Storage
  - AUS-0A8S Load Line III
  - AUS-0A09 Load Line I
  - AUS-0A10 Fuse and Booster Storage Magazines
  - AUS-A11A Acid & Ammonium Nitrate Area (part of Load Line II)
  - AUS-A11H High Explosives Area (part of Load Line II)
  - AUS-A11N Nitroglycerin Area
  - AUS-A11P Pilot Propellant Plant/CAP Production Area
  - AUS-A11S Support Area (part of Load Line II)
  - AUS-0A12 Former Ammonium Nitrate Plant
  - AUS-0A13 Finished Ammunition Igloos
  - AUS-0062 COC (Mounds and Pits)
  - AUS-0063 COC (Fenced Area West of COC-1)
  - AUS-0064 COC (Mounds and Brick Pit)
  - AUS-0065 COC (Foundations Northeast of COC-1)
  - AUS-0066 COC (Berm with Red Brick Rubble)
  - AUS-0067 COC (Fence with Contaminated Area Sign – Northwest of COC-6)
  - AUS-0069 COC (Dump Near South Shore of Crab Orchard Lake)
  - AUS-0109 COC (Possible Former Explosives Detonation Area)
  - AUS-0001 Fire and Police Headquarters
  - AUS-0002 Wastewater Treatment Plant

- AUS-0018 Railroad Classification Yard
- AUS-0019 Former Railroad Spur (North of Area 4E)
- AUS-0021 Area 7 Fire Station
- AUS-0022 Small Arms Training Facility
- AUS-0043 Areas 11 & 12 Fire Station
- AUS-0060 Fulminate Storage Igloos
- AUS-0061 Detonation & Disposal Area
- AUS-106A Drum Disposal Area East of Area 11
- AUS-0107 Possible Former Disposal Area Located Just Northwest of Area 8
- AUS-0108 Possible Disposal Area East of COC-10

FINAL

ATTACHMENT B

ENVIRONMENTAL LAND USE CONTROL IMPLEMENTATION PLAN

Crab Orchard National Wildlife Refuge NPL Site
Marion, Illinois

U.S. Fish & Wildlife Service
Crab Orchard National Wildlife Refuge
Marion, Illinois

April 2008

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1.1 INTRODUCTION

This attachment contains the individual environmental Land Use Control Implementation Plans (LUCIPs) for sites at the Crab Orchard National Wildlife Refuge National Priority List (NPL) Site (CONWR or Refuge) (**Figure 1-1**). For ease of use, the sites are organized by area on the Refuge. Refer to the table of contents for the area of interest.

All but four of the sites are within that part of the CONWR that had been the Illinois Ordnance Plant (IOP) during World War II. The IOP area was leased to industrial tenants after the war.

Because of these past uses, many sites may not be appropriate for certain uses, and therefore IOP-wide restrictions are placed on land usage. These following IOP-wide LUCIPs are included in Section 2 of this document:

- A LUCIP prohibiting installation of production wells.
- A LUCIP prohibiting residential use and camping.

Most of the sites also have restrictions on digging and have Land Use Controls (LUCs) beyond these IOP-wide LUCs and digging restrictions. Refer to the individual areas for more information. Sections 3 through 17 include the individual LUCIPs for all identified sites, categorized first by Refuge area (i.e., Area 2, Area 3, etc.), then by site/operable unit.

Of the four sites outside the IOP, three are outside the Refuge and not under the control of the U.S. Fish and Wildlife Service (FWS), and are therefore not included in the LUCIPs. These are Sites 24, 25, and 26 of the Miscellaneous Areas Operable Unit (MISCA OU) (see Subsection 1.2.3 below). The fourth site that is outside the IOP boundary is the Cedar Point Water Tower. Based on sampling in 2000, lead concentrations at the Cedar Point Water Tower averaged 16 milligrams per kilogram (mg/kg), well below levels of concern for human health. Therefore, the site does not require LUCs and is not included in this document.

Section 18 includes a list of references.

Note that for sites under investigation, in accordance with the NCP and EPA guidance, the site-wide and site-specific ELUCs will not be used when conducting Remedial Investigations/Baseline Risk Assessments (RI/BRA). To do so would be contrary to the NCP and USEPA guidance documents warning against presuming the best remedy prior to going through the remedy selection process. In responses to comments on conducting BRAs (Final NCP Rulemaking, Federal Register, Vol.55, no.46, March 8, 1990, page 8709) EPA disagreed that institutional controls should be considered in the BRA:

> *The role of the baseline risk assessment is to address the risk associated with a site in the absence of any remedial action or control, including institutional controls. The baseline assessment is essentially an evaluation of the no-action alternative. Institutional controls, while not actively cleaning up the contamination at the site can control exposure and, therefore, are considered to be limited action alternatives. The effectiveness of the institutional controls in controlling risk may appropriately be considered in evaluating the effectives of a particular remedial alternative, but not as part of the baseline risk assessment.*

In order to obtain unbiased sampling data for use in a BRA, RIs also must be conducted without consideration for any existing or anticipated institutional controls.

1.2 CONWR OPERABLE UNITS

Since the CONWR was put on the NPL in 1987, seven different operable units (OUs) have been created to address the different types of contamination that have been found:

- PCB [polychlorinated-biphenyl] Areas Operable Unit (PCB OU)
- Metals Area Operable Unit (MAOU)
- Miscellaneous Areas Operable Unit (MISCA OU)
- Explosives/Munitions Manufacturing Areas Operable Unit (EMMA OU)
- Water Towers Operable Unit (WTOU)
- Lake Monitoring Operable Unit (LMOU)
- Additional and Uncharacterized Sites Operable Unit (AUS OU)

The OUs are in various phases of cleanup: investigation, remediation, and long term monitoring, as discussed below. This section identifies the area or part of the Refuge where the each site is found; figures showing site locations are included in Sections 3 through 17, with the individual LUCIPs.

1.2.1 PCB Areas Operable Unit (PCB OU)

The PCB OU consists of four sites with PCB and metals contamination (**Figure 1-2**):

- Site 17, the Job Corps Landfill, located north of Crab Orchard Lake (Section 15.7).
- Site 28, the Water Tower Landfill, located south of Crab Orchard Lake (Section 16.4).
- Site 32, the Area 9 Landfill (Section 10.1.3).
- Site 33, the Area 9 Building Complex (Section 10.1.3).

Remediation for these sites for PCBs and metals was completed in 1996, under a record of decision (ROD) signed in 1990.[1] During remediation, chlorinated volatile organic (CVOC) contamination was found in soils and groundwater at Site 32 and 33 in Area 9. Further investigation was conducted. In August 2003, a feasibility study for remediation of the CVOC contamination was submitted.

1.2.2 Metals Area Operable Unit (MAOU)

The MAOU consisted of three sites with metals contamination in soils and sediments (**Figure 1-3**):

- Site 15, the "Plating Pond," located near Area 7
- Site 22, the Old Refuge Shop Channel, located near Area 4 (Section 5.1.4)
- Site 29, the Fire Station Landfill, located near Area 4 (Section 5.1.5)

Site 15 was a pond south of Area 7 that received waste from an operation in Area 7. The primary contaminant was chromium, which was required to be remediated to the background level for chromium, then considered to be 35 mg/kg. Groundwater was investigated and no detected constituents exceeded federal maximum contaminant levels (MCLs). The remediation was completed in 1996. The cleanup objective was achieved.[2] Because the site was cleaned up to levels that allow unrestricted use, and no exceedances of MCLs were found in the groundwater, no LUCs are needed for Site 15 and it is not included in this document

Site 29 was contaminated primarily with lead and was remediated to 450 mg/kg. Site 22 was contaminated with cadmium, chromium, lead, and cyanide. It was required to be remediated to 10 mg/kg for cadmium, but the ROD (1990) did not specify numeric values for cleanup for the other constituents[3]. For confirmation sampling, the level of 450 mg/kg for lead and 35 mg/kg for chromium were used. Cyanide was rarely detected in confirmation samples, and when it was the concentration was near the detection limit. Both sites 29 and 22 had exceedances of MCLs in groundwater. LUCIPs are included for both.[4]

[1] U.S. Environmental Protection Agency, 1990. Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, PCB Areas Operable Unit, August 1, 1990.
[2] U.S. Fish and Wildlife Service, November 1997. Closeout Report for the Metals Areas Operable Unit, Crab Orchard National Wildlife Refuge Superfund Site, Marino, Illinois (Williamson County).
[3] USEPA, Region V, Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, Metals Areas Operable Unit, March 30, 1990.
[4] U.S. Fish and Wildlife Service, November 1997. Closeout Report for the Metals Areas Operable Unit, Crab Orchard National Wildlife Refuge Superfund Site, Marino, Illinois (Williamson County).

1.2.3 Miscellaneous Areas Operable Unit (MISCA OU)

The Refuge-wide 1988/89 Remedial Investigation/Feasibility Study (RI/FS) by O'Brien & Gere[5] identified 22 sites as requiring no further work or needing further investigation, monitoring, or maintenance. The DOI, the Department of the Army, the U.S. Environmental Protection Agency (USEPA), and the Illinois Environmental Protection Agency (IEPA) entered into a Federal Facilities Agreement (FFA) in 1991[6] which designated these 22 sites, plus Site 36, the CONWR wastewater treatment plant, as the MISCA OU. The DOI added another site, Site 22A, to the MISCA OU. The sites comprising the MISCA OU are summarized in **Table 1-1**, which also references the Sections of this document where the LUCIP for each site can be found (see also **Figure 1-4**).

DOI completed a Remedial Investigation/Baseline Risk Assessment[7] of these 24 sites in two phases from 1993 to 1995, however, only 13 sites (Sites 7, 7A, 8, 9, 10, 11, 11A, 12, 14, 16, 20, 22A and 36) were investigated. The remaining 11 sites (13, 18, 21, 24, 25, 26, 27, 30, 31, 34, and 35) were excluded from the investigation during the planning process as follows:

- Sites 21, 24, 25, 26, 27, 30, 31, and 35 were determined to require no action.
- Sites 13 and 18 were incorporated into the AUS OU.
- Site 34 became the LMOU.

Of the 13 sites that were investigated, the RI determined that eight sites did not pose an unacceptable risk to human health or the environment (7, 7A, 8, 9, 11, 11A, 12, and 20), while three sites required further action (14, 22A, and 36). The remaining two sites, 10 and 16, required institutional controls to appropriately restrict human access. As noted previously, Sites 24, 25, and 26 of the MISCA OU are located outside the Refuge boundaries, and are therefore not included in this document. Because Sites 13, 18, and 34 were incorporated into other OUs, they also are not included. Sites 30 and 31 were reference sites and no LUCs are needed.

1.2.4 Explosives/Munitions Manufacturing Areas Operable Unit (EMMA OU)

The FFA identified the EMMA OU, with the Department of the Army as lead agency. Many of the sites were in the Hampton Cemetery Area (or Crab Orchard Cemetery, hence the COC-designation). Sites COC-1 through COC-10, Bunker 1-3, and COP-1 through COP-4 were investigated for chemical contamination; of these, only sites COC-3 and COP-4 were remediated. Sites COC-11 through COC-15 were investigated for ordnance only. The sites

[5] O'Brien & Gere, 1988. Remedial Investigation, Crab Orchard National Wildlife Refuge, August.
[6] U.S. Environmental Protection Agency, Region V, and the Illinois Environmental Protection Agency, and the United States Department of the Interior, and the United States Department of the Army, 1991. Federal Facilities Agreement Under CERLCA Section 120, in the Matter of the U.S. Department of the Interior's Crab Orchard National Wildlife Refuge. September 1991.
[7] Woodward-Clyde (W-C). 1996. Final RI Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois (Williamson County).

comprising the EMMA OU are summarized in **Table 1-2**, which also references the sections of this document where the LUCIP for each site can be found (see also **Figure 1-5**).

1.2.5 Water Towers Operable Unit (WTOU)

The WTOU consisted of the following sites with contamination from lead paint (**Figure 1-6**):

- Water Tower Number 1, located in Area 2
- Water Tower Number 2, located in Areas 11/12
- Water Tower Number 3, located south of Crab Orchard Lake
- Water Tower Number 4, located in Area 4
- Cedar Point Water Tower, located south of the IOP
- Visitors' Center, located north of Crab Orchard Lake (Section 15)

All water towers have been removed, as has the structure of the Visitors' Center that contained the lead paint.

A cleanup goal of 450 mg/kg was identified in the *Action Memorandum for the Water Towers Operable Unit at the Crab Orchard National Wildlife Refuge (Refuge) Superfund site* (WTOU), 1992. At the time of the cleanup, that level was considered protective for residential use. However, USEPA Region 9 has recently published a residential preliminary remediation goal (PRG) of 150 mg/kg for lead. Even so, the average lead concentrations of confirmation sampling at the water tower sites, which are all less than ½ acre in size, are well below that preliminary remediation goal (PRG). Average lead concentrations for the water towers that have been removed are as follows: Water Tower No. 1, 83 mg/kg; Water Tower No. 2, 97 mg/kg; Water Tower No. 3, 85.6 mg/kg; Water Tower No. 4, 48 mg/kg; and Cedar Point Water Tower, 16 mg/kg. Therefore these sites are suitable for unrestricted use and are not included in this document. However, soil from these sites should not be used for borrow material.

1.2.6 Lake Monitoring Operable Unit (LMOU)

The Lake Monitoring OU was established by FWS in 1997 and included the entire lake within the CONWR, but aside from its mention here in the introduction, further discussion of this OU is not included in this document since FWS issued a Final Risk Management Decision Memorandum[8,9] in October 2001, explaining the basis for the discontinuation of the LMOU. It identified areas of potential risk to be further evaluated as part of other OUs. As investigations continue at these other OUs, any human health risk identified will addressed at that time and as part of those OUs.

[8] 2001, April 11. Letter from U.S. Fish and Wildlife Service to the U.S. Environmental Protection Agency re Final Risk Management Decision Memorandum and Subsequent Activities for the LMOU.
[9] 2001. Final Risk Management Decision Memorandum, Lake Monitoring Operable Unit, October.

1.2.7 Additional and Uncharacterized Sites Operable Unit (AUS OU)

Thirty-nine sites were investigated for chemical contamination in a preliminary assessment/site inspection done in 2000.[10] Thirty-one of these were retained for an RI/FS, and an additional site, AUS-0A03, will be included in the RI/FS. Of the 8 sites not included in the RI/FS, one site, AUS-0021, was combined with Site AUS-0A07. AUS-0063 was determined to require no further action after it was determined that it was actually part of EMMA OU COC-9.[11,12,13] The sites comprising the AUS OU are summarized in **Table 1-3**, which also references the sections of this document where the LUCIP for each site can be found (see also **Figure 1-7**).

Six sites were judged to have sufficiently low human health and ecological risk such that no further investigation or action under CERCLA[14] was warranted. The justification for each is detailed in the Preliminary Assessment/Site Inspection (PA/SI) report[15] and summarized here.

AUS-0019 - Former Railroad Spur North of Area 4 East. Analytical results for Site AUS-0019 indicated there were no chemicals present at levels of potential human health or ecological concern warranting further evaluation. This was based on organic results that did not exceed screening criteria, and inorganic results that did not exceed both project screening criteria and Refuge background.

AUS-0022 - Probable IOP Small Arms Training Range. Analytical results for Site AUS-0022 indicated there were no chemicals present at levels of potential human health concern warranting further evaluation. One inorganic compound (boron) in soil slightly exceeded an ecological screening value and background, however, it was an estimated result and was not considered a significant concern. The remaining inorganic detections did not exceed both background and screening criteria, nor were there any organic results that exceeded screening criteria.

AUS-0064 - Mounds and Brick Pit Near AUS-0063 (Former COC-13). Two inorganic compounds (barium and cadmium) detected in soil at Site AUS-0064 slightly exceeded background and the Region 9 migration to groundwater criteria for DAF 1. Neither exceeded the screening values for the soil component of the groundwater ingestion route for State of Illinois Class I groundwater. The Region 9 DAF 1 factor assumes that groundwater is at the surface, an

[10] U.S. Fish and Wildlife Service, 2003. *Preliminary Assessment/Site Inspection Report, Additional and Uncharacterized Sites Operable Unit, Crab Orchard National Wildlife NPL Site.*

[11] Based on the findings for COC-9 of the EMMA OU Baseline Risk Assessment, COC-9 was recommended for no further action in the EMMA OU ROD.

[12] U.S. Army Corps of Engineers, April 1996. Record of Decision (ROD), for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU).

[13] Environmental Science and Engineering, Inc., September 1994. Draft Final Remedial Investigation/ Baseline Risk Assessment Report, Explosives/Munitions Manufacturing Areas Operable Unit. Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes III – Baseline Risk Assessment.

[14] Comprehensive Environmental Response, Compensation, and Liability Act

[15] U.S. Fish and Wildlife Service, 2003. *Preliminary Assessment/Site Inspection Report, Additional and Uncharacterized Sites Operable Unit, Crab Orchard National Wildlife NPL Site.* June.

unnecessarily conservative assumption for this site, which is located on the side of a hill. At the Refuge, groundwater is not expected to rise to the surface on hillsides.

Iron and zinc slightly exceeded ecological screening and background values for soil, but were not at levels considered to be significant ecological concerns. Mercury in soil did not exceed ecological screening values, but is considered a potential bioaccumulative constituent. However, its potential to bioaccumulate is less pronounced in terrestrial systems as compared to aquatic systems, and was judged not to warrant further evaluation at this site.

The remaining inorganic detections did not exceed both background and screening criteria, nor were there any organic results that exceeded screening criteria. Based on the above, Site AUS-0064 was judged to have sufficiently low human health and ecological risk such that no further investigation was warranted.

AUS-0107—Possible Disposal Area Northwest of Area 8. Some inorganic compounds detected in a trench water sample exceeded the MCL/Class I groundwater standard. This sample, however, was obtained to evaluate potential contaminants that may have migrated to groundwater, and was not intended for use in screening. Additionally, inorganic results in this sample are not considered significant because of the high suspended solids content of the trench water.

Zinc in soil slightly exceeded background and an ecological screening value, but was not at a level considered to be a significant ecological concern. A detection of magnesium in soil exceeded background and an ecological screening value as well, however, magnesium is an essential nutrient and is generally not a toxic constituent in soils. Mercury was detected in soil, however, its potential to bioaccumulate is less pronounced in terrestrial systems as compared to aquatic systems, and was judged not to warrant further evaluation at this site.

The remaining inorganic detections did not exceed both background and screening criteria, nor were there any organic results that exceeded screening criteria. Based this and the above, no further investigation was warranted at this site.

AUS-0108 - Possible Disposal Area East of COC-10). Cadmium at Site AUS-0108 exceeded the Region 9 migration to groundwater criteria for DAF 1 and the Refuge background value. It did not, however, exceed the screening value for the soil component of the groundwater ingestion route for State of Illinois Class I groundwater. The Region 9 DAF 1 factor assumes that groundwater is at the surface, a somewhat conservative assumption for Site AUS-0108.

Bis(2ethylhexyl)phthalate was detected at this site, and is considered to be a potential bioaccumulative constituent. However, it is readily metabolized and therefore is not likely to biomagnify in food chains.

The remaining inorganic detections did not exceed both background and screening criteria, nor were there any other organic results that exceeded screening criteria. No further investigation at Site AUS-0108 was warranted.

AUS-0109 - Possible Former Explosives Detonation Area. Mercury at Site AUS-0109 slightly exceeded background and the Illinois TACO Class I migration to groundwater screening value. This site is very small and any area of elevated mercury concentrations was expected to be very limited. No other screening values were exceeded. Based on this information, and the fact that the screening criterion was only slightly exceeded, mercury was not considered a significant human health concern.

Iron and slightly exceeded background and an ecological screening value, but was not detected at a level considered to be a significant ecological concern. Mercury did not exceed ecological screening values, but was considered a potential bioaccumulative constituent. However, its potential to bioaccumulate is less pronounced in terrestrial systems as compared to aquatic systems, and was judged not to warrant further evaluation at Site 0109.

Based on the above information, no further investigation at Site AUS-0109 was warranted.

Because residential screening criteria and migration to groundwater criteria (when the size of these six sites is considered) were not exceeded, even the IOP-wide LUCs are not needed for these sites, and they are therefore not included in this document.

1.3 BASIS FOR EVALUATION

The Refuge as a whole and all seven OUs within the Refuge were evaluated with the purpose of identifying sites that are not currently appropriate for unrestricted human use and/or unlimited human exposure. Sites within the OUs are in various stages from sites that are closed to sites that have had only preliminary evaluations. At some remediated and No-Action sites, the cleanup may not have allowed for unrestricted use and unlimited exposure. Other sites are in various stages of remediation and investigation, and, as such, some restrictions are appropriate, at least until investigations and any required remediation are complete. Each site for which analytical data have been collected was evaluated. For sites which were included in baseline human health risk assessments, the results and assumptions of the risk assessments were evaluated to determine if certain exposure scenarios were excluded.

1.3.1 Soil and Sediment

For all sites, analytical data from soil and sediment that was not remediated were compared with the following values (refer to **Table 1-4**):

- *Background soil and sediment contaminant levels.* These are background levels established during the PA/SI of the AUS OU.[16]

- *TACO[17] Tier 1 Soil Remediation Objectives for Residential Properties.*[18] Results were compared with both the ingestion and inhalation exposure route-specific values.

- *TACO Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties (construction worker).*[19] Results were compared with both the ingestion and inhalation exposure route-specific values.

- *U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Residential Soil[20].* PRGs were modified using the approach recommended by USEPA.[21] As identified in the USEPA guidance, carcinogens are to be screened using the standard PRG, based on a target cancer risk of 1E-6 per chemical. Non-carcinogens are to be screened using one tenth the PRG (e.g., based on a target hazard index of 0.1 per chemical) to address the concern of potential additive effects of multiple chemicals. If only one chemical of concern is present, the actual PRG is used for screening for non-carcinogens.

1.3.2 Surface Water

For all sites, analytical data from surface water that was not remediated were compared with the following values:

- *Background surface water contaminant levels.* These are background levels established during the PA/SI of the AUS OU.[22]

- *State of Illinois General Use Water Quality Standards for Human Health[23]* (35 IAC 302), as well as any site-specific human health standards established by the State of Illinois.

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[16] USFWS, June 2003. Final Preliminary Assessment/Site Inspection Report, Additional and Uncharacterized Sites Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois, Volume I, Table 2-14.
[17] TACO refers Tiered Approach to Corrective Action under the Illinois Environmental Protection Agency, Illinois Pollution Control Board - Title 35 of the Illinois Administrative Code, Subtitle G, Chapter I, Subchapter f, Part 742.
[18] 35 IAC, Section 742, Appendix B, Table A.
[19] 35 IAC, Section 742, Appendix B, Table B.
[20] U.S. Environmental Protection Agency, Region 9 at http://www.epa.gov/region09/wate/prg/index.htm.
[21] U.S. Environmental Protection Agency, 2001. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).
[22] USFWS, June 2003. Final Preliminary Assessment/Site Inspection Report, Additional and Uncharacterized Sites Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois, Volume I, Table 2-14.
[23] These values were derived from a compilation of Illinois General Use Water Quality Standards for Site 36 of the MISCA OU (Table 2-2 of the FSP) and Sites 32/33 of the PCB OU (Table 7-1 of the Ecological Risk Assessment).

1.4 LAND USE CONTROL DETERMINATION

Based on the above review, for each site a determination was be made as to whether land use controls are needed. In general, if results exceed the listed standards or criteria, land use controls are needed. Exceptions are if TACO inhalation or ingestion exposure values or Region PRGs are exceeded for specific chemicals, and a baseline risk assessment evaluated those same chemicals and concluded that the site is acceptable for unrestricted use and unlimited exposure, then the baseline risk assessment results will control.

1.4.1 Personal Protective Equipment Guidelines

Until the nature and extent of contamination has been fully delineated throughout the entire site and appropriate final remedies are in place, interim guidelines for personal protective equipment (PPE) at various areas throughout the Refuge are necessary in an order to protect human health from potential exposure to site-related contamination. These guidelines are based upon current knowledge of the site and are subject to modification as the nature and extent of contamination is characterized further and final remedies are selected and implemented. Furthermore, site-specific Health & Safety Plans, in accordance with OSHA standards, should include contingencies for upgrading to an appropriate PPE level if unanticipated contamination is discovered during any intrusive activities.

These guidelines do not replace United States Occupational Safety and Health Administration (OSHA) worker protection standards (29 CFR 1910) or the need for company and site-specific Health & Safety and Respiratory Protection Plans in accordance with all appropriate OSHA requirements.

PPE Definitions

The PPE guidelines in this document are based on the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard (29 CFR 1926.120) as follows:

- Level A
  - Positive-pressure, full-face self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH)
  - Totally-encapsulating chemical-protective suit
  - Coveralls (optional, as applicable)
  - Gloves, outer, chemical-resistant
  - Gloves, inner, chemical-resistant
  - Boots, chemical-resistant, protective steel toe and shank
  - Hard hat (under suit, optional, as applicable)

- Level B
  - Positive-pressure, full-face self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator (NIOSH approved)
  - Hooded chemical-resistant clothing (overalls with long-sleeved jacket; coveralls; or one or two-piece splash suit; disposable chemical-resistant overalls)
  - Coveralls (optional, as applicable)
  - Gloves, outer, chemical-resistant
  - Gloves, inner, chemical-resistant
  - Boots, chemical-resistant, protective steel toe and shank
  - Hard hat (under suit, optional, as applicable)
  - Face shield (optional, as applicable)

- Level C
  - Full or half-face, air purifying respirator (NIOSH approved)
  - Hooded or non-hooded (based on task-specific potential for splashing and/or dust generation) chemical-resistant clothing (overalls with long-sleeved jacket; coveralls; or one or two-piece splash suit; disposable chemical-resistant overalls)
  - Coveralls (optional, as applicable)
  - Gloves, outer, chemical-resistant
  - Gloves, inner, chemical-resistant
  - Boots, chemical-resistant, protective steel toe and shank
  - Hard hat (under suit, optional, as applicable)
  - Face shield (optional, as applicable)

- Level D1
  - Dust mask, snug-fitting
  - Coveralls (optional, as applicable)
  - Hooded chemical-resistant clothing (overalls with long-sleeved jacket; coveralls; or one or two-piece splash suit; disposable chemical-resistant overalls) if potentially exposed to groundwater at bottom of trench or excavation
  - Gloves, outer, chemical-resistant
  - Gloves, inner, chemical-resistant
  - Boots, chemical-resistant, protective steel toe and shank
  - Hard hat (optional, as applicable)
  - Face shield (optional, as applicable)

- Level D1*
  - Same as Level D1 with the addition of chemical-protective boot covers

- Level D2
  - Same as Level D1 but without the dust mask

- Level D3 - Strictly limited to short-time site worker and/or visitor conducting non-invasive activities
  - Dust mask, snug-fitting if airborne dust is visible
  - Long pants (i.e., no shorts)
  - Short or long-sleeve shirts
  - Work gloves (optional, as applicable)
  - Boots, chemical-resistant, protective steel toe and shank

Applicability

These PPE guidelines (Table 1-5) are intended to serve as a starting point for FWS personnel responsible for evaluating and approving intrusive activities at the site. These guidelines do not replace the requirements set forth in Section 2.3 of this Attachment, which requires a site-specific risk-based screening for all potential activities involving digging, excavation, or major soil disturbance (e.g., grading). It should be noted that various contaminants (VOCs, SVOCs, inorganics, etc.) have been detected in groundwater throughout the site and groundwater is relatively shallow (0-20 feet below ground surface); therefore, any time groundwater is encountered during excavation activities, PPE should be upgraded to Level C at a minimum in order to offer workers protection from exposure to groundwater via dermal contact, incidental ingestion, and inhalation of vapors.

Reference Documents

The PPE guidelines in Table 1-5 are based on a review of the following information:

- U.S. Fish and Wildlife Service, 2003. Final Preliminary Assessment/Site Inspection Report. Additional and Uncharacterized Sites Operable Unit. Crab Orchard National Wildlife Refuge NPL Site. Marion, Illinois. June.
- URS Corporation, 2006. Final Technical Memorandum of the Baseline Human Health Risk Assessment Technical Approach for the Additional and Uncharacterized Sites Operable Unit. Crab Orchard National Wildlife Refuge NPL Site. Marion, Illinois. Prepared by: URS Corporation. April.
- U.S. Occupational Safety and Health Administration, 2006. OSHA Standards 29 CFR 1910 Subpart I – Personal Protective Equipment. and 29 CFR 1910.134 – Respiratory Protection.
- U.S. Environmental Protection Agency, 2004. Region 9 Preliminary Remediation Goals. http://www.epa.gov/region09/waste/sfund/prg/index.html.

1.5 COMPREHENSIVE CONSERVATION PLAN

The FWS is required to prepare and then manage the CONWR consistent with a Comprehensive Conservation Plan (CCP). The CCP provides guidance for Refuge management and boundary modification, and when used in conjunction with the ELUC Plan, provide a framework for

adaptive management of the Refuge, especially as it relates to Refuge land use. Both the CCP and the ELUC Plan should serve as a central ELUC reference source to assist CONWR personnel with completing periodic site inspections, review, and certifications required under Paragraph VI of this Plan.

TABLE 1-1

SITES SUMMARY
MISCELLANEOUS AREAS OPERABLE UNIT

CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

SITE NUMBER	LOCATION	SITE NAME	ACTION IDENTIFIED IN THE ROD[1]
7	Area 2 (Sec. 3.2.2)	D Area Southeast Drainage Channel	No Action
7A	Area 2 (Sec. 3.2.3)	D Area North Lawn	No Action
8	Area 2 (Sec. 3.2.4)	D Area Southwest Drainage Channel	No Action
9	Area 2 (Sec. 3.4.2)	P Area Northwest Drainage Channel	No Action
10	Area 2 (Sec. 3.4.3)	Waterworks North Drainage Channel	Institutional Controls
11	Area 2 (Sec. 3.4.4)	P Area Southeast Drainage Channel	No Action
11A	Area 2 (Sec. 3.4.5)	P Area North	No Action
12	Area 8 (Sec. 9.1.2)	Area 8 Impoundment	No Action
13	Area 8	Area 8 Change House	Transferred to AUS OU
14	Area 8 (Sec. 9.1.3)	Area 8 Solvent Storage Drainage Ditch	Remedial Action Needed
16	Area 7 (Sec. 8.1.2)	Area 7 Industrial Site	Institutional Controls
18	Area 13	Area 13 Loading Platform	Transferred to AUS OU
20	Area 2 (Sec. 3.3.2)	F Area South Drainage Channel	No Action
21	South of Area 7 (Sec. 16.2)	Southeast Corner Field	No Action
22A	Area 4 (Sec. 5.1.3)	Former Post Treating Facility	No Further Action
24	Located outside Refuge	Pepsi Plant West Drainage Ditch (Site Located Outside Refuge)	No Action
25	Located outside Refuge	Crab Orchard Creek at Marion Landfill (Site Located Outside Refuge)	No Action
26	Located outside Refuge	Crab Orchard Creek Below Marion Sewage Treatment Plant (Site Located Outside Refuge)	No Action
27	Crab Orchard Creek (Sec. 15.4)	Crab Orchard Creek Below I-57 Dredge Area	No Action
30	Area 13	Munitions Control Site (Background)	No Action

[1] USFWS, April 2002. Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois.

TABLE 1-1

SITES SUMMARY
MISCELLANEOUS AREAS OPERABLE UNIT

CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

SITE NUMBER	LOCATION	SITE NAME	ACTION IDENTIFIED IN THE ROD[1]
31	Adjacent to Refuge Headquarters	Refuge Control Site (Background)	No Action
34	Crab Orchard Lake	Crab Orchard Lake	Lake Monitoring OU
35	East of Area 9 (Sec. 10.1.2)	Area 9 East Waterway	No Action
36	North of Area 3 (Sec. 15.5)	Refuge Wastewater Treatment Plant	Remedial Action Needed

TABLE 1-2

SITES SUMMARY
EXPLOSIVES/MUNITIONS MANUFACTURING AREA OPERABLE UNIT

CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

SITE NAME/NUMBER	LOCATION	ACTION IDENTIFIED IN THE ROD[1] OR EE/CA[2]
COC-1 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COC-2 (Not Applicable)	Near Hampton Cemetery	No Further Action[1,2]
COC-3 (Section 17.6)	Near Hampton Cemetery	Remedial Action Needed[1]
COC-4 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COC-5 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COC-6 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COC-7 (Not Applicable)	Near Hampton Cemetery	No Further Action[1]
COC-8 (Not Applicable)	Near Hampton Cemetery	No Further Action[1]
COC-9 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COC-10 (Section 16.3)	East of Area 10, Northwest of Area 11	No Further Action[1]
COC-11 (Section 17.7)	Near Hampton Cemetery	No Further Action[2]
COC-12 (Not Applicable)	Near Hampton Cemetery	No Further Action[2]
COC-13 (Not Applicable)	Near Hampton Cemetery	No Further Action[2]
COC-14 (Not Applicable)	Near Hampton Cemetery	No Further Action[2]
COC-15 (Section 17.6)	Near Hampton Cemetery	UXO Removal[2]
COP-1 (Not Applicable)	Near Area 11	No Further Action[1,2]
COP-2 (Not Applicable)	Near Area 11	No Further Action[1,2]
COP-3 (Not Applicable)	Near Areas 11 and 12	No Further Action[1,2]
COP-4 (Section 12.2)	Area 12	Remedial Action Needed[1]
BUNKER 1-3 (Not Applicable)	Area 13	No Further Action[1,2]

[1] U.S. Army Corps of Engineers, April 1996. Record of Decision (ROD), for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU).

[2] Parsons Engineering Science, Inc., October 1997. Engineering Evaluation and Cost Analysis, Final Report Former Illinois Ordnance Plant, Marion, Illinois.

TABLE 1-3

SITES SUMMARY
ADDITIONAL AND UNCHARACTERIZED SITES OU

CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

Site	Location	Approx. Size (Acres)	Site Name
AUS-0A2B (Section 3.1.1)	Area 2	125	IOP Booster Load Line
AUS-0A2D (Section 3.2.1)	Area 2	150	IOP Detonator Load Line
AUS-0A2F (Section 3.3.1)	Area 2	125	IOP Fuse Load Line
AUS-0A2P (Section 3.4.1)	Area 2	150	IOP Primer Load Load
AUS-0A2R (Section 3.5.1)	Area 2	30	Railroad Spur
AUS-0A03 (Section 4.1.1)	Area 3	150	IOP Finished Ammunition Group I Area
AUS-0A4E (Section 5.1.1)	Area 4	60	East Shop Area
AUS-0A4W (Section 5.1.2)	Area 4	80	West Shop Area
AUS-0A06 (Section 7.1.1)	Area 6	550	Ammonium Nitrate High Explosive and Smokeless Powder Storage Area
AUS-0A07 (Section 8.1.1)	Area 7	100	Inert Storage
AUS-0A8S (Section 9.1.1)	Area 8	150	Southern Portion of IOP Load Line III
AUS-0A09 (Section 10.1.1)	Area 9	100	Western Portion of IOP Load Line I
AUS-0A10 (Section 11.1.1)	Area 10	40	Fuse & Booster Storage Magazines
AUS-A11A (Section 12.1.1)	Area 11	50	Part of IOP Load Line II - later Acid and Ammonium Nitrate Area
AUS-A11H (Section 12.1.2)	Area 11	70	Part of IOP Load Line II - later High Explosives Area
AUS-A11N (Section 12.1.3)	Area 11	30	Part of IOP Load Line II - later Nitroglycerin Area
AUS-A11P (Section 12.1.4)	Area 11	30	Part of IOP Load Line II - later Pilot Propellant Plant/CAP Production Area
AUS-A11S (Section 12.1.5)	Area 11	50	Part of IOP Load Line II - later Support Area
AUS-0A12 (Section 12.1.6)	Area 12	100	Former Ammonium Nitrate Plant
AUS-0A13 (Section 13.1.1)	Area 13	500	Finished Ammunition Igloos
AUS-0062 (Section 17.1)	Near Hampton Cemetery	2	Mounds & Pits West of COC-1
AUS-0063 (Section 1.2.7)	Near Hampton Cemetery	<1	Fenced Area West of COC-11
AUS-0064 (Section 1.2.7)	Near Hampton Cemetery	<1	Mounds and Brick Pit Near AUS-0063
AUS-0065 (Section 17.2)	Near Hampton Cemetery	1/2	Foundations Northeast of COC-1
AUS-0066 (Section 17.3)	Near Hampton Cemetery	1/2 to 1	Berm with Red Brick Rubble
AUS-0067 (Section 17.4)	Near Hampton Cemetery	1/4	Fence with "Contaminated Area" Sign Northwest of COC-6
AUS-0069 (Section 17.5)	Near Hampton Cemetery	15±	Dump near South Shore of Crab Orchard Lake

TABLE 1-3

SITES SUMMARY
ADDITIONAL AND UNCHARACTERIZED SITES OU

CRAB ORCHARD NATIONAL WILDLIFE REFUGE
MARION, ILLINOIS

Site	Location	Approx. Size (Acres)	Site Name
AUS-0109 (Section 1.2.7)	Near Hampton Cemetery	<1	Possible Former Explosives Detonation Area
AUS-0001 (Section 15.1)	West of Area 1	1.5	Fire and Police Headquarters
AUS-0002 (Section 15.2)	West of Area 1	1.5	Wastewater Treatment Plant
AUS-0018 (Section 6.1.1)	Area 5	7	Railroad Classification Yard
AUS-0019 (Section 1.2.7)	South of Area 5	<1	Former Railroad Spur North of Area 4 East
AUS-0021 (Section 1.2.7)	South of Area 7	<1	Area 7 Fire Station
AUS-0022 (Section 1.2.7)	Southeast of Area 7	1/4	Probably IOP Small Arms Training Range
AUS-0043 (Section 16.1)	Northwest of Area 11 East of Area 10	1/2	Areas 11 and 12 Fire Station
AUS-0060 (Section 14.1.1)	Area 14	6	Fulminate Storage Igloos
AUS-0061 (Section 15.3)	West of Area 2	1/2	IOP Detonation and Disposal Area
AUS-106A (Section 12.1.7)	Southeast of Area 11 West of Area 8	0.1	Drum Disposal Area East of Area 11
AUS-0107 (Section 1.2.7)	Northwest of Area 8 South of Area 9	<1	Possible Disposal Area Northwest of Area 8
AUS-0108 (Section 1.2.7)	North of Area 11 East of Area 10	<1	Possible Disposal Area East of COC-10

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
CONSTITUENT										
1,1,1,2-Tetrachloroethane								3.19	ca	
1,1,1-Trichloroethane					1,200		1,200	198.24	nc	
1,1,2,2-Tetrachloroethane								0.41	ca	
1,1,2-Trichloroethane				310	1,800	8,200	1,800	0.73	ca	
1,1,2-Trichloropropane								1.51	nc	
1,1-Biphenyl								300	nc	
1,1-Dichloroethane				7,800	1,300	200,000	130	506.40	nc	
1,1-Dichloroethylene				700	1,500	1,800	300	12.35	nc	
1,1'-Sulfonylbis (4-chlorobenzene)								78.21	nc	
1,2,3-Trichloropropane								0.01	ca	
1,2,3-Trichloropropene								1.15	nc	
1,2,4,5-Tetrachlorobenzene								18.33	nc	
1,2,4-Tribromobenzene								30.55	nc	
1,2,4-Trichlorobenzene				780	3,200	2,000	920	65	nc	
1,2,4-Trimethylbenzene								5.16	nc	
1,2-Dibromo-3-chloropropane				0.46	11	89	0.11	0.15	nc	
1,2-Dibromoethane				0.0075	0.17	1.5	0.45	0.01	ca	
1,2-Dichlorobenzene				7,000	560	18,000	310	110.33	nc	5500
1,2-Dichloroethane (Ethylene dichloride)				7	0.4	1,400	0.99	0.28	ca	
1,2-Dichloroethylene (cis)				780	1,200	20,000	1,200	4.29	nc	
1,2-Dichloroethylene (trans)				1,600	3,100	41,000	3,100	6.95	nc	34000
1,2-Dichloropropane				9	15	1,800	0.5	0.34	ca	
1,2-Dinitrobenzene								6.11	nc	
1,2-Diphenylhydrazine								0.61	ca	
1,2-Epoxybutane								34.83	nc	
1,3,5-Trimethylbenzene								2.13	nc	
1,3,5-Trinitrobenzene								183.31	nc	
1,3-Butadiene								0.01	ca	
1,3-Dichlorobenzene								15.94	nc	
1,3-Dichloropropene				6.4	1.1	1,200	0.39	0.78	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
1,3-Dinitrobenzene								6.11	nc	
1,4-Dibromobenzene								611.03	nc	
1,4-Dichloro-2-butene								0.01	ca	
1,4-Dichlorobenzene					11000		340	3.45	ca	
1,4-Dinitrobenzene								6.11	nc	
1,4-Dioxane								44.22	ca	
1,4-Dithiane								611.03	nc	
1,6-Hexamethylene diisocyanate								0.02	nc	
1-Butanol								6103.52	nc	
1-Chloro-1,1-difluoroethane (HCFC-142b)								340.00	sat	
1-Chlorobutane								71.00	nc	
2-(2,4,5-Trichlorophenoxy) propionic acid				630		1,600		48.88	nc	
2-(2-Methyl-1,4-chlorophenoxy) propionic acic								6.11	nc	
2-(2-Methyl-4-chlorophenoxy) propionic acic								0.61	nc	
2,3,4,6-Tetrachlorophenol								183.31	nc	
2,3,7,8-TCDD (Dioxin)								0.0000039	ca	
2,3-Dichloropropanol								18.33	nc	
2,4,5-Trichlorophenol				7,800		200,000		611.03	nc	
2,4,5-Trichlorophenoxyacetic Acid								61.10	nc	
2,4,6-Trichloroaniline								14.31	ca	
2,4,6-Trichloroaniline hydrochloride								16.77	ca	
2,4,6-Trichlorophenol				58	200	11,000	540	0.61	nc	
2,4,6-Trinitrotoluene								3.06	nc	
2,4-Dichlorophenol				230		610		18.33	nc	
2,4-Dichlorophenoxyacetic Acid (2,4-D)				780		2,000		68.61	nc	
2,4-Dimethylaniline								0.65	ca	
2,4-Dimethylaniline hydrochloride								0.84	ca	
2,4-Dimethylphenol				1,600		41,000		1222.06	nc	740
2,4-Dinitrophenol				160		410		122.21	nc	
2,4-Dinitrotoluene				0.9		180		0.72	ca	
2,6-Dimethylphenol								36.66	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
2,6-Dinitrotoluene				0.9		180		0.72	ca	
2-Chloro-1,3-butadiene								0.36	nc	
2-Chloroacetophenone								0.00	nc	
2-Chlorophenol				390	53,000	10,000	53,000	6.34	nc	130
2-Chloropropane								17.02	nc	
2-Ethoxyethanol								2443.69	nc	
2-Ethoxyethanol acetate								1833.09	nc	
2-Mercaptobenzothiazole								16.77	ca	
2-Methoxy-5-nitroaniline								10.57	ca	
2-Methoxyethanol								6.11	nc	
2-Methoxyethanol acetate								12.22	nc	
2-Methyl-4-chlorophenoxyacetic acid								3.06	nc	
2-Methyl-5-nitroaniline								14.74	ca	
2-Methylaniline (o-toluidine)								2.03	ca	
2-Methylaniline hydrochloride								2.70	ca	
2-Methylnaphthalene										
2-Methylphenol (o-Cresol)				3,900		100,000		305.52	nc	
2-Nitroaniline								1.75	nc	
2-Phenylphenol								250.71	ca	
3,3'-Dichlorobenzidine				1		280		1.08	ca	
3,3'-Dimethoxybenzidine								34.74	ca	
3,3'-Dimethylbenzidine								0.05	ca	
3,4-Dimethylphenol								61.10	nc	
3-Methylphenol								305.52	nc	
4-(2,4-Dichlorophenoxy)butyric Acid								48.88	nc	
4-(2-Methyl-4-chlorophenoxy) butyric acid								61.10	nc	
4,4'-DDD				3		520		2.44	ca	0.00027
4,4'-DDE				2		370		1.72	ca	0.00019
4,4'-DDT				2		100	2,100	1.72	ca	0.00019
4,4'-Dichlorobenzophenone								1833.09	nc	
4,4'-Methylene bis(2-chloroaniline)								3.74	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
4,4'-Methylene bis(N,N'-dimethyl)aniline								10.57	ca	
4,4'-Methylene diphenyl diisocyanate								1.04	nc	
4,4'-Methylenebisbenzeneamine								1.95	ca	
4,6-Dinitro-o-cyclohexyl phenol								122.21	nc	
4-Aminopyridine								0.12	nc	
4-Chloro-2-methylaniline								0.84	ca	
4-Chloro-2-methylaniline hydrochloride								1.06	ca	
4-Chloroaniline								24.44	nc	
4-Chloroaniline (p-Chloroaniline)				310		820		122.21	nc	
4-Methylphenol								30.55	nc	
Acenaphthene				4,700		120,000		36.82	nc	
Acephate								24	nc	
Acetaldehyde								5	nc	
Acetochlor								120	nc	
Acetone				7,800	100,000	200,000	100,000	160	nc	
Acetone cyanohdrin								4.9	nc	
Acetonitrile								42	nc	
Acrolein								0.01	nc	
Acrylamide								0.11	ca	
Acrylic acid								2904.52	nc	
Acrylonitrile								0.21	ca	
Alachlor				8		1,600		6.04	ca	
Alar								916.55	nc	
Aldicarb				78		200		6.11	nc	
Aldicarb sulfone								6.11	nc	
Aldrin				0.04	3	6.1	9.3	0.03	ca	0.000046
Ally								1527.58	nc	
Allyl alcohol								30.55	nc	
Allyl chloride								303.95	nc	
Alpha-HCH (alpha-BHC)				0.1	0.8	20	2.1	0.09	ca	
Aluminum	28800	11241	200					7614.20	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Aluminum phosphide								3.13	nc	
Amdro								1.83	nc	
Ametryn								54.99	nc	
Amitraz								15.28	nc	
Ammonium sulfamate								1222.08	nc	
Aniline								42.74	nc	
Anthracene				23,000		610,000		2189.61	nc	35000
Antimony	0.83	1.9	6	31		82		3.13	nc	
Antimony pentoxide								3.91	nc	
Antimony potassium tartrate								7.04	nc	
Antimony tetroxide								3.13	nc	
Antimony trioxide								3.13	nc	
Apollo								79.43	nc	
Aramite								19.46	ca	
Aroclor 1016								3.93	nc	
Aroclor 1221								0.22	ca	
Aroclor 1232								0.22	ca	
Aroclor 1242								0.22	ca	
Aroclor 1248								0.22	ca	
Aroclor 1254								0.11	nc	
Aroclor 1260								0.22	ca	
Arsenic	13.5	10.3	10		750	61	25,000	0.39	ca	
Arsine								0.39	ca	
Assure								54.99	nc	
Asulam								305.52	nc	
Atrazine				2700		7,100		2.19	ca	
Avermectin B1								2.44	nc	
Azobenzene								4.42	ca	
Barium	195	196	22.7	5,500	690,000	14,000	870,000	537.49	nc	
Baygon								24.44	nc	
Bayleton								183.31	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Baythroid								152.76	nc	
Benefin								1833.09	nc	
Benomyl								305.52	nc	
Bentazon								183.31	nc	
Benz[a]anthracene				0.9		170		0.62	ca	0.1
Benzaldehyde								611.03	nc	
Benzene				12	0.8	2,300	2.2	0.60	ca	
Benzidine								0.0021	ca	
Benzo[a]pyrene				0.09		17		0.06	ca	0.01
Benzo[b]fluoranthene				0.9		170		0.62	ca	0.1
Benzo[k]fluoranthene				9		1,700		6.21	ca	
Benzoic Acid				310,000		820,000		24441.24	nc	
Benzotrichloride								0.04	ca	
Benzyl alcohol								1833.09	nc	
Benzyl chloride								0.89	ca	
Beryllium	0.8	1.6	5	160	1,300	410	44,000	15.44	nc	
beta-Chloronaphthalene								493.66	nc	
Bidrin								0.61	nc	
Biphenthrin (Talstar)								91.65	nc	
Bis(2-chloro-1-methylethyl)ether								2.88	ca	
Bis(2-chloroethyl)ether				0.6	0.2	75	0.66	0.21	ca	
Bis(2-chloroisopropyl)ether								2.88	ca	
Bis(2-ethylhexyl)phthalate				46	31,000	4,100	31,000	34.74	ca	
Bis(chloromethyl)ether								0.00019	ca	
Bisphenol A								305.52	nc	
Boron	5.3			7,000		18,000	1,000,000	1562.84	nc	
Bromate								31.29	nc	
Bromobenzene								2.78	nc	
Bromodichloromethane				10	3,000	2,000	3,000	0.82	ca	
Bromoform				81	53	16,000	140	61.57	ca	
Bromophos								30.55	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Bromoxynil								122.21	nc	
Bromoxynil octanoate								122.21	nc	
Butanol				7,800	10,000	200,000	10,000			
Butyl benzyl phthalate				16,000	930	410,000	930	1222.06	nc	
Butylate								3055.15	nc	
Butylphthalyl butylglycolate								6110.31	nc	
Cacodylic acid								0.18	nc	
Cadmium	0.19	1.6	5	78	1,800	200	59,000	3.70	nc	
Calcium	2497	1448	7197							
Caprolactam								3055.15	nc	
Captafol								12.22	nc	
Captan								138.97	ca	
Carbaryl								611.03	nc	
Carbazole				32		6,200		24.32	ca	
Carbofuran				390		1,000		30.55	nc	
Carbon disulfide				7,800	720	20,000	9	35.53	nc	
Carbon tetrachloride				5	0.3	410	0.9	0.22	nc	
Carbosulfan								61.10	nc	
Carboxin								611.03	nc	
Chloramben								91.65	nc	
Chloranil								1.21	ca	
Chlordane				1.8	72	100	22	1.62	ca	0.00019
Chlorimuron-ethyl								122.21	nc	
Chloroacetic acid								12.22	nc	
Chlorobenzene				1,600	130	4,100	1.3	15.07	nc	
Chlorobenzilate								1.80	ca	
Chlorodifluoromethane								340.00	sat	
Chloroethane								3.03	ca	
Chloroform				100	0.3	2,000	0.76	0.36	nc	
Chloromethane								1.23	ca	
Chlorothalonil								44.22	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Chlorpropham								1222.06	nc	
Chlorpyrifos								18.33	nc	
Chlorpyrifos-methyl								61.10	nc	
Chlorsulfuron								305.52	nc	
Chlorthiophos								4.89	nc	
Chromium III				120,000		310,000		11729.39	nc	210
Chromium VI				230	270	4,100	690	22.31	nc	11
Chromium, Total	25.2	17.2	10	230	270	4,100	690	210.68	ca	
Chrysene				88		17,000		62.15	ca	10
Cobalt	21.7	9.1	50	4,700		12,000		138.03	nc	
Copper	11.3	16.8	10	2,900		8,200		312.86	nc	12
Crotonaldehyde								0.005	ca	
Cumene (isopropylbenzene)								57.21	nc	
Cyanazine								0.58	ca	
Cyanide	0.41			1,600		4,100		122.21	nc	
Cyanogen								12.75	nc	
Cyanogen bromide								28.69	nc	
Cyanogen chloride								15.94	nc	
Cyclohexane								140.00	sat	
Cyclohexanone								30551.55	nc	
Cyclohexylamine								12220.62	nc	
Cyhalothrin/Karate								305.52	nc	
Cypermethrin								611.03	nc	
Cyromazine								458.27	nc	
Dacthal								611.03	nc	
Dalapon				2,300		6,100		1833.09	nc	
Danitol								1527.58	nc	
Decabromodiphenyl ether								611.03	nc	
Demeton								2.44	nc	
Di(2-ethylhexyl)adipate								405.32	ca	
Diallate								7.97	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Diazinon								54.99	nc	
Dibenz[ah]anthracene				0.09		17		0.06	ca	
Dibenzofuran								290.53	nc	
Dibromochloromethane				1,600	1,300	41,000	1,300	1.11	ca	
Dicamba								1833.09	nc	
Dichlorodifluoromethane								93.88	nc	
Dichlorvos								1.68	ca	
Dicofol								1.11	ca	
Dicyclopentadiene								0.05	nc	
Dieldrin				0.04	1	7.8	3.1	0.03	ca	
Diethyl phthalate				63,000	2,000	1,000,000	2,000	4888.25	nc	
Diethylene glycol, monobutyl ether								61.10	nc	
Diethylene glycol, monomethyl ether								365.87	nc	
Diethylformamide								24.44	nc	
Diethylstilbestrol								0.00	ca	
Difenzoquat (Avenge)								488.82	nc	
Diflubenzuron								122.21	nc	
Diisononyl phthalate								122.21	nc	
Diisopropyl methylphosphonate								488.82	nc	
Dimethipin								122.21	nc	
Dimethoate								1.22	nc	
Dimethyl phthalate								61103.10	nc	
Dimethyl terephthalate								6110.31	nc	
Dimethylamine								0.01	nc	
Dimethylphenethylamine								61.10	nc	
Di-n-butyl phthalate				7,800	2,300	200,000	2,300	6110.31	nc	
Di-n-octyl phthalate				1,600	10,000	4,100	10,000	2444.12	nc	
Dinoseb				78		200		61.10	nc	
Diphenamid								1833.09	nc	
Diphenyl sulfone								183.31	nc	
Diphenylamine								1527.58	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Diquat								134.43	nc	
Direct black 38								0.06	ca	
Direct blue 6								0.06	ca	
Direct brown 95								0.05	ca	
Disulfoton								2.44	nc	
Diuron								12.22	nc	
Dodine								24.44	nc	
Dysprosium								1564.24	nc	
Endosulfan				470		1,200		36.66	nc	
Endothall				1,600		4,100		122.21	nc	
Endrin				23		61		1.83	nc	
Endrin Aldehyde										0.26
Epichlorohydrin								0.76	nc	
EPTC (S-Ethyl dipropylthiocarbamate)								152.76	nc	
Ethephon (2-chloroethyl phosphonic acid)								30.55	nc	
Ethion								3.06	nc	
Ethyl acetate								1870.98	nc	
Ethyl acrylate								0.21	ca	
Ethyl chloride								3.03	ca	
Ethyl ether								6755.28	nc	
Ethyl methacrylate								208.09	nc	
Ethyl p-nitrophenyl phenylphosphorothioate								0.06	nc	
Ethylbenzene				7,800	400	20,000	58	8.92	ca	
Ethylene cyanohydrin								1833.09	nc	
Ethylene diamine								122.21	nc	
Ethylene glycol								12220.62	nc	
Ethylene glycol, monobutyl ether								3055.23	nc	
Ethylene oxide								0.14	ca	
Ethylene thiourea (ETU)								0.49	nc	
Ethylphthalyl ethyl glycolate								18330.93	nc	
Express								48.88	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Fenamiphos								1.53	nc	
Fluometuron								79.43	nc	
Fluoranthene				3,100		82,000		229.36	nc	120
Fluorene				3,100		82,000		274.71	nc	4500
Fluoride				4,700		12,000		366.63	nc	
Fluoridone								4888.25	nc	
Flurprimidol								1222.06	nc	
Flutolanil								3666.28	nc	
Fluvalinate								611.03	nc	
Folpet								138.97	ca	
Fomesafen								2.56	ca	
Fonofos								122.21	nc	
Formaldehyde								9165.65	nc	
Formic Acid								12220.62	nc	
Fosetyl-al								18330.93	nc	
Freon 113								2090.62	nc	
Furan								2.54	nc	
Furazolidone								0.13	ca	
Furfural								183.31	nc	
Furium								0.01	ca	
Furmecyclox								16.21	ca	
gamma -HCH (Lindane)				0.5		96		0.44	ca	
Glufosinate-ammonium								24.44	nc	
Glycidaldehyde								24.44	nc	
Glyphosate								6110.31	nc	
Haloxyfop-methyl								3.06	nc	
Harmony								794.34	nc	
HCH (beta)								0.32	ca	
HCH-technical								0.32	ca	
Heptachlor				0.1	0.1	28	16	0.11	ca	0.000068
Heptachlor epoxide				0.07	5	2.7	13	0.05	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Crileria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Hexabromobenzene								122.21	nc	
Hexachlorobenzene				0.4	1	78	2.6	0.30	ca	
Hexachlorobutadiene								1.83	nc	
Hexachlorocyclopentadiene				550	10	14,000	1.1	3.65	nc	
Hexachloroethane				78		2,000		6.11	nc	
Hexachlorophene								1.83	nc	
Hexahydro-1,3,5-trinitro-1,3,5-triazine								4.42	ca	
Hexazinone								201.64	nc	
HMX								3055.15	nc	
Hydrazine, dimethyl								0.16	ca	
Hydrazine, hydrazine sulfate								0.16	ca	
Hydrazine, monomethyl								0.16	ca	
Hydrogen cyanide								1.08	nc	
Imazalil								79.43	nc	
Imazaquin								1527.58	nc	
Indeno[1,2,3-cd]pyrene				0.9		170		0.62	ca	0.1
Iprodione								244.41	nc	
Iron	19306	20750	100					2346.32	nc	
Isobutanol								1251.39	nc	
Isophorone				15,600	4,600	410,000	4,600	511.98	ca	
Isopropalin								91.65	nc	
Isopropyl methyl phosphonic acid								611.03	nc	
Isoxaben								305.52	nc	
Kepone								0.06	ca	
Lactofen								12.22	nc	
Lead	23.4	24	2	400		400		400	nc	20000
Lead (tetraethyl)								0.00061	nc	
Linuron								12.22	nc	
Lithium								156.43	nc	
Londax								1222.09	nc	
Magnesium	1552	1909	2534							

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Malathion								122.21	nc	
Maleic anhydride								611.03	nc	
Maleic hydrazide								166.79	nc	
Malononitrile								0.12	nc	
m-Aminophenol								427.72	nc	
Mancozeb								183.31	nc	
Maneb								8.11	ca	
Manganese	3640	1043	582	3,700	69,000	9,600	8,700	176.24	nc	
Mephosfolan								0.55	nc	
Mepiquat chloride								183.31	nc	
Mercury	0.1	0.2	0.2	23	10	61	52,000			
Merphos								0.18	nc	
Merphos oxide								0.18	nc	
Metalaxyl								366.63	nc	
Methacrylonitrile								0.21	nc	
Methamidophos								0.31	nc	
Methanol								3055.15	nc	
Methidathion								6.11	nc	
Methomyl								4.43	nc	
Methoxychlor				390		1,000		30.55	nc	
Methyl acetate								2208.67	nc	
Methyl acrylate								6.97	nc	
Methyl bromide (Bromomethane)				110	10	1,000	3.9	0.39	nc	
Methyl ethyl ketone								732.54	nc	
Methyl isobutyl ketone								78.65	nc	
Methyl Mercaptan								3.48	nc	
Methyl methacrylate								218.74	nc	
Methyl parathion								1.53	nc	
Methyl phosphonic acid								122.21	nc	
Methyl styrene (alpha)								680.00	sat	
Methyl styrene (mixture)								13.06	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Methyl tertbutyl ether (MTBE)								61.54	ca	
Methylcyclohexane								259.11	nc	
Methylene bromide								6.69	nc	
Methylene chloride								9.11	ca	
Methylene chloride (Dichloromethane)				85	13	12,000	34	916.55	nc	
Metribuzin								152.76	nc	
Mirex								0.27	ca	
m-Nitrotoluene								366.75	nc	
Molinate								12.22	nc	
Molybdenum								39.11	nc	
Monochloramine								611.03	nc	
m-Phenylenediamine								366.62	nc	
m-Xylene				160,000	420	410,000	420			
N,N-Dimethylformamide								6108.38	nc	
N,N-Diphenyl-1,4 benzenediamine (DPPD)								18.33	nc	
Naled								12.22	nc	
Naphthalene				1,600	170	25,000		5.59	nc	
Napropanide								6110.31	nc	
n-Butylbenzene								58.00	nc	
n-Hexane								12.08	nc	
Nickel	18.9	16.9	10	1,600	13,000	4,100	440,000	1564.28	nc	
Nitrate as N				130,000						
Nitrobenzene				39	92	18		19.64	nc	
Nitrofurantoin								4277.22	nc	
Nitrofurazone								0.32	ca	
Nitroglycerin								34.74	ca	
Nitroguanidine								6110.31	nc	
N-N-Dimethylaniline								12.22	nc	
N-Nitroso di-n-propylamine								0.07	ca	
N-Nitrosodiethanolamine								0.17	ca	
N-Nitrosodiethylamine								0.0032	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
N-Nitrosodimethylamine								0.01	ca	
N-Nitrosodi-n-butylamine				0.09		1,000	9.4	0.02	ca	
N-Nitrosodiphenylamine				130		4,100	1.8	99.26	ca	
N-Nitroso-N-methylethylamine								0.02	ca	
N-Nitrosopyrrolidine								0.23	ca	
Norflurazon								2444.12	nc	
n-Propylbenzene								57.86	nc	
NuStar								42.77	nc	
o-Chloronitrobenzene								0.14	nc	
o-Chlorotoluene								15.84	nc	
Octabromodiphenyl ether								183.31	nc	
Octamethylpyrophosphoramide								122.21	nc	
o-Nitrotoluene								366.75	nc	
Oryzalin								3055.15	nc	
Oxadiazon								305.52	nc	
Oxamyl								1527.58	nc	
Oxyfluorfen								183.31	nc	
o-Xylene				160,000	410	410,000	410			
pH										
p,a,a,a-Tetrachlorotoluene								0.02	ca	
Paclobutrazol								794.34	nc	
Paraquat								274.96	nc	
Parathion								366.62	nc	
p-Chlorobenzoic acid								1222.06	nc	
p-Chloronitrobenzene								1.02	nc	
Pebulate								3055.15	nc	
Pendimethalin								2444.12	nc	
Pentabromo-6-chloro cyclohexane								21.15	ca	
Pentabromodiphenyl ether								122.21	nc	
Pentachlorobenzene								48.88	nc	
Pentachloronitrobenzene								1.87	ca	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Pentachlorophenol				3		520		2.98	ca	
Perchlorate								0.78	nc	
Permethrin								3055.15	nc	
Phenmedipham								15275.77	nc	
Phenol				47,000		120,000		36661.86	nc	
Phenothiazine								122.21	nc	
Phenylmercuric acetate								4.89	nc	
Phorate								12.22	nc	
Phosmet								1222.06	nc	
Phosphine								18.33	nc	
Phosphorus (white)								1.56	nc	
Phthalic anhydride								12199.68	nc	
p-Hydroquinone								244.41	nc	
Picloram				5,500		14,000		4277.22	nc	
Pirimiphos-methyl								611.03	nc	
p-Nitrotoluene								366.75	nc	
Polybrominated biphenyls								0.04	nc	
Polychlorinated biphenyls (PCBs)				1		1		0.22	ca	0.000015
Polychlorinated terphenyls								0.11	ca	
Potassium	625	1421	1613							
p-Phenylenediamine								11609.59	nc	
p-Phthalic acid								61103.10	nc	
Prochloraz								3.24	ca	
Profluralin								36.66	nc	
Prometon								91.65	nc	
Prometryn								24.44	nc	
Pronamide								458.27	nc	
Propachlor								79.43	nc	
Propanil								30.55	nc	
Propargite								122.21	nc	
Propargyl alcohol								12.22	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Propazine								122.21	nc	
Propham								122.21	nc	
Propiconazole								79.43	nc	
Propylene glycol								3003.41	nc	
Propylene glycol, monoethyl ether								4277.22	nc	
Propylene glycol, monomethyl ether								4277.19	nc	
Propylene oxide								1.93	ca	
p-Toluidine								2.56	ca	
Pursuit								1527.58	nc	
p-Xylene				160,000	460	410,000	460			
Pydrin								152.76	nc	
Pyrene				2,300		61,000		231.60	nc	3500
Pyridine								61.10	nc	
Quinalphos								30.55	nc	
Quinoline								0.16	ca	
RDX (Cyclonite)								4.42	ca	
Resmethrin								1833.09	nc	
Ronnel								3055.15	nc	
Rotenone								244.41	nc	
Savey								1527.58	nc	
sec-Butylbenzene								45.00	nc	
Selenious Acid								305.52	nc	
Selenium	2.3	0.64	2.7	390		1,000		391.07	nc	
Selenourea								305.52	nc	
Sethoxydim								5499.28	nc	
Silver	0.6	3	10	390		1,000		391.07	nc	
Simazine				390		1,000		4.05	ca	
Sodium	170	1450	3169							
Sodium diethyldithiocarbamate								1.80	ca	
Sodium fluoroacetate								1.22	nc	
Sodium metavanadate								61.10	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Strontium, stable								46924.17	nc	
Strychnine								18.33	nc	
Styrene				16,000	1,500	41,000	430	438.21	nc	
Systhane								1527.58	nc	
Tebuthiuron								4277.22	nc	
Temephos								1222.06	nc	
Terbacil								794.34	nc	
Terbufos								1.53	nc	
Terbutryn								61.10	nc	
tert-Butylbenzene								53.00	nc	
Tetrachloroethylene (PCE)				12	11	2,400	28	1.51	ca	2.8
Tetrachlorovinphos								20.27	ca	
Tetraethyldithiopyrophosphate								3.06	nc	
Tetrahydrofuran								9.36	ca	
Tetryl								61.10	nc	
Thallium	0.4	0.3	10	6.3		160		0.52	nc	
Thiobencarb								61.10	nc	
Thiocyanate								305.52	nc	
Thiofanox								1.83	nc	
Thiophanate-methyl								488.82	nc	
Thiram								30.55	nc	
Tin								4692.42	nc	
Titanium										
Toluene				16,000	650	410,000	42	65.60	nc	62000
Toluene-2,4-diamine								0.15	ca	
Toluene-2,5-diamine								3666.19	nc	
Toluene-2,6-diamine								1222.06	nc	
Toxaphene				0.6	89	110	240	0.44	ca	
Tralomethrin								45.83	nc	
Triallate								79.43	nc	
Triasulfuron								61.10	nc	

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]		ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca		Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(ug/L)
Tributyltin oxide (TBTO)								1.83	nc	
Trichloroethylene (TCE)				58	5	1,200	12	0.05	ca	25
Trichlorofluoromethane								38.58	nc	
Tridiphane								18.33	nc	
Triethylamine								2.34	nc	
Trifluralin								45.83	nc	
Trimellitic Anhydride (TMAN)								0.86	nc	
Trimethyl phosphate								13.15	ca	
Triphenylphosphine oxide								30.55	nc	
Tris(2-chloroethyl) phosphate								151.99	ca	
Uranium								1.56	nc	
Vanadium	47.2	28	50	550		1,400		54.75	nc	
Vernam								6.11	nc	
Vinclozolin								152.76	nc	
Vinyl acetate				78,000	1,000	200,000	10	42.57	nc	
Vinyl bromide (bromoethene)								0.19	ca	
Vinyl chloride				0.46	0.28	170	1.1	0.08	ca	120
Warfarin								1.83	nc	
Xylenes (total)				160,000	320	410,000	320	27.50	nc	62000
Zinc	51.4	57.1	20	23,000		61,000		2346.32	nc	
Zinc phosphide								2.35	nc	
Zineb								305.52	nc	

Legend
mg/kg = milligrams per kilogram
ug/L = micrograms per Liter

Footnotes
[1] USFWS, 2001. Draft-Final Preliminary Assessment/Site Inspection Report, Additional and Uncharacterized Sites Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, IllinoisVolume 1, Table 2-14, September 2001. *Background numbers represent the 95% upper tolerance level for each matrix.*

TABLE 1-4
SCREENING VALUES

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

	BACKGROUND CONTAMINENT LEVELS[1]			IEPA SOIL REMEDIATION OBJECTIVES FOR RESIDENTIAL PROPERTIES[2]		IEPA SOIL REMEDIATION OBJECTIVES FOR CONSTRUCTION WORKER[3]		PRGs FOR RESIDENTIAL SOIL[4]	ILLINOIS GENERAL USE WATER QUALITY STANDARDS[5]
Matrix	Soil	Sediment	Surface Water	Ingestion	Inhalation	Ingestion	Inhalation	Human Health = nc Cancer = ca	Human Health Criteria
	(mg/kg)	(mg/kg)	(ug/L)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(ug/L)

[2] Illinois Environmental Protection Agency, Illinois Pollution Control Board, Title 35, Subtitle G, Chapter I, Subchapter f, Part 742, Tiered Approach to Corrective Action Objectives, Appendix B, Table A at *http://www.ipcb.state.il.us/TITLE_35/main.htm*.

[3] Illinois Environmental Protection Agency, Illinois Pollution Control Board, Title 35, Subtitle G, Chapter I, Subchapter f, Part 742, Tiered Approach to Corrective Action Objectives, Appendix B, Table B at *http://www.ipcb.state.il.us/TITLE_35/main.htm*.

[4] United States Environmental Protection Agency, Region 9 at http://www.epa.gov/region09/waste/prg/index.htm.

[5] This table is a compilation of Illinois General Use Water Quality Standards for Site 36 of the MISCA OU (Table 2-2 of the FSP) and Sites 32/33 of the PCB OU (Table 7-1 of the Ecological Risk Assessment).

