Final Fourth Five-Year Review Report
Explosives/Munitions Manufacturing Area Operable Unit

Crab Orchard National Wildlife Refuge

Marion, Williamson County, Illinois

FUDS ID: E05IL000204
EPA ID: IL8143609487

PREPARED BY:

U.S. Army Corps of Engineers
Louisville District

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Approved:

Eric D. Crispino

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LIST OF ABBREVIATIONS AND ACRONYMS

AOC	Area of Concern
AUS	Additional Uncharacterized Sites
BRA	Baseline Risk Assessment
BAT	BAT Associates, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Crab Orchard Cemetery
CONWR	Crab Orchard National Wildlife Refuge
COP	Crab Orchard Plant
DA	Department of the Army
DNT	Amino-dinitrotoluenes
DOD	Department of Defense
DOI	Department of Interior
EMMA	Explosive/Munitions Manufacturing Area
EE/CA	Engineering Evaluation and Cost Analysis
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
INPR	Inventory Project Report
LUCIP	Land Use Control Implementation Plan
LUC	Land Use Control
LTM	Long-term Monitoring
MA	Metals Area
MCL	Maximum Contaminant Level
MEC	Munitions and Explosives of Concern
MISCA	Miscellaneous Area
MMRP	Military Munitions Response Program
MOA	Memorandum of Agreement
MWH	Montgomery Watson, Inc.
NCP	National Contingency Plan
NFA	No Further Action
NDAI	No DOD Action Indicated
NPL	National Priorities List
NTCRA	Non-Time Critical Removal Action
O&M	Operation and Maintenance
OE	Ordnance and Explosives
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PRP	Potentially Responsible Party
PQL	Practical Quantitation Level
QL	Quantitation Limit

RA	Remedial Actions
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosives, Hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SC	Screening Criteria
TACO	Tiered Approach to Corrective Action Objectives
TAL	Target Analyte List
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WAA	WAR Assets Administration
WT	Water Towers

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FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (USDOI)		
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? No

REVIEW STATUS
Lead agency: Department of the Army
Author name (Federal or State Project Manager): Valerie Doss
Author affiliation: U.S. Army Corps of Engineers, Louisville District
Review period: 8/6/2020 - 12/30/2020
Date of site inspection: 10/5/2020
Type of review: Statutory
Review number: 4
Triggering action date: 6/6/2016
Due date (five years after triggering action date): 6/6/2021

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
EMMA OU

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Protectiveness Statement(s)		
Operable Unit: EMMA OU	Protectiveness Determination: Protective	Addendum Due Date (if applicable): N/A
Protectiveness Statement: The remedy at the Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) OU COC-3 and COP-4 is protective of human health and the environment.		

1. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Army Corps of Engineers (USACE) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering U.S. Environmental Protection Agency (EPA), DOD, and FUDS policy.

This is the fourth FYR for OU3, the Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU). See Figure 1 for the site location. The triggering action for this statutory review is the completion date of the third 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).

EMMA OU addresses the soil remedy at Crab Orchard Cemetery 3 (COC-3) shown in Figure 2 and Crab Orchard Plant 4 (COP-4) shown in Figure 4.

Conditions at Sites COC-1, COC-2, COC-4, COC-5, COC-6, 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 and no further action (NFA) was needed at these sites. Nothing has changed in these areas that would invalidate the NFA decision.

The EMMA OU is one of nine OUs located within the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge (CONWR) (USDOI) Superfund Site. These OUs are the EMMA OU, the Polychlorinated Biphenyl (PCB) OU, the Miscellaneous Area (MISCA) OU, the Water Towers (WT) OU, the Additional Uncharacterized Sites (AUS) OU, the Lake Monitoring (LM) OU, the Metals Area (MA) OU, and the Area 7 Pesticides Area Non-Time Critical Removal Action (NTCRA) OU. A Memorandum of Agreement (MOA) between the Department of the Army (DA) and Department of the Interior (DOI), and a Federal Facilities Agreement (FFA) among the DOI, the DA, the U.S. Environmental Protection Agency (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, MISCA OU, AUS OU, Water Towers OU, and the Lake OU (EPA 2016). Five-Year Reviews of the six DOI OUs are contained within a comprehensive CONWR FYR written by the USEPA. The sixth comprehensive CONWR FYR is being developed concurrently and will include this FYR for EMMA OU as an appendix.

This EMMA OU FYR was led by Mr. William Clabaugh of USACE Louisville District. Participants included Mr. Charles Duenas, Ms. Anna Scoggins, and Ms. Angela Schmidt of the Louisville District, as well as Ms. Melinda McClellan of the Environmental and Munitions Center of Expertise (EM CX). The review began on August 6th, 2020.

2. 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 Illinois Ordnance Plant (IOP) was constructed.	1941
IOP 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 (except Ammonia Nitrate Plant which was transferred on June 1, 1950).	1947
U.S. Fish and Wildlife Services (USFWS) has managed and controlled the property. Various users have been utilizing portions of the EMMA OU. Known uses of the property have included forested and grass lands, ponds, commercial/industrial, agricultural, and recreational.	1947-Current
CONWR was proposed for inclusion on the National Priorities List (NPL).	1984
As part of the Formerly Used Defense Sites (FUDS) program, USACE Chicago District initiated an Inventory Project Report (INPR). Site surveys were limited to areas associated with the EMMA OU.	1986
USEPA and USFWS entered a Federal Facility Initial Compliance Agreement for the performance of a Remedial Investigation/Feasibility Study (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

Event	Date
An FS for the EMMA OU was completed in September 1995.	1995
Record of Decision (ROD) signed for EMMA OU January 1997 by USACE, and 19 February 1997 by USEPA	1997
An Engineering Evaluation and Cost Analysis (EE/CA) was completed at EMMA OU for MEC concerns.	1997
An EE/CA Action Memorandum was signed by USACE and determined that a removal action was required at multiple areas within EMMA OU.	1998
Explanation of Significant Differences (ESD) selected No Further Action (NFA) for COC-4	1999
Remedial Actions (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
An Ordnance and Explosives (OE) Non-Time Critical Removal Action (NTCRA) was completed at multiple areas within EMMA OU; COC-1, COC-4, COC-5, COC-6, and parts of COC-15; to address Munitions and Explosives of Concern (MEC) under FUDS Project E05IL000203 (OEW Investigation).	1999-2000
The OEW Investigation project was declared No DoD Action Indicated (NDAI).	2003
First FYR completed for the EMMA OU in August 2006.	2006
Second FYR completed for the EMMA OU in June 2011.	2011
Third FYR completed for the EMMA OU in June 2016	2016

3. BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

The CONWR is located approximately five miles west of Marion, Illinois, primarily in Williamson County, extending into Jackson and Union Counties in southern Illinois. The CONWR is located near the center of the southern tip of the state, with the Mississippi River twenty-five miles to the west and the Ohio River fifty-five miles to the east.

The topography of the area is relatively uniform, characterized by flat to moderately sloping areas ranging from 420 to 455 feet above mean sea level (msl). The site sits at the southwestern limit of the Illinois Basin, with bedrock consisting of shales, sandstones and think limestones of the Carbondale formation. Bedrock was encountered at depths of 6 to 23 feet. Groundwater at EMMA OU was encountered at about 18 to 20 feet. While groundwater resources in Williamson County are relatively poor, specific site conditions at EMMA OU indicated that the shallow groundwater meets the technical definition of a Class I groundwater classification pursuant to 35 Illinois Administrative Code Part 620, Section 620.210(a). See Figures 3 and 5 for the potentiometric maps of COC-3 and COP-4, respectively. Potable water is supplied by the City of Marion.

3.2 LAND AND RESOURCE USE

While the EMMA OU sites are located within a portion of the refuge with restricted access to the public, the CONWR is a national wildlife refuge established for wildlife conservation as well as recreational, agricultural, and industrial purposes. Industrial activities such as manufacturing and commercial storage are located in the eastern portion of the refuge. Crop growing and cattle raising also occurs in various areas throughout the refuge including the EMMA OU. USFWS is currently exploring whether to convert land uses in the Hampton Cemetery, which may include parts of EMMA OU. 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 habitat suitable for one endangered species, the Indiana bat, and one threatened species, the Northern Long-Eared Bat.

3.3 HISTORY OF CONTAMINATION

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. In 1947, the former IOP property was transferred to the authority of DOI as part of the CONWR.

The EMMA OU sites were grouped into three discrete areas: ten sites (Sites COC-1 through COC-10) were referred to as the Crab Orchard Cemetery (COC) - due to their proximity to the Hampton Cemetery; four of the sites (Sites COP-1 through COP-4) were referred to as the Crab Orchard Plant (COP) area, located to the south of the Former Group II load line and former Ammonium Nitrate Plant (Areas 11/12); and one site (Site Bunker 1-3) was in the finished explosives storage bunker area. Historic land use in and around the COP sites has been largely for activities associated with ordnance

manufacturing as part of the former IOP. The COC sites have been associated with a variety of ordnance storage, and testing practices.

Due to an acute hazard from the presence of munitions and explosives of Concern (MEC) at EMMA OU, an Engineering Evaluation and Cost Analysis (EE/CA, USACE 1997) was developed for multiple sites within EMMA OU in 1997 and a Non-Time Critical Removal Action was completed in 2000 (USACE 2001). Completion of the NTCRA resulted in a determination that there was no remaining risk due to the potential presence of MEC at EMMA OU, and the project was declared No Further DOD Action Indicated (NDAI) for MEC in 2003.

3.4 BASIS FOR TAKING ACTION

Sites COC-3 and COP-4 were found to pose a potential unacceptable risk to human health for the adult worker and adult and child recreational user. In addition, potential ecological risks were associated with these two sites. Risks and potential impacts identified for these sites were due to the residual elevated levels of nitroaromatic compounds and metals in the soils. The Baseline Risk Assessment (BRA) indicated Site COC-4 posed a potential ecological risk to the bobwhite quail, while not posing any unacceptable risk to human health. Because ecological risks associated with Site COC-4 were several orders of magnitude lower than those estimated at Sites COC-3 and COP-4, they were further evaluated separately to avoid overestimation of risks.

4. REMEDIAL ACTIONS

4.1 REMEDY SELECTION

USEPA signed the Record of Decision (ROD) for the EMMA OU at the CONWR on February 19, 1997. The ROD determined that no further action was required at twelve of the fifteen EMMA OU sites (USACE 1997). It was further concluded in the 1999 Explanation of Significant Differences (ESD) that conditions at COC-4 posed no current or potential threat to human health or the environment and no additional remedial actions needed to be implemented (USACE/USEPA 1999).

The remedial action objective (RAO) for the EMMA OU is:

- to minimize potential human health and ecological risks associated with the direct contact of affected surface soils 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;
- Additional removal of RDX/HMX contaminated soil at Site COP-4 to a depth of 2 feet below grade within the existing fenced area. Excavated soils will be disposed of at an offsite permitted special waste landfill;
- Sampling to ensure remaining affected soils (i.e., soils with contaminants above remediation goals) at Sites COC-3 and COP-4 do not exhibit the characteristics of a Resource Conservation and Recovery Act (RCRA) hazardous waste for lead and 2,4- amino-dinitrotoluenes (2,4-DNT); and
- Backfill excavated areas to shape the base of the covers;
- Placing 24-inch clean soil covers over the remaining affected soils at Sites COC-3 and COP-4;
- Long-term maintenance of the soil covers for a period of up to 30 years;
- Implementation of land use controls at Sites COC-3 and COP-4; and
- Groundwater monitoring.

Table 2 shows the remediation goals (RGs) for EMMA OU as selected in the ROD.

Table 2: Remediation Goals for EMMA OU Soil (mg/kg)

Contaminant	Remediation Goal	Basis*
NITROAROMATIC		
2,4,6, - 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

*Source: 1997 ROD. The nitroaromatics remediation goals are based on the 1997 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.

The overall response strategy was developed to prevent human and ecological receptors contacting the contaminated soil at Sites COC-3 and COP-4, while monitoring the groundwater at Sites COC-3 and COP-4 for contaminants over time. Groundwater is a potential secondary migration pathway for contaminants in soil. According to the IEPA, the primary objective of the groundwater sampling is to monitor the extent of migration of contaminants from soil into groundwater until such time that a demonstration is made that the COC-3 and COP-4 source areas no longer are or will migrate into groundwater.

4.2 REMEDY IMPLEMENTATION

From 1998 to 2000, Montgomery Watson, Inc. (MWH) completed the remedial action (RA) construction activities at COC-3 and COP-4 including:

- Soils were sampled at both sites to confirm/determine the lateral extent of soil contamination.
- Groundwater monitoring wells within the footprint of the covers 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 were 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 the request of USFWS and directed by IEPA in an area of suspected contamination at COP-4, and additional confirmation samples were collected.
- Soils at both sites were sampled to ensure that soils with residual contamination did not exhibit RCRA characteristics for lead and 2,4-DNT. Soil exhibiting RCRA characteristics was removed, and additional samples were taken until soil did not exhibit RCRA characteristics.
- Borrow soils were sampled to ensure soil imported for cover 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 at each site to prevent direct human or animal contact with the remaining affected soils and to promote revegetation.
- Bulk TNT nuggets generated during remedial activities at COC-3 and COP-4 were disposed of by burning. Unexploded Ordnance (UXO) consisting of mines, booster cups, and fuses were disposed of by detonation onsite.
- New groundwater monitoring wells were installed at each site to support groundwater monitoring.

The remedy in the 1997 ROD included Land Use Controls (LUCs). As noted in the ROD, "Land use controls will be implemented at Sites COC-3 and COP-4 to reduce potential future exposure to the remaining affected soil and restrict the construction of drinking water wells at EMMA OU. 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 USFWS has prepared an Environmental Land Use Control Implementation Plan (LUCIP) 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 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 10P-wide LUCs, certain restrictions are applicable to the EMMA ELUC Area (Figure 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 FYR.

Table 3: ICs for EMMA OU

Media	ICs Needed	ICs Called For in ROD	Impacted Parcels	IC Objective	Title of IC Instrument
Groundwater	Yes	Yes	COC-3 and COP-4	Prohibit groundwater well installation Prevent exposure to contaminated groundwater	CONWR LUCIP, April 2008
Soil	Yes	Yes	COC-3 and COP-4	Prohibit subgrade activities Prevent exposure to contaminated soil	CONWR LUCIP, April 2008
Soil	Yes	Yes	COC-3 and COP-4	Prohibit pond creation Prevent surface water infiltration into soils beneath cover	CONWR LUCIP, April 2008

4.3 SYSTEM OPERATIONS/O&M

The ROD required monitoring of groundwater at sites COC-3 and COP-4 and stated that the groundwater monitoring program will be developed as part of the Operations and Management (O&M) plan. Following the completion of the RA activities, the O&M plan was developed in July 2001. The O&M plan required semi-annual groundwater sampling for volatile organic compounds (VOCs), target analyte list (TAL) metals, explosives, nitrate and nitrite, and chloride. The groundwater results were compared against USEPA maximum contaminant levels (MCLs) and Illinois Class I and Class II groundwater

standards, which were selected as the screening criteria (SC) for the groundwater monitoring program. The analytes selected for groundwater include the explosive and lead from the soil remediation goals in the ROD (Table 2), as well as additional metals and explosives that are likely to migrate from the soil into the groundwater. Table 4 shows the current list of analytes at COC-3 and COP-4 and their respective SC.

The O&M Report required a review at the first FYR (2006) to determine the effectiveness of the RA activities. The RA activities were also reviewed in each subsequent FYR. The following issues were to be evaluated during the O&M review:

- 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 (above SC)? 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 indicates that if the above conditions are satisfied at either COC-3 or COP-4, then termination of additional O&M and groundwater monitoring of the applicable site(s) would be appropriate.

O&M at EMMA OU COC-3 and COP-4 include annual soil cover inspections including any necessary repairs, landscaping work, and groundwater monitoring at 20 wells.

- MW-03A, MW-04A, MW-04B, MW-05A, MW-05B, MW-06, MW-07, MW-08, MW-09, and MW-10 at COC-3,
- MW-02R, MW-05A, MW-05B, MW-06A, MW-06B, MW-07A, MW-07B, MW-08A, MW-08B, and MW-09 at COP-4.

Groundwater is sampled for metals and explosives. Mowing is completed by the USFWS, and cover inspections and groundwater monitoring are completed by USACE.

After completion of the May 2015 sampling event, the IEPA, CONWR, and the EPA have agreed to reduce the frequency of groundwater monitoring events from twice annually to once every five years in conjunction with the FYR as indicated in the letter from the IEPA to the USACE dated February 1, 2016. Inspections at EMMA OU have changed from semi-annual (during the semi-annual sampling events) to annual. Annual inspections at EMMA OU also include purging of all groundwater wells to limit sediment buildup between sampling events.

During the 2018 annual inspection, the vegetation at COP-4 was overgrown, and access to the site was difficult. The vegetation also impeded a thorough inspection of the soil cover. This is likely due to the 12-month accumulation of vegetation after the suspension of semiannual sampling. Starting in October 2018, USFWS has administered a vegetation clearance contract for areas of the CONWR including EMMA OU that enhances access and visual inspections of the soil cover.

Groundwater samples were collected twice in 2020 (June 2020 and October 2020) to gather enough data to evaluate concentrations at EMMA OU due to the longer period between sampling events. A failure of data usability would cause unacceptable period between data points without a second event.

Table 4: EMMA OU Groundwater Screening Criteria (µg/L)

Contaminant	USEPA MCL	Illinois Class I GW	Illinois Class II GW
HMX	N/A	1400	1400
RDX	N/A	84	84
1,3,5-Trinitrobenzene	N/A	210	210
Tetryl	N/A	N/A	N/A
Nitrobenzene	N/A	3.5	3.5
2,4,6-TNT	N/A	1.4	1.4
4-Amino-2,6-DNT	N/A	2.7 (combined)	2.7 (combined)
2-Amino-4,6-DNT	N/A		
2,4-DNT	N/A	0.02 (a)	0.02 (a)
2,6-DNT	N/A	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	N/A	70	70
3-Nitrotoluene (m-nitrotoluene)	N/A	70	70
4-Nitrotoluene (p-nitrotoluene)	N/A	70	70
Aluminum	50 to 200 (b)	N/A	N/A
Arsenic	10	50	200
Beryllium*	4	4	500
Cadmium*	5	5	50
Iron*	300 (b)	5000	5000
Lead	15	7.5	100
Manganese*	50 (b)	150	10000
Nickel*	100	100	2000
Thallium*	2	2	20
Vanadium*	N/A	49	N/A
Zinc*	5000 (b)	5000	10000

a: Reporting limit does not meet SC
b: Value is a Secondary Drinking Water Regulation (non-enforceable guidelines for cosmetic or aesthetic affects)
* Contaminant analyzed at COC-3 only.

5. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

5.1 PROTECTIVENESS STATEMENT FROM THE PREVIOUS FIVE-YEAR REVIEW

The protectiveness statement from the previous FYR signed 6 June 2016 was:

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.

There were no issues noted in the previous FYR.

6. FIVE YEAR REVIEW PROCESS

6.1 ADMINISTRATIVE COMPONENTS

The FYR team includes engineering, hydrogeologic and environmental professionals led by Mr. William Clabaugh of USACE Louisville District. Participants included Mr. Charles Duenas, Ms. Anna Scoggins, and Ms. Angela Schmidt of the Louisville District.

6.2 COMMUNITY INVOLVEMENT

This FYR for the EMMA OU is done in conjunction with a primary FYR containing the other OUs within the CONWR. All public involvement requirements are completed within the primary CONWR FYR, including the public notice of the initiation of the FYR process. Please refer to Appendix D for the public notice within the local newspaper, "The Southern Illinoisan". EMMA OU (OU3) is included in the public notice language.

6.3 DOCUMENT REVIEW

This fourth FYR consisted of a review of relevant documents including:

- 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 1997)
- Crab Orchard National Wildlife Refuge Explanation of Significant Differences (USACE 1999)
- 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 2016)
- Environmental Land Use Control Plan, Crab Orchard National Wildlife Refuge NPL Site (USFWS 2004)

6.4 DATA REVIEW

The following items were reviewed during the fourth FYR. All forms were created specifically for this FYR.

Form 4:	Summary of Periodic Groundwater Monitoring Results, COC-3 and COP-4
Form 5:	Summary of Groundwater SC Exceedances in current FYR Period
Form 6:	Mann-Kendall Trend Analysis

Groundwater Monitoring Results:

The groundwater monitoring results were reviewed to determine whether the soil cover was protective of the groundwater by preventing migration of contaminants from soil to groundwater, and to note the exceedances of the SC at each well. Please refer to Table 4 which presents the results of each periodic sampling event. Table 5 contains data from only the wells that had exceedances in the current FYR period. Evaluation of the data was conducted using a Mann-Kendall statistical trend analysis tool and was performed on data from select wells taken from the previous nine sampling events, from May 2012 to October 2020. Analytes for the Mann-Kendall were limited to contaminants from the soil remedial goal table (Table 2) with the inclusion of both Amino Dinitrotoluenes. Form 6 contains the Mann Kendall spreadsheets for all trend analyses conducted, and Table 5 summarizes the results of the Mann-Kendall trend analyses.

COC- 3: Before the 2020 sampling events, MW-04A, MW-05A, and MW-07 had previously shown a combined amino-dinitrotoluenes (DNT) concentration above the SC (Class I Illinois Groundwater Standard) for a majority of periodic sampling events since the inception of sampling in May 2001 (see Form 4). The DNT were non-detect for the June 2020 sampling event but were above the RG during the subsequent October 2020 sampling event.

Concentrations of lead continue to show exceedances of the SC (Class I Illinois Groundwater Standards) only at MW-05A, MW-07, and MW-09 (see Form 4). Lead concentrations at MW-03A and MW-04A previously exceeded SC but have dropped below the SC for both 2020 sampling events.

To determine if soil contaminants were leaching into the groundwater, a Mann-Kendall trend analysis was completed for the COC-3 wells that showed exceedances of SC within the last FYR period; MW-04A, MW-04B, MW-07 and MW-09. See Figure 2 for well locations. Two contaminants show an increasing or probably increasing trend: 1,3,5-Dinitrotoluene at MW-04A and RDX at MW-07. These concentrations are only slightly above the limit of quantitation for the contaminants and are orders of magnitude below the SC for the most recent sampling events. All others show as stable or show no trend, which gives evidence that contaminants are not leaching from soil to groundwater at COP-3.

The combined amino-dinitrotoluenes October 2020 data from both the MW0-04A and MW-07 analysis includes qualifiers for failed quality control criteria and blank contamination. No data validation report or data usability report have been completed for the October 2020 data. A Mann-Kendall analysis was conducted on MW-04A amino DNT concentrations, and adding the October 2020 data changed the trend for 4-Amino-2,6-DNT for MW-04A from “Stable” to “No Trend”, and for MW-07 from “No Trend” to “Probably Increasing”. The trends for 2-Amino-4,6-DNT did not change. As a conservative approach, the October 2020 data has been included in data evaluation.

COP-4: Results for explosives during this review period reveal that explosives above the SC are present in wells MW-06A and MW-07A. See Figure 4 for well locations. MW-06A had exceedances of RDX and the combined amino-dinitrotoluenes above the SC since the implementation of sampling in May 2001 (see Form 4). MW-07A has had exceedances of RDX above the SC for all periodic sampling events since the inception of sampling in May 2001, except for the June 2020 sampling event when RDX concentration fell to 3.1 µg/L.

Concentrations of lead no longer show exceedances of the SC at MW-05A, MW-05B, MW-06A, MW-07A, MW-09.

To determine if soil constituents were leaching into the groundwater, a Mann-Kendall trend analysis was completed for the COP-4 wells that showed exceedances of SCs within the last FYR period; MW-06A and MW-07A. Data show a decreasing trend, stable trend, or no trend for all contaminants, which gives evidence that contaminants are not leaching from soil to groundwater at COP-4.

Table 5: Mann-Kendall Trend Analysis Results

Well	HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
COC-3 MW-04A	N/A	No Trend	Stable	Increasing	No Trend	No Trend*	Stable
COC-3 MW-05A	N/A	No Trend	N/A	No Trend	No Trend	Prob. Decr.	Stable
COC-3 MW-07	N/A	Prob. Incr.	N/A	No Trend	Stable	Prob. Incr.*	Stable
COC-3 MW-09	N/A	N/A	N/A	N/A	Prob. Decr.	N/A	N/A
COP-4 MW-06A	Stable	Stable	No Trend	Stable	No Trend	No Trend	Decreasing
COP-4 MW-07A	Stable	Decreasing	N/A	N/A	No Trend	Stable	Prob. Decr.

* Trend dependent on usability of October 2020 sampling event data

Details on the Mann-Kendall trend analysis for the selected wells can be found in Form 6.

6.5 SITE INSPECTION

A Site Inspection was conducted on 27 October through 29 October 2020 by William Clabaugh and Anna Scoggins. The purpose of the inspection was to assess the protectiveness of the remedy. Due to the outbreak of COVID-19 during the scheduled inspection date, the field team was limited to only USACE employees to minimize the risk of infection. A conference call was held with members of USEPA, IEPA, USFWS, and USACE prior to the site inspection to coordinate inspection and sampling activities. The team inspected COC-3 and COP-4 during groundwater sampling activities, inspecting and photographing wells, signage, gates, and the soil covers at both sites.

The soil covers and groundwater wells are inspected at Sites COC-3 and COP-4 annually by USACE staff William Clabaugh, Charles Duenas, and Corey Knox. Please see Form 1 – Five Year Review Site Inspection Checklist for details. The last inspection of the cover occurred during the October 2020 sampling event. At COC-3 and COP-4 there were no signs of erosion and the grass was thick and healthy. Both covers look healthy and in very good shape. Precipitation was not ponding within the area of the cover. The cover inspection forms for 2020 are included as Form 3. Previous inspection forms are located within the annual EMMA OU Inspection Reports.

The sites are within a restricted access area which limits human exposure. No unauthorized personnel were encountered at EMMA OU during the inspection or the groundwater sampling events. No evidence of subsurface activities was encountered, and no new unauthorized groundwater wells were present.

6.6 SITE INTERVIEWS

A telephonic interview was conducted with Leanne Moore of the USFWS on 24 November 2020. Please see Form 2 – Five Year Review Interviews for details. Leanne is the Senior Contaminant Biologist with the USFWS and is confident on the effectiveness of the overall remedy at EMMA OU, including the O&M and the administration of the LUCs. She advised that land mines were found in July 2019 that USFWS

utilized a contractor to detonate and suggested that USACE consider including the Military Munitions Response Program (MMRP) efforts at EMMA OU in the FYR schedule.

It should be noted that the mines were not found within the boundary of the EMMA OU and do not affect the ongoing protectiveness of the remedy at the EMMA OU or the NTCRA conducted at EMMA OU. The NTCRA removed all residual risk of MEC within the project boundary, and USACE is not aware of any MEC discovered within EMMA OU since completion of the NTCRA in 2000. The NTCRA project at EMMA OU was declared NDAI on 30 September 2003.

7. TECHNICAL ASSESSMENT

7.1 TECHNICAL ASSESSMENT ANALYSIS

Question A: ***Is the remedy functioning as intended by the decision documents? YES***

Yes, the selected remedy of soil excavations as the RAs are all functioning as intended. All exposure pathways have been restricted. There appears to be no groundwater migration of contaminants outside of the sites (COC-3 and COP-4) based on the far fewer exceedances of explosives and lead in downgradient wells compared to upgradient wells. COC-3 perimeter wells MW-09 and MW-10 have never had a detection of explosives. All contaminant concentrations at COP-4 perimeter wells MW-05A and MW-05B were within applicable groundwater SC for both 2020 sampling events.

The soil cover is functioning as intended to protect the groundwater. There appears to be limited, if any, migration of contaminants from soil to groundwater. The Mann-Kendall trend analyses at COC-3 showed an increasing trend for RDX at MW-07 and 1,3,5-TNB at MW-04A, but these concentrations were orders of magnitude below the SC for groundwater and only slightly above the limit of quantitation for each contaminant. Concentrations of 4-Amino-2,6-DNT* at MW-07 were shown to be probably increasing and the combined Amino DNT concentration at MW-07 is above the SC. Since this increase of concentration is only found at an isolated location and there is low confidence in the trend, this result is most likely not related to leaching of contaminants from the soil. Concentrations at COP-4 did not show any increasing trends.

The remedial actions objective of minimizing potential human health and ecological risks associated with the direct contact of affected surface soils continues to be met by the installation and maintenance of the soil covers at COC-3 and COP-4, in combination with access controls at the sites. Although the site contaminants remain in the soil, proper maintenance of the backfilled materials and soil covers eliminate 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 through the USFWS LUCIP 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 to prevent further contact with the residual contamination. There has been no evidence of groundwater well installation, subsurface activities, or pond creation at any inspection or groundwater sampling event.

* The 4-Amino-2,6-DNT increasing trend uses October 2020 data, which has failed data qualifiers and has not gone through data validation or data usability.

Question B**:** ***Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid? YES***

Changes in Standards and To-Be-Considered (TBC) Criteria

There have been no changes to the ARARs, and no new standards or TBC criteria enforced that would affect the protectiveness of the remedy. The MCLs and Class I and Class II Illinois water standards have not changed since the 1997 ROD and therefore the remedy is protective since all uses of groundwater above these levels are prohibited.

The only metal considered a COC in soil at EMMA OU is lead. Although it is listed as a COC, lead was not identified in the baseline risk assessment as a COC for human health or the environment for the receptor exposure scenarios that were assessed. Since lead was identified as a COC in soil at other OUs for the CONWR, the RG established for lead at these other OUs was also applied to the EMMA OU. This was done to make RGs consistent across the entire Site. The USEPA RSL Residential for soil of 400 mg/kg from the 1994 USEPA's Office of Solid Waste Emergency Response (OSWER) Directive for Revised Interim Lead Guidance for CERCLA and RCRA Corrective Action Facilities is comparable to the greatest concentrations of lead (450 mg/kg) that was left in soils at the EMMA OU. The residual concentrations of lead remaining in the soil are expected less than the 450 mg/kg maximum residual soil concentration for most of the values but not greater than 450 mg/kg.

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics

Land use at COC-3 and COP-4 has not changed since the 1997 ROD was finalized. Human health and ecological receptors and routes of exposure have not changed since the ROD. No new COCs or contaminant sources have been identified. Controls were implemented during the remedy to prevent the release of residual contamination. The conceptual site models for the site, as they relate to soil contamination and its transport, have not changed since the remedy was completed. Groundwater use at the site has not changed since the time the ROD was finalized. Changes in toxicity and exposure assumptions are discussed below.

Changes to toxicity information were evaluated for the COCs (remaining residual contamination under the soil cover). The concentrations of COCs detected in the confirmation samples are much greater than that of the RGs, and the remedy of the soil cover and land use controls prevent exposure to those contaminants. The RGs for explosives in soil at the EMMA OU were based on PQLs because there the elevated concentrations of the TNT interfered with the sample analysis for the remaining explosives. Table 2 presents the Soil RGs for EMMA OU.

The PQLs are compared to the current USEPA Regional Screening Levels (RSLs) for Residential and Industrial Receptors in Table 5. As demonstrated, the PQL-based soil RGs for the EMMA OU COCs are all less than the USEPA Residential RSLs at a target cancer risk at 1 x 10-6 or non-cancer hazard quotient threshold value = 0.1. The current Land Use is Recreational. Although the RSLs are screening values, it demonstrates that the PQL-based RGs remain protective and exposure to any soil outside the soil cover would not result in unacceptable risks.

Table 6: Comparison of the RGs/PQLs in EMMA OU 1997 ROD to current USEPA Residential and Industrial RSLs. Concentrations are in mg/kg.

Chemical	PQL in 1997 ROD *Lead in RG value	USEPA Residential RSL (Nov. 2020)	USEPA Industrial RSL (Nov. 2020)
HMX	4.19	390	5700
RDX	4.13	8.30	38
1,3,5-TNB	2.25	220	3200
2,4,6, - TNT	2.11	3.6	51

* RSL reported at Target Cancer Risk at 1.0 X 10^{-6} or HQ = 0.1 for non-cancer.

As demonstrated, the PQL-based RGs for the EMMA OU COCs are all less than the USEPA Residential RSLs at the 1.0 X 10-6 screening level for all COCs. The only RG that exceeds the Residential RSL is lead. However, lead is not an actual COC for the EMMA OU and was only added to address the site evaluated in the ESD to the 1997 ROD if lead would have been identified as a COC. The current Land Use is Recreational. The MCLs and Class I and Class II Illinois water standards have not changed since the 1997 ROD and do not have any impact on the remedy since all uses of groundwater are prohibited.

Changes in Exposure Assumptions

There have been no changes to exposure assumptions within the FYR period (2016-2021). In 2014, the USEPA modified several of the standard default values. These changes however did not make Exposure Parameters more stringent. One of the exposure parameters that changed and is a common parameter in risk calculation was the average weight of a human was raised from 70 kg to 80 kg. This means that the average human receptor's weight increased and would ultimately result in lower risks based on an assumed dose (concentration from residual contamination that the receptor would be exposed to through ingestion, inhalation, or dermal absorption). For example, a person weighing 70 kgs can receive a larger dose without it resulting in an increase of risks. These changes would have no effect on human health risks and risk-based remediation goals for the RGs (COCs in soil and groundwater) at the EMMA OU. The RGs would be more stringent since they were based on the lesser body weight.

Several parameters used in the calculation of risks and RGs for residential land use had several changes: a decrease in the child skin surface area and an increase in the adult skin surface area (for the dermal contact pathway), an increase in the adult body weight, and a decrease in the adult exposure duration. Several exposure parameters used in the calculations of risks and RGs for industrial land use/receptors included an increase in the skin surface area and an increase in body weight. The overall effect of these changes in exposure parameters are negligible and would not change the risk values. It is likely the risk(s) would be less, since body weight is a large component of the adult human risk calculations. With reduced risks, the RGs calculated are still protective.

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.

7.2 TECHNICAL ASSESSMENT SUMMARY

The soil covers are in good shape with thick vegetation. The remedy is operating as intended. Groundwater monitoring and cover maintenance and inspection continues at COC-3 and COP-4. There appears to be no migration of contaminants off the sites based on stable or decreasing downgradient perimeter well concentrations. Mann-Kendall trend analysis shows that little, if any, contaminants are migrating from the contaminated soil under the soil covers to the groundwater. There has been no evidence of any prohibited activities at either site.

8. ISSUES

No issues affecting the protectiveness of the remedy were identified during this review.

9. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

While not affecting the protectiveness of the remedy, USACE recommends the following actions to increase the efficiency of O&M activities at EMMA OU.