Table 1-5
Crab Orchard National Wildlife Refuge
Personal Protective Equipment Guidelines for Intrusive and Non-Intrusive Activities

Site Number	Site Name	Other Site Designations	Approximate Size (Acres)	Site-Specific Land Use Controls in Effect/PPE Required (Yes/No)	Justification for Land Use Controls (contaminants exceeding risk-based screening criteria)	Minimum OSHA PPE Level for activities involving digging	Minimum PPE for short-term site visitors	Additional Measures to Minimize Exposure	Specific Locations within each Site	Contaminants
Metals Area Operable Unit (MAOU)										
15	Plating Pond			No						
22	Old Refuge Shop Channel			No						
29	Fire Station Landfill			No						
PCB Areas Operable Unit (PCB OU)										
17	Job Corps Landfill			No						
28	Water Tower Landfill			No						
32 and 33	Area 9 Landfill and Building Complex			Yes	Groundwater - TCE and other VOCs Soil - VOCs, SVOCs, PCBs, inorganics	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed		
Explosives/Munitions Manufacturing Operable Unit (EMMA OU)										
COC-1	COC-1 near Hampton Cemetery		0.75	No						
COC-2	COC-2 near Hampton Cemetery		2	No						
COC-3	COC-3 near Hampton Cemetery		Unknown	No						
COC-4	COC-4 near Hampton Cemetery		3.5	No						
COC-5	COC-5 near Hampton Cemetery		1.4	No						
COC-6	COC-6 near Hampton Cemetery		6	No						
COC-7	COC-7 near Hampton Cemetery		2	No						
COC-8	COC-8 near Hampton Cemetery		Unknown	No						
COC-9	COC-9 near Hampton Cemetery		4	No						
COC-10	COC-10 near Hampton Cemetery		Unknown	No						
COC-11	COC-11 near Hampton Cemetery		Unknown	No	COC-11 is now part of AUS-0062 (Site 62), so Site-wide land use controls appy since site AUS-0062 has no site-specific land use controls.					
COC-12	COC-12 near Hampton Cemetery		Unknown	No						
COC-13	COC-13 near Hampton Cemetery		Unknown	No	COC-13 is now part of AUS-0064 (Site 64), so Site-wide land use controls apply since site AUS-0064 has no site-specific land use controls.					
COC-14	COC-14 near Hampton Cemetery		Unknown	No	COC-14 is now part of AUS-0066 (Site 66), so Site-wide land use controls apply since site AUS-0066 has no site-specific land use controls.					
COC-15	COC-15 near Hampton Cemetery			No						
COP-1	Crab Orchard Pond No. 1			No						
COP-1	Crab Orchard Pond No. 2			No						
COP-3	Crab Orchard Pond No. 3			No						
COP-4	Crab Orchard Pond No. 4			No						
BUNKER 1-3	Bunker 1-3			No						
Miscellaneous Areas Operable Unit (MISCA OU)										
7	D Area Southeast Drainage Channel			No						
7A	D Area North Lawn			No						
8	D Area Southwest Drainage Channel			No						
9	P Area Northwest Drainage Channel			No						
10	Waterworks North Drainage Channel			No						
11	P Area Southeast Drainage			No						
11A	P Area North			No						
12	Area 8 Impoundment			No						

Table 1-5
Crab Orchard National Wildlife Refuge
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13	Area 8 Change House			No	Site Number 13 is now part of AUS-0A8S (Load Line III), so Site-wide land use controls apply since site AUS-0A8S has no site-specific land use controls.					
14	Area 8 Solvent Storage Drainage Ditch		3.5	Yes	Groundwater - VOCs Soil - VOCs, lead	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed		Soil and GW have toluene, ethylbenzene, xylenes, and methylene chloride. Remediation is planned for GW and soil. Soil also has Cr and Pb. Couldn't find any analytical data in ELUCIP or PA/SI. I suggest Level C anywhere there is known or likely to be VOCs exceeding screening criteria in soil and/or groundwater, within 500' for GW samples and within 250' for soil samples.No analytical data could be found in the PA/SI or LUCIP.
16	Area 7 Industrial Site			No						
18	Area 13 Loading Platform			No	Site Number 18 is now part of AUS-0A13 (Finished Ammonium Igloos), so Site-wide land use controls apply since site AUS-0A13 has no site-specific land use controls.					
20	D Area South Drainage Channel			No						
21	Southeast Corner Field			No						
22A	Former Post Treating Facility			No						
24	Pepsi Plant West Drainage Ditch			No						
25	Crab Orchard Creek at Marion Landfill			No						
26	Crab Orchard Creek Below Marion Sewage			No						
27	Crab Orchard Creek Below I-51 Dredge Area			No						
30	Munitions Control Site			No						
31	Refuge Control Site			No						
34	Crab Orchard Lake			Yes	PPE not required; however, fish consumption restrictions are in effect					
35	Area 9 East Waterway			No						
36	Refuge Wastewater Treatment Plant			Yes	Soil - PCBs, cadmium,	D1 for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed		Remediation planned since ROD in 2002. No analytical data could be found in the PA/SI or LUCIP. If there are large portions of this site without PCB or cadmium contamination, then change excavation workers to D2 unless airborne dust is visible.
Water Towers Operable Unit (WTOU)										
Water Tower No. 1	Water Tower No. 1			No						
Water Tower No. 2	Water Tower No. 2			No						
Water Tower No. 3	Water Tower No. 3			No						
Water Tower No. 4	Water Tower No. 4			No						
Cedar Point Water Tower	Cedar Point Water Tower			No						
Visitor Center	Visitor Center			No						
Additional and Uncharacterized Sites Operable Unit (AUS OU)										
AUS-0A2B	Booster Loading Line	Area 2B	125	Yes	Groundwater - TCE and other VOCs Soil - TCE	C for workers in an excavation			Within 500' of groundwater sample W02	Groundwater sample W02, TCE = 47 ug/L
AUS-0A2D	Detonator Loading Line	Area 2D	150	Yes	Groundwater - TCE and other VOCs	C for workers in an excavation			Within 1,000' of groundwater sample W01, and within 500' of groundwater sample W03	Sample W01, TCE = 54,000 ug/L, cis-1,2-DCE = 9,700 ug/L Sample W03, TCE = 4,200 ug/L, cis-1,2-DCE = 400 ug/L, PCE = 2,800 ug/L, VC = 11 ug/L

Table 1-5
Crab Orchard National Wildlife Refuge
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Site Number	Site Name	Other Site Designations	Approximate Size (Acres)	Site-Specific Land Use Controls in Effect/PPE Required (Yes/No)	Justification for Land Use Controls (contaminants exceeding risk-based screening criteria)	Minimum OSHA PPE Level for activities involving digging	Minimum PPE for short-term site visitors	Additional Measures to Minimize Exposure	Specific Locations within each Site	Contaminants
AUS-0A2F	Fuse Loading Line	Area 2F	125	Yes	Groundwater - TCE and other VOCs	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible			Within 1,000' of groundwater sample W02	Sample W02, TCE = 2,400 ug/L, cis-1,2-DCE = 210 ug/L
AUS-0A2P	Artillery Primer Loading Line	Area 2P	150	Yes	Groundwater - TCE and other VOCs	C for workers in an excavation			Within 1,000' of groundwater sample W03	Sample W03, TCE = 120,000 ug/L, PCE = 230 ug/L
AUS-0A2R	Railroad Spur	Area 2R	30	No						
AUS-0A03	IOP Finished Ammunition Group 1 Area	Area 3	150	No						
AUS-0A4E	East Shop Area	Area 4 East	60	No						
AUS-0A4W	West Shop Area	Area 4 West	80	Yes	Soil - Inorganics	D1 for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 250' of soil sample 003	Sample 003, Cadmium = 4,520 mg/kg, arsenic = 60.1 mg/kg
AUS-0A06	Ammonium Nitrate High Explosives & Smokeless Powder Storage Area	Area 6	550	No						
AUS-0A07	Inert Storage	Area 7	100	Yes	Soil - Pesticides	D1 for workers inside or outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible, D1* for workers in buildings IN-1-3, IN-1-4, IN-1-5 and IN-1-6 if airborne dust is visible	D1 if airborne dust is visible, D1* in buildings IN-1-3, IN-1-4, IN-1-5, and IN-1-6, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 250' of soil samples 001, 002, 004, 033, 036, 038, 039, 047, and 061	Sample 001, Aldrin = 520,000 ug/kg, Dieldrin = 55,000 ug/kg, Sample 002, Aldrin = 240,000 ug/kg, Dieldrin = 240,000 ug/kg, Sample 004, Aldrin = 350,000 ug/kg, Dieldrin = 290,000 ug/kg, Sample 033, Aldrin = 160,000 ug/kg, Dieldrin = 22,000 ug/kg, Sample 036, Dieldrin = 13,000 ug/kg, Sample 038, Aldrin = 54,000 ug/kg, Sample 039, Dieldrin = 49,000 ug/kg, Sample 047, Aldrin = 88,000 ug/kg, Dieldrin = 140,000 ug/kg, Sample 061, Dieldrin = 13,000 ug/kg
AUS-0A8S	Load Line III	Area 8	150	No						
AUS-0A09	Load Line I	Area 9	100	Yes	Groundwater - TCE	C for workers in an excavation			Within 500' of groundwater sample W01	
					Soils - PCBs	D1 for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Refer to Figures 10-1 and 10-2	Refer to Figures 10-1 and 10-2

Table 1-5
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AUS-0A10	Fuse and Booster Storage Magazines	Area 10	40	Yes	Soil - TCE	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible		Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 250' of soil sample 002	
AUS-A11A	Acid & Ammonium Nitrate Area (part of Load Line II)	Area 11A	50	No						
AUS-A11H	High Explosives Area (part of Load Line II)	Area 11H	70	Yes	Soil and Sediment - Explosives (not at levels of concern for explosive effects), VOCs	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 250' of soil samples 022 and 028	Sample 022, 2,4-DNT = 210,000 ug/kg, Sample 028, TCE = 92 ug/k. Although this TCE concentration is below risk-based screening criteria for industrial soil, the absence of groundwater data in the immediate vicinity of this soil sample 028 justifies the use of land use controls until the nature and extent of contamiantion is fully delineated.
AUS-A11N	Nitroglycerin Area	Area 11N	30	No						
AUS-A11P	Pilot Propellant Plant/CAP Production Area	Area 11P	30	No						
AUS-A11S	Support Area (part of Load Line II)	Area 11S	50	Yes	Groundwater - TCE and other VOCs, trinitrotoluene (not at levels of concern for explosive effects)	C for workers in an excavation		Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 1,000' of groundwater samples W01, W02, and W04	Sample W01, TCE = 6 ug/L, Sample W02, TCE = 280,000 ug/L, cis-1,2-DCE = 10,000 ug/L, Sample W04, TCE = 520, cis-1,2-DCE = 78
					Soil - TCE and other VOCs	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 250' of soil sample 002	Sample W02 (soil sample), TCE = 21,000 ug/kg, cis-1,2-DCE = 1,100 ug/L
AUS-0A12	Former Ammonium Nitrate Plant	Area 12	100	Yes	Groundwater - VOCs	C for workers in an excavation			Within 500' of groundwater sample 008	Sample 008, TCE = 6 ug/L, PCE = 54, cis-1,2-DCE = 130 ug/L.
AUS-0A13	Finished Ammonium Igloos	Area 13	500	No						
AUS-0062	COC (Mounds and Pits)	Area 62	2	No						
AUS-0063	COC (Fenced Area West of COC-1)	Area 63		No						
AUS-0064	COC (Mounds and Brick Pit)	Area 64		No						
AUS-0065	COC (Foundations Northeast of COC-1)	Area 65	0.5	No						
AUS-0066	COC (Berm with Red Brick Rubble)	Area 66	0.5-1	No						
AUS-0067	COC (Fence with "Contaminated Area" Sign - Northwest of COC-6)	Area 67	0.25	Yes	Water from Cistern - Dinitrotoluene (not at levels of concern for explosive effects)	D2 modified for protection against splashing (e.g., waterproof coveralls) if water from cistern is to be sampled or handled in any way.			Cistern	Sample 002, 2,6-DNT = 6.5 ug/L

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Crab Orchard National Wildlife Refuge
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AUS-0069	COC (Dump Near South Shore of Crab Orchard Lake)			No						
AUS-0109	COC (Possible Former Explosives Detonation Area)			No						
AUS-0001	Fire and Police Headquarters		1.5	No						
AUS-0002	Wastewater Treatment Plant		1.5	No						
AUS-0018	Railroad Classification Yard		7	No						
AUS-0019	Former Railroad Spur (North of Area 4E)			No						
AUS-0021	Area 7 Fire Station	Incorporated Into AUS-0A07		No						
AUS-0022	Small Arms Training Facility			No						
AUS-0043	Areas 11 & 12 Fire Station	Area 43	0.5	No						
AUS-0060	Fulminate Storage Igloos	Area 60	6	No						
AUS-0061	Detonation & Disposal Area	Area 61	0.5	No						
AUS-106A	Drum Disposal Area East of Area 11		0.1	Yes	Soil - TCE	C for workers in an excavation, D1 for workers outside excavation if airborne dust is visible, D2 for workers outside excavation if airborne dust is not visible	D1 if airborne dust is visible, D3 if airborne dust is not visible	Dust control measures should be implemented during excavation or other activities where soil is disturbed	Within 500' of soil samples 001, 002, 003, 004, 005, 007	Sample 001, TCE = 94 ug/kg, Sample 002, TCE = 13,000 ug/kg, Sample 003, TCE = 140 ug/kg, Sample 004, TCE = 2,500 ug/kg, Sample 005, TCE = 110 ug/kg, Sample 007, TCE = 260 ug/kg
AUS-0107	Possible Former Disposal Area Located Just Northwest of Area 8			No						
AUS-0108	Possible Disposal Area East of COC-10			No						

Notes:

Level C — Full or half-face, air purifying respirator (NIOSH approved)

Hooded or non-hooded (based on task-specific potential for splashing and/or dust generation) chemical-resistant clothing (overalls with long-sleeved jacket; coveralls; or one or two-piece splash suit; disposable chemical-resistant overalls)
Coveralls (optional, as applicable)
Gloves, outer, chemical-resistant
Gloves, inner, chemical-resistant
Boots, chemical-resistant, protective steel toe and shank
Hard hat (under suit, optional, as applicable)
Face shield (optional, as applicable)

Level D1 — Dust mask, snug-fitting
Coveralls (optional, as applicable)

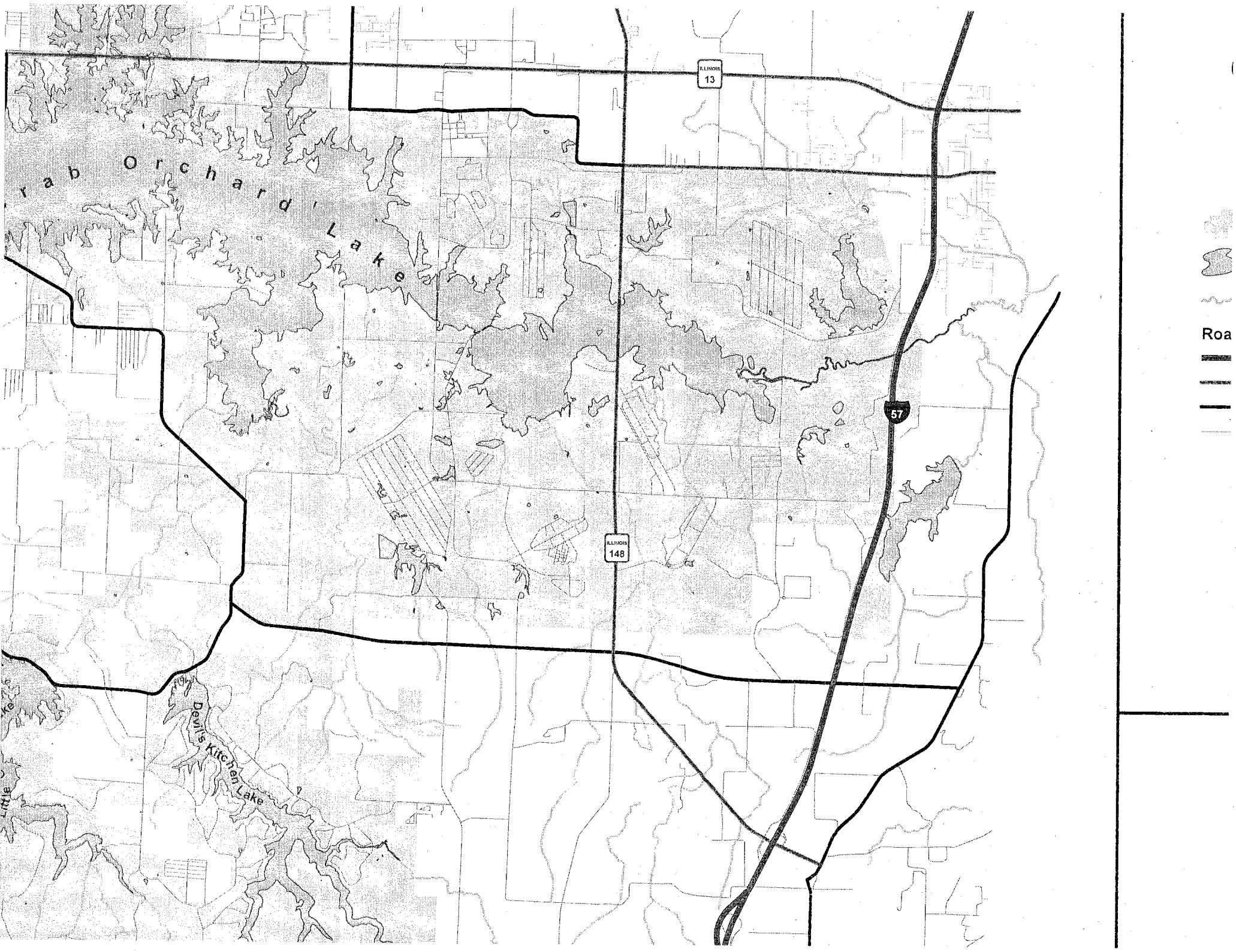
Hooded chemical-resistant clothing (overalls with long-sleeved jacket; coveralls; or one or two-piece splash suit; disposable chemical-resistant overalls) if potentially exposed to groundwater at bottom of trench or excavation
Gloves, outer, chemical-resistant
Gloves, inner, chemical-resistant
Boots, chemical-resistant, protective steel toe and shank
Hard hat (optional, as applicable)
Face shield (optional, as applicable)

Level D1* — Same as Level D1 with the addition of chemical-protective boot covers

Level D2 — Same as Level D1 but without the dust mask

Level D3 - Strictly limited to short-time site worker and/or visitor conducting non-invasive activities
Dust mask, snug-fitting if airborne dust is visible
Long pants (i.e., no shorts)
Short or long-sleeve shirts
Work gloves (optional, as applicable)
Boots, chemical-resistant, protective steel toe and shank

TCE = Trichloroethylene
PCE = Tetrachloroethylene
cis-1,2-DCE = cis-1,2-Dichloroethylene
VC = Vinyl Chloride
2,4-DNT = 2,4-Dinitrotoluene
2,6-DNT = 2,6-Dinitrotoluene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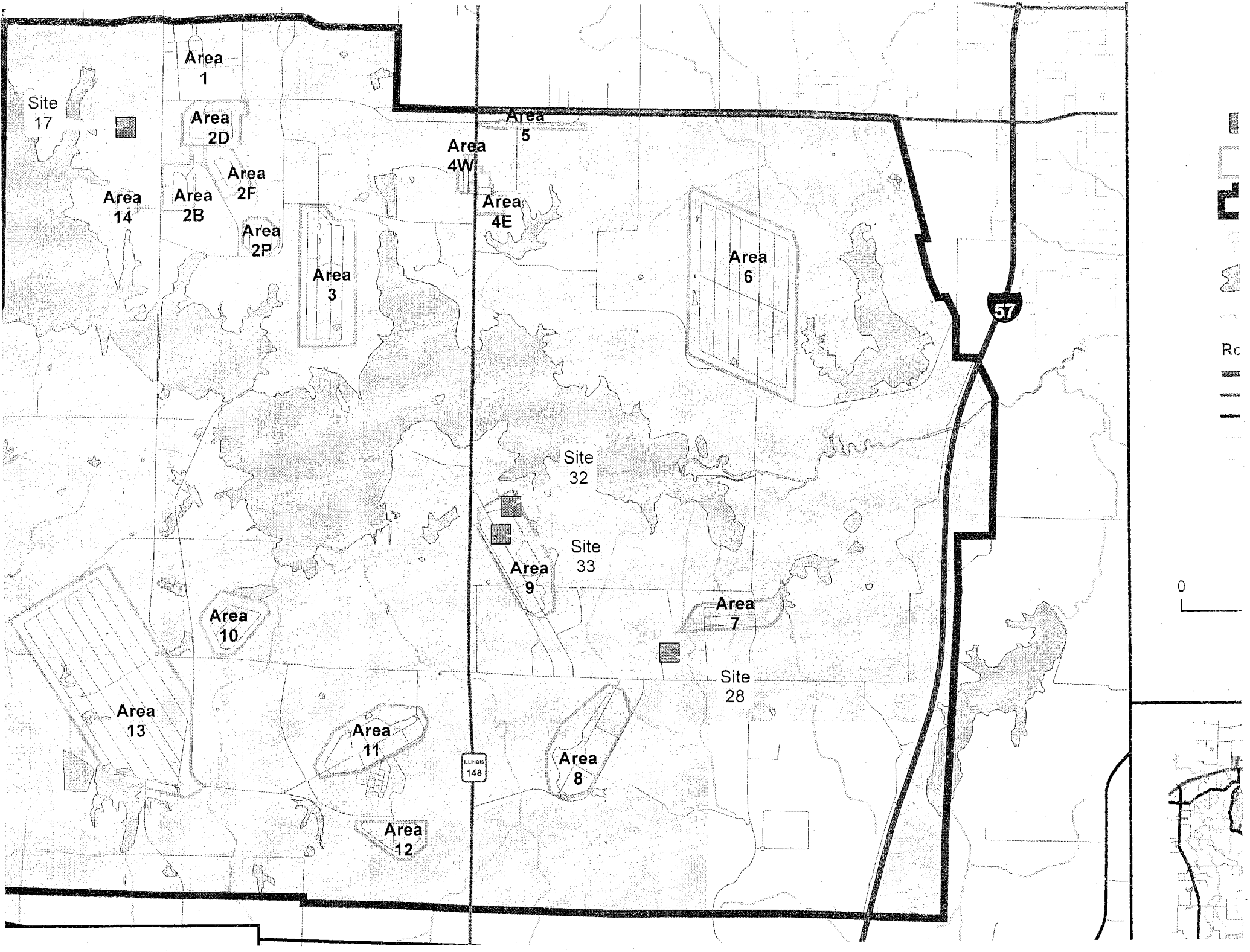
57
ILLINOIS
148
Devil's Kitchen Lake
Roa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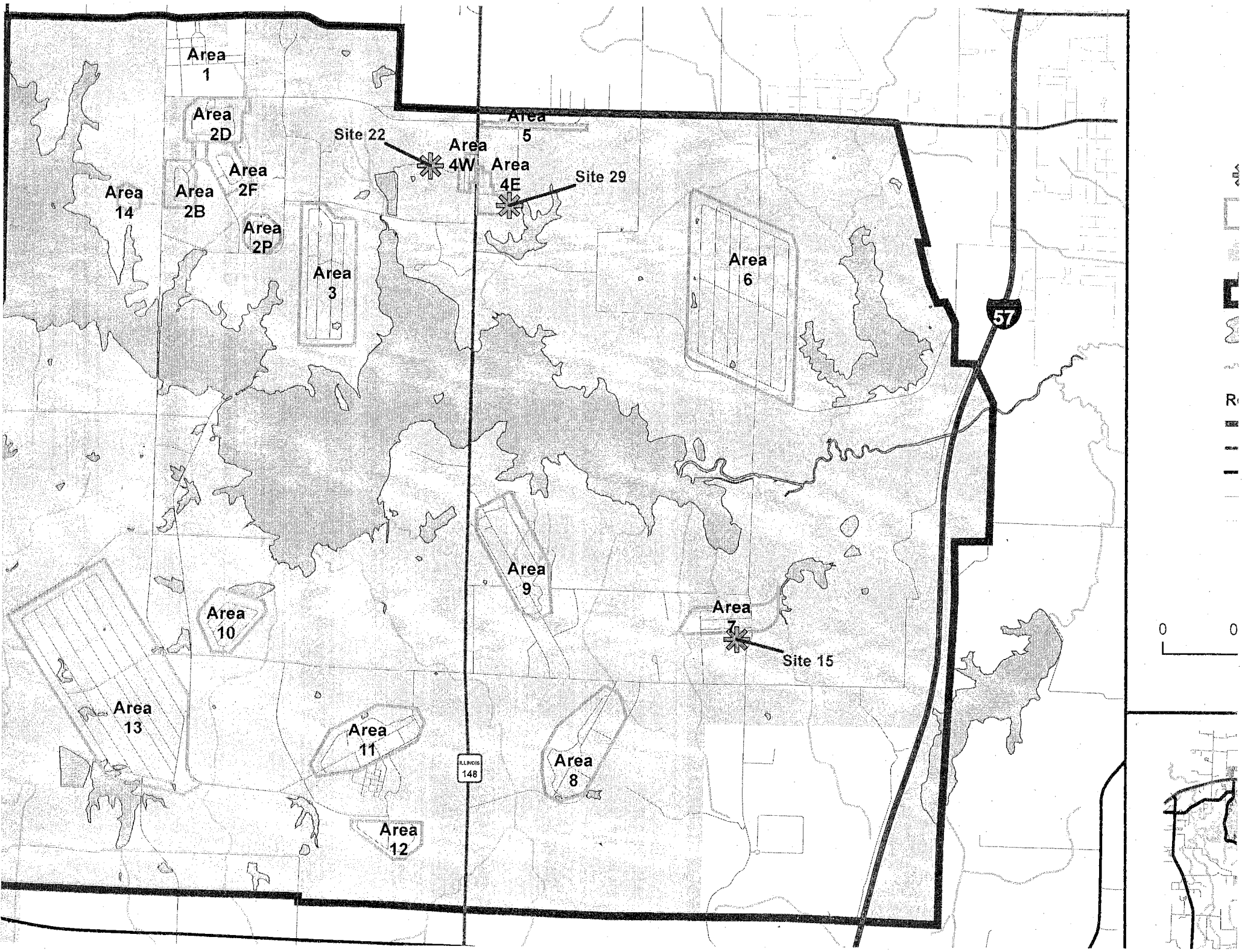
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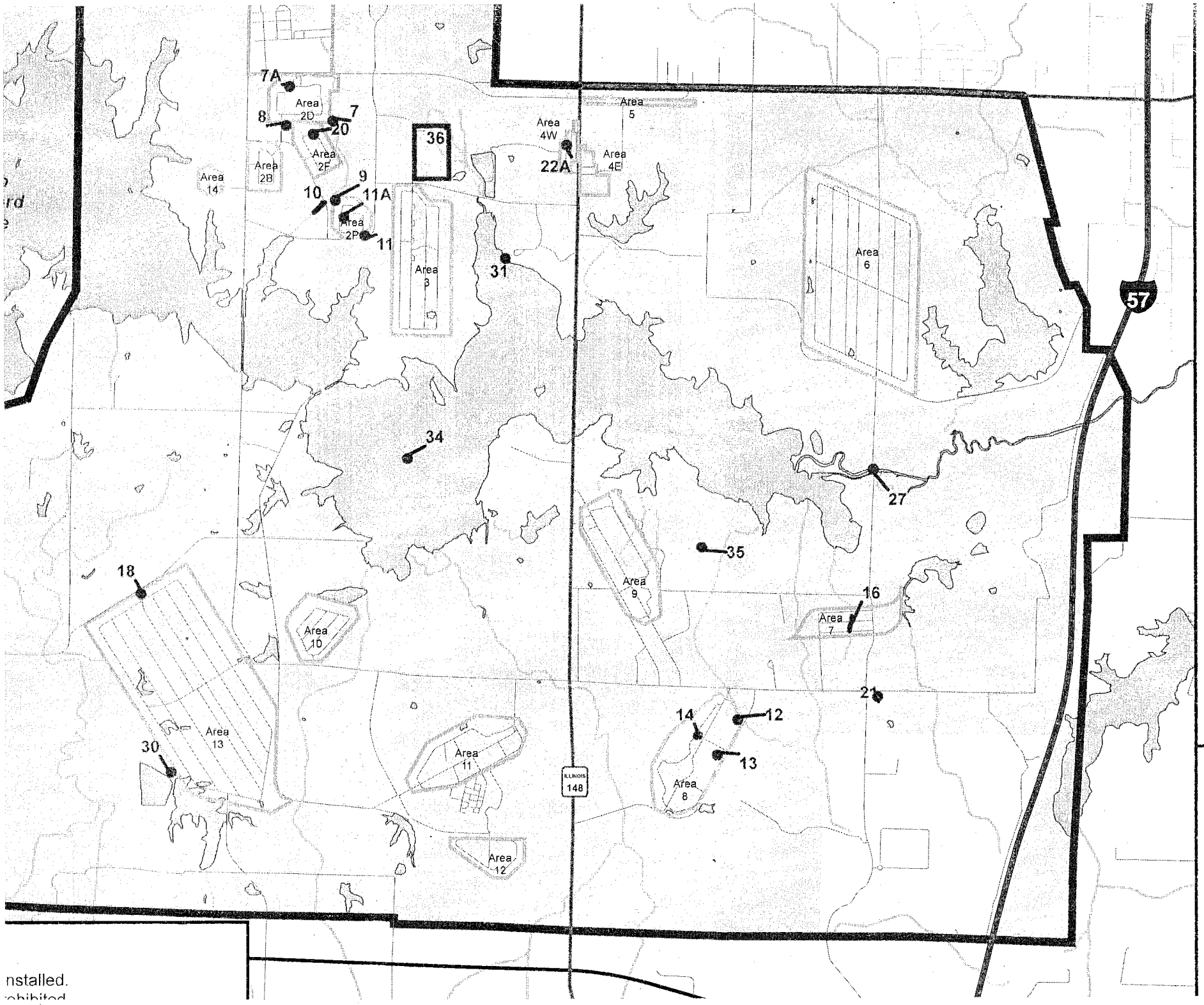
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22A
Area 5
Area 4E
Area 6
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ILLINOIS 148
Area 8
Area 12

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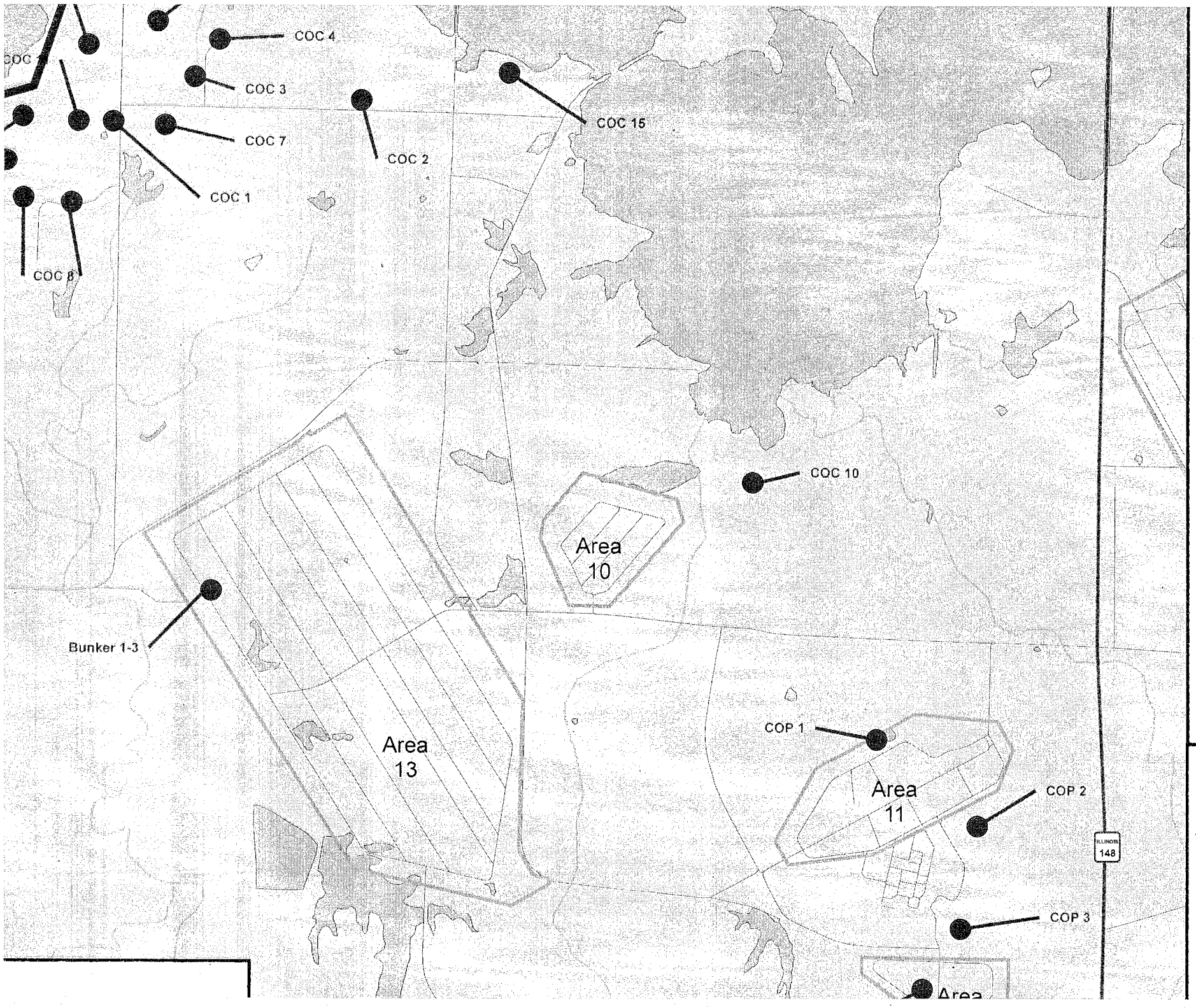
COC 4
COC 3
COC 7
COC 2
COC 15
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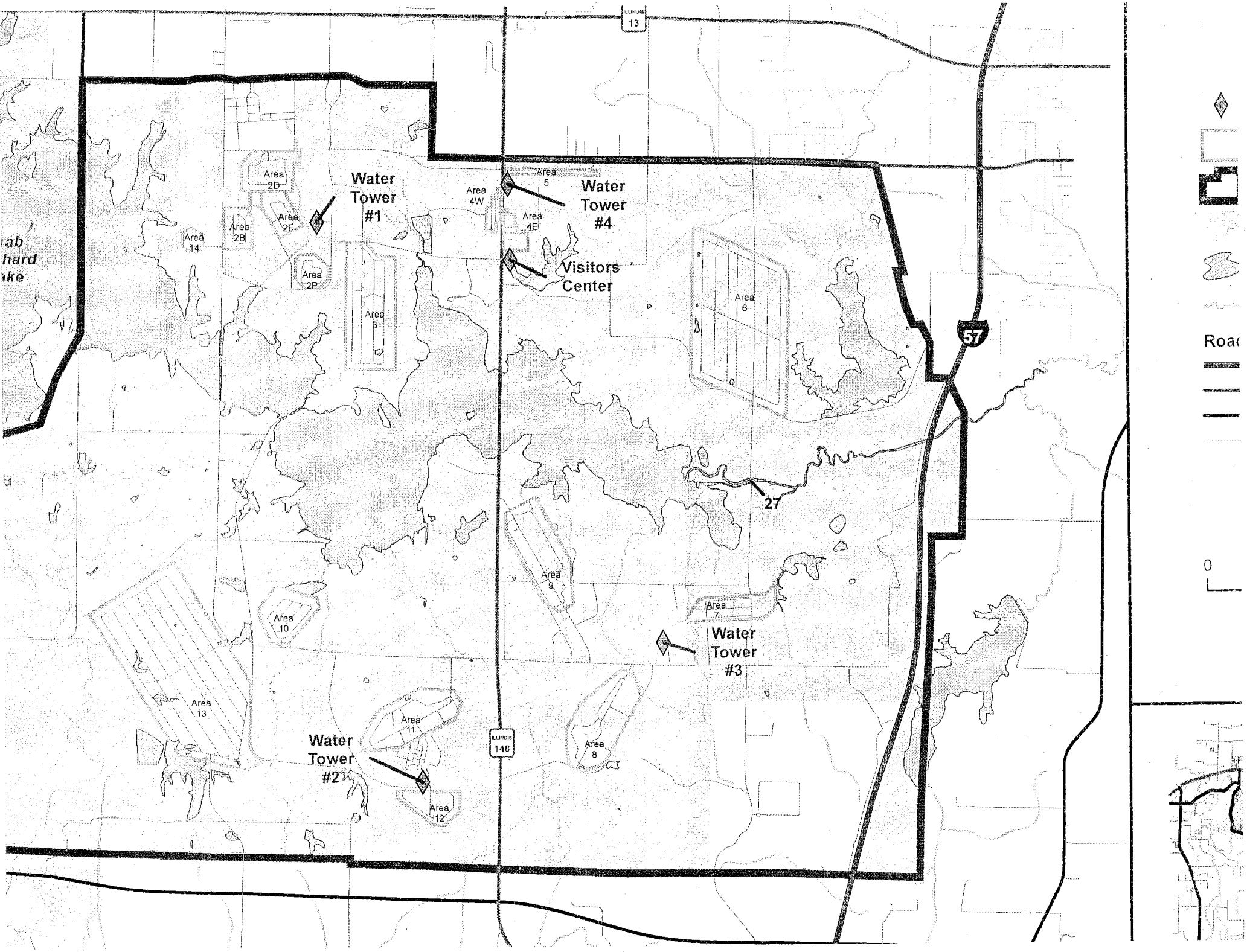
Area 10
Bunker 1-3
Area 13
COP 1
Area 11
COP 2
COP 3
ILLINOIS 148

Man

Road

0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Water Tower #4
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Water Tower #3
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Area 2F
Area 2B
Area 2P
Area 14
Area 3
Area 4W
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Road
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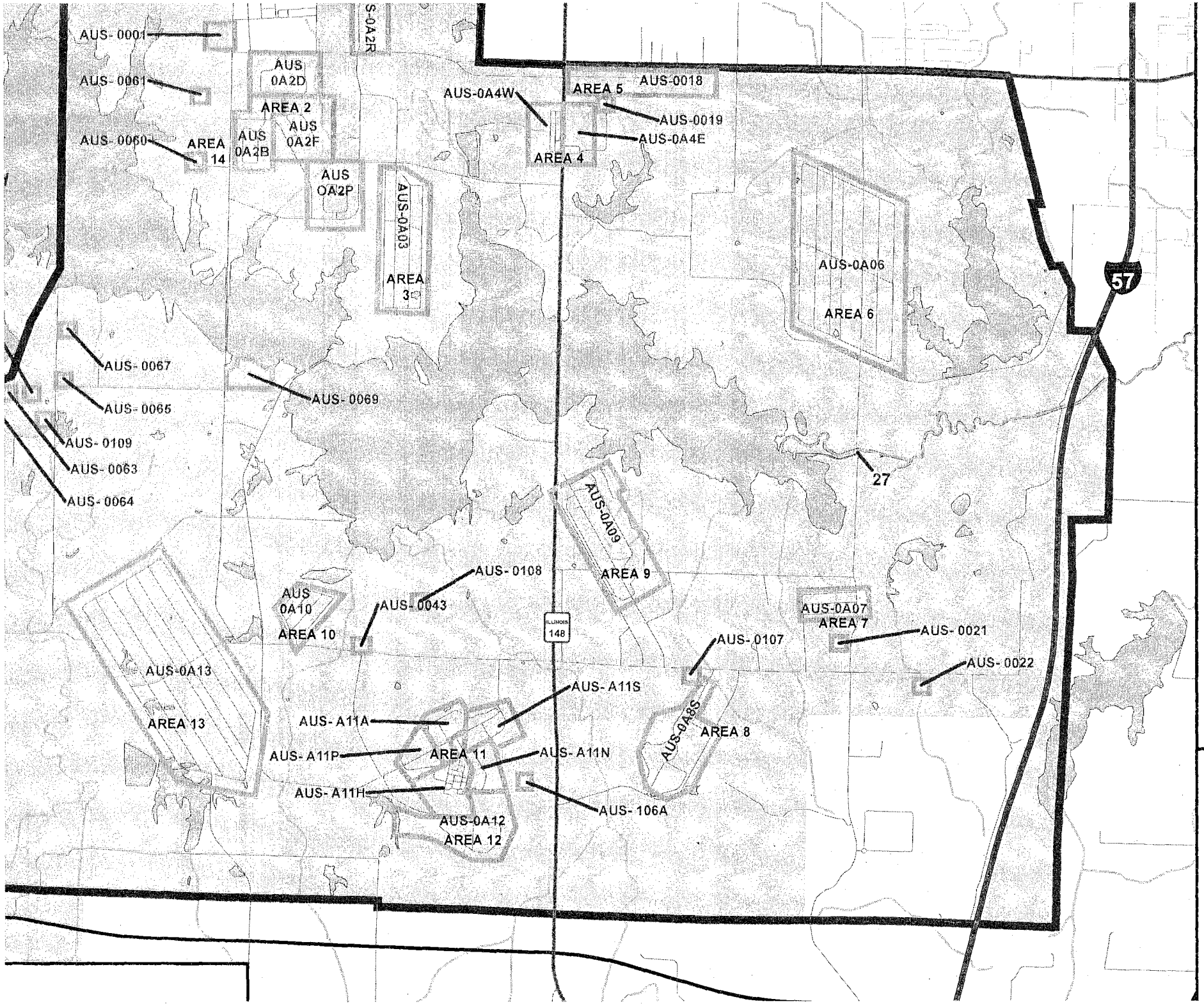
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AREA 3
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AREA 8
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AREA 11
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AUS- A11H
AUS- 106A
AUS-0A12
AREA 12

Unc

Road

0

2.1 LUCIP— PRODUCTION WELL RESTRICTION

2.1.1 Site Location

This restriction applies to the entire closed area of the Refuge, which is the area of the former Illinois Ordnance Plant (IOP). The site boundary is shown in **Figure 2-1**.

2.1.2 LUC Objective

The objective of this LUC is to prevent ingestion of potentially contaminated groundwater and induced migration of contaminant plumes.

2.1.3 LUC(s) Implemented to Achieve Objective(s)

FWS is implementing a ban on all production wells within the boundaries of the former IOP.

Some Sites within the former IOP have groundwater contaminant levels in the upper aquifer that are in excess of federal regulatory maximum concentration limits (MCLs), State of Illinois standards for Class I (potable) Groundwater, and risk-based tap water concentrations established by U.S. EPA Region 9. At other sites the groundwater has not been characterized, but soil concentrations of chemicals indicate that the groundwater may have concentrations exceeding the same standards indicated above. The extent of groundwater contamination at these sites has not been fully characterized, and some sites will have exceedances of standards even after remedies are implemented.

There are currently no production wells on the Refuge; the potable water for the Refuge is supplied by the City of Herrin, which has a reservoir for its source. There are some potable wells near the Refuge boundaries, located within the bedrock materials.

All production wells, not just potable wells, are prohibited, as the installation and pumping of production wells in or near contaminant plumes could lead to inadvertent creation of vertical and/or horizontal preferential migration pathways.

Because of the uncertainty regarding the nature and extent of groundwater contamination, installing production wells will not be allowed.

2.1.4 Actions Needed to Implement and Maintain the LUC

All construction activities must be approved by the Refuge. Refuge staff will be well aware of the well restriction. The stand alone portion of the ELUC will be given to all lease and special use permit holders, and Refuge staff and volunteers. Hunters and other IOP users will receive a briefing detailing the restrictions.

In accordance with Section VI of the ELUC, this LUC will be implemented 30 days after the acceptance of the ELUC Plan, and annual certification will be maintained by the FWS Refuge Manager.

2.1.5 Action Needed to Remove the LUC

This restriction can be removed for a specific location only by an investigation of the groundwater that confirms that the groundwater concentrations are within MCLs, Illinois Class I standards, and the Region 9 risk-based concentrations over an area sufficiently large such that pumping would not influence any other nearby plumes. At any site with known exceedances, the ban can be lifted only after the site groundwater is remediated to achieve these levels, and confirmation that the levels have been achieved is completed. The ban is site-wide except for those specific areas that have been determined to have clean groundwater. The site-wide ban could be considered for removal when all known sites have been cleaned up to Class I standards and all potential sites have been investigated and confirmed clean.

2.1.6 Applicable Decision Document

No specific decision document applies, since this LUCIP applies to the entire former IOP area, and decision documents address specific sites or OUs.

2.2 LUCIP— RESIDENTIAL/CAMPING RESTRICTION

2.2.1 Site Location

This restriction applies to the entire closed area of the Refuge, which is the area of the former Illinois Ordnance Plant. The site boundary is shown in **Figure 2-1**.

2.2.2 LUC Objective

The objective of this LUC is to prevent potential unacceptable risks to residential users and campers.

2.2.3 LUC(s) Implemented to Achieve Objective(s)

FWS is implementing a ban on residential use and camping within the boundaries of the former Illinois Ordnance Plant (IOP) at the Refuge. This restriction, and the provisions below, would also apply to any IOP land considered for a land transfer.

2.2.4 Actions Needed to Implement and Maintain the LUC

In accordance with Section VI of the ELUC, this LUC will be implemented 30 days after the acceptance of the ELUC, and annual certification will be maintained by the FWS Refuge Manager.

2.2.5 Action Needed to Remove the LUC

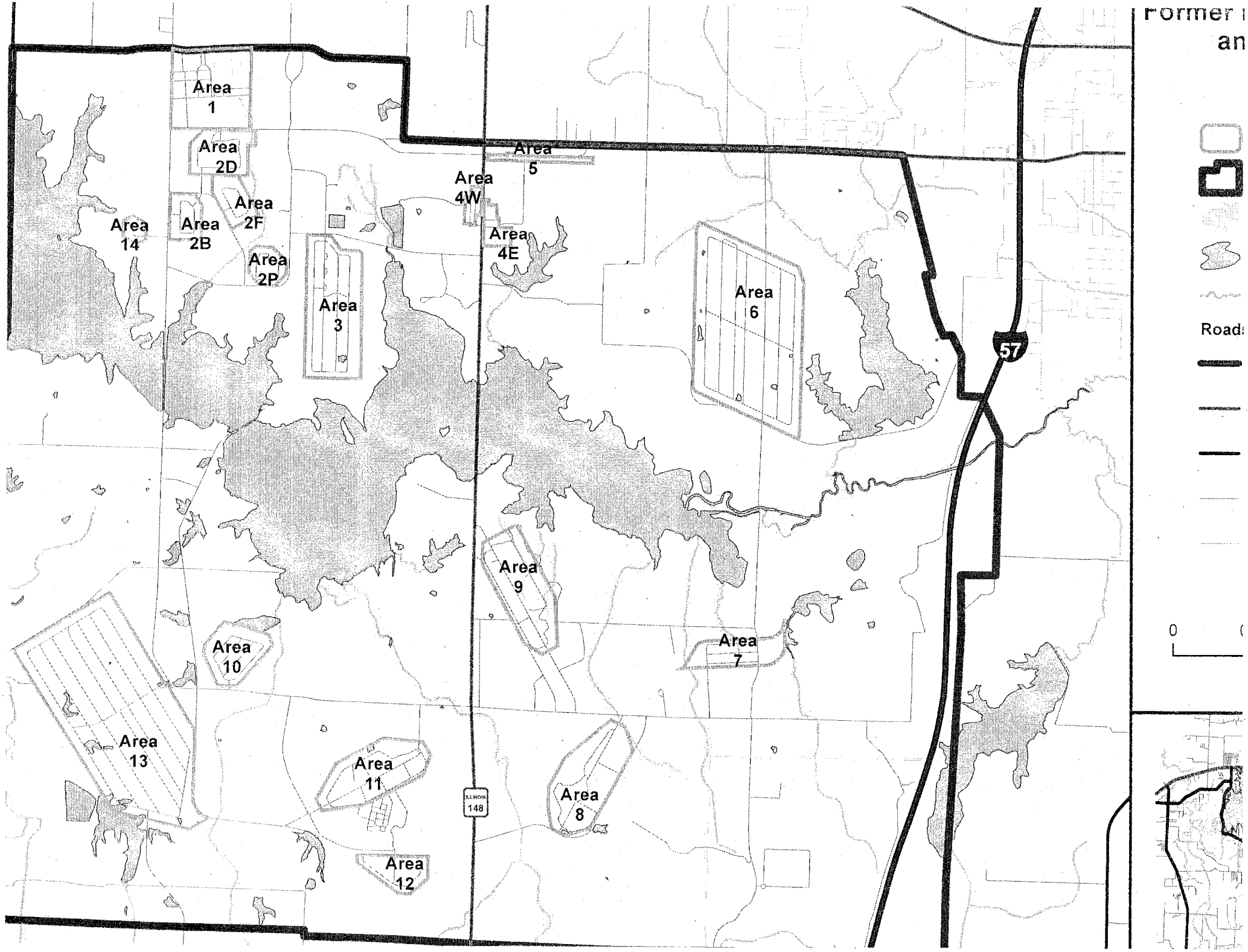
This restriction can be removed for a specific location only by an investigation of the location proposed for residential use or camping, as described below.

If the site proposed for residential use is within any of the operable units (OUs) established for the Crab Orchard NPL site, analytical sampling of all potentially affected media (for example, soil, soil vapor, sediment, surface water as applicable) would be required. The sampling density and depths need to be sufficient to allow evaluation of residential exposure scenarios within individual half-acre parcels. A risk assessment for the proposed use scenarios would be needed. If the risk assessment shows unacceptable risk, remediation would be required before a ban could be considered for lifting. The ban could be lifted only after all risks are shown to be at acceptable levels for the proposed use scenario.

At any sites considered for residential use that are outside of designated OUs, the investigation would require evaluation of all available aerial photographs and other information related to potential contamination of the site. If the photographs show any evidence of post-1940 construction, dumping, or other ground disturbance, the site will be treated as if it were in an OU, and sampling and a risk assessment as described above would be needed. If available records and photographs show no indication of past use that could lead to contamination, nor evidence of contamination from migration from an OU, this information shall be documented. The ban could be considered for removal on the basis that potential for contamination was not found.

2.2.6 Applicable Decision Document

No specific decision document applies, since this LUCIP applies to the entire former IOP area, and decision documents address specific sites or OUs.


Area 1
Area 2D
Area 2F
Area 14
Area 2B
Area 2P
Area 3
Area 4W
Area 5
Area 4E
Area 6
57
Area 9
Area 10
Area 7
Area 13
Area 11
ILLINOIS 148
Area 8
Area 12
Roads
0

Area 2 is located on the east side of Wolf Creek Road, north of Crab Orchard Lake **(Figure 3-1)**. During the Illinois Ordnance Plant (IOP) era (1942-1945), this area was used for loading boosters, detonators, fuses, and primers for the ordnance produced at the IOP. Boosters, detonators, fuses and primers are parts of the explosive train in a device such as a bomb or mine. These IOP uses are the basis for the sub-area designations still in use today (Areas 2B, 2D, 2F, and 2P).

Area 2 is currently fenced, and access is controlled by the tenant. Areas 2B, 2F, and 2D are connected by roadways and are serviced by a single main security entrance on Post Oak Road, at the north end of Area 2. Access to Area 2P is through a security entrance on Stringtown Road, at the south end of Area 2.

3.1 AREA 2B

Site Description

Area 2B, the former IOP Booster Load Line, is on the west side of Area 2 **(Figures 1-7 and 3-1)**. The IOP Booster Load Line consisted of 17 buildings. All the building numbers were prefixed with "B-2." Later industrial tenants added and removed buildings. This fenced site covers about 125 acres.

Operational History and Waste Characteristics

Boosters produced at the IOP used tetryl (2,4,6-tetranitro-N-methyl aniline) for the explosive charge and they may also have contained some mercury fulminate. Tetryl was delivered from off site; processing on the booster load line included screening, blending, pressing, and loading.

Post-World War II industrial tenants used Area 2B for ordnance and pyrotechnic manufacturing. Universal Match Corporation (UMC) began operating in Area 2B sometime after 1952. UMC used Area 2B for tetryl-pelleting operations, manufacturing gas generators and delayed fuses, and for loading large explosive devices. UMC also used this area for manufacturing and testing pyrotechnic devices including explosive switches, igniters, detonators, flares, and atomic bomb burst simulators. UMC left the Refuge in 1963.

After UMC left, several former UMC employees formed Central Technologies, Inc. (CTI), which manufactured and tested pyrotechnic devices in Areas 2B for a short period. Little is known of their operation

Olin/Primex/GDO&TS began leasing in Area 2B in 1963 and have been the only documented lessee in Area 2B since 1970. GDO&TS is the current tenant. Olin/Primex/GDO&TS has used Area 2B for manufacturing ammonium nitrate propellants, ammonium oxalate inhibitors, insulator mixes, and magnesium-teflon flares; for machining; testing gas generators; storing hazardous waste; and for quality assurance laboratory analysis. One building contained a trichlorethane vapor degreaser.

Statements by former employees of both UMC and Olin indicate that dumping of organic chemicals (solvents) onto the grounds around process buildings was common. It is likely that this type of activity was also prevalent during the IOP period. Solvents reportedly used and/or dumped by industrial tenants include methylene chloride, methyl ethyl ketone, acetone, trichloroethylene (TCE), and hexane. Documented Olin wastes include the following, among others: beryllium dust; salts of barium, cadmium, chromium, lead, mercury, selenium, and silver; trichloroethane; di-n-octyl phthalate; dimethyl phthalate; toluene di-isocyanate, spent halogenated solvents; and 2-nitrodiphenylamine.

During regular cleaning activities in some process buildings not containing sumps, water was used to hose down the building interiors. The wash water was then allowed to drain out the door onto the surrounding grounds and ditches.

Olin was known to have used the following chemicals at the Refuge, among others: boron, barium nitrate, chromic acid, mercury, copper sulfate, zinc oxide, chloroform, and several phthalates.

Both UMC and CTI reportedly maintained burn pads in Area 2B. Early industrial tenants at the Refuge used burning as a principal means of waste disposal.

3.1.1 LUCIP for AUS-0A2B – IOP Booster Load Line (AUS OU)

3.1.1.1 Site Description and Investigation Results

AUS-0A2B (**Figure 3-1**) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

Site Investigation

The SI included sampling of soil, groundwater, surface water and drums.

Notable Contamination Found

TCE was detected in the groundwater at a maximum concentration of 47 micrograms per liter (ug/L). The federal maximum contaminant level (MCL), one of the SI screening criterion, is 5 ug/L for TCE. Cis-1,2-dichloroethene a degradation product of TCE, was detected above the respective SI screening criteria for groundwater. TCE concentrations exceeded screening criteria in the soil.

Detections of 18 semivolatile organic compounds (SVOCs) in soils exceeded SI screening criteria. These included dibenzofuran and 12 polyaromatic hydrocarbons (PAHs), which are products of incomplete combustion; they are all common industrial contaminants. Other SVOCs detected above SI screening criteria included three phthalates, which are common plasticizers; methylnaphthalene, a component of diesel fuel; and carbazole. Carbazole has been found to be common at other propellant manufacturing sites. It is a possible breakdown product of the nitrodiphenylamines used as stabilizers in propellant.

Most inorganic constituents exceeded SI soil screening criteria, including, among others, barium, beryllium, boron, cadmium, copper, cyanide, lead, mercury, selenium, silver, and zinc. Maximum detections included antimony at 56 mg/kg *(background = 0.8 mg/kg)*, lead at 2,000 mg/kg *(background = 23 mg/kg)*, and copper at 1,560 mg/kg *(background = 11 mg/kg)*. Lead detections in surface water exceeded State of Illinois Water Quality Criteria. Several inorganic detections in drum samples exceeded SI screening criteria.

3.1.1.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the presence in groundwater and known use of chlorinated solvents at this site, particularly TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

3.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. In the areas around the industrial facilities likely to have used chlorinated solvents, CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled, other than soil collection by OSHA-trained personnel, as noted above. These areas are shown in **Figure 3-1**. Agricultural use is prohibited at this site.

These LUCs will be modified as appropriate as data are obtained in the RI. In particular, any soil locations with TCE concentrations in excess of 10 mg/kg will be designated as off-limits for excavation except by OSHA-trained and certified work crews. This information will also be updated as EPA finalizes its guidance for TCE exposure.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 3-1**.

3.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

3.2 AREA 2D

Site Description

Area 2D, the IOP Detonator Load Line, is located on the north side of Area 2 (**Figures 1,7 and 3-2**). The original building complex consisted of 41 buildings. All the building numbers were prefixed with "D-1." Industrial tenants have removed some buildings and added many more. Building numbers now extend into the 90s. This fenced site covers about 150 acres.

Operational History and Waste Characteristics

Detonators produced at the IOP used lead azide, tetryl, and probably mercury fulminate as the explosive charge. Other materials used in production were antimony sulfide and potassium chlorate. Explosives were not manufactured at the IOP; they were shipped in and processed on the load lines.

Since World War II, ordnance and pyrotechnic manufacturers have used Area 2D for production. UMC leased Area 2D from 1953 to 1963. UMC reportedly began with research and development of primary and secondary explosives, pyrotechnic devices, and propellants in Area 2D. Originally UMC's production work at the Refuge consisted mainly of pyrotechnic devices, initiators (fuse trains), large explosive devices, smoke markers, and photoflash shells. UMC's pyrotechnic devices included explosive switches; igniters, detonators, flares and atomic bomb burst simulators. UMC reportedly used lead styphnate and lead azide in their operations.

Olin/Primex/GDO&TS have operated in Area 2D from 1964 to the present. Olin began the bulk of their solid propellant operations (SPO) in Area 2D in 1964. This included gas generators, jet starters (starter cartridges), tank pressurizers, missile guidance control products, and aircraft emergency evacuation slide inflation devices. Solid propellants are manufactured by mixing the propellant components together in a mixer either dry or with a solvent. Powdered lead stearate was reportedly used in the manufacture of gas generators in Area 2D, as was TCE.

Other Olin/Primex/GDO&TS Area 2D products include the Light Antitank Weapon (LAW) rocket, 20mm fuses, boosters, and ammunition ignition mixes. Olin/Primex also used several building in Area 2D for storage of explosive/hazardous waste and used some buildings as explosive scrap pick-up points.

Refer to the discussion under AUS-0A2B above for a description of the dumping of organic chemicals, industrial tenant cleaning activities, chemicals used, waste products, and waste burning.

Both UMC and Olin reportedly maintained burn pads in Area 2D.

3.2.1 LUCIP for AUS-0A2D – IOP Detonator Load Line (AUS OU)

3.2.1.1 Site Description and Investigation Results

AUS-0A2D (**Figure 3-2**) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems for the AUS OU. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

Site Investigation

The SI included soil, groundwater, and surface water samples.

Notable Contamination Found

TCE was detected in the groundwater at a maximum concentration of 54,000 ug/L *(MCL = 5 ug/L).* Detections of cis-1,2-dichloroethene and vinyl chloride, degradation products of TCE, also exceeded SI screening criteria for groundwater, as did several other chlorinated volatile organic compounds (VOCs). RDX (Royal Demolition Explosive), was detected in soils at concentrations exceeding SI screening criteria. Detections of several VOCs in soil exceeded SI screening criteria.

Most of the SVOCs that exceeded SI soil screening at AUS-0A2B also exceeded the screening criteria at AUS-0A2D, including the PAHs, the phthalates, methylnaphthalene, dibenzofuran, and carbazole. At AUS-0A2D, concentrations of carbazole and most PAHs were well above screening criteria.

Detections of most inorganics in soils exceeded SI screening criteria, including the same chemicals listed under AUS-0A2B, except that cyanide and selenium did not exceed the criteria at AUS-0A2D. Maximum detections include arsenic at 120 mg/kg *(background = 13 mg/kg),* chromium at 97 mg/kg *(background = 25),* copper at 937 *(background = 11 kg),* silver at 40 mg/kg *(background = 0.6 mg/kg),* and zinc at 1,060 mg/kg *(background = 51 mg/kg).*

3.2.1.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the presence in groundwater and known use of chlorinated solvents at this site, particularly TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

3.2.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. In the areas around the industrial facilities likely to have used chlorinated solvents, CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled, other than soil collection by OSHA-trained personnel, as noted above. These areas are shown in **Figure 3-2**. Agricultural use is prohibited at this site.

These LUCs will be modified as appropriate as data are obtained in the RI. In particular, any soil locations with TCE concentrations in excess of 10 mg/kg will be designated as off-limits for excavation except by OSHA-trained and certified work crews. This information will also be updated as EPA finalizes its guidance for TCE exposure.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 3-2**.

3.2.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.2.1.5 Applicable Decision Document

There is not yet a decision document for this site.

3.2.2 LUCIP for Site 7 – D Area Southeast Drainage Channel (MISCA OU)

3.2.2.1 Site Description

Site 7 of the MISCA OU includes a segment of a drainage channel (intermittent stream) located southeast of the D Area (also known as Area 2D) as shown on **Figure 1-4**. Area 2D was the former IOP Detonator Loading Line. Since the 1950s, this area has been leased by industrial tenants for explosives and munitions manufacturing.

The stream flows south and southwest eventually discharging into Crab Orchard Lake. Other than the intermittent stream as discussed above, there are no other distinguishing surface or subsurface features associated with this site. The suspected sources of contamination at this site are discharges into the drainage channel from industrial activities in this area.

Previous investigations at Site 7 include the 1988 RI and the 1993 Phase I RI.

3.2.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one sediment sample (0-1 foot deep) and one surface water sample were analyzed. Both samples were analyzed for VOCs, PCBs, pesticides, explosives, and other indicator parameters.

Table 3-1 summarizes only the detected analytical results from both samples.[24] None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 3-1**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows two potential chemicals of concern for the sediment sample only. Both aluminum and antimony exceeded the following screening criteria in the sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

Sampling performed at Site 7 under the 1993 Phase I was conducted in order to further evaluate the potential risk to human health, wildlife, and the environment. One composite/discrete sediment sample pair was collected. The composite sample (1.7 to 1.8 feet deep) was analyzed for SVOCs,

[24] Note that a number of analytes are not included because these data were later rejected: DPRA Document No. 00018887, a letter from USEPA to USFWS regarding Crab Orchard Lake RI/FS, dated February 18, 1987. A list of the rejected data can be found in the letter. This is true for all references to analytical data from samples in this section collected during the 1988 O'Brien & Gere RI.

PCBs, pesticides, explosives, metals, and cyanide, while the discrete sample (1.9 feet deep) was analyzed for VOCs.

Table 3-1 summarizes only the detected analytical results from the two samples.[25] None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. A comparison of the 1993 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-1**).

3.2.2.3 LUCIP Objective

The LUCIP objective is the same as for the entire IOP (see Section 2 – IOP-Wide LUCIPS). Based on the available data, no other restrictions are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.2.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.2.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.2.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

[25] Split samples were taken of both the composite/discreet sample pair. Information other than the location of those samples is not available. The 1993 analytical results for Site 7 shown in Table 6-2 are from the original composite/discrete sample pair.

3.2.3 LUCIP for Site 7A – D Area North Lawn (MISCA OU)

3.2.3.1 Site Description

This site is also located in Area 2D and is part of the MISCA OU. Site 7A, shown on **Figure 1-4**, is located in a 3-acre lawn northwest of Building D-1-35 within the fence line defining Area 2D. There is a drainage channel located south of the lawn extending beneath a fence to the west, flowing some 2,500 feet to Crab Orchard Lake. It was reported that barrels of chemicals were dumped on a knoll in this lawn area. However, during site visits, there was no evidence of a knoll but there were a few depressions in the lawn area. There were no other surface or subsurface features observed in this area.

Previous investigations at Site 7A include the 1988 RI and the 1993 Phase I RI.

3.2.3.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, several soil samples were analyzed and magnetometer and electromagnetic surveys were performed. Neither survey detected anomalies suggestive of buried metallic objects. Seventeen composite soil samples were collected from three transects established in the three-acre lawn area from the surface (0-6 inches) to depths of 1-2 feet and 2-3 feet.[26] Sixteen of the samples were analyzed for metals, and all 17 samples were analyzed for VOCs, PCBs, pesticides, explosives, and other indicator parameters. One sample was also analyzed for SVOCs.

Table 3-2 summarizes only the detected analytical results from the composite soil samples. None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 3-2**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows two potential chemicals of concern: aluminum and iron.

Aluminum exceeded the following screening criteria in one surface soil sample:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Iron exceeded the following screening criteria in five soil samples (one surface, one 1-2' sample, and two 2-3' samples):

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

[26] The entire lawn area was not included in this site – only the sample locations are a part of this site. These sample locations were not surveyed, but they can be approximated from the figure.

1993 Phase I RI (Woodward Clyde)

Four composite/discrete surface soil sample pairs were collected. The four composite samples (1.4 to 1.7 feet deep) were analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the four discrete samples (1.8 to 1.9 feet deep) were analyzed for VOCs.

Table 3-2 summarizes only the detected analytical results from the eight soil samples. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. A comparison of the 1993 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-2**).

3.2.3.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives (Section 2) other are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.2.3.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.2.3.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.2.3.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

3.2.4 LUCIP for Site 8 – D Area Southwest Drainage Channel (MISCA OU)

3.2.4.1 Site Description

Site 8 is located in a perennial stream (south of Area 2D) that receives surface runoff from the active industrial facility in Area 2D (**Figure 1-4**). The stream flows to the southwest for approximately 4,000 feet discharging into Crab Orchard Lake. There are no other distinguishing surface or subsurface features associated with this site. The suspected source of contamination at this site is industrial discharges into streams and drainage ditches from industrial activities in Area 2.

Previous investigations at Site 8 include the 1988 RI and the 1993 Phase I RI.

3.2.4.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one sediment sample (0-1 foot deep) and one surface water sample were analyzed for VOCs, PCBs, pesticides, and explosives. **Table 3-3** summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1988 RI, nor did they exceed any screening criteria used for this LUCIP (**Table 3-3**).

1993 Phase I RI (Woodward Clyde)

One composite surface soil sample (1.6-1.7 feet) and two discreet soil samples (1.6 and 1.7 feet) were collected from Site 8. The composite sample was analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete samples (1.9 feet deep) were analyzed for VOCs.

Table 3-3 summarizes only the detected analytical results from the three samples. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. A comparison of the 1993 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-3**).

3.2.4.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.2.4.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.2.4.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.2.4.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the lack of groundwater data.

3.3 AREA 2F

Site Description

Area 2F, the IOP Fuse Load Line, is located east of Area 2B and south of Area 2D (**Figures 1-7 and 3-3**). The original Area 2F building complex consisted of 14 buildings, all prefixed with "F-2." Industrial tenants have removed some buildings and added others. This fenced site covers about 125 acres.

Operational History and Waste Characteristics

The IOP Fuse Loading Line was used for manufacturing delays and fuses which included the preparation and loading of black powder, lead azide, antimony sulfide, potassium chlorate, and tetryl.

UMC leased Area 2F from 1959 to 1961. There is little information about UMC's activities in Area 2F.

Olin/Primex/GDO&TS have operated in Area 2F from 1970 to the present. Olin/Primex/GDO&TS manufactured artillery projectiles in Area 2F. Olin also had a metal fabrication operation in Area 2F that used cutting oils and degreasers, including TCE and/or methylene chloride. This area has also been used as a storage facility for components and finished products, as well as for fuels and oxidizers such as magnesium, boron, perchlorates, nitrates, and peroxides. The area has also reportedly been used for manufacturing propellant systems and gas generators.

Refer to the discussion under AUS-0A2B above for a description of the dumping of organic chemicals, industrial tenant cleaning activities, chemicals used, waste products, and waste burning.

A large area that has been used as a dumping ground was observed during the site reconnaissance, at the north end of Area 2F. The materials dumped in the area include soil, trees, construction debris and three boilers.

3.3.1 LUCIP for AUS-0A2F – IOP Fuse Load Line (AUS OU)

3.3.1.1 Site Description and Investigation Results

AUS-0A2F (**Figure 3-3**) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

Site Investigation

The SI included soil, groundwater, and surface water samples.

Notable Contamination Found

TCE was detected in the groundwater at a maximum concentration of 2,400 ug/L (MCL = 5 ug/L). Detections of cis-1,2-dichloroethene, tetrachloroethylene, nitrate-nitrite, and phosphorous also exceeded SI screening criteria for groundwater. Detections of TCE and cis-1,2-dichloroethene in soil exceeded SI screening criteria.

Among the SVOCs, nine PAHs exceeded soil screening criteria.

Maximum detections of most inorganic constituents in soils exceeded SI screening criteria, including antimony, boron, cadmium, copper, mercury, silver, and zinc.

3.3.1.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the presence in groundwater and known use of chlorinated solvents at this site, particularly TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

3.3.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available,

digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. In the areas around the industrial facilities likely to have used chlorinated solvents, CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled, other than soil collection by OSHA-trained personnel, as noted above. These areas are shown in **Figure 3-3**. Agricultural use is prohibited at this site.

These LUCs will be modified as appropriate as data are obtained in the RI. In particular, any soil locations with TCE concentrations in excess of 10 mg/kg will be designated as off-limits for excavation except by OSHA-trained and certified work crews. This information will also be updated as EPA finalizes its guidance for TCE exposure.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 3-3**.

3.3.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.3.1.5 Applicable Decision Document

There is not yet a decision document for this site.

3.3.2 LUCIP for Site 20 – F Area South Drainage Channel (MISCA OU)[27]

3.3.2.1 Site Description

Site 20 is located in a drainage ditch to of Building F-2-2 in the F Area (also known as Area 2F) as shown on **Figure 1-4**. This drainageway segment receives runoff from a nearby abandoned industrial building where chemicals were reportedly dumped (1988 RI). Area 2F was the former IOP Fuse Loading Line and has been used by industrial tenants primarily for munitions manufacturing since the 1950s.

The drainage ditch flows to the northeast and discharges into an un-named stream that flows southwest discharging into Crab Orchard Lake. There was a sheen on the water in this drainage ditch during 1988 RI sampling activities.

Previous investigations at Site 20 include the 1988 RI, the 1993 Phase I RI, and the 1996 Phase II RI. The limits of Site 20 are defined by the sample locations and the sample depths described below.

3.3.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one composite sediment sample (0-1ft deep) was analyzed for VOCs, SVOCs, Pesticides, metals, and other indicator parameters.

Table 3-4 summarizes only the detected analytical results from the sediment sample. None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 3-4**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows one potential chemical of concern:

- N-Nitrosodimethylamine exceeded the USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

One composite/discrete surface soil sample pair was collected. The composite sample (1.0 to 2.0 feet deep) was analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete samples (1.5 feet deep) was analyzed for VOCs.

[27] The 1988 O'Brien & Gere mistakenly refers to this site as the "D Area South Drainage Channel." Site 20 is located within Area 2F and will be noted as the "F Area Drainage Channel" in all tables and text of this document.

Table 3-4 summarizes only the detected analytical results from the soil sample. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. A comparison of the 1993 data with the screening criteria established for this LUCIP shows one potential chemical of concern (**Table 3-4**).

Thallium exceeded the following screening criteria in the soil sample:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

3.3.2.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.3.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

3.3.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.3.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

3.4 AREA 2P

Site Description

Area 2P, the IOP Primer Load Line, is on the south side of Area 2, and originally consisted of 14 buildings, all designated with "P-1." (**Figures 1-7 and 3-4**). Since the end of World War II, some buildings have been removed and others added by industrial tenants. This fenced site covers about 150 acres.

Operational History and Waste Characteristics

Primers that were loaded at the IOP Primer Loading Line were constructed of inert materials such as brass, onion skin paper, percussion cup and beeswax. They also contained ignitable components such as percussion compounds and black powder, which is made up of potassium nitrate, sulfur, and charcoal.

The only known industrial tenant in Area 2P is Olin/Primex/GDO&TS, which has leased the area from 1957 to the present. Olin's use of Area 2P began with research and development (R&D) of solid propellants, and some production of solid propellants. A small part of Olin's work in the P area was developing ball powder propellant that included materials such as nitroglycerin, di-octyl phthalate, and other plasticizers. Initially, a larger part of Olin's work in Area 2P involved gas generators that included the use of ammonium nitrate with a plastic/rubber base.

Olin's solid propellant R&D activities involved the small scale mixing of solid propellants and their subsequent testing. During the 1970s, Olin began R&D for their ammunition product lines in Area 2P.

Chemicals used in Area 2P include degreasers and solvents used in solid propellant production. Olin used some of the buildings in this area for storage of solvents, plasticizers, propellants, ammunition, incendiary mixes, and for PCB transformers. Olin also used some of the buildings for ballistic testing, black powder screening and pelleting, gas generator testing, and for machine shop activities such as welding, lathing, and degreasing.

Olin also generated the following explosive scrap which was stored at pick up points in Area 2P: J-66 type ammonium perchlorate, ammonium nitrate rubber, perchlorate propellant with iron oxide, composite double base propellant containing aluminum and ammonium perchlorate, and ethyl acetate with scrap propellant. Primex used some of the buildings as 90-day hazardous waste accumulation areas.

3.4.1 LUCIP for AUS-0A2P – IOP Primer Load Line (AUS OU)

3.4.1.1 Site Description and Investigation Results

AUS-0A2P (**Figure 3-4**) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

Site Investigation

The SI included soil, groundwater, and surface water samples.

Notable Contamination Found

TCE was detected in the groundwater at a maximum concentration of 110,000 ug/L *(MCL = 5 ug/L)*. Other VOCs in groundwater detected above SI screening criteria include trichloroethane, dichloroethane, dichloroethene, chloroform (an industrial solvent), tetrachloroethylene (PCE, used for vapor degreasing of metals), vinyl chloride, nitrate-nitrite and phosphorous. Detections of PCE and TCE in soil exceeded SI screening criteria.

The SVOCs that exceeded soil screening criteria were the same as those in AUS-0A2B, except that two additional PAHs exceeded SI screening criteria, and only two of the three phthalates exceeded the criteria.

Detections of most inorganic constituents in soils exceeded SI screening criteria, including antimony, boron, cadmium, chromium, copper, mercury, selenium, silver, and zinc.

3.4.1.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the presence in groundwater and known use of chlorinated solvents at this site, particularly TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

3.4.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. In the areas around the industrial facilities likely to have used chlorinated solvents, CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled, other than soil collection by OSHA-trained personnel, as noted above. These areas are shown in **Figure 3-4**. Agricultural use is prohibited at this site.

These LUCs will be modified as appropriate as data are obtained in the RI. In particular, any soil locations with TCE concentrations in excess of 10 mg/kg will be designated as off-limits for excavation except by OSHA-trained and certified work crews. This information will also be updated as EPA finalizes its guidance for TCE exposure.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 3-4**.

3.4.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.4.1.5 Applicable Decision Document

There is not yet a decision document for this site.

3.4.2 LUCIP for Site 9 – P Area Northwest Drainage Channel (MISCA OU)

3.4.2.1 Site Description

Site 9 is located in a perennial stream northwest of the P Area (also known as Area 2P) as shown on **Figure 1-4**. Area 2P was the former IOP Primer Loading Line to be used later used by industrial tenants for explosives and munitions manufacturing. This stream, which flows southwest eventually discharging into Crab Orchard Lake, receives runoff from industrial activities in both Areas 2D and 2P. There are no other distinguishing surface or subsurface features associated with this site. The suspected source of contamination at this site is industrial discharges into streams and drainage ditches from industrial activities in Area 2.

Previous investigations at Site 9 include the 1988 RI and the 1993 Phase I RI.

3.4.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one composite sediment sample (0-1 foot deep) and one composite surface water sample were analyzed. Both samples were analyzed for VOCs, PCBs, pesticides, explosives, and other indicator parameters.

Table 3-5 summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 3-5**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows three potential chemicals of concern: iron, manganese, and Aroclor 1254.

Both iron and manganese exceeded the following screening criteria in the sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Aroclor-1254 exceeded the following screening criterion in the sediment sample:

- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

One composite/discrete sediment sample pair was collected. The composite sample (2.0 to 2.1 feet deep) was analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete sample (2.0 to 2.1 feet deep) was analyzed for VOCs.

Table 3-5 summarizes only the detected analytical results from these samples.[28] None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. However, as shown in **Table 3-5**, a comparison of the 1993 data with the screening criteria used for this LUCIP shows one potential chemical of concern. Iron exceeded the following screening criteria in the sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

3.4.2.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives (Section 2) are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.4.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.4.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.4.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

[28] Split samples were taken of both the composite/discreet sample pair. Information other than the location of those samples is not available. The 1993 analytical results for Site 9 shown in Table 6-5 are from the original composite/discrete sample pair.

3.4.3 LUCIP for Site 10 – Waterworks North Drainage Channel (MISCA OU)

3.4.3.1 Site Description

Site 10 is comprised of two drainage ways that converge just prior to discharging into Crab Orchard Lake (**Figures 1-4 and 3-4**). The first segment is located in the southwest-flowing perennial stream northwest of Area 2P, downstream from Site 9; and the second segment is located in a southeast-flowing drainage way just west of the Sites 9/10 perennial stream. The second (southeast-flowing) drainage way discharges into the southwest flowing stream which discharges into Crab Orchard Lake. There are no other distinguishing surface or subsurface features associated with this site. The suspected sourced of contamination at this site are discharges into streams and drainage ditches from industrial activities in Area 2.

Previous investigations at Site 10 include the 1988 RI, the 1993 Phase I RI, and the 1996 Phase II RI.

3.4.3.2 Investigations

1988 RI (O'Brien & Gere)

Two composite surface water samples, two composite sediment samples (0 to 1 foot deep), and five grab sediment samples (0 to 1 foot deep) were collected from this site during both phases of the 1988 RI. One surface water sample and one sediment sample were analyzed for VOCs, pesticides, metals, and other indicator parameters. The second composite sediment sample was analyzed for VOCs, SVOCs, and pesticides. Analytical results for the other surface water sample and all five of the grab sediment samples are considered not usable due to exceedances of holding times and other QA/QC problems. Therefore, those samples are not discussed further in this LUCIP. **Table 3-6** summarizes only the detected analytical results from the viable sample results. None of the detections exceeded levels of concern established for the 1988 RI. Further, a comparison of the 1988 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-6**).

1993 Phase I RI (Woodward Clyde)

Two composite/discrete sediment sample pairs were collected. The two composite samples (1.5 to 2.3 feet deep) were analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the two discrete samples (1.6 to 1.7 feet deep) were analyzed for VOCs.

Table 3-6 summarizes only the detected analytical results from the sediment sample pairs. Some PAHs exceeded levels of concern established for the 1993 Phase I RI resulting in further sampling (Phase II – see 6.5.2.3). A comparison of the 1993 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-6**).

1996 Phase II RI (Woodward Clyde)

Due to the elevated concentrations of some analytes evaluated during the 1993 Phase I investigation, an additional seven discreet sediment samples (ranging from 1 to 1.7 feet deep), plus two soil (0.2 to 2 feet deep) and two surface water samples were collected at Site 10. One of the soil sample was analyzed for metals while both soil samples were analyzed for SVOCs. All seven of the sediment samples were analyzed for SVOCs. One of the sediment samples was also analyzed for VOCs, pesticides, metals and cyanide. Both of surface water samples were analyzed for VOCs, SVOCs, pesticides, metals, and cyanide.

The results of these analyses along with the results of sediment collected for solid phase toxicity testing for the *hyallela azteca* and fat head minnow were used to verify and further delineate the extent of contamination and to perform a baseline risk assessment. Note, sediment collected for the solid phase toxicity testing is not discussed nor used for comparison in this LUCIP.

Table 3-6 summarizes only the detected analytical results from the Phase II samples. Some elevated VOCs were noted in surface water samples, however, the results were below the screening criteria. Further, a baseline ecological risk assessment concluded that Site 10 posed little risk to ecological receptors. The RI concluded that no further action was necessary for Site 10. However, the RI also reported that the Refuge restricts human use of Site 10 and anticipates future restrictions on human use at the site. The report further stated "a human health risk assessment was not conducted at Site 10 since a completed exposure pathway for human risk does not exist at this site."[29]

A comparison of the 1996 data with the screening criteria established for this LUCIP shows several potential chemicals of concern.

Aluminum, arsenic, and iron exceeded the following screening criteria in one sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Iron exceeded the following screening criteria in one surface soil sample:
- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Benzo(a)pyrene exceeded the following screening criterion in two sediment samples:
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Benzo(a)pyrene exceeded the following screening criterion in one sediment sample:

[29] USFWS, April 2002. Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois. Pages 14-15 of the Decision Summary.

- IEPA TACO Tier 1 Soil Remediation Objective for Residential Properties (ingestion exposure route)

Benzo(b)fluoranthene and N-Nitroso-di-n-propylamine exceeded the following screening criterion in one sediment sample each:

- USEPA Region 9 Residential Soil Preliminary Remediation Goal

3.4.3.3 LUCIP Objective

The Site 36 Record of Decision, which included Site 10 (see reference below in Section 3.4.3.6) includes land use controls as the remedy for Site 10. The objective of the LUCIP for Site 10 is to implement those controls in accordance with the ROD. Based on the available data, no objectives other than the IOP-wide are needed at this time (**Figure 3-4**). Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI. The applicable ROD text is as follows (note that Sites 36 and 16 are also included in the discussion):

> Institutional controls will be implemented at Site 36 to ensure that potable water supply wells are not installed at the site in the region of exceedances of MCLs/State of Illinois Class I groundwater standards until groundwater is restored for contaminants of concern. Institutional controls will also be implemented at Sites 10 and 16 to appropriately restrict human access. If future risk assessments show that the sites are appropriate for unrestricted use or reduced limitations on human activity, the institutional controls will be removed or modified as appropriate. These institutional controls will be implemented, maintained, and enforced by DOI/FWS. An Institutional Control Implementation Plan (ICIP) will be prepared as part of the Remedial Design Document. The following items will be included in the ICIP:
>
> • Identification of specific land use restrictions applicable to Sites 10, 16 and 36, the specific geographic extent of the restrictions, and the basis for the restrictions.
>
> • Implementation of enforcement procedures, including control methods, use of existing GIS contaminant database for the site, and visual inspection frequency and methodology.
>
> • Procedure for routine inspection reports.
>
> The exposure assumptions used in the human health risk assessments were consistent with the current human uses of the site. Regarding future land use, any change in land use inconsistent with any land use contained in those

specific exposure assumptions in the risk assessments will require an evaluation of whether the anticipated land use change will pose unacceptable risks to human health and the environment or negatively impact the effectiveness of the selected Site remedy. This is enforceable under the National Wildlife Refuge Administration Act (16USC668dd), Section (d)(3)(A)(I), which requires that the Secretary of the Interior (Secretary)"...shall not initiate or permit a new use of a refuge or expand, renew, or extend an existing use of a refuge, unless the Secretary has determined that the use is a compatible use and that the use is not inconsistent with public safety." The Secretary's determination must be in writing and is subject to public review and comment. Potential land use changes are currently being evaluated through the CCP process that is required by 16USC668dd.

3.4.3.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.4.3.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.4.3.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002).

3.4.4 LUCIP for Site 11 – P Area Southeast Drainage (MISCA OU)

3.4.4.1 Site Description

Site 11, the P Area Southeast Drainage, is a segment of a perennial stream channel southwest of Area 2P (**Figure 1-4**). This stream segment receives runoff from parts of the active industrial facility at Area 2, and flows southwest then south (approximately 3,000 feet) discharging to Crab Orchard Lake. There are no other distinguishing surface or subsurface features associated with this site. The suspected source of contamination at this site is industrial discharges into streams and drainage ditches from industrial activities in Area 2.

Previous investigations at Site 11 include the 1988 RI and the 1993 Phase I RI.

3.4.4.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, two sediment samples (0-1 foot deep) and one surface water sample were analyzed. The surface water sample and one of the sediment samples were analyzed for VOCs, PCBs, pesticides, explosives, metals, and other indicator parameters.

Table 3-7 summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1988 RI. Further, a comparison of the 1988 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 3-7**).

1993 Phase I RI (Woodward Clyde)

One composite/discrete soil pair was collected. The composite sample (1.7 to 1.9 feet deep) was analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete sample (1.3 feet deep) was analyzed for VOCs.

Table 3-7 summarizes only the detected analytical results from the soil sample pair. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. However, as shown in **Table 3-7**, a comparison of the 1993 data with the screening criteria used for this LUCIP shows two potential chemicals of concern.
Arsenic and iron exceeded the following screening criteria in the composite soil sample:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

3.4.4.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives (Section 2) are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.4.4.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.4.4.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.4.4.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

3.4.5 LUCIP for Site 11A – P Area North (MISCA OU)

3.4.5.1 Site Description

Site 11A is located in the northern portion of area 2P near several existing buildings that were reportedly used for storage of materials for explosives production (**Figure 1-4**). Chemicals were reportedly dumped on the ground in this area which consists of drainage ditches around and near two buildings and an L-shaped walkway. Runoff from this area of the site flows to the drainage ditches that carry the water northwest of Area 2P into a southwest-flowing drainage way discharging into Crab Orchard Lake. Samples were collected from drainage ditches.

Previous investigations at Site 11A include the 1988 RI and the 1993 Phase I RI

3.4.5.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, five sediment samples (0-1 foot deep) and four soil samples (0-1 foot deep) were analyzed. VOCs, PCBs, and metals were analyzed in all the sediment samples. SVOCs were analyzed in only one sediment sample. Explosives and pesticides were analyzed in four of the sediment samples. All four soil samples were analyzed for VOCs, pesticides, total PCBs, and metals.

Table 3-8 summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 3-8**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows five potential chemicals of concern for sediment and one potential chemical of concern for soil.

Sediment

Aluminum and iron exceeded the following screening criteria in three sediment samples:
- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Antimony and manganese exceeded the following screening criteria in one sediment sample:
- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Aroclor-1254 exceeded the following screening criterion in one sediment sample:
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Soil

Iron exceeded the following screening criteria in two soil samples:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

Four composite/discrete surface soil sample pairs were collected. The four composite samples (1.5 to 1.9 feet deep) were analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the four discrete samples (1.7 to 1.8 feet deep) were analyzed for VOCs.

Table 3-8 summarizes only the detected analytical results from the four sample pairs. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. However, as shown in **Table 3-8**, a comparison of the 1993 data with the screening criteria used for this LUCIP shows two potential chemicals of concern.

Iron and thallium exceeded the following screening criteria in three soil samples:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

3.4.5.3 LUCIP Objective

Based on the available data, no restrictions other than the IOP-wide restrictions are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

3.4.5.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

3.4.5.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.4.5.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

3.5 AREA 2R

Site Description

Area 2R is a railroad spur that was constructed as part of the IOP and has been used by later industrial tenants (**Figures 1-7 and 3-5**).

The site currently consists of two storage areas, a railroad spur and a loading dock. There were originally two rail spurs and one main line.

Operational History and Waste Characteristics

The USFWS operated the railroads on the Refuge from 1947 to 1976. It is assumed that any of the tenants in Area 2 may have used the rail lines and loading docks in Area 2R.

Open storage of materials, a excavation with probable liquid, and a probable horizontal tank were observed on the 1943 aerial photograph. A possible disposal area was noted on the 1980 aerial photograph.

3.5.1 LUCIP for AUS-0A2R – Railroad Spur (AUS OU)

3.5.1.1 Site Description and Investigation Results

AUS-0A2R (**Figure 3-5**) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

Site Investigation

The SI included soil and trench water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

Detections of methylnaphthalene and 13 PAHs, common contaminants at rail yards, exceeded SI soil screening criteria. Several inorganic constituents in soil exceeded SI screening criteria, including antimony, barium, boron, cadmium, copper, lead, mercury, and zinc.

3.5.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

3.5.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. In the areas around the industrial facilities likely to have used chlorinated solvents, CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled, other than soil collection by OSHA-trained personnel, as noted above. These areas are shown in **Figure 3-5**. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

3.5.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

3.5.1.5 Applicable Decision Document

There is not yet a decision document for this site.