USACE recommends continuation of the vegetation clearance, and that the vegetation clearance be added to the LUCIP. Vegetation overgrowth limits access to the sites and causes accurate visual inspections of the landfill cover to be much more difficult.

USACE also recommends further inquiry into the background levels of multiple metals at EMMA OU. The O&M Plan allows for cessation of the inspections, maintenance, and groundwater monitoring based off the concentration of contaminants, including TAL metals. Multiple TAL metals, especially aluminum and manganese, have been detected in concentrations that exceed their respective SC for groundwater at both COC-3 and COP-4. A background metals investigation is recommended to determine if these elevated metals concentrations are naturally occurring at the site. Concentrations of metals upgradient to the remedy will be compared to downgradient concentrations.

The PQLs for soil could be updated and possibly improved to better address the interference from elevated concentrations of TNT but the concentrations remaining in the soil are likely still greater than the RGs.

10. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: EMMA OU	Protectiveness Determination: Protective	Addendum Due Date (if applicable): N/A
Protectiveness Statement: The remedy at the Crab Orchard National Wildlife Refuge Explosives/Munitions Manufacturing Area (EMMA) OU COC-3 and COP-4 is protective of human health and the environment		

11. NEXT REVIEW

The next FYR for the EMMA OU is required five years from the June 2021 completion date of this FYR.

12. REFERENCE

ESE (Environmental Science & Engineering, Inc.). 1994. Final Remedial Investigation/Baseline Risk Assessment Report, Explosive/Munitions Manufacturing Area (EMMA) Operable Unit (OU), for Crab Orchard National Wildlife Refuge. September 15.

ESE (Environmental Science & Engineering, Inc.). 1995. Final Revised Feasibility Study Report Explosives/Munitions Manufacturing Areas Operable Unit, Crab Orchard National Wildlife Refuge., Marion, Illinois. September 26.

MWH (Montgomery Watson Inc.). 2001. RA Report for Crab Orchard National Wildlife Refuge, Explosive/Munitions Manufacturing Area (EMMA) Operable Unit (OU) Site COC-3 and COP-4. August

USACE/USEPA, 1999. Explanation of Significant Differences: Explosives/Munitions Manufacturing Area Operable Unit Site COC-4. May.

USACE. 2016. FYR Report, Third FYR Report For Explosives/Munitions Manufacturing Area Operable Unit, Crab Orchard Wildlife Refuge, Marion, Williamson County, Illinois. June.

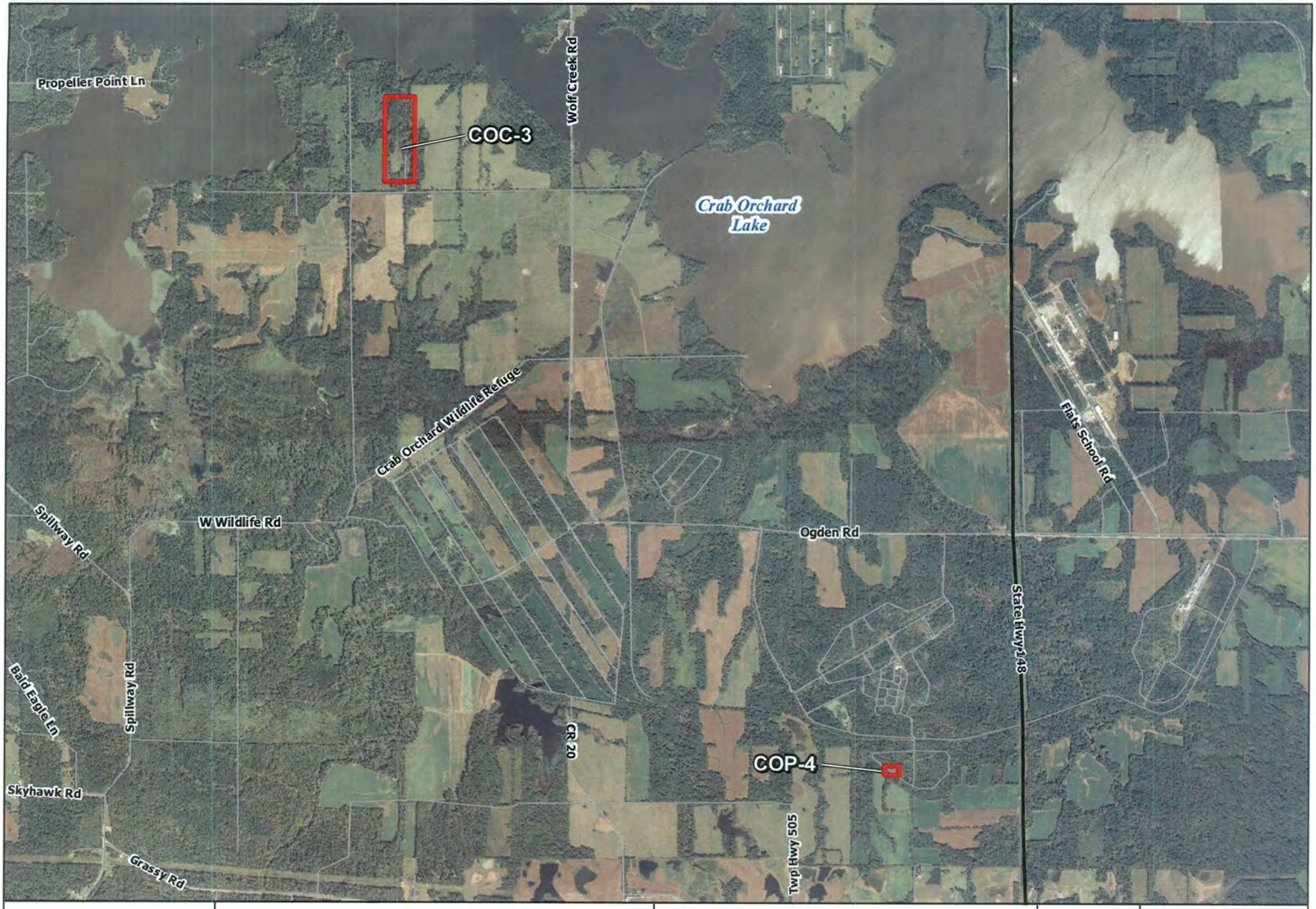
USACE (prepared by Environmental Science & Engineering, Inc.). 1997. ROD for Crab Orchard National Wildlife Refuge, Explosive/Munitions Manufacturing Area (EMMA) Operable Unit (OU). August 22.

USFWS. 2008. Environmental Land Use Control Plan, Crab Orchard National Wildlife Refuge NPL Site, Marion, Illinois. April.

USEPA. 2016. Fifth FYR Report for Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois. June.

USACE. 1997. Engineering and Cost Analysis Final Report, Former Illinois Ordnance Plant, Marion, Illinois. October

USACE. 2001. Final Removal Report, Ordnance and Explosives (OE) Removal Action, Former Illinois Ordnance Plant, 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

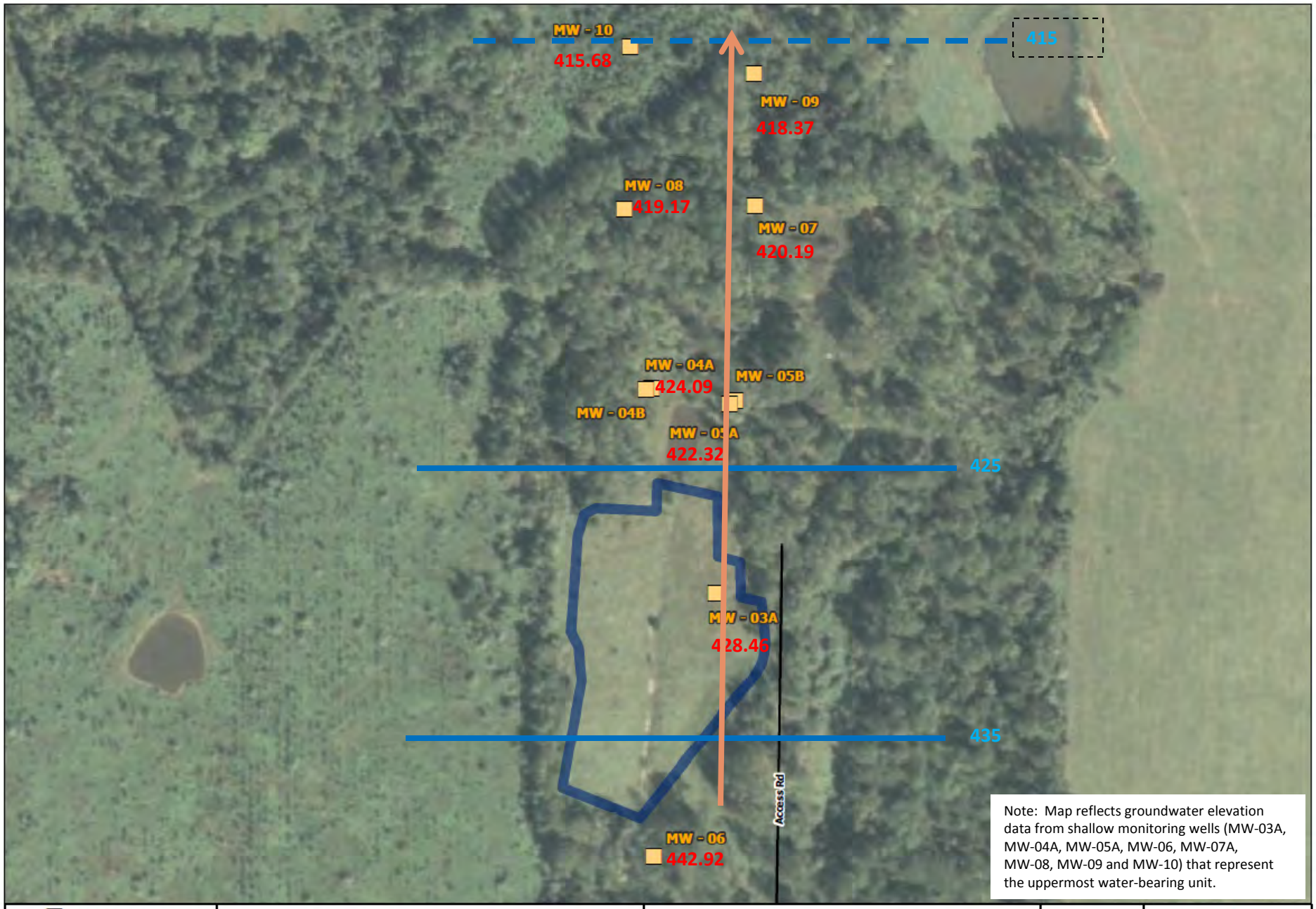
1 inch = 200 feet

0 125 250 500 Feet

Location is approximate.

N

US Army Corps of Engineers
Louisville District



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

Form 1
Five-Year Review Site Inspection Checklist

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I. SITE INFORMATION	
Site name: Crab Orchard	**Date of inspection: 27 October 2020**
Location and Region: Marion, IL	**EPA ID: IL8143609487**
Agency, office, or company leading the five-year review: USACE Louisville	**Weather/temperature: 50's / raining and overcast**

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: X Inspection team roster attached X Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager:** Leanne Moore (Name) CONWR Senior Biologist (Title) 24 November 2020 (Date)
   Interviewed ☐ at site ☐ at office X by phone Phone no. _____
   Problems, suggestions; X 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 _____
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 _____
_____

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 — X N/A
   - ☐ As-built drawings — ☐ Readily available — ☐ Up to date — X N/A
   - ☐ Maintenance logs — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

2. **Site-Specific Health and Safety Plan** — X Readily available — ☐ Up to date — ☐ N/A
   - ☐ Contingency plan/emergency response plan — X Readily available — ☐ Up to date — ☐ N/A

   Remarks_____

3. **O&M and OSHA Training Records** — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

4. **Permits and Service Agreements**
   - ☐ Air discharge permit — ☐ Readily available — ☐ Up to date — X N/A
   - ☐ Effluent discharge — ☐ Readily available — ☐ Up to date — X N/A
   - ☐ Waste disposal, POTW — ☐ Readily available — ☐ Up to date — X N/A
   - ☐ Other permits_____ — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

5. **Gas Generation Records** — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

6. **Settlement Monument Records** — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

7. **Groundwater Monitoring Records** — X Readily available — X Up to date — ☐ N/A

   Remarks_____

8. **Leachate Extraction Records** — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

9. **Discharge Compliance Records**
   - ☐ Air — ☐ Readily available — ☐ Up to date — X N/A
   - ☐ Water (effluent) — ☐ Readily available — ☐ Up to date — X N/A

   Remarks_____

10. **Daily Access/Security Logs** — ☐ Readily available — ☐ Up to date — X 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 X Gates secured ☐ 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 X N/A
Reports are verified by the lead agency ☐ Yes ☐ No X N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No X N/A
Violations have been reported ☐ Yes ☐ No X 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** ☐ N/A
Remarks_____
_____

3. **Land use changes off site** ☐ 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.)** ☐ 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 X Applicable ☐ 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)
X Properly secured/locked X Functioning X Routinely sampled X 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 ☐ 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 ☐ Applicable ☐ N/A	
1.	**Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks_____
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition☐ Needs Maintenance Remarks_____
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided Remarks_____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A	
1.	**Collection Structures, Pumps, and Electrical** ☐ Good condition☐ Needs Maintenance Remarks_____
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition☐ Needs Maintenance Remarks_____
3.	**Spare Parts and Equipment** ☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided Remarks_____

C. Treatment System ☐ Applicable ☐ 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
   ☐ Is routinely submitted on time X Is of acceptable quality

2. Monitoring data suggests:
   X 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: An MNA-style inspection was performed but MNA is not a part of the remedy. Groundwater monitoring is conducted to ensure contamination is not migrating off-site.

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 gas emission, etc.).

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. Landfill cover is in good condition and maintenance activities are adequate.

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. None found.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. No optimization opportunities evident.

Form 2
Five-Year Review Interviews

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INTERVIEW RECORD

Site Name: Crab Orchard EMMA OU	**EPA ID No.: IL8143609487**	
Subject: 4th Five Year Review	**Time: 1340**	**Date: 11/24/20**
Type: X Telephone Visit Other **Location of Visit:**	**Incoming** **X Outgoing**	

Contact Made By:

Name: William Clabaugh	**Title: Environmental Engineer**	**Organization: USACE**

Individual Contacted:

Name: Leanne Moore	**Title: Senior Contaminant Biologist**	**Organization: USFWS**

Telephone No: 618-889-6268 **Fax No:** **E-Mail Address: Leanne_Moore@FWS.gov**	**Street Address: Crab Orchard NWR** **City, State, Zip: Marion, IL 62959**

Summary Of Conversation

1. What is your overall impression of the project?
It is well maintained.

2. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.
No, there is very little public interest in the EMMA OU.

3. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities? If so, please give details.
No, not at EMMA OU. Did find landmines in July 2019 that USFWS utilized SRS to detonate.

4. Is there any hunting or other activities on the site.
Hunting is restricted at the sites. Hunters have a map that shows the areas that are restricted.

5. Do you feel well informed about the site's activities and progress?
Yes

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
Consider including the MMRP project in the Five Year Review schedule.

Page 1 of 1

Form 3
Cover Inspection Forms

Cover Inspection Form

EMMA-OU
Crab Orchard National Wildlife Refuge
Marion, IL

Date of Inspection: 26 October 2020
Inspector: *William Clabaugh, USACE*
Site Inspected: COC-3

Check Cover	Observation Made:
Major storm event occurred (1 inch in 2 hours)?	
During Inspection	
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. Stormwater draining from cover and collecting in north channel.	

Cover Inspection Form
EMMA-OU
Crab Orchard National Wildlife Refuge
Marion, IL

Date of Inspection: 26 October 2020
Inspector: *William Clabaugh, USACE*
Site Inspected: COP-4

Check Cover	Observation Made:
Major storm event occurred (1 inch in 2 hours)?	
During Inspection	
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. Stormwater draining from cover into surrounding wooded area.	

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	MW03A	USEPA	Groundwater Standards	
Date Sampled =	5/14/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/8/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	5/16/2006	10/19/2006	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	6/24/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 U	0.26 U/UJ [(a)]	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.8 U	0.78 JP	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	195,000 J [(e)]	74,800 J [(e)]	65,800	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	45000	40800	37000	32000	32900	50 to 200 (c)	NS	NS
Antimony	60 UR [(h)]	400 U/UJ [(c)]	400 U	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	-							6	6	24
Arsenic	211 J [(e,i)]	400 UR [(f)]	400 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	28.5	22.8 J	26.5	22.4	12.6	10	50	200
Barium	485 J [(i)]	14.8 B/100 U(I)	100 U	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	-							2000	2000	2000
Beryllium	39.4 B	25.7 B/40 U(I)	23.5 B	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	17.8	15.7	2.2	8.9	11.2	4	4	500
Cadmium	1,860	1,510	1,300	1,280	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	717	695	827	611	637	5	5	50
Calcium	434,000	441,000	431,000	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	-	-	-	-	-	-		NS	NS	NS
Chromium, total	237	28.1 B/100 U(I)	21.1 B/100 U [(j)]	44.7 B/100 U [(j)]	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	-	-	-	-	-	-		100	100	1000
Cobalt	1,130	870	793	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	-	-	-	-	-	-		NS	1000	1000
Copper	452	200 U	222	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	-	-	-	-	-	-		1300	650	650
Iron	741,000	327,000	279,000	311,000 NJ [(l,k)]	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	238000	182000	139000	228000 M	172000	192000	156000	171000	136000	120000	300(c)	5000	5000
Lead	265	200 U	200 U	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	36.7	36.1 J	87.9	9.9	74 B	5.4	9.2	15	7.5	100
Magnesium	425,000	324,000	306,000	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	-	-	-	-	-	-		NS	NS	NS
Manganese	36,900	25,700	24,400	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	20600	23100	22700	21200	20700	23000 M,B	19500	19400	18700	17400	13900	14400	50(c)	150	10000
Mercury	0.987	0.86	0.140	0.18 B/0.2 U(I)	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	-							2	2	10
Nickel	8,530 J [(l)]	6,560	5,790	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	3520	3340	3170	3960	4140	100	100	2000
Potassium	28,900	6,030 J [(l)]	4,660 B	8,710 NEJ [(l,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	-	-	-	-	-	-		NS	NS	NS
Selenium	75.1	400 U	400 U	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	-	-	-	-	-	-		50	50	50
Silver	23.3	60 U	60 U	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	-	-	-	-	-	-		100(c)	50	NS
Sodium	85,500	80,000	83,400	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	-	-	-	-	-	-		NS	NS	NS
Thallium	8.69	8.98	6.40	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	11.3 J	3.8 J	3 J	5 U	4 U	2	2	20
Vanadium	818	262	221	268	260	140	240	77	340	68	77	56	8 U	96.2 D	440 UN	111 JD	141 D	137 JD	122	65.8	74.6	144	68.9	49.7	10.8	63.2	83.4	66.4	78.1	57	50.3	NS	49	NS
Zinc	66,400	57,600	49,700	48,200	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	29100	21900	25400	34800	33000	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.16	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.19	0.1 U	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	MW04A	USEPA	Groundwater Standards	
Date Sampled =	5/14/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/7/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	5/16/2006	10/18/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/6/2009	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	6/25/2020	10/27/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 U	0.26 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 U	0.26 U	0.519 U	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	0.6 U	0.6 U	0.6 U	5.5 MJ	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.938	0.986	1.03	1.4 J[d]	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	0.6 U	0.6 U	0.78 J	2.8 MJ	1.8 MJ	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.205 /0.26 U [f]	0.25 J[d]	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	0.6 U	0.6 U	0.6 U	0.44 J	0.37	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	3.99	4.72	4.15	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	1.3	5.8	4.7	0.15 U	20 MJK	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	7.90	10.90	8.95	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	3.3	11	8.6	0.11 U	12 Q	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 U	0.26 U/UJ [e]	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	0.6 U	0.6 U	0.56 J	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.42 JP	0.48 J	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	2890 J [g, k]	4,290 J[d]	13,300	2,390 NJ[k]	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	9280	70000	520	158	345	50 to 200 (c)	NS	NS
Antimony	6.0 UR [h]	20 U/UJ[f]	20 U	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	-	-	-	-	-	-		6	6	24
Arsenic	5.0 UR [f]	20 UR[f]	5.50 B	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	12 U	38.6	9.1 J	2.1 J	2 U	10	50	200
Barium	38.6 J [l, x]	42.3	80.6	25.2 J[x]	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	-	-	-	-	-	-		2000	2000	2000
Beryllium	4.0 U	2.0 U	1.20 B	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	0.31 J	7.1	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	5.0 U	1.31 B/3 U[f]	2.30 B	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	1 U	3.5	1 U	1.3 J	1.5	5	5	50
Calcium	72,800	72,200	70,500	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	-	-	-	-	-	-		NS	NS	NS
Chromium, total	23.4 [x]	8.77 [x]	24.7	5.2 J[x]	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	-	-	-	-	-	-		100	100	1000
Cobalt	2.29 B/5 U [f]	5.1	12.1	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	-	-	-	-	-	-		NS	1000	1000
Copper	8.0 BU [f]	9.71 B/10 U[f]	22.5	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	-	-	-	-	-	-		1300	650	650
Iron	5800 [x]	6650 [x]	30,200	5,430 NJ[l, x]	10,000	3,500	130,000	10,000	660	58,000	1,600	3,200	932	2,720	1720	665	6750 D	1910	2330	5830	1670	9040	424	55700	91200 M	378000	14400	125000	1100	40 U	317	300(c)	5000	5000
Lead	4.31 /10 U [g, l]	7.31 B/10 U[f]	22.5	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	29.7	85.3	2 U	6.3	4.4	15	7.5	100
Magnesium	30,400	30,800	33,600	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	-	-	-	-	-	-		NS	NS	NS
Manganese	140 J [h,x]	433 [h]	565	146 J[d]	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	468	2330	36.8	12.5	36.1	50(c)	150	10000
Mercury	0.2 U	0.2 U	0.2 U	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	-	-	-	-	-	-		2	2	10
Nickel	19.2 J [l,k,x]	18	44.9	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	16.8	130	3.4 J	-	10 U	100	100	2000
Potassium	2700 [x]	3,560 J[l]	5,670	3,120 NEJ[l, y]	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	-	-	-	-	-	-		NS	NS	NS
Selenium	538	343	356 J[y]	512	450	360	350	320	340	370	670	290	4 U	329	383	299 E	26.2 D	304	311	314	415	314	229	299	-	-	-	-	-	-		50	50	50
Silver	10.0 U	3.0 U	3 U	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	-	-	-	-	-	-		100(c)	50	NS
Sodium	141,000	106,000	105,000	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	-	-	-	-	-	-		NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.24 /2 U(l)	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	7.5 U	7.5 U	7.5 U	4 U	4 U	2	2	20
Vanadium	7.18 B/10 U [f]	9.81 B/10 U[f]	31.0	5.5 B/10 U(l)	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	17.8	131	2.5 U	3 U	3 U	NS	49	NS
Zinc	43.5 J [k, x]	234 [x]	183	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	51.9	546	4.4 J	15	7.3	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	1.46	1.32	1.53	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	MW04B	USEPA	Groundwater Standards	
Date Sampled =	5/14/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/8/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	5/16/2006	11/18/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/6/2009	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	6/25/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 U	0.417 J/0.519 U(I)	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 U	2.02	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	0.345 J/0.519 U(I)	0.519 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 U	0.26 U [(e)]	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	260,000 J [(k,)]	42,500 J[(e)]	985	1570 NJ[(k)]	78,000	610	2,700	83 B	40	2,600	160 B	150 B	50.4 J	538	109 JD	132 U	231 D	1000 UD	880	102	179 J	474	16.7 J	25700	213	458	26.4 J	205	18 U	219	35.7	50 to 200 (c)	NS	NS
Antimony	21.4 UR [(h, j)]	10.4 B/20 U(t, u)	7.60 B	4.7 B/20 U[(j)]	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	-	-	-	-	-	-	-	6	6	24
Arsenic	280 J [(t)]	37.6 J[(d)]	20.0 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	12 U	12 U	12 U	2 U	2 U	10	50	200
Barium	1890 J [(t)]	399	61.2	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	16.8	3.46	0.640 B	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	0.3 U	0.3 U	0.3 U	3 U	3 U	4	4	500
Cadmium	89.1	10.3	5.70	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	1 U	1 U	1 U	1.6 J	1.6 J	5	5	50
Calcium	619,000	501,000	489,000	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	33400D	350000	382000	358000	363000	321000	236000	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	538	84.6	1.10 B/5 U (I)	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	348	55.5	30.5	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	831	102	10.8	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	-	-	-	-	-	-	-	1300	650	650
Iron	867,000	118,000	8,870	4000* NJ[(l, k)]	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	284	1240	88.8 JB	40 U	40 U	300(c)	5000	5000
Lead	578	67.2	10 U	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	6.5	2 U	2 U	7	4.8	15	7.5	100
Magnesium	310,000	138,000	116,000	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	20,100	4780	3,480	2,680	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	5.1 J	515	275	5 U	10	50(c)	150	10000
Mercury	0.632	1.12	0.2 U	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	-	-	-	-	-	-	-	2	2	10
Nickel	1,100 J [(t)]	169	84.5	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	7.5 U	5.3 J	4.8 J	10 U	10 U	100	100	2000
Potassium	61,700	33,700 J[(t)]	20,100	20,900 NEJ[(l, v)]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	163	28.4	5.80 B/20 U[(t)]	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	-	-	-	-	-	-	-	50	50	50
Silver	15.2 B/20 U [(t)]	5.01	3.0 U	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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	181,000	259,000	210,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	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	0.88 J	7.5 U	7.5 U	4 U	4 U	2	2	20
Vanadium	692	160	2.20 B	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	28.8	2.5 U	2.5 U	3 U	3 U	NS	49	NS
Zinc	3,480	451	113	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	104	23.1	12.1	9	4	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.1 U	0.27	0.690	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	USEPA	Groundwater Standards	
Date Sampled =	5/14/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/8/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	5/16/2006	10/19/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/6/2009	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	6/25/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 U	0.26 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 U	1.23	0.519 U	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	0.6 U	0.6 U	0.6 U	2.7 J	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.468 J [m]	0.821	0.741	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	0.6 U	0.6 U	0.24 J	0.91 J	0.8 J	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	4.39 J [m]	5.1	4.40	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	0.88 J	2.2	2.5	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	5.24 J [m]	8.70	8.03	5.1	10	12 (u)	11	12	8.2	11	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	4	5.6	6	0.11 U	5.8	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 U	0.26 UJ [o]	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	0.6 U	0.6 U	0.72 J	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.76 MJ	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	212,000 J [e]	46,900 J[e]	1,840	4,230* N	13,000	81,000	2,700	6,200	400	28,000	1,100	10,000	10,500	15,000	2210	1070 D	12100 ND	838 JD	11600	558 M,Y	9820	4780	4460	10400	21100	9070	2480	3060	317	228	35 U	50 to 200 (c)	NS	NS
Antimony	9.05 B	20 UJ [r, v]	20 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	165 J [t]	34.4 J[d]	20 U	4.1 U	14 B	13	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	12 U	12 U	8.6 J	2.0 U	2.4	10	50	200
Barium	1830 J [l]	335	28.7	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	23.7	3.24	0.260 B/2 U [t]	0.44 B/2 U [t]	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	0.3 U	0.52 JB	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	29.00	11	7.20	8.20	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	8.2	5.1	7.8	7.6	4.8	10.7	11.4 J	6.4	11.5	7.6	15.4	19.9	5	5	50
Calcium	361,000	370,000	356,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	385	96.4	4.00 B/5 U [t]	7.9 J[k]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	254	43.7	9.30	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	355	60.8	10.0	8.2 B/10 U[t]	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	-	-	-	-	-	-	-	1300	650	650
Iron	646,000	105,000	1,740	7,210 NJ[l, k]	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	4030	6050	585	40 U	40 U	300(c)	5000	5000
Lead	375	53.9	2.30 B/10 U [t]	4.8 B/10 U[t]	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	16.5	3.4 J	2 U	9.8	7.1	15	7.5	100
Magnesium	277,000	265,000	271,000	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	15,100	6440	5,000	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	1450	4760	1870	5450	6750	50(c)	150	10000
Mercury	1.59	0.589	0.2 U	0.1 U/0.2 U[t]	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	-	-	-	-	-	-	-	2	2	10
Nickel	958 J [e]	407	344	372	420	750	450	550	310	340	140	200	169	219	59.2	211 ED	302 D	215D	236	298	672	228	265	187	388	435	209	429	221	600	765	100	100	2000
Potassium	22,000	12,700 J[l]	6,100	6,900 NE[l, 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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	248	128	96.8 J [r]	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	-	-	-	-	-	-	-	50	50	50
Silver	2.91 B/ 20 U [t,i]	3.0 U	3 U	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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	108,000	124,000	118,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.41 /2 U[t]	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	7.5 U	2.5 J	7.5 U	4 U	4 U	2	2	20
Vanadium	320	77.9	3.30 B/10 U [t]	6.6 B/10 U[t]	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	3.4 J	5.2	2.5 U	3 U	3 U	NS	49	NS
Zinc	2,800	536	207	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	300	581	338	724	903	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.100	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	1.270	1.26	1.42	1.99 J[l]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05 B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	USEPA	Groundwater Standards	
Date Sampled =	5/14/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/8/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	5/16/2006	10/19/2006	6/4/2007	10/9/2007	5/13/2008	10/14/2008	5/6/2009	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	6/25/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 U	0.26 U	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	-	0.6 UJ	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	1.9	0.786	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 U	0.26 U [ss]	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.92	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	875 J [ac]	16,200 J[ac]	2140/J [ac]	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	81	70.1	23.7 J	65.3 J	86.1	50 to 200 (c)	NS	NS
Antimony	6.0 UR [h]	7.2 B	20 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	12.5 B	20 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	12 U	12 U	7.7 J	4.1	2.4	10	50	200
Barium	54.9 J [ij]	111	44.9 J [ix]	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	0.305 B/2 U [fl]	0.280 B/3 U [fl]	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	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	5.0 U	4.13	1.30 B/5 U [fl]	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	2.3	1.7 J	0.35 J	1.3 J	1.1	5	5	50
Calcium	489,000	611,000	412,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	11.6 B/20 U [fl]	31.9	5.70	1.4 B/5 U[fl]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	5.0 U	18.5	2.8 B/ 5 U [fl]	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	10.0 B/20 U [fl]	39.9	17	6.2 B/10 U[fl]	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	-	-	-	-	-	-	-	1300	650	650
Iron	1,450	40,100	13,000	2,530 NJ[fl, k]	2,200	1,300	31,000	340	190	8,800	280	160 B	90.7	272	76.9	152.0	176.0	447.0	599	33	348	100 U	50 U	237	416	183 UJ	161	213	200	40 U	3750	300(c)	5000	5000
Lead	1.8 U [ij]	23.3	4.30 B/10 U [fl]	2.1 B/10 U[fl]	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	3.6 J	2 U	2 U	3	3.9	15	7.5	100
Magnesium	1,880	88,800	9,150	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	92	2,570	682	165	96	75	230	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	9.6	11.5	112	4 U	152	50(c)	150	10000
Mercury	0.2 U	0.2 U	0.2 U	0.1 U/0.2 U[fl]	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	-	-	-	-	-	-	-	2	2	10
Nickel	8.96 B/10 U [fl]	82.8	16.3	5.2 B/10 U[fl]	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	1.1 J	1 J	1.6 J	10 U	10 U	100	100	2000
Potassium	16,900	19,900 J[fl]	15,800	14,300 NE/J[fl, vl]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	30.6	32.8	14.0 B/20 U [fl]	7.5 B/20 U(I)	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	-	-	-	-	-	-	-	50	50	50
Silver	10.0 U	3.0 U	3 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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	234,000	207,000	202,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.15 /2 U[fl]	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	7.5 U	7.5 U	7.5 U	4 U	4 U	2	2	20
Vanadium	1.57 B/10 U [fl]	45.8	6.90 B/10 U [fl]	1.8 B/10 U[fl]	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	2.5 U	2.5 U	2.5 U	3 U	3 U	NS	49	NS
Zinc	108	252	57.2 U [ij]	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	3.9 J	15.9	5 U	14	4 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	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	0.18	0.1 U	0.190	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	4.4	2.5	1.85	0.64 J[fl]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	MW06	USEPA	Groundwater Standards	
Date Sampled =	5/15/2001	8/20/2001	11/13/2001	2/12/2002	2/19/2003	10/7/2003	5/26/2004	10/27/2004	5/10/2005	10/18/2005	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	6/24/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																			
HMX	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [g]	0.26 U	0.26 UJ [g]	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 UJ [g]	0.26 U	0.26 U	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	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 UJ [g]	0.519 U	0.519 U	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	0.6 U	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																			
Aluminum	925 J [e]	1,500 J [e]	239	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	11000	498	70.7	86.9 J	56.3	50 to 200 (c)	NS	NS
Antimony	6.0 U	20 UJ [s, v]	20 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	6.27 B/20 UR [f, v]	20 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	7.7 J	12 U	5.4 J	2 U	2 U	10	50	200
Barium	7.44 BU [f]	8.19	5.40	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	2.0 U	2.0 U	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	1.1	0.3 U	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	3.04 BU [f]	2.56 B/3 U [f]	2.10 B/3 U [f]	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	8.2	1.8 J	1.6 J	2.5	2.8	5	5	50
Calcium	50,200	53,900	50,600	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	5.64 BU [f]	12.4	2.40 B/5 U [f]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	2.27 BU [f]	0.951 B/5 U [f, v]	5 U	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	12.3 BU [f]	8.24 B/10 U [f, v]	28.7	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	-	-	-	-	-	-	-	1300	650	650
Iron	2,450	2,410	477	475 N/J [f, N]	200 U	200 U	1,400	190 B	130 B	2,100	460	1,100	1,820	780	1190	172	1020	300E	915	1340	866	5020	389	8870	13600	1510	23700 M	1080 M	129 B	40 U	40 U	300(c)	5000	5000
Lead	4.25	3.22 B/10 U [f, u]	5.90 B/10 U [f]	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	74.3	2 U	2 UM	4.9	4.4	15	7.5	100
Magnesium	18,800	18,600	18,500	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	87.4	55.9	39.1	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	323	32.3	4.1	4 U	4 U	50(c)	150	10000
Mercury	0.2 U	0.2 U/	0.2 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	-	-	-	-	-	-	-	2	2	10
Nickel	12	14.6	9.30 B	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	71	6.7	5.3 JM	10 U	10 U	100	100	2000
Potassium	2,890	3,340 J [f]	2,850	2,830 NE/J [f, vj]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	319	330	303 J [e]	334	300	300	310	290	290	280	270	240	223E	227	272 N	251.0	232.0	258.0	295	264	265	268	283	246	-	-	-	-	-	-	-	50	50	50
Silver	10.0 U	3.0 U	3 U	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	-	-	-	2 U	-	-	-	100(c)	50	NS
Sodium	106,000	108,000	105,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	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	7.5 U	7.5 UM	7.5 U	4 U	4 U	2	2	20
Vanadium	7.89 BU [f]	8.59 B/10 U [f, v]	2.7	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	77.3	1.6 J	2.5 U	3 U	3 U	NS	49	NS
Zinc	99.8	95.5	148	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	479	44.6	29.3	41	34	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	2.31	2.04	2.10	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	MW07	USEPA	Groundwater Standards	
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	6/25/2020	10/27/2020	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	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	0.21 U	0.21 U	NS	1400	1400
RDX	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	4.1 MJ	3.3 MJ	NS	84	84
1,3,5-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	0.21 U	0.84 J	NS	210	210
1,3-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	0.7
Tetryl	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	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	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	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-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	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-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	0.15 U	8.0 JK	NS	2.7 [See	2.7 [See
2-Amino-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	0.11 U	2.5 MQ	NS	Note (u)]	Note (u)]
2, 4-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	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-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	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (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	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (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	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (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	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																								
Aluminum	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	222	52.5	50 to 200 (c)	NS	NS
Antimony	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	24
Arsenic	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	2 U	2 U	10	50	200
Barium	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	2000
Beryllium	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	0.3 U	0.3 U	4	4	500
Cadmium	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	13	24.6	5	5	50
Calcium	160,000	180,000	152,000	21,300	196000	207000	161000	156000	142000	211000 B	205000	213000	188000	262000	-	-	-	-	-	-	-	NS	NS	NS
Chromium, 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	1000
Cobalt	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	1000
Copper	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	650
Iron	760	1,100	1,340	236	727	715	3260	6310	414	548	578 Y	1420	126	21000	3300	7470 J	2340	621	105 B	40 U	40 U	300(c)	5000	5000
Lead	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	8.5	5.8	15	7.5	100
Magnesium	90,000	120,000	85,600	140,000 D	109000 D	121000 D	96900	93600	77900	157000 B	130000	138000	128000	188000	-	-	-	-	-	-	-	NS	NS	NS
Manganese	160	2,200	127	1,780	39.0	402.0	52.2	273.0	21.8	1560	28.6	468	142	1850	81.3	130	82.7	1210	38.6	655	1470 J	50(c)	150	10000
Mercury	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	10
Nickel	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	15	59.6	100	100	2000
Potassium	3,600	6,000	2,960	4,610	3290	3670 E	3100 NE	3890	2490	5780	3020	3280	3590 B	7330	-	-	-	-	-	-	-	NS	NS	NS
Selenium	270	230	205E	190	170 N	161 E	135	180	220	199 B	154	161	154	139	-	-	-	-	-	-	-	50	50	50
Silver	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	NS
Sodium	100,000	98,000	103,000	108,000	105000	104000	92400	92800	88300	110000	95100	96700	98500 B	111000	-	-	-	-	-	-	-	NS	NS	NS
Thallium	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	4 U	4 U	2	2	20
Vanadium	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	3 U	3 U	NS	49	NS
Zinc	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	191	291	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
Nitrate + 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	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	MW08	USEPA	Groundwater Standards	
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	6/25/2020	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
Explosives																							
HMX	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	0.21U	0.21U	NS	1400	1400
RDX	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	0.21 U	0.21 U	NS	84	84
1,3,5-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	0.21 U	0.33 J	NS	210	210
1,3-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	0.7
Tetryl	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	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	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	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-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	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-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	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-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	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-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	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
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	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (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	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (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	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (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	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																							
Aluminum	570	440	321	308	182.0	54.3 J	2060 N	566.0	344	171	410	251 Y	18 U	34.2 J	456	36 UJ	15.3 J	21.5 J	18 U	173	57.6	50 to 200 (c)	NS	NS
Antimony	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	24
Arsenic	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	2 U	2 U	10	50	200
Barium	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	2000
Beryllium	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	0.3 U	0.3 U	4	4	500
Cadmium	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	2.7	2.6	5	5	50
Calcium	150,000	150,000	138,000	138,000	136000.0	161000.0	131000	139000	144000	158000	160000	157000	138000	154000	-	-	-	-	-	-	-	NS	NS	NS
Chromium, 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	1000
Cobalt	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	1000
Copper	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	650
Iron	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	40 U	40 U	300(c)	5000	5000
Lead	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	7	5.2	15	7.5	100
Magnesium	73,000	71,000	60,600	63,700	55200.0	701000.0	58000	61400	56000	65700 B	75000	71400	61400	65000	-	-	-	-	-	-	-	NS	NS	NS
Manganese	500	500	260	275	260.0	351.0	384	306	251	259	194	255	151	329	273	289	289	304	107	236	298	50(c)	150	10000
Mercury	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	10
Nickel	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	10 U	11.6	100	100	2000
Potassium	10,000	10,000	6,200	6,690	6240.0	6910 E	6000 NE	5860.0	5540	7600	6120	5780	5850	6620	-	-	-	-	-	-	-	NS	NS	NS
Selenium	290	270	250E	287	280 N	279 E	239	268	295	296	251	269	248	219	-	-	-	-	-	-	-	50	50	50
Silver	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	NS
Sodium	120,000	110,000	116,000	116,000	11400.0	124000.0	108000	102000	105000	118000	105000	106000	104000	112000	-	-	-	-	-	-	-	NS	NS	NS
Thallium	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	4 U	4 U	2	2	20
Vanadium	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	3 U	3 U	NS	49	NS
Zinc	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	14	10.8	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
Nitrate + 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	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW09	MW09	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	6/25/2020	10/27/2020	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
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	0.21U	0.21U	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	0.21 U	0.21 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	0.21 U	0.21 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	0.11 U	0.11 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	0.21 U	0.21 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	0.11 U	0.11 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	0.15 U	0.15 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	0.11 U	0.11 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	0.1 U	0.1 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	0.1 U	0.1 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	0.21 U	0.21 U	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	0.40 U	0.40 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	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																
Aluminum	28900	12200	41500	20000	19900	51700	26000	31200	10800	20900	1870	42500	24400	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	31.7	12.4	10	50	200
Barium	50.3	10.9	11.5	9.6	9	22.7	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	12.2	7.1	9.9	9.5	9.9	12.5	4.2	10.1	2.1	8.1	5.7	13.3	9.3	4	4	500
Cadmium	1220	341	195	429	494	621	234	549	151	483	286	958	768	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	203000	166000	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	4.9	10.5	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	17900	15200	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	6870	5090	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	19.5	18.8	2	2	20
Vanadium	81.3	43.2	140	76.6	83.7	165	101	94.4	68.6	90.3	3 J	194	86.9	NS	49	NS
Zinc	3340 M	10900	5190	11400	15000	16000	5170	13900	3380	11700	4750	36100	23200	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
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.84 UM,V	1.1	0.8 U	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW10	MW10	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	6/25/2020	10/27/2020	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
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	0.21U	0.21U	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	0.21 U	0.21 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	0.21 U	0.21 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	0.11 U	0.11 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	0.21 U	0.21 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	0.11 U	0.11 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	0.15 U	0.15 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	0.11 U	0.11 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	0.1 U	0.1 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	0.1 U	0.1 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	0.21 U	0.21 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	0.40 U	0.40 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	0.28 JM	0.41 U	NS	70	70
Metals - Unfiltered																
Aluminum	242	573	1570	1700	18 U	420	704	296	143	175	18 U	200	55.5	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	2 U	2 U	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	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	2.7	0.8	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	1080	241	720	394	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	6.7	4.3	15	7.5	100
Magnesium	32200	109000 B	30500	29700	25500	23500	-	-	-	-	-	-	-	NS	NS	NS
Manganese	260	2960	120	206	10.3	34.6	57.2	95.7 U	26.5	24.4	19	84.2	32.4	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	15	10 U	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	4 U	4 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	3 U	3 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	9.2	4 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	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 1997).
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.
M = Manual Integrated Compound.
Q = One or more quality control criteria failed.
K = Blank contamination: the analyte was detected above one-half the reporting limit in an associated blank.
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 c concern the remediation objectives cannot
be met by current laboratory methods.
(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)