TABLE 3-1
ANALYTICAL DATA SCREENING FOR
SITE 7 - D AREA SOUTHEAST DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1993 Phase I)		O'B&G		O'B&G	
Sample ID	COSE0701/2		7-2-3-1		7-1-2-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Sediment	*R. Code*	Sediment	*R. Code*	Surface Water	*R. Code*
Depth (feet)	1.7-1.8/1.9		0-1		NA	
CONSTITUENT						
Aluminum	9100	H	14400	B H	500	C
Antimony	ND		7.3	B H	ND	
Arsenic	4.4	H	--		--	
Barium	120		114		72	C
Beryllium	0.92		--		--	
Boron			39		30	
Calcium	16000	B	6980	B	19800	C
Chromium	11.5		17		ND	
Cobalt	15	B	8		ND	
Copper	12.2		--		--	
Iron	16000	H	16500	H	3200	C
Lead	11.4		--		--	
Magnesium	9500	B	16700	B	7240	C
Manganese	1040	H	405	H	1500	C
Nickel	11.8		--		--	
Potassium	347					
Silver	0.6		--		--	
Sodium	370		150		4900	C
Thallium	0.33	B				
Vanadium	26		37	B	ND	
Zinc	31		--		--	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-2, ANALYTICAL DATA SCREENING FOR
SITE 7A - D AREA NORTH LAWN, MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G	
Sample ID	7A-1-1-1		7A-2-1-1		7A-3-1-1		7A-4-1-1		7A-5-1-1		7A-6-1-1		7A-7-1-1		7A-8-1-1		7A-9-1-1		7A-9-1-6		7A-10-1-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*
Depth (feet)	Surface		0.5-1		1-2		2-3		Surface		0.5-1		1-2		2-3		Surface		Surface		0.5-1	
CONSTITUENT																						
2-Methylnaphthalene																			0.003			
Aluminum	58600	A H	15600	H	27800	H	18500	H	15700	H	14700	H	12800	H	24200	H	8100	H			9290	H
Anthracene																			0.004			
Arsenic	--		--		--		--		--		--		--		--		--		--		--	
Barium	43.6		85.4		98		257	A	120		120		130		130		67.9				129	
Boron			2.9		4.7		4.9		8.3	A	6	A	4.5		6.5	A					2.7	
Butyl benzyl phthalate																			0.022			
Calcium	1510		2160		1000		780		9890	A	12200	A	33300	A	1200		5930	A			2070	
Chromium	6		17		27	A	21		17		17		14		23		10				10	
Cobalt	2		3		5		9		5		5		5		6		3				5	
Copper	--		--		--		--		--		--		--		--		--		--		--	
Di-n-butyl phthalate																			0.013			
Endosulfan																						
Fluoranthene																			0.033			
Iron	59400	A H	14600	H	25300	A H	25300	A H	19000	H	17000	H	14100	H	26100	A H	10100	H			9460	H
Lead	--		--		--		--		--		--		--		--		--		--		--	
Magnesium	1110		2390	A	3110	A	2620	A	5800	A	5720	A	6540	A	2700	A	1930	A			1350	
Manganese	3330	H	455	H	264	H	754	H	775	H	688	H	1090	H	558	H	693	H			1420	H
Mercury	--		--		--		--		--		--		--		--		--		--		--	
Methylene chloride (Dichloromethane)	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Molybdenum											1		4									
Nickel	--		--		--		--		--		--		--		--		--		--		--	
Phenanthrene																			0.021			
Potassium																						
Pyrene																			0.039			
Sodium	40		120		170		220	A	130		140		190	A	290	A	70		263	A	170	
Thallium																						
Titanium	92.2		265		288		319		213		210		237		246		102				99.8	
Vanadium	14		35		54	A	45		39		36		31		48	A	26				31	
Zinc	--		--		--		--		--		--		--		--		--		--		--	

Legend
mg/kg = milligrams per kilogram
ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.
Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

TABLE 3-2, ANALYTICAL DATA SCREENING FOR
SITE 7A - D AREA NORTH LAWN, MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		WCC (1993 Ph I)		WCC (1993 Ph I)		WCC (1993 Ph I)		WCC (1993 Ph I)	
Sample ID	7A-11-1-1		7A-12-1-1		7A-13-1-1		7A-14-1-1		7A-15-1-1		7A-16-1-1		COSO7A01/2		COSO7A03/4		COSO7A05/6		COSO7A07/8	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*
Depth (feet)	1-2		2-3		Surface		0.5-1		1-2		2-3		1.4/1.9		1.5-1.6/1.8		1.6-1.7/1.8		1.5/1.9	
CONSTITUENT																				
2-Methylnaphthalene													ND		ND		ND		ND	
Aluminum	13000	H	16000	H	12300	H	12200	H	16800	H	17600	H	6000		6100		7100		9200	H
Anthracene																				
Arsenic	--		--		--		--		--		--		3.2	H	2.9	H	4.9	H	3.4	H
Barium	109		113		129		85		68.8		460	A	51		130		62		60	
Boron	4.3		5		16	A			3.9		9.3	A								
Butyl benzyl phthalate																				
Calcium			2410		1830		2160		740		680		1180		13000	A	1090		1400	
Chromium	14		17		15		10		18		22		8.1		7.5		8.2		11.6	
Cobalt	5		4		7		4		4		9		3.4							
Copper	--		--		--		--		--		--		5.2		5.7		6.1		9.2	
Di-n-butyl phthalate																				
Endosulfan																				
Fluoranthene																				
Iron	10600	H	19100	H	15700	H	12000	H	16500	H	35600	A H	7800	H	8700	H	8000	H	11800	H
Lead	--		--		--		--		--		--		7.6		7.2		11.4		7.9	
Magnesium	3200	A	2360	A	1630	A	1850	A	2150	A	2900	A	1010		1400		1000		1500	
Manganese	767	H	534	H	1350	H	698	H	166		534	H	410	H	1200	H	310	H	280	H
Mercury	--		--		--		--		--		--		0.04		0.02		0.04			
Methylene chloride (Dichloromethane)	ND		ND		ND		ND		ND		ND		ND		ND		0.014		0.014	
Molybdenum											1									
Nickel	--		--		--		--		--		--		3.6		5.8		3.8		6.6	
Phenanthrene																				
Potassium													310		190		240		350	
Pyrene																				
Sodium	230	A	270	A	110		86		130		280	A	60		120		150		120	
Thallium													0.36							
Titanium	162		235		185		82.2		233		255									
Vanadium	29		41		38		29		38		42		16		18		15		21	
Zinc	--		--		--		--		--		--		21		20		21		28	

Legend
mg/kg = milligrams per kilogram
ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.
Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge , February.

TABLE 3-3
ANALYTICAL DATA SCREENING FOR
SITE 8 - D AREA SOUTHWEST DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1993 Ph I)		WCC (1993 Ph I)		WCC (1993 Ph I)		O'B&G		O'B&G	
Sample ID	COSO0801		COSO0802		COSO0803		8-2-3-1		8-1-2-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L.)	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Sediment	*R. Code*	Surface Water	*R. Code*
Depth (feet)	1.6-1.7		1.7		1.6		0-1		NA	
CONSTITUENT										
4,4'-DDT	ND						0.022		ND	
Acetone			0.07		0.2		ND		ND	
Aluminum	8400	H					9160	H	ND	
Arsenic	2.5	H					--		--	
Barium	150						110		90	C
Beryllium	0.86	A					--		--	
Boron							46		60	
Calcium	2800	A					38200	B	76600	C
Chromium	12						10		ND	
Cobalt	8.5						8		ND	
Copper	10.6						--		--	
Iron	10500	H					15600	H	300	C
Lead	12						--		--	
Magnesium	1800	A					16700	B	16500	C
Manganese	250	H					428	H	160	
Methyl ethyl ketone			ND		0.06					
Methylene chloride (Dichloromethane)			ND		0.008		ND		ND	
Molybdenum									ND	
Nickel	11.5						--		--	
Potassium	310									
Silver	0.74	A					--		--	
Sodium	310	A					100		22000	C
Thallium	0.4									
Titanium							125		ND	
Vanadium	22						20		ND	
Zinc	32						--		--	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram
ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed

For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge , February.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-4
ANALYTICAL DATA SCREENING FOR
SITE 20 - F AREA DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC		O'B&G	
Sample ID	COSO2001		20-2-3-6	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Soil	R. Code	Sediment	R. Code
Depth (feet)	1.0-2.0/1.5		0-1	
CONSTITUENT				
2-Methylnaphthalene	ND		0.321	
Acetone	0.37			
Aluminum	10600	H		
Arsenic	7.3	H	--	
Barium	150			
Beryllium	0.6		--	
Bis(2-ethylhexyl)phthalate	ND		2.32	
Cadmium	0.74	A	--	
Calcium	1900			
Chromium	17			
Cobalt	8.6			
Copper	11.3		--	
Dibenzofuran	ND		0.144	
Fluoranthene	ND		0.057	
Iron	17000	H		
Lead	50	A	--	
Magnesium	2200	A		
Manganese	310	H		
Naphthalene	ND		0.069	
Nickel	19	A	--	
N-Nitrosodimethylamine	ND		0.336	H
Phenanthrene	ND		0.247	
Potassium	550			
Silver	1.5	A	--	
Sodium	200	A	200	
Thallium	0.52	A H		
Vanadium	23			
Zinc	40		--	

Note: The O'Brien & Gere RI mistakenly refers to this site as the "D Area South Drainage Channel." Site 20 is located within Area 2F and will be noted as the "F Area Drainage Channel" in all tables and text of this document.

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988 Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.

(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge February.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-5
ANALYTICAL DATA SCREENING FOR
SITE 9 - P AREA NORTHWEST DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1993 Phase I)		O'B&G		O'B&G	
Sample ID	COSE0901/2		9-2-3-1		9-1-2-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Sediment	*R. Code*	Sediment	*R. Code*	Surface Water	*R. Code*
Depth (feet)	2.0-2.1/2.0-2.1		0-1		NA	
CONSTITUENT						
Aluminum	7800	H	7620	H	ND	
Aroclor 1254	ND		0.249	H	ND	
Arsenic	4.9	H	--		--	
Barium	150		116		51	C
Beryllium	0.89		--		--	
Boron			53		50	
Calcium	2000	B	1800	B	42900	C
Chromium	15		10		ND	
Cobalt	16	B	10	B	ND	
Copper	14		--		--	
Iron	22000	B H	28600	B H	ND	
Lead	15		--		--	
Magnesium	1800		1230		10500	C
Manganese	900	H	1460	B H	ND	
Nickel	16		--		--	
Potassium	470					
Silver	1.7		--		--	
Sodium	180		60		17400	C
Thallium	0.51	B				
Titanium			109		ND	
Vanadium	23		40	B	ND	
Zinc	44		--		--	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considred not useable refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to (USFWS).
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

Reference Codes:
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B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-6
ANALYTICAL DATA SCREENING FOR
SITE 10 - WATERWORKS NORTH DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		WCC (1993 Phase I)		WCC (1993 Phase I)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)	
Sample ID	10-1-2-1		10-2-3-4		10-2-3-7		COSE1001/2		COSE1003/4		COSO21001		COSO21002		COSE21001	
Matrix (soil & sediment values shown in mg/kg surface water values in ug/L)	Surface Water	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Soil	R. Code	Soil	R. Code	Sediment	R. Code
Depth (feet)	NA		0-1		0-1		1.5-1.8/1.6		1.8-2.3/1.7		0.2-1		0.2-1		1-3	
CONSTITUENT																
1,2-Dichloroethene	ND		ND		ND		ND		ND						ND	
2,4-Dimethylphenol					0.06		ND		ND		ND		ND			
2-Methylnaphthalene					0.004		ND		ND		ND		ND		ND	
Acenaphthylene							ND		ND		ND		ND		ND	
Acetone							0.083		ND						0.1	
Aluminum	ND		8130	H			5100		7100		13000	H			17600	B H
Anthracene					ND		ND		ND		ND		ND		0.11	
Arsenic	--		--		--		4.6	H	2.9	H	8.2	H			13.3	B H
Barium	44	C	68.8				68		84		142				147	
Benz[a]anthracene					0.025		0.25		ND		ND		ND		0.43	
Benzo[a]pyrene	--		--		--		ND		ND		ND		ND		0.25	D H
Benzo[b]fluoranthene					ND		0.34		ND		ND		ND		0.64	H
Benzo[g,h,i]perylene					ND		ND		ND		ND		ND		0.063	
Benzo[k]fluoranthene					ND		ND		ND		ND		ND		0.25	
Beryllium	--		--		--		ND		ND		0.6				0.74	
Bis(2-ethylhexyl)phthalate					0.54		0.39				0.066		ND		ND	
Boron	50		23												ND	
Butyl benzyl phthalate					0.003		ND		ND		ND		ND		ND	
Calcium	30500	C	1900	B			1500	B	1150		2450				3940	B
Chloroform	ND		ND		ND		ND		ND						ND	
Chromium	ND		10				9.7		12		14.9				23.2	B
Chrysene					ND		ND		ND		ND		ND		0.55	
Cobalt	ND						8.4		10	B	21.2				8.9	
Copper	--		--		--		8.9		8.8		12.3	A			20.2	B
Dibenz[ah]anthracene					ND		ND		ND		ND		ND		0.048	
Fluoranthene					ND		0.69		ND		ND		ND		0.91	
Indeno[1,2,3-cd]pyrene					ND		ND		ND		ND		ND		0.18	
Iron	600	C	9430	H			12800	H	16000	H	20700	A H			28800	B H
Lead	--		--		--		12.8		9.5		14.1				16.4	
Magnesium	9850	C	1160				800		950		2260	A			3080	B
Manganese	270		168				560	H	850	H	1620	H			430	H
Mercury	--		--		--		ND		ND		ND				0.2	
Methyl ethyl ketone	--		--		--		0.00002		ND						0.009	
Methylene chloride	ND		ND		ND		ND		ND						ND	
Nickel	--		--		--		7.7		5.6		14.8				13.8	
N-Nitroso di-n-propylamine					ND		ND		ND		ND		ND		ND	
Phenanthrene					ND		0.45		ND		ND		ND		0.43	
Potassium							390		350		510				825	
Pyrene					0.038		0.51		ND		ND		ND		0.54	
Selenium	--		--		--						2				ND	
Silver	--		--		--		1.24		1.2		1.2	A			ND	
Sodium	16700	C	254				65		89		123				116	
Thallium							0.3		0.29		ND				ND	
Titanium	ND		111													
Trichloroethylene (TCE)	ND		ND		ND										ND	
Vanadium	ND		20				22		23		22.8				32	B
Zinc	--		--		--		34		27		84.5	A			95.5	B

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
ND = Not detected, NA = Not Applicable
For data qualifiers, refer to source reports.
Blank results indicate no analyses for that compound in that sample.
Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated.
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E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-6
ANALYTICAL DATA SCREENING FOR
SITE 10 - WATERWORKS NORTH DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)		WCC (1996 Phase II)	
Sample ID	COSE21002		COSE21003		COSE21004		COSE21005		COSE21006		COSE21007		COSE21008		COSW21001	
Matrix (soil & sediment values shown in mg/kg, surface water values in ug/L)	Sediment	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Surface Water	*R. Code*
Depth (feet)	1-2		1.3-1.7		1.1-1.3		1.2-1.5		1-1.3		1.2-1.5				NA	
CONSTITUENT																
1,2-Dichloroethene													ND		ND	
2,4-Dimethylpheno					ND						ND		ND		ND	
2-Methylnaphthalene	ND		ND		ND		ND		ND		ND		ND		ND	
Acenaphthylene	ND		ND		ND		ND		ND		ND		ND		ND	
Acetone													ND		ND	
Aluminum													8410	H	1350	C
Anthracene	ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic													8.8	H	7	
Barium													59.8		37.9	C
Benz[a]anthracene	ND		ND		ND		ND		ND		ND		0.1		ND	
Benzo[a]pyrene	ND		ND		ND		ND		ND		ND		0.067	H	ND	
Benzo[b]fluoranthene	ND		ND		ND		ND		ND		ND		0.15		ND	
Benzo[g,h,i]perylene	ND		ND		ND		ND		ND		ND		ND		ND	
Benzo[k]fluoranthene	ND		ND		ND		ND		ND		ND		0.071		ND	
Beryllium													0.24		ND	
Bis(2-ethylhexyl)phthalate	ND		ND		ND		ND		ND		ND		0.045		ND	
Boron																
Butyl benzyl phthalate	ND		ND		ND		ND		ND		ND		ND		ND	
Calcium													93300	B	21800	C
Chloroform													ND		ND	
Chromium													10.1		ND	
Chrysene	ND		ND		ND		ND		ND		ND		0.12		ND	
Cobalt													5.6		ND	
Copper													10.7		ND	
Dibenz[ah]anthracene	ND		ND		ND		ND		ND		ND		ND		ND	
Fluoranthene	ND		ND		ND		ND		ND		ND		0.24		ND	
Indeno[1,2,3-cd]pyrene	ND		ND		ND		ND		ND		ND		0.055		ND	
Iron													13600	H	1480	C
Lead													11.4		ND	
Magnesium													9180	B	5260	C
Manganese													495	H	276	
Mercury													0.12		ND	
Methyl ethyl ketone													0.004		ND	
Methylene chloride													ND		ND	
Nickel													7		ND	
N-Nitroso di-n-propylamine	ND		ND		ND		ND		ND		ND		0.35	H	ND	
Phenanthrene	ND		ND		ND		ND		ND		ND		0.1		ND	
Potassium													451		3280	C
Pyrene	ND		ND		ND		ND		ND		ND		0.14		ND	
Selenium													1.3	B	ND	
Silver													ND		ND	
Sodium													81.3		7850	C
Thallium													ND		ND	
Titanium																
Trichloroethylene (TCE)													ND		5	
Vanadium													21.3		3.4	
Zinc													187	B	ND	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates exceedance of at least one screening criterion.

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mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
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TABLE 3-6
ANALYTICAL DATA SCREENING FOR
SITE 10 - WATERWORKS NORTH DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1996 Phase II)		WCC (1996 Phase II)	
Sample ID	COSW21002		COSW21003	
Matrix (soil & sediment values shown in mg/kg surface water values in ug/L)	Surface Water	*R. Code*	Surface Water	*R. Code*
Depth (feet)	NA		NA	
CONSTITUENT				
1,2-Dichloroethene	23		ND	
2,4-Dimethylphenol	ND		ND	
2-Methylnaphthalene	ND		ND	
Acenaphthylene	ND		ND	
Acetone	ND		ND	
Aluminum	1570	C	1480	C
Anthracene	ND		ND	
Arsenic	6.3		5.1	
Barium	52.3	C	38.2	C
Benz[a]anthracene	ND		ND	
Benzo[a]pyrene	ND		ND	
Benzo[b]fluoranthene	ND		ND	
Benzo[g,h,i]perylene	ND		ND	
Benzo[k]fluoranthene	ND		ND	
Beryllium	ND		ND	
Bis(2-ethylhexyl)phthalate	ND		ND	
Boron				
Butyl benzyl phthalate	ND		ND	
Calcium	36500	C	21800	C
Chloroform	4		ND	
Chromium	ND		ND	
Chrysene	ND		ND	
Cobalt	ND		ND	
Copper	ND		ND	
Dibenz[ah]anthracene	ND		ND	
Fluoranthene	ND		ND	
Indeno[1,2,3-cd]pyrene	ND		ND	
Iron	1650	C	1530	C
Lead	ND		ND	
Magnesium	9750	C	5280	C
Manganese	160		287	
Mercury	ND		ND	
Methyl ethyl ketone	ND		ND	
Methylene chloride	ND		ND	
Nickel	ND		ND	
N-Nitroso di-n-propylamine	ND		ND	
Phenanthrene	ND		ND	
Potassium	4840	C	3390	C
Pyrene	ND		ND	
Selenium	ND		ND	
Silver	ND		ND	
Sodium	36100	C	8760	C
Thallium	ND		ND	
Titanium				
Trichloroethylene (TCE)	46	I	5	
Vanadium	3.5		2.3	
Zinc	ND		ND	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
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For data qualifiers, refer to source reports

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G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
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I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 3-7
ANALYTICAL DATA SCREENING FOR
SITE 11 - P AREA SOUTHEAST DRAINAGE CHANNEL
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		WCC (1993 Ph I)		WCC (1993 Ph I)	
Sample ID	11-1-2-1		11-2-3-1		11-2-3-6		COSO1101		COSO1102	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Surface Water	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Soil	*R. Code*	Soil	*R. Code*
Depth (feet)	NA		0-1		0-1		1.7-1.9		1.3	
CONSTITUENT										
1,1-Dichloroethylene	ND		ND		0.014				ND	
2-Methylnaphthalene					0.004		ND			
Acetone									0.28	
Aluminum	ND		11200	H			12400	H		
Arsenic	--		--				15	A H		
Barium	44	C	91.1				130			
Benzyl alcohol					0.008					
Beryllium	--		--		--		1	A		
Boron	50		45							
Bromodichloromethane	3		ND		ND				ND	
Cadmium	--		--		--		0.73	A		
Calcium	44100	C	3220	B			2200			
Carbon disulfide					0.003				ND	
Chlorobenzene	ND		ND		0.002				ND	
Chloroform	31		ND		0.006				ND	
Chromium	ND		20	B			20			
Cobalt	ND		10	B			9.9			
Copper	--		--		--		16	A		
HMX	8		ND				ND			
Iron	ND		20400	H			26000	A H		
Lead	--		--		--		12.3			
Magnesium	10600	C	1550				1800	A		
Manganese	95		986	H			420	H		
Nickel	--		--		--		11.8			
Potassium							659	A		
Silver	--		--		--		1.6	A		
Sodium	18300	C	100		240		710	A		
Thallium							0.33			
Titanium	ND		104							
Toluene	ND		ND		0.002				ND	
Vanadium	ND		37	B			43			
Zinc	--		--		--		71	A		

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend

mg/kg = milligrams per kilogram, ug/L = micrograms per Liter

-- = Analyzed but not shown (see Note included in Source (1), below)

ND = Not detected

For data qualifiers, refer to source reports.

Blank results indicate no analyses for that compound in that sample.

NA = Not Applicable

Sources:

(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable, all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.

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Reference Codes:

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G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
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I - Illinois General Use Water Quality Standards - Created for the AUS OU. CONWR

TABLE 3-8. ANALYTICAL DATA SCREENING FOR
SITE 11A - P AREA NORTH, MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		WCC (1993 Ph I)		WCC (1993 Ph I)		WCC (1993 Ph I)		WCC (1993 Ph I)	
Sample ID	11A-1-3-1		11A-2-3-1		11A-3-3-1		11A-3-3-6		11A-4-3-1		11A-5-1-1		11A-6-1-1		11A-7-1-1		11A-8-1-1		COSO11A01/5		COSO11A02/6		COSO11A03/7		COSO11A04/8	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code
Depth (feet)	0-1		0-1		0-1		0-1		0-1		0-1		0-1		0-1		0-1		1.5-1.6/1.7		1.7-1.8/1.7		1.7-1.8/1.7		1.7-1.8/1.8	
CONSTITUENT																										
1,1,2-Trichloroethane	ND		ND		ND		0.019		ND		ND		ND		ND		ND		ND		ND		ND		ND	
2,4,6-Trinitrotoluene	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND		ND		0.38		ND	
2-Methylnaphthalene							0.003												ND		ND		ND		ND	
2-Methylphenol (o-Cresol)							0.004												ND		ND		ND		ND	
Acetone							0.43												ND		ND		ND		0.052	
Aluminum	21800	B H	23200	B H	16800	B H			15700		9780	H	15100	H	9640	H	11600	H	12100	H	10800	H	16000	H	9400	H
Antimony	ND		ND		11	B H			ND		ND		ND		ND		ND		ND		ND		ND		ND	
Aroclor 1254	ND		ND		0.892	H	ND		0.279		ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	--		--		--		--		--		--		--		--		--		7.2	H	6	H	5.9	H	7.4	H
Barium	127		123		135				102		66.5		109		72.9		96.5		88		190		108		180	
Boron	8.4		8.4		7.4				3		14	A	4.4		16	A	14	A								
Bromoform	ND		ND		ND		0.007		ND		ND		ND		ND		ND				ND					
Butyl benzyl phthalate							0.049																			
Calcium	1200		2930	B	2860	B			1610		44200	A	2140		50500	A			26000	A	2000		1600		2300	
Chloroform	ND		ND		ND		0.004		ND		ND		ND		ND		ND				ND					
Chromium	25	B	26	B	20	B			18		10		19		10		17		15		16		20		14.2	
Cobalt	7		6		9				10		10		10		3		6		8.6		12.4		7.1		9.5	
Copper	--		--		--		--		--		--		--		--		--		15	A	19	A	18	A	12.6	A
Di-n-butyl phthalate							0.024																			
Heptachlor epoxide	ND		ND				ND		ND		ND		ND		ND		ND		0.0044		ND		ND		ND	
Iron	26400	B H	27100	B H	22200	B H			21800		12600	H	22500	A H	11700	H	36200	A H	20000	A H	20000	A H	22000	A H	15000	H
Lead	--		--		--		--		--		--		--		--		--		16		10.2		12		12.7	
Magnesium	3610	B	3910	B	2930	B			2410		26900	A	2740	A	29900	A	15100	A	17000	A	2600	A	2600	A	1800	A
Manganese	314	H	428	H	1180	B H			852		567	H	733	H	639	H	939	H	690	H	580	H	320	H	610	H
Mercury	--		--		--		--		--		--		--		--		--		0.02		ND		0.02		0.04	
Methyl ethyl ketone	--		--		--		--		--		--		--		--		--		ND		ND		0.004		0.014	
Methylene chloride	ND		ND		ND		0.027		ND		ND		ND		ND		ND		0.007		ND		ND		0.017	
Nickel	--		--		--		--		--		--		--		--		--		11		15		11.2		8.8	
Phenol							0.028												ND		ND		ND		ND	
Potassium																			740	A	600		720	A	610	
Silver	--		--		--		--		--		--		--		--		--		1.8	A	1.08	A	1.09	A	0.86	A
Sodium	110		89		80		324		60		100		70		110		87		67		140		72		64	
Thallium																			0.55	A H	0.54	A H	0.56	A H	0.36	
Titanium	430		370		388				249		192		251		136		261									
Vanadium	54	B	53	B	46	B			42		23		38		22		29		27		22		24		26	
Zinc	--		--		--		--		--		--		--		--		--		45		59	A	51		115	A

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
ND = Not detected
For data qualifiers, refer to source reports.
Blank results indicate no analyses for that constituent in that sample.
NA = Not Applicable
Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report. Crab Orchard National Wildlife Refuge , August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge , February.

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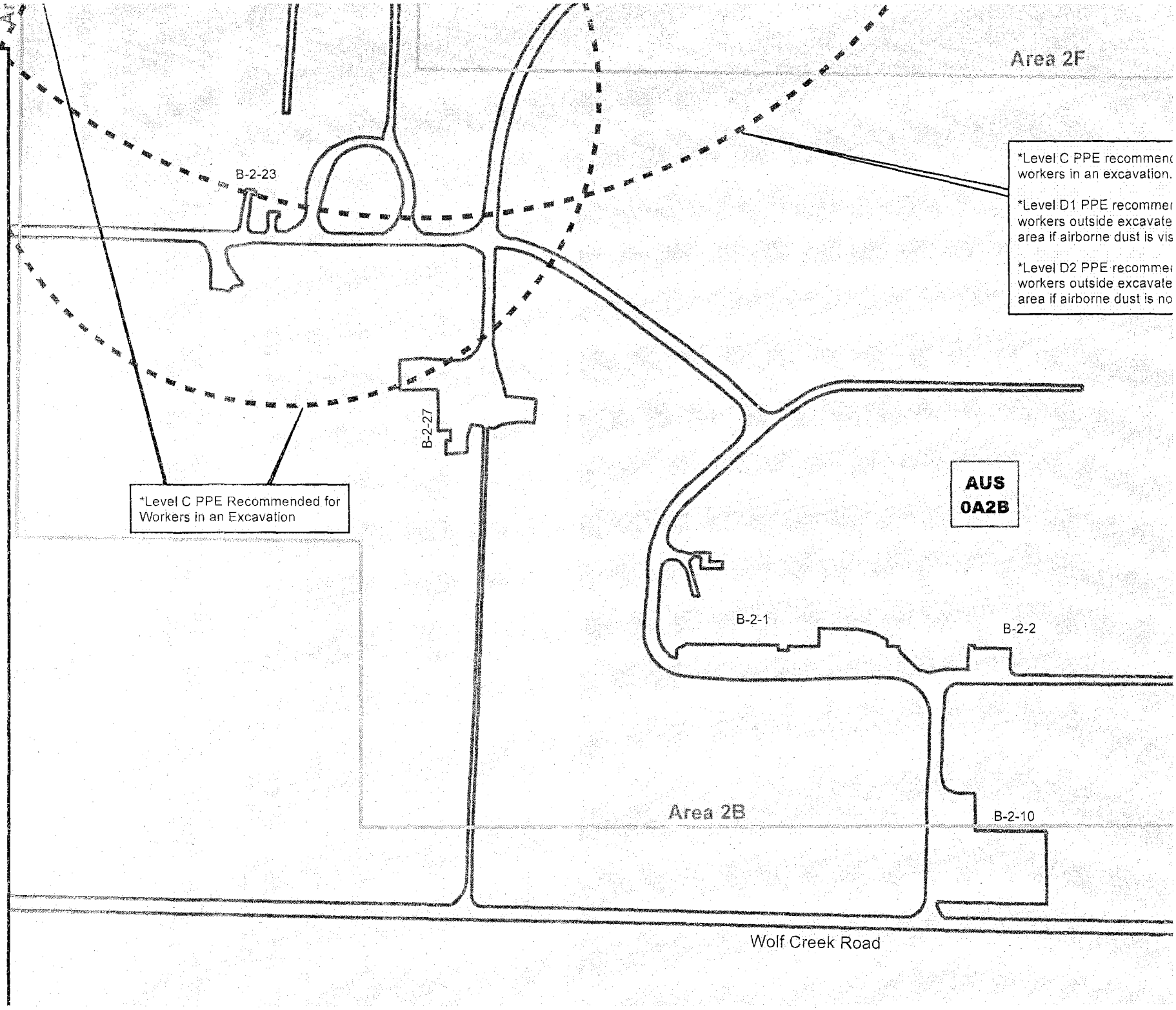

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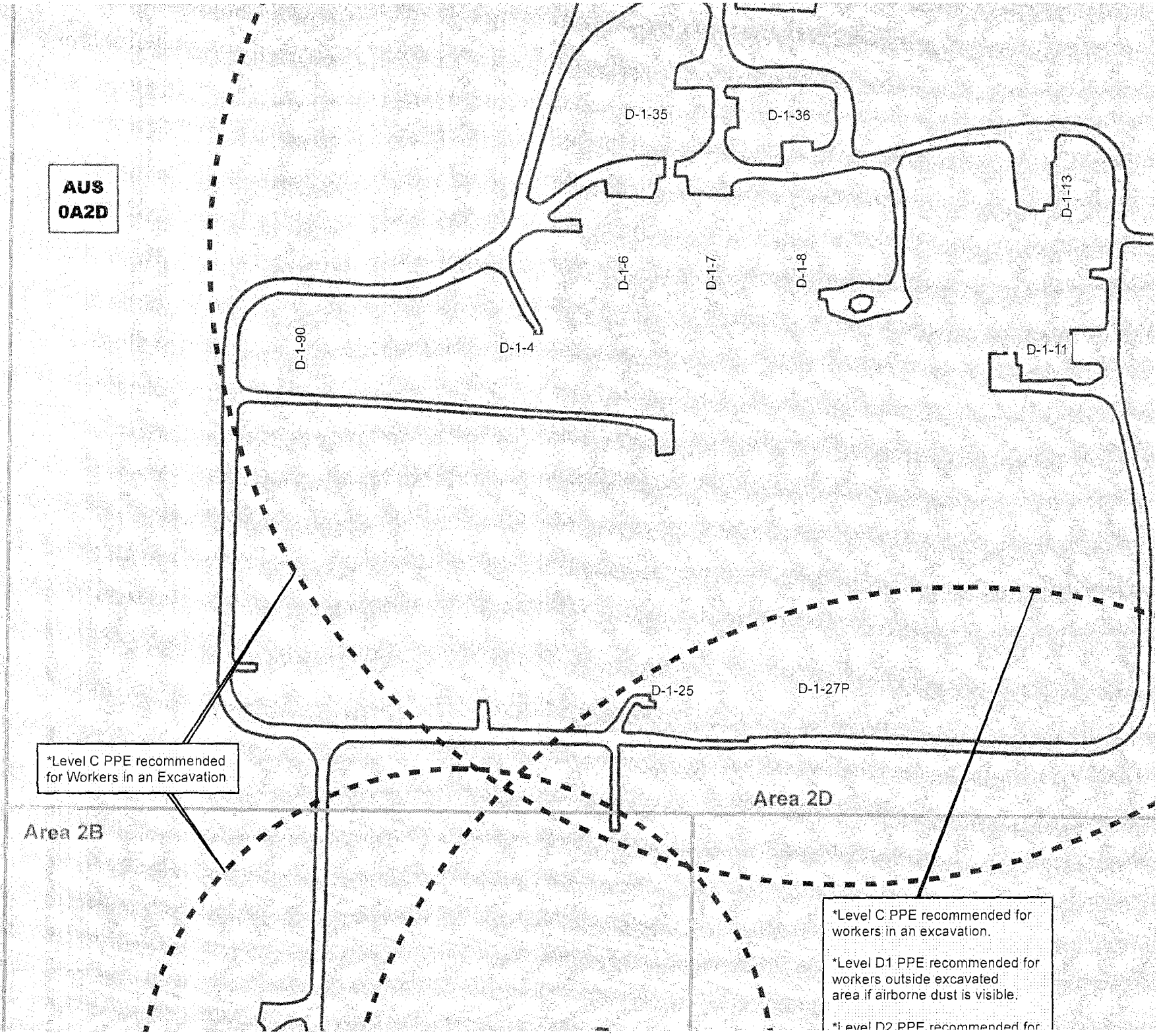

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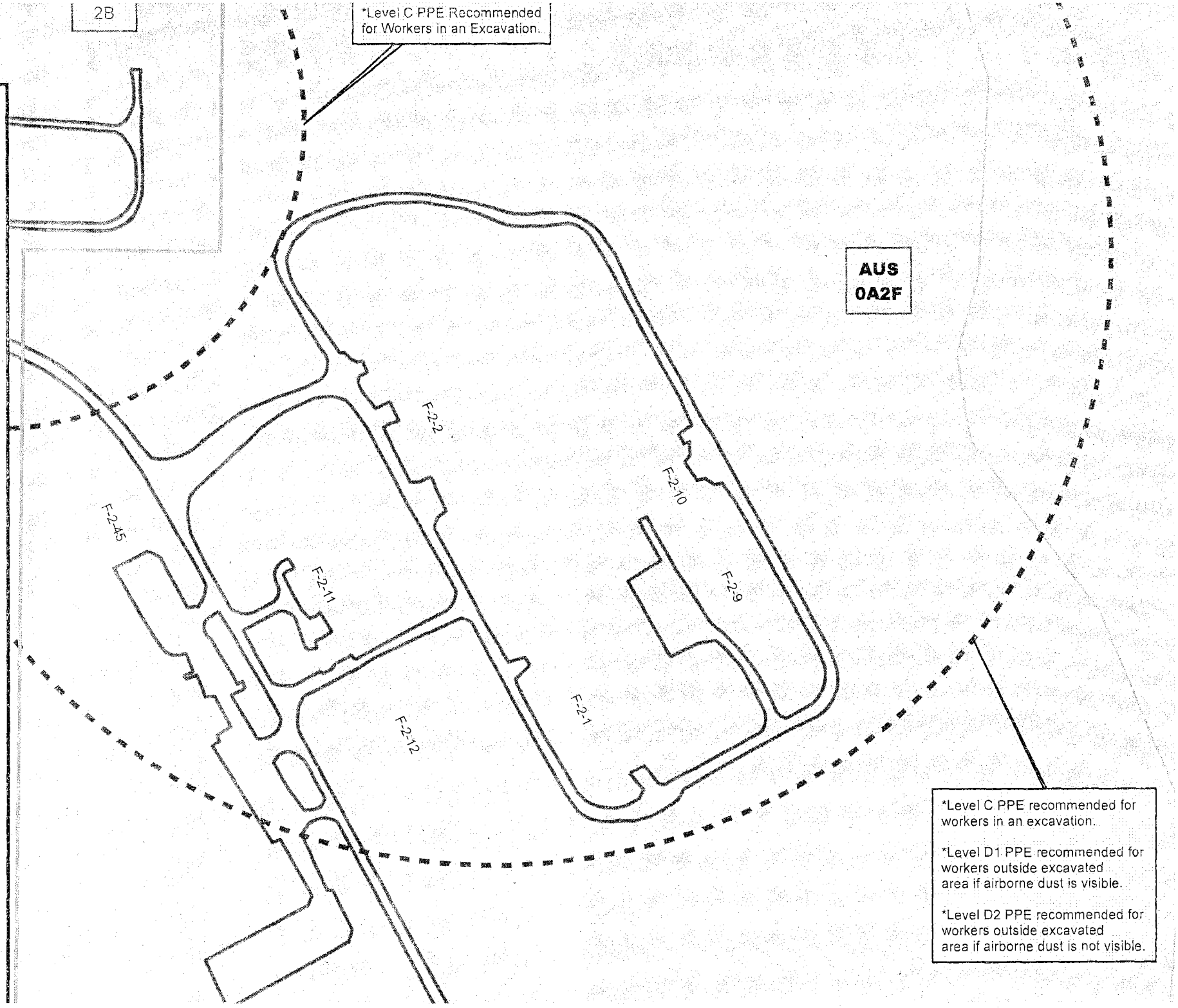

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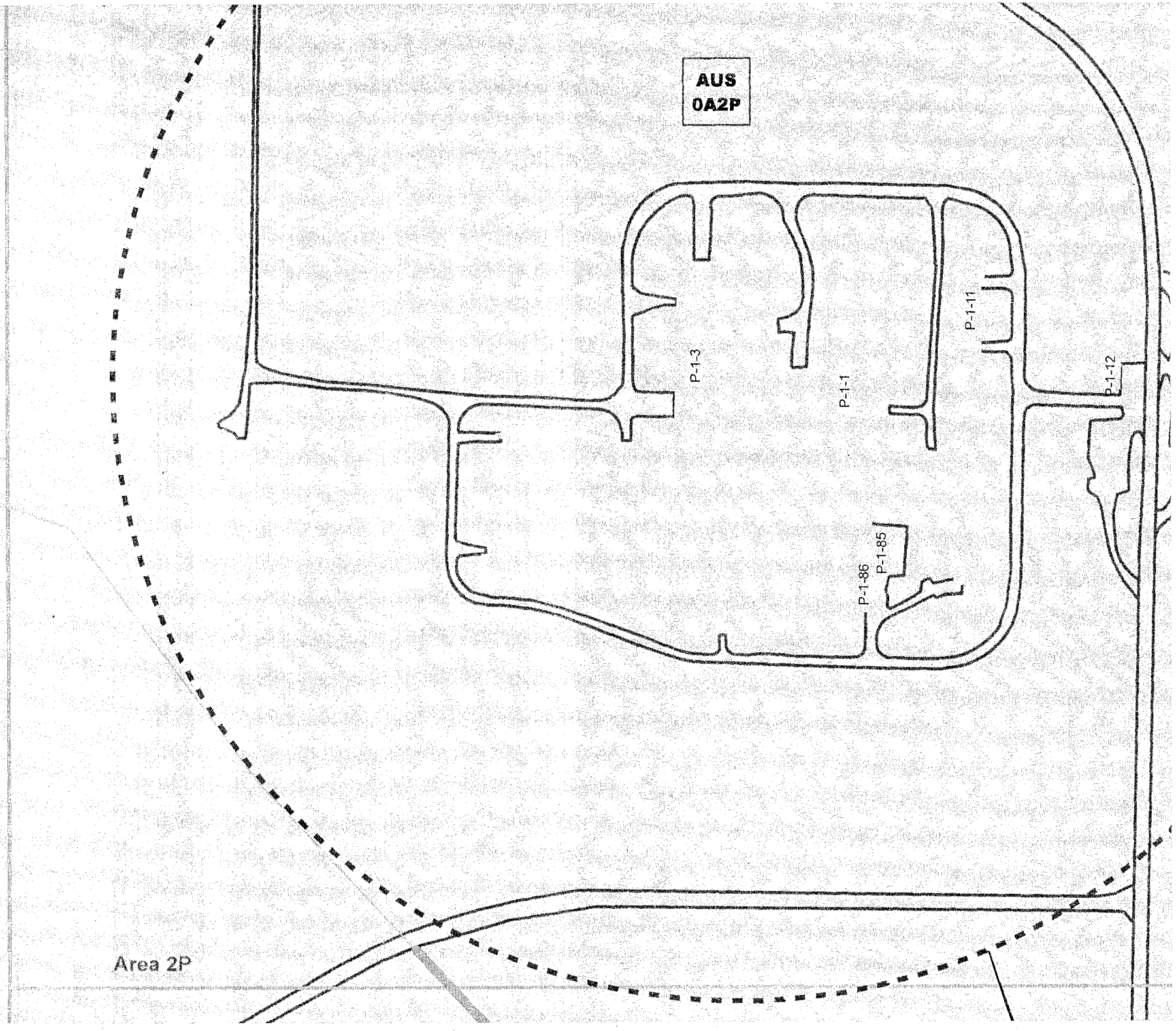

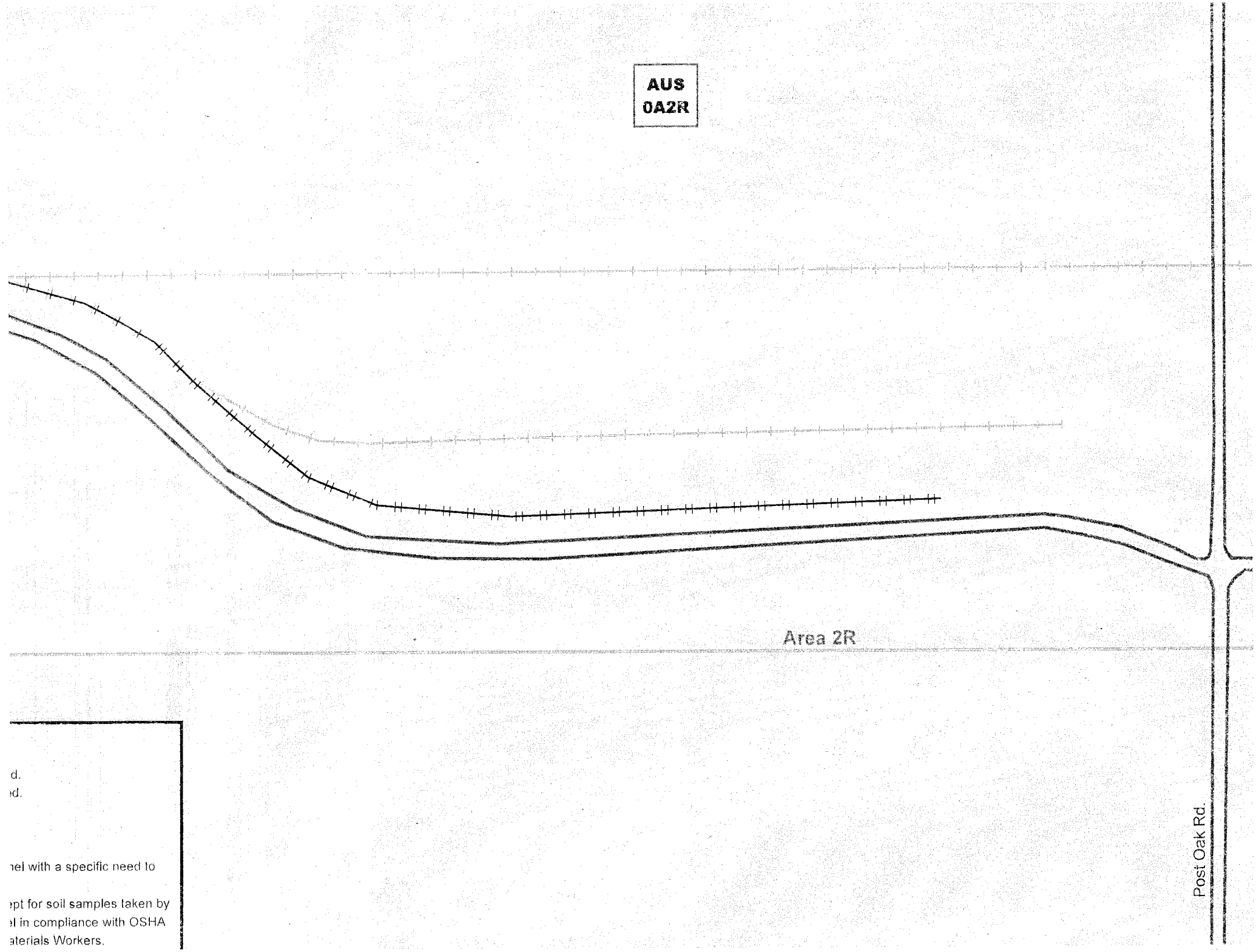

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4.1 AREA 3

Area 3 is the former IOP Finished Ammunition Group I Area – a warehouse area used for storage of finished ammunition **(Figures 1-7 and 4-1).** Since World War II, it has been used by tenants for storage. No chemical data and little historic use data are available for the site. It is currently being investigated as part of the AUS OU RI conducted by General Dynamics Ordnance and Tactical Systems.

4.1.1 LUCIP for AUS-0A03 – IOP Finished Ammunition Group I Area (AUS OU)

4.1.1.1 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

4.1.1.2 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, no soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers (**Figure 4-1**). Additionally, soil from this site should not be used for borrow material.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

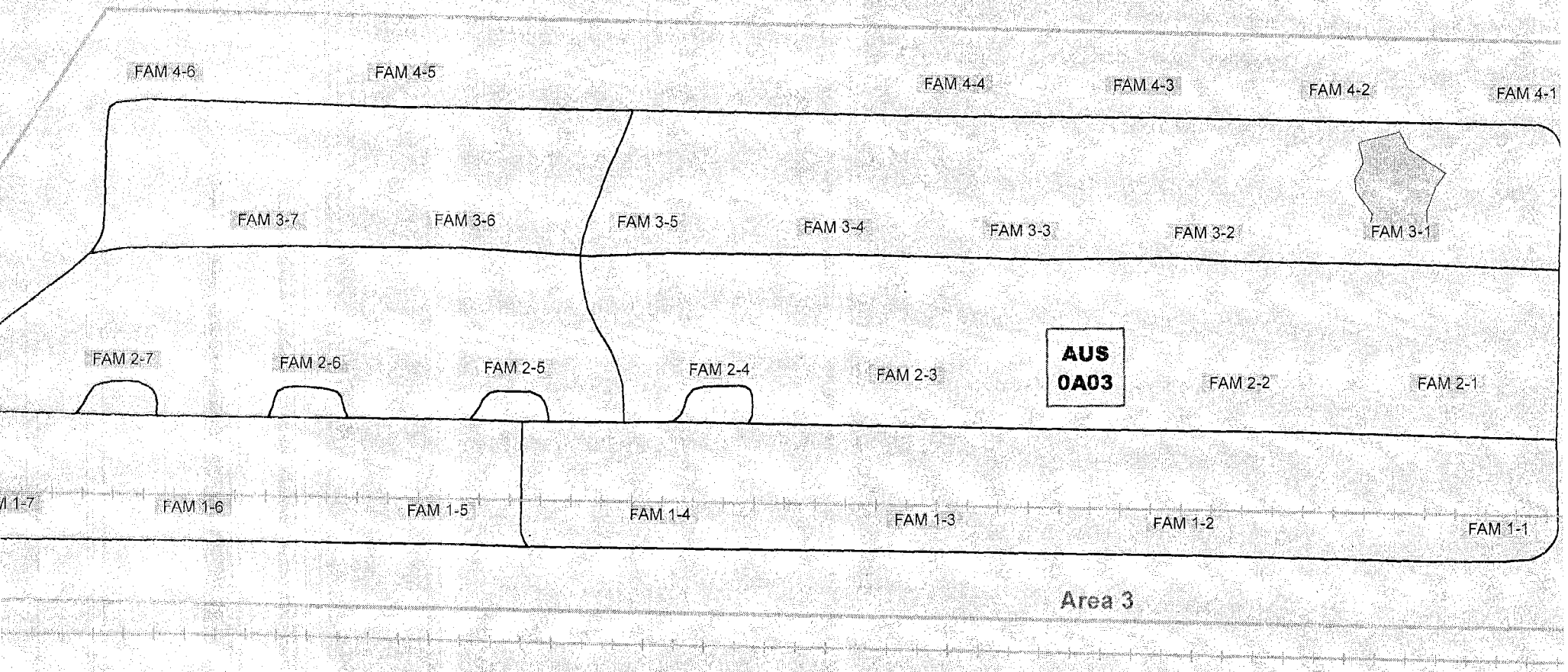
4.1.1.3 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

4.1.1.4 Applicable Decision Document

There is not yet a decision document for this site.



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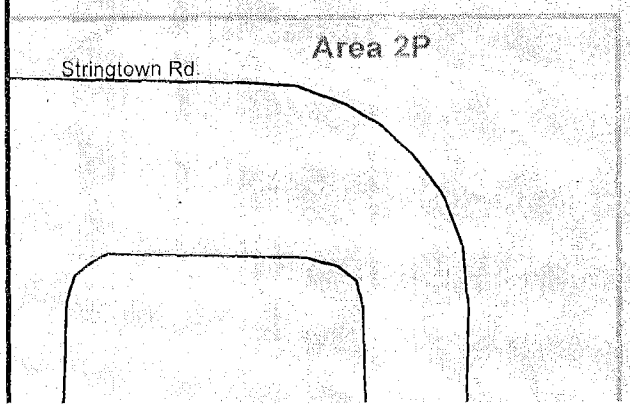

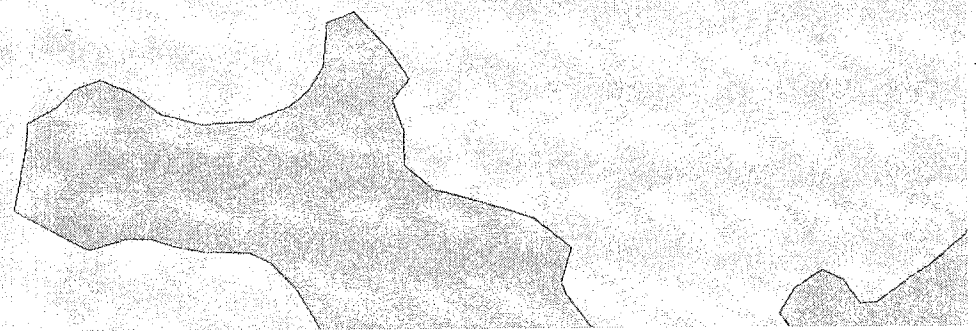

5.1 AREA 4

Area 4, the IOP Shop Area, is north of Crab Orchard Lake on both sides of Highway 148 (**Figures 1-7 and 5-1**). This was an IOP support area, with machine shop, electrical and communication facility, diesel repair shop, automotive repair shop, laboratory, and similar facilities. The buildings have since been used by various tenants.

5.1.1 LUCIP for AUS-0A4E – East Shop Area (AUS OU)

AUS-0A4E (Area 4 East) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values. See **Figure 5-1** for location.

5.1.1.1 Site Description and Investigation Results

Site Description

Area 4 East was originally built as an automotive shop to support IOP operations. Only two of the six original buildings remain. Since World War II, the area has been used by various tenants for purposes such as manufacturing and storage.

Operational History and Waste Characteristics

During World War II, this area was used for maintenance of the IOP truck pool and heavy equipment. All automotive shop buildings begin with the designation "S-4"; they include a wash and grease house, a gas station, a garage, and buildings for the storage of oil and auto parts. Another building, S-3-4, was used to pump fuel to the West Shop Area.

Tenant uses of the buildings varied from manufacturing wrought iron items (Southern Metal Arts Company), latex rolls (Midwest Brush), and crates and cartons (Dura Crates, Inc.). Area 4 East was also used for refurbishing mining equipment (Electric & Machine Company) and likely for vehicle maintenance (Southern Illinois University). Schilli Transportation used a building Area 4 East as a service garage. Other tenants included Diagraph Corporation, GTE, Mark Twain Marine Industries, McBride Trucking, Shamrock Boat Manufacturing, Trojan Powder/Ensign Bickford Industries, and Primex Technologies.

There was debris, mostly automotive related, scattered throughout the wooded parts of the site, including an area of empty, abandoned drums along a drainageway.

Site Investigation

The SI included soil, groundwater, and surface water samples.

Notable Contamination Found

Exceedances of screening criteria at this site were mostly relatively small. Detections of ethylbenzene and xylenes in the soil near the former IOP gas station exceeded SI screening criteria. Among the SVOCs, methylnaphthalene, dibenzofuran, two phthalates and 12 PAHs in soils exceeded SI screening criteria. SI soil screening criteria was exceeded for most inorganics, although, except for copper which was detected at 816 mg/kg *(background = 11 mg/kg)* the exceedances were small.

5.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

5.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access should be limited to personnel who need to use the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Refer to **Figure 5-1**. Agricultural use is prohibited at this site.

This LUCIP will be re-evaluated as RI data are obtained.

5.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

5.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

5.1.2 LUCIP for AUS-0A4W – West Shop Area (AUS OU)

AUS-0A4W (Area 4 West) is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values. See **Figure 5-1** for location.

5.1.2.1 Site Description and Investigation Results

Site Description

Area 4 West, located west of Highway 148, originally housed buildings that supported IOP infrastructure and operation. All of the buildings started with the prefixes "S-1," "S-2" or "S-3, " and are arranged in three north-south oriented rows. Some buildings are no longer on site.

Operational History and Waste Characteristics

IOP buildings included a laundry, a locomotive repair building, a tool and gage shop, a laboratory, a machine shop, a piping and plumbing shop, a boiler house, and a light equipment repair building.

After the end of World War II, several of the buildings were leased by businesses including furniture, transformer, and coder cartridge manufacturers; printers; lumber suppliers; and publishers. There were also two plating operations, Supreme Plating Company and Herrin Plating. Under the directive of the Illinois Environmental Protection Agency, Supreme Plating cleaned and emptied an underground tank that contained liquid waste from its operation. Part of this area was also remediated under the Metals Areas Operable Unit (MAOU).

GDO&TS is the major current tenant in Area 4 West.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

SVOCs that exceeded SI soil screening criteria included methylnaphthalene, dibenzofuran, carbazole, two phthalates, and nine PAHs; exceedances were generally small.

Most inorganic constituents were detected at levels exceeding SI screening criteria, including arsenic at 60 mg/kg, cadmium at 4,520 mg/kg, chromium at 298 mg/kg, and zinc at 780 mg/kg.

Later investigations found relatively high levels of cadmium in dust samples taken from Building S-2-5, which was being used for storage. FWS's contractor recommended that workers in the building monitor the dust and use respiratory protection.[30]

5.1.2.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. A specific objective for this site is to limit exposure to the remaining contamination from plating activities that occurred in Building S-2-4 (demolished, with building debris buried on site) and Building S-2-5 (existing and recently used by tenants for storage). As with all sites under investigation in the RI, access should be limited to personnel who need to use the site, to prevent potential exposure. Additionally, any proposed activities at or near these two buildings must be coordinated closely with Refuge CERCLA staff. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

5.1.2.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access should be limited to personnel who need to use the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material and agricultural use is prohibited. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts.

Access to Building S-2-5 is restricted to personnel who are OSHA-trained and certified, as noted above. Workers in building S-2-5 should wear respiratory protection, in conjunction with dust monitoring, to insure that OSHA levels are not exceeded. All OHSA-trained personnel should have received instructions in selection of appropriate respirators and cartridges.

Any proposed activities at or near Buildings S-2-4 and S-2-5 must be coordinated closely with Refuge CERCLA staff. Lawn mowing is prohibited in the area around Buildings S-2-4 and S-2-5 (**Figure 5-1**). Warning signs have been placed in the area.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 5-1**.

This LUCIP will be re-evaluated as RI data are obtained.

[30] Letter from URS Corporation to U.S. Fish and Wildlife Service, regarding Worker Respiratory Protection in Building S-2-5, September 26, 2002.

5.1.2.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Remediation of the cadmium contamination at and in the vicinity of former Buildings S-2-4 and existing Building S-2-5 will be needed before the LUC can be removed. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

5.1.2.5 Applicable Decision Document

There is not yet a decision document for this site.

5.1.3 LUCIP for Site 22A – Former Post Treating Facility (MISCA OU)

5.1.3.1 Site Description

Site 22A is a potential former post-treating facility with dioxin and pentachlorophenol contaminated soil. In 1996, the Department of the Interior/Fish and Wildlife Service (DOI/FWS) conducted a removal action at Site 22A. Site 22A is located adjacent to the former Refuge shop and maintenance yard in Area 4 West (**Figure 1-4**).

The following table is from the ROD which includes Site 22A.[31] The tabulated concentrations are those remaining after the remedy was complete.

Summary of Maximum Detections of Contaminants of Concern in Soil at Site 22A			
Contaminant	**Maximum Original Concentration, mg/kg**	**Maximum Concentration after Removal Action, mg/kg**	**USEPA Region 9 PRG for Residential Soil, mg/kg**
Pentachlorophenol	26	4.6 (8.5 to 9.5 ft depth)	3.0
Dioxins and furans (TCDD TEQs)	3,800E-6	81E-6	3.9E-6
DDT	0.038	0.023	1.7
DDE	0.042	0.027	1.7
DDD	0.012	0.004	2.4
PCBs	0.140	0.140	0.22
Mercury	0.26	<0.12	23
Selenium	2.3	<2	390
Zinc	119	81	23,000

The ROD states:

> Only TCDD TEQs and one pentachlorophenol detection exceeded the Region 9 residential PRGs. However, the maximum TCDD TEQ was below USEPA's current cleanup goal for TCDD TEQ of one part per billion. For pentachlorophenol, the reasonable maximum exposure (RME) for this site is below the Region 9 PRG. Of 29 samples originally analyzed for pentachlorophenol at Site 22A, 18 represent soil that was excavated and disposed as part of the removal action. Of the 11 samples from soil that was outside the excavated area, 9 were non-detect for pentachlorophenol, one had a detection of 0.054 mg/kg, and one had a detection of 4.6 mg/kg, from the depth interval 8.5 to 9.5 feet below the ground surface. This area was backfilled with clean soil to the ground surface.

[31] USFWS, April 2002. Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois, Page 61 of the Decision Summary.

Based on the human health risk assessment, comparison to Region 9 Residential PRGs, and the current USEPA cleanup goals for dioxin, Site 22A was determined to require no further action for protection of human health.

5.1.3.2 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives (Section 2) are needed.

5.1.3.3 LUC(s) Implemented to Achieve Objective

No additional LUC beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

5.1.3.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

5.1.3.5 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002).

5.1.4 LUCIP for Site 22 – Old Refuge Shop Channel (MAOU)

5.1.4.1 Site Description and Investigation Results

Site 22 was a drainageway leading away from Area 4 West that was contaminated with cadmium, lead, chromium and cyanide (**Figure 1-3**). It was required to be remediated to 10 mg/kg for cadmium, but the ROD (1990) did not specify numeric values for cleanup for the other constituents. Remediation was completed in 1996. For confirmation sampling, the level of 450 mg/kg for lead and 35 mg/kg for chromium were used. Cyanide was rarely detected in confirmation samples, and when it was the concentration was near the detection limit.[32] Groundwater concentrations in excess of federal maximum concentration limits were detected, but the groundwater was not included in the remedy.

5.1.4.2 LUCIP Objective

No objectives besides the IOP-wide objectives (Section 2) are needed.

5.1.4.3 LUC(s) Implemented to Achieve Objective

No LUCs other than the IOP-wide LUCs are needed, except that soil from this site should not used for borrow material.

5.1.4.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

5.1.4.5 Applicable Decision Document

The applicable decision document is the MAOU ROD.[33]

[32] U.S. Fish and Wildlife Service, November 1997. Closeout Report for the Metals Areas Operable Unit, Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois (Williamson County).
[33] USEPA, Region V, *Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, Metals Areas Operable Unit*, March 30, 1990.

5.1.5 LUCIP for Site 29 - Fire Station Landfill (MAOU)

5.1.5.1 Site Description and Investigation Results

Site 29 was a landfill near Area 4 East, with lead as the primary contaminant (**Figure 1-3**). During the remediation, which was completed in 1996, all landfilled materials were removed, down to natural soil. The cleanup objective of 450 mg/kg for lead was achieved.[34] Groundwater concentrations in excess of federal maximum concentration limits were detected, but the groundwater was not included in the remedy.

5.1.5.2 LUCIP Objective

No objectives besides the IOP-wide objectives (Section 2) are needed.

5.1.5.3 LUC(s) Implemented to Achieve Objective

No LUCs other than the IOP-wide LUCs are needed, except that soil from this site should not used for borrow material.

5.1.5.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

5.1.5.5 Applicable Decision Document

The applicable decision document is the MAOU ROD. [35]

[34] U.S. Fish and Wildlife Service, November 1997. Closeout Report for the Metals Areas Operable Unit, Crab Orchard National Wildlife Refuge Superfund Site, Marino, Illinois (Williamson County).
[35] USEPA, Region V, *Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, Metals Areas Operable Unit*, March 30, 1990.

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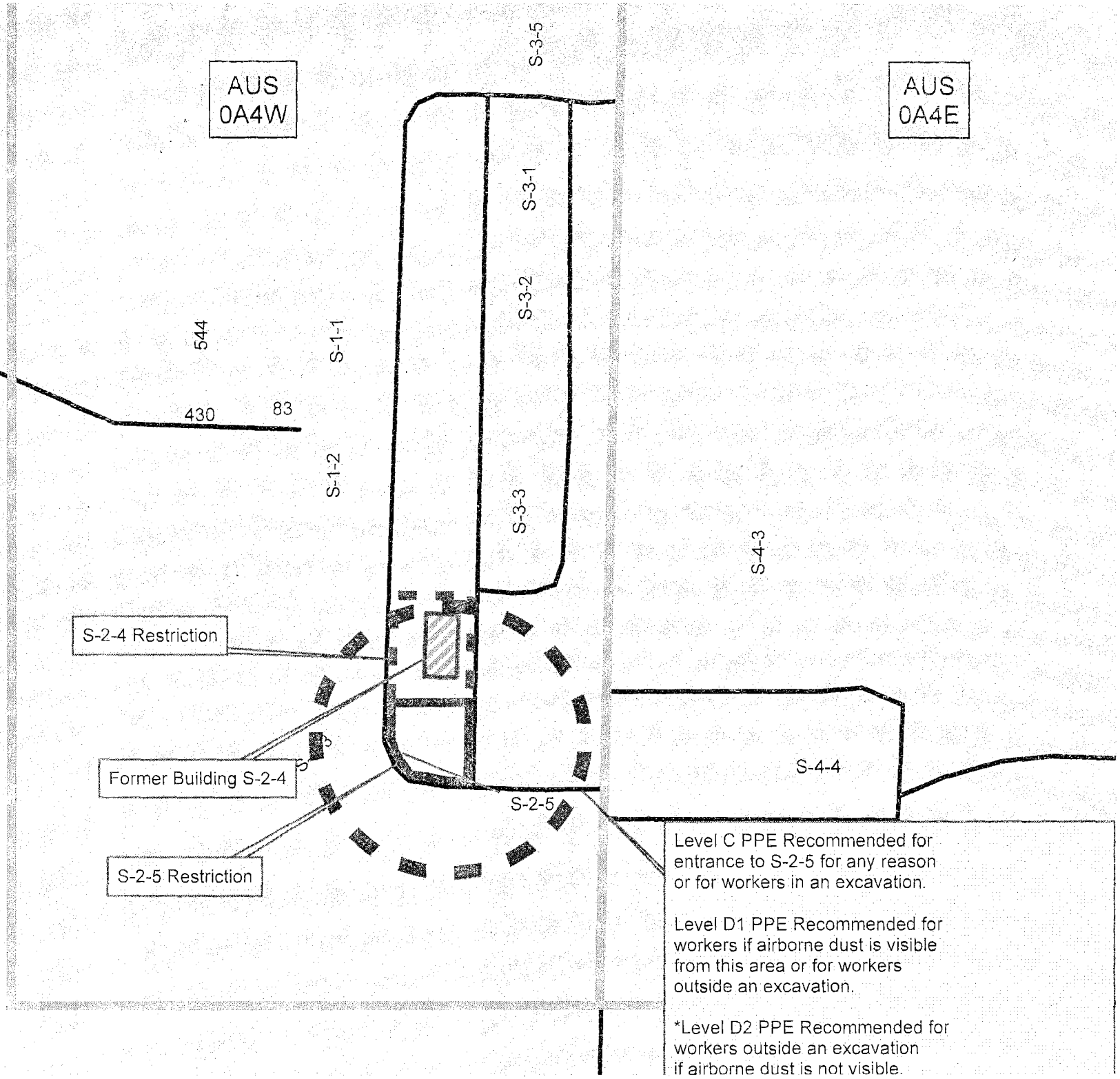


6.1 AREA 5

Area 5, the former IOP Railroad Classification Yard, is located at the southeast corner of the intersection of Old Highway 13 and Route 148 (**Figures 1-7 and 6-1**). The building has been used over the years by tenants, primarily for office space.

6.1.1 LUCIP for AUS-0018 – Railroad Classification Yard (AUS OU)

AUS-0018 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

6.1.1.1 Site Description and Investigation Results

Site Description

AUS-0018, the former IOP Railroad Classification Yard, is located at the southeast corner of the intersection of Old Highway 13 and Route 148 (**Figure 6-1**). Based on IOP drawings, there were numerous sets of railroad tracks and four buildings, all prefixed with "Y-1."

At the time of the site reconnaissance in the spring of 1999, all the tracks had been removed and only building remaining on site was the IOP Station Ordill & Yard Office. This building has since been removed.

Operational History and Waste Characteristics

This train-sorting facility was originally constructed and operated by SWDC/War Department as a part of the IOP and it had a 200-car capacity.

Larger tenants in this area included Olin and Trojan/U.S. Powder/Commercial Solvents Corporation.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

Inorganics in soil that exceeded SI screening criteria are arsenic, barium, chromium, lead, and nickel.

6.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. No soil will be removed from the site, except for soil samples taken by OSHA-trained sampling personnel for the purpose of analysis. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

6.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 6-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material and agricultural use is prohibited at this site.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. These LUCs will be modified as appropriate as data are obtained in the RI.

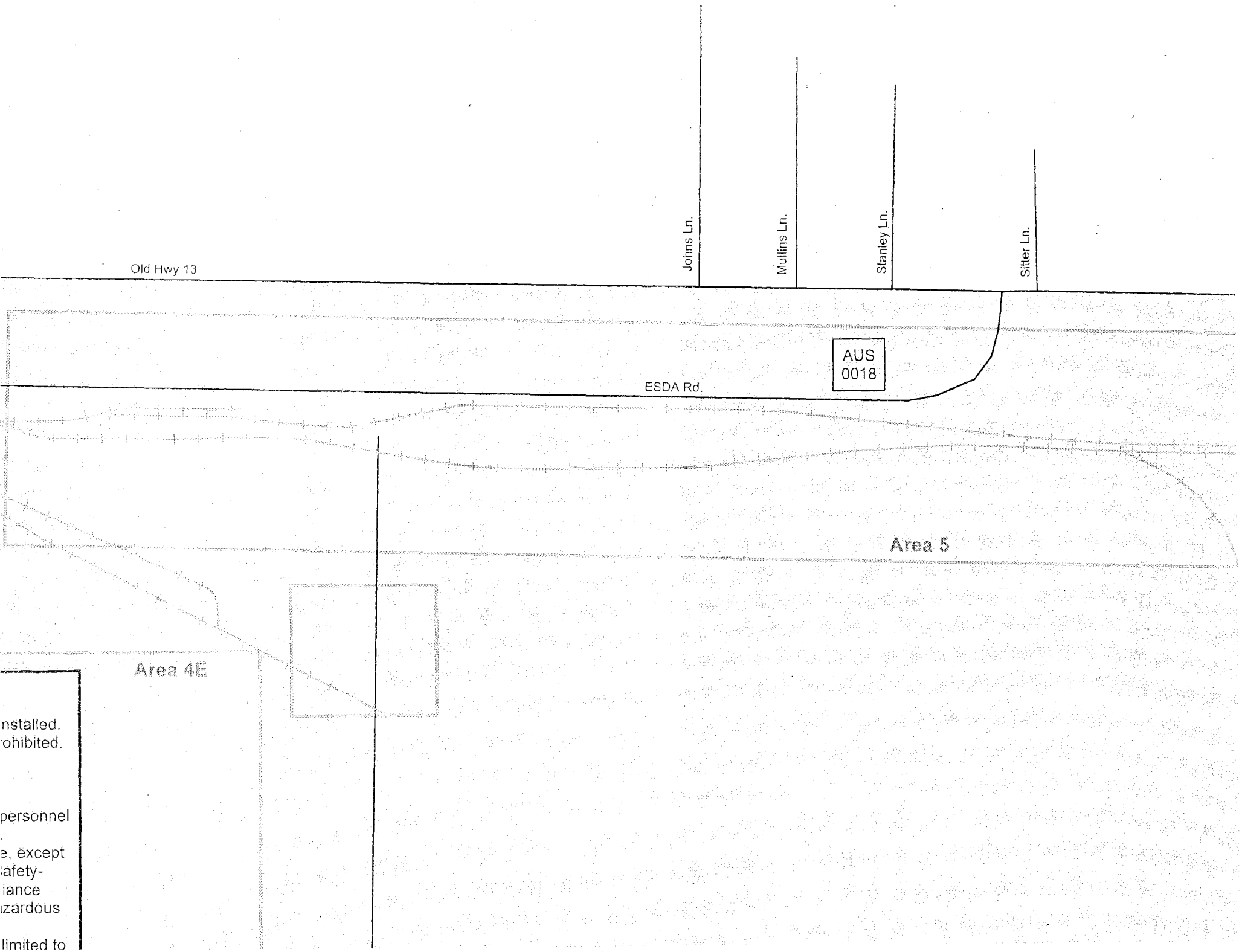
6.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

6.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.



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7.1 AREA 6

Area 6 is the former IOP Ammonium Nitrate High Explosive and Smokeless Powder Storage Area. This approximately 550-acre site is located south of Old Highway 13, in the eastern part of the Refuge (**Figures 1-7 and 7-1**). Area 6 consists of 79 explosive storage igloos in 7 rows. All of the igloos numbers are prefixed with "HE" (high explosives).

7.1.1 LUCIP for AUS-0A06 – IOP Ammonium Nitrate High Explosive & Smokeless Powder Storage Area

AUS-0A06 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

7.1.1.1 Site Description and Investigation Results

Site Description

Area 6 is the former IOP Ammonium Nitrate High Explosive and Smokeless Powder Storage Area. This approximately 550-acre site is located south of Old Highway 13, in the eastern part of the Refuge (**Figure 7-1**).

Area 6 consists of 79 explosive storage igloos in 7 rows. All of the igloos numbers are prefixed with "HE" (high explosives).

Operational History and Waste Characteristics

During the IOP era from 1942 through 1945, all of the igloos in this area were used for storage of high explosives. Tenants have since used the igloos mostly for storage of propellants and explosives. Some tenants have also stored pesticides, gunpowder, fireworks, and fertilizers.

One of the current tenants, Dooley Brothers, Inc., indicated they buried explosive materials next to Igloos HE-7-11 and HE-7-12 on two occasions.

GDO&TS and Ensign Bickford are the two major current tenants in Area 6.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

Detections of the explosive compound nitrobenzene exceeded SI soil screening criteria. It was not detected at levels at which explosion is a hazard; the issue is toxicity.

Detections of many SVOCs in soil exceeded screening criteria. N-nitroso-di-n-propylamine and n-nitrosodiphenylamine were detected at concentrations well above screening criteria. Diphenylamines are commonly used as stabilizers and antioxidants for propellants. 2-nitrodiphenylamine is a documented Olin waste product. Carbazole, a possible degradation production of diphenylamines, was also detected above SI soil screening criteria.

Four phthalates exceeded SI soil screening criteria, including di-n-octyl phthalate, a documented Olin waste product.

Fourteen PAHs exceeded screening criteria, many by a wide margin.

Pentachlorophenol, a wood preservative that has also been used as a herbicide and pesticide, was detected above SI soil screening criteria. Hexachlorobenzene, which is used in some military explosives and is a contaminant in some pesticides, was detected above SI soil screening criteria. Another pesticide ingredient, 2,4,6-trichlorophenol, was detected above SI soil screening criteria.

7.1.1.2 LUCIP Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 7-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. These LUCs will be modified as appropriate as data are obtained in the RI.

7.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access should be limited to personnel who need to use the site. Earthmoving should be limited to activities necessary for facility operation.

These LUCIPs will be re-evaluated as RI data are obtained.

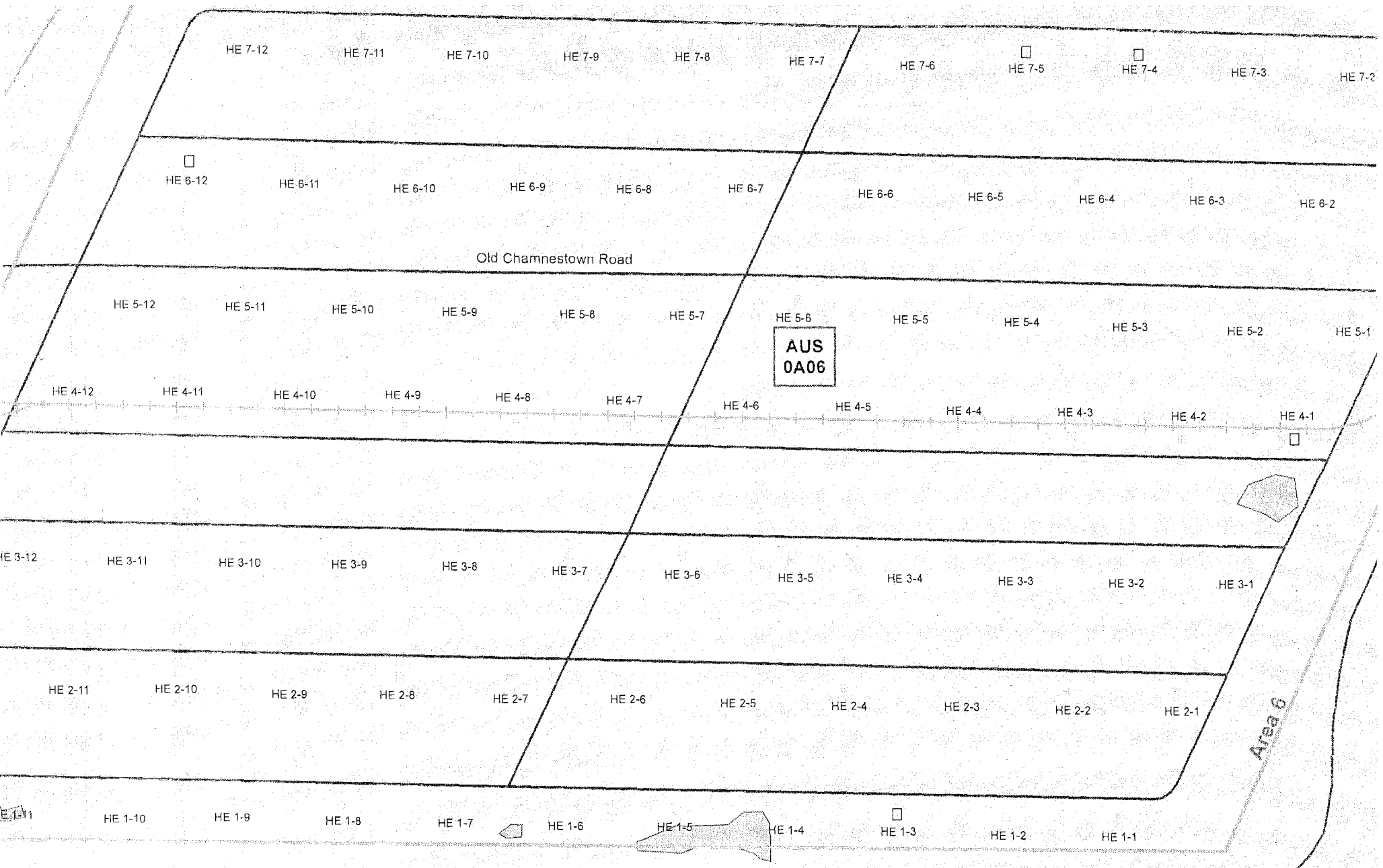
7.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

7.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.



e installed.
prohibited.

o personnel with a specific need to

8.1 AREA 7

Area 7, the IOP Inert Storage Area, is located just south of the east end of Crab Orchard Lake (**Figures 1-7 and 8-1**). It was used for warehousing metal parts and other inert materials used in ordnance production.

The original building complex consisted of 6 rows of buildings (6 to 7 buildings per row) each of which were 51 feet (ft) wide by 200 ft long. All building numbers were prefixed with "IN" (for Inert Storage). The site covers about 100 acres.

8.1.1 LUCIP for AUS-0A07 – Inert Storage (AUS OU)

AUS-0A07 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values. The site also incorporates the former Site AUS-0021, the Area 7 Fire Station.

8.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

During the IOP era, all but two of the buildings in Area 7 were used as warehouses for inert storage (**Figure 8-1**).

A succession of tenants have since leased the buildings, mostly for storage, but a few were used for manufacturing and maintenance work. Based on the information to date, the most significant areas of concern appear to the related to the Great Lakes Terminal and Transport Company's pesticide storage, Olin's short-lived metal fabrication operation, and the related operations of Helical Bit/R.A. Wilkie Machine and Plating Co.

Site Investigation

The SI included only shallow soil samples; no groundwater monitoring wells were installed.

Notable Contamination Found

TCE, a common metal degreaser, was found in the soil above the SI screening criteria at many sampling locations throughout the site. Methylene chloride was also detected above SI soil screening criteria.

Many pesticides concentrations exceeded SI screening criteria for soil in the vicinity of the former pesticide storage areas. Pesticides, with maximum soil concentrations detected include aldrin, 520 mg/kg (SI screening criterion = 0.15 mg/kg), and dieldrin, 290 mg/kg (SI screening criterion = 0.15 mg/kg). DDE, DDT, DDD, chlordane, heptachlor, and others were detected above SI screening criteria. SVOCs, PCBs, and several metals were detected above SI soil screening criteria.

Later investigations found pesticide-contaminated dust in Buildings IN-1-3, IN-1-4, IN-1-5, and IN-1-6, which had previously been used for pesticide storage.

8.1.1.2 LUCIP Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (e.g., employees of tenants, sampling crews). No soil will be removed from the site, except for soil samples taken by OSHA-trained sampling personnel for the purpose of analysis. The site will not be used for agricultural purposes.

A specific objective for this site is to limit exposure to the pesticide contamination associated with Buildings IN-1-3, IN-1-4, IN-1-5, and IN-1-6. As with all sites under investigation in the RI, access should be limited to personnel who need to use the site, to prevent potential exposure. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

8.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 8-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

As shown in **Figure 8-1**, access to immediate surroundings and inside of Buildings IN-1-3 through -6 is restricted to personnel with a specific need to be at or in these locations. Exposure should be minimized as much as practicable. Additionally, moving is prohibited around these buildings.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 8-1**.

These LUCIPs will be re-evaluated as RI data are obtained.