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	MW02R	USEPA	Groundwater Standards	
Date Sampled =	5/15/2001	8/21/2001	11/15/2001	2/13/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/24/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	1.61	2.34	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	0.82 JP	5	1.1 M	1.2 M	NS	1400	1400
RDX	9.00	12.10	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	10	22	4.3 M	3.9 M	NS	84	84
1,3,5-Trinitrobenzene	0.26 U	0.26 U	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	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 U	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 U	0.519 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 U	0.519 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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 U	0.519 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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 U	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	259 J [(e)]	10,800 N/J [(e)]	4,940 J (q)	272	2,800	920	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	2580J +	520	368	12.5 J	135	149	50 to 200 (c)	NS	NS
Antimony	6.0 U	4.5 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 U/R [(f)]	5.7 B/J [(e)]	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	12 U	10.3 JB	3 U	3 U	10	50	200
Barium	33.8	118	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	0.84 B/2 U [(j)]	2 U	0.22 B/2 U [(j)]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	5.0 U	0.40 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	0.073 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	-	-	-	-	-	-	-	5	5	50
Calcium	87,900	105,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	20 U	20.2	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	5.0 U	9.3	3.60 B/5 U [(j)]	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	5.64 B/20 U [(j)]	17.1 J [(e)]	9.00 B/20 U [(j)]	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	-	-	-	-	-	-	-	1300	650	650
Iron	312	19,000 N/J [(e)]	7,390/J [(e)]	418	4,500	1,400	2,600	42,000	500	3,900	1,300	2,700	46.4	2,450	344	1080	279	1090	920	22900 B	605	587	43.2 J	2950	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	3.0 U/10 U	11.3 J (e)	4.20 B/10 U [(j)]	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	2 U	2 U	3.6	3.8	15	7.5	100
Magnesium	48,500	55,000	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	25.5	575	230	43	91	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	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U	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	-	-	-	-	-	-	-	2	2	10
Nickel	10 U	20.6	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	-	-	-	-	-	-	-	100	100	2000
Potassium	625 B/1000 U (j)	2,650 J [(q)]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.4 U	20 U	4.2 B/20 U [(j)]	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 U	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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	48,600	55,600	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2 U	1.1 /2 U [(j)]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	20 U	24.7	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	16.2 B/20 U [(j)]	77.9	35.0	10.0 B/20 U [(j)]	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	-	-	-	-	-	-	-	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***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	1.28	1.19 J [(q)]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A
Date Sampled =	5/15/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/10/2003	5/27/2004	10/26/2004	5/10/2005
Analytes	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives									
HMX	0.519 UJ [i]	0.554	0.519 U	0.52 U	0.57 J	0.53 J	1.5 U	0.72 J	0.66 J
RDX	0.801 J [l, r]	1.86	1.47	3.3	9.8	8.5	5.1	5.9	4.7
1,3,5-Trinitrobenzene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U
1,3-Dinitrobenzene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U
Tetryl	0.519 UJ [i]	0.519 U	0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
Nitrobenzene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U
2,4,6-Trinitrotoluene	0.26 UJ [i]	0.26 U	7.63	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U
4-Amino-2,6-dinitrotoluene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
2-Amino-4,6-dinitrotoluene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
2, 4-Dinitrotoluene	0.26 UJ [i]	0.26 U	51.4	0.26 U	0.64 U	0.49 U	0.76 U	0.39 U	0.39 U
2, 6-Dinitrotoluene	0.26 UJ [i]	0.26 U	0.26 U	0.26 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
2-Nitrotoluene (o-nitrotoluene)	0.519 UJ [i]	0.519 U	0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
3-Nitrotoluene (m-nitrotoluene)	0.519 UJ [i]	0.519 U	0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.78 U	0.78 U
4-Nitrotoluene (p-nitrotoluene)	0.519 UJ [i]	0.519 U	0.519 U	0.52 U	1.3 U	0.98 U	1.5 U	0.31 U	0.31 U
Metals - Unfiltered									
Aluminum	87.1 J [e, r]	5190 NJ [p]	21300	1,730 J [r]	3,700	1,200	6,300	860	4,800
Antimony	6.0 U	4.5 U	20 UR (f)	4.5 U	50 U	3.5B	6.0 U	6.0 U	6.0 U
Arsenic	5.0 UR (f)	4.1 UJ (e)	11.1 BJ [e]	4.1 U	20 U	4.0 U	4.1	0.53B	4.0 U
Barium	23.9	53.2	128	40.4	63	38	56	36	59
Beryllium	4.0 U	0.41 B/2 U [j]	1.10 B/2 U [j]	0.35 B/2 U [j]	4.0 U	4.0 U	0.35B	4.0 U	0.22B
Cadmium	5.0 U	0.40 B/3 U [j]	3 U	0.40 U	2.0 U	2.0 U	2.0 U	0.50B	2.0 U
Calcium	101,000	102,000	121,000	115,000	110,000	110,000	120,000	110,000	130,000
Chromium, total	20 U	21.8	43	2.4 B/5 U [j]	7.8 B	6.3B	13	1.6B	8.4B
Cobalt	5.0 U	2.2 B/5 U [j]	9.3	1.3 B/5 U [j]	10 U	1.1B	2.8B	10 U	3.1B
Copper	20 U	5.4 BJ [q]	23.3	10.1	3.2 B	3.4B	5.3B	2.5B	3.6B
Iron	23.8 B/150 U [j]	7,350 NJ [p])	34200	1,590 J [j]	4,600	1,500	8,000	950	6,300
Lead	1.56 B/3 U [j]	2.4 B/3 U [j]	13.7	2.7 B/10 U [j]	3.0 B	7.5 U	3.2B	7.5 U	4.8B
Magnesium	48,500	49,100	57,800	50,000	55,000	55,000	58,000	52,000	65,000
Manganese	204	380	724	407	170	600	510	420	430
Mercury	0.2 U	0.10 U	0.2 U	0.10 U/0.2 U [j]	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	10 U	15.6	33.6	3.3 B/10 U [j]	4.9 B	4.4B	13	2.4B	5.4B
Potassium	330 B/1000 U [j]	1,370 J [q]	3,870	730	1,300	780B	1,500	670B	1,300
Selenium	5.0 U	3.4 U	20 U	3.4 U	15 U	15 U	15 U	15 U	15 U
Silver	10 U	1.4 U	3 U	1.4 U	10 U	10 U	10 U	10 U	1.2B
Sodium	65,600	68,100	73,100	70,000	62,000	67,000	66,000	70,000	69,000
Thallium	2.0 U	2.0 U	2.0 U	0.19 /2 U [j]	25 U	4.0 U	4.0 U	4.0 U	4.0 U
Vanadium	20 U	10.1	43.6	3.2 B/10 U [j]	5.8 B	10 U	11	10 U	12
Zinc	8.72 B/20 U [j]	41.7	83.5	18.3 B/20 U [j]	48	22B	21B	10B	20B
Indicators	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-
Nitrate + Nitrite	0.88	0.75 J [q]	0.66	0.74	0.73	0.55	0.34	0.22	0.46

Sample ID =	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A
Date Sampled =	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	5/25/2011	10/25/2011
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
Explosives													
HMX	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
RDX	3.3	5.5	6.1	13	18	7.0	10.0	5.5	0.87	13	1.2 U	53	1 U
1,3,5-Trinitrobenzene	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
1,3-Dinitrobenzene	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
Tetryl	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
Nitrobenzene	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
2,4,6-Trinitrotoluene	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
4-Amino-2,6-dinitrotoluene	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
2-Amino-4,6-dinitrotoluene	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
2, 4-Dinitrotoluene	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
2, 6-Dinitrotoluene	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
2-Nitrotoluene (o-nitrotoluene)	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
3-Nitrotoluene (m-nitrotoluene)	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
4-Nitrotoluene (p-nitrotoluene)	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
Metals - Unfiltered													
Aluminum	880	550	2,200	834	4,240	1530	3190	1250	809	1660 Y	28700	2610 M	685
Antimony	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
Arsenic	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
Barium	35	27	38	32.2	43.6	30.1	125	28.7	26.8	33	170 B	47.1	157
Beryllium	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
Cadmium	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
Calcium	120,000	120,000	110,000	126,000	119,000	119000	123000	112000	119000	131000	147000	128000 Y	66300
Chromium, total	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
Cobalt	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
Copper	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
Iron	1,000	650	2,500	932	4,660	1680	17500 N	1190	943	2540	59400 B	3050	1440
Lead	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
Magnesium	58,000	60,000	54,000	61,000	60,300	52300	55200	55100	56200	67800	77400 B	62100 B	32700
Manganese	460	120	490	405	705	240	3460	301	260	402	1160	256	213
Mercury	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
Nickel	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
Potassium	730B	580B	730 B	430	984	477	1080	476	404 J	616 J	2980	651 J	7720
Selenium	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
Silver	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
Sodium	70,000	66,000	60,000	68,700	68,600	64600	66500	61400	63700	62700	77500	66200	57400
Thallium	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
Vanadium	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
Zinc	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
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
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	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	-