8.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Remediation of pesticide contamination will be necessary to remove the LUCs related to pesticides. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

8.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

8.1.2 LUCIP for Site 16 – Area 7 Industrial Site (MISCA OU)

8.1.2.1 Site Description

This site is located in Area 7, the former IOP Inert Storage Area (**Figures 1-4 and 8-1**). The buildings in the area have been leased to a variety of industrial tenants since the end of World War II. The 1988 O'Brien & Gere RI reported that in the mid-1980s, black residues were noted near five of the large buildings in this area. Samples were located in the stream and around several buildings. Note, this site includes only those sample locations

There are several warehouse-type buildings remaining in Area 7. There is an intermittent stream that runs from south to north through the center of this site, which coincides with the center of Area 7. This stream transports all drainage from Area 7 northward discharging into Crab Orchard Lake. While some oil-stained soils were noted during RI activities, they are no longer evident on site. The suspected sources of contamination at this site were a waste oil recovery and recycling facility, and a facility that refurbished mining equipment.

Previous investigations at Site 16 include the 1988 RI, the 1993 Phase I RI and the 1996 Phase II RI.

8.1.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, three composite surface water samples, four composite sediment samples, and 11 composite soil samples were. Two of the surface water samples and three of the sediment samples were analyzed for VOCs, total PCBs, pesticides, explosives, and metals. The remaining surface water sample was analyzed for metals; and the remaining sediment sample was analyzed for VOCs, SVOCs, pesticides, PCBs, and sodium. Most of the soil samples were analyzed for the full list of analytes as well, with a few exceptions.

Table 8-1 summarizes only the detected analytical results from these samples. The 1988 RI determined that none of the detections posed a risk to humans or wildlife and nor further evaluation was recommended for Site 16. However, the RI also reported that the Refuge restricts human use of Site 16 and anticipates future restrictions on human use at the site. The report further stated "a human health risk assessment was not conducted at Site 16 since a completed exposure pathway for human risk does not exist at this site."[36]

However, as shown in **Table 8-1**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows several potential chemicals of concern in sediment and soil.

[36] USFWS, April 2002. Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois, Page 17 of the Decision Summary.

Soil

Antimony and iron exceeded the following screening criteria in some soil samples:
- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Aroclor 1254 exceeded the following screening criteria in three soil samples:
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Sediment

Aluminum, antimony, iron, and manganese exceeded the following screening criteria in some sediment samples:
- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

N-Nitrosodi-n-propylamine exceeded the following screening criteria in one sediment sample:
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

Two composite/discrete surface soil sample pairs were collected. The composite samples (0.5 to 0.8 feet deep) were analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete samples (1.8 to 1.9 feet deep) were analyzed for VOCs.

Table 8-1 summarizes only the detected analytical results from the two sample pairs. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. However, as shown in **Table 8-1**, a comparison of the 1993 data with the screening criteria used for this LUCIP shows one potential chemical of concern in sediment:

Arsenic exceeded the following screening criteria in one soil sample:
- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

8.1.2.3 LUCIP Objective

The Site 36 Record of Decision, which included Site 16 (see reference below in Section 8.1.2.6) includes land use controls as the remedy for Site 10. The objective of the LUCIP for Site 16 is to implement those controls in accordance with the ROD. Based on the available data, no objectives other than the IOP-wide are needed at this time (**Figure 8-1**). Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will

be evaluated as part of that RI. The applicable ROD text is as follows (note that Sites 36 and 10 are also included in the discussion):

> Institutional controls will be implemented at Site 36 to ensure that potable water supply wells are not installed at the site in the region of exceedances of MCLs/State of Illinois Class I groundwater standards until groundwater is restored for contaminants of concern. Institutional controls will also be implemented at Sites 10 and 16 to appropriately restrict human access. If future risk assessments show that the sites are appropriate for unrestricted use or reduced limitations on human activity, the institutional controls will be removed or modified as appropriate. These institutional controls will be implemented, maintained, and enforced by DOI/FWS. An Institutional Control Implementation Plan (ICIP) will be prepared as part of the Remedial Design Document. The following items will be included in the ICIP:
>
> • Identification of specific land use restrictions applicable to Sites 10, 16 and 36, the specific geographic extent of the restrictions, and the basis for the restrictions.
>
> • Implementation of enforcement procedures, including control methods, use of existing GIS contaminant database for the site, and visual inspection frequency and methodology.
>
> • Procedure for routine inspection reports.
>
> The exposure assumptions used in the human health risk assessments were consistent with the current human uses of the site. Regarding future land use, any change in land use inconsistent with any land use contained in those specific exposure assumptions in the risk assessments will require an evaluation of whether the anticipated land use change will pose unacceptable risks to human health and the environment or negatively impact the effectiveness of the selected Site remedy. This is enforceable under the National Wildlife Refuge Administration Act (16USC668dd), Section (d)(3)(A)(I), which requires that the Secretary of the Interior (Secretary)"...shall not initiate or permit a new use of a refuge or expand, renew, or extend an existing use of a refuge, unless the Secretary has determined that the use is a compatible use and that the use is not inconsistent with public safety." The Secretary's determination must be in writing and is subject to public review and comment. Potential land use changes are currently being evaluated through the CCP process that is required by 16USC668dd.

8.1.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

8.1.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

8.1.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002).

TABLE 8-1, ANALYTICAL DATA SCREENING FOR
SITE 16 - AREA 7 INDUSTRIAL SITE, MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G	
Sample ID	16-1-2-1		16-3-2-1		16-18-2-8		16-2-3-1		16-4-3-1		16-4-3-6		16-8-3-1		16-9-1-4		16-10-1-1		16-10-1-7		16-11-1-1		16-12-1-1	
Depth (feet)	NA		NA		NA		0-1		0-1		0-1		0-1		0-1		0-1		0-1		0-1		0-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Surface Water	R. Code	Surface Water	R. Code	Surface Water	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code
CONSTITUENT																								
2-Methylnaphthalene											0.005								ND					
Acetone									ND								ND							
Aluminium	ND		ND				12900	B H	8170	H			11200	H	2990		17900	H			16000	H	1850	
Anthracene					0.256														ND					
Antimony	ND		ND				ND		ND				20	B H	ND		ND				ND		22	A H
Aroclor 1254									ND						0.263	H	ND							
Arsenic	--		--		--		--		--		--		--		--		--		--		--		--	
Barium	69	C	74	C			104		75.3				180		61.1		180				122		75.3	
Benz[a]anthracene											0.191								ND					
Bis(2-ethylhexyl)phthalate											0.044								ND					
Boron	70		60				43		38				49		14	A	11	A			7.6	A	19	A
Calcium	74700	C	93700	C			7320	B	22100	B			9890	B	225000	A	3170	A			3220	A	133000	A
Chromium	ND		ND				20	B	10				38	B	16		25				21		19	
Chrysene											0.453								ND					
Cobalt	ND		ND				9		8				20	B	4		9				10		ND	
Copper	--		--		--		--		--		--		--		--		--		--		--		--	
Dibenzofuran											0.006								ND					
Di-n-butyl phthalate											0.007								ND					
Ethylbenzene	ND		ND				ND		ND		ND				ND		ND		ND		ND		ND	
Fluoranthene											0.389								ND					
Iron	300	C	ND				20300	H	16900	H			26000	B H	6760	H	22300	A H			19500	A H	14100	H
Lead	--		--		--		--		--		--		--		--		--		--		--		--	
Magnesium	25600	C	36700	C	23700	C	2840	B	7280	B			2710	B	12800	A	3850	A			3500	A	7940	A
Manganese	340		70				929	H	650	H			2010	B H	202	H	410	H			508	H	235	H
Methyl ethyl ketone (2-Butanone)	--		--		--		--		--		--		--		--		--		--		--		--	
Naphthalene																			ND					
Nickel	--		--		--		--		--		--		--		--		--		--		--		--	
N-Nitroso di-n-propylamine											0.115	H							ND					
Phenanthrene											0.019								ND					
Potassium																								
Pyrene											0.336								ND					
Silver	--		--		--		--		--		--		--		--		--		--		--		--	
Sodium	28300	C	40300	C	40300	C	100		100		190		90		300	A	230	A	170		170		230	A
Thallium																								
Titanium	ND		ND		ND		148		148				141		18		407				302		1107	
Vanadium	ND		ND		ND		36	B	28				44	B	ND		46				42		10	
Xylenes (total)	ND		ND		ND		ND		ND		ND		ND		ND		ND				ND		ND	
Zinc	--		--		--		--		--		--		--		--		--		--		--		--	

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
-- = Analyzed but not shown (see Note included in Source (1), below)
ND = Not detected
For data qualifiers, refer to source reports.
Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.
Note: If result is blank, the constituent was not analyzed in that sample.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remed. Object. for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remed. Object. for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remed. Object. for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remed. Object. for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

NA = Not Applicable

Sources
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

TABLE 8-1. ANALYTICAL DATA SCREENING FOR
SITE 16 - AREA 7 INDUSTRIAL SITE, MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		O'B&G		WCC		WCC		WCC		WCC		WCC		WCC	
Sample ID	16-13-1-1		16-14-1-1		16-15-1-4		16-15-1-6		16-16-1-1		16-17-1-1		COCO1601/2		COCO1603/4		COSE21601		COSE21602		COSE21603		COSE21604	
Depth (feet)	0-1		0-1		0-1		0-1		0-1		0-1													
Matrix (soil & sediment values shown in mg/kg, surface water values in ug/L)	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code
CONSTITUENT																								
2-Methylnaphthalene							0.139						ND		ND		ND		ND		ND		ND	
Acetone													0.22		0.022		ND		ND		ND		ND	
Aluminum	16100	H	3280		5320				13800	H	15600	H	8400	H	10900	H								
Anthracene							ND																	
Antimony	5.1	A H	ND		ND				ND		ND													
Aroclor 1254			2,552	H			0.28	H									ND		ND		ND		ND	
Arsenic	--		--		--		--		--		--		3.4	H	5.1	H	12.2	B H	5.3	H	5.1	H	5.9	H
Barium	135		52.7		119				146		113		109		105									
Benz[a]anthracene							ND						ND		ND		ND		ND		ND		ND	
Bis(2-ethylhexyl)phthalate							ND						ND		ND		ND		ND		ND		ND	
Boron	5.1		17	A	67	A			3.4		7.6	A												
Calcium	2660	A	197000	A	105000	A			883		7640	A	53000	A	5400	A								
Chromium	22		18		83	A			42	A	21		14		19		15.6		12.4		15.8		12.8	
Chrysene							0.041						ND		ND		ND		ND		ND		ND	
Cobalt	10		4		5				6		7		7.2		15									
Copper	--		--		--		--		--		--		14	A	35	A	7.9		7.4		15.8		11.8	
Dibenzofuran							0.05						ND		ND		ND		ND		ND		ND	
Di-n-butyl phthalate							0.041						ND		ND		ND		ND		ND		ND	
Ethylbenzene	ND		ND		ND				ND		ND		ND		ND		ND		1.2		ND		ND	
Fluoranthene							ND						ND		ND		ND		ND		ND		ND	
Iron	18900	H	8580	H	30700	A H			16600	H	19200	H	14000	H	19000	H								
Lead	--		--		--		--		--		--		9.6		24	A	17		7.4		9.7		11.8	
Magnesium	3040	A	21100	A	10700	A			2370	A	5660	A	14000	A	19000	A								
Manganese	476	H	236	H	460	H			411	H	394	H	440	H	780	H								
Methyl ethyl ketone (2-Butanone)	--		--		--		--		--		--		ND		ND		ND		0.57		ND		ND	
Naphthalene							0.051						ND		ND		ND		ND		ND		ND	
Nickel	--		--		--		--		--		--		11		15		10.5		7.8		9.7		9.9	
N-Nitroso di-n-propylamine							ND						ND		ND		ND		ND		ND		ND	
Phenanthrene							0.107						ND		ND		ND		ND		ND		ND	
Potassium													400		570									
Pyrene							0.034						ND		ND		ND		ND		ND		ND	
Silver	--		--		--		--		--		--		ND		1.8	A	ND		ND		ND		ND	
Sodium	160		270	A	240	A	140		130		110		89		80									
Thallium													0.36		0.44	A	ND		ND		ND		ND	
Titanium	167		32		77.7				205		247													
Vanadium	43		ND		10				36		39		19		28									
Xylenes (total)	ND		ND		ND				ND		ND		ND		ND		13		7.9		ND		ND	
Zinc	--		--		--		--		--		--		40		88	A	22		26.2		39.7		35.4	

Legend

mg/kg = milligrams per kilogram, ug/L = micrograms per Liter

--= Analyzed but not shown (see Note included in Source (1), below)

ND = Not detected

For data qualifiers, refer to source reports.

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Note: If result is blank, the constituent was not analyzed in that sample.

D - IEPA TACO Tier 1 Soil Remed. Object. for Residential Properties – Ingestion Exposure Route

E - IEPA TACO Tier 1 Soil Remed. Object. for Residential Properties – Inhalation Exposure Route

F - IEPA TACO Tier 1 Soil Remed. Object. for Construction Worker Ingestion Exposure Route

G - IEPA TACO Tier 1 Soil Remed. Object. for Construction Worker Inhalation Exposure Route

H - USEPA Region 9 Residential Soil Preliminary Remediation Goals

I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

NA = Not Applicable

(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.

(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

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IA 29 CFR 2910.120 for
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two-piece splash suit;
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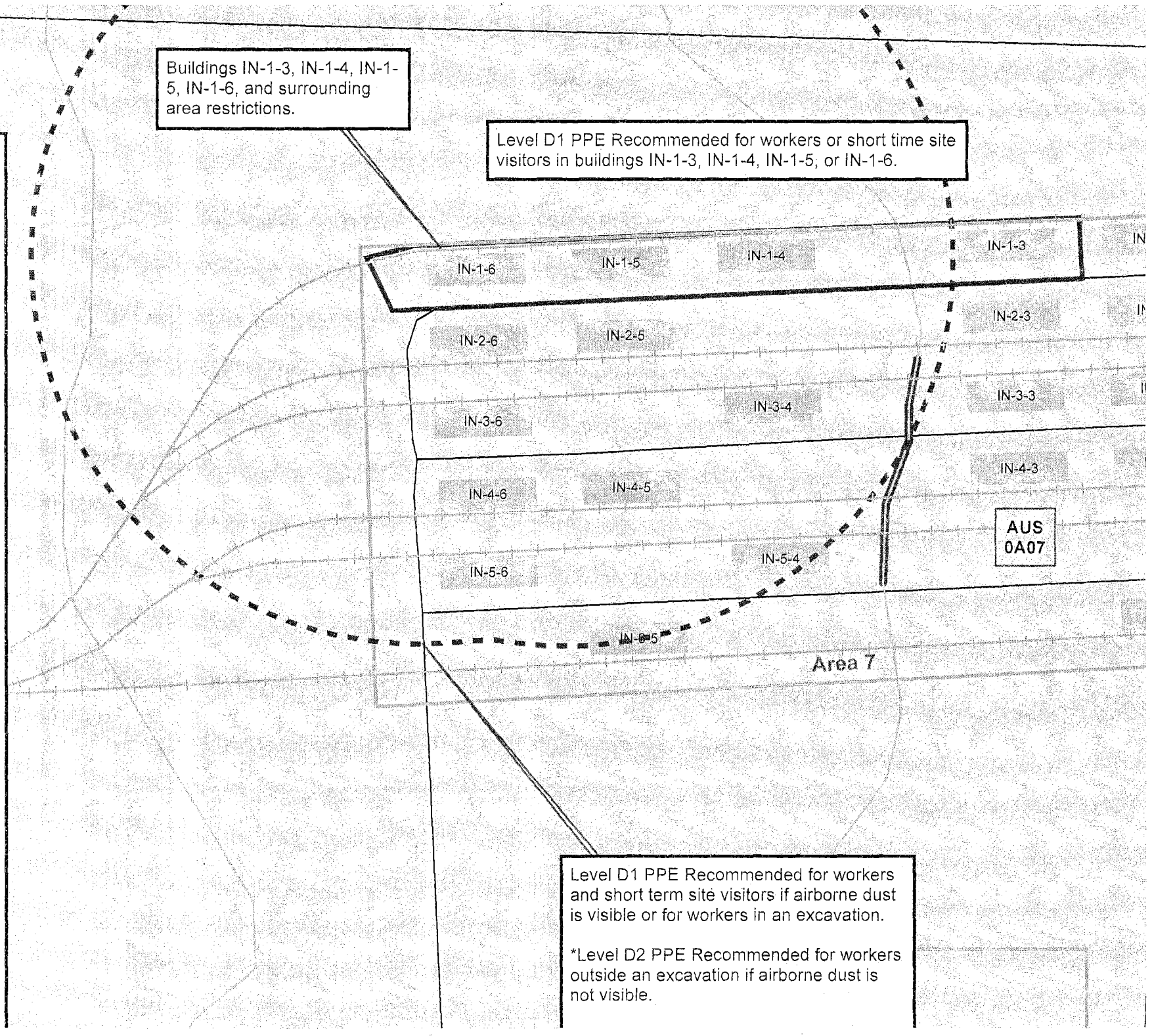


9.1 AREA 8

Site AUS-0A8S is south of Crab Orchard Lake and includes the southern part of the former IOP Group III Load Line (**Figures 1-7 and 9-1**). The load line originally included 29 buildings, which were prefixed with "III-1." The site includes about 150 acres.

The only remaining buildings from the Group III Load Line are those from the northern portion of the former load line. None of the buildings in the site designated as AUS-0A8S are still on site.

9.1.1 LUCIP for AUS-0A8S – Load Line III (AUS OU)

AUS-0A08 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

9.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

Load Line III was an IOP melt-pour operation for 500-pound bombs (**Figure 9-1**). TNT, which was sometimes blended with ammonium nitrate, was brought from off-site, melted, and poured into the bomb casings.

Products manufactured by post-World War II tenants included fiberglass canoes, propellants, pyrotechnics, and ground explosive powder. After a 1981 fire, the entire site was razed and buried. No industrial activity has taken place at Area 8 South since that time.

Olin occupied several of the former IOP buildings in Area 8 South from 1959 through the early 1960s for storage of ammonium nitrate fertilizer. Lease information indicates that Olin occupied the entire southern portion of Area 8 from 1960 through 1962.

Petrof Trading Company (Petrof) occupied two Area 8 buildings in the late 1960s. Petrof's operation in Area 8 involved grinding explosive powder. After Petrof left the site, black powder that was left behind was buried by the USFWS and the burial area was fenced off and marked.

CTI leased the south end of Area 8 from June 1969 to November 1970. CTI produced pyrotechnic devices for the military and their major product was the Mark II ground burst simulator. They also produced cannon net traps and parts for rocket separators.

American Fiber-Glass, Incorporated (AFL), leased this area from 1973 to 1981, when fire destroyed the facility. AFL manufactured fiberglass products, primarily canoes. A former employee reported that AFL used organic solvents, such as toluene, for cleanup operations.

Site Investigation

The SI included drum content, soil, sediment, groundwater, and surface water samples.

Notable Contamination Found

Most of the contamination was limited to the far southern end of the site. Both 2,4-and 2,6-dinitrotoluene were detected in the soil above SI screening criteria. 2,4-dinitrotoluene was

detected at 1,400 ug/kg, compared to a screening criterion of 0.8 ug/kg. Dinitrotoluene is used as a gelatinizing and waterproofing agent in explosives, and as an additive in propellant and smokeless powder. 2,4-dinitrotoluene is also used in the production of toluene di-isocyanate.

Maximum concentrations of several metals in sediments exceeded SI screening criteria, including copper at 3,300 mg/kg, arsenic at 63 mg/kg, lead at 665 mg/kg, and zinc at 1,800 mg/kg.

The Illinois surface water quality standard for copper was exceeded.

9.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions (**Figure 9-1**).

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

9.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 9-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 9-1**.

9.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

9.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

9.1.2 LUCIP for Site 12 – Area 8 Impoundment (MISCA OU)

9.1.2.1 Site Description

Site 12 is located to the east of former Area 8 Building III-1-24 in the location of a circular impoundment approximately 100 feet in diameter (**Figure 1-4**). In the past, there was an aboveground storage tank located within the circular berm. The tank was reportedly used for storage of fuel oil for the IOP boiler house previously located nearby. The tank was reportedly removed during the early 1960s. The 6-foot walls of the bermed area were previously breached. The suspected source of contamination at this site is the former fuel oil tank - several black oily pools and black sediment and tars located in and around the impoundment were visible in the mid-1980s. By 1992 these features were not visible. The area is now overgrown with trees and vegetation.

Previous investigations at Site 12 included the 1988 RI and the 1993 Phase I RI

9.1.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, two composite sediment samples (0-1 foot deep) and one composite soil sampled (0-1 foot deep) were analyzed. The soil sample and one of the sediment samples were analyzed for VOCs, pesticides, total PCBs, and metals. The remaining sediment sample was analyzed for VOCs, SVOCS, pesticides, PCBs, and sodium.

Table 9-1 summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1988 RI. However, as shown in **Table 9-1**, a comparison of the 1988 data with the screening criteria used for this LUCIP shows one potential chemical of concern for soil and one for sediment.

Soil

Aldrin exceeded the following screening criteria in the soil sample:

- IEPA TACO Tier 1 Soil Remediation Objective for Residential Properties (ingestion exposure route)
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Sediment

Aluminum exceeded the following screening criteria in one sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1993 Phase I RI (Woodward Clyde)

Two composite/discrete surface soil sample pairs were collected. The composite samples (1.8 to 2.2 feet deep) were analyzed for SVOCs, PCBs, pesticides, explosives, metals, and cyanide, while the discrete samples (1.8 feet deep) were analyzed for VOCs.

Table 9-1 summarizes only the detected analytical results from the two sample pairs. None of the detections exceeded levels of concern established for the 1993 Phase I RI which determined that no further investigation was necessary. However, as shown in **Table 9-1**, a comparison of the 1993 data with the screening criteria used for this LUCIP shows one potential chemical of concern.

Thallium exceeded the following screening criteria in three soil samples:

- Background Soil 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

9.1.2.3 LUCIP Objective

Based on the available data, no restrictions other than the IOP-wide LUCs are needed at this time. Additional investigation may be done in this area as part of the AUS OU RI. The need for any additional restrictions will be evaluated as part of that RI.

9.1.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

9.1.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

9.1.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the exceedances of screening criteria and lack of groundwater data.

9.1.3 LUCIP FOR Site 14 – Area 8 Solvent Storage Drainage Ditch (MISCA OU)

9.1.3.1 Site Description and Location

Site 14 is an approximately 3.5-acre area at a current tenant's active manufacturing and warehouse facility (**Figures 1-4 and 9-1**). Soil and groundwater are contaminated primarily with toluene, ethylbenzene, xylenes, and methylene chloride. The groundwater contamination exceeds MCLs and State of Illinois Class I groundwater standards for these constituents. Remediation will be done to prevent further degradation of the groundwater and to restore the groundwater to its State designated beneficial use (State of Illinois Class I groundwater standards or MCLs). In addition, soil at this site is also contaminated with chromium (representing a potential risk to the American Robin) and with lead (representing a potential human health risk). Site 14 is located in the northern part of Area 8. It is a relatively flat, poorly drained area. It is located at an existing manufacturing facility in the industrial part of the Refuge. The buildings shown in the attached figure are part of the operating facility. The site consists primarily of the grassy area partially surrounded by three buildings (the former Repour Building, Building 3 [including Annex 3], and Annex 3A), and the soil beneath the former Repour Building. Elevations at Site 14 range from a high of 440 feet just south of Annex 3, to a low of 433 feet, in the drainage channel north of the former Repour Building. See attached figure for site location details.

9.1.3.2 LUCIP Objective

The IOP-wide objectives apply. An additional objective is to ensure awareness of pre-remediation contamination by all persons potentially affected.

9.1.3.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, installation of warning signs around the Site 14 perimeter is required (**Figure 9-1**) and access to this area is restricted to personnel with a specific need to be at the site. No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Soil from this site should not be used for borrow material. These LUCs will be modified as appropriate as data are obtained in the RI.

9.1.3.4 Action Needed to Remove the LUC

This LUCIP will be revised after the remediation is complete, based on whatever residual contamination is left at the site. Requirements applicable to removal of the IOP-wide LUC would also apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

9.1.3.5 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 14 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2001).

TABLE 9-1
ANALYTICAL DATA SCREENING FOR
SITE 12 - AREA 8 IMPOUNDMENT
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		WCC (1993 Ph I)		WCC (1993 Ph I)	
Sample ID	12-3-1-4		12-2-3-1		12-2-3-7		COSO1201/3		COSO1202/4	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Soil	*R. Code*	Sediment	*R. Code*	Sediment	*R. Code*	Soil	*R. Code*	Soil	*R. Code*
Depth (feet)	0-1		0-1		0-1		1.8-2.2/1.8		1.9-2.2/1.8	
CONSTITUENT										
Acenaphthene	NA		NA		0.035		ND		ND	
Acetone	NA		NA		NA		1.7		0.059	
Aldrin	0.082	D H	ND		ND		ND		ND	
Aluminum	14300	H	13000	B H	NA		8400	H	9100	H
Anthracene	NA		NA		0.104		ND		ND	
Arsenic	--		--		--		8.2	H	7.4	H
Barium	157		151		NA		140		120	
Beryllium	--		--		--		0.67		0.6	
Boron	2.5		37		NA		NA		NA	
Calcium	1830		3300	B	NA		2400		1160	
Chromium	17		10		NA		13		12	
Cobalt	6		ND		NA		7.8		7.6	
Copper	--		--		--		12	A	8	
Fluoranthene	NA		NA		0.035		ND		ND	
Fluorene	NA		NA		0.108		ND		ND	
Iron	15300	H	16200	H	NA		18000	H	NA	
Lead	--		--		--		16		9.9	
Magnesium	2010	A	2110	B	NA		2000	A	1240	
Manganese	561	H	559	H	NA		1070	H	890	H
Mercury	--		--		--		0.02		ND	
Methyl ethyl ketone	--		--		--		0.007		ND	
Methylene chloride (Dichloromethane)	ND		ND		NA		0.009		0.006	
m-Xylene	0.012		ND		NA		ND		ND	
Nickel	--		--		--		10.5		10.4	
Phenanthrene	NA		NA		0.655		ND		ND	
Potassium	NA		NA				440		360	
Pyrene	NA		NA		0.301		ND		ND	
Silver	--		--		--		1.3	A	1.15	A
Sodium	120		50		210		98		60	
Thallium	NA		NA		NA		0.48	A	0.6	A H
Titanium	200		90.8		NA		NA		NA	
Toluene	ND		ND		NA		ND		0.011	
Vanadium	36		33	B	NA		29		25	
Zinc	--		--		--		32		31	

Note: The O'Brien & Gere RI mistakenly refers to Area 8 as Area 14. MISCA OU Sites 12, 13, and 14 are all located within Area 8. Therefore, all three of these sites will be noted as Area 8 sites, not Area 14. Tables and text for this Institutional Control Plan will be referenced accordingly.

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend

mg/kg = milligrams per kilogram, ug/L = micrograms per Liter

-- = Analyzed but not shown (see Note included in Source (1), below)

ND = Not detected

For data qualifiers, refer to source reports.

NA = Not Applicable or Not Analyzed

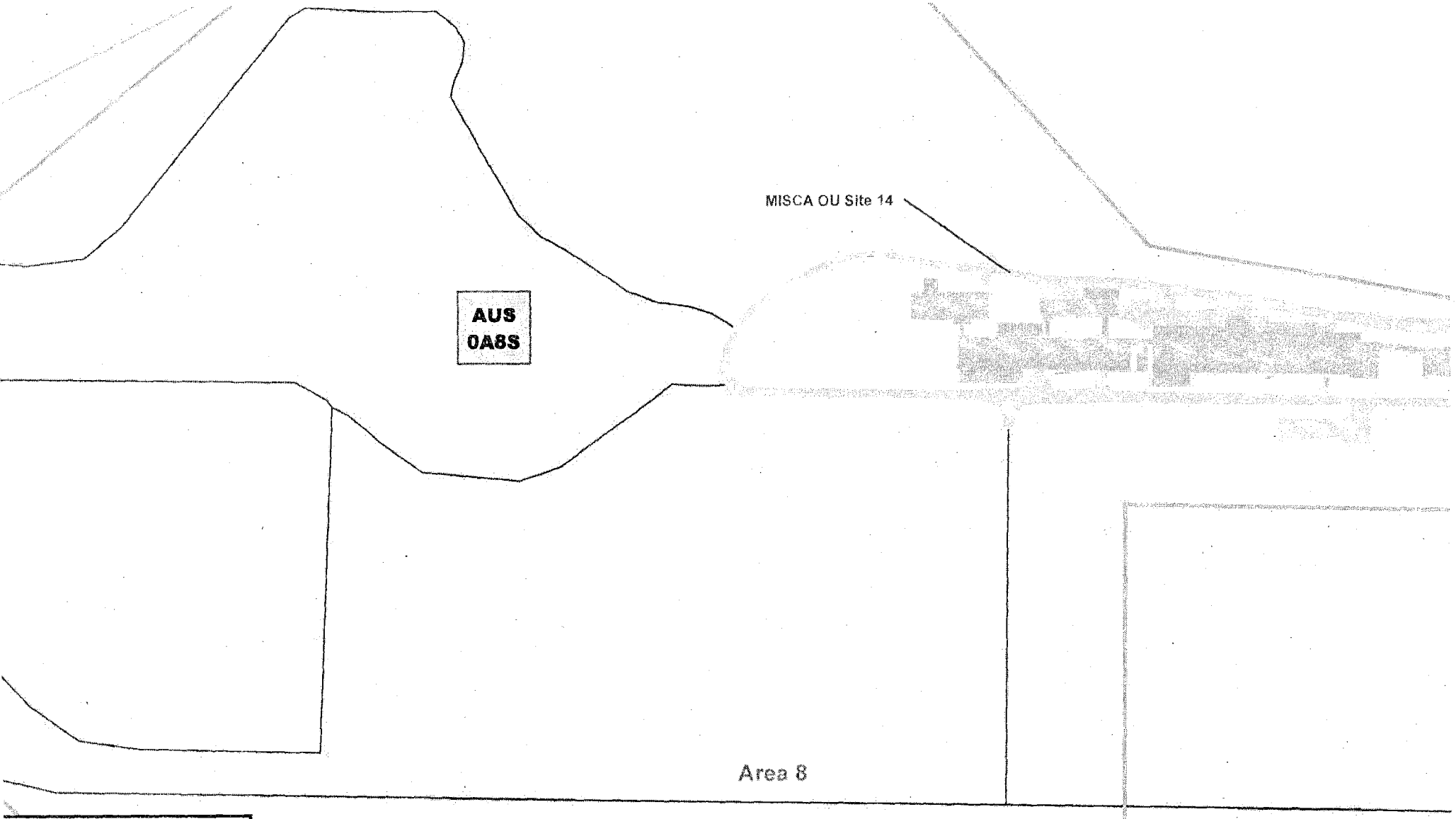
Sources:

(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.

(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

Reference Codes:

A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR



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10.1 AREA 9

Area 9 was the IOP Group Load Line I and is located south of Crab Orchard Lake and east of Highway 148 (**Figures 1-7, 10-1, and 10-2**). Load Line I originally consisted of the 38 buildings. All the building numbers are prefixed with "I-1." Later industrial tenants have added many buildings and building numbers now extend into the 100s.

10.1.1 LUCIP for AUS-0A09 – Load Line I (AUS OU)

In 1996 and 1997, a large area in and near Area 9 was remediated as a part of the PCB OU (See Sites 32/33 of the PCB OU). Site AUS-0A09 includes that part of Area 9 located outside the excavation boundaries for the original PCB OU remediation, and outside the area currently planned for remediation for chlorinated VOC groundwater contamination under the PCB OU (**Figures 10-1 and 10-2**). Site AUS-0A09 includes about 100 acres.

AUS-0A09 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

10.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

During World War II, TNT was screened, melted, and loaded on this artillery and bomb loading line.

There were two major tenants and several minor ones in Area 9. Sangamo Electric Company (Sangamo), now Schlumberger Industries, Inc., was the first major tenant, and contamination from its operations is the focus of the PCB OU remediation. Olin and its successors were the other major tenant.

From 1946 to 1962, Sangamo leased the site and manufactured various kinds of capacitors as well as transducers and delay line equalizers. Sangamo used lead to coat small parts, such as electrical connections. Sangamo also used degreasers and other chemicals in their manufacturing processes, such as acids, acetone, ethylene glycol, epoxy resins, silver, ammonia, trichloroethylene, perchloroethylene (PCE), liquid Aroclor 1254 and 1242.

Olin/Primex/GDO&TS have leased buildings in Area 9 from 1967 to the present, for several different activities, including pyrotechnic operations, which included manufacturing magnesium flares and illumination flares; as well as medium caliber ammunition production.

See the discussion under the AUS-0A2B summary for known chemicals used and waste products generated by Olin and its successors.

Site Investigation

The SI included soil and groundwater samples.

Notable Contamination Found

Many PAHs, three phthalates, and several metals were detected in soil at concentrations above SI screening criteria. 2,4-dinitrotoluene was detected at 2,100 ug/kg in soil.

10.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions (**Figures 10-1 and 10-2**).

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

10.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figures 10-1 and 10-2**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts; CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figures 10-1 and 10-2**.

10.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

10.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

10.1.2 LUCIP for Site 35 – Area 9 East Waterway (MISCA OU)

10.1.2.1 Site Description

Site 35 is a depression lacking vegetation in an agricultural field east of Area 9 (**Figure 1-4**). While the site is not known to have a history of industrial use, the lack of vegetation in the depression suggested possible contamination.

Previous investigations at Site 35 include the 1988 RI.

10.1.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one composite sediment sample (0-1ft deep) was collected and analyzed for VOCs, SVOCs, pesticides, PCBs, explosives, metals, some indicator parameters.

Table 10-1 summarizes only the detected analytical results from the sediment sample. None of the detections exceeded levels of concern established for the 1988 RI, nor did they exceed any screening criteria used for this LUCIP (**Table 10-1**).

10.1.2.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives (Section 2) are needed at this time ().

10.1.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

10.1.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

10.1.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS,

2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the lack of groundwater data.

10.1.3 LUCIP for Sites 32/33 – Area 9 Landfill/Area 9 Building Complex (PCB OU)

10.1.3.1 Site Description and Investigation Results

Remediation for these sites for PCBs and metals was intended to be completed in 1996, and a draft Closeout Report was submitted. PCB contamination was a result of Sangamo's operations (See discussion under AUS-0A09) (**Figures 1-2, 10-1, and 10-2**).

The remediation criteria, in accordance with the ROD, was as follows:

- Lead to 450 ppm dry soil (dry weight basis)
- Cadmium to 10 ppm dry soil
- PCBs to 1 ppm dry soil in surface soils (defined as the top foot [12 inches] of soils)
- PCBs to 25 ppm dry soil in subsurface soils (defined as soils below the 1-foot depth)
- PCBs to 0.5 ppm dry sediments.

PCBs in soil at most locations were removed to a greater depth than required. A repository was constructed at Site 32 to contain ash from incinerated PCB waste, and also to contain soils with PCB contamination less than 25 ppm. The contaminated material in the repository is covered with 2 feet of clean material (one foot of ash and one foot of soil). Sampling done by FWS of soils and sediments since 1996 has found PCB concentrations at the site in excess of cleanup levels, up to 5,000 ppm. Based on a review of past investigation and remediation data, FWS has concluded that PCBs above cleanup levels may be present at locations throughout the site. FWS is investigating.

During remediation, chlorinated volatile organic (CVOC) contamination was found in soils and groundwater at Site 32 and 33 in Area 9. Further investigation was conducted. In August 2003, a feasibility study for remediation of the CVOC contamination was submitted.

10.1.3.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. Any digging or earthmoving on the Repository is prohibited, except for purposes of repair. An additional objective is to limit exposure to the CVOC contamination near some buildings, and remaining PCB contamination.

10.1.3.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access should be limited to personnel who need to use the site. The site is in an area with restricted access, which will remain in effect at least until all remediation is complete. In addition, because of the TCE contamination in soil and groundwater, earthmoving and excavation should be limited to activities necessary for facility operation. Any excavation in areas where TCE concentrations exceed 10 mg/kg should be done by OSHA-trained and certified (OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers) work crews. The crews should have respirators available and should be trained in their proper use. These areas of TCE contamination in excess of 10 mg/kg are shown in **Figures 10-1 and 10-2**.

Digging should be prohibited except for investigatory purposes. Soil from this site should not be used for borrow material.

Due to TCE and other VOCs found in groundwater and to VOCs, SVOCs, PCBs, and inorganics found in soil, PPE guidelines are provided for this site. Refer to Section 1.4.1, Table 1-5, and **Figures 10-1 and 10-2**.

The PCB OU ROD requires a final risk assessment for this site, after completion of remediation.

10.1.3.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. The LUCs for CVOC contamination will remain in effect at least until the CVOC remediation is complete.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

10.1.3.5 Applicable Decision Document

The applicable decision document is the PCB OU ROD, signed in 1990.[37]

[37] U.S. Environmental Protection Agency, 1990b. *Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, PCB Areas Operable Unit*, August 1, 1990.

TABLE 10-1
ANALYTICAL DATA SCREENING FOR
SITE 35 - AREA 9 EAST WATERWAY
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G	
Sample ID	35-1-3-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Sediment	*R. Code*
Depth (feet)	0-1	
CONSTITUENT		
Aluminum	7850	H
Aroclor 1254	0.016	
Barium	71.9	
Boron	29	
Calcium	4540	B
Chromium	10	
Iron	13200	H
Magnesium	1730	
Manganese	684	H
Sodium	650	
Titanium	142	
Vanadium	28	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge, February.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

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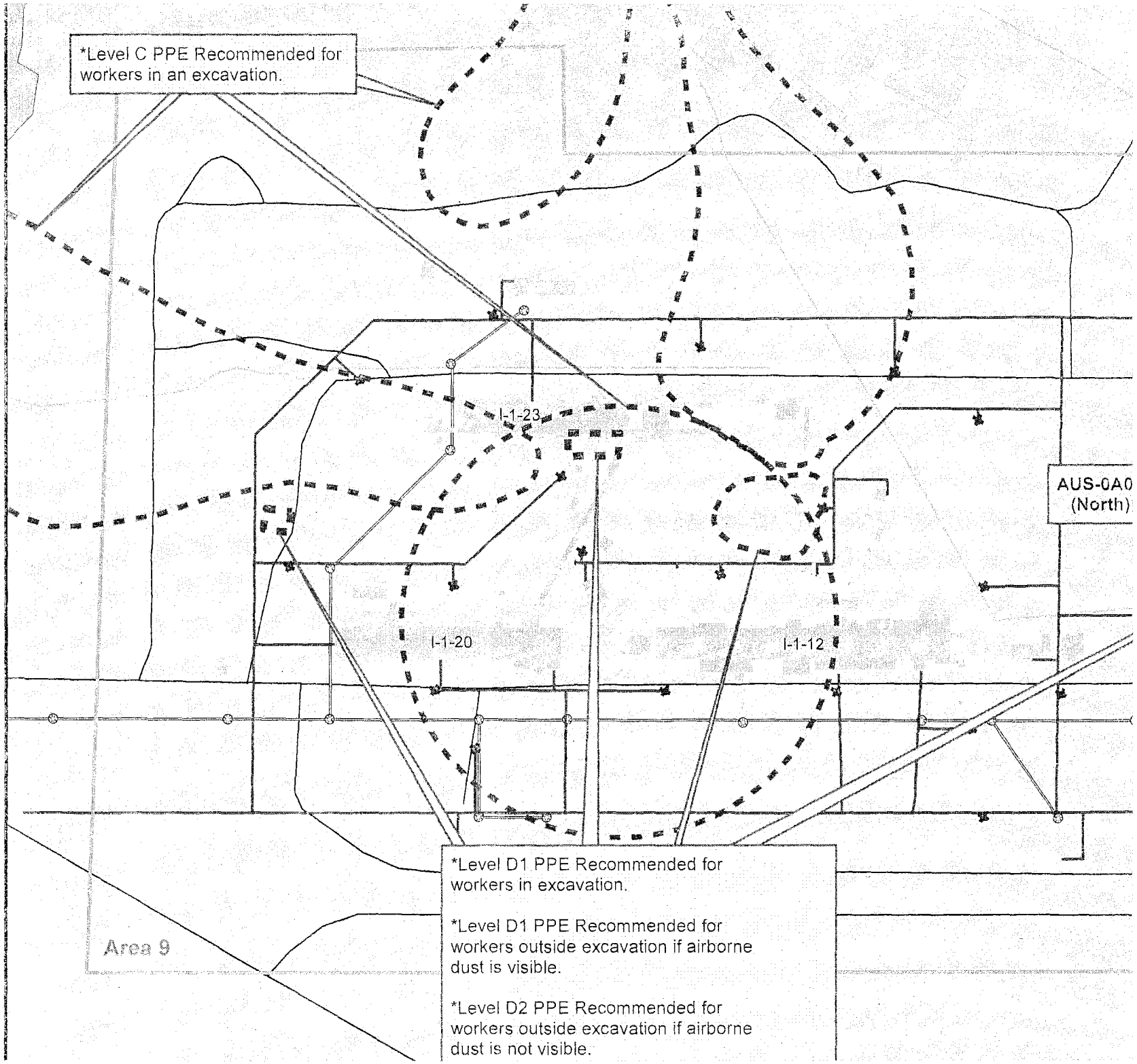

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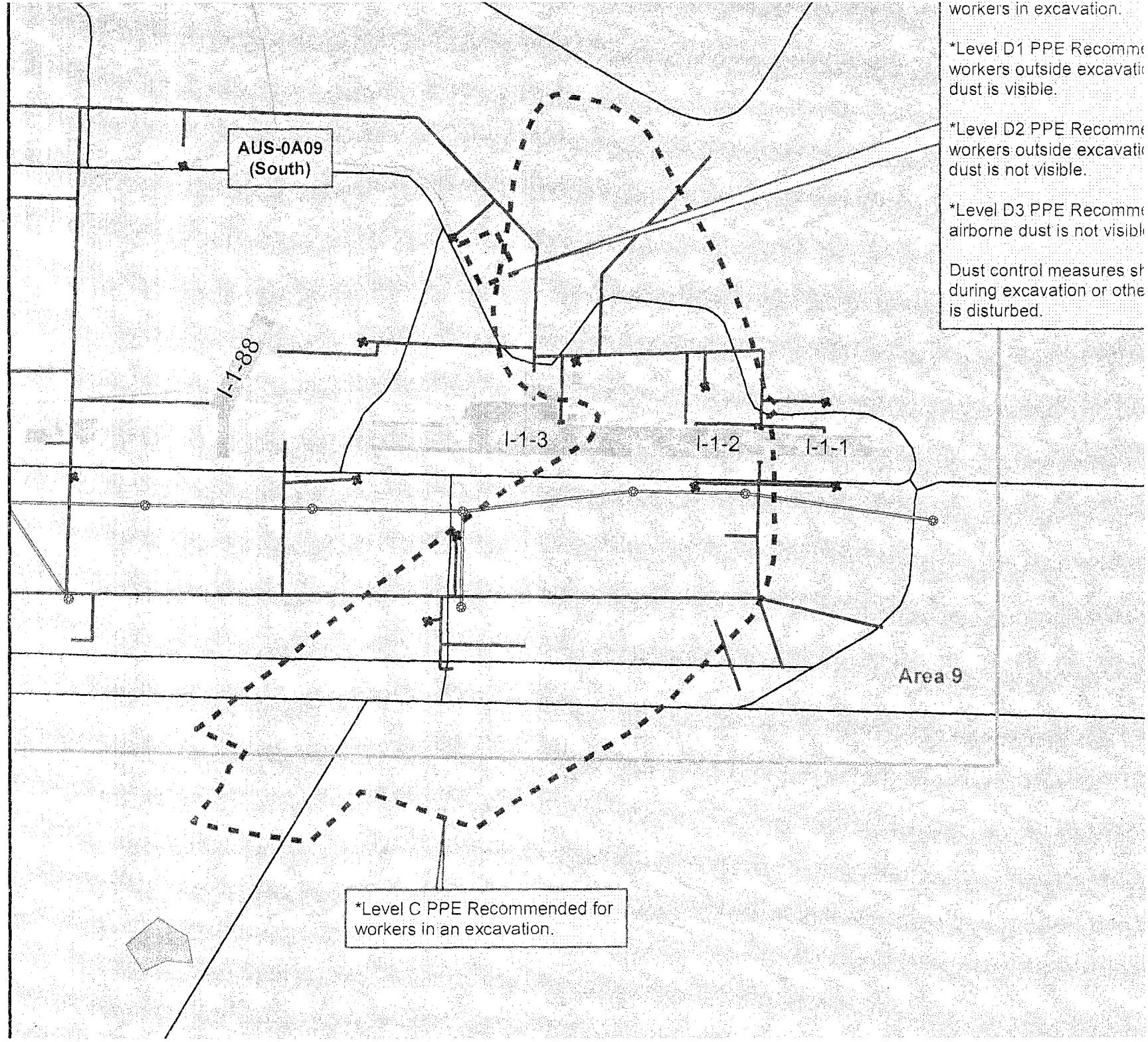

11.1 AREA 10

Area 10, the former IOP Fuse and Booster Storage Magazine (FBM) area, is located south of Crab Orchard Lake, on the north side of Ogden Road (**Figures 1-7 and 11-1**). Area 10 was a group of 16 storage magazines for components of ordnance produced on the load lines. The site covers about 40 acres.

The FBM area was in the shape of a trapezoid, and the storage magazines were arranged in four rows. All of the magazine numbers started with the prefix "FBM." By 1965, all of the magazines had been removed.

11.1.1 LUCIP for AUS-0A10 – Fuse and Booster Storage Magazines (AUS OU)

AUS-0A10 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

11.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

During World War II, fuses and boosters stored in Area 10 were transported to the IOP Load Lines, where anti-tank mines, bombs and artillery were being produced (**Figure 11-1**).

In 1949, USFWS used three of the magazines for grain storage. Sangamo Weston, Inc. (Sangamo), the only documented tenant in Area 10, leased two magazines from 1949 to at least 1951.

Although it had no leases in Area 10, Olin constructed and used large pits in this area for the incineration of ignitable wastes from its production operations. John Miller, a former Olin manager and chemist, indicated that Olin moved from one burning ground to another as they outgrew the previous burn area, and that all of Olin's manufacturing operations on the Refuge used a single burn area at the same time. Olin documents indicate that they moved their burning grounds from Area 12 to Area 2D in 1965, from Area 2D to Area 9 in 1967 and from Area 9 to Area 10 in 1968. The Area 10 burn area was in operation until open burning was banned at the Refuge in 1970.

Scrap explosive wastes that Olin burned at Area 10 consisted of propellant, illumination scrap mix, igniter scrap, laboratory waste pyrotechnic materials, and other explosives and explosive contaminated materials. Oil was added to explosive material to cushion and dampen the material to prevent explosions prior to burning. Scrap was collected at workstations or scrap areas and taken to Area 10 where it was dumped into the burn pits and topped with small quantities of ignitable powders.

Olin has estimated that 120,000 pounds (lbs) of waste were burned in this area and that about 1,000 lbs of residue remained, consisting mainly of metal oxides. Olin reported that the soils in the vicinity of this burning ground possibly contained lead contamination, and also that fuel oil, acetone, lupersol (methyl ethyl ketone peroxide)and other chemicals would have been present in these pits.

In 1970, when open burning was banned, the pits were covered. Since that time the site has been used by local law enforcement personnel for small arms practice.

Site Investigation

The SI included soil and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

TCE was detected above SI screening criteria in soil. Maximum detections of several inorganics exceeded SI screening criteria, including barium at 14,100 mg/kg, and boron at 513 mg/kg.

11.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

11.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 11-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled. Agricultural use is prohibited at this site. These LUCs will be modified as appropriate as data are obtained in the RI.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 11-1**.

11.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

11.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

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personnel in compliance with OSHA
Waste/Materials Workers.
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ace utility repair and roadway repair,

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Equipment (PPE) Recommendations

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resistant clothing (overalls with long-
r two-piece splash suit; disposable

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sh suit; disposable chemical-resistant
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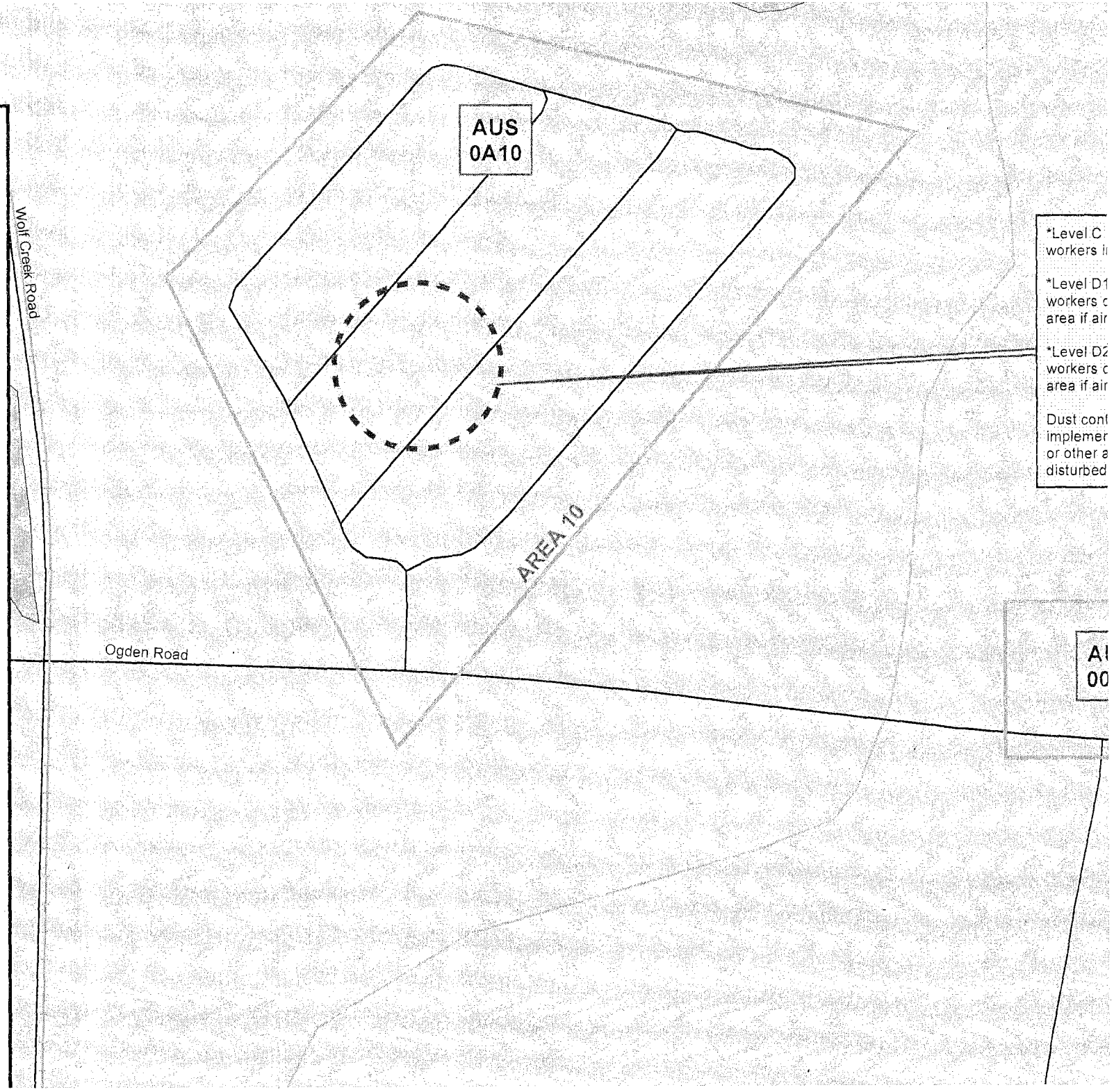

12.1 AREAS 11 AND 12

Areas 11 and 12, located south of Crab Orchard Lake, are addressed together because they were part of a single, large post-World War II industrial facility. At the north end of this now contiguous area is the site of the IOP Group II Load Line, which is in Area 11. At the south end is the site of the IOP Ammonium Nitrate Plant, which is in Area 12. The current Areas 11/12 include these two IOP features plus about 100 to 200 acres of Refuge land between them that was developed by post-Word War II industrial tenants.

The enlarged industrial complex, including buffer zones, was over 600 acres in size. Access was limited to tenant employees. Because of its size and the variety of past industrial activities, Area 11 was subdivided into five sites for the purposes of the PA/SI report (**Figures 1-7 and 12-1**). The boundaries of these five sites are based on industrial use by Olin and Commercial Solvents Corporation (CSC), the major tenants, as follows:

- Area 11A—acid and ammonium nitrate manufacturing (Site AUS-A11A).
- Area 11H—high explosives manufacturing (Site AUS-A11H).
- Area 11N—nitroglycerin manufacturing (Site AUS-A11N).
- Area 11P—propellant manufacturing (Olin), explosive cap manufacturing (CSC) (Site AUS-A11P).
- Area 11S—support area for explosives manufacturing (Site AUS-A11S).

Beginning in 1956, Areas 11 and 12 were leased by Olin and used primarily for manufacturing industrial (non-military) explosives. Olin built an acid and ammonium nitrate plant using some of the IOP Load Line II structures. Olin also constructed and operated a nitroglycerin plant, dynamite mix houses, a burn area, and ponds for storage of millions of pounds of explosives. These features were built in previously undeveloped parts of the Refuge between the original Group II Load Line and the Ammonium Nitrate Plant.

Olin sold its industrial explosives business to CSC in 1963 and CSC moved into Areas 11/12 in 1964. CSC and its successors leased this area from 1964 through 1982. Part of the sale to CSC included an RDX manufacturing operation and an explosive cap manufacturing operation, both of which were located at Olin facilities off the Refuge and moved by CSC to Areas 11/12. Olin also operated a pilot propellant plant in Area 11 which was not included in the sale. The propellant operation had been moved to Area 2 prior to the sale.

Trojan Powder Company, a CSC division, operated the Area 11/12 facility. Manufacturing was phased out beginning in 1968, and ended completely sometime before 1976. Trojan did some explosive decontamination in 1971 and 1972, but was still storing explosives at the site in 1977, when its successor, IMC Chemical Group (IMC), petitioned the Illinois Pollution Control Board for a variance from the regulations that prohibited open burning because such burning was necessary for further decontamination of the buildings in Areas 11 and 12. Three variances were

granted during 1977 and 1978, for building decontamination and destruction of unusable explosives. After IMC removed the remaining usable explosives and completed the explosive decontamination, they left the site in 1982. Mallinckrodt, Inc, is the corporate successor to CSC/IMC. The purpose of the CSC/IMC decontamination was to eliminate explosive hazards at the site. The work did not address chemical contamination. The remaining buildings in the area were demolished by the USFWS in the late 1980s and early 1990s.

Area 12 was the former IOP Ammonium Nitrate Plant. It is located south of Area 11, and is accessible by way of Area 11 roadways (**Figures 1-7 and 12-1**). It originally consisted of 12 buildings designated with the prefix "ANP-1. The area has been unoccupied since 1982, and all buildings have been removed.

12.1.1 LUCIP for AUS-A11A – Acid and Ammonium Nitrate Area (AUS OU)

AUS-A11A is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.1.1 Site Description and Investigation Results

Area 11A is the acid and ammonium nitrate manufacturing area and is located in the north-central portion of Area 11 between Areas 11P and 11S (**Figure 12-1**). This area was part of the IOP Group II Load Line and was used mostly for TNT and ammonium nitrate storage and screening.

Both Olin and CSC used this area as an acid and ammonium nitrate production facility. In 1957, Olin began production of acid and ammonium nitrate in this area. Nitric and possibly sulfuric acid were produced. Both acids were stored in this area. CSC used the buildings and other facilities as Olin did, with minor changes.

Site Investigation

The SI included soil, sediment, groundwater, and surface water samples.

Notable Contamination Found

Phosphorus and nitrate-nitrite in groundwater exceeded SI screening criteria. N-nitrosodiphenylamine, pentachlorophenol, and 2,4-dinitrotoluene detections in sediments exceeded SI screening criteria. Detections of most inorganics, many PAHs, three phthalates, and carbazole exceeded screening criteria in soil and/or sediments.

12.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities

necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.2 LUCIP for AUS-A11H – High Explosives Area (AUS OU)

AUS-A11H is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.2.1 Site Description and Investigation Results

Site AUS-A11H, the High Explosives Area, is located in the western portion of Area 11 just south of Area 11P (**Figure 12-1**). It was used by industrial tenants for manufacturing high explosives from the 1950s to the 1970s. During World War II, the northern section of Site AUS-A11H was part of the IOP Group II Load Line.

Operational History and Waste Characteristics

Area 11H was used by the SWDC/War Department during IOP operations as a part of the Melt Loading Line and contained two change houses and a melt loading building.

Olin constructed the High Explosives Manufacturing Area, or Dynamite Area, on the property between the IOP Group II Load Line and the IOP Ammonium Nitrate Plant. Note that the term "dynamite" as used here is a generic term for industrial blasting explosives. It appears that Olin produced nitroglycerin dynamite in this area, as well as ammonium nitrate fuel oil explosives (ANFO), and water gel and slurry explosives which are the common explosives used in the mining industry.

The major constituents of nitroglycerin dynamite are nitroglycerin and dope, which is a general term for the porous combustible material that is combined with nitroglycerin to form dynamite. Some other raw materials used in production were ammonium nitrate, nitrocellulose, nitrocotton, ethyl centralite, and dimethyl sebacate (also known as dimethyl ester).

Water gels and slurry explosives consist of ammonium nitrate with or without other oxidizing agents, sensitizers, fuels, and gelatin forming compounds. Materials that are commonly used as additives in these explosives, and that Olin was known to have used in Area 11H, include TNT and smokeless powder. Other common additives that might have been used are pentolite, methylamine nitrate, potassium dichromate and PETN.

CSC and its successors operated the High Explosives Area from 1964 until they phased out production between 1968 and 1971. CSC most often used the same buildings as Olin; however, CSC used Building 22 for their Torpex operation. Torpex is composed of RDX, TNT, aluminum powder and wax.

Site Investigation

The SI included soil, sediment, groundwater, surface water, and trench water samples.

Notable Contamination Found

The following explosive compounds exceeded SI screening criteria in sediment: nitroglycerin, HMX (Her Majesty's Explosive), RDX, TNT, nitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 1,3,5-trinitrobenzene, and 1,3-dinitrobenzene. These compounds were detected at levels of concern for toxicity and/or cancer effects, but not at levels of concern for explosive effects.

TCE, PCE, and cis-1,2-dichloroethene exceeded SI screening criteria in soils.

Nitrate-nitrite and phosphorus detection in groundwater exceeded SI screening criteria.

Detections of most PAHs in soil and/or sediment exceeded screening criteria, plus two phthalates, carbazole, and n-nitrosodiphenylamine. Maximum detections of most inorganics in soil and/or sediment exceeded screening criteria, including soil concentrations of cadmium at 204 mg/kg, and chromium at 585 mg/kg.

12.1.2.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.2.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 12-1**.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.2.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.2.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.3 LUCIP for AUS-A11N – Nitroglycerin Area (AUS OU)

AUS-A11N is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.3.1 Site Description and Investigation Results

Area 11N, the Nitroglycerin Area, is located in the eastern portion of Area 11, south of Area 11S and east of Area 11H (**Figure 12-1**). Post-World War II industrial tenants used this area for manufacturing nitroglycerin, from the 1950s to the 1970s. During World War II, a small portion of the northern section of Site AUS-A11N was within the IOP Group II Load Line and was used as a parking area, with no buildings.

Operational History and Waste Characteristics

The part of the former IOP Group II Load Line that is within Area 11N was used for loading shells with melted TNT, which sometimes had added ammonium nitrate.

Olin began manufacturing nitroglycerin in late 1957, at the same time it began acid and ammonium nitrate production in Area 11A. Olin produced nitroglycerin by the Biazzi process, which used concentrated nitric and sulfuric acid, pure glycerin or ethylene glycol, and soda ash. The wastewater from the nitroglycerin manufacturing was probably discharged to the East Holding Pond just north of the Nitroglycerin Area. This wastewater probably contained soluble materials like ammonium nitrate, sodium nitrate, acid, and traces of nitroglycerin.

After they acquired it from Olin, CSC probably continued to operate the nitroglycerin manufacturing facility the same way as Olin had.

There were eight possible burning trenches located in AUS-A11N that were identified in historical aerial photographs. The AUS OU site reconnaissance identified two buried railroad tank cars in Area 11N. Buried railroad tank cars are known to have been used at other industrial facilities for liquid waste or fuel storage.

Site Investigation

The SI included soil and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

Several SVOC and inorganic detections in soil exceeded SI screening criteria. Illinois Surface Water Quality Standards were exceeded for copper, iron, lead, and manganese. Lead was detected in the soil at 568 mg/kg.

12.1.3.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.3.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.3.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.3.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.4 LUCIP for AUS-A11P – Pilot Propellant Plant/CAP Production Area (AUS OU)

AUS-A11P is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.4.1 Site Description and Investigation Results

Site AUS-A11P, the former Area 11 Pilot Propellant Plant/CAP Production Area, is located in the northwestern portion of Area 11, west of Area 11A and north of Area 11H (**Figure 12-1**). From the 1950s to the 1970s, industrial tenants used this area for propellant/explosives manufacturing. During World War II, this site was part of the IOP Group II Load Line.

Operational History and Waste Characteristics

Several buildings within AUS-A11P were originally a part of the IOP Group II Load Line which SWDC/War Department operated during World War II. Shells, anti-tank mines and 500-pound (lb) bombs were loaded with TNT on this line.

Olin began occupying Area 11 in 1956. They initially used this area as a Pilot Propellant Plant for research and development of propellants, and may have later used this area for the manufacture of jet starter cartridges or jet engine starters. Solid propellant used at this plant was composed of ammonium nitrate, synthetic rubber, carbon black, and ammonium oxalate. The propellants contained ammonium perchlorate, magnesium, aluminum, and a plastic binder.

Some of the chemical constituents of gas generators produced by Olin were perchlorates, ammonium nitrate, hexane and various plasticizers. Olin also tested experimental explosive devices in a building in this area. Olin jet engine starters were made using nitroglycerin and ball powder. Ammonium nitrate, nitrocellulose and a plasticizer – dioctyl phthalate – were also used in the gas generators for the jet engine starters.

After Olin sold a portion of its business to CSC in 1964, CSC leased the former Olin facility and used it for the manufacture of Big Inch Caps, which were listed as "Blasting Caps" "for detonators" in the Olin/CSC agreement. The caps were ½-inch in diameter and 1-inch long. They were used with a cord fuse and contained a combination of lead azide and lead styphnate. According to CSC/IMC records, RDX, lead azide and lead styphnate were the explosive contaminants of concern in the buildings used for Big Inch Cap production.

Site Investigation

The SI included soil, sediment, groundwater, and surface water samples.

Notable Contamination Found

TCE and PCE were detected in groundwater above SI screening criteria, but just below MCLs. Many SVOCs were detected in soils and sediments above SI screening criteria, including n-nitrosodiphenylamine and carbazole. 2,4-dinitrotoluene exceeded screening criteria in soils, as did most inorganics. Copper, iron, and manganese exceeded Illinois Surface Water Quality Standards.

12.1.4.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made. The current hunting restriction would remain in place.

12.1.4.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.4.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.4.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.5 LUCIP for AUS-A11S – Support Area

AUS-A11S is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.5.1 Site Description and Investigation Results

Site AUS-A11S, the Support Area, is located in the northeastern portion of Area 11, east of Area 11A and north of Area 11N. During World War II, the area was part of the IOP Group II Load Line (**Figure 12-1**). Site AUS-A11S was used by industrial tenants from 1946 to the 1980s as a support area for the high explosives manufacturing.

Operational History and Waste Characteristics

SWDC/War Department operated the IOP Group II Load Line during World War II. The area occupied by Site AUS-A11S was on the front end of the load line, where shells were delivered, cleaned and painted.

Silas Mason Company, a Department of. Army contractor who operated the IOP Ammonium Nitrate Plant (Area 12) from 1946 to 1950, also occupied two buildings in Area 11 as warehouses from 1946 to 1948.

Post-IOP industrial tenants included Hoosier Cardinal Corporation (Hoosier) who leased property in Area 11 from 1948 to 1956. Hoosier manufactured and finished decorative equipment and emblems for stoves, refrigerators and automobiles.

During Olin's tenure from 1956 to 1964, most of the buildings in the Support Area were former IOP buildings. Olin used the buildings in this area for a boiler house, laboratory, a component magazine, a carpenter and machine shop, a garage, a welding shop, and oil storage.

CSC/IMC apparently used most of the buildings in Site AUS-A11S for the same purposes as Olin.

Site Investigation

The SI included soil, sediment, groundwater, and surface water samples.

Notable Contamination Found

TCE was detected in the groundwater at 280,000 ug/L. Other contaminants that exceed SI screening criteria for groundwater are: cis-1,2-dichloroethene, naphthalene, TNT, phosphorus, and sulfate. Several chlorinated VOCs exceeded SI screening criteria in soils.

2,4-dinitrotoluene in soil exceeded screening criteria, as did many PAHs and three phthalates. Maximum detections of most inorganics exceeded SI screening criteria in soils and/or sediments.

12.1.5.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the presence in groundwater and known use of chlorinated solvents at this site, particularly TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.5.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

In the areas around the industrial facilities likely to have used chlorinated solvents or in areas with soil TCE concentrations in excess of 10 mg/kg, excavation shall be done only by the aforementioned OSHA-trained and certified personnel. These approximate areas are shown in **Figure 12-1**. CERCLA staff should be consulted at the time any earthmoving activities are planned or scheduled. Further, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 12-1**.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.5.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.5.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.6 LUCIP for AUS-0A12 – Former Ammonium Nitrate Plant (AUS OU)

AUS-0A12 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.6.1 Site Description and Investigation Results

Area 12 was the former IOP Ammonium Nitrate Plant. It is located south of Area 11, and is accessible by way of Area 11 roadways (**Figure 12-1**). It originally consisted of 12 buildings designated with the prefix "ANP-1.

The area has been unoccupied since 1982, and all buildings have been removed.

Operational History and Waste Characteristics

SWDC/War Department used Area 12 for ammonium nitrate production during World War II. The IOP was a "melt-pour" facility. Explosives that were produced elsewhere were melted and poured into various ordnance shells and bombs. TNT was the preferred explosive, but because of a TNT shortage, many ordnance plants, including the IOP, were designed and built to use amatol, a mixture of TNT and ammonium nitrate. Unlike TNT, ammonium nitrate was produced at the plant. When the TNT shortage ended in 1943, TNT alone was used for the main ordnance explosive, and ammonium nitrate production stopped.

The process of producing ammonium nitrate included passing ammonia gas through the nitric acid creating a solution that was then stirred to complete the evaporation process.

Silas Mason, under contract with the Army, manufactured fertilizer-grade ammonium nitrate sometime between 1946 and 1950. In 1950, fertilizer production ended, and the Department of Army transferred control and jurisdiction of the facility to the United States Department of Interior (USDOI).

Post-IOP industrial tenants included UMC, who tested photo flash signals in this area for approximately six months during 1955. Barium nitrate and potassium perchlorate were waste products from the manufacture of photo flash signals.

Olin leased this area from January 1956 through April 1964 for storage, burning, and explosives manufacturing. Olin originally manufactured ammonium nitrate in Area 12 until the ammonium nitrate facility in Area 11 was completed. It is likely that Olin also used Area 12 to manufacture Olinite 7, which was a form of dynamite made with ammonium nitrate and diesel fuel.

In 1960, Olin constructed and filled eight powder storage ponds in the area between the IOP Group II Load Line and the Ammonium Nitrate Plant. The ponds were excavated, lined with a black

plastic, filled with powder and then filled with water. Olin stored flashless, non-hygroscopic powder (FNH) in these ponds.

Olin reported that open burning began in this area in 1956 and continued until 1964, and they estimated that 4,000,000 lbs of explosives, pyrotechnics and propellants were burned in these burning grounds from 1956 through 1964. They also estimated that approximately 40,000 lbs of primarily metal oxides remained at the burning grounds.

CSC occupied Area 12 from April 1964 through 1982. CSC (and its successors) used this area for storage and for RDX production. Additionally, burning grounds were still present on the western side of the property during CSC's tenure, and presumably used by CSC.

Site Investigation

The SI included drum content, soil, sediment, groundwater, surface water, and trench water samples.

Notable Contamination Found

Arsenic, beryllium, chromium, lead, and RDX exceeded SI screening criteria in groundwater.

Detections of carbon tetrachloride, choroform, dichloroethene, methylene chloride, PCE and TCE in soil exceeded SI screening criteria.

Maximum detections of most inorganics in soils exceeded SI screening criteria, including chromium at 1,370 mg/kg, copper at 846 mg/kg, lead at 3,330 mg/kg, cadmium at 15 mg/kg, and zinc at 1,970 mg/kg.

Illinois Surface Water Quality Standards were exceeded for copper, lead, and manganese.

12.1.6.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.6.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 12-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for

Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 12-1**.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.6.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.6.5 Applicable Decision Document

There is not yet a decision document for this site.

12.1.7 LUCIP for AUS-106A – Drum Disposal Area East of Area 11 (AUS OU)

AUS-106A is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

12.1.7.1 Site Description and Investigation Results

AUS-106A is a former drum disposal area. It is located due east of the former Nitroglycerin Area in Area 11 (AUS-A11N) on the north side of an abandoned roadway (**Figure 12-1**). The site covers approximately 3,000 square feet (ft) and consists of a mounded area of partially buried drums with some nearby debris, including an oven hood and two former smoke stacks.

Operational History and Waste Characteristics

The 1951 aerial photograph showed a possible disposal site in this location, just north of what appeared to be a farm lane. There was no evidence of this disposal site in the 1943 aerial photographs. In 1951, portions of the site were vegetated, indicating that they may not have been used for some time. By 1960, this area was completely covered with vegetation and the former farm lane no longer appears on the photo, suggesting that this area had been inactive for some time. This also suggests that an operator/tenant who was at the site prior to 1951 may have been responsible for the drums. These operators/tenants include the SWDC/War Department (operator 1942-1945), Hoosier Cardinal (tenant, 1948 through 1954) or Silas Mason (operator, 1947 through 1950).

During the site reconnaissance, it was estimated that 50 to 100 drums were in this area. The drums were partially buried and located along an intermittent streambed. There was a blue-gray solid substance visible in several of the exposed drums.

Site Investigation

The SI included drum content samples and several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

Benzene, dichloroethene, toluene, and TCE were detected in the drums. TCE was detected at a maximum concentration of 13,000 ug/kg in the soil, well above SI screening criteria.

Soil results included cadmium at 150 mg/kg, chromium at 222 mg/kg, copper at 3,300 mg/kg, lead at 24,700 mg/kg, selenium at 22 mg/kg, and zinc at 3,160 mg/kg.

12.1.7.2 LUCIP Objective

The IOP-wide LUCIPs are applicable (Section 2). In addition, because the site is not characterized, another LUCIP objective is to reduce potential for exposure until specific objectives can be identified based on site characterization data. In particular, because of the high soil concentrations of TCE, a specific objective is to prevent harmful exposure to chlorinated solvent vapors. Another specific objective is to prevent exposure to the drummed materials.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

12.1.7.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is prohibited except for OSHA-trained personnel. The restricted area is shown in **Figure 12-1**.

No soil nor drummed materials will be removed from the site, except for samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. CERCLA staff should be consulted at the time digging activities are planned or scheduled. Soil from this site should not be used for borrow material, and agricultural use is prohibited at this site.

Controlled burns will not be conducted in this area, and the current hunting restriction will remain in place.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 12-1**.

These LUCs will be modified as appropriate as data are obtained in the RI.

12.1.7.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.1.7.5 Applicable Decision Document

There is not yet a decision document for this site.

12.2 LUCIP FOR COP-4 (EMMA OU)

12.2.1 Site Description

Placeholder for Army Information. **Figures 1-5 and 12-1**.

12.2.2 LUCIP Objective

In addition to the LUCIP objective for the entire IOP (see Section 2), other objectives for the COC ELUC Area are to protect against exposure to contaminated soil and protect against possible contact with UXO.

12.2.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, certain restrictions are applicable to the COC ELUC Area (**Figure 12-1**). Additional LUCs will include the prohibition of agricultural uses within the area and the prohibition of digging, trenching, or any other disturbance of the soil with the exception of soil samples to be taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Controlled burns will not be conducted within the COC LUC Area. Because live munitions have been found in this area in the past, there is a likelihood of finding them in the future.

12.2.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

12.2.5 Applicable Decision Document

The applicable decision document is the Record of Decision (ROD) for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) (U.S. Army Corps of Engineers, 1996) along with the Engineering Evaluation and Cost Analysis Final Report, Former Illinois Ordnance Plant, Marion, Illinois (Parsons Engineering Science, Inc., October 1997).

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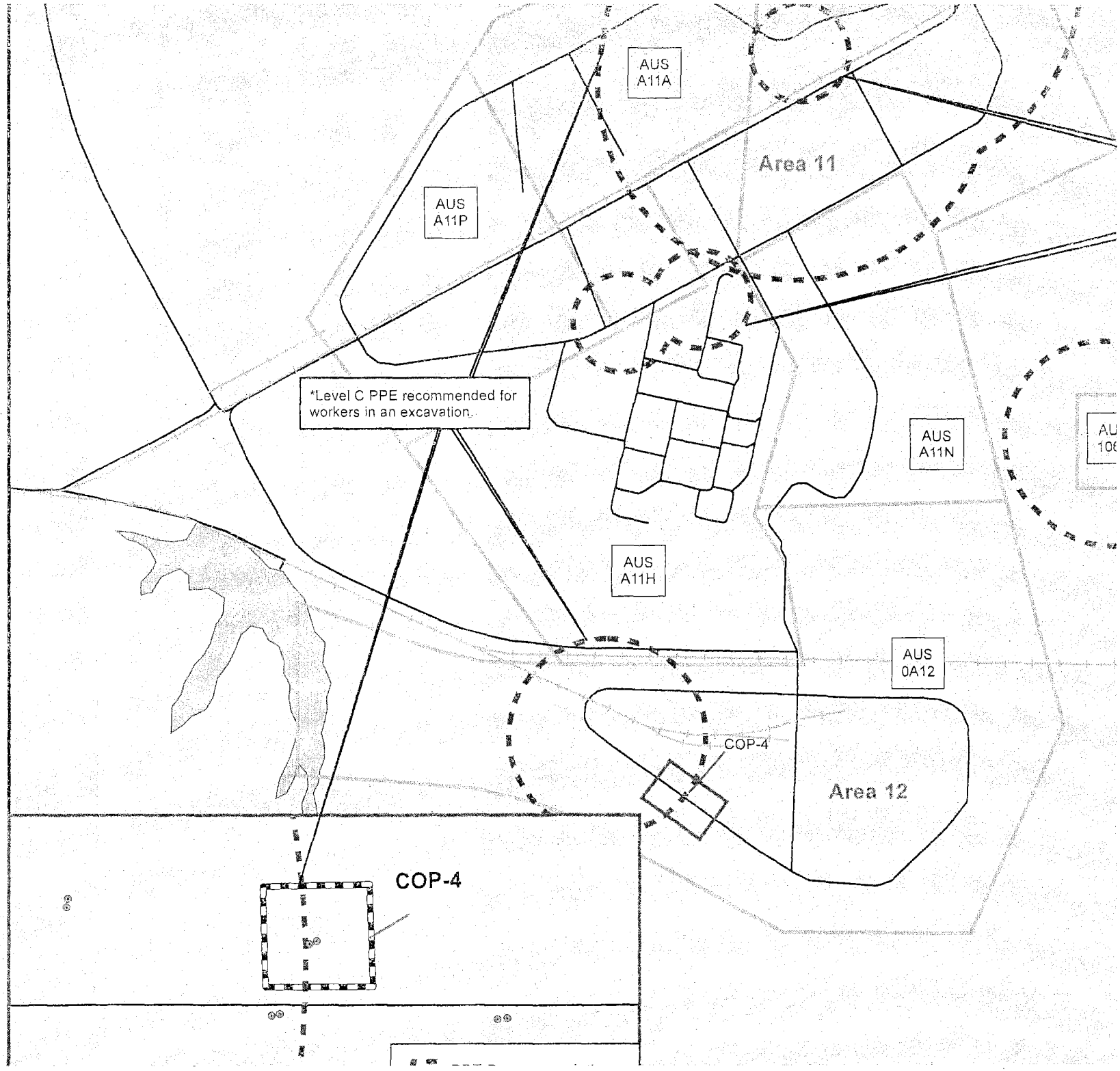


13.1 AREA 13

Area 13, IOP Finished Ammunition Igloos (FAI) Area, is west of Areas 10 and 11, and south of Crab Orchard Lake (**Figures 1-7 and 13-1**). The site originally included 88 igloos, and covers about 500 acres.

13.1.1 LUCIP for AUS-0A13 – Finished Ammunition Igloos (AUS OU)

AUS-0A13 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

13.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

These finished ammunition storage igloos were constructed and operated by SWDC/War Department as part of the IOP (**Figure 13-1**). The igloos have been used by various post-war tenants to store raw materials and products.

Olin Corporation (formerly Olin Mathieson Chemical Company) began leasing igloos in the southern half of Area 13 in 1956. It continued to lease igloos in Area 13, including some in the northern half, until the end of 1996 when its ordnance manufacturing business was spun off to Primex Technologies, Inc. (Primex). Primex took over the Olin leases, which were assumed by GDO&TS in January 2001.

Reportedly, Olin stored and detonated (tested) nitroglycerin in Area 13. Also, Olin reportedly burned dynamite on the road in Area 13, in front of the igloos, using straw and diesel fuel.

Early lease and corporate information is incomplete, but it appears that CSC took over some of Olin's igloos in the northern portion of Area 13 when it purchased a portion of the Olin business on the Refuge in 1963. CSC later changed its name to International Minerals and Chemical Corporation (IMC). IMC sold a portion of its explosives business to Trojan Corporation in 1982. Trojan was acquired by Ensign Bickford Industries in 1986. For a time, Trojan leased the igloos in the southern portion of Area 13 in its own name; Ensign Bickford later took over the leases.

GDO&TS and Ensign Bickford currently lease all the igloos in Area 13. These igloos, in the southern and northern half of the area, respectively, have been used historically for propellant and explosives storage.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

The following explosives were detected in soils above SI screening criteria: 2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitroglycerin. None of these were detected at potentially explosive levels. 2,4-dinitrotoluene was detected at 64,000 ug/kg in the soils.

N-nitrosodiphenylamine and carbazole were also detected above SI screening criteria in the soils, as were many other SVOCs and inorganics.

Chromium was detected at 155 mg/kg in the soil.

13.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

13.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 13-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. These LUCs will be modified as appropriate as data are obtained in the RI.