Sample ID =	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	MW05A	USEPA	Groundwater Standards	
Date Sampled =	5/16/2012	11/1/2012	6/25/2013	11/20/2013	5/21/2014	10/29/2014	5/28/2015	6/23/2020	10/28/2020	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
Explosives												
HMX	5.8	3	6.6	3.8	16	30	35	14 QJDM	41 DM	NS	1400	1400
RDX	63	7.9	15	16	21	69	50	75 QD	63 D	NS	84	84
1,3,5-Trinitrobenzene	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	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	0.6 U	0.6 U	0.21 U	0.6 UJ	5.5 P	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.6 U	0.6 U	0.28 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.6 U	0.6 U	0.3 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.6 U	0.6 U	0.4 U	0.6 UJ	0.6 U	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.6 U	0.6 U	0.23 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.6 U	0.6 U	0.22 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered												
Aluminum	243	12900	7640	10800 J+	836	2160	378	334	106	50 to 200 (c)	NS	NS
Antimony	6 U	6 U	-	-	-	-	-	-	-	6	6	24
Arsenic	12 U	6.1 J	4 U	12 UJ	12 U	12 U	7.7 JB	2 U	2 U	10	50	200
Barium	27.3	76.6	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	0.3 U	0.54 J	-	-	-	-	-	-	-	4	4	500
Cadmium	1 U	1 U	-	-	-	-	-	-	-	5	5	50
Calcium	123000	93700	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	1.7 J	13.2	-	-	-	-	-	-	-	100	100	1000
Cobalt	2 U	5.1	-	-	-	-	-	-	-	NS	1000	1000
Copper	3.5 UY	13	-	-	-	-	-	-	-	1300	650	650
Iron	282	11200	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	2 U	14.4	9.7	27 J	30.3	2.2 J	2 U	4.9	3.7	15	7.5	100
Magnesium	61200	45900	-	-	-	-	-	-	-	NS	NS	NS
Manganese	379 M	971	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.06 U	0.06 U	-	-	-	-	-	-	-	2	2	10
Nickel	1.3 J	10.8	-	-	-	-	-	-	-	100	100	2000
Potassium	250 U	1260	-	-	-	-	-	-	-	NS	NS	NS
Selenium	6.5 U	6.5 U	-	-	-	-	-	-	-	50	50	50
Silver	2 U	2 U	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	64500	62200	-	-	-	-	-	-	-	NS	NS	NS
Thallium	7.5 U	7.5 U	-	-	-	-	-	-	-	2	2	20
Vanadium	0.89 J	19.4	-	-	-	-	-	-	-	NS	49	NS
Zinc	1.6 J	38.2	-	-	-	-	-	-	-	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
Nitrite Nitrogen	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	MW05B	USEPA	Groundwater Standards	
Date Sampled =	5/15/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/10/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	5/26/2010	10/26/2010	5/16/2012	11/1/2012	6/25/2013	11/20/2013	5/21/2014	10/29/2014	5/28/2015	6/23/2020	10/28/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 UJ [d]	0.519 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	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	17	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.519 UJ [d]	0.519 U	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	26	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [d]	0.26 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	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	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519UJ [d]	0.765	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 UJ [d]	0.519 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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 UJ [d]	0.519 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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 UJ [d]	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	311,000 J [ej]	18,000 NJ [ej]	22600	1,610	4,400	87,000	4,400	100B	260	120B	430	200	300E	237	125 J	51.2 J	355	52.6 J	3930	698	263	2000	27.5 J	29.8 J	46.2	5710 J+	38.6	34.2 J	18 U	66	82.4	50 to 200 (c)	NS	NS
Antimony	30 U	4.5 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	364	16.5 BJ [ej]	22.4 J [ej]	4.1 U	6.9 B	37	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	12 U	4 JB	2 U	14.9	10	50	200
Barium	3,220	522	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	54.7	2.2	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	-	-	-	-	-	-	-	4	4	500
Cadmium	25 U	1.0 B/3 U [ej]	1.2 B/3 U [ej]	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	-	-	-	-	-	-	-	5	5	50
Calcium	293,000	112,000	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	1200000	52900	113000	62300	64700	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	557	47.8	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	578	19.1	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	761	28.4 J [ej]	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	-	-	-	-	-	-	-	1300	650	650
Iron	1,200,000	41,500 NJ [ej]	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	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	385	14.0 J [ej]	18.8	4.9 B/10 U[j]	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	8	2 U	2 U	3.8	15	7.5	100
Magnesium	131,000	10,100	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	8,460	377	603	151	94	1,900	1,900	8.0B	16	93	24	170	54.1	80.8	157	232	667	43.8	1110	356	173	400	216	315	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.15 B/0.2 U [g]	0.2 U	0.10 U/0.2 U[j]	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	-	-	-	-	-	-	-	2	2	10
Nickel	1,030	50.4	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	-	-	-	-	-	-	-	100	100	2000
Potassium	181,000	62,900 J [ej]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	25 U	5.2 BU [ej]	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	-	-	-	-	-	-	-	50	50	50
Silver	50 U	1.4 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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	335,000	222,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.43 /2 U[j]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	593	37.3	46.7	7.9 B/10 U[j]	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	2,320	107 J [ej]	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	-	-	-	-	-	-	-	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.16	0.1 U	0.11	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.1 U	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	MW06A	USEPA	Groundwater Standards	
Date Sampled =	5/15/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/18/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/23/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	381 J [f]	403	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	130	180	390 DMQ	130 DQ	NS	1400	1400
RDX	2420 J [f]	2,530	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	680	760	1200	730	310	460	850	650	620	450 DMQ	610 DMQ	NS	84	84
1,3,5-Trinitrobenzene	291 J [f]	225	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	58	91	63 QD	130 DQ	NS	210	210
1,3-Dinitrobenzene	0.384 J [f]	0.26 U	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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	65.2 J [f]	0.519 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 UJ (i)	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	101 J [f]	78.7	60.5 J [g]	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	0.6 U	0.6 U	0.914 MJ	0.61 MQ	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	39.7 J [f]	46.9	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	11	13	10 M	23 J	NS	5.6 [See	5.6 [See
2-Amino-4,6-dinitrotoluene	37.5 J [f]	46.4	50.9	47	42	38 [h]	35	36	60	50	29	34	20	0.20 U	0.26 U	24	12	18	20	17	12	18	18	18	7.4	12	13 P	12	9.9	11 M	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [f]	0.26 U	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 UJ [f]	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 UJ [f]	0.519 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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 UJ [f]	0.519 U	1.28 U [g]	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	1.9	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	1.06 J [f]	0.519 U	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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	2,080 J [e]	19,400 NJ [e]	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	4420	9.6 JB	91.3	35 U	50 to 200 (c)	NS	NS
Antimony	6.0 U	4.5 U	20 UR [f]	4.5 U	50 U	4.4B	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	6.0 BJ [e]	27.5 J [e]	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	22.4	13 U	24 U	8 J	12 U	4.5 J	4 U	12 UJ	12 U	4.6 J	2 U	2 U	2 U	10	50	200
Barium	90.7	185.0	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	1.1 B/2 U [j]	3	0.72 B/2 U [j]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	5.0 U	0.44 B/3 U [j]	1.2 B/5 U [g]	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	-	-	-	-	-	-	-	5	5	50
Calcium	88,900	93,200	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	2.15 B/5 U [j]	41.3	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	4.02 B/5 U [j]	11.1	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	9.09 B/10 U [j]	21.7 J [g]	58.5	7.5 B/10 U [j]	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	-	-	-	-	-	-	-	1300	650	650
Iron	2,050	28,300 N/J [e]	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	8990	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	4.83	14.2 J [e]	44.2	7.2 B/.10 U [j]	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	12.9	75	4.3	4	15	7.5	100
Magnesium	52,100	55,300	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	629	1,030	1,540	623	410	5,600	6.3B	140	78	4,600	120	170	119	784	92.0	12.6	224.0	124.0	169	4030	71.2	779	79.9	222	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U	0.2 U	0.10 U/0.2 U [j]	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	-	-	-	-	-	-	-	2	2	10
Nickel	4.33 B/10 U [j]	33.4	71.0	5.2 B/10 U [j]	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	-	-	-	-	-	-	-	100	100	2000
Potassium	642 B/1000 U [j]	2,960 J [g]	6,900	534	2,500	21,000	6.3B	950B	400B	10,000	1,000	790 B	534	5820 N	489	355	1110	558 J	1110	10200	511 J	801	250 U	898	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.4 U	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	37,900	37,700	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.19 /2 U [j]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	20 U	38.9	115	4.4 B/10 U [j]	23	460	6.3B	6.1B	1.7B	210	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	40 U	97.9	238	15.9 B/20 U [j]	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	-	-	-	-	-	-	-	5000(c)	5000	10000
Indicators	mg/L	mg/L	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.33	0.20 J [g]	0.11	0.22 J [g]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	2.21	1.78 J [g]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	MW06B	USEPA	Groundwater Standards	
Date Sampled =	5/15/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/18/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/23/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.519 UJ [d]	0.519 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	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	0.21U	0.21U	NS	1400	1400
RDX	1.75 J [d]	0.598	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	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.519 UJ [d]	0.519 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 UJ [d]	0.26 U	0.706 J [bq]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	3.61 J [d]	0.26 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	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [d]	0.26 U	6.01 U [be]	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	0.6 U	1.3 J	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 UJ [d]	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.519 UJ [d]	0.519 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	0.8 U	0.8 UY	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.519 UJ [d]	0.519 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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.519 UJ [d]	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	4,800 J [be]	27,900 NJ [be]	1470	155 B/200 U[j]	5,200	590,000	110,000	170B	500	470	680	11,000	4,280	18300 N	326	2340	144	295	19000	315	35900	4330	655	43.7	20.8 J	61 J+	12 J	17.5 J	35.5 J	88.6	35 U	50 to 200 (c)	NS	NS
Antimony	6.0 U	4.5 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	25.8 J [be]	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	10.5	37.9	17	64.7	17.5 J	16.7 J	12 U	4 U	15.1 J	12 U	14.8 J	14.6 JB	2.8	2.4	10	50	200
Barium	159	591	205	188	220	5,500	1,100	220	170	220	190	340	244	357	203	272	203	267	549	269 B	785	193	215	157	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	2.1	2 U	0.21 B/2 U [j]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	5.0 U	1.2 B/3 U [j]	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	-	-	-	-	-	-	-	5	5	50
Calcium	45,600	247,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	85.7	42.7	5.6	1.6 B/5 U [j]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	5.9	51.7	1.4 B/5 U [j]	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	14.8 B/20 U [j]	28.1 J [bq]	11.5	7.7 B/10 U [j]	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	-	-	-	-	-	-	-	1300	650	650
Iron	10,100	100,000 NJ [be]	2,450	1,200	11,000	2,800,000	260,000	2,300	1,500	2,800	1,500	22,000	7,200	31,700	1560	5750	577	3560	55000	5400 B	121000	11700	5050	335	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	7.74	23.3 J [be]	3.2 B/10 U [j]	2.0 B/10 U [j]	6.4 B	840	110	4.7B	8	3.1B	13	16	23.8	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	2 U	2 U	3.2	2 U	15	7.5	100
Magnesium	35,100	74,800	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	344	4,520	861	768	380	17,000	2,800	710	130	630	160	560	211	748	109	427	77.4	361	642	367	1700	359	136	113 B	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U	0.2 U	0.10 U/0.2 U [j]	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	0.06 U	-	-	-	-	-	-	-	2	2	10
Nickel	57.8	50.8	6.10 B/10 U [j]	4.2 B/10 U [j]	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	-	-	-	-	-	-	-	100	100	2000
Potassium	25,100	6,000 J [bq]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.4 U	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 U	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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	125,000	56,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2.0 U	0.66 /2 U [j]	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	2	20
Vanadium	20 U	58.1	2.9 B/10 U [j]	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	235	128	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	-	-	-	-	-	-	-	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.11	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	1.72	0.56 J [bq]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	MW07A	USEPA	Groundwater Standards	
Date Sampled =	5/16/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/24/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	54.9 /j [g]	58.7 /	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	59	39	0.5 MJ	18 DMQ	NS	1400	1400
RDX	554 /j [g]	600	1240	530	410	350	460	500	1,200	490	330	360	210E	150E	140	160 D	160	130	240	87	220	180	280	280	320	310	240	280	240	3.1 M	120 DQ	NS	84	84
1,3,5-Trinitrobenzene	0.26 /UJ [g]	0.26 U	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	0.6 U	0.68 J	0.21 U	0.17 J	NS	210	210
1,3-Dinitrobenzene	0.26 /UJ [g]	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	7.15 /J [g]	0.519 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.164 J/0.26 U [g]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	12.4	10.2	16	8.4	7.9	5.5 (u)	7.9	8.6	5.2	7.8	5.3	5.8	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	3.4	3.1	0.15 U	0.15 U	NS	5.6 [See	5.6 [See
2-Amino-4,6-dinitrotoluene	7.18	6.6	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	2.1	1.6	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [g]	0.26 U	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.52 U	0.519 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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.52 U	0.519 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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.52 UJ [g]	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	828 J [e]	4,690 NJ [g]	16800	738	8,400	1,300	310	970	970	20,000	22,000	1,300	760E	9290 N	483	4580	1860	573	1930	80900	1200	3240	21.6 J	846	2850	646 J+	162	2070	18 U	170	35 U	50 to 200 (c)	NS	NS
Antimony	6 UR [e]	4.5 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5 UR [e]	4.1 UJ [e]	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	18.1	13 U	24 U	24 U	12 U	12 U	4 U	12 UJ	18.9 J	4.7 J	10.2 JB	3 U	2 U	10	50	200
Barium	43.9	63.5	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4 U	0.42 B/3 U [g]	0.95 B/3 U [g]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	5 U	0.40 U/5 U [g]	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	-	-	-	-	-	-	-	5	5	50
Calcium	100,000	97,100	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	1.97 B/20 U [g]	18.8	29.2	1.0 B/5 U [g]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	1.68 B/5 U [g]	2.6 B/5 U [g]	8.8	1.7 B/5 U [g]	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	5.80 B/20 U [g]	6.2 BJ [g]	21.7	5.2 B/10 U [g]	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	-	-	-	-	-	-	-	1300	650	650
Iron	977	7,050 NJ [g]	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	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	3.0 U	2.4 B/10 U [g]	12.1	3.0 B/10 U [g]	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	2.1 J	2 U	4.3	4.1	15	7.5	100
Magnesium	62,900	62,900	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	218	226	461	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	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U	0.2 U	0.10 U/0.2 U [g]	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	-	-	-	-	-	-	-	2	2	10
Nickel	2.55 B/10 U [g]	14	26	1.8 B/10 U [g]	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	-	-	-	-	-	-	-	100	100	2000
Potassium	682 B/1000 U [g]	1,500 J [h]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.4 U	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 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	0.38	0.25	0.3 U	2 U	2 U	8 U	4 U	2 U	2 U	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	48,800	49,900	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	5.1 UR [e]	2.0 U	2.0 U	0.80 /2 U [g]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	1.58 B/20 U [g]	10.5	37.4	2.0 B/10 U [g]	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	13.1 B/40 U [e]	47.3 J [f]	82	11.6 B/20 U [g]	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	-	-	-	-	-	-	-	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***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Nitrite Nitrogen	0.1 J	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	2.2	1.94 J [g]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	MW07B	USEPA	Groundwater Standards	
Date Sampled =	5/16/2001	8/21/2001	11/14/2001	2/13/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/24/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.52 UJ [h]	0.519 U	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	0.6 U	0.46 J	0.26 MJ	0.21U	NS	1400	1400
RDX	0.52 UJ [h]	1.22	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	0.6 U	0.6 U	0.21 U	0.7 M	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [h]	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [h]	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.52 UJ [h]	0.519 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 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	0.6 U	1.8 P	2.7 MJ	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 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	2 U	0.6 U	0.6 U	0.24 U	0.6 UJ	0.6 U	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [h]	0.26 U	1.76 U [g]	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.52 U	0.519 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	0.8 U	2.3 JP	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.52 U	0.519 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	0.6 U	1.4 JP	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.52 UJ [h]	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	958 J [w]	18,800 NJ [w]	40600	1,900	3,600	200,000	35,000	510	300	190B	350	530	2,470E	2940 N	29000 D	1840	415	100	27600	2350	210 U	2420	31 J	18 U	42.2	28.6 UJ+	66	11.1 J	44.8	102	35 U	50 to 200 (c)	NS	NS
Antimony	6.0 UR [f]	4.5 U	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	15.0 BJ [w]	19.2 BJ [w]	4.1 U	9.0 B	82	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	14.5 J	12.2 JB	3 U	2 U	10	50	200
Barium	7.65 B/10 U [j]	478	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	1.8 B/3 U [j]	2.6	0.75 B/2 U [j]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	3.20 B/5 U [j]	1.1 B/5 U [j]	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	-	-	-	-	-	-	-	5	5	50
Calcium	50,900	206,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	5.34 B/20 U [j]	33.4	80.8	3.2 B/5 U [j]	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	2.08 B/20 U [j]	26.7	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	12.1 B/20 U [j]	24.1 J [q]	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	-	-	-	-	-	-	-	1300	650	650
Iron	2,500	53,000 NJ [w]	77,500	12,200	6,900	460,000	78,000	2,500	590	2,700	2,100	4,300	2,980	8,000	49900 D	1770	834	1990	81800	9570	410	7120	1720	264	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	2.57 B/10 U [j]	17.2 J [w]	36.7	5.2 B/10 U [j]	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	2 U	2 U	3 U	2 U	15	7.5	100
Magnesium	18,900	75,200	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	89.2	4,300	3350	1,910	840	9900	3,000	1,100	210	1,300	1,200	1,400	147	949	1280 ND	971	110	750	1820	763	89.1	643	264	26.7	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U	0.2 U	0.10 U/0.2 U [j]	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	-	-	-	-	-	-	-	2	2	10
Nickel	12	41.3	76.7	8.9 B/10 U [j]	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	-	-	-	-	-	-	-	100	100	2000
Potassium	2,890	5,300 J [q]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	321	3.4 U	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	106,000	54,600	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	4.5 U	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	-	-	-	-	-	-	-	2	2	20
Vanadium	20 U	15.0 BJ [w]	19.2 BJ [w]	4.1 U	9.0 B	561.3333333	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	100	135	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	-	-	-	-	-	-	-	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.81	0.33 J [q]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	MW08A	USEPA	Groundwater Standards	
Date Sampled =	5/16/2001	8/22/2001	11/15/2001	2/14/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	10/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/23/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.52 UJ [h]	0.519 U	0.519 U	0.52 UJ[f]	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	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.52 UJ [h]	0.519 U	0.519 U	0.32 J/0.52 UJ[f]	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	0.6 U	0.6 U	0.21 U	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [h]	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [h]	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.52 UJ [h]	0.519 U	0.519 U	0.52 UJ[f]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 U	0.874	0.26 UJ[f]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [h]	0.26 U	13.6	0.26 UJ[f]	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 U	0.26 U	0.26 UJ[f]	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.52 U	0.519 U	1.63	0.52 UJ[f]	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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.52 U	0.519 U	0.519 U	0.52 UJ[f]	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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.52 UJ [h]	0.519 U	1.17 U [o]	0.52 UJ[f]	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	0.6 U	0.6 U	0.26 JM	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	156 J [e]	1,460 J [e]	304 J [e]	12,200 NJ[ge]	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	894	18 U	66.8	35 U	50 to 200 (c)	NS	NS
Antimony	6.0 UR [f]	4.5 UNJ [s]	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.0 UR [f]	4.1 U	20 UJ (e)	5.5 B/20 UJ(j)	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	12 U	8.8 JB	2 U	2 U	10	50	200
Barium	24.6	33.4	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	4.0 U	0.20 U2 U	2 U	0.81 B/2 UJ[j]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	5.0 U	0.40 U3 U	3 U	0.40 U/3 UJ[j]	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	-	-	-	-	-	-	-	5	5	50
Calcium	144,000	147,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	20 U	9.5	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	5.0 U	1.1 B/5 UJ(j)	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	20 U	6.2 B/10 U [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	-	-	-	-	-	-	-	1300	650	650
Iron	174	2,540	354 J [e]	26,200.0	3,200	90,000	150B	920	63B	3,800	290	11,000	2,070	3,940	537	748 N	390	149	1890	7950 B	2070	1490	48.4 J	5170	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	3.0 U	2.0 B/10 U[j]	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	11.1	3.8 J	4 U	1.5 J	6.6	3.7 J	7 J	27.3	2 U	2 UM	3.6	2.7	15	7.5	100
Magnesium	77,300	75,700	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	59.9	195	108	449	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	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 U/0.2 U	0.2 U	0.1 U/0.2 UJ[j]	0.20 U	0.0998	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	-	-	-	-	-	-	-	2	2	10
Nickel	10 U	8.1 B/10 U[j]	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	-	-	-	-	-	-	-	100	100	2000
Potassium	600 B/1000 U (j)	989 NJ [e]	623	2,990 NJ[ge]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.5 BU [e]	20 U	3.4 U20 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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	59,400	60,700	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2 U	0.54 /2 U[j]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	20 U	3.0 B/20 U[j]	10 U20 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	-	-	-	-	-	-	-	NS	49	NS
Zinc	40 U	22.1	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	-	-	-	-	-	-	-	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***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.75	0.67 J [q]	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	MW08B	USEPA	Groundwater Standards	
Date Sampled =	5/16/2001	8/22/2001	11/15/2001	2/14/2002	2/26/2003	10/9/2003	5/27/2004	10/26/2004	5/10/2005	8/19/2005	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/23/2020	10/29/2020	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	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Explosives																																		
HMX	0.52 UJ [h]	0.519 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	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	0.6 U	0.6 U	0.21U	0.21U	NS	1400	1400
RDX	0.52 UJ [h]	0.519 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	0.6 U	0.6 U	0.45 MJ	0.21 U	NS	84	84
1,3,5-Trinitrobenzene	0.26 UJ [h]	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	210	210
1,3-Dinitrobenzene	0.26 UJ [h]	0.26 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	0.6 U	0.6 U	-	-	NS	0.7	0.7
Tetryl	0.52 UJ [h]	0.345 /0.519 U [ij]	0.266 J/0.519 U [ij]	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	0.6 U	0.6 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.26 U	0.26 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	0.6 U	0.6 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.15 U	0.15 U	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.26 UJ [h]	0.26 U	1.89 U [ss]	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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.26 U	0.26 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	0.6 U	0.6 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.52 U	0.519 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	0.8 U	0.8 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.52 U	0.519 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	0.6 U	0.6 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.52 UJ [h]	0.519 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	0.6 U	0.6 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																																		
Aluminum	12,600 J [w]	33,100 J [w]	5,290 J [ss]	7,530 NJ[gg]	2,900	36,000	31,000	240	230	310	320	1,100	804E	2,080	1370	287	407	511	280	571	255	369	68.9	51.7	47.5	40.7 UJ+	34.4 J	49.9	18 U	89.6	35 U	50 to 200 (c)	NS	NS
Antimony	6.0 UR (f)	4.5 BUJ [u]	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	-	-	-	-	-	-	-	6	6	24
Arsenic	5.34	18.7 B	20 UJ [w]	7.2 B/20 U[jj]	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	4.9 J	7.8 JB	2 U	5.8	10	50	200
Barium	231	288	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	-	-	-	-	-	-	-	2000	2000	2000
Beryllium	1.49 B/2 U [ij]	1.5 B/2 U[jj]	2 U	0.67 B/2 U[jj]	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	-	-	-	-	-	-	-	4	4	500
Cadmium	1.38 B/3 U [ij]	1.9 B/3 U[jj]	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	-	-	-	-	-	-	-	5	5	50
Calcium	257,000	187,000	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	-	-	-	-	-	-	-	NS	NS	NS
Chromium, total	19.8 B/20 U [ij]	57.9	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	-	-	-	-	-	-	-	100	100	1000
Cobalt	31.2	26.6	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	-	-	-	-	-	-	-	NS	1000	1000
Copper	16.9 B/10 U [ij]	40.2	9.90 B/10 U[jj]	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	-	-	-	-	-	-	-	1300	650	650
Iron	30,700	56,600	8,060 J [rr]	14,400.0	4,300	62,000	53,000	570	730	2,300	2,900	4,800	2,820	4,780	3290	2800 N	2940	5720	2390	5770 B	2170	3440	1610	661	-	-	-	-	-	-	-	300(c)	5000	5000
Lead	12.3	31.2	4.50 B/10 U [ij]	7.4 B/10 U[jj]	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	1.7 J	2 U	3.8	2 U	15	7.5	100
Magnesium	98,900	77,700	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	-	-	-	-	-	-	-	NS	NS	NS
Manganese	4,560	3,580	2,620	2,390	990	2200	2,100	1,700	420	2,200	710	2,100	823	1,340	661	1590	222	1260	815	1230	737	958	469	547	-	-	-	-	-	-	-	50(c)	150	10000
Mercury	0.2 U	0.10 B/0.2 U[jj]	0.2 U	1.0 U/0.2 U[jj]	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	-	-	-	-	-	-	-	2	2	10
Nickel	35.7	49.9	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	-	-	-	-	-	-	-	100	100	2000
Potassium	6,130	7,220 NJ [w]	3,880	4,260 NJ[gg]	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	-	-	-	-	-	-	-	NS	NS	NS
Selenium	5.0 U	3.4 U	20 U	3.4 U20 U[jj]	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	-	-	-	-	-	-	-	50	50	50
Silver	10 U	1.4 U	3 U	1.4 U/3 U[jj]	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	-	-	-	-	-	-	-	100(c)	50	NS
Sodium	119,000	78,000	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	-	-	-	-	-	-	-	NS	NS	NS
Thallium	2.0 U	2.0 U	2 U	0.30 /2 U[jj]	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	-	-	-	-	-	-	-	2	2	20
Vanadium	32	74.4	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	-	-	-	-	-	-	-	NS	49	NS
Zinc	119	139	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	-	-	-	-	-	-	-	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	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrite Nitrogen	0.1 U	0.1 U	0.1 U	0.1 U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	NS	NS
Nitrate + Nitrite	0.5	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	-	-	-	-	-	-	-	-	-	-	10	10	100