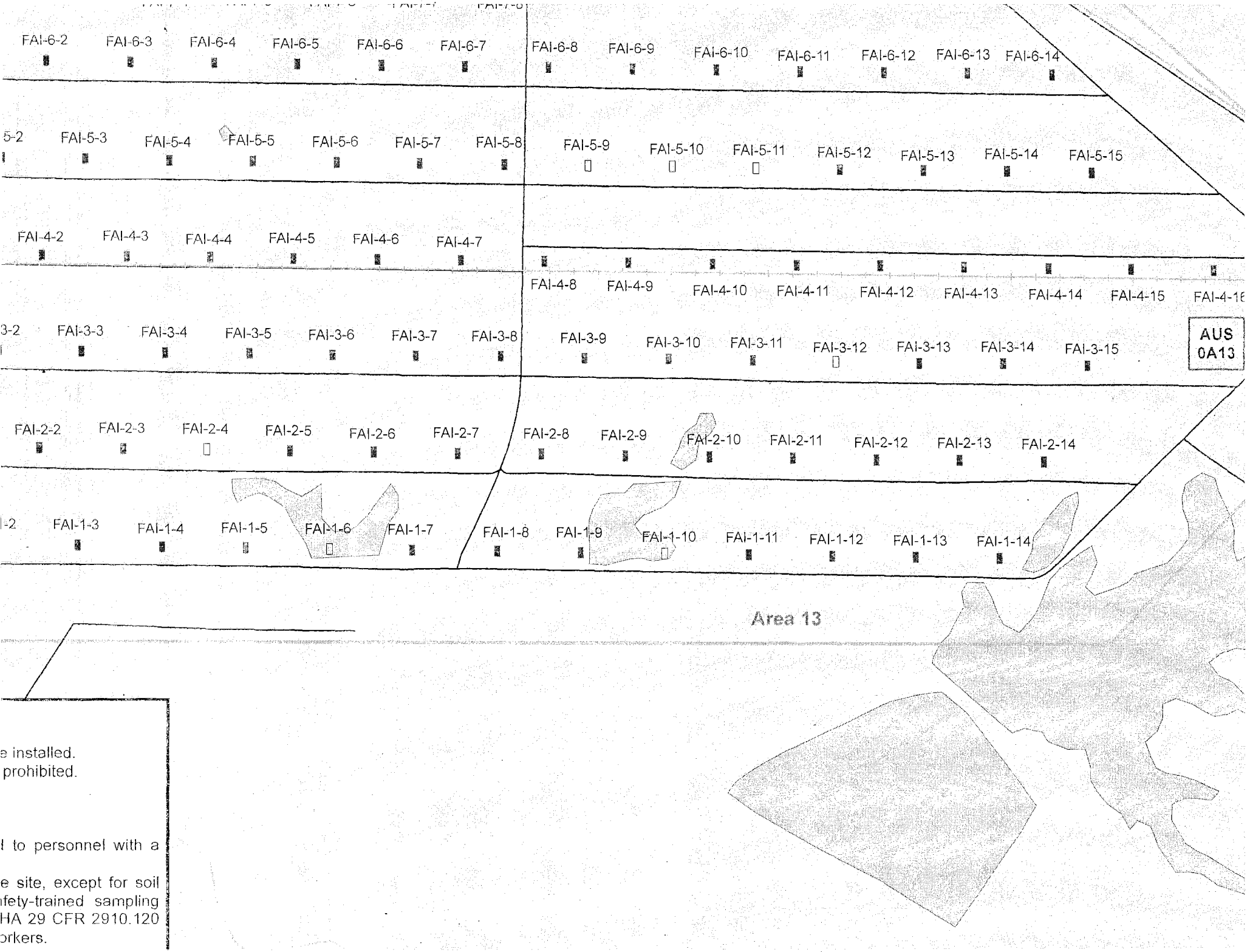
13.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

13.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.



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14.1 AREA 14

Site AUS-0060 is the location of the IOP Fulminate Storage Igloos, Area 14. The site is located north of Crab Orchard Lake and west of Area 2 (**Figures 1-7 and 14-1**). It covers about 6 acres. Because of the relatively small size of the site and the fact that the original AUS OU designation as Site 60 included the entire area, the original designation was retained, rather than renaming it as Area 14. IOP used this site for storing lead azide and mercury fulminate, which are explosive components of detonators.

14.1.1 LUCIP for AUS-0060 – Fulminate Storage Igloos (AUS OU)

AUS-0060 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

14.1.1.1 Site Description and Investigation Results

Operational History and Waste Characteristics

This site was originally designed, built and used by SWDC/War Department for the storage of lead azide and mercury fulminate for use in detonators (**Figure 14-1**). There were five structures located in this area: two azide storage vaults, two fulminate storage vaults and a guard house.

After World War II, the storage igloos may have been used to store other compounds including trinitrotoluene (TNT), tetryl, and nitrocellulose. Lease documents indicate UMC occupied this area from 1956 to 1964. According to a former UMC employee, one of the materials stored in this area was mercury fulminate, along with other high explosives and propellants. They may have also stored lead azide and/or lead styphnate in these igloos, since UMC conducted testing of these explosives.

Olin also used these igloos for general storage from 1970 through at least 1985. Wildlife Materials, Inc., leased Igloo FS-2-2 from at least 1970 to 1985 for storage of black powder, M6 propellant. and electric squibs.

In 1997, under contract with the Department of the Army, Parsons Engineering (1997) investigated this site to determine if ordnance or explosives (OE) remained in the bunkers. A small amount of propellant powder was removed and destroyed.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

Several metal detections in soil exceeded SI screening criteria: arsenic, chromium, lead, mercury, and nickel.

14.1.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

14.1.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 14-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Additionally, soil from this site should not be used for borrow material.

Because standard hand-held organic vapor monitors are not sensitive enough to detect low concentrations that may be harmful, and site-specific soil concentration data are not available, digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Agricultural use is prohibited at this site.

These LUCs will be modified as appropriate as data are obtained in the RI.

14.1.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

14.1.1.5 Applicable Decision Document

There is not yet a decision document for this site.

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15.1 LUCIP FOR AUS-0001 – FIRE AND POLICE HEADQUARTERS (AUS OU)

AUS-0001 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

15.1.1 Site Description and Investigation Results

AUS-0001, the former IOP Police and Fire Headquarters or Fire Station No. 1, is located west of Wolf Creek Road and south of Old Highway 13 (**Figure 14-1**). No buildings remain on this site, which covers less than one acre.

Operational History and Waste Characteristics

This facility was originally constructed and operated by SWDC/War Department as a part of the IOP. The main building was razed sometime between 1971 and 1980.
The Crab Orchard Sportsmen's Association used this building as their club headquarters.

Site Investigation

The SI included soil and groundwater samples.

Notable Contamination Found

Maximum detections of SVOCs and inorganics in soils exceeded SI screening criteria, including arsenic at 535 mg/kg and zinc at 1,410 mg/kg.

15.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

15.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 14-1**). No soil will be removed from the site, except for soil samples taken

by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material. These LUCs will be modified as appropriate as data are obtained in the RI.

15.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.1.5 Applicable Decision Document

There is not yet a decision document for this site.

15.2 LUCIP FOR AUS-0002 –WASTEWATER TREATMENT PLANT (AUS OU)

AUS-0002 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

15.2.1 Site Description and Investigation Results

AUS-0002, the IOP Administrative Area Wastewater Treatment Plant, is south of Old Highway 13 and west of Wolf Creek Road (**Figure 14-1**). The site is less than a acre in size.

Operational History and Waste Characteristics

This IOP WWTP was originally constructed and operated by SWDC/War Department. It appears from an IOP sewer distribution drawing that this WWTP may have supported not only Area 1 but also parts of Area 2.

The WWTP consisted of a blockhouse with four treatment pits and an assumed underground sewer line to the west emptying into two small lagoons. The blockhouse and the four treatment pits were razed sometime between 1980 and 1993. The lagoons are still on site.

No industrial lessees were identified for this plant. According to the historical aerial photograph interpretations, this plant appears to have been abandoned sometime between 1943 and 1951.

Site Investigation

The SI included soil and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

Maximum detections of many inorganics in soils exceeded SI screening criteria, including chromium at 737 mg/kg and silver at 99 mg/kg.

15.2.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

15.2.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 14-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material. These LUCs will be modified as appropriate as data are obtained in the RI.

15.2.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.2.5 Applicable Decision Document

There is not yet a decision document for this site.

15.3 LUCIP FOR AUS-0061 – IOP DETONATION AND DISPOSAL AREA (AUS OU)

AUS-0061 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

15.3.1 Site Description and Investigation Results

"IOP Detonation and Disposal Area" is not an official IOP designation. The site name was developed during the PA/SI investigation as a description of the site which was apparently used during the IOP era for testing explosives, and for disposal. There are three concrete structures on the explosives testing portion of the site. The disposal portion of the site is adjacent to the PCB OU Site 17, the Job Corps Landfill.

The access road to the site is located on the west side of Wolf Creek Road one mile south of Old Highway 13 (**Figure 14-1**). The detonation area portion of the site is approximately 0.1 miles west of Wolf Creek Road, on the south side of the access road and the disposal area is located on the north side of this access road.

The disposal portion of the site was not investigated during the PA/SI because it was not discovered until the SI field investigation was already in progress. The disposal area is north of the detonation area. It was included with AUS-0061 because of proximity and because both sites appear to be related to IOP activities.

Operational History and Waste Characteristics

According to Mr. Wayne Adams, a former Refuge manager, the concrete structures in the "Detonation Area" of the site were used to detonate explosives during World War II. The two westernmost structures are probable detonation pits and the easternmost structure is a probable firing pit. These conclusions are based on the layout and configuration of the structures, supported by statements from Mr. Adams.

The IOP Disposal Area portion of this site was observed in the 1943 historical aerial photographs. This area appeared to contain 12 to 14 north-south trending trenches and one east-west trending trench. The trenches were filled with unidentifiable materials and were observed in the 1943 aerial photograph only. By 1951, the trenches were filled.

The 1951 and 1960 aerial photographs showed evidence of surface dumping in the western part of the former trench area. This activity appeared to be unrelated to the IOP Disposal Area observed in

the 1943 photograph. This surface dump was apparently the Job Corps Landfill, which was remediated as part of the PCB OU.

There were no known industrial lessees of this property.

Site Investigation

The SI included several soil samples of varying depths in the Detonation Area only; no groundwater monitoring wells were installed. The SI included only the detonation pits and not the trenches.

Notable Contamination Found

SVOCs and most inorganics exceeded SI soil screening criteria at the detonation pits. In the soil samples, cadmium was detected at 91 mg/kg and mercury at 1.1 mg/kg.

15.3.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions. An additional objective is to prevent exposure to unknown materials buried at the disposal part of the site.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

15.3.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 14-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material. These LUCs will be modified as appropriate as data are obtained in the RI.

15.3.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.3.5 Applicable Decision Document

There is not yet a decision document for this site.

15.4 LUCIP FOR SITE 27 – CRAB ORCHARD CREEK BELOW I-57 DREDGE AREA (MISCA OU)

15.4.1 Site Description

Site 27 is a segment of Crab Orchard Creek, in an area dredged a number of years ago (**Figure 1-4**). Because it is located downstream of the Marion Sewage Treatment Plant, it was investigated in the 1988 RI to evaluate whether discharges from the Marion Sewage Treatment Plant may be impacting Crab Orchard Lake.

Previous investigations at Site 27 include the 1988 RI.

15.4.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, one composite surface water sample and one composite sediment sample (0-1ft deep) were collected and analyzed for VOCs, pesticides, total PCBs, explosives, metals, some indicator parameters.

Table 15-1 summarizes only the detected analytical results from the surface water and sediment samples. None of the detections exceeded levels of concern established for the 1988 RI, nor did they exceed any screening criteria used for this LUCIP (**Table 15-1**).

15.4.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives are needed.

15.4.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

15.4.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP:

15.4.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002). While the ROD identifies this site as a "No Action" site, the IOP-wide LUCs are still needed because of the lack of groundwater data.

15.5 LUCIP FOR SITE 36 – REFUGE WASTEWATER TREATMENT PLANT (MISCA OU)

15.5.1 Site Description

Site 36, the former refuge wastewater treatment plant, is located on the north side of Crab Orchard Lake (**Figure 1-4**). Soil, sludge, surface water and sediment at the site was remediated in 2005 in accordance with the Record of Decision (ROD) for Site 36, signed in 2002. While there were a number of contaminants of concern, PCBs and cadmium were most notable, with maximum detected concentrations of 130 mg/kg and 584 mg/kg, respectively. The remediation criteria for these contaminants of concern were 0.6 ppm for PCBs in soil and 4 ppm (in soil) and 5 ppm (in sediment) for cadmium.

15.5.2 LUCIP Objective

The IOP-wide LUCIP objectives apply.

15.5.3 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed.

15.5.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. However, if additional data show risks not yet identified, additional restrictions may apply.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.5.5 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002).

15.6 LUCIP FOR THE VISITOR CENTER (WTOU)

15.6.1 Site Description

The Visitor Center is located Highway 148 just north of Crab Orchard Lake (**Figure 1-6**).

This site was addressed by a removal action in 1992. The site was cleaned up to the goal of 450 mg/kg identified in the *Action Memorandum for the Water Towers Operable Unit at the Crab Orchard National Wildlife Refuge (Refuge) Superfund site* (WTOU), 1992. At the time of the cleanup, that level was considered protective for residential use. However, USEPA Region 9 has recently published a residential preliminary remediation goal (PRG) of 150 mg/kg for lead.

15.6.2 LUCIP Objective

The LUCIP objective is the same as for the entire IOP (see Section 2 – IOP-Wide LUCIPS). Based on the available data, no other restrictions are needed.

15.6.3 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

15.6.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.6.5 Applicable Decision Document

The applicable decision document is the action memorandum referenced above.

15.7 LUCIP FOR SITE 17 – JOB CORPS LANDFILL (PCB OU)

15.7.1 Site Description and Investigation Results

This former landfill was used by Sangamo Electric and was contaminated with PCBs and heavy metals (**Figure 1-2**).

The remediation criteria, in accordance with the ROD, was as follows:

- Lead to 450 ppm dry soil (dry weight basis)
- Cadmium to 10 ppm dry soil
- PCBs to 1 ppm dry soil in surface soils (defined as the top foot [12 inches] of soils)
- PCBs to 25 ppm dry soil in subsurface soils (defined as soils below the 1-foot depth)
- PCBs to 0.5 ppm dry sediments.

Recent studies by FWS indicate the potential for elevated PCB concentrations remaining at this site. FWS is investigating.

15.7.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. An additional objective is to prevent potential exposure to PCBs remaining at this site.

15.7.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access should be limited to personnel who need to use the site. Digging should be prohibited, except for investigatory purposes and soil from this site should not be used for borrow material.

15.7.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUCs apply, Confirmation that the PCB OU clean up objectives have been met will be needed to remove the LUC restricting digging.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

15.7.5 Applicable Decision Document

The applicable decision document is the PCB OU ROD, signed in 1990.[38]

[38] U.S. Environmental Protection Agency. 1990b. *Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge, PCB Areas Operable Unit*, August 1, 1990.

TABLE 15-1
ANALYTICAL DATA SCREENING FOR
SITE 27 - CRAB ORCHARD CREEK BELOW I-57 DREDGE AREA
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G	
Sample ID	27-1-2-1		27-2-3-4	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Surface Water	*R. Code*	Soil	*R. Code*
Depth (feet)	NA		0-1	
CONSTITUENT				
Aluminum	ND		10400	H
Barium	40	C	125	
Boron	71		34	A
Calcium	49000	C	2320	
Chromium	ND		10	
Cobalt	ND		9	
Iron	500	C	14900	H
Magnesium	12400	C	1570	A
Manganese	638	C	679	H
Sodium	28400	C	100	
Titanium	ND		134	
Vanadium	ND		20	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge, August. Note, results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable, all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.
(2) Woodward-Clyde, 1996. Remedial Investigation Report, Remedial Investigation Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge February.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWF

16.1 LUCIP FOR AUS-0043 – AREAS 11 & 12 FIRE STATION (AUS OU)

AUS-0043 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

16.1.1 Site Description and Investigation Results

AUS-0043, the former IOP Fire Station No. 4, is located south of Crab Orchard Lake and northwest of Areas 11 and 12 (**Figures 1-7 and 11-1**). The site covers less than an acre. The fire station building is no longer on site.

Operational History and Waste Characteristics

This Fire Station was operated by SWDC/War Department as a part of the IOP, and serviced IOP facilities in its area. No industrial lessees were identified for this site.

Site Investigation

The SI included soil and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

2,6-dinitrotoluene in soil exceeded SI screening criteria. SVOCs and inorganics exceeded SI soil screening criteria. Lead was detected at 1,110 mg/kg in soil.

16.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

16.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 11-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material and agricultural use is prohibited. These LUCs will be modified as appropriate as data are obtained in the RI.

16.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

16.1.5 Applicable Decision Document

There is not yet a decision document for this site.

16.2 LUCIP FOR SITE 21 – SOUTHEAST CORNER FIELD (MISCA OU)

16.2.1 Site Description

Site 21, the Southeast Corner Field, was identified as a possible former dumping area. The site, shown on (**Figure 1-4**) is a fenced area (with many large trees) that gradually slopes to the southeast towards a swampy ditch. It is located near the southeast corner of the Refuge in a pasture where a pile of concrete debris was observed. Field investigations found no evidence of dumping at this site, other than the concrete rubble. It was later determined that the rubble was probably part of a church that pre-dated the Illinois Ordnance Plant (IOP) (1996 RI).

16.2.2 Investigations

1988 RI (O'Brien & Gere)

During the 1988 RI, several samples were analyzed and magnetometer and electromagnetic surveys were conducted. The RI reported that no metallic objects were buried at the site. Four composite soil samples (0 to 1 foot depth) were collected along north-south transects at this site and were analyzed for VOCs, SVOCs, PCBs, pesticides, metals, explosives, and other indicator parameters.

Table 16-1 summarizes only the detected analytical results from the composite soil samples.[39] None of the detections exceeded levels of concern established for the 1988 RI. Because no concerns were indicated, this site was not investigated in the 1993 Phase I MISCA OU RI. Historic and aerial photo review done as part of the 1996 Phase II RI indicated that the debris might have been from the demolition of a church. No evidence of industrial usage was found and no sampling was done at this site as part of the 1996 RI. However, as shown in **Table 16-1**, a comparison of the 1988 data with the screening criteria used for this document shows three potential chemicals of concern.

Antimony exceeded the following screening values in all four soil samples:

- Background Soil 95% Upper Tolerance Limit
- USEPA Region 9 Residential Soil Preliminary Remediation Goal.

PCBs and SVOCs were analyzed in only one sample. The estimated concentration of Aroclor 1254 exceeded the USEPA Region 9 Residential Soil Preliminary Remediation Goal.

[39] Note that a number of analytes are not included because these data were later rejected: DPRA Document No. 00018887, a letter from USEPA to USFWS regarding Crab Orchard Lake RI/FS, dated February 18, 1987. A list of the rejected data can be found in the letter.

16.2.3 LUCIP Objective

Based on the available data, no objectives other than the IOP-wide objectives are needed.

16.2.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used as borrow material.

16.2.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

16.2.6 Applicable Decision Document

The applicable decision document is the Record of Decision, Site 36 of the Miscellaneous Areas Operable Unit, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois (USFWS, 2002).

16.3 LUCIP FOR COC-10 (EMMA OU)

16.3.1 Site Description

COC-10 is located east of Area 10 and north of Areas 11 and 12 (**Figure 1-5**). It is a well-vegetated site approximately 120 feet square located on the northern edge of a corn field. A man-made depression characterizes most of the site.

Previous investigations at COC-10 include the 1988 FCS, the 1991 Phase I RI, and the 1994 Phase II RI.

16.3.2 Investigations

1988 Final Confirmation Study (Woodward-Clyde Consultants)

During the 1988 FCS, a magnetometer survey was conducted which indicated no detected anomalies suggestive of buried metallic objects. One sediment, one surface water, and two soil samples were collected and analyzed for VOCs, petroleum hydrocarbons, explosives, and metals.

Table 16-2 summarizes only the detected analytical results from the soil samples. While some metals exceeded the 95% upper confidence limit established for the 1988 FCS, the results were judged to be well within the range reported for soils in the United States. A comparison of the 1988 data results with the screening criteria used for this LUCIP shows one exceedance (**Table 16-2**):

Cadmium exceeded the following screening criteria in the sediment sample:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1991 Phase I RI (Environmental Science and Engineering, Inc.)

Four soil, one surface water, and two sediment samples were collected from COC-10 during the 1991 Phase I RI and analyzed for VOCs, SVOCs, explosives, metals, and total petroleum hydrocarbons.

Table 16-2 summarizes only the detected analytical results from the soil samples. Some of the detected analytes warranted further investigation during Phase II RI activities (following). A comparison of the 1991 data with the screening criteria established for this LUCIP shows several potential chemicals of concern (**Table 16-2**).

Iron exceeded the following screening criteria in two soil samples:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

Aluminum and iron exceeded the following screening criteria in sediment:

- Background Sediment 95% Upper Tolerance Limit (UTL), and
- USEPA Region 9 Residential Soil Preliminary Remediation Goal

1994 Phase II RI (Environmental Science and Engineering, Inc.)

Two soil, five sediment, and two surface water samples were collected and analyzed for explosives and metals during the 1994 Phase II RI sampling event. **Table 16-2** summarizes only the detected analytical results from these samples. None of the detections exceeded levels of concern established for the 1994 RI. In fact, the 1994 BRA determined that there was no ecological nor human health risk at COC-10. Further, a comparison of the 1994 data with the screening criteria established for this LUCIP shows no potential chemicals of concern (**Table 16-2**):

16.3.3 LUCIP Objective

The LUCIP objective is the same as for the entire IOP (see Section 2). Based on the available data, no other restrictions are needed at this time.

16.3.4 LUC(s) Implemented to Achieve Objective

No additional LUCs beyond the IOP-wide LUCs are needed except that soil from this site should not be used for borrow material.

16.3.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

16.3.6 Applicable Decision Document

The applicable decision document is the Record of Decision (ROD) for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) (U.S. Army Corps of Engineers, 1996).

16.4 LUCIP FOR SITE 28 LANDFILL – WATER TOWER (PCB OU)

16.4.1 Site Description and Investigation Results

This former landfill was used by Sangamo Electric and was contaminated with PCBs and heavy metals (**Figure 1-2**).

The remediation criteria, in accordance with the ROD, was as follows:

- Lead to 450 ppm dry soil (dry weight basis)
- Cadmium to 10 ppm dry soil
- PCBs to 1 ppm dry soil in surface soils (defined as the top foot [12 inches] of soils)
- PCBs to 25 ppm dry soil in subsurface soils (defined as soils below the 1-foot depth)
- PCBs to 0.5 ppm dry sediments.

Recent studies by FWS indicate the potential for elevated PCB concentrations remaining at this site. FWS is investigating.

16.4.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. An additional objective is to prevent potential exposure to PCBs remaining at this site.

16.4.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, nobody should enter this site until further investigated. Digging should be prohibited, except for investigatory purposes, and soil from this site should not be used for borrow material.

16.4.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUCs apply. Confirmation that the PCB OU cleanup objectives have been met will be needed to remove the LUC restricting digging.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

16.4.5 Applicable Decision Document

The applicable decision document is the PCB OU ROD, signed in 1990.[40]

[40] U.S. Environmental Protection Agency, 1990b. *Declaration for the Record of Decision, Crab Orchard National Wildlife Refuge. PCB Areas Operable Unit*, August 1, 1990.

TABLE 16-1
ANALYTICAL DATA SCREENING FOR
SITE 21 - SOUTHWEST CORNER FIELD
MISCA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	O'B&G		O'B&G		O'B&G		O'B&G	
Sample ID	21-1-1-1/6/29		21-2-1-1		21-3-1-1		21-4-1-1	
Matrix (soil & sediment values shown in mg/kg; surface water values in ug/L)	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*	Soil	*R. Code*
Depth (feet)	0-1		0-1		0-1		0-1	
CONSTITUENT								
2-Methylnaphthalene	0.051							
Aluminum	7980	H	13200	H	14000	H	12000	H
Anthracene	0.105							
Antimony	7.9	A H	8.2	A H	7	A H	8.4	A H
Aroclor 1254	0.133	H						
Barium	95.2		81.2		87.2		98.2	
Boron	16	A	9.7	A	8.8	A	3	
Calcium	45000	A	16700	A	12100	A	1800	
Chromium	9		17		17		14	
Cobalt	6		8		6		7	
Dibenzofuran	0.018							
Iron	12700	H	16800	H	18300	H	16600	H
Magnesium	27200	A	10500	A	3280	A	1740	A
Manganese	995	H	638	H	418	H	611	H
Molybdenum	2		2		2		2	
N-Nitrosodimethylamine	0.011	H						
Phenanthrene	0.105							
Sodium	170		80		80		120	
Titanium	202		292		301		164	
Vanadium	18		32		32		31	

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram
ug/L = micrograms per Liter
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) O'Brien & Gere, 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge , August. Note, Results for some chemicals reported by O'Brien & Gere (1988 RI) were determined to be not useable; all usable results are considered estimated. For a list of chemicals considered not useable, refer to DPRA Document No. 00018887, a letter dated 02/18/87 from USEPA to USFWS.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 16-2, ANALYTICAL DATA SCREENING FOR
COC-10 of the EMMA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	WCC (1988 CS)		WCC (1988 CS)		WCC (1988 CS)		WCC (1988 CS)		ESE (1991 Ph I RI)		ESE (1991 Ph I RI)		ESE (1991 Ph I RI)		ESE (1991 Ph I RI)		ESE (1991 Ph I RI)		ESE (1991 Ph I RI)	
Sample ID	COC-10-1		COC-10-3		SSCOC-10-1		SWCOC-10-1		SSCOC10-1		SSCOC10-2		SSCOC10-3		SSCOC10-4		SWCOC10-1		SDCOC10-1	
Matrix (soil & sediment values shown in mg/kg surface water values in ug/L)	Soil	R. Code	Soil	R. Code	Sediment	R. Code	Surface Water	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Soil	R. Code	Surface Water	R. Code	Sediment	R. Code
Depth (feet)	Composite (2, 7, & 12)		Composite (2, 7, & 12)		Surface		NA		Surface		Surface		Surface		Surface		NA		Surface	
CONSTITUENT																				
2,4,6-Trinitrotoluene	ND		ND		ND		ND		ND		ND		ND		ND		ND		0.66	
Aluminum	6650		8930	H	8590	H	36		10500	H	14100	H	17700	H	13900	H	0.8		14400	B H
Antimony	ND		ND		ND		NA		0.81		0.45		ND		ND		ND		ND	
Arsenic	ND		ND		ND		ND		7.69	H	7.46	H	0.603	H	5.23	H	0.003		0.636	H
Barium	140		114		104		24	C	69.2		119		74.2		65.6		0.08		138	
Beryllium	0.57		1	A	0.33		ND		0.61		0.7		0.47		0.47		ND		0.59	
Cadmium	ND		ND		3.8	B H	ND	C	0.24	A	0.27	A	0.23	A	ND		ND		1.54	
Calcium	995		1310		924		6510		417		546		530		582		5.2		848	
Chromium	12		14		12		ND		17.6		19		20.9		17.8		ND		18.7	B
Cobalt	9.6		5.4		6.6		NA		17.1		13.3		7.72		7.97		ND		9.91	B
Copper	9.2		8.1		18	B	ND		9.85		12.9	A	17.1	A	10.7		0.004		21.8	B
Iron	16900	H	18200	H	13100	H	689	C	19300	H	23000	A H	25600	A H	18900	H	7.73		23200	B H
Lead	9.1		10		19		ND		17.3		20.1		17.8		14.4		0.003		16	
Magnesium	1830	A	1890	A	1510		3840	C	1420		2030	A	2710	A	1980	A	1.92		2470	B
Manganese	944	H	320	H	361	H	58		886	H	1740	H	307	H	519	H	0.69		517	H
Mercury	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	20	A	20	A	11		ND		9.42		12.7		13.9		10.3		ND		15.3	
Nitrobenzene	ND		ND		ND		ND		ND		0.58		ND		ND		ND		ND	
Potassium	ND		ND		ND		NA		232		557		677	A	424		7.5		579	
Selenium	ND		ND		ND		ND		0.41		0.58		0.2		0.45		ND		0.79	B
Silver	0.55		ND		0.63		14	C	0.57		0.85	A	0.4		0.25		ND		0.45	
Sodium	ND		ND		ND		ND		36.1		64.9		53.2		68.9		1.42		92.3	
Thallium	ND		ND		ND		NA		0.46	A	0.14		0.28		0.29		ND		0.26	
Total Petroleum Hydrocarbons	ND		ND		1500		ND		25		18		ND		ND		ND		ND	
Vanadium	19		30		21		NA		34.6		40.6		39.5		35.3		0.002		36.8	B
Zinc	37		32		70	B	6.7		32.7		49.2		50.5		41		0.05		64.4	B

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) Woodard-Clyde Consultants, 1988. Final Confirmation Study, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.
(2) ESE, 1994. Draft-Final Remedial Investigation/Baseline Risk Assessment Report, EMMA OU, CONWR, Marion, Illinois, Volumes I through V.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

TABLE 16-2, ANALYTICAL DATA SCREENING FOR
COC-10 of the EMMA OU

LAND USE CONTROL IMPLEMENTATION PLAN
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Source	ESE (1991 Ph I RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)		ESE (1994 Ph II RI)	
Sample ID	SDCOC10-2		BCOC10-1-2		BCOC10-1-4		SDCOC10-1		SDCOC10-1		SDCOC10-1		SDCOC103		SDCOC104		SWCOC102		SWCOC103	
Matrix (soil & sediment values shown in mg/kg surface water values in ug/L)	Sediment	R. Code	Soil	R. Code	Soil	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Sediment	R. Code	Surface Water	R. Code	Surface Water	R. Code
Depth (feet)	Surface		0-2		4-6		Surface		Surface		Surface		Surface		Surface		NA		NA	
CONSTITUENT																				
2,4,6-Trinitrotoluene	0.72		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Aluminum	12100	B,H	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Antimony	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Arsenic	5.27	H	10.1	H	5.77	H	4.38	H	5.03	H	2.25	H	5.5	H	7.98	H	55.2	C	52.9	C
Barium	198	B	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	0.64		0.809	A	0.981	A	0.642		0.886		0.754		0.935		ND		ND		ND	
Cadmium	ND		ND		ND		0.906		ND		ND		ND		ND		ND		ND	
Calcium	1010		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Chromium	19.4	B	16.9		17		18.9	B	16.5		17		12.3		16.5		ND		ND	
Cobalt	10.3	B	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Copper	15.6		18.9	A	15.6	A	19.9	B	16.5		9.16		7.76		13.8		ND		ND	
Iron	20000	H	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Lead	10.8		17.7		11.9		15.1		15.9		13.2		14.9		14.1		ND		ND	
Magnesium	2620	B	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Manganese	325	H	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Mercury	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Nickel	17.5	B	17.2		26.8	A	21.5	B	16.6		11.2		12.7		10.9		ND		ND	
Nitrobenzene	ND		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Potassium	522		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Selenium	0.39		0.529		0.637		0.559		0.341		ND		ND		ND		2.6		ND	
Silver	0.46		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Sodium	93.5		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Thallium	0.26		ND		ND		ND		ND		ND		ND		ND		ND		ND	
Total Petroleum Hydrocarbons	ND		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Vanadium	34.7	B	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	47.6		59.1	A	49.8		62	B	50.1		27.9		32.2		39.2		ND		64.3	C

Shading indicates constituent exceeded background and at least one screening criterion for inorganics; for all other constituents, shading indicates an exceedance of at least one screening criterion.

Legend
mg/kg = milligrams per kilogram, ug/L = micrograms per Liter
NA = Not Applicable or Not Analyzed
ND = Not detected
For data qualifiers, refer to source reports.

Sources:
(1) Woodard-Clyde Consultants, 1988. Final Confirmation Study, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.
(2) ESE, 1994. Draft-Final Remedial Investigation/Baseline Risk Assessment Report, EMMA OU, CONWR, Marion, Illinois, Volumes I through V.

Reference Codes:
A - Background Soil 95% UTL
B - Background Sediment 95% UTL
C - Background Surface Water 95% UTL
D - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Ingestion Exposure Route
E - IEPA TACO Tier 1 Soil Remediation Objectives for Residential Properties – Inhalation Exposure Route
F - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Ingestion Exposure Route
G - IEPA TACO Tier 1 Soil Remediation Objectives for Construction Worker Inhalation Exposure Route
H - USEPA Region 9 Residential Soil Preliminary Remediation Goals
I – Illinois General Use Water Quality Standards – Created for the AUS OU, CONWR

17.1 LUCIP FOR AUS-0062 – MOUNDS AND PITS WEST OF COC-1 (AUS OU)

AUS-0062 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

17.1.1 Site Description and Investigation Results

AUS-0062 is located in the Crab Orchard Cemetery (COC) area, south of Crab Orchard Lake (**Figures 1-7 and 17-1**). According to the USFWS, AUS-0062 is a former landfill that was closed by the Refuge in 1974.

Operational History and Waste Characteristics

The aerial photograph interpretation indicated that this site appeared to be a roadside clearing and fill operation in 1971, the year of the first photograph that showed any signs of activity in this area. By 1980, the site appeared to be inactive.

Site Investigation

The SI included soil, sediment, and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

TCE and most inorganics in soil exceeded SI screening criteria.

17.1.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

17.1.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 17-1**). No soil will be removed from the site, except for soil samples taken

by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material and agricultural use is prohibited. These LUCs will be modified as appropriate as data are obtained in the RI.

17.1.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.1.5 Applicable Decision Document

There is not yet a decision document for this site.

17.2 LUCIP FOR AUS-0065 – FOUNDATIONS NORTHEAST OF COC-1 (AUS OU)

AUS-0065 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

17.2.1 Site Description and Investigation Results

AUS-0065 is a small site in the COC area with building foundations and suspect debris (**Figures 1-7 and 17-1**).

Operational History and Waste Characteristics

It appears that AUS-0065 is the location of a former farmstead as observed in the 1943 aerial photographs. Concrete foundations, soil mounds, depressions, and a brick structure resembling a well are currently visible on site. There have been no known industrial lessees of this property.

Site Investigation

The SI included several soil samples of varying depths; no groundwater monitoring wells were installed.

Notable Contamination Found

Many SVOCs and several inorganics exceeded SI soil screening criteria.

17.2.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

17.2.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 17-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material and agricultural use is prohibited. These LUCs will be modified as appropriate as data are obtained in the RI.

17.2.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.2.5 Applicable Decision Document

There is not yet a decision document for this site.

17.3 LUCIP FOR AUS-0066 – BERM WITH RED BRICK RUBBLE (AUS OU)

AUS-0066 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

17.3.1 Site Description and Investigation Results

AUS-0066 is a small wooded site in the COC area (**Figures 1-7 and 17-1**).

Operational History and Waste Characteristics

AUS-0066 was originally described as "berm with red brick rubble" with a "Danger Contaminated Area" sign to the west. It was identified by USFWS as COC-14 of the EMMA OU and was one of the COC sites investigated only for unexploded ordnance (UXO).

AUS-0066 appears to have been the location of a former farmstead according to the 1943 aerial photographs. There was no other evidence of activity observed in this area on the historical aerial photographs.

In 1997, the Department of Army conducted an ordnance and explosive waste (OEW) investigation at this site. A total of 20 magnetic anomalies were identified; all twenty were identified as ordnance scrap.

There have been no known industrial lessees of this property.

Site Investigation

The SI included soil, sediment, and surface water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

Many SVOCs and several inorganics exceeded SI soil screening criteria. Maximum concentrations detected included cadmium at 36 mg/kg and zinc at 447 mg/kg.

Illinois Surface Water Quality Standards were exceeded for cadmium, copper, iron, lead, manganese, and zinc.

17.3.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

17.3.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 17-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material and agricultural use is prohibited. These LUCs will be modified as appropriate as data are obtained in the RI.

17.3.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.3.5 Applicable Decision Document

There is not yet a decision document for this site.

17.4 LUCIP for AUS-0067 – Fence with "Contaminated Area" Sign, Northwest of COC-6 (AUS OU)

AUS-0067 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

17.4.1 Site Description and Investigation Results

AUS-0067 is west of Wolf Creek Road and north of the COC Area Road (**Figures 1-7 and 17-1**). It was included in the AUS OU primarily because of suspect fencing and signage.

Operational History and Waste Characteristics

AUS-0067 was originally described as "fence with contaminated area (sign) northwest of COC-6." It appears this site was the location of a former farmstead as observed in the 1943 aerial photographs. Subsequent aerial photographs revealed no other activities in this area. A collapsed foundation, a cistern, some construction debris and some soil mounds were observed during the site visit.

There have been no industrial lessees of this property.

Site Investigation

The SI included soil samples and a water sample from a cistern; no groundwater monitoring wells were installed.

Notable Contamination Found

The dinitrotoluene concentration in a water sample from a cistern exceeded SI screening criteria.

17.4.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

17.4.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 1-7**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material and agricultural use is prohibited. These LUCs will be modified as appropriate as data are obtained in the RI.

PPE guidelines are provided for a portion of this site. Refer to Section 1.4.1, Table 1-5, and **Figure 17-1**.

17.4.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.4.5 Applicable Decision Document

There is not yet a decision document for this site.

17.5 LUCIP FOR AUS-0069 – DUMP NEAR SOUTH SHORE OF CRAB ORCHARD LAKE (AUS OU)

AUS-0069 is currently part of a remedial investigation conducted by General Dynamics Ordnance and Technical Systems. It was identified in the AUS OU PA/SI as requiring an RI because of exceedances of screening values.

17.5.1 Site Description and Investigation Results

AUS-0069 is in the COC area, adjacent to Crab Orchard Lake (**Figure 1-7 and 17-1**). AUS-0069 partially coincides with EMMA OU Site COC-15, one of the COC sites for which no chemical analyses were performed as part of the EMMA OU RI. AUS-0069 is also a dump site.

Operational History and Waste Characteristics

AUS-0069 was identified in aerial photographs as a potential dump. The 1943 aerial photographs, taken during the IOP operation, show deposits of probable debris and large numbers of crated materials in this area along with a looping access road. By 1951, there was still some ground scarring and mounded debris present on site, however it appears that activity in this area had been terminated.

During the site visit, the following types of material were observed: construction debris (culverts, corrugated asbestos sheeting, concrete rubble, clay blocks, bricks, steel scrap), rusted drums, piping and soil mounds. Most of the debris is located in a stand of trees along the lakeshore and some of the debris is in Crab Orchard Lake.

There have been no known industrial lessees of this property.

Site Investigation

The SI included soil, sediment and trench water samples; no groundwater monitoring wells were installed.

Notable Contamination Found

PCE was detected in soils above the SI screening criteria. Maximum detections of many SVOCs and inorganics exceeded soil and/or sediment SI screening criteria, including antimony at 173 mg/kg, barium at 4,940 mg/kg, cadmium at 28 mg/kg, chromium at 266 mg/kg, lead at 51,000 mg/kg, and zinc at 16,400 mg/kg.

17.5.2 LUCIP Objective

The IOP-wide LUCIP objectives apply. As with all sites under investigation in the AUS OU RI, exposure should be minimized as much as practicable. RI results may indicate the need for additional restrictions. A specific objective is to prevent exposure to the debris at the site.

When the results from the current RI are available, this LUCIP will be reviewed and appropriate modifications made.

17.5.3 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, access to this area is restricted to personnel with a specific need to be at the site (**Figure 17-1**). No soil will be removed from the site, except for soil samples taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers.

Digging and trenching at the site is limited to activities necessary for facility operation, such as subsurface utility repair and roadway repair, including culverts. Further, soil from this site should not be used for borrow material.

Note, the part of the site with the debris is off-limits except for OSHA-trained and certified personnel involved with CERCLA work.

This LUCIP will be re-evaluated as RI data are obtained.

17.5.4 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. Other restrictions will depend upon the results of the RI/FS currently in progress.

See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.5.5 Applicable Decision Document

There is not yet a decision document for this site.

17.6 LUCIP FOR HAMPTON CEMETERY COC ELUC AREA (EMMA OU)

17.6.1 Site Description

The COC ELUC Area borders Crab Orchard Lake and consists of sites COC-1, COC-3, COC-4, COC-5, COC-6, COC-9 and the reforested areas around the sites (**Figure 17-1**). COC-1 is located southwest of the Hampton Cemetery at the southwest intersection of Old Carterville Road and Hampton Cemetery Road. COC-3 is just west of COC-4 and both sites are east of Old Carterville Road and just north of Hampton Cemetery Road. COC-5 is northwest of the intersection of Old Carterville Road and Hampton Cemetery Road. COC-6 is northwest of COC-3 and east of Old Carterville Road. COC-9 lies west of COC-1. The reforested areas are north of Hampton Cemetery Road and surround the other sites. COC-15 is east of these other sites, north of Hampton Cemetery Road and east of Wolf Creek Road, along the south side of Crab Orchard Lake. COC-15 coincides with AUS-0069. All of the sites were suspected of being detonation or disposal areas. Sites COC-4, 5, 6, and 9 appear to be detonation areas from the detonation pits and associated fragmentation zones. Because of the trenches or pits that were dug out and filled with scrap and defective ordnance and then covered with dirt, Sites COC-1, 3, and 15 are considered to be disposal areas.

Previous investigations at the COC ELUC AREA include the 1988 Final Confirmation Study (FCS) by Woodward-Clyde Consultants (WCC),[41] the 1991 Phase I Remedial Investigation (RI) by Environmental Science and Engineering, Inc (ESE),[42,43] and the 1994 Phase II RI by ESE.[44,45] A 1997 Engineering Evaluation and Cost Analysis (EE/CA) report by Parsons Engineering (Parsons)[6] was also performed which included an unexploded ordnance (UXO) investigation only.

[41] Woodward-Clyde Consultants (WCC), April 1988. Final Confirmation Study, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.
[42] Environmental Science and Engineering, Inc. December 1991. Explosives/Munitions Manufacturing Areas Operable Unit, Analytical Data Report, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I and II.
[43] Environmental Science and Engineering, Inc., September 1994. Draft Final Remedial Investigation/ Baseline Risk Assessment Report, Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.
[44] Environmental Science and Engineering, Inc. January 1994. Explosives/Munitions Manufacturing Areas Operable Unit, Phase II Analytical Data Report, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I and II.
[45] Environmental Science and Engineering, Inc., September 1994. Draft Final Remedial Investigation/ Baseline Risk Assessment Report, Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.
[6] Parsons Engineering Science, Inc., October 1997. Engineering Evaluation and Cost Analysis, Final Report Former Illinois Ordnance Plant, Marion, Illinois.

17.6.2 Investigations

In 1991 an RI was conducted at the EMMA OU which included a Baseline Risk Assessment (BRA). A Feasibility Study (FS) was performed on the EMMA OU sites based on the RI and BRA findings. The FS evaluated 7 remedial alternatives and was completed in September 1995. The RI included sampling and analysis to characterize the nature and extent of site contamination and background conditions, and the Baseline Risk Assessment (BRA) of current and potential future risks to human health and the environment posed by the contamination for the exposure pathways associated with future land use. Detailed description of the investigation work performed at CONWR and the BRA are presented in the *Remedial Investigation/Baseline Risk Assessment Report, Explosive/Munitions Manufacturing Area (EMMA) Operable Unit (OU), for Crab Orchard National Wildlife Refuge, September 15 (ESE, 1994).* .

Based on the findings of the 1994 Remedial Investigation Report for the EMMA OU, soil, sediment, surface water, and groundwater had been affected at 13 of the 15 sites (COC-1 through COC-10, COP-1 through COP-4, and Bunker1-3). The sites contained metals and nitroaromatic compounds in various media above background concentrations. The results of the Baseline Risk Assessment (BRA) concluded conditions at Sites COC-1, COC-2, COC-5, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3, and Bunker 1-3 do not pose an unacceptable potential risk to human health and the environment. There was a potential unacceptable risk indicated at Site COC-6. However, this potential unacceptable risk at Site COC-6 is based on an exposure scenario that is extremely unlikely. Therefore, no further action was recommended for those sites by the ROD for the EMMA OU prepared by ESE and signed by the USEPA and the DA in February 1997 (**Table 1-2**).

The BRA indicated that Site COC-3 posed a potential and unacceptable risk to human health due to elevated levels of nitroaromatic compounds and metals in the soils. Additionally, potential ecological risks to white-tailed deer, small mammals, and bobwhite quail were identified. The Record of Decision (ROD) determined the following selected remedy for Sites COC-3:

- Excavation and offsite treatment and disposal of soil with concentrations of nitroaromatic compounds; greater than 100,000 mg/kg and lead greater than 450 mg/kg (approximately 270 cy)
- Further removal and offsite disposal of soil shown by TCLP analysis to match the RCRA definition of a characteristic hazardous waste (2,4-DNT greater than 0.13 mg/L and lead greater than 5 mg/L);
- Backfill excavated areas and construction and long-term maintenance of 24-inch soil covers, land use controls, and groundwater monitoring.

Parsons Engineering Science, Inc. conducted an unexploded ordnance investigation and prepared an Engineering Evaluation and Cost Analysis (EE/CA), (Parsons 1997). The investigation recovered

UXO at COC-1, COC-4, COC-5, COC-6, COC-9, and COC-15. A total of 1,107 anomalies were identified at COC-1 during the 1997 UXO site investigation. Three UXO items, all M-1 mine fuzes, were recovered. A total of 165 pounds of ordnance scrap and 60 pounds of non-ordnance scrap were collected and recycled. A total of 1,108 anomalies were identified at COC-3. A total of 150 pounds of non-ordnance scrap and 3.5 pounds of ordnance scrap were recovered. A total of 1,650 anomalies were identified at COC-4. One UXO item, an M-1 mine booster, was found. Approximately of 270 pounds of ordnance scrap and 12 pounds of non-UXO related scrap were removed from COC-4. A total of 3,429 anomalies were identified at COC-5. Two M-1 fuzes were found and removed. Approximately 181 pounds of ordnance scrap and 77 pounds of non-ordnance scrap were removed. A total of 3,894 anomalies were identified at COC-6 during the 1997 UXO site investigation. Five of the anomalies were UXO, three M1 fuzes, One M1 mine, and one projectile fuze. Approximately 220 pounds of ordnance scrap and 71 pounds of non-ordnance scrap were removed. At COC-9, a total of 1,707 anomalies were identified. Eight UXO items were removed; four M51 series fuzes, two M-1 mines, and two M-1 mine boosters. A total of 139 pounds of ordnance scrap and 33 pounds of non-ordnance scrap were recovered. At COC-15, a total of 2,702 anomalies were identified. Seven M-1 mine fuzes were recovered. Approximately 86 pounds of ordnance scrap and 174 pounds of non-ordnance scrap were recovered at COC-15. No UXO were recovered at the other COC sites and they are sites for no further action (**Table 1-2**). The EE/CA recommended the alternative to reforest approximately 70 acres of pastureland, clearance of UXO at selected areas to a depth of 1 foot, and institutional controls to be implemented by the USFWS.

17.6.3 LUCIP Objective

In addition to the LUCIP objective for the entire IOP (see Section 2), other objectives for the COC ELUC Area are to protect against exposure to contaminated soil and protect against possible contact with UXO.

17.6.4 LUC(s) Implemented to Achieve Objective

In addition to the IOP-wide LUCs, certain restrictions are applicable to the COC ELUC Area (**Figure 17-1**). Additional LUCs will include the prohibition of agricultural uses within the area and the prohibition of digging, trenching, or any other disturbance of the soil with the exception of soil samples to be taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Controlled burns will not be conducted within the COC LUC Area. Because live munitions have been found in this area in the past, there is a likelihood of finding them in the future.

17.6.5 Action Needed to Remove the LUC

Actions applicable to removal of the IOP-wide LUC would apply. See also Page 4, Paragraph VII (Agency Coordination) of the ELUCP.

17.6.6 Applicable Decision Document

The applicable decision document is the Record of Decision (ROD) for Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) (U.S. Army Corps of Engineers, 1996) along with the Engineering Evaluation and Cost Analysis Final Report, Former Illinois Ordnance Plant, Marion, Illinois (Parsons Engineering Science, Inc., October 1997).

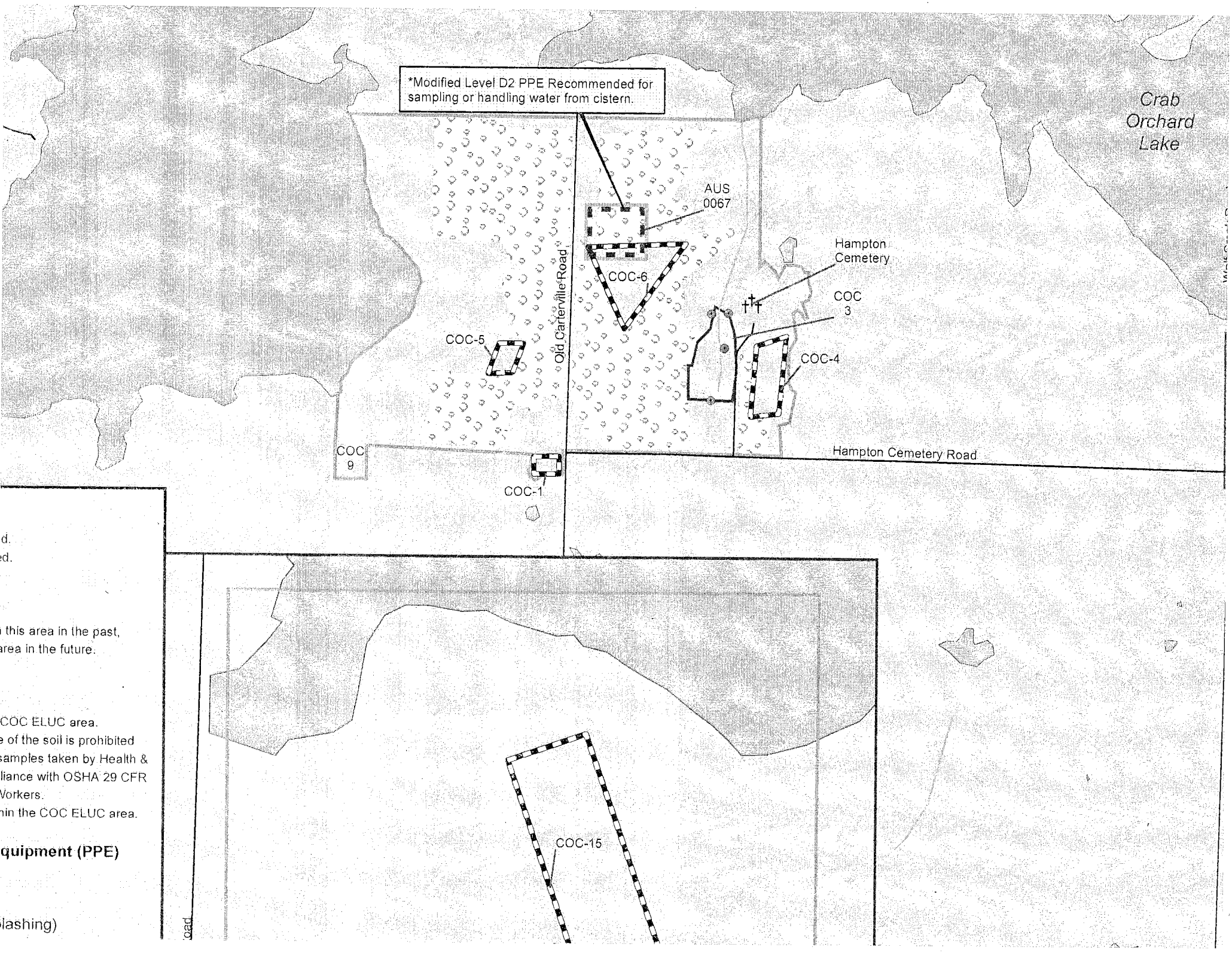
17.7 LUCIP FOR COC-11 (EMMA OU)

COC-11 is small site located southwest of Hampton Cemetery, just south of Hampton Cemetery Road (**Figure 1-5**). Chemical data for COC-11 was never collected as part of the EMMA OU; only a UXO investigation was performed. Note, COC-11 was formed into the AUS OU Site AUS-0062, a discussion of which can be found in Section 18.1.

During the 1997 UXO investigation, a total of 133 anomalies were identified and 21 pounds of scrap were removed from COC-11.[46]

<<Placeholder for Army information>>

[46] Parsons Engineering Science, Inc., October 1997. Engineering Evaluation and Cost Analysis Final Report, Former Illinois Ordnance Plant, Marion, Illinois.



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e of the soil is prohibited
samples taken by Health &
liance with OSHA 29 CFR
Vorkers.
hin the COC ELUC area.

quipment (PPE)

lashing)

Environmental Science and Engineering, Inc., September 1994. Draft Final Remedial Investigation/ Baseline Risk Assessment Report, Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I through V.

Environmental Science and Engineering, Inc. January 1994. Explosives/Munitions Manufacturing Areas Operable Unit, Phase II Analytical Data Report, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I and II.

Environmental Science and Engineering, Inc. December 1991. Explosives/Munitions Manufacturing Areas Operable Unit, Analytical Data Report, Crab Orchard National Wildlife Refuge, Marion, Illinois, Volumes I and II.

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O'Brien & Gere, August 1988. Remedial Investigation Report, Crab Orchard National Wildlife Refuge.

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Final Third Five-Year Review Report

Explosives/Munitions Manufacturing Area Operable Unit

Crab Orchard National Wildlife Refuge

Marion, Williamson County, Illinois

EPA ID: IL8143609487

PREPARED BY:

U.S. Army Corps of Engineers
Louisville District

(Revised Date 5-20-2016)

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FINAL THIRD FIVE-YEAR REVIEW REPORT

Explosives/Munitions Manufacturing Area Operable Unit

Crab Orchard National Wildlife Refuge

Marion, Williamson County, Illinois

Prepared By:

U.S. Army Corps of Engineers
Louisville District

Approved:

6 JUNE 2016

CHRISTOPHER G. BECK
COL, EN
Commanding

DATE

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LIST OF ACRONYMS

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AUS	Additional Uncharacterized Sites
BRA	Baseline Risk Assessment
BAT	BAT Associates, Inc.
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Crab Orchard Cemetery
CONWR	Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund Site
COP	Crab Orchard Plant
DA	Department of the Army
DOD	Department of Defense
DOI	United States Department of Interior
EMMA	Explosive/Munitions Manufacturing Area
ERI	Ecological Risk Indices
ESD	Explanation of Significant Differences
ESE	Environmental Science & Engineering, Inc.
FFA	Federal Facilities Agreement
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
FYR	Five-Year Review
IEPA	Illinois Environmental Protection Agency
IOP	Illinois Ordnance Plant
LTM	Long-Term Monitoring
MISCA	Miscellaneous Area
MOA	Memorandum of Agreement
MSL	Mean Sea Level
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OE	Ordnance and Explosives
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PRP	Potentially Responsible Party
PQL	Practical Quantitation Limit
QL	Quantitation Limit
RA	Remedial Actions
RAE	Reasonable Average Exposure
RDX	Royal Demolition Explosives, Hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure

ROD	Record of Decision
SCI	SCI UXO/OE Services
SMCL	Secondary Maximum Contaminant Level
TAL	Target Analyte List
TNT	Trinitrotoluene
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WAA	WAR Assets Administration

EXECUTIVE SUMMARY

This document summarizes the third Five-Year Review for the Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) of the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund Site located near Marion, Illinois. The results of the Five-Year Review indicate that the remedies described in the 1997 Record of Decision (ROD) and 2000 Explanation of Significant Difference (ESD) are protective of human health and the environment. Overall, the remedial actions (RAs) are functioning as designed, and no deficiencies were identified that impact the protectiveness of the remedies.

The remedial action objective of prohibiting human contact and minimizing wildlife contact with the affected soil was met by the installation of the soil covers/caps at COC-3 and COP-4. Although the site contaminants still remain in the soil, the backfilled materials and soil covers installed eliminated the pathway that presents potentially unacceptable risks to human health and the environment (i.e., direct contact). Additionally, the land use controls implemented at Sites COC-3 and COP-4 included restriction of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4 prevent further contact with the affected areas.

Groundwater sampling serves to provide an early indication of changing conditions and a warning system in case of migration of contaminants in shallow groundwater. Some metals and explosive compounds continue to have isolated instances where concentrations have values exceeding the United States Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs) or Illinois groundwater standards at both sites. In accordance with the Operation and Maintenance (O&M) Plan, termination of additional operation and maintenance and groundwater monitoring is not appropriate at this time due to concerns of hazardous substances remaining under the soil cap.

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 are protective of human health and the environment. For long-term protectiveness effective institutional controls (ICs) have been implemented, maintained, and monitored by the Unites States Fish and Wildlife Service (USFWS).

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Sangamo Electric Dump/**Crab Orchard National Wildlife Refuge**		
EPA ID: **IL8143609487**		
Region: 5	**State:** IL	**City/County:** Marion/Williamson

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** Department of the Army
Author name (Federal or State Project Manager): Department of the Army
Author affiliation: U.S. Army Corps of Engineers, Louisville District
Review period: 6/17/2015 – 6/1/2016
Date of site inspection: 6/14/2015
Type of review: Statutory
Review number: 3
Triggering action date: 6/6/2011
Due date ***(five years after triggering action date)***: 6/6/2016

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Crab Orchard Cemetery (COC)-3 and Crab Orchard Plant (COP)-4

Operable Unit:	*Protectiveness Determination:*
EMMA OU Sites COC-3 and COP-4	Protective
Protectiveness Statement: 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 are protective of human health and the environment. For long-term protectiveness effective ICs have been implemented, maintained, and monitored by USFWS.	

1.0 INTRODUCTION

The Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (CONWR) Superfund Site is approximately five miles west of Marion, Illinois, primarily in Williamson County, extending into Jackson and Union Counties in southern Illinois. It is located near the center of the southern tip of the state, with the Mississippi River approximately twenty-five miles to the west and the Ohio River approximately fifty-five miles to the east. The CONWR is currently comprised of approximately 43,500 acres of land used as a wildlife refuge in addition to recreational, agricultural, and industrial purposes. Since 1947, the USFWS operated CONWR under the authority of the United States Department of the Interior (DOI).

Affected areas within the refuge are divided into seven separate Operable Units (OUs). These OUs are the Polychlorinated Biphenyl (PCB) OU, Metals Area (Metals) OU, Explosives/Munitions Manufacturing Area (EMMA) OU, Miscellaneous Area (MISCA) OU, Water Towers OU, Additional Uncharacterized Sites (AUS) OU, and Lake Monitoring (Lake) OU. A Memorandum of Agreement (MOA) between the Department of the Army (DA) and DOI, and a Federal Facilities Agreement (FFA) among DOI, DA, USEPA, and the Illinois Environmental Protection Agency (IEPA) were signed into effect in the months of August and September of 1991, respectively. The MOA and FFA identified Areas of Concern (AOCs) and the lead agency at respective AOCs. The DA became the lead agency for the EMMA OU. The DOI became the lead agency for the PCB OU, MA OU and MISCA OU.

This document presents the third Five-Year Review (FYR), conducted by the United States Army Corps of Engineers (USACE), for the EMMA OU of the CONWR. The first FYR for the EMMA OU, completed in September 2006, was prepared by USACE and incorporated, by reference, in the USEPA's comprehensive third FYR Report for the CONWR. Similarly, the second FYR for the EMMA OU, dated June 2011, was included in USEPA's comprehensive fourth FYR for the CONWR.

The purpose of the FYR is to determine whether the selected remedy at a site is protective of human health and the environment. The methods, findings, and conclusions are documented in FYR reports. In addition, FYR reports identify issues, if any, found during the review and recommendations to address them.

USACE prepared this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Chapter 121 and the National Contingency Plan (NCP).

CERCLA § 121 states:

> *If the President selects a remedial action (RA) that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such RA no less often than each five years after the initiation of such RA to assure that human health and the environment are being protected by the RA being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [9604] or [9606], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP in 40 Code of Federal Regulation (CFR) §300.430(f)(4)(ii) further states:

> *If an RA 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 RA.*

This report documents the results of the review.

2.0 BACKGROUND

2.1 GENERAL SETTING AND LAND USE

The CONWR is located approximately five miles west of Marion, Illinois, primarily in Williamson County, extending into Jackson and Union Counties in southern Illinois. See Figure 1 in Attachment A. It is located near the center of the southern tip of the state, with the Mississippi River approximately twenty-five miles to the west and the Ohio River approximately fifty-five miles to the east. The CONWR is comprised of approximately 43,500 acres of forested lands, commercial/industrial, and cultivated lands. Since 1947, the USFWS has operated CONWR under the authority of the DOI. Twelve lakes are located within the CONWR, including Crab Orchard Lake, a 7,000-acre man-made reservoir.

The CONWR was included into the National Priorities List (NPL) in 1987. The USFWS, an agency of the DOI, administers the refuge. Affected areas within the refuge are divided into seven separate OUs. These OUs are the PCB OU, MA OU, EMMA OU, MISC OU, WT OU, AUS OU, and LM OU.

The CONWR is situated on the Illinois Basin, which is the major geological feature of southern Illinois. The Illinois Basin is a broad, gentle, structural depression that contains more than 10,000 feet of sedimentary rock. Williamson County lies in the southwestern limit of the basin, so the regional dip of the bedrock is towards the center of the basin to the north and east. The topography of the area is relatively uniform, characterized by flat to moderately sloping areas. Elevations across the area range from 420 to 455 feet above mean sea level (msl). Numerous streams, drainage ways, and drainage courses dissect the area.

Williamson County is underlain by Pennsylvanian-age bedrock. The bedrock at the CONWR consists of shales, sandstones, and thin limestones of the Carbondale Formation and interbedded shales and sandstones of the Pottsville Formation. Illinoisian glacial till overlies the bedrock and overlying the glacial till is a loess layer from the Wisconsin age.

Groundwater resources in Williamson County are relatively poor. Shallow drift wells and cisterns have been utilized by farmers in the area; however, surface water is the principal water source for industries and towns.

The former Illinois Ordnance Plant (IOP) was comprised of approximately 22,481 acres of which 10,122 acres were a public domain transfer from the Department of Agriculture to the War Department and 12,359 acres were acquired by purchase and condemnation. This acreage is currently part of the CONWR. The entire CONWR comprises an area of approximately 43,500 acres.

The CONWR is used as a wildlife refuge in addition to recreational, agricultural, and industrial purposes. The western end of CONWR, 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 agricultural fields and restricted access to hunters, cemetery visitors/workers, and various special interest groups (occasional bike tours or half marathon races). Crab Orchard Lake supports a large population of sport fish. Wetlands are found in some areas adjacent to the lakes. Wildlife in the area includes many game and non-game species. CONWR has suitable habitat for threatened and endangered bat species, including the Indiana bat, Northern Long-eared bat, and Southeastern *Myotis sp.*

2.2 History of Contamination

The EMMA OU sites were grouped into three discrete areas: ten sites (Sites COC-1 through COC-10) were located in the Crab Orchard Cemetery (COC - due to the proximity of Hampton Cemetery); four of the sites (Sites COP-1 through COP-4) were in the Crab Orchard Plant (COP) area, near the Former Group II load line and former Ammonium Nitrate Plant; and one site (Site Bunker 1-3) was in the finished ammunition igloos area. The COC and COP sites were located within a portion of the refuge closed to the public except for permitted activities such as hunting. Historic land use in and around the COP sites has been largely associated with ordnance manufacturing. The COC sites have been associated with a variety of ordnance storage, and testing practices. Crop growing and cattle raising have also been practiced.

Pursuant to the MOA and FFA, DA prepared the FYR of the EMMA OU. Site surveys were conducted and limited to areas known as the EMMA OU. Based upon the findings of the 1986 USACE Inventory Project Report, a Confirmation Study was conducted at the direction of the USACE-Omaha District. The Confirmation Study Report was completed by Woodward Clyde Consultants (WCC) in April 1988 (WCC, 1988).

The Confirmation Study focused on fourteen sites associated with the Former Illinois Ordnance Plant. Activities conducted as part of the Confirmation Study included magnetometer surveys, surface and subsurface soil sampling and analysis, groundwater monitoring well installation, groundwater sampling and analysis, and surface water and sediment sampling. The results of the magnetometer surveys indicated the presence of buried ferrous materials at eight sites. Results of some of the samples indicated the presence of munitions related compounds.

The fifteen EMMA OU sites consist of the fourteen Confirmation Study sites (COC and COP areas) plus the Bunker 1-3 Site [referred to as Site 19 from the 1988 Remedial Investigation (RI) conducted at the PCB OU and MA OU.] An RI was conducted at the EMMA OU which included a Baseline Risk Assessment (BRA). Phase I of the RI field investigation involved the excavation of 40 test pits; the installation and sampling of fourteen monitoring wells; the collection of samples from twelve previously existing monitoring wells; and the drilling and sampling of ten soil borings. Samples were analyzed for volatile organic compounds, base/neutral acid extractable compounds, nitroaromatic compounds (this reference in this document includes nitroaromatics, nitrosamines, and nitrate esters), metals, and total petroleum hydrocarbons. The Phase I field work was conducted from mid-August to mid-October 1991.

The Phase II RI field investigation was conducted in June, July, and September of 1993 and focused on eight of the fifteen EMMA OU sites based on data gathered in the Phase I investigation. A separate field effort was conducted in October and December 1993 based on the results of a Preliminary Ecological Risk Assessment. The Phase II investigation involved the collection of surface soil, surface water, and sediment samples; drilling and sampling of soil borings; and the installation and sampling of two monitoring wells. Groundwater samples were also collected from all 26 previously existing monitoring wells. Small mammal trapping was conducted at Site COC-9 to evaluate potential ecological effects. Surface water samples were collected for aquatic toxicity testing from Site COC-6 to assess potential effects on aquatic species. Analyses performed on collected samples included metals, nitroaromatic compounds, volatile organic compounds, and base/neutral acid extractable compounds. The RI was completed in September 1994.

A summary from the 1994 RI of the two sites that is the focus of this FYR is discussed as follows:

Site COC-3

Site COC-3 is a large area divided into two halves, the southern fenced heavily wooded area and the northern area. Various sized pieces of TNT, metal debris, and asbestos containing tile were found scattered across the northern half. The area of concentrated debris remained void of vegetation. A north-south oriented erosional gully bisected the northern half, with the debris concentrated on the west bank of the berm. Stained soil of an apparent burn layer was seen approximately 2 feet below the gully bank. A sample from the stained soil contained 223,000 mg/kg of TNT. Nitroaromatic compounds detected in the soils above detection limits included TNT; 1,3,5-trinitrobenzene(TNB); 2-amino-4,6-dinitrotoluene (2-amino-4,6-DNT); 2,4-DNT,1,3-dinitrobenzene (1,3-DNB); 2-nitrotoluene; 4-nitrotoluene; tetryl; 2,6-DNT; and 4-amino-2,6-DNT. The following metals were detected/reported: antimony, arsenic, barium, beryllium, calcium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, silver, and zinc. Nitroaromatic compounds were observed primarily in the 0- to 2-foot levels with two boring samples exhibiting nitroaromatic compounds in the 3- to 5-foot interval and one boring exhibiting nitroaromatic compounds in the 7- to 9-foot interval samples. The prevalent metals (beryllium, copper, antimony, mercury, and lead) were observed primarily in the 0- to 2-foot and 7- to 9-foot interval samples with four borings exhibiting the metal compounds in the 3- to 5-foot interval and two borings in the 4- to 6-foot interval samples.

Nitroaromatic compounds above detection limits and metals above background or detection limits were also present in Site COC-3 sediment samples.

Surface water samples collected at Site COC-3 exhibited nitroaromatic and metal compounds above background concentrations including High Melting Explosive, cyclotetramethylenetetranittranmine, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); 2,4-DNT; copper; selenium; and sulfate.

Nitroaromatic compounds above detection limits present in groundwater samples included Royal Demolition Explosive, cyclonite hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); nitrobenzene; TNT; 1,3,5-TNB; 2,4,6-DNT; 2-nitrotoluene; 3-nitrotoluene; 4-amino-2,6-DNT; and 2-amino-4,6-DNT. Both wells exhibited thallium and iron concentrations above background or detection limits in groundwater samples. Additional compounds detected include chloride, fluoride, and sulfate.

Site COP-4

Three types of disposal activities were identified at Site COP-4. These activities included burning operations in the northwest portion of the site, burial activities in the southwest portion, and surface dumping in the south central portion. The area is bounded by old roads and is transected in an east-west direction by an old railroad grade. Extensive magnetic anomalies (identified in the area south of the railroad tracks) and debris (found during excavation of test pits in this area) indicated that this area may have been used as a burial or disposal area. The area north of the railroad tracks was reported to have been used to burn ordnance. Land mine casings and pieces of TNT have been observed on the surface in the southeast corner of Site COP-4 in an area referred to as the former land mine disposal area.

TNT, HMX, RDX, and 1,3,5-TNB were detected in samples collected from and throughout the soil column to a depth of 6 feet in the burial area south of the railroad tracks.

Concentrations of 2-amino-4, 6-DNT, 2,6-DNT, 2-nitrotoluene, and 4-nitrotoluene were also detected in soil samples. HMX and RDX were also detected in one soil boring in the 12- to 14-foot interval. Metals such as antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, silver, sodium, thallium, and zinc were also detected in soils in varying sample intervals.

Surface soil samples collected from the reported burn area north of the railroad grade contained no detectable concentrations of nitroaromatic compounds. One surface soil sample exhibited levels of barium, calcium, copper, lead, silver, and zinc above background concentrations. Soil samples collected from the former land mine disposal area revealed significant concentrations of nitroaromatic compounds. Constituent concentrations were highest in the surface soils for RDX and TNT in various sampling intervals between 0 and 10 feet. Metals detected in soil samples were sporadic in this area. Only three metals were detected above background more than once: calcium, lead, and mercury.

Metals detected above background in groundwater samples included aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, vanadium, and zinc. Arsenic, beryllium, chromium, copper, lead, and zinc were detected at levels above background in samples from Well COP4-3 during Phase II sampling. RDX was detected in Phase II groundwater samples at 0.00118 and 0.00199 mg/L. No Phase I groundwater samples exhibited detectable concentrations of nitroaromatic compounds.

2.3 SITE CHRONOLOGY

A chronology of the major events for the EMMA OU is presented in the following table:

Table 1: Chronology of Events for EMMA OU

Event	Date
Eastern portion of the refuge was transferred to the War Department. The IOP was constructed.	1941
IOP era operation included trinitrotoluene (TNT) melt-pour operations, ammonium nitrate production, storage, shipping, and maintenance.	1941 - 1945
IOP was closed shortly after the end of World War II and was transferred to the WAR Assets Administration (WAA) for disposition.	1945
The property was transferred to DOI.	1947
USFWS has managed and controlled the property. Various users have been utilizing portions of the EMMA OU. Known uses of the property have include, forested lands, commercial/industrial and cultivated lands.	1947-Current
CONWR was proposed for inclusion on the NPL.	1984
As part of the FUDS program. USACE Chicago District initiated an Inventory Project Report. Site surveys were limited to areas associated with the EMMA OU.	1986

Event	Date
USEPA and USFWS entered a Federal Facility Initial Compliance Agreement for the performance of a RI/FS for the CONWR in February 1986.	1986
RI/FS for the CONWR began at CONWR in May 1986	1986
CONWR was included as final on the NPL as published in the July 22 1987 Federal Register (52 FR 27620).	1987
A Preliminary Assessment of the former IOP was conducted by USACE, Chicago District with the Findings and Determination of Eligibility dated 8 June 1990.	1990
Federal Facilities Agreement signature 13 September 1991.	1991
The RI for the EMMA OU was completed in September 1994.	1994
Woodward-Clyde compiled a database of background concentrations of metals in soil at CONWR.	1995
A FS for the EMMA OU was completed in September 1995.	1995
ROD signed for EMMA OU 19 February 1997	1997
RA activities – soil sampling, excavation and off-site treatment and disposal of soils, backfilling of excavations, placement of soil covers, establishment of institutional controls, and installing groundwater monitoring wells.	1998 - 2000
ESD for the EMMA OU 11 January 2000.	2000
First FYR completed for the EMMA OU in August 2006.	2006
Second FYR completed for the EMMA OU in June 2011.	2011

3.0 REMEDIAL ACTIONS

3.1 BASIS FOR TAKING ACTION

The results of the BRA concluded conditions at Sites COC-1, COC-2, COC-5, COC-7, COC-8, COC-9, COC-10, COP-1, COP-2, COP-3, and Bunker 1-3 do not pose an unacceptable potential risk to human health and the environment. There was a potential unacceptable risk indicated at Site COC-6. However, this potential unacceptable risk at COC-6 is based on a hypothetical exposure scenario that is extremely unlikely. The exposure scenario assumes a bald eagle would consume fish from the man-made depressions at COC-6 that contain minnows resulting in potential exposure to manganese in surface water. Therefore, no further action was recommended for those sites by the ROD for the EMMA OU prepared by ESE and signed by the USEPA and the DA in February 1997.

The BRA indicated that Sites COC-3 and COP-4 posed a potential and unacceptable risk to human health due to elevated levels of nitroaromatic compounds and metals in the soils. Additionally, potential ecological risks to white-tailed deer, small mammals, and bobwhite quail were identified with the two sites. The BRA indicated that Site COC-4 posed a potential ecological risk to bobwhite quail, while not posing any unacceptable risk to human health.

3.2 REMEDY SELECTION

USEPA and DA signed the ROD for the EMMA OU at the CONWR on February 19, 1997. The remedial action objective for the EMMA OU is to minimize potential human health and ecological risks associated with site contaminants present in the soil above remediation goals at Sites COC-3 and COP-4. The ROD determined that no further action was required at twelve of the fifteen EMMA OU sites. The studies undertaken at the EMMA OU identified potential human and ecological risks associated with nitroaromatic compounds and metals, specifically lead, in soil at Sites COC-3 and COP-4. The selected remedy for Sites COC-3 and COP-4 included:

- Excavation and offsite treatment (offsite incineration) and disposal of soil with concentrations of nitroaromatic compounds greater than 100,000 mg/kg or lead greater than 450 mg/kg (approximately 270 cy);
- Removal of RDX/HMX contaminated soil at Site COP-4 to a depth of 2 feet below grade within the fenced area and disposal at an offsite permitted special waste landfill;
- Further removal and offsite disposal of soil shown by TCLP analysis to match the RCRA definition of a characteristic hazardous waste (2,4-DNT greater than 0.13 mg/L and lead greater than 5 mg/L) at both sites; and
- Backfill excavated areas and construction and long-term maintenance of 24-inch soil covers, land use controls, and groundwater monitoring.
- The remediation goals shown in Table 2 for EMMA OU soil were used for the purpose of defining the footprint of the required soil cover at COC-3 and COP-4.

Table 2: Remediation Goals for EMMA OU Soil (mg/kg), Crab Orchard National Wildlife Refuge, Marion, Illinois

Contaminant	Remediation Goal	Basis
NITROAROMATIC		
TNT	2.11	PQL
1,3,5-TNB	2.25	PQL
HMX	4.19	PQL
RDX	4.13	PQL
METALS		
Lead	450	MA OU and PCB OU Remediation Goal

*The nitroaromatics remediation goals are based on the current Practical Quantitation Levels (PQLs). PQLs are generated by the laboratory based on site-specific samples/information. In the case of the EMMA OU sites, enough data are available to provide PQLs based on analytical results from the site. These PQL values are higher than the estimated method quantitation limits (QLs) due to matrix interferences and other laboratory instrumentation interferences from the soils (clays) at the EMMA OU sites. The estimation method QLs are developed under "ideal" situations (sands), where extraction and analysis are optimal.

In addition, the DA conducted removal activities to address unexploded ordnance at some of the EMMA sites. The response included surveying and excavation for unexploded ordnance over 20 acres and reforestation of 83 acres to eliminate intrusive land use activities. These removal actions and surveys were separate from the remedial actions designed to address soil contaminants at COC-3 and COP-4. The ordnance and explosives (OE) removal activities were designed to safely locate, identify, and dispose of OE and OE/non-OE related scrap greater than one square inch in size to a depth of one foot. These activities were conducted at Crab Orchard sites COC-1, COC-4, COC-5, COC-6, and COC-15 in 1999 to 2000. Asbestos containing materials encountered during the OE removal activities were removed and disposed off-site. Details of OE removal activities are documented in HFA (2000) and SCI (2001).

The overall response strategy consistent with CERCLA is to restrict the ability of humans and animals to contact nitroaromatic compounds and lead in soils at Sites COC-3 and COP-4, while monitoring the groundwater at Sites COC-3 and COP-4 for contaminants over time. Groundwater sampling serves to provide early indication of changing conditions to provide a warning system in case of shallow groundwater migration.

Additionally, the remedy selection included land use controls as noted in the 1997 ROD, "Implementation of land use controls at Sites COC-3 and COP-4 will reduce the potential for future exposure to the remaining affected soil (soil containing contaminants above remediation goals) and restrict the construction of drinking water wells at Sites COC-3 and COP-4. These land use controls include restriction of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeters of the soil covers at Sites COC-3 and COP-4." The ROD also indicates, "Shallow groundwater at the EMMA OU sites is not currently used for drinking water nor is it expected to be used in the foreseeable future."

3.3 REMEDY IMPLEMENTATION

From 1998 to 2000, MWH. Inc. completed the RA construction activities including:

- Soils were sampled at both sites to confirm/determine the lateral extent of soil contamination.
- Groundwater monitoring wells within the footprint of the cover were abandoned.
- Soils at both sites with concentrations of nitroaromatic compounds greater than 100,000 mg/kg and lead greater than 450 mg/kg were excavated and disposed off-site.
- Soils at COP-4 was removed to a depth of 2-ft within the existing fenced area. An additional excavation was completed to a depth of approximately 10 feet at COP-4 at the request of USFWS and directed by IEPA to remove soils with concentrations of nitroaromatic compounds greater than 100,000 mg/kg and additional confirmation samples were collected.
- Soils at both sites were sampled to ensure that remaining affected soils did not exhibit RCRA characteristics for lead and 2, 4-DNT.
- Borrow soils were sampled to ensure soil imported for cap construction at both sites did not contain contaminant concentration levels above background levels for the CONWR.
- Excavations were backfilled and a soil cover was constructed to prevent direct human or animal contact with the remaining affected soils and to promote vegetation.
- Bulk TNT nuggets generated during remedial activities at COC-3 and COP-4 were disposed of by burning. UXO consisting of mines, booster cups, and fuses were disposed of by detonation onsite. Additionally, asbestos containing materials encountered during OE removal activities were removed and disposed off-site.
- New groundwater monitoring wells were installed at each site.

Confirmatory analytical results of closure soil sample locations from the excavated areas at COC-3 and COP-4 were all below the Record of Decision cleanup levels for lead and nitroaromatics. The highest concentrations of contaminants left on-site at COC-3 were 258 mg/kg for lead, 3100 mg/kg for 2,4,6-TNT, and 97 mg/kg for amino DNTs. The highest concentrations of contaminants left on-site at COP-4 were 61 mg/kg for lead, and 12 mg/kg for total explosives.