Form 4
Summary of Groundwater Results for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	MW09	USEPA	Groundwater Standards	
Date Sampled =	5/17/2006	10/17/2006	6/5/2007	10/10/2007	5/14/2008	10/16/2008	5/5/2009	10/20/2009	5/26/2010	10/26/2010	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	6/24/2020	10/28/2020	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	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	0.21U	0.21U	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	0.21 U	0.21 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	0.21 U	0.21 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	0.11 U	0.11 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	0.21 U	0.21 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	0.11 U	0.11 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	0.15 U	0.15 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	0.11 U	0.11 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	0.1 U	0.1 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	0.1 U	0.1 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	0.21 U	0.21 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	0.40 U	0.40 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	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered																								
Aluminum	1,800	790	12,800E	4,840	9540	616	6790	5630	Not Sampled	2520	7350	685	354	21700	7890	3970 J+	11900	1390	283	158	68.8	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	3 U	3 U	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	3.6	5.4	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	304	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	16.8	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	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.
M = Manual Integrated Compound
E = February and October 2003; and May 2004 analytical data were not validated.
Q = One or more quality control criteria failed.
K = Blank contamination: the analyte was detected above one-half the reporting limit in an associated blank.
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)

Form 5
Summary of Exceedances for COC-3
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

Sample ID =	MW04A	MW04A	MW05A	MW05A	MW07	MW07	USEPA	Groundwater Standards	
Date Sampled =	6/25/2020	10/27/2020	6/25/2020	10/28/2020	6/25/2020	10/27/2020	MCL	Class I	Class II
Analytes	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
Explosives									
HMX	0.21U	0.21U	0.21U	0.21U	0.21 U	0.21 U	NS	1400	1400
RDX	5.5 MJ	0.21 U	2.7 J	0.21 U	4.1 MJ	3.3 MJ	NS	84	84
1,3,5-Trinitrobenzene	2.8 MJ	1.8 MJ	0.91 J	0.8 J	0.21 U	0.84 J	NS	210	210
1,3-Dinitrobenzene	-	-	-	-	-	-	NS	0.7	0.7
Tetryl	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.44 J	0.37	0.11 U	0.11 U	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	0.15 U	20 MJK	0.15 U	0.15 U	0.15 U	8.0 JK	NS	2.7 [See	2.7 [See
2-Amino-4,6-dinitrotoluene	0.11 U	12 Q	0.11 U	5.8	0.11 U	2.5 MQ	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.41 U	0.41 U	0.76 MJ	0.41 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered									
Aluminum	158	345	228	35 U	222	52.5	50 to 200 (c)	NS	NS
Antimony	-		-	-	-	-	6	6	24
Arsenic	2.1 J	2 U	2.0 U	2.4	2 U	2 U	10	50	200
Barium	-		-	-	-	-	2000	2000	2000
Beryllium	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	4	4	500
Cadmium	1.3 J	1.5	15.4	19.9	13	24.6	5	5	50
Calcium	-		-	-	-	-	NS	NS	NS
Chromium, total	-		-	-	-	-	100	100	1000
Cobalt	-		-	-	-	-	NS	1000	1000
Copper	-		-	-	-	-	1300	650	650
Iron	40 U	317	40 U	40 U	40 U	40 U	300(c)	5000	5000
Lead	6.3	4.4	9.8	7.1	8.5	5.8	15	7.5	100
Magnesium	-		-	-	-	-	NS	NS	NS
Manganese	12.5	36.1	5450	6750	655	1470 J	50(c)	150	10000
Mercury	-		-	-	-	-	2	2	10
Nickel	-	10 U	600	765	15	59.6	100	100	2000
Potassium	-		-	-	-	-	NS	NS	NS
Selenium	-		-	-	-	-	50	50	50
Silver	-		-	-	-	-	100(c)	50	NS
Sodium	-		-	-	-	-	NS	NS	NS
Thallium	4 U	4 U	4 U	4 U	4 U	4 U	2	2	20
Vanadium	3 U	3 U	3 U	3 U	3 U	3 U	NS	49	NS
Zinc	15	7.3	724	903	191	291	5000(c)	5000	10000
Indicators	***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	-	-	-	-	-	-	10	10	100

Form 5
Summary of Exceedances for COP-4
Long-Term Groundwater Monitoring Report
Crab Orchard National Wildlife Refuge, Marion, Illinois

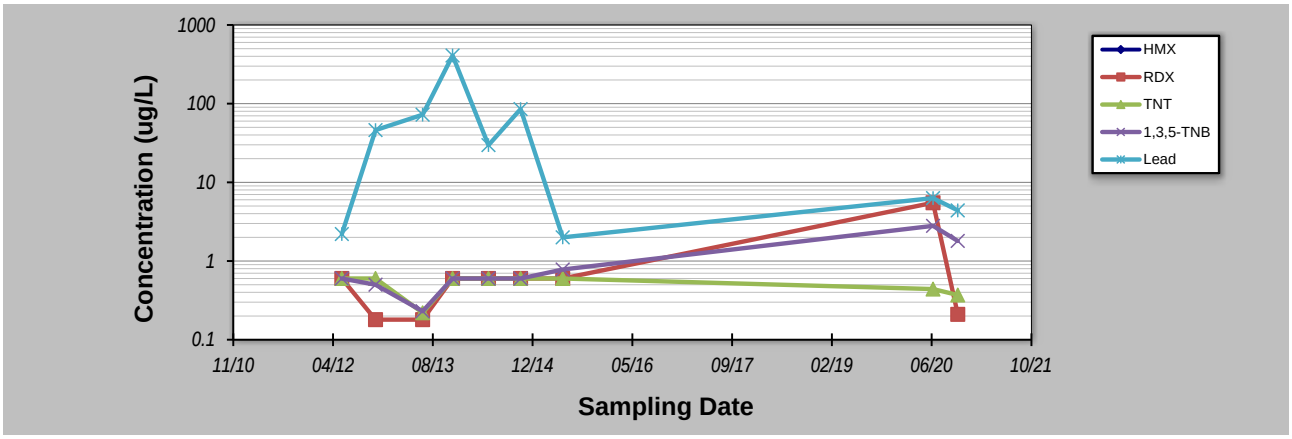
Sample ID =	MW06A	MW06A	MW07A	MW07A	USEPA	Groundwater Standards	
Date Sampled =	6/23/2020	10/29/2020	6/24/2020	10/29/2020	MCL	Class I	Class II
Analytes	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*	*ug/L*
Explosives							
HMX	390 DMQ	130 DQ	0.5 MJ	18 DMQ	NS	1400	1400
RDX	450 DMQ	610 DMQ	3.1 M	120 DQ	NS	84	84
1,3,5-Trinitrobenzene	63 QD	130 DQ	0.21 U	0.17 J	NS	210	210
1,3-Dinitrobenzene	-	-	-	-	NS	0.7	0.7
Tetryl	0.11 U	0.11 U	0.11 U	0.11 U	NS	NS	NS
Nitrobenzene	0.21 U	0.21 U	0.21 U	0.21 U	NS	3.5	3.5
2,4,6-Trinitrotoluene	0.914 MJ	0.61 MQ	0.11 U	0.11 U	NS	1.4	1.4
4-Amino-2,6-dinitrotoluene	10 M	23 J	0.15 U	0.15 U	NS	5.6 [See	5.6 [See
2-Amino-4,6-dinitrotoluene	11 M	0.11 U	0.11 U	0.11 U	NS	Note (u)]	Note (u)]
2, 4-Dinitrotoluene	0.1 U	0.1 U	0.1 U	0.1 U	NS	0.02 (a)	0.02 (a)
2, 6-Dinitrotoluene	0.1 U	0.1 U	0.1 U	0.1 U	NS	0.31	0.31
2-Nitrotoluene (o-nitrotoluene)	0.21 U	0.21 U	0.21 U	0.21 U	NS	70	70
3-Nitrotoluene (m-nitrotoluene)	0.40 U	0.40 U	0.40 U	0.40 U	NS	70	70
4-Nitrotoluene (p-nitrotoluene)	0.41 U	0.41 U	0.41 U	0.41 U	NS	70	70
Metals - Unfiltered							
Aluminum	91.3	35 U	170	35 U	50 to 200 (c)	NS	NS
Antimony	-	-	-	-	6	6	24
Arsenic	2 U	2 U	3 U	2 U	10	50	200
Barium	-	-	-	-	2000	2000	2000
Beryllium	-	-	-	-	4	4	500
Cadmium	-	-	-	-	5	5	50
Calcium	-	-	-	-	NS	NS	NS
Chromium, total	-	-	-	-	100	100	1000
Cobalt	-	-	-	-	NS	1000	1000
Copper	-	-	-	-	1300	650	650
Iron	-	-	-	-	300(c)	5000	5000
Lead	4.3	4	4.3	4.1	15	7.5	100
Magnesium	-	-	-	-	NS	NS	NS
Manganese	-	-	-	-	50(c)	150	10000
Mercury	-	-	-	-	2	2	10
Nickel	-	-	-	-	100	100	2000
Potassium	-	-	-	-	NS	NS	NS
Selenium	-	-	-	-	50	50	50
Silver	-	-	-	-	100(c)	50	NS
Sodium	-	-	-	-	NS	NS	NS
Thallium	-	-	-	-	2	2	20
Vanadium	-	-	-	-	NS	49	NS
Zinc	-	-	-	-	5000(c)	5000	10000
Indicators	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Nitrite Nitrogen	-	-	-	-	1	NS	NS
Nitrate + Nitrite	-	-	-	-	10	10	100