Following the completion of the RA activities, an O&M plan was developed in July 2001. The ROD required monitoring of groundwater at sites COC-3 and COP-4. The O&M plan required groundwater sampling for VOCs, TAL metals, explosives, nitrate and nitrite, and chloride. The groundwater results were compared against USEPA MCL, and Illinois Class I and Class II groundwater standards. The O&M Report requires a review at the first FYR (2006) to determine the effective of the RA activities. The following issues were to be evaluated:

- Is good vegetation established on the cover?
- Has minimal erosion occurred on the cover within the last 3 years?
- Are the storm water drainage structures operating as designated?
- Are the concentrations of VOC, TAL metals, nitrate & nitrite explosives and chemicals in the groundwater of concern? Are contaminant concentrations stabilizing or decreasing, if detected?
- Are the assumptions used at the time of remedy selection still valid?
- Has any other information come to light that could call into questions the protectiveness of the remedy?

The O&M Plan indicated that if COC-3 and COP-4 satisfy the above conditions, then termination of additional operation and maintenance and groundwater monitoring of the sites is appropriate.

3.4 INSTITUTIONAL CONTROLS

ICs are non-engineered instruments, such as administrative and legal controls that help to minimize the potential for 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 and unrestricted exposure (UU/UE).

The USFWS has prepared an Environmental Land Use Control Plan that became final in April 2008 which identifies all ICs required under RODs signed for the Metals OU, PCB OU, EMMA OU, and MISCA OU at the Crab Orchard Site. USFWS is responsible for implementing, maintaining, reporting on, and enforcing ICs and land use controls.

Status of Access Restrictions and ICs: *In addition to the IOP-wide LUCs, certain restrictions are applicable to the EMMA ELUC Area (Figure 12-1) read in the April 2008 ENVIRONMENTAL LAND USE CONTROL PLAN, Crab Orchard National Wildlife Refuge NPL Site Marion, Illinois.*

Additional LUCs will include the prohibition of agricultural uses within the area and the prohibition of digging, trenching, or any other disturbance of the soil with the exception of soil samples to be taken by Health & Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910.120 for Hazardous Waste/Materials Workers. Controlled burns will not be conducted within the COC LUC Area. Because live munitions have been found in this area in the past, there is a likelihood of finding them in the future.

Current Compliance: *USFWS continues to implement, maintain, report on, and enforce ICs and land use controls. There have been no reports on variances to these ICs for the EMMA OU since the last five year review.*

IC Follow up Actions needed and Long Term Stewardship: *The IEPA along with the USEPA have requested of USFWS a Memorandum of Agreement that will formalize the Land Use Controls for the CONWR. The Land Use Controls MOA is scheduled to be final before the ROD for the AUS OUs that is tentatively scheduled for mid-2018.*

3.5 SYSTEM OPERATIONS/O&M

The EMMA OU ROD required monitoring of groundwater at Sites COC-3 and COP-4. At Site COC-3, one well (MW-06) was installed up-gradient from the soil cover and three pairs of wells (MW-03A and B, MW-04A and B, and MW-05A and B) were installed down-gradient. Wells A and B were designated in different hydrological units as noted in Figure 6. Based on IEPA concerns, in April 2006, two more wells were installed down-gradient (MW-07 and MW-08). Then in May 2010, wells MW-09 and MW-10 were installed north of wells MW-07 and MW-08.

At Site COP-4, one monitoring well was installed up-gradient of the cover (MW-02R) and four pairs of wells (MW-05A and B, MW-06A and B, MW-07A and B, and MW-08A and B) surround the area of excavation. In April 2006 one new well (MW-09) was installed cross-gradient to further delineate the explosives contamination at Site COP-4. Groundwater samples were collected from the original wells in 2001 through 2006. The wells installed in April 2006 were added to the monitoring for the May 2006

round of sampling. The two newest wells were added to the May 2010 sampling event.

Under the original O&M Plan, quarterly monitoring activities were conducted in May, August, and November 2001, and February 2002. Annual monitoring and reporting began in February 2003. After completion of the annual monitoring and reporting for February 2003, a decision was made necessitating an additional sampling event for 2003, which was conducted in October 2003. Subsequently, semi-annual monitoring has been performed at the two sites; in May and October in 2004, 2005, and 2006, June and October in 2007, May and October of 2008, 2009, 2010, 2011, and 2012, June and November 2013, May and October 2014, and May 2015. Subsequent to the May 2015 sampling event, the IEPA, CONWR, and the EPA have agreed to reduce the frequency of groundwater monitoring event from twice annually to once every five year in conjunction with the five year review as indicated in the letter from the IEPA to the USACE on February 1, 2016.

Recommendations of changes to the analytes sampled were presented in respective long term groundwater monitoring report and approved by the IEPA in a letter. Subsequently, the implementation of the change occurred on the next sampling event post approval of change.

Beginning with the October 2003 monitoring event, USACE, with concurrence from the IEPA, approved removing the sampling and analysis of volatile organic compounds (VOCs) and chlorides from the program, and added the in-lab filtering of the metals samples. These analytes were removed from the monitoring program because they were not identified as contaminants of concern in the ROD and they were not detected in the prior groundwater sampling events. Beginning with the May 2010 event, USACE, with concurrence from the IEPA, removed the analyses of nitrate-nitrites since there had been no detections above the Illinois groundwater standard of 10 mg/L in many years.

Operation and maintenance (O&M) at EMMA OU COC-3 and COP-4 includes annual cap inspections, mowing the vegetative cover, and once every five years groundwater monitoring. Mowing the vegetative cover is completed by the USFWS.

During the October 2012 landfill inspection, the berm at COC-3 was observed to display erosion issues posing difficulty for vehicular movement across the berm to complete the necessary sampling activities. A week prior to the October 2013 sampling event, the berm was removed and a gravel pathway was developed.

4.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

4.1 PROTECTIVENESS STATEMENT FROM THE PREVIOUS FIVE-YEAR REVIEW

The protectiveness statement from the previous FYR was:

The remedies at the Crab Orchard National Wildlife Refuge EMMA OU are protective of human health and the environment, because the RAs and land use controls at both Site COC-3 and Site COP-4 are protective.

4.1.1 CORRECTIONS FROM THE 2011 FIVE YEAR REPORT

Two statements made in the 2006 and 2011 reports need correction:
First the discovery of the M1A1 mine: The discovery of the mine (2006) is discussed in the EMMA OU reports as if it were discovered within the boundaries. Pursuant to meetings with the Department of Justice, if was determined that the mine is south of EMMA OU but not within the EMMA OU boundaries. This clarification is now made in this 2016 report.

Pursuant to the Federal Facilities Agreement (FFA) dated February 26, 1986, the Department of the Army is the lead agency for only the EMMA OU. Prior to the initiation of investigatory and remedial response at EMMA OU by the Army, a substantial effort was undertaken to establish and define the EMMA OU boundaries. Specifically, the M1A1 mine discovered in 2006 was identified and removed as south of sites COC-3 and COP-4, and not within the established boundaries of the EMMA OU. The removal of the mine by UXO specialists includes an understanding if it is anomalous or an indicator of buried ordnance/explosives (OE). There was no additional OE uncovered. USACE estimated the chance of injury or death due to ordnance contamination to be less than 1 in 1,900,000. This is an extremely low risk. To purpose a 100% assurance of absence of OE in this case it is neither technically possible, nor economically beneficial. Further, the continued inspections as part of the FYRs remain absent of MEC. These inspections along with ICs are sufficient removing any further need of an investigation.

Second: The reports read with a recommendation of: "At the EMMA OU, a recommendation of continued groundwater monitoring at Sites COC-3 and COP-4 to determine the extents of the plumes and whether natural attenuation is occurring." The purpose of the groundwater monitoring is NOT to determine natural attenuation. Rather, in accordance with the O&M Plan (July, 2001), groundwater sampling serves to provide an early indication of changing conditions and a warning system in case of migration of contaminants in shallow groundwater.

4.2 CHANGE SINCE PREVIOUS FIVE-YEAR REVIEW

Recommendations of changes to the analytes sampled and sampling frequency were presented in respective long term groundwater monitoring report and approved by the IEPA in a letter. Subsequently, the implementation of the change occurred on the next sampling event post approval of change.

Beginning with the June 2013 event, USACE, with concurrence from the IEPA in a letter, dated May 14, 2016, removed the analyses for twelve metals (i.e., Antimony, Barium, Calcium, Chromium, Cobalt, Copper, Magnesium, Mercury, Potassium, Silver, Selenium, and Sodium) at COC-3 and twenty metals (i.e., Antimony, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Magnesium,

Manganese, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, and Zinc) at COP-4.

After completion of the May 2015 sampling event, the IEPA, CONWR, and the EPA have agreed to reduce the frequency of groundwater monitoring event from twice annually to once every five year in conjunction with the FYR as indicated in the letter from the IEPA to the USACE dated February 1, 2016.

5.0 FIVE YEAR REVIEW PROCESS

5.1 PROJECT DELIVERY TEAM MEMBERS

The FYR team includes engineering, hydrogeologic and environmental professionals. The team is led by Mr. Quyet La, Environmental Engineer for the USACE Louisville District, and includes Mr. Douglas Buchanan, P.G., and Mr. Andrew (Brooks) Evens, P.G. of the USACE Louisville District.

5.2 DOCUMENT REVIEW

This third FYR consisted of a review of relevant documents including:

- Investigation Former Illinois Ordnance Plant (UXB 1991)
- Final Remedial Investigation/Baseline Risk Assessment Report Explosives/Munitions Manufacturing Area Operable Unit (ESE 1994)
- Final Revised Feasibility Study Report Explosives/Munitions Manufacturing Areas Operable Unit (ESE 1995)
- ROD for Crab Orchard National Wildlife Refuge, Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) (ESE 1996)
- RA Report for Crab Orchard National Wildlife Refuge, Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) COC-3 and COP-4 (MWH, 2001)
- Five Year Review Report, Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (USACE 2006)
- FYR Report for Crab Orchard National Wildlife Refuge Superfund Site (USEPA, Region 5, 2006)
- Five Year Review Report, Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (USACE 2011)
- FYR Report for Crab Orchard National Wildlife Refuge Superfund Site (USEPA, Region 5, 2011)
- Environmental Land Use Control Plan, Crab Orchard National Wildlife Refuge NPL Site (USFWS 2004)
- Long-Term Groundwater Monitoring, Sites COC-3 and COP-4, Crab Orchard National Wildlife Refuge, Final Report – May 2009 Survey, (BAT Associates, Inc. 2010)
- Long-Term Groundwater Monitoring, Sites COC-3 and COP-4, Crab Orchard National Wildlife Refuge, Final Reports from: October 2010, May and October 2011, May and October 2012, June and November 2013, May and October 2014, and May 2015 Surveys, (USACE)

5.3 DATA REVIEW

The following items were reviewed:

Form 1: 5-Year Review Site Inspection Attendees
Form 2: Site Inspection Checklist
Form 3: Cover Inspection Forms, COC-3 and COP-4
Form 4: Summary of Groundwater Results (May 2001 – May 2015)

Groundwater Monitoring Results:

COC-3: MW-04A and MW-05 have shown a combined amino-dinitrotoluenes above the Class I Illinois Groundwater Standards for every sampling event since the inception of sampling in May 2001 (see Form 5). However there have been no other explosive detections in any well since the October 2007 event.

Concentrations of lead continue to show exceedances of the Class I Illinois Groundwater Standards at MW-03A, MW-04A, MW-05A, and MW-09 for lead (see Form 5). Down-gradient wells MW-03A and MW-05A at COC-3 displayed statistically significant higher concentrations (ANOVA – Kruskal-Walis Test) for lead. However, lead also exceeded Class I Illinois Groundwater Standards.

May 2015 groundwater sampling results at COC-3 exceeded monitoring goals for lead (7.5 ug/L) and total ADNT (2.7 ug/L) at MW-03A (lead = 74B ug/L), MW-04A (total ADNT = 13.3 ug/L), MW-05 (total ADNT = 8.5 ug/L), and MW-09 (lead = 12 ug/L). Refer to Figure 2 for sample locations.

COP-4: Results for explosives during this review period reveal that explosives above the Class I Illinois Groundwater Standards only show up in wells MW-06A and MW-07A. MW-06A had exceedances of RDX and the combined amino-dinitrotoluenes above the Illinois groundwater standards since the inception of sampling in May 2001 (see Form 5). MW-07A had exceedances of RDX above the Illinois groundwater standards since the inception of sampling in May 2001. Concentrations appear to fluctuate during this review period.

Concentrations of lead continue to show exceedances of the Class I Illinois Groundwater Standards at MW-05A, MW-05B, MW-06A, MW-07A, MW-09, for lead (see Form 5). Concentrations appear to fluctuate during this review period, but are relatively low; within one order of magnitude. Down-gradient wells MW-06A at COP-3 displayed statistically significant higher concentrations (ANOVA – Kruskal-Walis Test) for lead.

May 2015 groundwater sampling results at COP-4 exceeded monitoring goals for lead (7.5 ug/L), total ADNT (2.7 ug/L), and RDX (84 ug/L) at MW-06A (lead = 75 ug/L, total ADNT = 22.9 ug/L, and RDX = 620 ug/L), and MW-07A (total ADNT = 4.7 ug/L, and RDX = 240 ug/L). Refer to Figure 4 for sample locations.

Groundwater sampling serves to provide early indication of changing conditions to provide a warning system in case of shallow groundwater migration. Some metals and explosive compounds continue to have isolated instances where concentrations have values exceeding the USEPA MCLs or Illinois groundwater standards at both sites (see Form 4). In accordance with the O&M Plan, termination of additional operation and maintenance and groundwater monitoring is not appropriate at this time due to concerns of the exceedances. Additionally, soils at COC-3 and COP-4 with concentrations of nitroaromatic compounds as high as 100,000 mg/kg and lead as high as 450 mg/kg were left in place.

5.4 SITE INSPECTION

A Site Inspection was conducted on June 17, 2015 by representatives of the IEPA, USEPA, USFWS, and the USACE. The purpose of the inspection was to assess the protectiveness of the remedy. Subsequent to the inspection, a meeting was held to serve as the interview for the respective members as part of this FYR. A complete list of inspection attendees is provided in Form 1. The team started at COC-3 then continued to COC-4, driving by COC-8 and COC-9. The temperature was in the mid-70s degrees Fahrenheit and sunny.

At COC-3 and COP-4 there were no signs of erosion and the grass was thick and healthy. The oak, hickory, and walnut trees that were planted in the reforested areas appear to be growing well.

At the semi-annual rounds of groundwater sampling, the soil covers are inspected at Sites COC-3 and COP-4. The last inspection of the cover occurred during the May 2015 sampling event. Both covers look healthy and in very good shape. The cover inspection forms can be seen in Form 3.

The sites are within fenced areas which limits any exposures. Land use controls (LUCs) follow the USFWS Environmental LUC Plan (USFWS 2008) and will continue to protect human health and the environment. All areas in the former IOP are prohibited from installing production water wells and from residential use and camping. COC-3 and COP-4 are also prohibited from controlled burns and agricultural digging, trenching, or other disturbances of the soil (except for soil samples taken by Health and Safety-trained sampling personnel in compliance with OSHA 29 CFR 2910 120 for Hazardous waste/Materials Workers).

6.0 TECHNICAL ASSESSMENT

The objective of this FYR is to evaluate if the remedies at COC-3 and COP-4 remain protective of human health and the environment. The technical assessment of the protectiveness of the remedy is based on the responses to these three questions posed in the USEPA Comprehensive FYR Guidance (EPA 540-R-01-007/OSWER No. 93557-03B-P, June 2001):

1. Question A: Is the remedy functioning as intended by the decision documents?
2. Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RA objectives (RAOs) used at the time of remedy selection still valid?
3. Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

6.1 TECHNICAL ASSESSMENT ANALYSIS

Question A: Is the remedy functioning as intended by the decision documents? YES

Yes, the selected alternatives of soil excavations as the RAs have all been successful. The remedial action objective of prohibiting human contact and minimizing wildlife contact with the affected soil was met by the installation of the soil covers/caps at COC-3 and COP-4. Although the site contaminants still remain in the soil, the backfilled materials and soil covers/capping installed eliminated the pathway that presents potential unacceptable risks to human health and the environment (i.e., direct contact). Additionally, the land use controls implemented at Sites COC-3 and COP-4 include restriction of the following activities: groundwater well installation; subgrade activities; and pond creation within the perimeter of the soil covers on Sites COC-3 and COP-4 prevent further contact with the affected areas.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? YES

The cap is still functioning as intended, the LUC continues to limit access to the property, water at COC-3 and COP-4 is not used as a potable water source and the restriction on well installation prevent direct contact and consumption of the contaminants; consequently, maintaining the validity of the exposure assumption. Toxicity data and cleanup levels were compared to EPA MCL and the IEPA Class I and Class II groundwater standards and are still valid (refer to the technical memorandum located at Figure 7).

The Human Health COCs are TNT, 1,3,5-TNB, RDX, HMX and lead. The ecological risk drivers at COC-3 are 1,3,5 TNB and TNT; and at COP-4 are HMX and RDX. The ecological toxicity reference values (TRVs) for the nitroaromatics have remained the same over the course of the five year reviews. The human health clean-up objectives for the nitroaromatics at COC-3 and COC-4 were based on analytical practical quantitation and not toxicity, whereas the clean-up objective for lead was based on toxicity. The toxicity criteria for lead has remained the same over the span of the five year reviews, while the practical quantitation limits for the nitroaromatics are now defined by DOD's and DOE's Quality Systems Manual version 5.0. However, because PQLs can change over time, same does not impact the remedy as judged by the chemical markers being monitored for nitroaromatics in groundwater.

Regarding groundwater, there have been no newly promulgated standards, revisions of existing standards, or changes in ground water criteria of MCL (40CFR141) or Ill EPA Class I and Class II (35Ill Administrative Code 620.410 and 620.420, respectively) groundwater standards for amino-dinitrotoluene(s), 2,4-dinitotoluene, 2,6-dinitrotoluene, trinitrotoluene (TNT), 1,3,5-Trinitrobenzene (TNB), HMX, RDX or lead that would confound a determination of the protectiveness of the remedy.

Additionally, there have been no changes in current or expected land use, exposure routes, receptors, sources, or site conditions that would affect the protectiveness of the remedy.

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

No new ecological risks have been identified at COC-3 or COP-4. No natural disasters have impacted the remedy. No additional information has come to light that affects the protectiveness of the remedy.

6.2 TECHNICAL ASSESSMENT SUMMARY

The Sites COC-3 and COP-4 are located within fenced areas, limiting access to the public. The soil covers are in good shape with thick vegetation. The remedy is operating as intended and continue to provide protectiveness to human health and the environment. Groundwater monitoring and cap maintenance and inspection continues at COC-3 and COP-4. The primary objective of the long-term monitoring is to evaluate any changes to overall protectiveness and to serve as a mechanism of providing early indication of changing conditions to provide a warning system in case of shallow groundwater migration. There appears to be no migration of contaminants outside of the sites (COC-3 and COP-4) based on the limited exceedances of downgradient compared to upgradient wells.

7.0 ISSUES

No issues affecting the protectiveness were identified during this review. The soil caps and LUCs continue to serve as a means of prohibiting human contact and minimizing wildlife contact with the affected soil. The site inspection did not identify any deficiency in the soil caps at either COC-3 or COP-4.

8.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

No recommendations are made during this review period.

9.0 PROTECTIVENESS STATEMENT

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 are protective of human health and the environment. For long-term protectiveness effective ICs have implemented, maintained, and monitored by USFWS.

10.0 NEXT REVIEW

The next FYR for the EMMA OU is required five years from the completion date of this FYR.

11.0 REFERENCES

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USACE. 2014. Crab Orchard National Wildlife Refuge, Marion, Illinois, Long-term Groundwater Monitoring, Sites COC-3 and COP-4, Final Report – October 2012 Survey. July.

USACE. 2014. Crab Orchard National Wildlife Refuge, Marion, Illinois, Long-term Groundwater Monitoring, Sites COC-3 and COP-4, Final Report – June 2013 Survey. January.

USACE. 2014. Crab Orchard National Wildlife Refuge, Marion, Illinois, Long-term Groundwater Monitoring, Sites COC-3 and COP-4, Final Report – November 2013 Survey. July.

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USACE. 2015. Crab Orchard National Wildlife Refuge, Marion, Illinois, Long-term Groundwater Monitoring, Sites COC-3 and COP-4, Final Report – October 2014 Survey. April.

USEPA 2006. FYR Report for Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois, September.

USFWS 2008. Environmental Land Use Control Plan, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois. April.

UXB 1991. Investigation Former Illinois Ordnance Plant, Marion, Illinois.

Woodward-Clyde 1995. Background Concentrations of Metals in Soil, Crab Orchard National Wildlife Refuge, Marion, Illinois, July.

Major Highways

Roads

Figure 1 Vicinity Map
Crab Orchard National Wildlife Refuge
Marion, IL

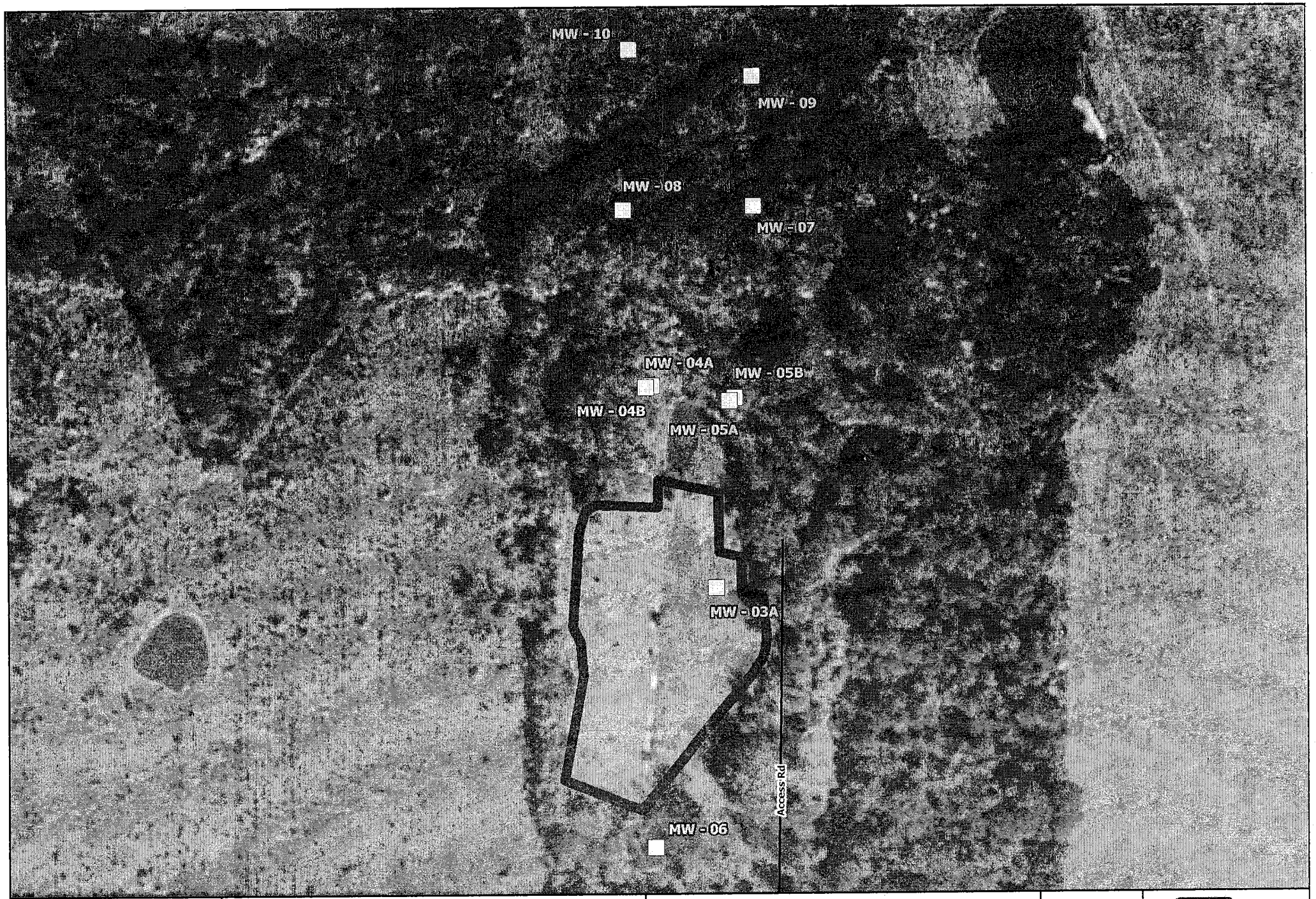
1 inch = 3,000 feet

0 0.25 0.5 1 Miles

Location is approximate.

N

US Army Corps of Engineers
Louisville District



Monitoring Wells

Remediation Area and Limits of Contaminated Soils

Service Roads

Figure 2 - Area COC - 3
Crab Orchard National Wildlife Refuge
Marion, IL

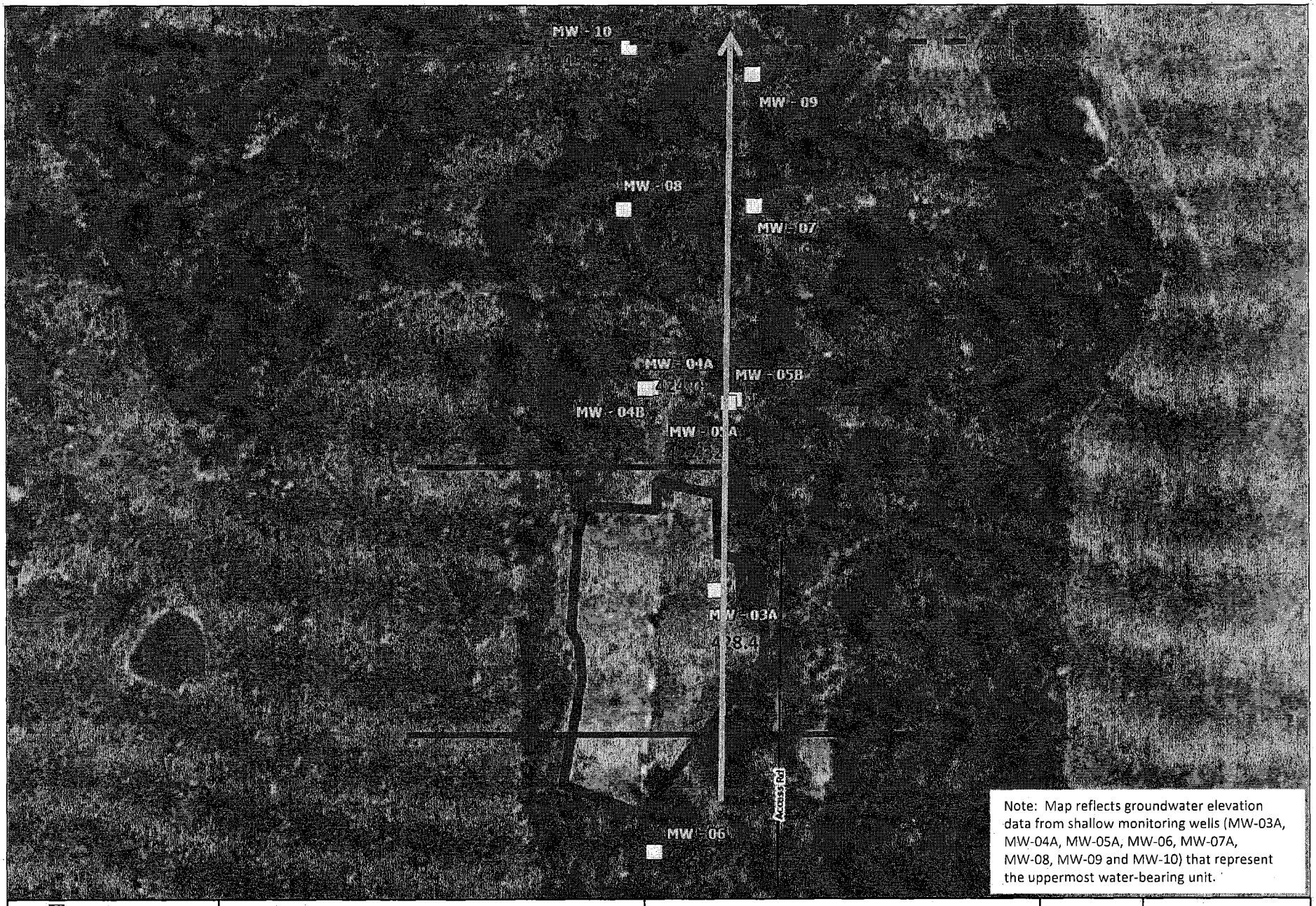
1 inch = 200 feet

0 125 250 500 Feet

Location is approximate.

N

US Army Corps of Engineers
Louisville District



Note: Map reflects groundwater elevation data from shallow monitoring wells (MW-03A, MW-04A, MW-05A, MW-06, MW-07A, MW-08, MW-09 and MW-10) that represent the uppermost water-bearing unit.

Monitoring Wells
Flow Direction
Water Elevation
Remediation Areas and Limits of Contaminated Soils
Service Roads

Figure 3: COC-3 May 2015
Groundwater Potentiometric Map
Crab Orchard National Wildlife Refuge
Marion, IL

0 125 250 500 Feet

Location is approximate.

N

US Army Corps of Engineers
Louisville District

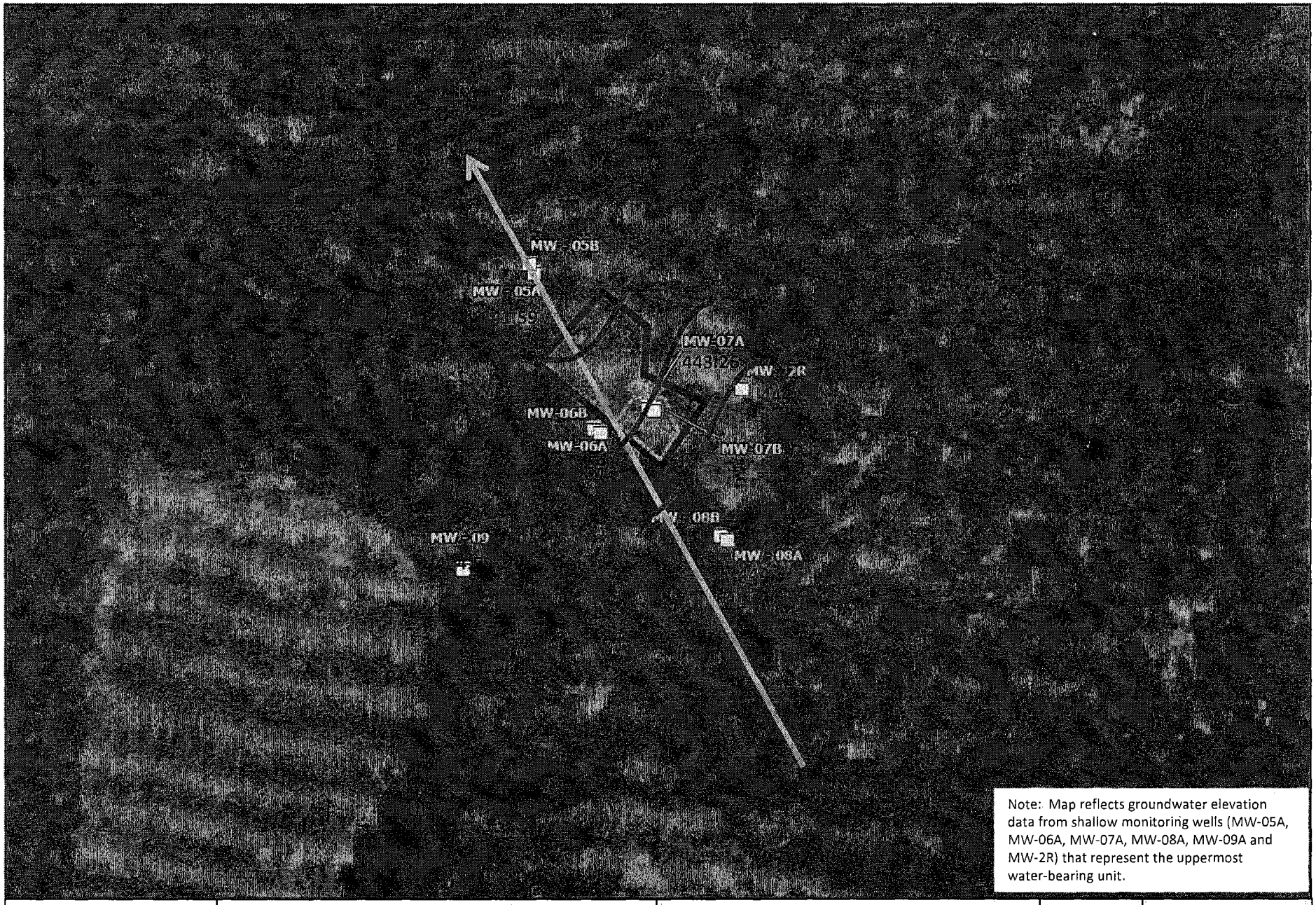
Monitoring Wells
Limits Contaminated Soils
Remediation Areas

Figure 4 - Area COP - 4
Crab Orchard National Wildlife Refuge
Marion, IL

1 inch = 100 feet
0 50 100 200 Feet
Location is approximate

N

US Army Corps of Engineers
Louisville District



Note: Map reflects groundwater elevation data from shallow monitoring wells (MW-05A, MW-06A, MW-07A, MW-08A, MW-09A and MW-2R) that represent the uppermost water-bearing unit.

Monitoring Wells
Flow_Direction
Water Elevation
Remediation Areas

Figure 5: COC-4 May 2015
Groundwater Potentiometric Map
Crab Orchard National Wildlife Refuge
Marion, IL

0 50 100 200 Feet

Location is approximate.

N

US Army Corps of Engineers
Louisville District

TECHNICAL MEMO TO PROJECT RECORD – SEPTEMBER 10, 2014
CRAB ORCHARD LAKE – AREA COC-3 GROUNDWATER MONITORING WELLS MW-4B AND MW-5B
PREPARED BY DOUG BUCHANAN (CELRL-ED-E)

A review of groundwater elevation data collected from May 2010 to November 2013 for monitoring wells MW-04B and MW-05B at COC-3 was performed to determine if the information from these wells should be used in the preparation of groundwater elevation maps for ongoing LTM activities.

Subsurface conditions at the MW-04A and MW-04B well pair location consist of overburden soil (predominantly clay) to a depth of 16.5 feet bgs that is underlain by inter-bedded sandstone and shale bedrock from a depth of 16.5 feet to 55.0 feet bgs. MW-04A has a 15-foot well screen at 10.0 to 25.0 feet bgs (an elevation of 425 to 410 feet above MSL). The upper 1.5 feet of the MW-04A screen interval is overburden soil and the lower 13.5 feet is inter-bedded sandstone and shale bedrock. From 2010 to 2013, the average depth to groundwater at MW-04A is 11.5 feet bgs and the average groundwater elevation is 423.8 feet above MSL. MW-04B has a 5-foot well screen at 50.0 to 55.0 feet bgs (an elevation of 386 to 381 feet above MSL). The entire 5 feet of the MW-04B screen interval is inter-bedded sandstone and shale bedrock. The MW-04B top of well screen is 33.5 feet below the bedrock surface. From 2010 to 2013, the average depth to groundwater at MW-04B is 15.0 feet bgs and the average groundwater elevation is 420.9 feet above MSL. The MW-04A and MW-04B screen intervals do not overlap and are separated by a vertical depth of approximately 24 feet of bedrock. The average groundwater elevation at MW-04A is approximately 3 feet greater than MW-04B. The above information suggests that MW-04A and MW-04B represent differing water-bearing hydrostratigraphic units and provides a reasonable basis for not including both wells in the same potentiometric surface maps used to evaluate the groundwater hydraulic gradient at COC-3.

Subsurface conditions at the MW-05A and MW-05B well pair location consist of overburden soil (predominantly clay) to a depth of 11.0 feet bgs that is underlain by inter-bedded sandstone and shale bedrock from a depth of 11.0 feet to 55.0 feet bgs. MW-05A has a 10-foot well screen at 10.0 to 20.0 feet bgs (an elevation of 422 to 412 feet above MSL). The upper 1.0 feet of the MW-05A screen interval is overburden soil and the lower 9.0 feet is inter-bedded sandstone and shale bedrock. From 2010 to 2013, the average depth to groundwater at MW-05A is 10.2 feet bgs and the average groundwater elevation is 421.4 feet above MSL. MW-05B has a 5-foot well screen at 50.0 to 55.0 feet bgs (an elevation of 382 to 377 feet above MSL). The entire 5 feet of the MW-05B screen interval is inter-bedded sandstone and shale bedrock. The MW-05B top of well screen is 39 feet below the bedrock surface. From 2010 to 2013, the average depth to groundwater at MW-05B is 10.9 feet bgs and the average groundwater elevation is 420.8 feet above MSL. The screen intervals for MW-05A and MW-05B do not overlap and are separated by a vertical depth of approximately 30 feet of bedrock. The average groundwater elevation at MW-05A is approximately 1-feet greater than MW-05B. The above information suggests that MW-05A and MW-05B represent differing water-bearing hydrostratigraphic units and provides a reasonable basis for not including both wells in the same potentiometric surface maps used to evaluate the groundwater hydraulic gradient at COC-3.

Figure 6

TECHNICAL MEMO TO PROJECT RECORD – MARCH 23, 2016
CRAB ORCHARD LAKE – AREA COC-3 TOXICITY AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) ANALYSIS
PREPARED BY DR. DAVID BRANCATO (CELRL-ED-E)

Subsequent to the May 2015 sampling event, the IEPA, FWS, and the EPA have agreed to reduce the frequency of groundwater monitoring event from twice annually to once every five year in conjunction with the five year review as indicated in the letter from the IEPA to the USACE on February 1, 2016.

From 2001 until the decision made in 2015 there have been no newly promulgated standards, revisions of existing standards, or changes in ground water criteria of MCL (40CFR141) or Ill EPA Class I and Class II (35Ill Administrative Code 620.410 and 620.420, respectively) groundwater standards for amino-dinitrotoluene(s), 2,4-dinitotoluene, 2,6-dinitrotoluene, trinitrotoluene (TNT), 1,3,5-Trinitrobenzene (TNB), HMX, RDX or lead that would confound a determination of the protectiveness of the remedy.

Post-remedy groundwater monitoring indicates that there have been no adverse impacts to groundwater either from the remedial activities or from residual constituent of potential concerns (COPCs) in the subsurface soil that have been covered over with two (2) feet of clean fill. There has been no exceedances for TNT, 1,3,5 TNB, HMX and RDX for COC-3 with respective to the Ill EPA GW criteria. However in groundwater monitoring wells MW-06A and MW-07A for COP-4 does exhibit exceedances for RDX and 1,3, 5-TNB that exhibit sinusoidal variances around their respective groundwater criteria, with the later year measurements starting in 2008 consistently decreasing. Further, the amino-dinitrotoluenes, 2,4- and 2,6-dinitrotoluenes and lead have detects in groundwater at both COC-3 and COP-4 from 2001, 2006 and 2011 that vary in a sinusoidal movement around their respective groundwater criteria that have remained constant from the time of post-remedy groundwater measurements to current.

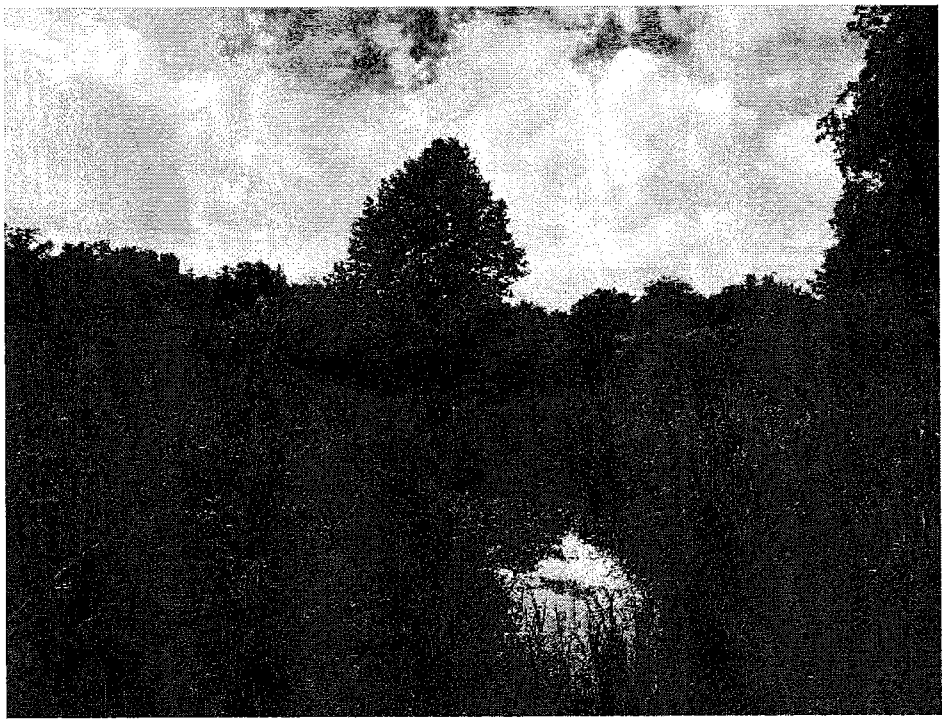
Additionally, there have been no changes in current or expected land use, exposure routes, receptors, sources, or site conditions that would affect the protectiveness of the remedy. Because there is no groundwater to surface water connection within COC-3 or COC-4, along with the restricted access removes any concern of soil vapor, recognizing that that the Henry Law constant for RDX, amino-dinitrotoluenes, 2,4- and 2,6-dinitrotoluenes, and lead would preclude volatilization through the soil pores under standard conditions of temperature and pressure.

EMMA OU COC-3 and COP-4 ARARs

35 Illinois Administrative Code (IAC) Part 620 Class 1 Groundwater

Contaminant	ROD (2000 - ug/L)	1st FYR (2006 - ug/L)	2nd FYR (2011 - ug/L)	3rd FYR (2016 - ug/L)
NITROAROMATIC				
TNTm	70	70	70	70
1,3,5-TNB	210	210	210	210
HMX	1400	1400	1400	1400
RDX	84	84	84	84
METALS				
Lead	7.5	7.5	7.5	7.5

Figure 7



PHOTOGRAPH 1
View looking south toward pond at COC-3.

PHOTOGRAPH 2
View looking west toward MW-04A and MW-04B
and new gravel path over previous berm at COC-3.

PHOTOGRAPH 3
Panoramic view looking west at east entrance of COC-3.

PHOTOGRAPH 4
View looking southwest toward the center of site at MW-07A and MW-07B at COP-4.

PHOTOGRAPH 5
View looking southeast from MW-05A and MW-05B towards center of site at COP-4.

Form 1

5 year review for COC-3 and COP-4 of the EMMA OU at the Illinois Ordnance Plant – Crab orchard.

17 June 2015

Name	**Affiliation**
Paul Lake	Illinois EPA
Nan Gowda	U.S. EPA
Chuck Beasley	USFWS
Mike Coffey	USFWS
Quyet La	USACE

Form -2

Site Inspection Checklist

I. SITE INFORMATION	
Site name: *Crab Orchard National Wildlife Refuge*	**Date of inspection:** *17 June 2015*
Location and Region: *Marion, IL*	**EPA ID:** ***IL8143609487***
Agency, office, or company leading the five-year review: *USACE, Louisville District*	**Weather/temperature:** *Clear, Sunny, 70s*
Remedy Includes: (Check all that apply) X_ Landfill cover/containment _ Access controls X_ Institutional controls _ Groundwater pump and treatment _ Surface water collection and treatment _ Other X_ Monitored natural attenuation _ Groundwater containment _ Vertical barrier walls	
Attachments: _ Inspection team roster attached _ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** *Mike Coffey* (Name) *CONWR Program Manager* (Title) *17 June 2015* (Date) Interviewed X at site _ at office _ by phone Phone no. Problems, suggestions; _ Report attached _____	
2. **O&M staff** _____ (Name) _____ (Title) _____ (Date) Interviewed _ at site _ at office _ by phone Phone no. _____ Problems, suggestions; _ Report attached _____	

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency *IEPA*
Contact *Paul Lake* *Remediation Project Manager* *7/15/15* *(217) 785-7728*
Name Title Date Phone no.
Problems; suggestions; _ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; _ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; _ Report attached _____

Agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; _ Report attached _____

4. **Other interviews** (optional) _ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   _ O&M manual _ Readily available _ Up to date _ N/A
   _ As-built drawings _ Readily available _ Up to date _ N/A
   _ Maintenance logs _ Readily available _ Up to date _ N/A
   Remarks_____

2. **Site-Specific Health and Safety Plan** X_ Readily available _ Up to date _ N/A
   _ Contingency plan/emergency response plan _ Readily available _ Up to date _ N/A
   Remarks_____

3. **O&M and OSHA Training Records** _ Readily available _ Up to date _ N/A
   Remarks_____

4. **Permits and Service Agreements**
   _ Air discharge permit _ Readily available _ Up to date _ N/A
   _ Effluent discharge _ Readily available _ Up to date _ N/A
   _ Waste disposal, POTW _ Readily available _ Up to date _ N/A
   _ Other permits_____ _ Readily available _ Up to date _ N/A
   Remarks_____

5. **Gas Generation Records** _ Readily available _ Up to date _ N/A
   Remarks_____

6. **Settlement Monument Records** _ Readily available _ Up to date _ N/A
   Remarks_____

7. **Groundwater Monitoring Records** *X*_ Readily available _ Up to date _ N/A
   Remarks__*Groundwater Monitoring Reports available upon request.*_____

8. **Leachate Extraction Records** _ Readily available _ Up to date _ N/A
   Remarks_____

9. **Discharge Compliance Records**
   _ Air _ Readily available _ Up to date _ N/A
   _ Water (effluent) _ Readily available _ Up to date _ N/A
   Remarks_____

10. **Daily Access/Security Logs** _ Readily available _ Up to date _ N/A
    Remarks_____

IV. O&M COSTS

1. **O&M Organization**

_ State in-house _ Contractor for State
_ PRP in-house _ Contractor for PRP
_ Federal Facility in-house _ Contractor for Federal Facility
_ Other_____

2. **O&M Cost Records**

_ Readily available _ Up to date
_ Funding mechanism/agreement in place
Original O&M cost estimate_____ _ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ _ Breakdown attached
Date Date Total cost
From_____ To_____ _____ _ Breakdown attached
Date Date Total cost
From_____ To_____ _____ _ Breakdown attached
Date Date Total cost
From_____ To_____ _____ _ Breakdown attached
Date Date Total cost
From_____ To_____ _____ _ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS *X*_ Applicable _ N/A

A. Fencing

1. **Fencing damaged** _ Location shown on site map _ Gates secured *X*_ N/A

Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** _ Location shown on site map _ N/A

Remarks *Deed Restrictions –No Digging. No use of groundwater.*

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented _ Yes *X*_ No _ N/A
Site conditions imply ICs not being fully enforced _ Yes *X*_ No _ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____
Frequency _____
Responsible party/agency _____
Contact _____ _____ _____ _____
Name Title Date Phone no.

Reporting is up-to-date _ Yes _ No _ N/A
Reports are verified by the lead agency _ Yes _ No _ N/A

Specific requirements in deed or decision documents have been met _ Yes _ No _ N/A
Violations have been reported _ Yes _ No _ N/A
Other problems or suggestions: _ Report attached

_____
_____
_____
_____

2. **Adequacy** *X*_ ICs are adequate _ ICs are inadequate _ N/A
Remarks_____
_____
_____

D. General

1. **Vandalism/trespassing** _ Location shown on site map *X*_ No vandalism evident
Remarks_____
_____

2. **Land use changes on site** X_ N/A
Remarks_____
_____

3. **Land use changes off site** *X*_ N/A
Remarks_____
_____

VI. GENERAL SITE CONDITIONS

A. Roads *X*_ Applicable _ N/A

1. **Roads damaged** _ Location shown on site map *X*_ Roads adequate _ N/A
Remarks_____
_____

B. Other Site Conditions

Remarks _____

_____

_____

_____

_____

_____

VII. LANDFILL COVERS X_ Applicable _ N/A

A. Landfill Surface

1. **Settlement** (Low spots) _ Location shown on site map X_ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** _ Location shown on site map X_ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** _ Location shown on site map X_ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** _ Location shown on site map X_ Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** X_ Grass X_ Cover properly established X_ No signs of stress
   _ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** **X**_ N/A
   Remarks_____

7. **Bulges** _ Location shown on site map X_ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** X_ Wet areas/water damage not evident

_ Wet areas _ Location shown on site map Areal extent_____

_ Ponding _ Location shown on site map Areal extent_____

_ Seeps _ Location shown on site map Areal extent_____

_ Soft subgrade _ Location shown on site map Areal extent_____

Remarks_____

9. **Slope Instability** _ Slides _ Location shown on site map X _ No evidence of slope instability

Areal extent_____

Remarks_____

B. Benches _ Applicable X_ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** _ Location shown on site map _ N/A or okay

Remarks_____

2. **Bench Breached** _ Location shown on site map _ N/A or okay

Remarks_____

3. **Bench Overtopped** _ Location shown on site map _ N/A or okay

Remarks_____

C. Letdown Channels _ Applicable X_ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** _ Location shown on site map _ No evidence of settlement

Areal extent_____ Depth_____

Remarks_____

2. **Material Degradation** _ Location shown on site map _ No evidence of degradation

Material type_____ Areal extent_____

Remarks_____

3. **Erosion** _ Location shown on site map _ No evidence of erosion

Areal extent_____ Depth_____

Remarks_____

4. **Undercutting** _ Location shown on site map _ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ _ No obstructions
_ Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
_ No evidence of excessive growth
_ Vegetation in channels does not obstruct flow
_ Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations _ Applicable X_ N/A

1. **Gas Vents** _ Active _ Passive
_ Properly secured/locked _ Functioning _ Routinely sampled _ Good condition
_ Evidence of leakage at penetration _ Needs Maintenance
_ N/A
Remarks_____

2. **Gas Monitoring Probes**
_ Properly secured/locked _ Functioning _ Routinely sampled _ Good condition
_ Evidence of leakage at penetration _ Needs Maintenance _ N/A
Remarks_____

3. **Monitoring Wells** (within surface area of landfill)
_ Properly secured/locked _ Functioning _ Routinely sampled _ Good condition
_ Evidence of leakage at penetration _ Needs Maintenance _ N/A
Remarks_____

4. **Leachate Extraction Wells**
_ Properly secured/locked _ Functioning _ Routinely sampled _ Good condition
_ Evidence of leakage at penetration _ Needs Maintenance _ N/A
Remarks_____

5. **Settlement Monuments** _ Located _ Routinely surveyed _ N/A
Remarks_____

E. Gas Collection and Treatment	_ Applicable X_ N/A
1.	**Gas Treatment Facilities** _ Flaring _ Thermal destruction _ Collection for reuse _ Good condition _ Needs Maintenance Remarks_____
2.	**Gas Collection Wells, Manifolds and Piping** _ Good condition _ Needs Maintenance Remarks_____
3.	**Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings) _ Good condition _ Needs Maintenance _ N/A Remarks_____
F. Cover Drainage Layer	X_ Applicable _ N/A
1.	**Outlet Pipes Inspected** X_ Functioning _ N/A Remarks_____
2.	**Outlet Rock Inspected** X_ Functioning _ N/A Remarks_____
G. Detention/Sedimentation Ponds	X_ Applicable _ N/A
1.	**Siltation** Areal extent_____ Depth_____ _ N/A X_ Siltation not evident Remarks_____
2.	**Erosion** Areal extent_____ Depth_____ X_ Erosion not evident Remarks_____
3.	**Outlet Works** X_ Functioning _ N/A Remarks_____
4.	**Dam** _ Functioning X_ N/A Remarks_____

H. Retaining Walls _ Applicable X_ N/A

1. **Deformations** _ Location shown on site map _ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____

2. **Degradation** _ Location shown on site map _ Degradation not evident
   Remarks_____

I. Perimeter Ditches/Off-Site Discharge _ Applicable X_ N/A

1. **Siltation** _ Location shown on site map _ Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Vegetative Growth** _ Location shown on site map _ N/A
   _ Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____

3. **Erosion** _ Location shown on site map _ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Discharge Structure** _ Functioning _ N/A
   Remarks_____

VIII. VERTICAL BARRIER WALLS _ Applicable *X*_ N/A

1. **Settlement** _ Location shown on site map _ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Performance Monitoring** Type of monitoring_____
   _ Performance not monitored
   Frequency_____ Evidence of breaching
   Head differential_____
   Remarks_____

IX. GROUNDWATER/SURFACE WATER REMEDIES _Applicable X_N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines X_Applicable _N/A

1. **Pumps, Wellhead Plumbing, and Electrical**

X_Good condition _All required wells located _Needs O&M _N/A

Remarks_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

X_Good condition _ Needs O&M

Remarks_____

3. **Spare Parts and Equipment**

X_Readily available _Good condition _Requires upgrade _Needs to be provided

B. Surface Water Collection Structures, Pumps, and Pipelines _Applicable X_N/A

1. **Collection Structures, Pumps and Electrical**

_Good condition _Needs O&M

Remarks _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

_Good condition _Needs O&M

Remarks_____

3. **Spare Parts and Equipment**

_Readily available _Good condition _Requires upgrade _Needs to be provided

Remarks_____

C. Treatment System _ Applicable X_ N/A

1. **Treatment Train** (Check components that apply)

_ Metals removal _ Oil/water separation _ Bioremediation
_ Air stripping _ Carbon adsorbers
_ Filters_____
_ Additive (*e.g.*, chelation agent, flocculent)_____
_ Others_____
_ Good condition _ Needs Maintenance
_ Sampling ports properly marked and functional
_ Sampling/maintenance log displayed and up to date
_ Equipment properly identified
_ Quantity of groundwater treated annually_____
_ Quantity of surface water treated annually_____

Remarks_____

2. **Electrical Enclosures and Panels** (properly rated and functional)

_ N/A _ Good condition _ Needs Maintenance

Remarks_____

3. **Tanks, Vaults, Storage Vessels**
_ N/A _ Good condition _ Proper secondary containment _ Needs Maintenance
Remarks_____

4. **Discharge Structure and Appurtenances**
_ N/A _ Good condition _ Needs Maintenance
Remarks_____

5. **Treatment Building(s)**
_ N/A _ Good condition (esp. roof and doorways) _ Needs repair
_ Chemicals and equipment properly stored
Remarks_____

6. **Monitoring Wells** (pump and treatment remedy)
_ Properly secured/locked _ Functioning _ Routinely sampled _ Good condition
_ All required wells located _ Needs Maintenance _ N/A
Remarks_____

D. Monitoring Data

1. Monitoring Data
*X*_ Is routinely submitted on time *X*_ Is of acceptable quality

2. Monitoring data suggests: *Two new wells added to define plume; further monitoring needed*
_ Groundwater plume is effectively contained _ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
*X*_ Properly secured/locked *X*_ Functioning *X*_ Routinely sampled *X*_ Good condition
*X*_ All required wells located _ Needs Maintenance _ N/A
Remarks_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and as emission, etc.).

Under the original O&M Plan, quarterly monitoring activities were conducted in May, August, and November 2001, and February 2002. Annual monitoring and reporting began in February 2003. After completion of the annual monitoring and reporting for February 2003, a decision was made necessitating an additional sampling event for 2003, which was conducted in October 2003. Subsequently, semi-annual monitoring has been performed at the two sites; in May and October in 2004, 2005, and 2006, June and October in 2007, May and October of 2008, 2009, 2010, 2011, and 2012, June and November 2013, May and October 2014, and May 2015. The most recent monitoring was completed in May 2015.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Current remedies protective of both human health and the environment.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

_____

_____

_____

_____

_____

_____

Cover Inspection Form
EMMA-OU
Crab Orchard National Wildlife Refuge
Marion, IL

Date of Inspection: 17 June 2015
Inspector: *Quyet La, USACE*
Site Inspected: COC-3

Check Cover	Observation Made:
Major storm event occurred (1 inch in 2 hours)?	
Not aware of any	
Erosion observed on cover? *No*	
Rills greater than 6 inches? *No*	
Condition of vegetation? *Thick and Healthy*	
Reseeding necessary? *No*	
Any repairs required? *No*	
Other? None	
Inspect Storm Water System:	Observation Made
Looks in good condition since restoration.	

Form 3

Cover Inspection Form
EMMA-OU
Crab Orchard National Wildlife Refuge
Marion, IL

Date of Inspection: 17 June 2015
Inspector: *Quyet La, USACE*
Site Inspected: COP-4

Check Cover	Observation Made:
Major storm event occurred (1 inch in 2 hours)?	
Not aware of any	
Erosion observed on cover? *No*	
Rills greater than 6 inches? *No*	
Condition of vegetation? *Thick and Healthy*	
Reseeding necessary? *No*	
Any repairs required? *No*	
Other? None	

Inspect Storm Water System:	Observation Made
Looks in good condition.	

Form 3

MW03A 2/12/2002	MW03A 2/19/2003	MW03A 10/8/2003	MW03A 5/26/2004	MW03A 10/27/2004	MW03A 5/10/2005	MW03A 10/18/2005	MW03A 5/16/2006	MW03A 10/19/2006	MW03A 6/4/2007	MW03A 10/9/2007	MW03A 5/13/2008	MW03A 10/14/2008	MW03A 5/7/2009	MW03A 10/21/2009	MW03A 5/25/2010	MW03A 10/27/2010	MW03A 5/24/2011	MW03A 10/26/2011	MW03A 5/15/2012	MW03A 10/31/2012	MW03A 6/24/2013	MW03A 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.519 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.42 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 UM	0.6 UJ
0.519 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	4.1 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.22 J	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ
0.26 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	4.1 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.26 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	4.1 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ
0.519 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.42 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	4.1 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.4 P	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	4.1 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ
0.26 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	4.1 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.26 U	0.43 U	0.41 U	0.94 U	0.96 U	0.53 U	2.0 U	4.6 U	8.2 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 UY	0.6 UJ
0.519 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.42 U	1.2 U	1.2 U	2 U	3.4 P	1.4 JP	0.6 U	6.2 M	0.6 UJ
0.519 U	0.86 U	0.82 U	1.9 U	1.9 U	1.1 U	3.9 U	9.1 U	8.2 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.42 U	7.5 P	1.2 U	0.8 U	5.4 P	0.6 U	0.6 U	0.23 U	4.4 J
0.519 U	0.86 U	0.82 U	1.9 U	0.76 U	0.42 U	1.6 U	3.6 U	3.3 U	0.40 U	0.40 U	0.519 U	0.519 U	0.519 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	5.1 P,M	0.6 UJ
82,400 N	83,000	54,000	64,000	41,000	100,000	41,000	41,000	41,000	71.9 JE	56,200 ND	46800 D	49100 D	52900 ND	51200 D	62500	45100	57500	66500	50300	47600	57400	13800
90.0 U	50 U	6.0 U	6.1	2.7 B	2.3 B	2.6 B	9.2	6.0 U	1 U	10 UD	30 UD	0.6 U	1 U	40 UD	13.5 J	5.4 J	10 J	9.5 J	6 U	6 U	-	
82.0 U	79	38	340	13	73	7.6	10.0	8.0	4 U	13.6 JD	320 UN	6.4 U	3.5 U	100 UD	13 U	13 U	26.5	46.5	16.7 J	16.1 J	29.6	21.4 J
58.7 B/100 U	140	30	58	7.3 B	130	6.8 B	6.9 B	5.0 B	39.3	14.9 D	7.6 JD	5.2 JED	9.2 JD	14.5 JD	19.7	3.2 B	12.1	42.1	7.7	2.4	-	
27.5 B	19	15	17	14	26	14	14	14	0.14 U	20.0 D	17.8 D	18.7 D	18.8 D	20.6 D	20.5	17.6	18.6	20.9	18.9	18.4	22.1 M	16.8
1,260	730	750	810	680	1,100	660	640	670	0.28 U	816 D	947 D	894 D	927 D	817 D	872	748	707	787	797	806	911 M	817
466,000	290,000	330,000	330,000	330,000	950,000	320,000	310,000	320,000	99,000	43,5000 D	450000 D	465000 D	393000 D	449000 D	485000	455000	437000	450000	394000	450000	-	-
44.7 B/100 U[m]	76	25	38	5.3 B	75	2.7 B	2.4 B	10 U	4.8 U	48 UD	158 UD	3.2 U	2 U	100 UD	20.9	2.1 J	6.3	22.8	9.6	9.6	-	-
807	530	540	550	520	770	500	480	530	0.12 J	586 D	626 D	670 D	672 D	623 D	621	586	571	592	550	546	-	-
118 B/200 U	240	140	140	46	240	75	46	52	1.6 J	69.6 D	95.0 D	57.5 D	52.0 D	61.6 JD	80.4	161	102	169	74	49.3	-	-
311,000 NJ[n,q]	270,000	190,000	220,000	150,000	340,000	140,000	140,000	130,000	46.4	171,000 D	203000 D	213000 D	200000 D	178000 ED	224000	163000	186000	218000	182000	159000	228000 M	172000
43.4 B	78	16	32	7.6	64	11	11	7.5 U	0.60 J	4.8 JD	18.5 UD	0.37 U	0.5 UD	5.5 JD	4.9 U	4.9 U	24.6	42.5	20.9	19.2	35.7	36.1 J
311,000	250,000	250,000	250,000	250,000	320,000	250,000	240,000	260,000	54,800	329,000 D	286000 D	316000 D	299000 D	317000 D	309000	334000 B	340000	328000	286000	289000	-	-
25,700	17,000	17,000	17,000	17,000	24,000	24,000	23,000	18,000	16.4	22,300 D	21900 D	27000 D	24300 D	23400 ED	19400	20800	23100	22700	21200	20700	23000 M,B	19500
0.18 B/0.2 U(l)	1.8	1.3	0.56	0.81	0.18 B	0.092 B	0.23	0.20 U	0.1 U	0.60	0.14 J	0.45	0.038 J	0.21	0.07 J	0.19	0.1 J	1	0.24	0.2 B	-	
5,660	3,700	3,600	3,700	3,500	5,400	3,400	3,200	3,500	1.0	4,020 D	4360 D	4550 ED	4530 D	4020 D	3910	3830	4840	4340	4130	3840	4380 M	3690
8,710 NEJ[k,v]	17,000	6,900	9,800	4,200	17,000	4,400	4,600	5,100	386	4,770 ND	3930 JD	3450 JED	3670 NE	5060 JED	4610	4770	4470	6350	4300 B	4550	-	-
68.0 U/400 U	52	36	56	11 B	55 B	6.8 B	12 B	15 U	3.1 J	14.2 JND	59.7 JDN	3.7 U	4 UD	100 UD	22.5	16.2 B	21.1	34.6	14.8	16.3 B	-	-
28.0 U/60 U	10	9.7 B	5.3 B	10 U	6.6 B	10 U	2.4 B	2.8 B	0.10 J	4.5 D	7.8 D	1.1 JD	0.25 UD	6 UD	6.8	1.6 J	4.5 J	7.1	6.3	3.3 J	-	-
88,900	56,000	78,000	100,000	74,000	96,000	65,000	56,000	68,000	42,800	79,500 D	82000 D	83000 D	79400 D	77300 D	46700	74300	73100	66100	68000 B	29800	-	-
7.00	19 B	2.6 B	8.3	3.3 B	4.0 U	4.5	2.3 B	3.8 B	0.38 U	4.5 D	32 UD	0.64 U	1 UD	40 UD	6.2	27.9	20.9	23.2	24.6	15.2	6.8 J	4.1 J
268	260	140	240	77	340	68	77	56	8 U	96.2 D	440 UN	111 JD	141 D	137 JD	122	85.8	74.6	144	68.9	49.7	10.8	63.2
46,200	46,000	38,000	39,000	38,000	45,000	34,000	34,000	37,000	9.0	32,400 D	36200 D	34400 D	35400 D	30900 D	33100	29300	28600	32700	34800	31400	32500 M	28700
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.15	0.050 U	0.050 U	0.050 U	0.10	0.050 U	0.45	0.94	1.9	0.2 J	-	-	-	-	-

MW04A 2/12/2002	MW04A 2/19/2003	MW04A 10/7/2003	MW04A 5/26/2004	MW04A 10/27/2004	MW04A 5/10/2005	MW04A 10/18/2005	MW04A 5/16/2006	MW04A 10/18/2006	MW04A 6/4/2007	MW04A 10/9/2007	MW04A 5/13/2008	MW04A 10/14/2008	MW04A 5/6/2009	MW04A 10/21/2009	MW04A 5/25/2010	MW04A 10/27/2010	MW04A 5/24/2011	MW04A 10/26/2011	MW04A 5/15/2012	MW04A 10/31/2012	MW04A 6/24/2013	MW04A 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.52 U	0.78 U	1.1 U	1.1 U	1.1 U	1.3 U	0.78 U	1.3 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ
0.52 U	0.23 J	0.55 U	0.53 U	0.57 J	0.65 U	0.17 J	0.64 U	0.17 J	0.40 U	0.40 U	0.24 J	0.52 U	0.52 J	0.42 U	1.2 U	1.2 U	1.1 P	1 U	0.6 U	0.18 JP	0.18 U	0.6 UJ
1.4 J[e]	0.70	1.30	1.2	2.0	0.87 U	2.7	1.1	0.85	0.65	0.84	0.62	0.55	0.077 J	0.21 U	1.1 JP	1.3	0.58 J	0.64 J	0.6 U	0.5 J	0.23 U	0.6 UJ
0.26 U	0.39 U	0.28 J	0.53 U	0.25 J	0.65 U	0.39 U	0.64 U	0.39 U	0.12 J	0.38	0.097 J	0.18 J	0.26 U	0.10 J	0.48 JP	0.4 J	0.8 U	0.8 U	0.6 U	0.22 JP	0.2 U	0.6 UJ
0.52 U	0.78 U	1.1 U	1.1 U	1.1 U	1.3 U	0.78 U	1.3 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.39 U	0.55 U	0.53 U	0.56 U	0.65 U	0.39 U	0.64 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.25 J[e]	0.39 J	0.37 J	0.44 J	0.56 U	0.65 U	0.25 J	0.44 J	0.38 J	0.21	0.45	0.12 J	0.27 J	0.26 U	0.21 U	0.52 JP	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
4.02	5.3	5.6 (u)	4.9	6	3.4 U	6	4.1	4.5	3.0 J	5.4	2	0.26 U	0.31	1.7	4.9	5.1	4.1	5.1	3.6	4.9	2.4 P	3.8
10.5	10	10 (u)	9.2	12	6.8 U	12	7.8	9.0	5.8	11	4.2	8.2	0.59	3.8	9.3	13	7	11	9.3	13	8.2	9.3
0.26 U	0.39 U	0.55 U	0.53 U	0.56 U	0.65 U	0.39 U	0.64 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	0.83	0.81 J	0.77 J	0.77 J	0.43 U	0.78 U	0.68 J	0.72 J	0.33	0.20 U	0.15 J	0.26 U	0.26 U	0.19 J	0.52 J	1.2 U	1 U	1 U	0.6 U	0.82 J	0.24 U	0.6 UJ
0.52 U	0.78 U	1.1 U	1.1 U	1.1 U	1.3 U	0.78 U	1.3 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ
0.52 U	0.78 U	1.1 U	1.1 U	1.1 U	1.3 U	0.78 U	1.3 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.52 U	0.78 U	1.1 U	1.1 U	0.44 U	0.52 U	0.31 U	0.51 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ
2,390 NJ[e]	4,800	1,700	45,000	4,200	350	22,000	1,300	1,900	834	1,610	753.0	751.0	3610 D	744.0	2110	4040	1660	4570	131	36400	57100	231000
4.5 U	50 U	6.0 U	6.0 U	6.0 U	6.0 U	2.3 B	6.0 U	6.0 U	1 U	1 U	0.16 J	0.18 J	1 UD	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-
4.1 U	8.0 B	4.0 U	37	4.9	4.0 U	16	4.0 U	4.0 U	4 U	4.3	4.8 J	4.7 J	2.3 JD	9.1	11.7 J	13 U	24 U	24 U	12 U	17 J	21.9 J	71.6 J
25.2 J[e]	38	17	220	34	8.6 B	110	32	14	32.2	17.5	18.6	14.1 E	36.9 D	7.0	8.9	39.9	19.9	25.6	5.7	111	-	-
0.31 B/2 U[f]	0.38 B	4.0 U	4.5	0.49 B	4.0 U	1.9 B	0.21 B	4.0 U	0.14 U	0.19	0.068 J	0.16 J	0.22 D	0.2 U	0.46 J	1.3	0.36 J	0.41 J	0.3 U	2.8	4.3 M	23.1
0.51 B/3 U[f]	0.81 B	2.0 U	6.6	1.1 B	0.38 B	2.5	0.38 B	0.72 B	0.13 J	0.80	0.30	0.95	3.4 D	0.35 J	0.27 J	2.2	0.13 J	0.85 J	1 U	0.45 J	2.2	13.2 J
81,300	72,000	65,000	68,000	72,000	66,000	77,000	110,000	69,000	126,000	80,300	91400	88600	159000 D	72600	68800	84800	69700	91000	85000	115000	-	-
5.2 J[e]	12	13	84	7.7 B	1.4 B	43	2.5 B	3.1 B	3.6 J	21 J	2.1 J	3.2 U	4.8 D	2.5 J	3.1	9.9	3 J	7.9	1.2 J	44.3	-	-
1.8 /5 U[f]	5.2 B	10 U	53	4.9 B	1.5 B	28	1.7 B	2.5 B	0.67	4.4	0.87	3.80	15.7 D	1.1 J	2.1 J	16.1	1.8 J	5.6	2 U	17.9	-	-
6.5 B/10 U[f]	8.6 B	4.3 B	65	6.1 B	3.5 B	32	10 U	2.4 B	2.7 J	4.8	3.5	3.5	9.5 D	2.8 J	394	122	4.4 J	14.5	3.5 U	34.3	-	-
5,430 NJ[e,h]	10,000	3,500	130,000	10,000	560	58,000	1,600	3,200	932	2,720	1720	665	6750 D	1910	2330	5830	1670	9040	424	59700	91200 M	378000
4.2 B/10 U[f]	7.9	7.5 U	87	5.7 B	7.5 U	35	7.5 U	3.8 B	1.5	2.6	1.4	4.5	3.7 D	1.2 J	6.3	14.2	6.4 J	10.3	2.2 J	46.1	72.4	409
33,600	34,000	30,000	37,000	33,000	32,000	38,000	47,000	32,000	61,000	38,100	34900	39000	113000 D	34100	32400	40400 B	40300	44800	42600	56700	-	-
146 /[e]	180	84	2,200	210	30	1,000	34	120	405	257	52.3	280.0	5640 D	47.5	114	724	56.2	290	72.9	754	1320	6280
0.1 U/0.2 U[f]	0.20 U	0.20 U	0	0.17 B	0.20 B	0.12 B	0.2 U	0.20 U	0.036 J	0.082 J	0.074 J	0.1 U	0.038 J	0.073 J	0.14 U	0.22	0.12 U	0.07 J	0.06 U	0.15 B	-	-
8.4 B/10 U[f]	17	10	170	14	10 U	73	4.4 B	4.0 B	3.6	7.8	1.7	6.9 E	213 D	3.6 J	4.9	25.6	10.3	17	2.5 J	45.2	78.3	337
3,120 NEJ[f,v]	4,100	2,700	11,000	3,500	2,500	8,100	2,500	3,000	430	2,560	1390	2250 E	3330 NE	2140	2050	2760	1290 J	2110	2120	4890	-	-
512	450	380	350	320	340	370	670	290	4 U	329	383	299 E	26.2 D	304	311	314	415	314	229	299	-	-
1.4 U	10 U	10 U	10 U	10 U	0.91 B	10 U	10 U	10 U	0.4 U	0.4 U	0.079	0.034 J	0.25 UD	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-
121,000	110,000	110,000	94,000	100,000	92,000	100,000	170,000	96,000	68,700	106,000	183000	113000	108000 D	102000	93300	111000	129000	105000	106000	120000	-	-
0.24 /2 U(f)	25 U	4.0 U	3.8 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.13 J	0.38 U	0.64 U	0.64 U	1 UD	2 U	5 U	5 U	9.6 U	15 U	7.5 U	2.8 J	2.5 U	7.5 UJ
5.5 B/10 U(f)	11	3.4 B	100	10	1.1 B	56	4.1 B	4.0 B	3.3 J	4.0 J	3.1 J	8.8 U	6.8 JD	2.3 J	2.9 B	7.7	2 J	8.2	2.5 U	63.1	91.3	372
37.5	69	39 B	710	56	18 B	280	14 B	26 B	14.1	36.5	17.4	30.1	140 D	17.5	41.7	260	13 J	88.1	8.4 J	181	301	1320
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.68 J[f]	1.6	1.4	1.1	1.5	1.3	1.6	0.8	0.97	1.2	1.4	0.62	1.5	0.12	0.98	0.9	2.9	0.23 J	-	-	-	-	-

MW04B 2/12/2002	MW04B 2/19/2003	MW04B 10/8/2003	MW04B 5/26/2004	MW04B 10/27/2004	MW04B 5/10/2005	MW04B 10/18/2005	MW04B 5/16/2006	MW04B 11/18/2006	MW04B 6/4/2007	MW04B 10/9/2007	MW04B 5/13/2008	MW04B 10/14/2008	MW04B 5/6/2009	MW04B 10/21/2009	MW04B 5/25/2010	MW04B 10/27/2010	MW04B 5/24/2011	MW04B 10/26/2011	MW04B 5/15/2012	MW04B 10/31/2012	MW04B 6/24/2013	MW04B 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.519 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ
0.519 U	0.39 U	0.66 U	0.51 U	0.77	0.63 U	0.67	0.62 U	.039 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ
0.26 U	0.39 U	0.66 U	0.51 U	0.39 U	0.63 U	0.39 U	0.62 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.26 U	0.39 U	0.66 U	0.51 U	0.39 U	0.63 U	0.39 U	0.62 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ
0.519 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.39 U	0.66 U	0.51 U	0.39 U	0.63 U	0.39 U	0.62 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.39 U	0.66 U	0.51 U	0.39 U	0.63 U	0.39 U	0.62 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	1.3	0.28 U	0.6 UJ
0.26 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 U	0.6 U	4.1	0.24 U	0.6 UJ
0.26 U	0.39 U	0.66 U	0.51 U	0.39 U	0.63 U	0.39 U	0.62 U	0.9 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.519 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	30	0.6 UJ
0.519 U	0.78 U	1.3 U	1.0 U	0.78 U	1.3 U	0.78 U	1.2 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.519 U	0.78 U	1.3 U	1.0 U	0.31 U	0.50 U	0.31 U	0.50 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ
1570 NJ[b]	78,000	610	2,700	83 B	40	2,600	160 B	150 B	50.4 J	558	109 JD	132 U	231 D	1000 UD	880	102	179 J	474	16.7 J	25700	213	458
4.7 B/20 U[f]	50 U	6.0 U	6.0 U	6.0 U	2.7 B	7.8	14.0	6.0 U	1.2	1.2	0.76 JD	3.2 JD	8.8	8.7 JD	16 U	16 U	32 U	2 J	6 U	6 U	-	-
4.1 U	89	4.0 U	1.9 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4 U	4 U	12.8 UD	6.4 U	3.5 U	50YD	11.6 J	13 U	24 U	24 U	12 U	13.7 J	4 U	12 UJ
97.7	1,100	89	170	63	66	110	78	61	56.6	130	47.9 D	120 ED	66.2 D	38.4 JD	44.6	40.9	31	47	30.7	120	-	-
0.24 B/2 U[f]	6.2	4.0 U	4.0 U	4.0 U	4.0 U	0.2 B	4.0 U	4.0 U	0.14 U	0.14 U	0.32 UD	1.1 JD	0.081 JD	2 UD	1.4	0.77 J	1.3	0.22 J	0.16 J	2	0.27 J	1.6 J
2.3 B/3 U[f]	22	0.98 B	1.3 B	0.47 B	2.0 U	0.4 B	0.58 B	0.37 B	0.15 J	0.35	1.4 D	2.5 D	0.7	0.80 JD	0.48	0.4 U	0.36 J	2 U	1 U	1.2 J	1.2 J	1 UJ
323,000	480,000	67,000	320,000	310,000	300,000	360,000	340,000	300,000	313,000	363,000 D	321000 D	431000 D	300000	334000D	350000	382000	358000	363000	321000	236000	-	-
4.7 B/5 U[f]	170	11	5.5 B	2.6 B	2.6 B	8.5 B	2.3 B	10 U	29.5	2.5 J	2.2 JD	3.2 U	2.4	50 UD	2.9	1.7 J	5.6	1.2 J	1.5 J	31.5	-	-
15.4	100	2.7 B	6.6 B	5.5 B	5.9 B	6.6 B	3.4 B	4.3 B	2.9	3.7	2.6 D	3.6 JD	2.5	3.7 JD	3.4 J	5.4	3.6 J	2 J	1.9 J	14.3	-	-
17.6	530	7.9 B	10	2.3 B	10 U	5.4 B	28	10 U	3.8	4.5	4.0 D	130 D	28.7	6.5 JD	110	112	134	21.2	17.5	36.8	-	-
4000 + NJ[b, g]	260,000	2,100	6,000	420	340	4,800	570	1,000	432	2,290	348 D	1030 D	931.0	936ED	1960	1170	841	2620	285	39300	710	3060
5.4 B/10 U[f]	310	7.5 U	3.0 B	7.5 U	10	38	28	7.1 B	2.3	3.8	2.6 D	11.8 D	25.3	5.1 JD	10.8	10.6	4.7 J	4 U	2 U	34.7	3.5 J	12.4 J
97,000	130,000	46,000	100,000	110,000	110,000	120,000	120,000	110,000	112,000D	120,000 D	106000 D	116000 D	107000 D	119000D	123000	130000 B	135000	136000	133000	90400	-	-
2,080	7,700	95	960	1,000	820	1,000	820	760	651	805	659 D	1160 D	750	1390ED	603	872	645	624	658	976	231	631
0.1 U/0.2 U[f]	0.48	0.20 U	0.02 U	0.081 B	0.20 U	0.2 U	0.2 U	0.20 U	0.023 J	0.1 U	0.0475 J	0.056 J	0.060 J	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.08 JB	-	-
45.8	320	6.9 B	17	12	8.1 B	11	8.8 B	5.2 B	7.8	7.1	6.5 D	12.1 ED	11.7 D	10.3 JD	6.8	7.8	12	5.4 J	5.9 J	37.2	7.8	7.4 U
20,900 NEJ[b, e]	39,000	27,000	22,000	18,000	19,000	20,000	19,000	17,000	12,400	12,800	12900 D	12000 D	11700 NE	11700ED	11700	14900	11600	10900	11700	9000	-	-
4.7 B/20 U[f]	44	16	15 U	15 U	31	15 U	4.5 B	15 U	35.9E	1.1 J	9.1 D	3.7 U	17.1	50 UD	205	14 U	82.4	2.7 J	13.2	121	-	-
1.4 U	4.6 B	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.4 U	0.4 U	0.067 JD	0.06 U	0.25 U	3 UD	2 U	2 U	8 U	4 U	2 U	2 U	-	-
225,000	160,000	240,000	250,000	260,000	240,000	220,000	210,000	170,000	166,000	173,000	160000 D	164000 D	149000 D	134000	158000	142000	133000	117000	118000	115000	-	-
0.8/2 U[f]	10 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.10 J	0.38 U	0.40 JD	0.64 U	1 U	20 UD	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ
5.9 B/10 U[f]	270	2.2 B	9.8 B	10 U	2.4 B	8.6 B	2.4 B	10 U	8 U	8 U	17.6 UD	8.8 U	5 UD	100 UD	1.7 U	1.7 U	6.8 U	5 U	2.5 U	44.5	2.2 J	1.4 J
81	1,100	39 B	46	18 B	19 B	17 B	31 B	11 B	28.1	17.6	62.9	396 D	28.6	28.0 UD	80.1	118	170	17.5	25	167	55.6	299
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.11 J[f]	0.27	0.12	0.10 U	0.10 U	0.7	0.10 U	0.64	0.10 U	0.94	0.092	0.93	0.26	0.096	0.97	0.84 UV	0.58	1.1	-	-	-	-	-

MW05A 2/12/2002	MW05A 2/19/2003	MW05A 10/8/2003	MW05A 5/26/2004	MW05A 10/27/2004	MW05A 5/10/2005	MW05A 10/18/2005	MW05A 5/16/2006	MW05A 10/19/2006	MW05A 6/4/2007	MW05A 10/9/2007	MW05A 5/13/2008	MW05A 10/14/2008	MW05A 5/6/2009	MW05A 10/21/2009	MW05A 5/25/2010	MW05A 10/27/2010	MW05A 5/24/2011	MW05A 10/26/2011	MW05A 5/15/2012	MW05A 10/31/2012	MW05A 6/24/2013	MW05A 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.52 U	1.1 U	1.3 U	1.4 U	1.4 U	1.2 U	0.82 U	0.91 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 UQ,M	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ
0.52 U	0.24 J	0.66 U	0.70 U	0.46 J	0.62 U	0.16 J	0.46 U	0.12 J	0.40 U	0.40 U	0.52 U	0.52 U	1.1	0.41 U	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ
0.81	0.51 J	0.94	0.74	0.97	0.79 U	1.6	0.67	0.47	0.38	0.20 U	0.31	0.14 J	0.16 J	0.21 U	0.44 JP	0.66 JP	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.26 U	0.53 U	0.66 U	0.70 U	0.68 U	0.62 U	0.41 U	0.46 U	0.42 U	0.65 J	0.20 U	0.26 U	0.10 J	0.26 U	0.21 U	1.2 U	0.34 J	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ
0.52 U	1.1 U	1.3 U	1.4 U	1.4 U	1.2 U	0.82 U	0.91 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.53 U	0.66 U	0.70 U	0.68 U	0.62 U	0.41 U	0.46 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.53 U	0.66 U	0.70 U	0.27 J	0.62 U	0.41 U	0.46 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
2.4	6.2	7.4 (u)	6.2	7	4.5	6.6	4.6	5.0	2.9 J	3.2	2.0	8.4	0.67	2	3.7	4.2	3.1	2.3	2.4	2.3 P	0.58 JP	2.3 J
5.1	10	12 (u)	11	12	8.2	13	8.8	9.5	5.3	6.5	4.5	0.26 U	1.3	3.9	6.8	11	5.8	6.4	7.1	7.5	2.6	6.4 J
0.26 U	0.53 U	0.66 U	0.70 U	0.68 U	0.62 U	0.41 U	0.46 U	0.42 U	0.20 U	0.20 U	0.26 U	1.0	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	0.87 J	0.99 J	0.82 J	0.82 J	0.57 J	0.82 U	0.78 J	0.76 J	0.36	0.20 U	0.26 U	0.26 U	0.26 U	0.24	1.2 U	1.5 P	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.52 U	1.1 U	1.3 U	1.4 U	1.4 U	1.2 U	0.82 U	0.91 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ
0.52 U	1.1 U	1.3 U	1.4 U	1.4 U	1.2 U	0.82 U	0.91 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.52 U	1.1 U	1.3 U	1.4 U	0.54 U	0.50 U	0.33 U	0.36 U	0.33 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ
4,230* N	13,000	81,000	2,700	6,200	400	28,000	1,100	10,000	10,500	19,000	2110	1070 D	12100 ND	838 JD	11600	558 M,Y	9820	4780	4480	10400	21100	9070
4.5 U	50 U	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	2.8 B	1 U	0.47 J	0.17 J	0.6 U	1 UD	22.7D	16 U	16 U	32 U	12 U	6 U	6 U	-	-
4.1 U	14 B	19	1.9 B	3.0 B	4.0 U	14	4.0 U	5.1	5.4	6.2	1.9 J	6.4 U	3.5 UD	50 U	29.6	13 U	7.3 J	24 U	12 U	9.1 J	17.9 J	5.9 J
34.8	91	510	34	60	12	200	22	70	55.2	77.6	46.8	18.8 ED	80.4 D	19.4 JD	61.4	13.8 Y	58.1	42.6	24.6	76.1	-	-
0.44 B/2 U[f]	1.2 B	6.8	0.20 B	0.97 B	4.0 U	2.4 B	0.30 B	0.82 B	0.49	1.3	0.14 J	0.16 U	0.89 D	2 UD	2.1	0.5 J	1.2	0.76	0.3 U	1.1	2.3	0.99 J
8.26	11	16	9.5	12	7.8	8.1	3.4	7.7	4.6	6.7	1.8	6.9 D	4.4 D	3.6 JD	10.1	6.2	5.1	7.8	7.6	4.8	10.7	11.4 J
350,000	320,000	300,000	300,000	290,000	250,000	240,000	200,000	210,000	249,000	229,000	193000	227000 D	151000 D	224000D	296000	293000	213000	218000	222000	156000	-	-
7.9 J[h]	32	130	4.3 B	9.2 B	10 U	44	2.5 B	14	11.4	19.1	5.0	3.2 U	14.4 D	12.8 JD	10.2	1.2 J	15.3	5.5	6.8	18.4	-	-
9.10	21	93	14	21	8.9 B	32	5.7 B	17	9.0	16.6	4.2	7.4 D	23.8 D	7.3 JD	8.7	6.8	17.7	20.2	4	22.6	-	-
8.2 B/10 U[f]	43	110	4.5 B	12	4.4 B	42	4.5 B	11	7.7	12.6	4.4 E	4.5 JD	12.6 D	5.0 JD	435	66.1 Y	21	28.6	1.7 J	17	-	-
7,210 NJ[f, u]	28,000	190,000	5,900	13,000	780	60,000	1,500	19,000	14,800	20,800	4390	1000 D	24200 D	2720D	11000	134 M	18000	7060	4730	25100	55300	22700
4.8 B/10 U[f]	26	110	7.5 U	6.0 B	7.5 U	34	7.5 U	11	9.7	12.1	2.7	0.37 U	12.3 D	20 UD	14.2	7.3 M	23.6	8.9	6.7	24.4	60.8	46.4
252,000	270,000	270,000	260,000	260,000	210,000	200,000	150,000	160,000	193,000D	173,000 D	131000 D	156000 D	116000 D	159000D	194000	216000 B	164000	162000	188000	119000	-	-
5,300	5,200	9,400	5,500	6,700	3,700	3,900	1,400	2,200	1,840	2,560	659 N	2480 D	6610 D	3940D	2340	3150	2180	3160	2650	2440	6820 B	3820
0.1 U/0.2 U[f]	0.20 U	0.71	0.20 U	0.20 U	0.20 U	0.2 B	0.2 U	0.20 U	0.031 J	0.13	0.067 J	0.062 J	0.056 J	0.15 J	0.14 U	0.13 J	0.12 U	0.15	0.06 U	0.16 B	-	-
372	420	750	450	550	310	340	140	200	169	219	59.2	211 ED	302 D	215D	236	298	672	228	265	187	386	435
6,900 NEJ[f, v]	9,300	18,000	7,700	8,600	6,000	11,000	4,400	7,100	5,320	6,530	3420 N	3120 ED	4760 NE	3530 JD	3670	4700	3810	2980	4330	4520	-	-
144	140	150	130	120	100	110	94	74	69.1E	107	33.8	41.2 ED	23.0 D	27.8 JD	52.4	73.4	48.9	41.8	71.3	34.4 B	-	-
1.4 U/3 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.4 U	0.4 U	0.048 J	0.06 U	0.25 UD	3 UD	2 U	2 U	8 U	4 U	2 U	2 U	-	-
130,000	110,000	110,000	130,000	120,000	140,000	110,000	110,000	100,000	116,000	117,000	117000	117000 D	96500 D	114000D	132000	131000	103000	100000	106000	91200	-	-
0.41 /2 U[f]	12 B	20 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.37 J	0.29 J	0.64 U	0.64 U	1 UD	20 UD	5 U	5 UM	9.6 U	15 U	4.2 J	7.5 U	2.5 U	7.5 UJ
6.6 B/10 U[f]	21	110	2.8 B	9.9 B	12	46	5.5 B	16	14.6	20.7	5.7 J	8.8 U	22.1 JD	100 UD	9.7	1.7 U	13.3	6.2	4.8 J	15.8	15.9	12.9 J
274	490	1,400	390	590	290	520	140	260	199	286	83.1	399 D	254 D	214D	418	342 Y	292	361	315	316	556	568
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.99 J[j]	1.7	1.1	1.2	1.2	1.1	1.1	1.1	0.77	1.3	0.84	0.30	0.65	0.56	0.25	0.21 JV	1.1 Y	0.2 J	-	-	-	-	-

MW05B 2/12/2002	MW05B 2/19/2003	MW05B 10/8/2003	MW05B 5/26/2004	MW05B 10/27/2004	MW05B 5/10/2005	MW05B 10/18/2005	MW05B 5/16/2006	MW05B 10/19/2006	MW05B 6/4/2007	MW05B 10/9/2007	MW05B 5/13/2008	MW05B 10/14/2008	MW05B 5/6/2009	MW05B 10/21/2009	MW05B 5/25/2010	MW05B 10/27/2010	MW05 B 5/24/2011	MW05B 10/26/2011	MW05B 5/15/2012	MW05B 10/31/2012	MW05B 6/24/2013	MW05B 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.52 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ
0.52 U	0.60 U	0.58 U	0.72 U	0.40 U	0.39 U	0.40 U	0.46 U	0.40 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	2.1 P	14	21 P	0.66 JP	0.6 U	0.18 U	0.6 UJ
0.49	0.60 U	0.58 U	0.72 U	0.40 U	0.39 U	0.40 U	0.46 U	0.40 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.26 U	0.60 U	0.58 U	0.72 U	0.40 U	0.39 U	0.40 U	0.46 U	0.40 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ
0.52 U	0.35 J	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.60 U	0.58 U	0.72 U	0.40 U	0.39 U	0.40 U	0.46 U	0.40 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1.3	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.60 U	0.13 J	0.72 U	0.40 U	0.39 U	0.17 J	0.46 U	0.40 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ
0.26 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.26 U	0.60 U	0.58 U	0.72 U	0.40 U	0.39 U	0.40 U	0.46 U	0.40 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.52 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	2.6 P	2.6 P	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ
0.52 U	1.2 U	1.2 U	1.4 U	0.79 U	0.78 U	0.79 U	0.92 U	0.81 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.7 P	1.7 P	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.52 U	1.2 U	1.2 U	1.4 U	0.32 U	0.31 U	0.32 U	0.37 U	0.32 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ
495 N	1,100	570	11,000	170 B	74 B	6,100	370	66 B	107	180 N	270	117 J	117 JND	329	61.6	5.1 J	62.8 J	9.1 J	11.3 J	116	205	56.8 UJ
4.5 U	50 U	6.0 U	6.0 U	6.0 U	3.2 B	3.5 B	6.0 U	2.6 B	1.1	0.86 J	0.35 J	0.33 J	3.9	2.0	16 U	16 U	32 U	12 U	6 U	6 U	-	-
4.1 U	20 U	4.0 U	12	0.83 B	4.0 U	2.7 B	4.0 U	4.0 U	4 U	4 U	6.4 U	1.8 J	3.5 U	5 U	5.4 J	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ
42.3	65	140	370	89	93	130	78	120	86.3	129	127	129	299 D	40	189	81.4	103	64.9	79.3	50.8	-	-
0.2 U	4.0 U	4.0 U	1.4 B	4.0 U	4.0 U	0.3 B	4.0 U	4.0 U	0.14 U	0.14 U	0.16 U	0.16 U	0.1 UD	0.2 U	5.3	0.19 J	2.2	0.14 J	0.3 U	0.3 U	0.1 U	0.1 J
0.4 U	1.1 B	2.0 U	0.59 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.28 U	0.80	0.10 J	0.5	0.25	0.32 J	0.4 U	0.15 J	0.3 J	2 U	1 U	1 J	0.3 U	1UJ
310,000	210,000	530,000	62,000	280,000	270,000	290,000	11,000	110,000	99,800	94,300	90600	80000	96700	28900	148000	23200 B	24900	31700	22200	20400	-	-
1.4 B/5 U[f]	4.2 B	2.6 B	16	10 U	10 U	10	12	5.3 B	4.8 U	4.8 U	3.2 U	3.2 U	2 U	2.2 J	2 J	2 U	4.2 U	4 U	0.95 J	0.84 J	-	-
0.8 U/5 U	1.9 B	10 U	14	10 U	10 U	3.8 B	10 U	10 U	0.16 J	0.18 J	0.56 U	1.0 U	0.25	0.080 J	4.3 U	4.3 U	8.6 U	4 U	2 U	2 U	-	-
6.2 B/10 U[f]	4.5 B	6.0 B	20	3.4 B	8.8 B	7.8 B	4.4 B	4.3 B	2.6 J	3.5	2.6 E	7.9	1.7	5.3	2580	30.3	137	25.5	3.5 U	8.1	-	-
2,530 N[f, v]	2,200	1,300	31,000	340	190	8,800	280	160 B	90.7	272	76.9	152.G	176.0	447.0	599	33	348	100 U	50 U	237	416	183 UJ
2.1 B/10 U[f]	7.5 U	7.5 U	7.6	7.5 B	21	18	7.3 B	7.5 U	2.0	2.0	0.63	2.80	6.50	2.10	6	4.9 U	9.8 U	4 U	2 U	2 U	6.8	2 UJ
15,600	6,500	3,200	41,000	1,000	330 B	2,600	830	340 B	692	6,810	10100	42600	8580	1130	35400	1850 B	49400	86200	9390	13700	-	-
165	96	75	130	15	7.0 B	180	12	6.0 B	5.5	10.5	5.1 N	4.7	10.7	9.3	9.2	1.7 JB	18.1	1.7 J	0.71 J	12.2	33.4	14.5 UJ
0.1 U/0.2 U[f]	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.1 U	0.1 U	0.046 J	0.2 U	0.6 U	0.043 J	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.03 JB	-	-
5.2 B/10 U[f]	10	7.1 B	27	10 U	2.4 B	10	2.7 B	10 U	1.8	3.4	0.16 J	1.3	2.9 D	1.8 J	1.2 J	4.2 U	3.2 J	6 U	3 U	8.8	1 U	3 UJ
14,300 NE/J[f, v]	15,000	14,000	17,000	14,000	14,000	16,000	6,200	9,600	9,600	10,200 N	9760 N	9999.0	8920 NE	8130.0	8160	9040	8690	8310	8290	7650	-	-
7.5 B/20 U(f)	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	4.3 UE	4. UN	3.7 U	3.7 U	4 U	5 U	14 U	6.6 JB	2.4 J	13 U	6.5 U	6.5 U	-	-
1.4 U/3 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.30 J	0.4 U	0.024 J	0.019 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-
210,000	190,000	130,000	84,000	160,000	150,000	150,000	100,000	110,000	134,000	146,000	146000	189000	152000 D	123000	135000	151000	160000	195000	130000	141000	-	-
0.15 /2 U[f]	25 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.15 J	0.13 J	0.64 U	0.64 U	1 U	2 U	5 U	2.3 J	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ
1.8 B/10 U[f]	3.0 B	10 U	21	10 U	10 U	13	3.0 B	10 U	8 U	8 U	8.8 U	8.8 U	5 UD	10 U	1.7 U	1.7 U	6.8 U	5 U	2.5 U	2.5 U	0.8 U	2.5 UJ
22.3	57	27 B	62	11 B	22 B	36 B	8.8 B	7.8 B	18.0	15.7	9.0 J	10.7	7.6	24.9	91.1	3 J	70.9	5 J	1.7 J	17.3	3.9 J	31.3 UJ
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.64 J[f]	0.36	0.18	0.10 U	0.10 U	0.059 B	0.10 U	0.34	0.12	0.26	0.15	0.080	0.050 U	0.066	0.17	0.15 J	1.1	0.8 U	-	-	-	-	-

MW06 2/12/2002	MW06 2/19/2003	MW06 10/7/2003	MW06 5/26/2004	MW06 10/27/2004	MW06 5/10/2005	MW06 10/18/2005	MW06 5/16/2006	MW06 10/18/2006	MW06 6/4/2007	MW06 10/9/2007	MW06 5/13/2008	MW06 10/14/2008	MW06 5/7/2009	MW06 10/21/2009	MW06 5/25/2010	MW06 10/27/2010	MW06 5/24/2011	MW06 10/26/2011	MW06 5/15/2012	MW06 10/31/2012	MW06 6/24/2013	MW06 11/21/2013
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
0.52 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ
0.52 U	0.39 U	0.39 U	0.46 U	0.18 J	0.49 U	0.47 U	0.44 U	0.39 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.55	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ
0.26 U	0.39 U	0.39 U	0.46 U	0.39 U	0.49 U	0.47 U	0.44 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.26 U	0.39 U	0.39 U	0.46 U	0.39 U	0.49 U	0.47 U	0.44 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ
0.52 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ
0.26 U	0.39 U	0.39 U	0.46 U	0.39 U	0.49 U	0.47 U	0.44 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.39 U	0.39 U	0.46 U	0.39 U	0.49 U	0.47 U	0.44 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ
0.26 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ
0.26 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.26 U	0.39 U	0.39 U	0.46 U	0.39 U	0.49 U	0.47 U	0.44 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ
0.26 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ
0.52 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ
0.52 U	0.78 U	0.78 U	0.91 U	0.78 U	0.98 U	0.94 U	0.88 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ
0.52 U	0.78 U	0.78 U	0.91 U	0.31 U	0.39 U	0.37 U	0.35 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ
166 B/200 U(I)	91 B	26 B	810	170 B	91 B	1,300	230	580	621	402	630	94.8 J	649 ND	177	1820	661	1040	2360	150	3650	5710	597
4.5 U/20 U	50 U	3.4 B	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	1 U	1 U	0.40 J	0.17 J	1 U	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-
4.1 U/20 U	20 U	4.0 U	1.6 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	3.6 J	2.5 J	3.0 JN	3.4 J	5.9	7.9	21.5	13 U	24 U	24 U	12 U	6.8 J	5.1 J	12 UJ
2.9 B/5 U[f]	5.6 B	1.5 B	7.0 B	5.0 B	2.3 B	11	2.9 B	4.9 B	7.2	4.1	6.9	3.0	3.5 D	2.1 J	6.9	10.2	3.6	9.9	2.2	16.2	-	-
0.2 U/2 U	4.0 U	4.0 U	4.0 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.064 J	0.14 U	0.045 J	0.16 U	0.1 UD	0.2 U	0.4 J	0.42 J	0.41 J	0.11 J	0.3 U	0.36 J	0.55 J	0.3 UJ
2.5 B/3 U[f]	2.0	1.6 B	2.6	2.2	1.9 B	2.8	2.0	2.0 B	2.0	1.7	1.8	2.1	1.9	1.8	3	5.7	2	3.5	2.3	4.5	5.8	1.6 UJ
55,500	51,000	49,000	53,000	51,000	51,000	53,000	48,000	47,000	54,400	49,600	53100	53300	46700	49400	55400	55300	48300	53300	51600	49500	-	-
2.0 B/5 U[f]	6.6 B	4.8 B	3.5 B	3.1 B	2.0 B	5.7 B	2.7 B	3.5 B	3.0 J	2.8 J	3.1 J	3.2 U	3.3	1.1 J	2.9	5.6	4 J	8.1	2.7 J	15.5	-	-
0.80 U/5 U	1.7 B	10 U	10 U	10 U	10 U	1.8 B	10 U	10 U	0.75	0.45	0.63	0.36 J	0.69	0.36 J	2.3 J	5.7	8.6 U	2.9 J	2 U	5	-	-
4.9 U/10 U	12	3.2 B	3.1 B	2.1 B	2.3 B	10 U	2.5 B	3.1 B	3.5	2.9 J	4.9	1.3	2.9	1.6 J	13.7	52.1	39.3	7.6	3.3 J	9.9	-	-
475 N/[j,k]	200 U	200 U	1,400	190 B	130 B	2,100	460	1,100	1,820	780	1190	172	1020	305E	915	1340	866	5020	389	8870	13600	1510
1.5 U/10 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	7.5 U	2.8 B	1.6	0.69	1.5	3.2	1.3	0.39 J	5.1	9.3	7.3 J	5.1	2.2 J	11.8	22.9	17.1 J
19,000	20,000	18,000	20,000	19,000	20,000	20,000	18,000	17,000	20,300	19,000	18800	18900	19000	18400	21000	20100 B	24100	20400	19900	18800	-	-
31.7	3.4 B	3.4 B	66	16	6.4 B	71	6.6 B	41	32.0	22.1	14.8	13.3	14.8	9.5E	78	360	33.7	212	18.7	219	312	57.1 U
0.10 U/0.2 U[f]	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.1 U	0.1 U	0.076 J	0.2 U	0.059 J	0.053 J	0.04 J	0.05 J	0.12 U	0.04 J	0.06 U	0.1 JB	-	-
9.8 B/10 U[f]	9.2 B	6.1 B	8.0 B	4.9 B	4.5 B	12	5.8 B	4.0 B	7.0	5.6	6.2	5.1	7.2 D	5.8	11.7	17.9	16.6	19.1	6.1	25.7	42.4	9.5 U
2,830 NE/[l,v]	2,900	2,900	3,200	2,900	2,900	3,400	2,600	3,200	2,540	2,720	2540	2540	2460 NE	2530E	2490	3070	2350	2350	2500	3840	-	-
334	300	300	310	290	290	280	270	240	1236	217	272 N	251.0	231.0	258.0	295	264	265	268	283	246	-	-
1.4 U/3 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.4 U	0.4 U	0.068	0.026 J	0.085 J	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-
110,000	100,000	110,000	100,000	110,000	100,000	110,000	97,000	91,000	98,000	107,000	105000	117000	107000 D	104000	102000	118000	101000	105000	102000	118000	-	-
0.76 /2 U(I)	11 B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.27 J	0.38 U	0.22 J	0.30 J	1 U	2 U	2.4 J	5 U	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ
1.2 U/10 U	10 U	10 U	2.4 B	10 U	10 U	4.7 B	2.3 B	3.9 B	6.0 J	3.5 J	3.2 JN	8.8 U	3.8 JD	10 U	2.3 B	1.3 J	1 J	6.6	2.5 U	12.2	17.9	1.4 J
62.3	52	38 B	76	45	38 B	84	36 B	43	46.9	38.7	51.7	36.1	53.7	31.5	94.3	176	67.2	141	49.2	206	334	67.9 J
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.64 J[f]	2.3	2.3	2.4	1.9	1.8	1.9	2.4	1.6	2.0	1.5	1.9	1.8	1.6	1.50	1.8	2.7	2.1	-	-	-	-	-

Sample ID =	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	USEPA	Groundwater St
Date Sampled =	5/16/2006	10/18/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/7/2009	10/21/2009	5/25/2010	10/27/2010	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I	
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	
osives																						
(	1.5 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 UQ	1 UM	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	
	0.75 U	0.12 J	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	9.1	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	
5-Trinitrobenzene	0.73 J	0.38 J	0.41	0.20 U	0.56	0.11 J	0.51	0.20 U	1.2 U	0.34 JP	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	
Dinitrobenzene	0.75 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	
yl	1.5 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	
obenzene	0.75 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	
5-Trinitrotoluene	0.75 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	
nino-2,6-dinitrotoluene	1.9	2.3	1.4	2.4	1.8	1.3	1.1	1.4	1.5	2.4	1.9	2	1.5	1.5 P	0.78 J	1.6 J	1.7 P	1.8	1.7	NS	2.7 (See	
nino-4,6-dinitrotoluene	1.6	2.1	1.4	2.2	1.7	1.5	1.0	1.3	1.5	2.4	1.3 P	2.4	2.2	2.3	1.5	2.2 J	1.5	2.1	2.2	NS	Note (v)]	
-Dinitrotoluene	0.75 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	
-Dinitrotoluene	1.5 U	0.30 J	0.20 U	0.20 U	0.26 U	0.26 U	0.094 J	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	
trotoluene (o-nitrotoluene)	1.5 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	
trotoluene (m-nitrotoluene)	1.5 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	
trotoluene (p-nitrotoluene)	0.59 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	1 UY	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	
als - Unfiltered																						
minum	440	400	597	140	544.0	477.0	1960 N	2640.0	393	843	496	680	41.9	6760	2590	5880	938	372	13.8 J	50 to 200 (c)	NS	
mony	2.2 B	6.0 U	1 U	1 U	0.6 U	0.6 U	1 U	0.70 J	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	
nic	4.0 U	4.0 U	2.8 J	2.0 J	3.1 JN	2.4 J	3.7	8.1	17.4	13 U	4.6 J	24 U	12 U	11.6 J	4 U	12 UJ	12 U	12 U	9.5 J	10	50	
um	18	19	19.3	18.3	22.7	23.2 E	26.0 D	33.4	11.2	20.6 B	16.7	19.2	17.2	52.3	-	-	-	-	-	2000	2000	
illum	4.0 U	4.0 U	0.042 J	0.14 U	0.049 J	0.2	0.090 JD	0.19 J	1.5	0.78 J	0.32 J	0.12 J	0.3 U	0.71	0.1 U	0.31 J	0.3 U	0.3 U	0.3 U	.4	4	
mium	1.0 B	2.1	0.95	8.9	0.93	3.20	0.94	2.90	0.5	13.9	1.1 J	6.6	1.6 J	25.5	0.79 J	2.8 UJ	1.3 J	19.5	1.3 J	5	5	
ium	160,000	180,000	152,000	21,300	196000	207000	161000	156000	142000	211000 B	205000	213000	188000	262000	-	-	-	-	-	NS	NS	
mium, total	2.1 B	10 U	4.8 U	4.8 U	1.3 J	3.2 U	2.5	7.4	1.9 J	1.8 J	2.2 J	2.1 J	1.5 J	15.1	-	-	-	-	-	100	100	
alt	10 U	3.8 B	1.0	4.0	0.57	1.50	1.80	2.8 J	4.3 U	2.4 J	8.6 U	4 U	2 U	8.1	-	-	-	-	-	NS	1000	
per	9.1 B	2.9 B	2.7 J	6.0	2.7	3.1	3.1	6.4	747	110	1.7 J	2.7 J	3.5 U	13	-	-	-	-	-	1300	650	
	760	1,100	1,340	236	727	715	3260	6310	414	548	578 Y	1420	126	21000	3300	7470 J	2340	621	105 B	300(c)	5000	
	7.5 U	3.1 B	1.6	0.60 J	1.3	4.2	2.9	4.7	5.7	4.8 J	5.1 J	2.7 J	2.3 J	17.5	8.7	30.3 J	15.3	2 U	2 U	15	7.5	
nesium	90,000	120,000	85,600	140,000 D	109000 D	121000 D	96900	93600	77900	157000 B	130000	138000	128000	188000	-	-	-	-	-	NS	NS	
nganese	160	2,200	127	1,780	39.0	402.0	52.2	273.0	21.8	1560	28.6	468	143	1850	81.3	130	82.7	1210	38.6	50(c)	150	
cury	0.2 U	0.20 U	0.032 J	0.052 J	0.092 J	0.068 J	0.071 J	0.091 J	0.14 U	0.05 J	0.12 U	0.03 J	0.06 U	0.25 B	-	-	-	-	-	2	2	
el	7.4 B	12	6.4	21.6	3.4	11.3 E	10.6 D	14.5	3.2 J	47.1	16.5	21.7	7.1	91.4	11	17.4 J	12.9	54	10.5	100	100	
sslum	3,600	6,000	2,960	4,610	3290	3670 E	3100 NE	3890	2490	5780	3020	3280	3590 B	7330	-	-	-	-	-	NS	NS	
nium	270	230	205 E	190	170 N	161 E	135	180	220	199 B	154	161	154	139	-	-	-	-	-	50	50	
r	1.2 B	10 U	0.17 J	0.4 U	0.039 J	0.047 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	
um	100,000	98,000	103,000	108,000	105000	104000	92400	92800	88300	110000	95100	96700	98500 B	111000	-	-	-	-	-	NS	NS	
lium	4.0 U	4.0 U	0.38 U	0.38 U	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ	7.5 U	7.5 U	7.5 U	2	2	
adium	2.7 B	1.0 B	2.4 J	24 J	8.8 UN	8.8 U	4.4 JD	2.8 J	1.7 UB	1.7 U	6.8 U	5 U	2.5 U	11.2	4.9 J	8.8 J	2.8 J	0.83 J	2.5 U	NS	49	
	38 B	44	40.1	67.9	45.5	64.6	61.8	94.3	61.9	285	52.7	114	47.7	578	81	133	92.1	284	57.7	5000(c)	5000	
cators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
ite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	
ate + Nitrite	1.3	1.2	1.2	1.4	0.96	1.2	0.71	0.98	0.77 JV	2.4	0.77 JM	-	-	-	-	-	-	-	-	10	10	

Sample ID =	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	USEPA	Groundwater St
Date Sampled =	5/16/2006	10/18/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/7/2009	10/21/2009	5/25/2010	10/27/2010	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
osives																					
(	1.2 U	1.5 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400
	0.61 U	0.75 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84
5-Trinitrobenzene	0.61 U	0.75 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210
Dinitrobenzene	0.61 U	0.75 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7
yl	1.2 U	1.5 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS
obenzene	0.61 U	0.75 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5
5-Trinitrotoluene	0.61 U	0.75 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4
nino-2,6-dinitrotoluene	1.2 U	1.5 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See
nino-4,6-dinitrotoluene	1.2 U	1.5 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]
-Dinitrotoluene	0.61 U	0.75 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)
-Dinitrotoluene	1.2 U	1.5 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31
trotoluene (o-nitrotoluene)	1.2 U	1.5 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70
trotoluene (m-nitrotoluene)	1.2 U	1.5 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70
trotoluene (p-nitrotoluene)	0.49 U	0.59 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70
als - Unfiltered																					
minum	570	440	321	308	182.0	54.4 J	2050 N	566.0	344	171	410	251 Y	18 U	34.2 J	456	36 UJ	15.3 J	21.5 J	18 U	50 to 200 (c)	NS
mony	6.0 U	3.1 B	1 U	0.35 J	0.16 J	0.38 J	0.83 J	0.57 J	16 U	16 U	4.6 J	12 U	6 U	6 U	-	-	-	-	-	6	6
nic	4.0 U	4.0 U	4.0	2.2 J	3.0 JN	2.6 J	7.2	7.8	13	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	12 U	12 U	11.1 J	10	50
um	10	15	9.5	8.4	6.9	7.7 E	12.8 D	7.3	3.4	8 B	5.5	5	3.9	6.4	-	-	-	-	-	2000	2000
illium	4.0 U	0.19 B	0.14 U	0.14 U	0.16 U	0.16 U	0.093 JD	0.035 J	0.25 J	0.86 U	1.6	0.6 U	0.3 U	0.3 U	0.1 U	0.3 UJ	0.3 U	0.3 U	3.3	4	4
mium	1.8 B	2.1	1.0	1.4	1.5	2.0	2.1	1.3	1.1	0.96	1.1 J	0.87 J	1 J	1.1 J	0.57 J	0.45 UJ	1.2 J	1.4 J	0.52 J	5	5
ium	150,000	150,000	138,000	138,000	136000.0	161000.0	131000	139000	144000	158000	160000	157000	138000	154000	-	-	-	-	-	NS	NS
omium, total	1.9 B	2.9 B	4.8 U	1.5 J	1.2 J	3.2 U	5.3	3.2 J	2.7	1.8 J	2 J	0.84 J	1.3 J	1.1 J	-	-	-	-	-	100	100
alt	1.3 B	3.6 B	0.80	0.78	0.52 J	0.6	2.30	0.87 J	4.3 U	4.3 U	8.6 U	4 U	2 U	2 U	-	-	-	-	-	NS	1000
per	12	3.4 B	3.9	2.9 J	2.4	2.6	4.7	3.0 J	11 4	15.5	210	5.5 J	3.5 U	1.7 J	-	-	-	-	-	1300	650
	1,100	1,100	1,060	579	333.0	174.0	3840	1790	476	59.2	700	424	50 U	116	1140	75.9 J	30.3 J	33.9 J	132 B	300(c)	5000
d	8.8	7.5 U	1.1	0.60	0.6	6.3	2.9	1.2 J	4.3 J	8.8	5.8 J	4 U	2 U	2.9 J	7.4	12.9 J	12.6	2 U	2 U	15	7.5
nesium	73,000	71,000	60,600	63,700	55200.0	701000.0	58000	61400	56000	65700 B	75000	71400	61400	65000	-	-	-	-	-	NS	NS
nganese	500	500	260	275	260.0	351.0	384	306	251	259	194	255	151	339	273	289	289	304	107	50(c)	150
cury	0.2 U	0.20 U	0.034 J	0.1 U	0.054 J	0.033 J	0.045 J	0.073 J	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.04 JB	-	-	-	-	-	2	2
el	14	10	8.8	8.4	6.3	9.5 E	17.6 D	9.7	7.8	7.9	14.4	6.9	11.2	8.4	7	9.1 UJ	11.3	10.9	8.3	100	100
ssium	10,000	10,000	6,200	6,690	6240.0	6910 E	6000 NE	5860.0	5540	7600	6120	5780	5850	6620	-	-	-	-	-	NS	NS
nium	290	270	250E	287	280 N	279 E	239	268	295	296	251	269	248	219	-	-	-	-	-	50	50
r	10 U	10 U	0.4 U	0.4 U	0.039 J	0.028 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50
um	120,000	110,000	116,000	116,000	11400.0	124000.0	108000	102000	105000	118000	105000	106000	104000	112000	-	-	-	-	-	NS	NS
llium	4.0 U	4.0 U	0.50	0.56	0.48 J	0.7	0.76 J	0.57 J	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ	7.5 U	7.5 U	7.5 U	2	2
adium	6.0 B	5.0 B	3.8 J	2.4 J	3.0 JN	8.8 U	12.3 D	4.0 J	1.7 U	1.7 U	1.2 J	0.94 J	2.5 U	2.5 U	2.5 J	1 J	1.2 J	2.5 U	2.5 U	NS	49
	28 B	18 B	16.8	18.5	15.0	18.5	28.0	19.3	25.6	22	164	11.9	9.3 J	28.4	13	11.1 UJ	13.5	12.8	3.1	5000(c)	5000
cators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS
ate + Nitrite	0.50	0.42	0.92	0.52	0.65	0.62	0.6	0.62	0.5 JV	1.1	1.2	-	-	-	-	-	-	-	-	10	10

Sample ID =	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	USEPA	Groundwater Standards	
Date Sampled =	5/25/2010	10/27/2010	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I	Class II
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives														
HMX	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400
RDX	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84
1,3,5-Trinitrobenzene	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
1,3-Dinitrobenzene	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
Tetryl	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS
Nitrobenzene	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	1 JP	1.2 U	3.7	3.6 P	0.6 U	0.6 U	0.4 U	0.54 J	0.6 U	0.8 U	0.58 JP	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	1.2 U	1.2 U	0.8 U	7.9 P	8.3 P	0.6 U	0.23 U	6 J	0.6 U	0.6 U	0.6 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
Metals - Unfiltered														
Aluminum	28900	12200	41500	20000	19900	51700	26000	31200	10800	20900	1870	50 to 200 (c)	NS	NS
Antimony	24.8 M	6.3 J	7.7 J	12 U	6 U	6 U	-	-	-	-	-	6	6	24
Arsenic	13 U	13 U	26.8	10.2 J	13.6 J	27.4	15 J	15.2 J	12 U	18.4 J	4 J	10	50	200
Barium	50 3	10.9	11.5	9.6	9	22.7	-	-	-	-	-	2000	2000	2000
Beryllium	11.2	7.1	9.9	9.5	9.9	12.5	4.2	10.1	2.1	8.1	5.7	4	4	500
Cadmium	1210	341	199	429	494	621	234	549	151	483	286	5	5	50
Calcium	521000	537000	351000	331000	397000	451000	-	-	-	-	-	NS	NS	NS
Chromium, total	29.6 M	2.3	5.7	2.2 J	6.6	14.9	-	-	-	-	-	100	100	1000
Cobalt	686	263	141	255	312	341	-	-	-	-	-	NS	1000	1000
Copper	24.1 M	270	7.7	29.8	3.5 U	21.8	-	-	-	-	-	1300	650	650
Iron	332000	106000	60200	90500	149000	149000	64200	132000 J	46400	112000	42800	300(c)	5000	5000
Lead	4.9 U	4.9 U	15.9	9.6	12.9	25.9	24.5	33.1 J	30	8.6	12	15	7.5	100
Magnesium	424000	282000 B	273000	262000	365000	339000	-	17200	-	-	-	NS	NS	NS
Manganese	26900	10600	14000	17400	14800	15100	15200 B	17200	11200	15400	12900	50(c)	150	10000
Mercury	0.1 J	0.06 J	0.04 J	0.05 J	0.04 J	0.36 B	-	-	-	-	-	2	2	10
Nickel	6630	2440	1660	2450	3010	3270	1300	3060	821	2560	1060	100	100	2000
Potassium	14700	12900	6920	6260	8510	10300	-	-	-	-	-	NS	NS	NS
Selenium	29	5.6 JB	22.8	12 J	7.7 J	14.5 B	-	-	-	-	-	50	50	50
Silver	7.8	1.7 J	2.6 J	1.5 J	3.1 J	3.7 J	-	-	-	-	-	100(c)	50	NS
Sodium	52600	73600	108000	93000	81700	61500	-	-	-	-	-	NS	NS	NS
Thallium	12 M	23	12.8	25.2	20.4	21.2	4.8 J	13.6 J	3.9 J	10.7 J	7.8 J	2	2	20
Vanadium	81.3	43.2	140	76.6	83.7	165	101	94.4	68.6	90.3	3 J	NS	49	NS
Zinc	3340 M	10900	5190	11400	15000	16000	5170	13900	3380	11700	4750	5000(c)	5000	10000
Indicators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.84 UM,V	1.1	0.8 U	-	-	-	-	-	-	-	-	10	10	100

Sample ID =	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	USEPA	Groundwater Standards	
Date Sampled =	5/25/2010	10/27/2010	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I	Class II
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives														
HMX	1.2 U	1.2 UQ	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400
RDX	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84
1,3,5-Trinitrobenzene	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
1,3-Dinitrobenzene	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
Tetryl	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS
Nitrobenzene	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.3 JP	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	1.2 U	1.2 U	2 U	0.76 J	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
Metals - Unfiltered														
Aluminum	242	573	1570	1700	18 U	420	704	296	143	175	18 U	50 to 200 (c)	NS	NS
Antimony	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	24
Arsenic	15.3	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	12 U	12 U	9 J	10	50	200
Barium	4.9	23 B	24.7	26.1	4.4	13.7	-	-	-	-	-	2000	2000	2000
Beryllium	0.34 J	0.86 U	0.23 J	0.15 J	0.12 J	0.3 U	0.1 U	0.3 UJ	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	0.59	0.17 J	0.86 J	0.58 J	1 U	0.61 J	0.32 J	1 UJ	1 U	1 U	1 U	5	5	50
Calcium	101000	307000 B	61700	76300	60200	62500	-	-	-	-	-	NS	NS	NS
Chromium, total	2.7	1.4 J	2.8 J	3 J	1.4 J	3 J	-	-	-	-	-	100	100	1000
Cobalt	3.1 J	11.9	1.8 J	1.1 J	2 U	2 U	-	-	-	-	-	NS	1000	1000
Copper	5.1	11.3	5.1 J	4.3 J	3.5 U	2.9 J	-	-	-	-	-	1300	650	650
Iron	1120	9730	1490	2740	76.6 J	1280	1450	983 UJ	2050	1060	241	300(c)	5000	5000
Lead	4.1 J	3.1 J	5.4 J	2.8 J	2 U	3.6 J	8.8	13.7 J	15.3	2 U	2 U	15	7.5	100
Magnesium	32200	109000 B	30500	29700	25500	23500	-	-	-	-	-	NS	NS	NS
Manganese	280	2960	120	206	10.3	34.6	57.2	95.7 U	26.5	24.4	19	50(c)	150	10000
Mercury	0.05 J	0.15	0.12 U	0.03 J	0.06 U	0.16 B	-	-	-	-	-	2	2	10
Nickel	10.6	34.7	13.8	7.5	1.3 J	2.9 J	3 J	3.1 UJ	2.2 J	1.9 J	1.7 J	100	100	2000
Potassium	3540	12800	2560	2260	2850	2460	-	-	-	-	-	NS	NS	NS
Selenium	120	53.9	88.7	83.2	118	109	-	-	-	-	-	50	50	50
Silver	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS
Sodium	74600	78900	83600	84800	79900	100000	-	-	-	-	-	NS	NS	NS
Thallium	5 U	4.8 J	9.6 U	15 U	7.5 U	7.5 U	2.5 U	7.5 UJ	7.5 U	7.5 U	7.5 U	2	2	20
Vanadium	1.7 U	1.7 U	3.5 J	6.5	2.5 U	3 J	3.5 J	1.7 J	1.4 J	2.5 U	2.5 U	NS	49	NS
Zinc	16.7	29	15.7 J	18	6 J	12.3	11	7.8 UJ	9.4 J	7.5 J	5 U	5000(c)	5000	10000
Indicators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.84 UV	0.67	0.23 J	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

General Notes:

NS = no standard established.
ug/L = microgram per liter
mg/L = milligram per liter
USEPA MCL = U.S. EPA Maximum Contaminant Levels (June 2000).
35 IAC 620 Subpart F is the basis for the derived groundwater standards. Ingestion Route for Class I: Potable Resource Groundwater and Class II General Resource Groundwater (revised June 1
B = laboratory qualifier indicating value (inorganic analyses) is estimated because it is between the method detection limit and the method reporting limit
U = laboratory qualifier indicating value is not detected above the method detection limit.
N = laboratory qualifier indicating value is estimated because the matrix spike recovery was outside criteria.
/ U, 0.2U, 2U, 3U, 5U, 10U, 20U, 200U = data validation qualifier indicating value is not detected above the method reporting limit.
J = data validation qualifier indicating the value is estimated.
R = data validation qualifier indicating the value is not detected and unusable.
D = Indicates that the analyte was reported from a diluted analysis.
E = Indicates that the reported value is estimated because of the possible presence of interference (i.e., the serial dilution not within control limits)
N = Spiked sample recovery not within control limits.
February and October 2003; and May 2004 analytical data were not validated.
Blue Background indicates that concentrations of that analyte equaled or exceeded at least one respective Illinois Groundwater Standard or ARAR (Does not include non-detects [U])

Footnotes:

(a) Reporting limit does not meet the 35 IAC 260 Groundwater Standard. Most are not compounds of concern at the site and will not affect the project. Although 2,4-dinitrotoluene and 2,6-dinitrotoluene are compounds of concern the remediation objectives cannot
(b) Value is for total xylenes (o, m, & p).
(c) Value is a Secondary Drinking Water Regulation. These are non-enforceable federal guidelines for cosmetic or aesthetic affects of drinking water
(d) Value is for cis plus trans 1,3-dichloropropene.
(e) Estimated value due to low quality control method reporting limit recovery (QC MRL).
(f) Unusable result because analyte is not detected and there is a low QC MRL recovery.
(g) Estimated value due to low initial calibration verification (ICV) recovery.
(h) Estimated quantitation limit due to low ICV recovery.
(i) Estimated due to a low surrogate recovery.
(j) Not detected, value is below the MRL.
(k) Unusable due to low relative response factor (<0.05).
(l) Unusable due to low laboratory control sample recovery (LCS).
(m) Estimated quantitation limit due to low LCS recovery.
(n) Estimated value due to low relative response factor (<0.05).
(o) Not detected due to similar concentartion in a blank (method, calibration, or field).
(p) Estimated value due to MS recovery greater than 125%.
(q) Estimated value due to high MRL recovery.
(r) Estimated due to relative percent difference of field duplicate greater than 25%.
(s) Estimated value due to low MS recovery.
(t) Estimated quantitation limit due to low surrogate recovery.
(u) The Health Advisory Value (2.7 ug/L) is for combined concentrations of 4-amino-2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene (i.e., total ADNTs)

MW02R 11/15/2001 ug/L	MW02R 2/13/2002 ug/L	MW02R 2/26/2003 ug/L	MW02R 10/9/2003 ug/L	MW02R 5/27/2004 ug/L	MW02R 10/26/2004 ug/L	MW02R 5/10/2005 ug/L	MW02R 10/19/2005 ug/L	MW02R 5/17/2006 ug/L	MW02R 10/17/2006 ug/L	MW02R 6/5/2007 ug/L	MW02R 10/10/2007 ug/L	MW02R 5/14/2008 ug/L	MW02R 10/16/2008 ug/L	MW02R 5/5/2009 ug/L	MW02R 10/20/2009 ug/L	MW02R 5/26/2010 ug/L	MW02R 10/25/2010 ug/L	MW02R 5/25/2011 ug/L	MW02R 10/25/2011 ug/L	MW02R 5/16/2012 ug/L	MW02R 11/1/2012 ug/L	MW02R 6/25/2013 ug/L	MW02R 11/20/2013 ug/L	MW02R 5/21/2014 ug/L	1(
1.13	1.5	2.8	3.4	1.5	2.7	4.1	3.0	0.98	2.9	0.40 U	2.0	0.98	2.3	0.52 U	1.6	2.2	1.2 U	1.6 P	1.3 J	1.1 P	0.6 U	0.25 U	3.5 J	2.5 P	
5.12	6.7	13	20	7.3	15	39	15	5.3	23	9.6	7.0	4.8	7.5	5.4	11	16	1.2 U	18	7	13 M	7.4	1.8	10	23	
0.26 U	0.26 U	0.63 U	0.55 U	0.41 U	0.55 U	0.16 J	0.46 U	0.39 U	0.39 U	0.61 J	0.20 U	0.12 J	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	
0.26 U	0.26 U	0.63 U	0.55 U	0.41 U	0.55 U	0.62 U	0.46 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	
0.519 U	0.52 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.91 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	
0.26 U	0.26 U	0.63 U	0.55 U	0.41 U	0.55 U	0.62 U	0.46 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
0.806 U [e]	0.26 U	0.63 U	0.55 U	0.41 U	0.55 U	0.62 U	0.46 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
0.26 U	0.26 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.46 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	
0.26 U	0.26 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.91 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	
9.7 U [e]	0.26 U	0.63 U	0.55 U	0.41 U	0.55 U	0.62 U	0.46 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	
0.26 U	0.26 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.91 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	
0.519 U	0.52 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.91 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	
0.519 U	0.52 U	1.3 U	1.1 U	0.82 U	1.1 U	1.2 U	0.91 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	
0.519 U	0.52 U	1.3 U	1.1 U	0.82 U	0.44 U	0.49 U	0.36 J	0.31 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
4.940 J [e]	272	2,800	820	1,900	21,000	330	2,700	910	1,800	71.9 JE	1,970	357	728	472	690	516	9460	666	523	41.8	1890	3600	25801 *	520	
20 U	4.5 U	50 U	5.3B	6.0 U	6.0 U	6.0 U	6.0 U	2.5B	6.0 U	1 U	1 U	0.6 U	0.6 U	1 U	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-	
20 UJ [e]	4.1 U	20 U	4.0 U	1.4B	20	4.0 U	4.0 U	4.0 U	4.0 U	4 U	4 U	6.4 U	6.4 U	3.5 U	1.1 J	15.7	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	12 U	
62.5	34.1	56	38	44	190	36	51	40	45	39.3	52.3	38.5	50.6	38.9	37.4	43	104 B	37.1	35.6	34.3	55.6	-	-	-	
2 U	0.22 B/2 U [d]	0.20 B	4.0 U	4.0 U	1.5B	4.0 U	4.0 U	4.0 U	4.0 U	0.14 U	0.072 J	0.16 U	0.16 U	0.5 U	0.2 U	0.86 U	0.54 J	0.86 U	0.12 J	0.3 U	0.13 J	-	-	-	
3 U	0.40 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.28 U	0.073 J	0.059 J	0.2 U	0.1 U	0.32 J	0.4 U	0.4 U	1.6 U	2 U	1 U	1 U	-	-	-	
88,100	106,000	94,000	88,000	99,000	96,000	98,000	95,000	110,000	98,000	99,000	97,200	93900	99800	94900	79700	90200	137000	63600	100000	87400	107000	-	-	-	
18.7	0.90 U/5 U	7.4 B	12	5.8B	38	1.9B	5.0B	2.0B	3.1 B	4.8 U	5.3	1.1 J	3.3	2.6	2.6 J	1.9 J	16.7	1.9 J	1 J	1.1 J	3.6 J	-	-	-	
3.60 B/5 U [f]	0.80 U/5 U	2.4 B	10 U	10 U	14	10 U	1.4B	10 U	1.3 B	0.12 J	1.1	0.56 U	0.36 J	0.1 U	0.55 J	4.3 U	9.4	8.6 U	4 U	2 U	2 U	-	-	-	
9.00 B/20 U [f]	4.9 U/10 U	4.0 B	3.5B	2.7B	25	10 U	10 U	10 U	3.2 B	1.6 J	3.3	5.2	1.5	2.9 N	2.0 J	9.6	21.5	3.8 J	7 U	3.5 U	3.3 J	-	-	-	
7,390 J [f]	416	4,500	1,400	2,800	42,000	500	3,800	1,300	2,700	46.4	2,450	344	1080	279	1090	920	22900 B	805	587	43.2 J	2950	-	-	-	
4.20 B/10 U [f]	1.5 U/10 U	3.2 B	7.5 U	7.5 U	17	7.5 U	2.6B	7.5 U	4.6 B	0.60 J	1.4	0.42	0.59	0.67	1.0 J	3.6 J	12.6	2.3 J	4 U	2 U	3.3 J	5.6	16 J	8.1 M	
48,900	55,200	54,000	50,000	57,000	56,000	56,000	55,000	65,000	55,000	54,800	54,800	49400	51300	53400	42600	53900	84500 B	39900 B	57800	51800	69600	-	-	-	
250	43	81	59	48	570	22	96	38	57	16.4	62.0	11.4	22	18.0	33.4	18.5	516	7.2	18.9	10.4	64.2 B	-	-	-	
0.2 U	0.10 U/0.2 U(j)	0.20 U	0.050B	0.20 U	0.080 U	0.20 U	0.2 U	0.2 U	0.20 U	0.1 U	0.1 U	0.13 J	0.055 J	0.046 J	0.2 U	0.14 U	0.04 J	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	
8.70 B/10 U (j)	1.1 U/10 U	5.4 B	7.3B	4.2B	31	10 U	2.8B	2.2B	10 U	1.0	4.1	0.6 U	2.3	0.6 U	2.8 J	1.1 J	22.4	8 J	6 U	3 U	2.6 J	-	-	-	
1,590	612	1,300	820B	1,000	4,200	520B	1,300	910B	1,000	386	802	464	566	438	545 J	506 J	2570	382 J	500 U	250 U	705	-	-	-	
20 U	4.2 B/20 U [f]	15 U	5.0B	15 U	8.5B	8.6B	15 U	15 U	15 U	3.1 J	1.9 J	2.6 J	2.9 J	3.1 J	2.5 J	14 U	14 U	14 U	2.6 J	4.1 J	3.1 JB	-	-	-	
3 U	1.4 U	10 U	10 U	10 U	10 U	1.1B	10 U	0.91B	10 U	0.10 J	0.4 U	0.018 J	0.015 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	
43,200	47,000	41,000	45,000	45,000	46,000	47,000	40,000	41,000	40,000	42,800	48,000	42500	43800	39900	36000	39400	44900	38600	36000	39600	46200	-	-	-	
2 U	1.1 / 2 U [f]	25 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.38 U	0.38	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-	
11.4	1.2 U/10 U	5.1 B	10 U	3.2B	47	1.6B	7.1B	3.2B	3.4 B	8 U	4.3 J	8.8 U	2.4 J	5 U	10 U	1.1 J	20.1	6.8 U	5 U	2.5 U	3.4 J	-	-	-	
35.0	10.0 B/20 U [f]	33 B	14B	40 U	96	6.9B	9.1B	9.7B	12 B	9.0	12.6	6.5 J	5.4 J	5.5	8.4 J	6.6	70.6	4.2 J	2.7 J	5 U	11.8	-	-	-	
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1.19	1.92	1.7	1.9	1.5	1.5	1.4	1.3	1.5	1.5	1.4	1.4	1.5	1.7	1.5	1.400	2.1	2.5	1.2	-	-	-	-	-	-	

MW05A 11/14/2001 ug/L	MW05A 2/13/2002 ug/L	MW05A 2/26/2003 ug/L	MW05A 10/10/2003 ug/L	MW05A 5/27/2004 ug/L	MW05A 10/26/2004 ug/L	MW05A 5/10/2005 ug/L	MW05A 10/19/2005 ug/L	MW05A 5/17/2006 ug/L	MW05A 10/17/2006 ug/L	MW05A 6/5/2007 ug/L	MW05A 10/10/2007 ug/L	MW05A 5/14/2008 ug/L	MW05A 10/16/2008 ug/L	MW05A 5/5/2009 ug/L	MW05A 10/20/2009 ug/L	MW05A 5/26/2010 ug/L	MW05A 10/26/2010 ug/L	MW05A 5/25/2011 ug/L	MW05A 10/25/2011 ug/L	MW05A 5/16/2012 ug/L	MW05A 11/1/2012 ug/L	MW05A 6/25/2013 ug/L	MW05A 11/20/2013 ug/L	MW05A 5/21/2014 ug/L
0.519 U	0.52 U	0.57 J	0.53 J	1.5 U	0.72 J	0.66 J	0.58 J	0.59 J	0.68 J	0.40 U	2	0.68	0.52 U	0.75	0.42 U	0.78 JP	1.2 U	1.5 P	2 U	5.8	3	6.6	3.8	16
1.47	3.3	9.8	8.5	5.1	5.9	4.7	3.3	5.5	6.1	13	18	7.0	10.0	5.5	0.87	13	1.2 U	53	1 U	63	7.9	15	16	21
0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U	0.68 U	0.42 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U	0.68 U	0.42 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	5.5 P
0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U	0.68 U	0.42 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
7.63	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U	0.68 U	0.42 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
51.4	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U	0.68 U	0.42 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	5.7 P	5.7 P	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U	1.4 U	0.85 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.31 U	0.31 U	0.54 U	0.34 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
21300	1,730 J[1]	3,700	1,200	6,300	860	4,800	880	550	2,200	834	4,240	1530	5190	1250	809	1660 Y	28700	2610 M	685	243	12900	7640	10800 J+	836
20 UR (f)	4.5 U	50 U	3.5B	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	1 U	1 U	0.6 U	0.6 U	1 U	2 U	16 U	5.1 J	32 U	12 U	6 U	6 U	-	-	-
11.1 BJ [h]	4.1 U	20 U	4.0 U	4.1	0.53B	4.0 U	4.0 U	4.0 U	4.0 U	4 U	2.8 J	6.4 U	5.4 J	1.9 J	1.6 J	16.8	13 U	4.6 J	24 U	12 U	6.1 J	4 U	12 UJ	12 U
128	40.4	53	38	56	36	59	35	27	38	32.2	43.6	30.1	125	28.7	26.8	33	170 B	47.1	157	27.3	76.6	-	-	-
1.10 B/2 U [i]	0.35 B/2 U[i]	4.0 U	4.0 U	0.35B	4.0 U	0.22B	4.0 U	4.0 U	4.0 U	0.14 U	0.19	0.045 J	1.4	0.034 J	0.2 U	0.48 J	1.8	0.33 J	0.19 J	0.3 U	0.54 J	-	-	-
3 U	0.40 U	2.0 U	2.0 U	2.0 U	0.50B	2.0 U	2.0 U	2.0 U	2.0 U	0.13 J	0.13 J	0.19 J	0.082 J	0.14 J	0.11 J	0.16 J	1	0.16 J	2 U	1 U	1 U	-	-	-
121,000	115,000	110,000	110,000	120,000	110,000	130,000	120,000	120,000	110,000	126,000	119,000	119000	123000	112000	119000	131000	147000	128000 Y	66300	123000	93700	-	-	-
43	2.4 B/5 U[i]	7.8 B	6.3B	13	1.6B	8.4B	2.3B	1.4B	2.5 B	3.6 J	5.3	2.0 J	6.0	1.7 J	2.0 J	3.8	44.4	4.2	4 U	1.7 J	13.2	-	-	-
9.3	1.3 B/5 U[i]	10 U	1.1B	2.8B	10 U	3.1B	10 U	10 U	1.6 B	0.67	2.4	2.7	13.7	0.46	0.48 J	4.3 U	17.3	8.6 U	4 U	2 U	5.1	-	-	-
23.3	10.1	3.2 B	3.4B	5.3B	2.5B	3.6B	10 U	10 U	11	2.7 J	5.3	6.3	3.2	4.4	2.7 J	231	51.2	9.2	11.6	3.5 UY	13	-	-	-
34200	1,590 J[j]	4,600	1,500	8,000	950	6,300	1,000	650	2,500	932	4,660	1680	17500 N	1190	943	2540	59400 B	3050	1440	282	11200	-	-	-
13.7	2.7 B/10 U[i]	3.0 B	7.5 U	3.2B	7.5 U	4.8B	7.5 U	7.5 U	4.5 B	1.5	2.9	1.2	2.2	0.94	0.61 J	6.8	29.4	2.7 J	4 U	2 U	14.4	9.7	27 J	30.3
57,800	50,000	55,000	55,000	58,000	52,000	65,000	58,000	60,000	54,000	61,000	60,300	52300	55200	55100	56200	67800	77400 B	62100 B	32700	61200	45900	-	-	-
724	407	170	600	510	420	430	460	120	490	405	705	240	3460	301	260	402	1180	256	213	379 M	971	-	-	-
0.2 U	0.10 U/0.2 U[i]	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.036 J	0.046 J	0.15 J	0.18 J	0.046 J	0.2 U	0.14 U	0.09 J	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-
33.6	3.3 B/10 U[i]	4.9 B	4.4B	13	2.4B	5.4B	10 U	10 U	10 U	3.6	5.6	0.92	18.3	1.5	3.1 J	3.4 J	50.6	12.8	3.1 J	1.3 J	10.8	-	-	-
3,870	730	1,300	780B	1,500	670B	1,300	730B	580B	730 B	430	984	477	1080	476	404 J	616 J	2980	651 J	7720	250 U	1260	-	-	-
20 U	3.4 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	4 U	4 U	3.7 U	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	6.5 U	-	-	-
3 U	1.4 U	10 U	10 U	10 U	10 U	1.2B	10 U	10 U	10 U	0.4 U	0.4 U	0.06 U	0.032 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
73,100	70,000	62,000	67,000	66,000	70,000	69,000	70,000	66,000	60,000	68,700	68,600	64600	66500	61400	63700	62700	77500	66200	57400	64500	62200	-	-	-
2.0 U	0.19 /2 U[i]	25 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.13 J	0.38 U	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
43.6	3.2 B/10 U[i]	5.8 B	10 U	11	10 U	12	3.2B	1.5B	3.8 B	3.3 J	7.7 U	3.1 J	15.9	3.0 J	10 U	3.2	51.6	4 J	5 U	0.89 J	19.4	-	-	-
83.5	18.3 B/20 U[i]	48	22B	21B	10B	20B	40 U	40 U	14 B	14.1	23.3	9.3	35.4	8.2	5.3 J	16.8	157	13.8 J	8 J	1.6 J	38.2	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.66	0.74	0.73	0.55	0.34	0.22	0.46	0.15	0.30	0.19	0.30	0.24	0.084	0.057	0.050 U	0.056	0.45	0.68	0.8 U	-	-	-	-	-	-

MW05B 11/14/2001 ug/L	MW05B 2/13/2002 ug/L	MW05B 2/26/2003 ug/L	MW05B 10/10/2003 ug/L	MW05B 5/27/2004 ug/L	MW05B 10/26/2004 ug/L	MW05B 5/10/2005 ug/L	MW05B 10/19/2005 ug/L	MW05B 5/17/2006 ug/L	MW05B 10/17/2006 ug/L	MW05B 6/5/2007 ug/L	MW05B 10/10/2007 ug/L	MW05B 5/14/2008 ug/L	MW05B 10/16/2008 ug/L	MW05B 5/5/2009 ug/L	MW05B 10/20/2009 ug/L	MW05B 5/26/2010 ug/L	MW05B 10/26/2010 ug/L	MW05B 5/26/2010 ug/L	MW05B 10/26/2010 ug/L	MW05B 5/16/2012 ug/L	MW05B 11/1/2012 ug/L	MW05B 6/25/2013 ug/L	MW05B 11/20/2013 ug/L	MW05B 5/21/2014 ug/L
0.519 U	0.52 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	3.2	0.40 U	0.52 U	0.52 U	0.52 U	0.44 U	1.2 U	1.2 U	1 U	6.1 P	0.6 U	0.6 U	0.25 U	0.6 UJ	17
0.519 U	0.52 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.39 U	0.39 U	0.18 J	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	.79 J	1.2 U	1.2 U	0.8 U	71	0.6 U	0.6 U	0.18 U	0.6 UJ	26
0.26 U	0.26 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U.	0.26 U	0.22 U	0.34 J	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.44 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
20.4	0.26 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.36 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.51 J	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
184	0.26 U	0.62 U	0.60 U	0.52 U	0.39 U	0.44 U	0.39 U	0.39 U	0.339 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.22 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.44 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	14	0.6 UJ	0.6 U
0.519 U	0.52 U	1.2 U	1.2 U	1.0 U	0.78 U	0.88 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.44 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.2 U	1.2 U	1.0 U	0.31 U	0.35 U	0.31 U	0.31 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.44 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
22600	1,810	6,400	87,000	4,400	1008	260	120B	430	200	300E	257	125 J	51.2 J	355	92.6 J	3930	698	263	2000	27.5 J	29.8 J	46.2	5710 J+	38.6
20 UR [f]	4.5 U	50 U	6 0 U	6 0 U	6.0 U	3.6B	6.0 U	3.7B	6.0 U	1.3	1.2	1.3	0.62	1.2	2 U	12.4 J	16 U	4.1 J	12 U	6 U	6 U	-	-	-
22.4 J [g]	4.1 U	6.9 B	57	39	0.63B	4.0 U	4.0 U	4.0 U	4.0 U	1.2 J	2.1 J	3.6 JN	8.8	19.0	5.6	29.3	8.3 J	8.5 J	24 U	12 U	12 U	4 U	23.7 J	12 U
856	228	420	850	1,100	310	180	150	180	230	107	92.8	153	163	377	154	926	308 B	143	39	156	155	-	-	-
2.7	0.90 B/2 U(j)	0.91 B	10	6.7	4.0 U	4 0 U	4.0 U	0.22B	4.0 U	0.14 U	0.14 U	0.16 U	0 16 U	0.1 U	0.2 U	1.8	0.84 J	0.82 J	0.16 J	0.3 U	0.3 U	-	-	-
1.2 B/3 U [f]	0.40 U/3 U	0.55 B	2.0 U	2.5	2.0 U	0.52B	2 0 U	2 0 U	0.47 B	0.42	0.077 J	1.3	0.13 J	0.12 J	0.17 J	0 3 J	0 4 U	0.62 J	2 U	1 U	1 U	-	-	-
189,000	72,100	150,000	120,000	210,000	94,000	140,000	60,000	100,000	75,000	52,500	25,400	82200	76600	173000	50300	385000	120000	52900	113000	62300	64700	-	-	-
48.1	3.9 B/5 U(j)	11	130	70	10 U	2.6B	1.4B	2.0B	7.4 B	2.5 J	2.5 J	3 2 U	3.2 U	2.4	1.7 J	7.4	1.9 J	0.99 J	2 J	0.87 J	0.67 J	-	-	-
23.6	6.1	8.8 B	120	73	10 U	10 U	1.4B	10 U	2.6 B	0.30	0.37	0.28 J	0.41 J	0.78	0.17 J	6.1	4.3 U	8.6 U	4 U	2 U	2 U	-	-	-
42.2	11.3	13	160	99	1.8B	2.8B	10 U	5.2B	2.9 B	2.3 J	4.0	4.3	1.3	2.2 N	4.5 J	134	181	165	1.6 J	3.5 U	1.3 J	-	-	-
58,400	6,030	12,000	240,000	160,000	370	340	270	410	390	362	540	388	1010 N	4210	412	12900	2040 B	821	1850	687	312	-	-	-
18.8	4 9 B/10 U [f]	8.2	78	44	7.5 U	17	4.5B	16	24	3.9	3.4	3.3	0.88	2.8	0.39 J	14.9	7.8	1.8 J	2.1 J	2 U	2 U	1.4 U	22 J	13.7
14,300	5,670	2,600	55,000	61,000	8,700	8,300	22,000	13,000	30,000	16,400	71,500	34500	64100	62300	57800	71200	57900 B	28000 B	56100	40000	34200	-	-	-
603	151	94	1,900	1,900	8.0B	16	93	24	170	84.1	80.8	157	232	667	43 B	1110	356	173	400	216	315	-	-	-
0.2 U	0.10 U/0.2 U [f]	0.20 U	0.21	0.058B	0.070B	0.20 U	0 2 U	0 2 U	0.20 U	0.035 J	0.066 J	0.029 J	0.029 J	0.055 J	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-
58.3	11.1	19	210	130	5.2B	7.3B	4.0B	6.2B	2.4 B	5.7	3.6	3.3	2.0	1.8	2.3	11.6	2.2 J	5 J	2.2 J	2.3 J	1.9 J	-	-	-
57,600	40,100	31,000	29,000	26,000	20,000	16,000	11,000	14,000	10,000	10,900	7,540	10300	6870	4020	6200	5190	4960	9290	500 U	6310	7390	-	-	-
20 U	3.4 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U	4 U	4 U	3.7 UN	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	3.5 J	6.5 U	-	-	-
3 U	1.4 U	10 U	10 U	10 U	10 U	1.0B	10 U	1.0B	10 U	0.4 U	0.4 U	0.020 J	0.06 U	0.25 U	0 3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
202,000	163,000	110,000	80,000	87,000	85,000	74,000	78,000	69,000	62,000	61,200	74,700	66600	70200	67300	65200	65700	74700	59300	60400	61500	66800	-	-	-
2.0 U	0.43 /2 U [f]	25 U	4.0 U	4.0 U	4.0 U	4.0 U	4 0 U	4.0 U	4.0 U	0.38 U	0.38 U	0.64 U	0.64 U	1 U	2 U	1.6 J	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
46.7	7.9 B/10 U [f]	10	140	85	10 U	1.4B	2.4B	2.3B	1.7 B	8 U	2.3 J	8.8 UN	8.8 U	5 U	10 U	7.4	1.7 U	6.8 U	2.6 J	2.5 U	2.5 U	-	-	-
118	34	44	440	290	40 U	25B	40 U	13B	21 B	28.7	10.3	11.2	8.3 J	21.7	3.6 J	71.3	312	65 7	5.1 J	1 6 J	2.2 J	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.11	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.97	0.1 U	0.10 U	0.067B	0.10 U	0.10 U	0 11	0.10 U	0.14	0.10 U	0.16	0.060	0.065	0.050 U	0.050 U	0.075	0.85	0.57	1	-	-	-	-	-	-

MW06A 11/14/2001 ug/L	MW06A 2/13/2002 ug/L	MW06A 2/26/2003 ug/L	MW06A 10/9/2003 ug/L	MW06A 5/27/2004 ug/L	MW06A 10/26/2004 ug/L	MW06A 5/10/2005 ug/L	MW06A 10/19/2005 ug/L	MW06A 5/17/2006 ug/L	MW06A 10/18/2006 ug/L	MW06A 6/5/2007 ug/L	MW06A 10/10/2007 ug/L	MW06A 5/14/2008 ug/L	MW06A 10/16/2008 ug/L	MW06A 5/5/2009 ug/L	MW06A 10/20/2009 ug/L	MW06A 5/26/2010 ug/L	MW06A 10/26/2010 ug/L	MW06A 5/25/2011 ug/L	MW06A 10/25/2011 ug/L	MW06A 5/16/2012 ug/L	MW06A 11/1/2012 ug/L	MW06A 6/25/2013 ug/L	MW06A 11/20/2013 ug/L	MW06A 5/21/2014 ug/L
802	503	480	500	400	440	2700	460	340	420	100	0.40 U	180	150 D	300	150	260	270	140	170	220	170	81	160	160
4530	2700	2,500	2,900	2,300	2,600	15,000	2,400	1,700	1,400	620E	0.40 U	850	860 D	1,300	780	1800	1300	880	760	1200	730	310	460	850
404	380	5.3 U	280	370	300	2,500	350	330	270	220E	0.20 U	0.26 U	190 D	290	200	230	180	120	130	160	92	47	56	140
0.577	0.26 U	5.3 U	0.73	6.8 U	4.1 U	0.5	7	0.61	0.34 J	0.25	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0.519 U	0.52 U	11 U	1.1 U	14 U	8.2 U	0.78 U	14 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0.26 U	5.3 U	0.53 U	6.8 U	4.1 U	0.39 U	7.0 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
60.5 J [c]	90	48	27	33	20	32	19	12	12	6.7	0.20 U	0.26 U	4.6	3.0	0.20 U	1.2 U	2.1	1 U	2 U	1.5 P	0.6 U	0.22 U	0.6 UJ	0.6 U
46.8	44	52	45 [h]	39	40	64	53	30	35	22	0.20 U	0.26 U	19	12	17	31 P	21 P	20 P	17	14	14	4 P	2.3 J	12 P
50.9	47	42	38 [h]	35	36	60	50	28	34	20	0.20 U	0.26 U	24	12	18	20	17	12	18	18	18	7.4	12	13 P
0.26 U	0.26 U	5.3 U	0.47 J	6.8 U	4.1 U	0.63	7.0 U	0.48	0.41	0.3	0.20 U	0.26 U	0.26 U	0.19	0.21	1.5 P	1.2 U	2 U	0.98 JP	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	11 U	0.87 J	14 U	8.2 U	0.88	14 U	0.65 J	0.46 J	0.35	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	11 U	1.1 U	14 U	8.2 U	0.78 U	14 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	4.5 P	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U
1.28 U [e]	0.52 U	11 U	5.1	14 U	8.2 U	0.78 U	14 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	1.9
0.519 U	0.52 U	11 U	1.1 U	14 U	3.3 U	0.31 U	5.6 U	0.31 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
59200	1,340	11,000	270,000	6,600	3,100	330	110,000	3,100	2,500	1,420E	47500 N	1160	11700	4060	1960	4920	146000	1060	13600	26.4 J	5680	761	1080 J+	4900
20 UR [f]	4.5 U	50 U	4.48	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	6.0 U	1 U	0.81 J	0.6 U	0.6 U	1 U	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-
27.5 J [g]	4.1 U	20 U	81	2.3B	1.7B	4.0 U	52	4.0 U	4.0 U	4 U	16.6	6.4 U	2.3 J	2.0 J	1.5 J	12.4	13 U	24 U	8 J	12 U	4.5 J	4 U	12 UJ	12 U
379	146	130	2,100	87	70	46	1,100	67	66	58.8	366	51.8	51.4	69.5	53.3	82.6	1790 B	54	172	42.7	88.3	-	-	-
3	0.72 B/2 U [f]	0.50 B	13	0.39B	0.22B	4.0 U	6.5	0.29B	4.0 U	0.057 J	2.3	0.16 U	0.37	0.17	0.064 J	0.44 J	14.7	0.2 J	1.4	0.3 U	0.22 J	-	-	-
1.2 B/5 U [f]	0.40 U/3 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.3	2.0 U	2.0 U	0.28 U	0.78	0.12 J	0.2 U	0.10 J	0.1	0.28 J	7	1.6 U	0.31 J	1 U	1 U	-	-	-
112,000	106,000	100,000	210,000	110,000	110,000	110,000	200,000	110,000	110,000	116,000	133,000	105000	116 J	104000	113000	115000	407000	82200	140000	108000	96000	-	-	-
84.2	0.90 U/5 U	18	390	14	4.3B	10 U	160	4.9B	4.3 B	2.5 J	58.1	2.2 J	13.3	5.6	3.9 J	8.7	217	2 J	18.5	1.2 J	9.1	-	-	-
27.8	5.3	6.0 B	160	3.1B	1.4B	10 U	83	2.2B	2.2 B	0.89	18.4	0.65	1.6	1.9	0.91 J	2.7 J	127	8.6 U	12.5	2 U	2.7 J	-	-	-
58.5	7.5 B/10 U [f]	11	320	6.3B	3.8B	10 U	150	3.7B	10 U	2.7 J	38.4	8.6	5.1	4.7	2.8 J	23.5	329	4.2 J	38.3	3.5 U	11.7	-	-	-
88,900	541	16,000	480,000	6.3B	4,200	320	200,000	3,900	3,200	1,800	61,500	1360	15400 N	5460	2550	8870	264000 B	1810	21900	50 U	8890	-	-	-
44.2	7.2 B/.10 U [f]	9.0	240.0	6.3B	7.5 U	7.5 U	110	7.5 U	3.4 B	1.6	29.4	1.1	10.5	2.9	1.5 J	10.2	245	9.8 U	24.1	2 U	8.9	3.7 J	10.4 J	61.6
68,800	55,700	65,000	140,000	6.3B	64,000	71,000	120,000	70,000	67,000	70,800	83,400	62000	507	63600	66800	75700	246000 B	59500 B	83400	69000	59500	-	-	-
1,540	623	410	5,600	6.3B	140	78	4,600	120	170	119	784	91.0	12.6	224.0	124.0	169	4090	71.2	779	79.9	222	-	-	-
0.2 U	0.10 U/0.2 U [f]	0.20 U	0.84	6.3B	0.20 U	0.20 U	0.38	0.2 U	0.20 U	0.043 J	0.13	0.15 J	0.020 J	0.15 U	0.2 U	0.14 U	0.94	0.12 U	0.03 J	0.06 U	0.06 U	-	-	-
71.0	5.2 B/10 U [f]	14	380	6.3B	4.3B	10 U	170	4.8B	10 U	3.0	46.2	0.73	3.5	5.0	4.3 J	8.1	305	9.3	25.2	3 U	8.2	-	-	-
6,900	534	2,500	21,000	6.3B	950B	400B	10,000	1,000	790 B	534	5820 N	469	355	1110	558 J	1110	10200	511 J	801	250 U	898	-	-	-
20 U	3.4 U	15 U	15 U	6.3B	15 U	15 U	5.3B	15 U	15 U	4 U	4 UN	3.7 U	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	6.5 U	-	-	-
3 U	1.4 U	10 U	10 U	6.3B	10 U	10 U	10 U	10 U	10 U	0.4 U	0.11 J	0.019 J	0.017 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
39,800	39,400	39,000	29,000	6.3B	43,000	41,000	40,000	38,000	38,000	38,400	44,600	39300	321 U	36500	38800	40200	46200	42800	42400	43300	49400	-	-	-
2.0 U	0.19 /2 U [f]	25 U	8.0B	6.3B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.11 J	0.63	0.25 J	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
115	4.4 B/10 U [f]	23	460	6.3B	6.1B	1.7B	110	8.2B	4.6 B	3.1 J	82.6	8.8 U	27.4	8.6	10 U	10.6	178	1.9 J	31.3	2.5 U	11.3	-	-	-
238	15.9 B/20 U [f]	58	1,300	6.3B	13B	40 U	520	19B	11 B	10.7	155	9.2	10.1	19.0	9.0 J	31	1190	9.5 J	89.3	5 U	29.4	-	-	-
mg/L	mg/L	mg/L	mg/L	6.3B	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.11	0.22 J [b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.95	2.38	4.4	2.5	2.3	1.9	2.3	1.7	1.7	1.4	1.7	1.6	1.4	1.2	1.2	1.300	1.9	2.2	1.3	-	-	-	-	-	-

MW06B 11/14/2001 ug/L	MW06B 2/13/2002 ug/L	MW06B 2/26/2003 ug/L	MW06B 10/9/2003 ug/L	MW06B 5/27/2004 ug/L	MW06B 10/26/2004 ug/L	MW06B 5/10/2005 ug/L	MW06B 10/19/2005 ug/L	MW06B 5/17/2006 ug/L	MW06B 10/18/2006 ug/L	MW06B 6/5/2007 ug/L	MW06B 10/10/2007 ug/L	MW06B 5/14/2008 ug/L	MW06B 10/16/2008 ug/L	MW06B 5/5/2009 ug/L	MW06B 10/20/2009 ug/L	MW06B 5/26/2010 ug/L	MW06B 10/26/2010 ug/L	MW06B 5/25/2011 ug/L	MW06B 10/25/2011 ug/L	MW06B 5/16/2012 ug/L	MW06B 11/1/2012 ug/L	MW06B 6/25/2013 ug/L	MW06B 11/20/2013 ug/L	MW06B 5/21/2014 ug/L	1(
0.519 U	0.52 U	0.88 U	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U
3.53	0.52 U	1.9	0.39 U	0.70 U	0.55 U	0.43 U	0.55 U	0.39 U	0.41	0.61 J	0.40 U	0.52 U	0.52 U	0.52 U	0.61	3.2	1.6	0.8 U	4.9	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.44 U	0.39 U	0.70 U	0.55 U	0.43 U	0.55 U	0.39 U	0.11 J	0.20 U	0.20 U	0.26 U	0.099 J	0.26 U	0.21 U	2.2 P	0.52 JP	2 U	1.4 J	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.44 U	0.39 U	0.70 U	0.55 U	0.43 U	0.55 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.88 U	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.44 U	0.39 U	0.70 U	0.55 U	0.43 U	0.55 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.706 U [e]	0.26 U	0.44 U	0.39 U	0.70 U	0.55 U	0.43 U	0.24 J	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.4	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.88 U	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	0.38 JP	1.2 U	1 U	0.32 J	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
6.01 U [e]	0.79	0.44 U	0.39 U	0.70 U	0.55 U	0.43 U	0.55 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.88 U	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.88 U	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	31	0.6 UJ	0.6 U
0.519 U	0.52 U	0.35 J	0.78 U	1.4 U	1.1 U	0.86 U	1.1 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.88 U	0.78 U	1.4 U	0.43 U	0.34 U	0.46	0.31 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.43 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
1470	155 B/200 U(j)	5,200	590,000	110,000	1700	500	470	680	11,000	4,280	16300 N	326	2340	144	295	19000	315	35900	4330	655	43.7	20.8 J	61.1	12 J
20 UR [f]	4.5 U	50 U	4.1B	4.2B	6 0 U	6 0 U	2.3B	3.7B	6.0 U	0.97 J	1.4	0.87	0.45 J	0.44 J	1.2 J	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-
20 UR [f]	4.1 U	8.1 B	79	63	9.5	2.9B	7.0	2.3B	21	4.5	21.1	6.6	10.4	3.7	10.8	37.9	17	64.7	17.5 J	16.7 J	12 U	4 U	15.1 J	12 U
205	188	220	5,300	1,100	220	170	220	190	340	244	357	203	272	203	267	549	269 B	785	193	215	157	-	-	-
2 U	0.21 B/2 U[d]	0.30 B	54	8.9	4.0 U	4.0 U	4.0 U	4.0 U	0.82 B	0.23	1.0	0.16 U	0.11 J	0.1 U	0.2 U	2.1	0.86 U	5.1	0.48 J	0.3 U	0.3 U	-	-	-
3 U	0.40 U/3 U	2.0 U	25	2.8	2.0 U	2.0 U	2.0 U	2.0 U	0.63 B	0.74	0.42	0.16 J	0.13 J	0.088 J	0.39 J	0.4 U	0.4 U	1.6 U	2 U	1 U	1 U	-	-	-
140,000	146,000	140,000	700,000	220,000	140,000	140,000	140,000	130,000	150,000	140,000	142,000	128000	145000	124000	144000	166000	148000	222000	140000	131000	128000	-	-	-
5.6	1.6 B/5 U[d]	10	1100	180	10 U	2.4B	2.1B	1.7B	17	7.7	24.1	1.4 J	1.5 J	2.5	2.5 J	34	1.5 J	57.4	5.9	2.1 J	1.3 J	-	-	-
1.4 B/5 U [d]	0.80 U/5 U	5.1 B	1000	140	2.1B	1.7B	3.4B	10 U	14	4.5	16.8	0.53 J	3.6	0.16	2.2 J	25.2	1.8 J	66.3	6.1	1.2 J	2 U	-	-	-
11.5	7.7 B/10 U[d]	7.3 B	1200	150	10 U	3.3B	10 U	6.6B	19	8.9	17.5	6.5	4.3	1.7 N	5.5	63	24.5	201	24.9	2.5 J	3.1 J	-	-	-
2,450	1,200	11,000	1,800,000	200,000	1,300	1,500	2,800	1,500	12,000	7,200	31,700	1560	5750	577	3560	55000	5400 B	121000	11700	5050	335	-	-	-
3.2 B/10 U (j)	2.0 B/10 U[d]	6.4 B	840	110	4.7B	8	3.1B	13	16	13.8	30.1	3.7	3.2	1.6	3.1	24.2	4.1 J	58.5	6.4	1.8 J	2 U	1.4 U	3.5 J	15.5
59,300	55,500	58,000	340,000	93,000	58,000	56,000	57,000	53,000	60,000	56,700	59,700	48100	57400	50100	55700	68500	61500 B	87500 B	58200	54700	57100	-	-	-
861	768	380	17,000	2,800	710	130	690	160	560	211	748	109	427	77.4	361	642	367	1700	359	136	119 B	-	-	-
0.2 U	0.10 U/0.2 U[d]	0.20 U	2.7	0.16B	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.025 J	0.086 J	0.12 J	0.037 J	0.15 U	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.05 U	-	-	-
6.10 B/10 U [d]	4.2 B/10 U[d]	7.3 B	1000	160	10 U	2.2B	2.2B	3.0B	12	6.4	20.0	0.6 U	3.5	0.83	3.5 J	27.1	0.66 J	97	5 J	1.5 J	3 U	-	-	-
3,660	2,520	3,200	44,000	13,000	1,900	1,900	1,900	2,000	3,600	2,360	4360 N	1580	1890	1490	1490	3280	1450	4510	845	995	1370	-	-	-
20 U	3.4 U	15 U	75 U	8.6B	15 U	15 U	15 U	15 U	15 U	4 U	4 UN	3.7 U	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	10.4 JB	-	-	-
3 U	1.4 U	10 U	3.4B	10 U	10 U	1.2B	10 U	10 U	10 U	0.4 U	0.4 U	0.015 J	0.028 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
65,900	61,900	55,000	41,000	78,000	74,000	65,000	75,000	63,000	67,000	69,600	74,800	63200	74400	63100	72400	70100	86300	78300	71200	69700	74800	-	-	-
2.0 U	0.66 /2 U[d]	25 U	20 U	2.6B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.15 J	0.47	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
2.9 B/10 U [d]	1.2 U/10 U	12	1300	240	10 U	2.2B	2.5B	2.2B	24	9.8	33.7	8.8 U	3.9 J	5 U	10 U	43.4	1.7 U	81.8	8.2	1.3 J	2.5 U	-	-	-
63.1	32.3	47	2,800	410	40 U	32B	11B	77	51	54.8	67.2	15.1	23.2	13.9	16.7	85	94.9	206	25.8	5.8 J	9.3 J	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0 11	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.95	1.94	1.1	0.10 U	0.10 U	0.10 U	2	0.088B	1.6	0 036B	1.4	0.052	0.050 U	0.050 U	1.9	0.065	0.42 U	0.92	2.1	-	-	-	-	-	-

MW07A 11/14/2001 ug/L	MW07A 2/13/2002 ug/L	MW07A 2/26/2003 ug/L	MW07A 10/9/2003 ug/L	MW07A 5/27/2004 ug/L	MW07A 10/26/2004 ug/L	MW07A 5/10/2005 ug/L	MW07A 10/19/2005 ug/L	MW07A 5/17/2006 ug/L	MW07A 10/17/2006 ug/L	MW07A 6/5/2007 ug/L	MW07A 10/10/2007 ug/L	MW07A 5/14/2008 ug/L	MW07A 10/16/2008 ug/L	MW07A 5/5/2009 ug/L	MW07A 10/20/2009 ug/L	MW07A 5/26/2010 ug/L	MW07A 10/26/2010 ug/L	MW07A 5/25/2011 ug/L	MW07A 10/25/2011 ug/L	MW07A 5/16/2012 ug/L	MW07A 11/1/2012 ug/L	MW07A 6/25/2013 ug/L	MW07A 11/20/2013 ug/L	MW07A 5/21/2014 ug/L
70 5	46	50	71	47	110	72	92	37	45	26	26	15	18	18	15	26	10 ,	22	20	27	52	34	43	24
1240	530	410	350	460	500	1,200	490	330	360	210E	190E	140	150 D	160	130	240	87	220	180	280	280	320	310	240
2.07	1.6	0.52 U	0.7	0.63 J	0.085 J	0.75	0.7	0.74	1.0	0.48	0.20 U	0.26 U	0.39	0.26 U	0.44	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.52 U	0.52 U	0.75 U	0.39 U	0.39 U	0.64 U	0.39 U	0.51 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.42 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0 519 U	0.52 U	1.0 U	1.0 U	1.5 U	0 78 U	0.78 U	1.3 U	0.78 U	1.0 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.83 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0 26 U	0.52 U	0.52 U	0.75 U	0.39 U	0.39 U	0.64 U	0.39 U	0.51 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.42 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
59.3	0.26 U	0.52 U	0.18 J	0.75 U	0.39 U	0.13 J	0 64 U	0.39 U	0.23 J	0.12 J	0.20 U	0.26 U	0.26 U	0 26 U	0.42 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
16	8.4	7.9	5.5 (u)	7.9	8.6	5.2	7.8	5.3	5.6	4.1	2.3	0.26 U	2.9	2.4	2.4	3.8	1.7	3.7	2.6	2.4	3.2	1.8 P	4.4 J	2.1 P
0.26 U	6.2	5.3	3.2 (u)	4 2	4.6	2.9	4.4	2.9	3.6	2.3	1.7	0.26 U	2.6	1.2	1.4	1.9	0.84 J	1.4	1.7 J	1.7	2.5	0.24 U	3.6 J	1.5
597	0.26 U	0.52 U	0.52 U	0 75 U	0.39 U	0.39 U	0 64 U	0.39 U	0.51 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.42 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.0 U	1.0 U	1.5 U	0.78 U	0.78 U	1.3 U	0.78 U	1.0 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1 0 U	1.0 U	1.5 U	0.78 U	0.78 U	1.3 U	0.78 U	1.0 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.83 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0 6 U
4.18	0.52 U	1.0 U	1.0 U	1.5 U	0.78 U	0 78 U	1.3 U	0.78 U	1.0 U	0 40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.83 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0 23 U	0.6 UJ	0.6 U
4	0.52 U	1.0 U	1.0 U	1.5 U	0.31 U	0.31 U	0.51 U	0.31 U	0.40 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.83 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0 6 UJ	0.6 U
16800	748	8,400	1,300	310	970	970	20,000	22,000	1,300	760E	9280 N	483	4580	1860	573	1930	80900	1200	3240	21.6 J	846	2850	646 J+	162
20 UR [f]	4 5 U	50 U	6.0 U	6 0 U	6.0 U	6.0 U	6.0 U	4.0B	6.0 U	1 U	0.30 J	0.6 U	0.20 J	1 U	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-
8.10 BJ [e]	4.1 U	20 U	0.76B	4.0 U	1.5B	4 0 U	18	20	4.0 U	4 U	4.7	6 4 U	4.5 J	1.9 J	1.5 J	16 J	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	18.9 J
133	44	96	36	32	39	29	190	210	38	30.2	79.9	29.4	116	35.9	30.7	50.2	744 B	32.2	51.1	23.7	34.8	-	-	-
0.95 B/3 U[d]	0.32 B/2 U(J)	0.33 B	4 0 U	4.0 U	4.0 U	4.0 U	1.1B	1.3B	4.0 U	0.14 U	0.35	0.16 U	0.37	0.070 J	0.2 U	0.28 J	5.9	0.23 J	0.6 U	0.3 U	0.3 U	-	-	-
3 U	0.40 U	2.0 U	2.0 U	2.0 U	2 0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.28 U	0.22 J	0.086 J	0.32	0.25 U	1 U	0.4 U	2.9	1.6 U	2 U	1 U	0.74 J	-	-	-
107,000	105,000	100,000	100,000	100,000	100,000	110,000	120,000	130,000	100,000	103,000	106,000	102000	149000	98000	105000	110000	339000	89200	116000	101000	106000	-	-	-
29.2	1.0 B/5 U[d]	16	7.6B	10 U	2.8B	2.5B	33	34	1.9 B	1.7 J	15.0	0.99 J	7.2	3.0	2.1 J	4.3	133	2.5 J	4.6	1.2 J	2.9 J	-	-	-
8.8	1.7 B/5 U[d]	5 2 B	10 U	10 U	10 U	1.7B	18	18	10 U	0.90	5.0	0.63	7.2	1.1	0.34 J	1.9 J	75	8.6 U	1.2 J	2 U	0.91 J	-	-	-
21.7	5 2 B/10 U[d]	8 3 B	3.5B	10 U	2.4B	10 U	24	31	3.6 B	1.9 J	10.1	5.3	7.1	2.2	1.6 J	19.8	152	7.7	5 J	3.5 U	4 5 J	-	-	-
26,400	520	14,000	1,800	380	1,300	1,300	36,000	39,000	1,800	876	126,000	573	6330 N	2370	882	4190	176000 B	1750	4820	27.1 J	1760	-	-	-
12.1	3.0 B/10 U[d]	7.4 B	7.5 U	7 5 U	7.5 U	7.5 U	19	19	2.8 B	0.79	6.4	0.75	5	1.3	0.57 J	6.4	90.9	9.8 U	3.7 J	2 U	3.3 J	5.4	8.9 J	48.9
68,100	61,400	69,000	67,000	66,000	65,000	73,000	76,000	81,000	66,000	66,200	68,700	63500	80000	63100	65300	75700	203000 B	69000	75400	66900	68300	-	-	-
481	191	370	160	54	110	160	1,100	780	120	89.8	250	94.1	770	111	58.4	149	3130	87.8	181	66.1	198	-	-	-
0.2 U	0.10 U/0.2 U[d]	0.090 B	0.20 U	0.20 U	0.082B	0.20 U	0.2 U	0.2 U	0.20 U	0.025 J	0 028 J	0.17 J	0.045 J	0.15 U	0.2 U	0 14 U	0.3	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-
26	1.8 B/10 U[d]	12	5.1B	10 U	2.6B	10 U	30	35	10 U	2.0	11.7	0.6 U	9.2	2.2	2.2 J	4.4	186	8.9	4.4 J	3 U	2.1 J	-	-	-
3,810	569	2,200	900B	590B	740B	790B	4,100	4,100	800 B	565	2250 N	513	1300	834	490 J	881 J	7640	648 J	500 U	250 U	543	-	-	-
20 U	3.4 U	15 U	15 U	15 U	15 U	5.8B	15 U	15 U	15 U	4 U	4 UN	3.7 U	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	2.8 JB	-	-	-
3 U	1.4 U	10 U	10 U	10 U	10 U	1 2B	10 U	10 U	10 U	0.4 U	0 4 U	0.06 U	0.38	0.25	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
51,000	51,700	46,000	50,000	46,000	49,000	46,000	42,000	42,000	40,000	42,200	45,500	43600	43300	40000	39700	40000	49100	42700	40600	42500	51300	-	-	-
2.0 U	0.80 /2 U[d]	25 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.38 U	0.18 J	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
37.4	2.0 B/10 U[d]	19	10 U	10 U	10 U	3.2B	46	49	2.7 B	8 U	17 3	8.8 U	11.2	4.7 J	10 U	5.4	137	1.2 J	6.1	2.5 U	2 J	-	-	-
82	11.6 B/20 U[d]	59	20B	15B	40 U	40 U	94	100	9.1 B	10.0	46.2	5.6 J	29.9	10.1	4.8 J	14.7	572	9 J	13.9	5 U	15.3	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.48	2.88	2.7	2.1	2.3	1.6	2.1	1.9	2.0	2.0	1.8	1.6	1.8	1.6	1.6	1.700	2	2.4	1.6	-	-	-	-	-	-

MW07B 11/14/2001 ug/L	MW07B 2/13/2002 ug/L	MW07B 2/26/2003 ug/L	MW07B 10/9/2003 ug/L	MW07B 5/27/2004 ug/L	MW07B 10/26/2004 ug/L	MW07B 5/10/2005 ug/L	MW07B 10/19/2005 ug/L	MW07B 5/17/2006 ug/L	MW07B 10/17/2006 ug/L	MW07B 6/5/2007 ug/L	MW07B 10/10/2007 ug/L	MW07B 5/14/2008 ug/L	MW07B 10/16/2008 ug/L	MW07B 5/5/2009 ug/L	MW07B 10/20/2009 ug/L	MW07B 5/26/2010 ug/L	MW07B 10/26/2010 ug/L	MW07B 5/25/2011 ug/L	MW07B 10/25/2011 ug/L	MW07B 5/16/2012 ug/L	MW07B 11/1/2012 ug/L	MW07B 6/25/2013 ug/L	MW07B 11/20/2013 ug/L	MW07B 5/21/2014 ug/L	1
0.519 U	0.52 U	0.37 J	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.8	0.52 U	1.3	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U
3.59	2.1	1.4	0.39 U	0.78 U	1.5	0.12 J	0.39 U	0.39 U	0.39 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.70 J	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.48 J	0.6 U
0.26 U	0.26 U	0.45 U	0.39 U	0.78 U	0.40 U	0.48 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.45 U	0.39 U	0.78 U	0.40 U	0.48 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.90 U	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.45 U	0.39 U	0.78 U	0.40 U	0.48 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.45 U	0.39 U	0.78 U	0.40 U	0.48 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.4	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	1.4
0.26 U	0.26 U	0.90 U	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
1.76 U [a]	0.26 U	0.45 U	0.39 U	0.78 U	0.40 U	0.48 U	0.39 U	0.39 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.90 U	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.90 U	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	7.6	0.6 UJ	0.6 U
0.519 U	0.52 U	0.56 J	0.78 U	1.6 U	0.81 U	0.96 U	0.78 U	0.78 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.519 U	0.52 U	0.90 U	0.78 U	1.6 U	0.32 U	0.38 U	0.29 J	0.31 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.42 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
40600	1,900	3,600	200,000	35,000	510	300	190B	350	530	2,470E	2940 N	29000 D	1640	415	100	27600	2350	210 U	2420	31 J	18 U	42.2	28.6 UJ+	66
20 UR [f]	4.5 U	50 U	2.9B	6.0 U	2.6B	5.4B	6.0 U	7.1	6.0 U	0.86 J	0.68 J	2.4 D	0.30 J	1 U	0.41 J	16 U	4.5 J	32 U	12 U	6 U	6 U	-	-	-
19.2 BJ [b]	4.1 U	9.0 B	42	36	9.9	4.0 U	6.9	4.9	12	4.4	15.9	27.5 D	6.5	3.7	8.6	45	8 J	24 U	8.2 J	5.7 J	12 U	4 U	5.8 J	12 U
472	233	210	1,800	630	220	190	190	200	250	175	215	427 D	200	129	180	654	249 B	133	172	162	111	-	-	-
2.6	0.75 B/2 U [d]	4.0 U	12	2.9B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.26	0.19	1.5 D	0.16 U	0.1 U	0.2 U	2.1	0.27 J	0.86 U	0.19 J	0.3 U	0.3 U	-	-	-
1.4	0.40 U	2.0 U	1.4B	1.9B	2.0 U	0.70B	2.0 U	2.0 U	0.52 B	0.25 J	0.17 J	0.94 D	0.2 U	0.10 J	0.21 J	0.4 U	0.4 U	1.6 U	2 U	1 U	1 U	-	-	-
196,000	180,000	100,000	470,000	310,000	160,000	180,000	160,000	150,000	190,000	156,000	149,000	192000 D	166000	113000	156000	217000	165000	156000	161000	139000	135000	-	-	-
80.8	3.2 B/5 U [d]	15	360	65	3.0B	3.5B	2.1B	2.4B	3.1 B	5.0	8.7	45.1 D	0.85 J	1.9 J	1.9 J	52	4.9	0.77 J	3.8 J	1.7 J	1.6 J	-	-	-
32.4	7.8	2.4 B	220	35	1.6B	10 U	10 U	2.2B	2.4 B	1.2	3.4	19.1 D	1.3	0.15	1.1 J	31.1	2.9 J	8.6 U	1.6 J	2 U	2 U	-	-	-
61	4.9 U	5.2 B	360	58	2.0B	10 U	10 U	5.6B	8.7 B	8.7	6.2	32.3 ED	2.4	2.9	4.3 J	57.4	47.2	4.4 J	25.9	3.5 U	2.9 J	-	-	-
77,500	12,200	6,900	460,000	78,000	1,500	590	1,700	2,100	4,300	2,980	8,000	49900 D	1770	834	1990	51800	6570	410	7120	1720	264	-	-	-
16.7	5.2 B/10 U [d]	7.5 U	220	36	17	11	5.3B	20	15	4.9	4.5	22.9 D	1.1	0.83	0.88 J	31.6	5.8	9.8 U	3.3 J	1.9 J	2 U	3 J	6 J	4.6
82,800	64,700	54,000	190,000	96,000	62,000	64,000	63,000	58,000	65,000	56,800	59,000	68300 D	61200	52500	52000	87900	67900 B	65100	65900	55900	53900	-	-	-
3350	1,910	840	9900	3,000	1,100	210	1,300	1,200	1,400	147	949	1280 ND	971	110	750	1820	789	89.1	642	264	26.7	-	-	-
0.2 U	0.10 U/0.2 U [d]	0.10 B	0.53	0.20 U	0.20 U	0.20 U	0.20 U	0.095B	0.20 U	0.026 J	0.053 J	0.075 J	0.036 J	0.15 U	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-
76.7	8.9 B/10 U [d]	11	400	68	4.5B	10 U	10 U	4.0B	10 U	4.8	7.4	36.1 D	2.3	2.4	4.1 J	53.3	4.5	5.5 J	4.1 J	3 U	3 U	-	-	-
9,170	2,580	3,500	23,000	8,900	2,300	2,100	2,100	2,200	2,200	1,960	2300 N	6700 ND	1730	1830	1680	4010	2270	1710 J	1150	1610	2250	-	-	-
20 U	3.4 U	15 U	15 U	6.9B	15 U	5.0B	15 U	15 U	15 U	4 U	4 UN	7.4 UD	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	6.5 U	-	-	-
3 U	1.4 U	10 U	10 U	10 U	10 U	1.2B	10 U	10 U	10 U	0.4 U	0.4 U	0.21 D	0.022 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
61,800	60,600	56,000	58,000	65,000	63,000	61,000	68,000	62,000	62,000	54,300	63,700	67800 D	66400	60300	62800	80600	82500	68500	70700	73000	83600	-	-	-
21 UR [f]	4.5 U	51 U	2.9B	6.0 U	2.6B	5.4B	6.0 U	263.6	6.0 U	0.86 J	0.68 J	2.4 D	0.30 J	2 U	0.41 J	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
19.2 BJ [b]	4.1 U	9.0 B	561.33333333	1224	430.1	4.0 U	373.1	360.0166667	488	4.5	15.10	27.5 D	393.5	254.3	351.4	64.4	3.2	6.8 U	4.4 J	2.5 U	2.5 U	-	-	-
237	33	47	1,300	250	11B	12B	40 U	22B	12 B	32.2	20.7	161 D	9.0 J	15.1	10.5	161	111	2.7 J	31.2	2.3 J	6 J	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.41	1.25	0.37	0.051B	0.10 U	0.10 U	2.0	0.028B	1.3	0.089B	0.28	0.14	0.62	0.050 U	1.8	0.390	0.57	0.61	2	-	-	-	-	-	-

MW08A 11/15/2001 ug/L	MW08A 2/14/2002 ug/L	MW08A 2/26/2003 ug/L	MW08A 10/9/2003 ug/L	MW08A 5/27/2004 ug/L	MW08A 10/26/2004 ug/L	MW08A 5/10/2005 ug/L	MW08A 10/19/2005 ug/L	MW08A 5/17/2006 ug/L	MW08A 10/17/2006 ug/L	MW08A 6/5/2007 ug/L	MW08A 10/10/2007 ug/L	MW08A 5/14/2008 ug/L	MW08A 10/16/2008 ug/L	MW08A 5/5/2009 ug/L	MW08A 10/20/2009 ug/L	MW08A 5/26/2010 ug/L	MW08A 10/26/2010 ug/L	MW08A 5/25/2011 ug/L	MW08A 10/25/2011 ug/L	MW08A 5/16/2012 ug/L	MW08A 11/1/2012 ug/L	MW08A 6/25/2013 ug/L	MW08A 11/20/2013 ug/L	MW08A 5/21/2014 ug/L	1(
0.519 U	0.52 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	1 U	2 UM,Y	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	
0.519 U	0.32 J/0.52 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.58	0.40 U	0.52 U	0.52 U	0.52 U	0.5	1.1 J	1.2 U	0.8 U	1 UM,Y	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.14 J	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	0.46 JP	1.2 U	2 U	2 UM,Y	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 UM,Y	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	
0.519 U	0.52 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	1 UM,Y	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	0.8 U	0.8 UM,Y	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
0.874	0.26 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 UM,Y	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 UM,Y	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	2 UM,Y	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	
13.6	0.26 UJ[t]	0.44 U	0.39 U	0.70 U	0.39 U	0.46 U	0.43 U	0.44 U	0.42 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	2 U	2 UM,Y	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	
0.26 U	0.26 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	1.2 U	1.2 U	1 U	1 UM,Y	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	
1.63	0.52 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	2 U	2 UM,Y	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	
0.519 U	0.52 UJ[t]	0.88 U	0.78 U	1.4 U	0.78 U	0.92 U	0.86 U	0.88 U	0.83 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	0.8 U	0.8 UM,Y	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	
1.17 U[e]	0.52 UJ[t]	0.88 U	0.78 U	1.4 U	0.31 U	0.37 U	0.58	0.35 U	0.33 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	1.2 U	1.2 U	1 U	1 UM,Y	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	
304 J[b]	12,200 NJ[e]	1,800	38,000	140B	540	98B	2,400	190B	5,900	1,650E	2,540	372	411	407	85.4 J	875	3540	1410	831	31.8 J	2780	1330	365 J+	105	
20 U	4.5 U	50 U	6.0 U	6.0 U	3.7B	6.0 U	6.0 U	6.0 U	6.0 U	0.35 J	1 U	0.6 U	0.6 U	1 U	2 U	16 U	16 U	32 U	12 U	6 U	6 U	-	-	-	
20 UJ (e)	5.5 B/20 UJ)	20 U	23	4.0 U	1.1B	4.0 U	4.0 U	4.0 U	3.2 B	4 U	4 U	6.4 U	6.4 U	3.5 U	5 U	15.4	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	12 U	
26.4	82.8	33	220	23	27	19	34	19	54	27.8	33.7	18.7	21.9	17.5	17.6	24.3	46.7 B	27.1	23.2	15.2	44.6	-	-	-	
2 U	0.81 B/2 U[g]	4.0 U	1.4B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.30 B	0.092 J	0.11 J	0.16 U	0.16 U	0.1 U	0.2 U	0.86 U	0.14 J	0.55 J	0.6 U	0.3 U	0.3 U	-	-	-	
3 U	0.40 U/3 U[g]	2.0 U	2.0 U	2.0 U	20 U	20 U	2.0 U	2.0 U	1.4 B	0.099 J	0.30	0.097 J	0.2 U	0.25 U	1 U	0.4 U	0.4 U	1.6 U	2 U	1 U	0.59 J	-	-	-	
138,000	140,000	120,000	170,000	120,000	120,000	130,000	120,000	120,000	140,000	116,000	136,000	101000	110000	96400	101000	119000	121000	91500	99900	75300	97100	-	-	-	
1.10 B/5 U (J)	22.2	5.2 B	71	10 U	10 U	10 U	4.5B	10 U	10	3.3 J	4.9	1.1 J	1.1 J	0.73 J	1.6 J	2.3	6.5	2.6 J	1.7 J	1.1 J	5.2	-	-	-	
5 U	7.7	10 U	34	10 U	10 U	10 U	1.4B	10 U	4.0 B	0.81	1.5	0.56 U	0.36 J	0.1 U	5 U	4.3 U	3.1 J	1.3 J	4 U	2 U	2.9 J	-	-	-	
10 U	18.8	3.7 B	60	10 U	1.7B	10 U	2.8B	10 U	23	3.4	4.0	2.0 E	1.4	1.6	1.5 J	3.8	19.5	50.1	1.8 J	3.5 U	25.8	-	-	-	
354 J[b]	28,200 J	3,200	90,000	150B	920	63B	3,800	290	11,000	2,070	3,940	537	746 N	390	149	1890	7950 B	2070	1490	48.4 J	5170	-	-	-	
10 UJ[e]	11.8	7.5 U	38	7.5 U	7.5 U	7.5 U	4.5B	7.5 U	9.9	2.1	2.1	0.55	0.52	0.49 J	0.36 J	4.9	11 J	3.8 J	4 U	1.5 J	6.6	3.7 J	7 J	17.3	
75,600	71,800	69,000	93,000	67,000	68,000	73,000	68,000	68,000	74,000	62,500	76,500	51500	58500	52500	53200	65300	60000 B	59200	55300	42600	52900	-	-	-	
108	445	140	1900	33	38	50	140	34	260	85.8	129	33.6 N	75.6	41.1 E	46.3	66.7	230	141	62.8	30.3	371	-	-	-	
0.2 U	0.1 U/0.2 U[g]	0.20 U	0.099B	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.023 J	0.041 J	0.040 J	0.049 J	0.15 U	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	
10 U	21.2	3.4 B	73	10 U	2.0B	10 U	2.5B	10 U	8.8 B	3.9	4.7	0.6 U	1.4	0.7	2.0 J	2.2 J	6.7	9.9	1.3 J	3 U	6.4	-	-	-	
623	2,990 NJ[e]	1,100	6,700	520B	700B	440B	1,200	650B	2,200	686	1,060	461 N	562	362	338 J	604 J	1430	555 J	500 U	250 U	771	-	-	-	
20 U	3.4 U/20 U	15 U	15 U	15 U	15 U	6.3B	15 U	15 U	15 U	4 U	4 U	3.7 U	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	6.5 U	-	-	-	
3 U	1.4 U	10 U	10 U	10 U	10 U	1.3B	10 U	1.1B	10 U	0.4 U	0.4 U	0.06 U	0.06 U	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	
55,400	54,900	40,000	42,000	40,000	41,000	41,000	39,000	42,000	42,000	33,500	40,400	34800	36000	31800	31400	26500	33400	29400	29500	25000	30200	-	-	-	
2 U	0.54 /2 U[f]	25 U	20 U	4.0 U	4.0 U	3.1B	4.0 U	4.0 U	4.0 U	0.38	0.14 J	0.64 U	0.18 J	1 U	2 U	5 U	5 UM	9.6 U	15 U	7.5 U	7.5 U	-	-	-	
10 U/20 U	29	3.0 B	85	10 U	10 U	1.0B	6.6B	1.7B	13	4.8 J	7.7 J	2.3 J	8.8 U	5 U	10 U	2.1	6.2	2.2 J	1.1 J	2.5 U	6.8	-	-	-	
20 U	64.6	33 B	240	40 U	40 U	40 U	21B	40 U	44	18.7	18.0	3.7 J	4.7 J	5.1	5.2 J	7.1	17.1 Y	35.6	4.2 J	5 U	36.6	-	-	-	
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0.530	0.590	0.49	0.50	0.51	0.44	0.59	0.54	0.54	0.38	0.41	0.56	0.22	0.24	0.16	0.180	0.56	0.76	0.23 J	-	-	-	-	-	-	

MW08B 11/15/2001 ug/L	MW08B 2/14/2002 ug/L	MW08B 2/26/2003 ug/L	MW08B 10/9/2003 ug/L	MW08B 5/27/2004 ug/L	MW08B 10/26/2004 ug/L	MW08B 5/10/2005 ug/L	MW08B 8/19/2005 ug/L	MW08B 5/17/2006 ug/L	MW08B 10/17/2006 ug/L	MW08B 6/5/2007 ug/L	MW08B 10/10/2007 ug/L	MW08B 5/14/2008 ug/L	MW08B 10/16/2008 ug/L	MW08B 5/5/2009 ug/L	MW08B 10/20/2009 ug/L	MW08B 5/26/2010 ug/L	MW08B 10/26/2010 ug/L	MW08B 5/25/2011 ug/L	MW08B 10/25/2011 ug/L	MW08B 5/16/2012 ug/L	MW08B 11/1/2012 ug/L	MW08B 6/25/2013 ug/L	MW08B 11/20/2013 ug/L	MW08B 5/21/2014 ug/L	1(
0.519 U	0.52 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	4.2 J	2	0.52 U	0.52 U	0.52 U	0.40 J	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U
1.12	0.52 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	1.2	1.2 U	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.074 J	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U
[d] 0.266 J/0.519 U [d]	0.52 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
1.89 U [e]	0.26 U	0.55 U	0.39 U	0.70 U	0.39 U	0.42 U	0.40 U	0.45 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U
0.26 U	0.26 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.21 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	2 U	2 U	0.6 U	0.6 U	2.6	0.6 UJ	0.6 U
0.519 U	0.52 U	1.1 U	0.78 U	1.4 U	0.78 U	0.85 U	0.79 U	0.90 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U
0.519 U	0.52 U	1.1 U	0.78 U	1.4 U	0.31 U	0.34 U	0.32 U	0.36 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.41 U	1.2 U	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U
5,290 J [e]	7,530 NJ[e]	2,900	36,000	31,000	240	230	310	320	1,100	804E	2,080	1370	287	407	511	280	571	255	359	68.9	51.7	47.5	40.7 UJ+	34.4 J
20 U	4.5 U	50 U	2.8B	6.0 U	6.0 U	6.0 U	6.0 U	3.0B	6.0 U	1 U	1 U	0.20 J	0.35 J	1 U	2 U	16 U	13.6 J	32 U	12 U	6 U	6 U	-	-	-
20 UJ [e]	7.2 B/20 U[d]	20 U	20	17	1.2B	4.0 U	5.1	4.8	8.6	4.5	7.2	4.7 JN	5.3 J	5.1	11	14.2	7.3 J	4.4 J	6.7 J	6 J	12 U	4 U	12 UJ	12 U
95.7	134	88	320	300	89	70	91	73	110	90.2	91.9	88.0	97.7	74.4	90.0	85.7	109 B	77.4	81.5	79.9	79.6	-	-	-
2 U	0.67 B/2 U[d]	4.0 U	1.7B	2.3B	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.14 U	0.11 J	0.078 J	0.16 U	0.1 U	0.2 U	0.19 J	0.45 J	4.2	0.26 J	0.3 U	0.15 J	-	-	-
3 U	0.4 U/3 U	2.0 U	2.0 U	0.98B	2.0 U	2.0 U	2.0 U	2.0 U	0.79 U	0.32	0.22 J	0.18 J	0.17 J	0.25 U	1 U	0.71	0.4 U	0.32 J	2 U	1 U	0.78 J	-	-	-
153,000	164,000	160,000	180,000	180,000	160,000	150,000	160,000	160,000	160,000	160,000	158,000	159000	150000	147000	157000	160000	163000	162000	159000	153000	151000	-	-	-
75.5	14.8	8.9 B	56	61	10 U	1.8B	2.1B	10 U	2.8 B	4.4 J	4.4 J	23. J	3.2 U	2.0 J	2.9 J	2.2	1.7 J	2.2 J	0.82 J	1.7 J	0.81 J	-	-	-
6.00	7.50	2.2 B	29	25	10 U	1.4B	1.4B	1.5B	4.0 B	1.6	2.5	1.5	1.8	0.54	0.69 J	4.3 U	4.3 U	8.6 U	4 U	2 U	2 U	-	-	-
9.90 B/10 U[d]	13.50	4.5 B	42	40	5.5B	10 U	10 U	10 U	2.9 B	3.6	3.4	3.3	1.5	2.1	1.9 J	22.1	83.1	757	26.3	4.4 J	20.1	-	-	-
8,000 J [e]	14,400.0	4,300	42,000	53,000	570	730	2,300	2,900	4,600	2,820	4,780	3290	2800 N	2940	5720	2390	5770 B	2170	3440	1610	661	-	-	-
4.50 B/10 U [d]	7.4 B/10 U[d]	5.1 B	29	26	7.5 U	7.5 U	3.0B	4.3B	5.4 B	2.0	1.8	1.5	0.55	0.76	0.81 J	2.7 J	4.9 U	4.3 J	4 U	2 U	2 U	2.2 J	5.3 J	20.2
67,900	67,200	71,000	79,000	80,000	70,000	69,000	69,000	69,000	70,000	69,200	72,400	66200	61800	65000	65200	72600	72100 B	70200	70900	67900	67600	-	-	-
2,620	2,390	990	2200	1,100	1,700	420	2,200	710	2,100	823	1,340	661	1590	222	1260	815	1230	737	958	469	547	-	-	-
0.2 U	1.0 U/0.2 U[d]	0.053 B	0.10B	0.20 U	0.20 U	0.20 U	0.2 U	0.2 U	0.20 U	0.036 J	0.1 U	0.041 J	0.019 J	0.15 U	0.2 U	0.14 U	0.14 U	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-
210	15.4	6.9 B	50	54	2.8B	10 U	10 U	2.3B	10 U	4.1	5.3	0.49 J	2.6	1.1	3.0 J	2.3 J	0.72 J	7.5 J	6 U	3 U	1.5 J	-	-	-
3,880	4,260 NJ[e]	3,900	7,000	7,000	3,100	2,600	3,100	2,900	3,300	3,090	2,860	2910	4100	1140	2440	3200	2750	2820	1930	2320	2510	-	-	-
20 U	3.4 U20 U[d]	15 U	5.2B	15 U	15 U	5.4B	15 U	15 U	15 U	4 U	4 U	3.7 UN	3.7 U	4 U	5 U	14 U	14 U	14 U	13 U	6.5 U	6.5 U	-	-	-
3 U	1.4 U/3 U[d]	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.4 U	0.4 U	0.06 U	0.036 J	0.25 U	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-
68,800	69,500	63,000	63,000	64,000	65,000	58,000	65,000	61,000	59,000	56,400	61,200	61700	55400	56100	54500	53900	65300	60700	58300	67100	69400	-	-	-
2 U	0.30 /2 U[d]	25 U	20 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	0.38 U	0.38 U	0.64 U	0.64 U	1 U	2 U	5 U	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-
11.5	17.5	4.8 B	74	67	10 U	2.1B	2.7B	1.8B	1.8 B	8 U	5.3 J	4.4 JN	8.8 U	5 U	10 U	1.7 U	1.7 U	6.8 U	5 U	2.5 U	2.5 U	-	-	-
46.2	50.6	51	170	140	40 U	12B	40 U	14B	25 B	36.6	26.8	20.3	21.6	11.7	9.2 J	44.2	19.2	354	32.4	6.4 J	18.6	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.1 U	0.32	0.22	0.053B	0.08B	0.10 U	0.85	0.010 U	0.76	0.15	0.92	0.050 U	0.78	0.050 U	0.48	0.050 U	0.66	0.56	0.9	-	-	-	-	-	-

Sample ID = / Date Sampled = / Analytes	MW09 5/17/2006 ug/L	MW09 10/17/2006 ug/L	MW09 6/5/2007 ug/L	MW09 10/10/2007 ug/L	MW09 5/14/2008 ug/L	MW09 10/16/2008 ug/L	MW09 5/5/2009 ug/L	MW09 10/20/2009 ug/L	MW09 5/26/2010 ug/L	MW09 10/26/2010 ug/L	MW09 5/25/2011 ug/L	MW09 10/25/2011 ug/L	MW09 5/16/2012 ug/L	MW09 11/1/2012 ug/L	MW09 6/25/2013 ug/L	MW09 11/20/2013 ug/L	MW09 5/21/2014 ug/L	MW09 10/29/2014 ug/L	MW09 5/28/2015 ug/L	USEPA MCL ug/L	Groundwater Standards Class I ug/L	Class II ug/L
Explosives																						
HMX	0.79 U	0.78 U	0.40 U	0.40 U	0.52 U	0.71	0.52 U	0.44	Not Sampled	1.2 U	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400
RDX	0.40 U	0.39 U	0.40 U	0.40 U	0.52 U	2.9	0.52 U	0.92	Not Sampled	1.2 U	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84
1,3,5-Trinitrobenzene	0.40 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 J	0.26 U	0.067 J	Not Sampled	1.2 U	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
1,3-Dinitrobenzene	0.40 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
Tetryl	0.79 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	Not Sampled	1.2 U	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS
Nitrobenzene	0.40 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.40 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.79 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.79 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.40 U	0.39 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.79 U	0.78 U	0.20 U	0.20 U	0.26 U	0.26 U	0.26 U	0.20 U	Not Sampled	1.2 U	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.79 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	Not Sampled	1.2 U	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.8 U	0.6 U	0.6 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.79 U	0.78 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	Not Sampled	1.2 U	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.32 U	0.31 U	0.40 U	0.40 U	0.52 U	0.52 U	0.52 U	0.40 U	Not Sampled	1.2 U	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
Metals - Unfiltered																						
Aluminum	1,800	790	12,800E	4,840	954D	616	6790	5630	Not Sampled	2520	7350	685	354	21700	7890	3970 J+	11900	1390	283	50 to 200 (c)	NS	NS
Antimony	6.0 U	6.0 U	0.52 J	1 U	0.36 J	0.17 J	1 U	2 U	Not Sampled	16 U	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	24
Arsenic	4.0 U	4.0 U	5.2	3.5 J	2.4 J	6.4 U	2.7 J	2.8 J	Not Sampled	4.2 J	4.6 J	24 U	12 U	15.1 J	5.4 J	5.4 J	5.3 J	12 U	9.7 JB	10	50	200
Barium	40	33	94.0	51.5	77.8	44.3	58.1	53.1	Not Sampled	46.4 B	55.2	28.7	27.7	126	-	-	-	-	-	2000	2000	2000
Beryllium	0.2B	4.0 U	0.64	0.30	0.61	0.16 J	0.37	0.32	Not Sampled	0.24 J	1.1	0.6 U	0.3 U	1.8	-	-	-	-	-	4	4	500
Cadmium	2.0 U	2.0 U	0.35	0.22 J	0.22	0.053 J	0.093 J	0.14 J	Not Sampled	0.4 U	1.6 U	2 U	1 U	1 U	-	-	-	-	-	5	5	50
Calcium	76,000	77,000	90,400	82,700	77500	73500	70100	79300	Not Sampled	81100	61200	80200	74600	87500	-	-	-	-	-	NS	NS	NS
Chromium, total	3.9B	10 U	23.4	9.5	11.6	3.2 U	9.1	9.3	Not Sampled	4.3	15.3	1.6 J	1.8 J	40.4	-	-	-	-	-	100	100	1000
Cobalt	1.8B	10 U	7.2	2.7	3.4	0.79	2.5	2.5 J	Not Sampled	4.3 U	4.4 J	4 U	2 U	16.5	-	-	-	-	-	NS	1000	1000
Copper	2.7B	10 U	17.2	7.1	11.2	2.8	5.7	7.1	Not Sampled	146	179	7 U	3.5 U	39.9	-	-	-	-	-	1300	650	650
Iron	2,200	620	15,200	5,100	8400	608 N	6400	5770	Not Sampled	3200	9180	470	374	33800	-	-	-	-	-	300(c)	5000	5000
Lead	7.5 U	5.1 B	17.0	5.5	8.6	2.1	5.9	5.6	Not Sampled	5.6	11.7	4 U	2 U	44.2	15.6	22.2 J	104	5.1	2 U	15	7.5	100
Magnesium	41,000	41,000	49,000	46,100	36500	34700	38200	42200	Not Sampled	45600 B	38600	44300	41900	48400	-	-	-	-	-	NS	NS	NS
Manganese	220	150	904	138	237	102	209	141	Not Sampled	86.7	236	30.7	31.7	998	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.20 U	0.050 J	0.066 J	0.16 J	0.1 U	0.060 J	0.2 U	Not Sampled	0.14 U	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	-	-	2	2	10
Nickel	3.5B	10 U	19.2	6.9	7.9	1.5	6.4	7.7	Not Sampled	3.4 J	26.4	6 U	3 U	37.7	-	-	-	-	-	100	100	2000
Potassium	960B	510 B	2,880	1,250	1620	446	1270	1160	Not Sampled	968	1390 J	500 U	250 U	2400	-	-	-	-	-	NS	NS	NS
Selenium	15 U	15 U	1.5 J	4 U	3.7 U	3.7 U	4 U	1.1 J	Not Sampled	14 U	14 U	13 U	6.5 U	2.7 JB	-	-	-	-	-	50	50	50
Silver	10 U	10 U	0.4 U	0.4 U	0.055 J	0.045 J	0.25 U	0.3 U	Not Sampled	2 U	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS
Sodium	46,000	51,000	51,000	56,700	51400	48400	49300	53400	Not Sampled	59800	51600	52400	53800	58000	-	-	-	-	-	NS	NS	NS
Thallium	4.0 U	4.0 U	0.23 J	0.38 U	0.64 U	0.64 U	1 U	2 U	Not Sampled	5 U	9.6 U	15 U	7.5 U	7.5 U	-	-	-	-	-	2	2	20
Vanadium	6.6B	2.0 B	36.6	16 B	20.1	2.7 J	14.9	14.9	Not Sampled	5	18.2	1 J	1.6 J	58	-	-	-	-	-	NS	49	NS
Zinc	10B	40 U	54.1	24.8	33.3	12.4	25.7	26.9	Not Sampled	14.6	77.2	3.2 J	2.3 J	124	-	-	-	-	-	5000(c)	5000	10000
Indicators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	6.5	6.0	5.5	4.6	5.3	4.8	5.8	5.300	Not Sampled	6.7	5.4	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

General Notes:

NS = no standard established.
ug/L = microgram per liter
mg/L = milligram per liter
USEPA MCL = U.S. EPA Maximum Contaminant Levels (June 2000).
35 IAC 620 Subpart F is the basis for the derived groundwater standards. Ingestion Route for Class I: Potable Resource Groundwater and Class II General Resource Groundwater (revised June 1997).
J = laboratory qualifier indicating value (organic analyses) is estimated because it is between the method detection limit and the method reporting limit.
B = laboratory qualifier indicating value (inorganic analyses) is estimated because it is between the method detection limit and the method reporting limit.
U = laboratory qualifier indicating value is not detected above the method detection limit.
N = laboratory qualifier indicating value is estimated because the matrix spike recovery was outside criteria.
/ U, 0.2U, 2U, 3U, 5U, 10U, 20U, 200U = data validation qualifier indicating value is not detected above the method reporting limit.
R = data validation qualifier indicating the value is not detected and unusable.
D = Indicates that the analyte was reported from a diluted analysis.
N = Spiked sample recovery not within control limits.
E = February and October 2003; and May 2004 analytical data were not validated.
Blue Background indicates that concentrations of that analyte equaled or exceeded at least one respective Illinois Groundwater Standard or ARAR (Does not include non-detects [U]).

Footnotes:

(a) Reporting limit does not meet the 35 IAC 260 Groundwater Standard. Most are not compounds of concern at the site and will not affect the project. Although 2,4-dinitrotoluene and 2,6-dinitrotoluene are compounds of concern the remediation objectives cannot
(b) Value is for total xylenes (o, m, & p).
(c) Value is a Secondary Drinking Water Regulation. These are non-enforceable federal guidelines for cosmetic or aesthetic affects of drinking water.
(d) Value is for cis plus trans 1,3-dichloropropene.
(e) Estimated value due to low quality control method reporting limit recovery (QC MRL).
(f) Unusable result because analyte is not detected and there is a low QC MRL recovery.
(g) Estimated value due to low initial calibration verification (ICV) recovery.
(h) Estimated quantitation limit due to low ICV recovery.
(i) Estimated due to a low surrogate recovery.
(j) Not detected, value is below the MRL.
(k) Unusable due to low relative response factor (<0.05).
(l) Unusable due to low laboratory control sample recovery (LCS).
(m) Estimated quantitation limit due to low LCS recovery.
(n) Estimated value due to low relative response factor (<0.05).
(o) Not detected due to similar concentartion in a blank (method, calibration, or field).
(p) Estimated value due to MS recovery greater than 125%.
(q) Estimated value due to high MRL recovery.
(r) Estimated due to relative percent difference of field duplicate greater than 25%.
(s) Estimated value due to low MS recovery.
(t) Estimated quantitation limit due to low surrogate recovery.
(u) The Health Advisory Value (2.7 ug/L) is for combined concentrations of 4-amino-2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene (i.e., total ADNTs)

Sample ID =	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	USEPA	Groundwater Standards		MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	USEPA
Date Sampled =	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I	Class II	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL
es	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	1 U	2 U	0.6 U	0.6 U	0.25 UM	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84	1.1 P	1 U	0.6 U	0.18 JP	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210	0.58 J	0.64 J	0.6 U	0.5 J	0.23 U	0.6 UJ	0.6 U	0.6 U	0.78 J	NS
	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7	0.8 U	0.8 U	0.6 U	0.22 JP	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
uene	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See	4.1	5.1	3.6	4.9	2.4 P	3.6	1.3	5.8	4.7	NS
uene	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]	7	11	9.3	13	8.2	9.3	3.3	13	8.6	NS
	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.56 J	NS
	1 U	1 U	0.6 U	0.6 U	0.24 UY	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31	1 U	1 U	0.6 U	0.82 J	0.24 U	0.6 UJ	0.6 U	0.42 JP	0.48 J	NS
toluene)	2 U	3.4 P	1.4 JP	0.6 U	6.2 M	0.6 UJ	0.6 U	0.8 U	0.78 JP	NS	70	70	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS
otoluene)	0.8 U	5.4 P	0.6 U	0.6 U	0.23 U	4.4 J	0.6 U	0.6 U	0.6 U	NS	70	70	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
toluene)	1 U	1 U	0.6 U	0.6 U	5.1 P,M	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	57500	66500	30300	47600	57400	13800	45000	40800	37000	50 to 200 (c)	NS	NS	1660	4570	131	36400	57100	231000	9280	70000	520	50 to 200 (c)
	10 J	9.5 J	6 U	6 U	-					6	6	24	32 U	12 U	6 U	6 U	-	-	-	-	-	6
	26.5	46.3	16.7 J	16.1 J	29.6	21.4 J	28.5	22.8 J	26.5	10	50	200	24 U	24 U	12 U	17 J	21.9 J	71.6 J	12 U	38.6	9.1 J	10
	12.1	42.1	7.7	2.4	-					2000	2000	2000	19.9	25.6	5.7	111	-	-	-	-	-	2000
	18.6	20.9	18.9	18.4	22.1 M	16.8	17.8	15.7	2.2	4	4	500	0.36 J	0.41 J	0.3 U	2.8	4.3 M	23.1	0.31 J	7.1	0.3 U	4
	707	787	797	808	911 M	817	717	695	827	5	5	50	0.13 J	0.85 J	1 U	0.45 J	2.2	13.2 J	1 U	3.5	1 U	5
	437000	450000	394000	450000	-	-	-	-	-	NS	NS	NS	69700	91000	85000	115000	-	-	-	-	-	NS
	6.3	22.8	9.6	9.6	-	-	-	-	-	100	100	1000	3 J	7.9	1.2 J	44.3	-	-	-	-	-	100
	571	592	550	546	-	-	-	-	-	NS	1000	1000	1.8 J	5.6	2 U	17.9	-	-	-	-	-	NS
	102	169	74	49.3	-	-	-	-	-	1300	650	650	4.4 J	14.5	3.5 U	34.3	-	-	-	-	-	1300
	186000	238000	182000	139000	228000 M	172000	192000	156000	171000	300(c)	5000	5000	1670	9040	424	55700	91200 M	378000	14400	125000	1100	300(c)
	24.6	42.5	20.9	19.2	36.7	36.1 J	87.9	9.9	74 B	15	7.5	100	6.4 J	10.3	2.2 J	46.1	72.4	409	29.7	85.3	2 U	15
	340000	328000	286000	289000	-	-	-	-	-	NS	NS	NS	40300	44800	42600	56700	-	-	-	-	-	NS
	23100	22700	21200	20700	23000 M,B	19500	19400	18700	17400	50(c)	150	10000	56.2	290	72.9	754	1320	6280	468	2330	36.8	50(c)
	0 1 J	1	0.24	0.2 B	-					2	2	10	0.12 U	0.07 J	0.06 U	0.15 B	-	-	-	-	-	2
	4840	4340	4130	3840	4380 M	3690	3520	3340	3170	100	100	2000	10.3	17	2.5 J	45.2	78.3	337	16.8	130	3.4 J	100
	4470	6350	4300 B	4550	-	-	-	-	-	NS	NS	NS	1290 J	2110	2120	4890	-	-	-	-	-	NS
	21.1	34.6	14.8	16.3 B	-	-	-	-	-	50	50	50	415	314	229	299	-	-	-	-	-	50
	4.5 J	7.1	6.3	3.3 J	-	-	-	-	-	100(c)	50	NS	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)
	73100	66100	68000 B	29800	-	-	-	-	-	NS	NS	NS	129000	105000	106000	120000	-	-	-	-	-	NS
	20.9	23.2	24.6	15.2	6.8 J	4.1 J	11.3 J	3.8 J	3 J	2	2	20	9.6 U	15 U	7.5 U	2.8 J	2.5 U	7.5 UJ	7.5 U	7.5 U	7.5 U	2
	74.6	144	68.9	49.7	10.8	63.2	83.4	66.4	78.1	NS	49	NS	2 J	8.2	2.5 U	63.1	91.3	372	17 B	131	2.5 U	NS
	28600	32700	34800	31400	32500 M	28700	29100	21900	25400	5000(c)	5000	10000	13 J	88.1	8.4 J	181	301	1320	51.9	546	4.4 J	5000(c)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	-	-	-	-	-	-	-	-	-	1	NS	NS	-	-	-	-	-	-	-	-	-	1
	0.2 J	-	-	-	-	-	-	-	-	10	10	100	0.23 J	-	-	-	-	-	-	-	-	10

Sample ID =	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	USEPA	Groundwater Standards		MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	USEPA
Date Sampled =	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL	Class I	Class II	5/24/2011	10/26/2011	5/15/2012	10/31/2012	6/24/2013	11/21/2013	5/20/2014	10/28/2014	5/27/2015	MCL
es	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.24 J	NS	210	210	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
uene	3.1	2.3	2.4	2.3 P	0.58 JP	2.3 J	0.88 J	2.2	2.5	NS	2.7 [See	2.7 [See	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
uene	5.8	6.4	7.1	7.5	2.6	6.4 J	4	5.8	6	NS	Note (u)]	Note (u)]	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.72 J	NS	0.02 (a)	0.02 (a)	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
toluene)	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	70	3.7	3.6 P	0.6 U	0.6 U	0.4 U	0.54 J	0.6 U	0.8 U	0.58 JP	NS
otoluene)	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70	0.8 U	7.9 P	8.3 P	0.6 U	0.23 U	6 J	0.6 U	0.6 U	0.6 U	NS
toluene)	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS
	9820	4780	4460	10400	21100	9070	2480	3060	317	50 to 200 (c)	NS	NS	41500	20000	19900	51700	26000	31200	10800	20900	1670	50 to 200 (c)
	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	24	7.7 J	12 U	6 U	6 U	-	-	-	-	-	6
	7.3 J	24 U	12 U	9.1 J	17.9 J	5.9 J	12 U	12 U	8.6 J	10	50	200	26.8	10.2 J	13.6 J	27.4	15 J	15.2 J	12 U	18.4 J	4 J	10
	58.1	42.6	24.6	76.1	-	-	-	-	-	2000	2000	2000	11.5	9.6	9	22.7	-	-	-	-	-	2000
	1.2	0.76	0.3 U	1.1	2.3	0.99 J	0.3 U	0.52 JB	0.3 U	4	4	500	9.9	9.9	9.9	12.5	4.2	10.1	2.1	8.1	5.7	4
	5.1	7.8	7.6	4.8	10.7	11.4 J	6.4	11.5	7.6	5	5	50	195	429	494	621	234	549	151	483	286	5
	213000	218000	222000	156000	-	-	-	-	-	NS	NS	NS	351000	331000	397000	451000	-	-	-	-	-	NS
	15.3	5.5	6.8	18.4	-	-	-	-	-	100	100	1000	5.7	2.2 J	6.6	14.9	-	-	-	-	-	100
	17.7	20.2	4	22.6	-	-	-	-	-	NS	1000	1000	141	255	312	341	-	-	-	-	-	NS
	21	28.6	1.7 J	17	-	-	-	-	-	1300	650	650	7.7	29.8	3.5 U	21.8	-	-	-	-	-	1300
	18000	7060	4730	25100	55300	22700	4030	6050	585	300(c)	5000	5000	60200	90500	149000	149000	64200	132000 J	46400	112000	42800	300(c)
	23.6	8.9	6.7	24.4	80.8	46.4	16.5	3.4 J	2 U	15	7.5	100	15.9	9.6	12.9	25.9	24.5	33.3 J	30	8.6	12	15
	164000	162000	188000	119000	-	-	-	-	-	NS	NS	NS	273000	262000	365000	339000	-	17200	-	-	-	NS
	2180	3160	2650	2440	6820 B	3820	1450	4760	1870	50(c)	150	10000	14000	17400	14800	15100	15200 B	17200	11200	15400	12900	50(c)
	0.12 U	0.15	0.06 U	0.16 B	-	-	-	-	-	2	2	10	0.04 J	0.05 J	0.04 J	0.36 B	-	-	-	-	-	2
	672	128	265	187	388	435	209	429	221	100	100	2000	1660	2490	3010	3270	1300	3060	821	2560	1080	100
	3810	2980	4330	4520	-	-	-	-	-	NS	NS	NS	6920	6260	8510	10300	-	-	-	-	-	NS
	48.9	41.8	71.3	34.4 B	-	-	-	-	-	50	50	50	22.8	12 J	7.7 J	14.5 B	-	-	-	-	-	50
	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS	2.6 J	1.5 J	3.1 J	3.7 J	-	-	-	-	-	100(c)
	103000	100000	106000	91200	-	-	-	-	-	NS	NS	NS	108000	93000	81700	61500	-	-	-	-	-	NS
	9.6 U	15 U	4.2 J	7.5 U	2.5 U	7.5 UJ	7.5 U	2.5 J	7.5 U	2	2	20	12.8	25.2	20.4	21.2	4.8 J	13.6 J	3.9 J	10.7 J	7.8 J	2
	13.3	6.2	4.8 J	15.8	15.9	12.9 J	3.4 J	5.2	2.5 U	NS	49	NS	140	76.6	83.7	165	101	94.4	68.6	90.3	3 J	NS
	292	361	315	316	556	568	300	581	338	5000(c)	5000	10000	5190	11400	15000	16000	5170	13900	3380	11700	4750	5000(c)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	-	-	-	-	-	-	-	-	-	1	NS	NS	-	-	-	-	-	-	-	-	-	1
	0.2 J	-	-	-	-	-	-	-	-	10	10	100	0.8 U	-	-	-	-	-	-	-	-	10

05A /2012 /L	MW05A 11/1/2012 ug/L	MW05A 6/25/2013 ug/L	MW05A 11/20/2013 ug/L	MW05A 5/21/2014 ug/L	MW05A 10/29/2014 ug/L	MW05A 5/28/2015 ug/L	USEPA MCL ug/L	Groundwater Standards Class I ug/L	Groundwater Standards Class II ug/L
8	3	6.6	3.8	16	30	35	NS	1400	1400
3	7.9	15	16	21	69	50	NS	84	84
5 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
5 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
5 U	0.6 U	0.21 U	0.6 UJ	5.5 P	0.6 U	0.6 U	NS	NS	NS
5 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
5 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4
5 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
5 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
5 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)
5 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
5 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	70
5 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
5 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
3	12900	7640	10800 J+	836	2160	378	50 to 200 (c)	NS	NS
U	6 U	-	-	-	-	-	6	6	24
U	6.1 J	4 U	12 UJ	12 U	12 U	7.7 JB	10	50	200
3	76.6	-	-	-	-	-	2000	2000	2000
5 U	0.54 J	-	-	-	-	-	4	4	500
U	1 U	-	-	-	-	-	5	5	50
000	93700	-	-	-	-	-	NS	NS	NS
7 J	13.2	-	-	-	-	-	100	100	1000
U	5.1	-	-	-	-	-	NS	1000	1000
UJ	13	-	-	-	-	-	1300	650	650
2	11200	-	-	-	-	-	300(c)	5000	5000
U	14.4	9.7	27 J	30.3	2.2 J	2 U	15	7.5	100
00	45900	-	-	-	-	-	NS	NS	NS
M	971	-	-	-	-	-	50(c)	150	10000
6 U	0.06 U	-	-	-	-	-	2	2	10
3 J	10.8	-	-	-	-	-	100	100	2000
U	1260	-	-	-	-	-	NS	NS	NS
5 U	6.5 U	-	-	-	-	-	50	50	50
U	2 U	-	-	-	-	-	100(c)	50	NS
00	62200	-	-	-	-	-	NS	NS	NS
5 U	7.5 U	-	-	-	-	-	2	2	20
9 J	19.4	-	-	-	-	-	NS	49	NS
6 J	38.2	-	-	-	-	-	5000(c)	5000	10000
/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	-	-	1	NS	NS
-	-	-	-	-	-	-	10	10	100

MW05B 5/25/2011 ug/L	MW05B 10/25/2011 ug/L	MW05B 5/16/2012 ug/L	MW05B 11/1/2012 ug/L	MW05B 6/25/2013 ug/L	MW05B 11/20/2013 ug/L	MW05B 5/21/2014 ug/L	MW05B 10/29/2014 ug/L	MW05B 5/28/2015 ug/L	USEPA MCL ug/L	Groundwater Standards Class I ug/L	Groundwater Standards Class II ug/L
1 U	6.1 P	0.6 U	0.6 U	0.25 U	0.6 UJ	17	17	0.6 U	NS	1400	1400
0.8 U	71	0.6 U	0.6 U	0.18 U	0.6 UJ	26	26	0.6 U	NS	84	84
2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS
0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4
1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)
1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
2 U	2 U	0.6 U	0.6 U	14	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	70
0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
283	2000	27.5 J	29.8 J	46.2	5710 J+	38.6	34.2 J	18 U	50 to 200 (c)	NS	NS
4.1 J	12 U	6 U	6 U	-	-	-	-	-	6	6	24
8.5 J	24 U	12 U	12 U	4 U	23.7 J	12 U	12 U	4 JB	10	50	200
143	39	156	155	-	-	-	-	-	2000	2000	2000
0.82 J	0.16 J	0.3 U	0.3 U	-	-	-	-	-	4	4	500
0.62 J	2 U	1 U	1 U	-	-	-	-	-	5	5	50
52900	113000	62300	64700	-	-	-	-	-	NS	NS	NS
0.99 J	2 J	0.87 J	0.67 J	-	-	-	-	-	100	100	1000
8.6 U	4 U	2 U	2 U	-	-	-	-	-	NS	1000	1000
165	1.6 J	3.5 U	1.3 J	-	-	-	-	-	1300	650	650
821	1850	687	312	-	-	-	-	-	300(c)	5000	5000
1.8 J	2.1 J	2 U	2 U	1.4 U	22 J	13.7	8	2 U	15	7.5	100
28000 B	56100	40000	34200	-	-	-	-	-	NS	NS	NS
173	400	216	315	-	-	-	-	-	50(c)	150	10000
0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	-	-	2	2	10
5 J	2.2 J	2.3 J	1.9 J	-	-	-	-	-	100	100	2000
9290	500 U	6310	7390	-	-	-	-	-	NS	NS	NS
14 U	13 U	3.5 J	6.5 U	-	-	-	-	-	50	50	50
8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS
59300	60400	61500	66800	-	-	-	-	-	NS	NS	NS
9.6 U	15 U	7.5 U	7.5 U	-	-	-	-	-	2	2	20
6.8 U	2.6 J	2.5 U	2.5 U	-	-	-	-	-	NS	49	NS
65.7	5.1 J	1.6 J	2.2 J	-	-	-	-	-	5000(c)	5000	10000
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	-	-	-	-	1	NS	NS
1	-	-	-	-	-	-	-	-	10	10	100

MW06A 5/25/2011 ug/L	MW06A 10/25/2011 ug/L	MW06A 5/16/2012 ug/L	MW06A 11/1/2012 ug/L	MW06A 6/25/2013 ug/L	MW06A 11/20/2013 ug/L	MW0 5/21/ ug/
140	170	220	170	81	160	16
680	760	1200	730	310	460	85
120	130	160	92	47	56	14
0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6
2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6
0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6
1 U	2 U	1.5 P	0.6 U	0.22 U	0.6 UJ	0.6
10 P	17	14	14	4 P	2.3 J	12
12	18	18	18	7.4	12	13
2 U	0.98 JP	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6
1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6
2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6
0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	1.9
1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6
1060	13600	26.4 J	5680	781	1080 J+	490
32 U	12 U	6 U	6 U	-	-	-
24 U	8 J	12 U	4.5 J	4 U	12 UJ	12
54	172	42.7	88.3	-	-	-
0.2 J	1.4	0.3 U	0.22 J	-	-	-
1.6 U	0.31 J	1 U	1 U	-	-	-
82200	140000	108000	96000	-	-	-
2 J	18.5	1.2 J	9.1	-	-	-
8.6 U	12.5	2 U	2.7 J	-	-	-
4.2 J	38.3	3.5 U	11.7	-	-	-
1810	21500	50 U	8990	-	-	-
9.8 U	24.1	2 U	8.9	3.7 J	10.4 J	51
59500 B	83400	69000	59500	-	-	-
71.2	779	79.9	772	-	-	-
0.12 U	0.03 J	0.06 U	0.06 U	-	-	-
9.3	25.2	3 U	8.2	-	-	-
511 J	801	250 U	898	-	-	-
14 U	13 U	6.5 U	6.5 U	-	-	-
8 U	4 U	2 U	2 U	-	-	-
42800	42400	43300	49400	-	-	-
9.6 U	15 U	7.5 U	7.5 U	-	-	-
1.9 J	31.3	2.5 U	11.3	-	-	-
9.5 J	89.3	5 U	29.4	-	-	-
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/
-	-	-	-	-	-	-
1.3	-	-	-	-	-	-

Sample ID =	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	USEPA	Groundwater Standards		MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	USEPA	Groundwater Standards	
Date Sampled =	5/25/2011	10/25/2011	5/16/2012	11/1/2012	6/25/2013	11/20/2013	5/21/2014	10/29/2014	5/28/2015	MCL	Class I	Class II	5/25/2011	10/25/2011	5/16/2012	11/1/2012	6/25/2013	11/20/2013	5/21/2014	10/29/2014	5/28/2015	MCL	Class I	Class II
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																								
HMX	22	20	27	52	34	43	24	59	39	NS	1400	1400	1 U	2 U	0.6 U	0.6 U	0.25 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1400	1400
RDX	220	180	280	280	320	310	240	280	240	NS	84	84	0.8 U	1 U	0.6 U	0.6 U	0.18 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	84	84
1,3,5-Trinitrobenzene	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.68 J	NS	210	210	2 U	2 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	210	210
1,3-Dinitrobenzene	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7	0.8 U	0.8 U	0.6 U	0.6 U	0.2 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.7	0.7
Tetryl	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS	2 U	1 U	0.6 U	0.6 U	0.21 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	NS	NS
Nitrobenzene	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5	0.8 U	0.8 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	1.4	1.4	1 U	2 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.5 U	0.6 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	3.7	2.6	2.4	3.2	1.8 P	4.4 J	2.1 P	3.4	3.1	NS	5.6 [See	5.6 [See	1 U	1 U	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	1.4	1.7 J	1.7	2.5	0.24 U	3.6 J	1.5	2.1	1.6	NS	Note (u)]	Note (u)]	1 U	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)	2 U	2 U	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31	1 U	1 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	NS	70	70	2 U	2 U	0.6 U	0.6 U	0.4 U	0.6 UJ	0.8 U	0.6 U	0.6 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70	0.8 U	0.8 U	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70	1 U	1 U	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	NS	70	70
Metals - Unfiltered																								
Aluminum	1200	3140	21.6 J	846	7890	648 J+	162	2070	18 U	50 to 200 (c)	NS	NS	7190	685	394	21700	7890	3970 J+	11900	1390	283	50 to 200 (c)	NS	NS
Antimony	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	24	32 U	12 U	6 U	6 U	-	-	-	-	-	6	6	24
Arsenic	24 U	24 U	12 U	12 U	4 U	12 UJ	18.9 J	4.7 J	10.2 JB	10	50	200	4.6 J	24 U	12 U	15.3 J	5.4 J	5.4 J	5.3 J	12 U	9.7 JB	10	50	200
Barium	32.2	51.1	23.7	34.8	-	-	-	-	-	2000	2000	2000	55.2	28.7	27.7	126	-	-	-	-	-	2000	2000	2000
Beryllium	0.23 J	0.6 U	0.3 U	0.3 U	-	-	-	-	-	4	4	500	1.1	0.6 U	0.3 U	1.8	-	-	-	-	-	4	4	500
Cadmium	1.6 U	2 U	1 U	0.74 J	-	-	-	-	-	5	5	50	1.6 U	2 U	1 U	1 U	-	-	-	-	-	5	5	50
Calcium	89200	116000	101000	106000	-	-	-	-	-	NS	NS	NS	61200	80200	74600	87500	-	-	-	-	-	NS	NS	NS
Chromium, total	2.5 J	4.6	1.2 J	2.9 J	-	-	-	-	-	100	100	1000	15.3	1.6 J	1.8 J	40.4	-	-	-	-	-	100	100	1000
Cobalt	8.6 U	1.2 J	2 U	0.91 J	-	-	-	-	-	NS	1000	1000	4.4 J	4 U	2 U	16.5	-	-	-	-	-	NS	1000	1000
Copper	7.7	5 J	3.5 U	4.5 J	-	-	-	-	-	1300	650	650	179	7 U	3.5 U	39.9	-	-	-	-	-	1300	650	650
Iron	1750	4920	27.1 J	1760	-	-	-	-	-	300(c)	5000	5000	9180	470	374	33800	-	-	-	-	-	300(c)	5000	5000
Lead	9.8 U	3.7 J	2 U	3.3 J	5.4	8.9 J	48.9	2.1 J	2 U	15	7.5	100	11.7	4 U	2 U	44.1	15.8	22.2 J	104	5.1	2 U	15	7.5	100
Magnesium	69000	75400	66900	68300	-	-	-	-	-	NS	NS	NS	38600	44300	41900	48400	-	-	-	-	-	NS	NS	NS
Manganese	87.8	181	66.1	198	-	-	-	-	-	50(c)	150	10000	236	30.7	31.7	999	-	-	-	-	-	50(c)	150	10000
Mercury	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	-	-	2	2	10	0.12 U	0.12 U	0.06 U	0.06 U	-	-	-	-	-	2	2	10
Nickel	8.9	4.4 J	3 U	2.1 J	-	-	-	-	-	100	100	2000	26.4	6 U	3 U	37.7	-	-	-	-	-	100	100	2000
Potassium	648 J	500 U	250 U	543	-	-	-	-	-	NS	NS	NS	1390 J	500 U	250 U	2400	-	-	-	-	-	NS	NS	NS
Selenium	14 U	13 U	6.5 U	2.8 JB	-	-	-	-	-	50	50	50	14 U	13 U	6.5 U	2.7 JB	-	-	-	-	-	50	50	50
Silver	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS	8 U	4 U	2 U	2 U	-	-	-	-	-	100(c)	50	NS
Sodium	42700	40600	42500	51300	-	-	-	-	-	NS	NS	NS	51600	52400	53800	58000	-	-	-	-	-	NS	NS	NS
Thallium	9.6 U	15 U	7.5 U	7.5 U	-	-	-	-	-	2	2	20	9.6 U	15 U	7.5 U	7.5 U	-	-	-	-	-	2	2	20
Vanadium	1.2 J	6.1	2.5 U	2 J	-	-	-	-	-	NS	49	NS	18.2	1 J	1.6 J	58	-	-	-	-	-	NS	49	NS
Zinc	9 J	13.9	5 U	15.3	-	-	-	-	-	5000(c)	5000	10000	77.2	3.2 J	2.3 J	124	-	-	-	-	-	5000(c)	5000	10000
Indicators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	1	NS	NS	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	1.6	-	-	-	-	-	-	-	-	10	10	100	5.4	-	-	-	-	-	-	-	-	10	10	100

RESTORATION INFORMATION MANAGEMENT SYSTEM
FORMERLY USED DEFENSE SITES (FUDS)
PROJECT FACT SHEET
AUGUST 1993
HNC Revision: 13 April 2006

1. **SITE NAME:** Illinois Ordnance Plant

SITE NUMBER: E05IL000200

LOCATION: City: Carbondale
Counties: Williamson
State: Illinois

PROJECT NUMBER: E05IL000203

CATEGORY: MMRP

INPR RAC: 2

ASR RAC: 2

TAG RAC:

2. **POC'S:**

GEOGRAPHIC DISTRICT:
Name: Gary Chisholm
Office: CELRL-PM-P
Phone: 502-315-6793

GEOGRAPHIC DIVISION:
Name: Patty Bertsch
Office: CELRD-MT-M
Phone: 513-684-6248

HEADQUARTERS:
Name: Dale Moeller
Office: CEMP-RF
Phone: 202-761-4649

ASR/INPR TEAM:
Name: Bradford McCowan
Office: CEHNC-OE-CX
Phone: 256-895-1174

ASR SUPPORT DISTRICT:
Name: Jodi Bausman
Office: CEMVR-ED-DO
Phone: 309-794-5504

ASR TECHNICAL REVIEWER:
Name: Ron Thornhill
Office: SJMAC-ESM
Phone: 918-420-8395

3. **SITE DESCRIPTION:**

a. The Illinois Ordnance Plant property consisted 22,481.9 acres, located in Williamson County, IL, approximately 5 miles west of the town of Marion.

b. The Army used the property as an ordnance plant to load, assemble, pack and store explosive munitions during the World War II period, which consisted of loading lines, burning and demolition grounds, ordnance storage, and other buildings and land.

c. The site visit team found landmines and landmine fuze debris during the site visit.

4. **SITE HISTORY:**

a. The Army acquired the property on 01 August 1941.

b. There is documented and physical evidence of MEC associated with the property.

c. A Certificate of Clearance was issued for this property on 06 August 1949. There was one instance where EOD came and blew a landmine that high ordered in place (interview, EOD report not provided). During a fire, there was a detonation in Area 8 on 13 April 1975.

d. There is no evidence of chemical warfare training, storage or disposal activities associated with the FUDS property.

e. The Army disposed of the property on 05 August 1947.

5. **PROJECT DESCRIPTION:**

Area A

Size:	3,087.1 acres (approximately)
Former Use:	Production/Load Line (Area 2, 8, 9, 11 & 12)
Present Use:	National Wildlife Refuge
Possible End Use:	Same
MEC Presence:	
Confirmed:	HE Landmines, Propellant, Detonators, Boosters, Bursters, Bulk Secondary Explosives (TNT)
Potential:	HE Bombs and HE Projectiles
ASR Recommends:	RAC 2
HNC Safety:	RAC NA (1)

Area B

Size:	2,638.7 acres (approximately)
Former Use:	Ammunition Storage (Area 3, 6, 10, & 13)
Present Use:	National Wildlife Refuge
Possible End Use:	Same
MEC Presence:	
Confirmed:	HE Landmines, Propellant, Detonators, Boosters, Bursters, Bulk Secondary Explosives (TNT)
Potential:	HE Bombs and HE Projectiles
ASR Recommends:	RAC 2
HNC Safety:	RAC NA (1)

Area C

Size:	421 acres (approximately)
Former Use:	Classification Yard
Present Use:	Agricultural
Possible End Use:	Same
MEC Presence:	
Confirmed:	None
Potential:	Detonators, Boosters, Bursters, Bulk Secondary Explosives (TNT)
ASR Recommends:	RAC 2
HNC Safety:	RAC NA (5)

Area D

Size:	421.7 acres (approximately)
Former Use:	Burning/Demolition Area
Present Use:	National Wildlife Refuge
Possible End Use:	Same
MEC Presence:	
Confirmed:	HE Landmines, Propellant, Detonators, Boosters, Bursters
Potential:	HE Bombs and HE Projectiles, Bulk Secondary Explosives (TNT)
ASR Recommends:	RAC 2
HNC Safety:	RAC NA (1)

Area E

Size:	244 acres (approximately)
Former Use:	Burial Site
Present Use:	National Wildlife Refuge
Possible End Use:	Same
MEC Presence:	
Confirmed:	None
Potential:	HE Landmines, Propellant, Detonators, Boosters, Bursters, Bulk Secondary Explosives (TNT), HE Bombs and HE Projectiles
ASR Recommends:	RAC 2
HNC Safety:	RAC NA (1)

Area F

Size:	15,669.4 acres (approximately)
Former Use:	All Remaining Lands
Present Use:	National Wildlife Refuge/Prison/ Agriculture
Possible End Use:	Same
MEC Presence:	
Confirmed:	None
Potential:	Same
ASR Recommends:	RAC 5
HNC Safety:	RAC NA (5)

6. **CURRENT STATUS:**

The U.S. Army Corps of Engineers, Rock Island District, completed the Archives Search Report for Illinois Ordnance Plant in August 1993.

7. **STRATEGY:**

RI/FS	Areas A, B, D and E
NDAI	Areas C & F

8. **ISSUES AND CONCERNS:**

a. There is a difference between ASR and FDE acreage. ASR determined the Army acquired 262.1 acres more than was addressed in the FDE.

b. There was a fire on 13 April 1975, which included an explosion that injured two personnel. Investigations by the U.S. Army Armament Command (ARMCOM) indicated that various locations within the area contained explosives and propellant. Documentation indicates there was

decontamination conducted. The question arises whether the explosives were a result of the War Department or Industrial Tenants (page 10).

c. Document E-4 indicates there were concerns of MEC presence at 10 suspect burial and/or burning sites (located in the Hampton Cemetery area) and four holding ponds (located near production areas 11 and 12).

d. In Appendix F-14, it indicates a company wanting to lease buildings III-1-13, F-2-1 and F-2-2 requested the buildings be decontaminated (January 1950). Further, after leasing building III-1-1, III-1-2 and III-1-3 a ramp was blocked between buildings due to contamination. These building were building included in the 1949 clearance report.

e. Numerous rejected HE loaded bombs, projectiles and anti-tank land mines accumulated. No disposition was indicated for these waste items. In June 1943, 69,055 pounds of TNT scrap had accumulated with no disposition identified (Appendix F-14)

f. According to the DERP Site Survey report prepared in 1984, the Army also fenced off several ½ to 2 acre areas near the Hampton Cemetery in 1946 for the disposal of landmine parts.

g. There are known Federally-and State-listed species occurring in the site area. An on-site inspection by the appropriate federal and state personnel may be necessary to verify the presence, absence or location of listed species, or natural communities.

9. **SCHEDULE SUMMARY:**

Phase	Orig. Start	Sch. Start	Actual Start	Orig. Comp.	Sch. Comp.	Actual Comp.

10. **FUNDING/BUDGET SUMMARY:**

Year	Phase	EXEC FOA	IN House Required	Contract Required	Funds Obligated

U. S. ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE — CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT DERP FUDS **Illinois Ordnance Plant**
E05IL000203

☐ ASR/INPR TEAM

REVIEW PA TAG MMRP
DATE 13 April 2006
NAME Ron Thornhill (918)420-8395

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.	General	Draft PA for Illinois Ordnance Plant, Williamson County, IL was reviewed for accuracy and completeness. Based on this review the following comments are provided:	
2.	General	There is a difference between ASR and FDE acreage. ASR determined the Army acquired 262.1 acres more than was addressed in the FDE.	
3.	General	There was a fire on 13 April 1975, which included an explosion that injured two personnel. Investigations by the U.S. Army Armament Command (ARMCOM) indicated that various locations within the area contained explosives and propellant. Documentation indicates there was decontamination conducted. The question arises whether the explosives were a result of the War Department or Industrial Tenants (page 10).	
4.	General	Document E-4 indicates there were concerns of MEC presence at 10 suspect burial and/or burning sites (located in the Hampton Cemetery area) and four holding ponds (located near production areas 11 and 12).	

Form 6

U. S. ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE — CORPS OF ENGINEERS

DESIGN REVIEW COMMENTS

PROJECT DERP FUDS **Illinois Ordnance Plant**
E05IL000203

☐ ASR/INPR TEAM

REVIEW PA TAG MMRP
DATE 13 April 2006
NAME Ron Thornhill (918)420-8395

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
5.	General	In Appendix F-14, it indicates a company wanting to lease buildings III-1-13, F-2-1 and F-2-2 requested the buildings be decontaminated (January 1950). Further, after leasing building III-1-1, III-1-2 and III-1-3 a ramp was blocked between buildings due to contamination. These building were building included in the 1949 clearance report.	
6.	General	Numerous rejected HE loaded bombs, projectiles and anti-tank land mines accumulated. No disposition was indicated for these waste items. In June 1943, 69,055 pounds of TNT scrap had accumulated with no disposition identified (Appendix F-14)	
7.	General	According to the DERP Site Survey report prepared in 1984, the Army also fenced off several ½ to 2 acre areas near the Hampton Cemetery in 1946 for the disposal of landmine parts.	
8.	General	The reviewer disagrees with the previous ASR overall RAC score of 2. Recommend Areas A, B, D and E receive a RAC score of 1. Areas C and F receive a RAC score of 5. Overall RAC score of 1. Updated RAC Forms are included.	

Form 6