FORM 6: MANN-KENDALL TREND ANALYSIS FOR SELECTED WELLS AT EMMA OU

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	2-Mar-21	Job ID:	COC-3 MW04A
Facility Name:	Crab Orchard EMMA OU	Constituent:	Explosives / Metals
Conducted By:	William Clabaugh	Concentration Units:	ug/L

Sampling Point ID:		HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event	Sampling Date	EXPLOSIVES / METALS CONCENTRATION (ug/L)						
1	15-May-12		0.6	0.6	0.6	2.2	3.6	9.3
2	31-Oct-12		0.18	0.6	0.5	46.1	4.9	13
3	24-Jun-13		0.18	0.22	0.23	72.4	2.4	8.2
4	21-Nov-13		0.6	0.6	0.6	409	3.8	9.3
5	20-May-14		0.6	0.6	0.6	29.7	1.3	3.3
6	28-Oct-14		0.6	0.6	0.6	85.3	5.8	11
7	27-May-15		0.6	0.6	0.78	2	4.7	8.6
8	25-Jun-20		5.5	0.44	2.8	6.3	0.15	0.11
9	27-Oct-20		0.21	0.37	1.8	4.4	20	12
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:			1.68	0.27	0.87	1.78	1.13	0.50
Mann-Kendall Statistic (S):			9	-9	22	-6	4	-5
Confidence Factor:			79.2%	79.2%	98.8%	69.4%	61.9%	65.7%
Concentration Trend:			No Trend	Stable	Increasing	No Trend	No Trend	Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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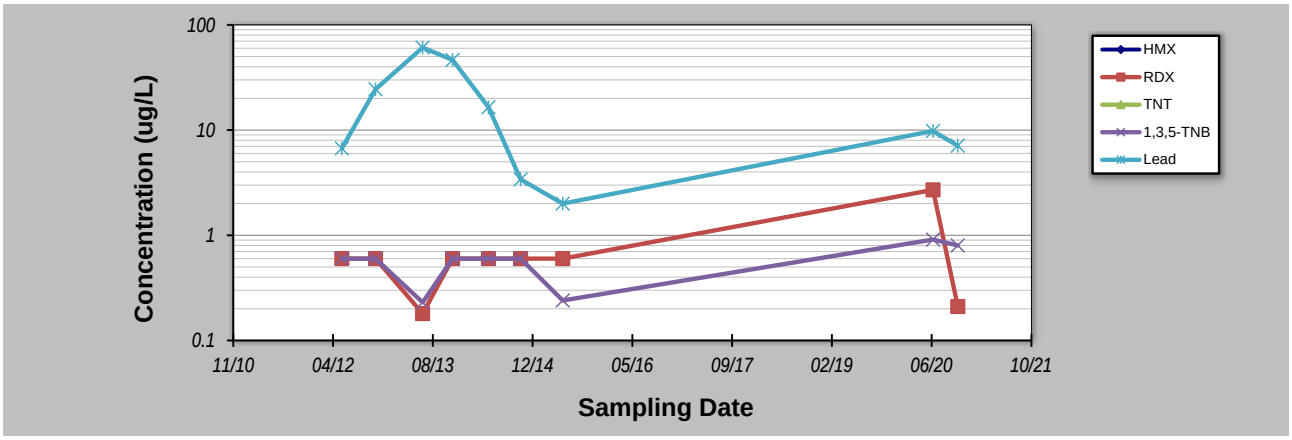
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	2-Mar-21	Job ID:	COC-3 MW05A
Facility Name:	Crab Orchard EMMA OU	Constituent:	Explosives / Metals
Conducted By:	William Clabaugh	Concentration Units:	ug/L

Sampling Point ID:		HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event	Sampling Date	EXPLOSIVES / METALS CONCENTRATION (ug/L)						
1	15-May-12		0.6		0.6	6.7	2.4	7.1
2	31-Oct-12		0.6		0.6	24.4	2.3	7.5
3	24-Jun-13		0.18		0.23	60.8	0.58	2.6
4	21-Nov-13		0.6		0.6	46.4	2.3	6.4
5	20-May-14		0.6		0.6	16.5	0.88	4
6	28-Oct-14		0.6		0.6	3.4	2.2	5.6
7	27-May-15		0.6		0.24	2	2.5	6
8	25-Jun-20		2.7		0.91	9.8	0.15	0.11
9	27-Oct-20		0.21		0.8	7.1	0.15	5.8
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:			1.01		0.39	1.05	0.69	0.47
Mann-Kendall Statistic (S):			3		10	-12	-14	-12
Confidence Factor:			58.0%		82.1%	87.0%	91.0%	87.0%
Concentration Trend:			No Trend		No Trend	No Trend	Prob. Decreasing	Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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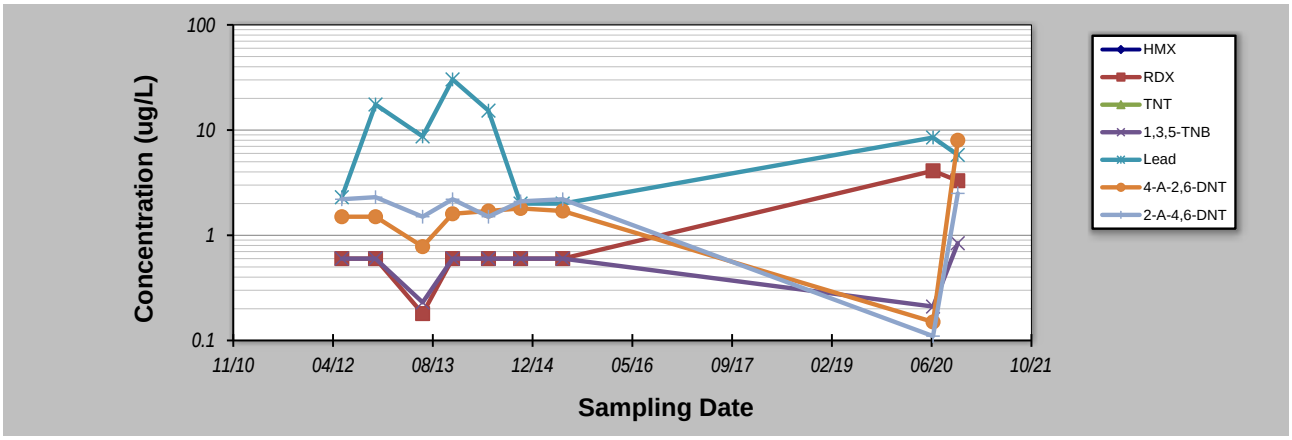
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	2-Mar-21	Job ID:	COC-3 MW07
Facility Name:	Crab Orchard EMMA OU	Constituent:	Explosives / Metals
Conducted By:	William Clabaugh	Concentration Units:	ug/L

Sampling Point ID:		HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event	Sampling Date	EXPLOSIVES / METALS CONCENTRATION (ug/L)						
1	15-May-12		0.6		0.6	2.3	1.5	2.2
2	31-Oct-12		0.6		0.6	17.5	1.5	2.3
3	24-Jun-13		0.18		0.23	8.7	0.78	1.5
4	21-Nov-13		0.6		0.6	30.3	1.6	2.2
5	20-May-14		0.6		0.6	15.3	1.7	1.5
6	28-Oct-14		0.6		0.6	2	1.8	2.1
7	27-May-15		0.6		0.6	2	1.7	2.2
8	25-Jun-20		4.1		0.21	8.5	0.15	0.11
9	27-Oct-20		3.3		0.84	5.8	8	2.5
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:			1.14		0.37	0.91	1.10	0.40
Mann-Kendall Statistic (S):			15		3	-9	14	-2
Confidence Factor:			92.5%		58.0%	79.2%	91.0%	54.0%
Concentration Trend:			Prob. Increasing		No Trend	Stable	Prob. Increasing	Stable



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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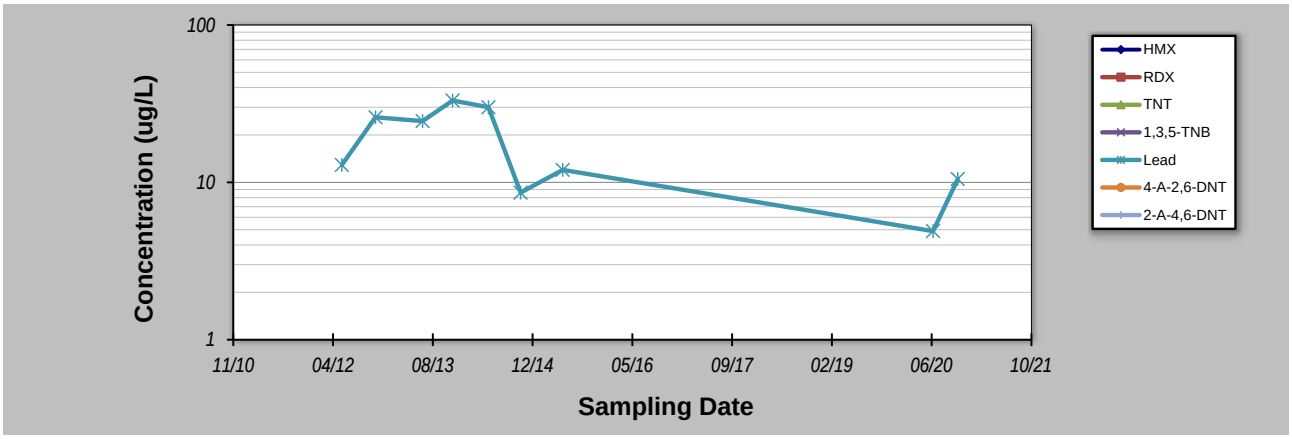
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	10-May-21	Job ID:	COC-3 MW09
Facility Name:	Crab Orchard EMMA OU	Constituent:	Metals
Conducted By:	William Clabaugh	Concentration Units:	ug/L

Sampling Point ID:	HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event / Sampling Date	METALS CONCENTRATION (ug/L)						
1 / 15-May-12					12.9		
2 / 31-Oct-12					25.9		
3 / 24-Jun-13					24.5		
4 / 21-Nov-13					33.1		
5 / 20-May-14					30		
6 / 28-Oct-14					8.6		
7 / 27-May-15					12		
8 / 25-Jun-20					4.9		
9 / 27-Oct-20					10.5		
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
Coefficient of Variation:					0.57		
Mann-Kendall Statistic (S):					-14		
Confidence Factor:					91.0%		
Concentration Trend:					Prob. Decreasing		



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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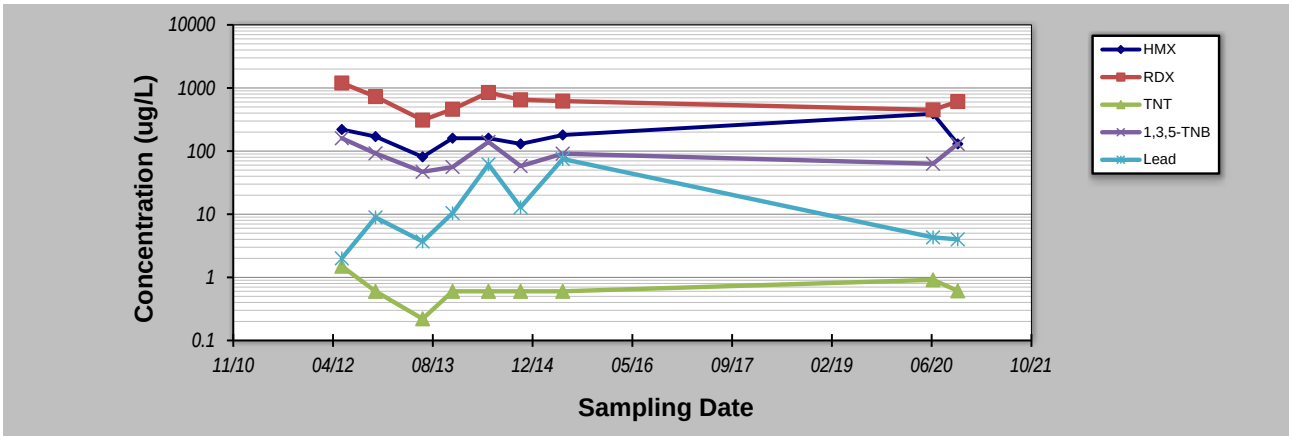
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **2-Mar-21**
Facility Name: **Crab Orchard EMMA OU**
Conducted By: **William Clabaugh**

Job ID: **COP-4 MW06A**
Constituent: **Explosives / Metals**
Concentration Units: **ug/L**

Sampling Point ID:		HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event	Sampling Date	EXPLOSIVES / METALS CONCENTRATION (ug/L)						
1	15-May-12	220	1200	1.5	160	2	14	18
2	31-Oct-12	170	730	0.6	92	8.9	14	18
3	24-Jun-13	81	310	0.22	47	3.7	4	7.4
4	21-Nov-13	160	460	0.6	56	10.4	2.3	12
5	20-May-14	160	850	0.6	140	61.6	12	13
6	28-Oct-14	130	650	0.6	58	12.9	11	12
7	27-May-15	180	620	0.6	91	75	13	9.9
8	25-Jun-20	390	450	0.914	63	4.3	10	11
9	27-Oct-20	130	610	0.61	130	4	23	0.11
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.49	0.40	0.50	0.44	1.36	0.53	0.48
Mann-Kendall Statistic (S):		-2	-12	6	0	10	1	-20
Confidence Factor:		54.0%	87.0%	69.4%	46.0%	82.1%	50.0%	97.8%
Concentration Trend:		Stable	Stable	No Trend	Stable	No Trend	No Trend	Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

DISCLAIMER: The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.

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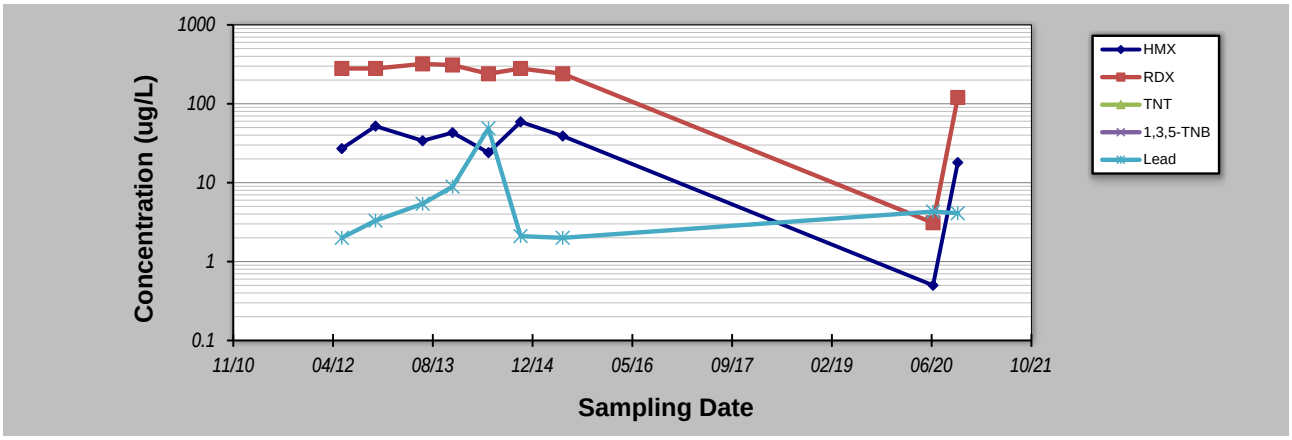
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	2-Mar-21	Job ID:	COP-4 MW07A
Facility Name:	Crab Orchard EMMA OU	Constituent:	Explosives / Metals
Conducted By:	William Clabaugh	Concentration Units:	ug/L

Sampling Point ID:		HMX	RDX	TNT	1,3,5-TNB	Lead	4-A-2,6-DNT	2-A-4,6-DNT
Sampling Event	Sampling Date	EXPLOSIVES / METALS CONCENTRATION (ug/L)						
1	15-May-12	27	280			2	2.4	1.7
2	31-Oct-12	52	280			3.3	3.2	2.5
3	24-Jun-13	34	320			5.4	1.8	0.24
4	21-Nov-13	43	310			8.9	4.4	3.6
5	20-May-14	24	240			48.9	2.1	1.5
6	28-Oct-14	59	280			2.1	3.4	2.1
7	27-May-15	39	240			2	3.1	1.6
8	25-Jun-20	0.5	3.1			4.3	0.15	0.11
9	27-Oct-20	18	120			4.1	0.15	0.11
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.54	0.45			1.68	0.63	0.79
Mann-Kendall Statistic (S):		-10	-20			3	-11	-15
Confidence Factor:		82.1%	97.8%			58.0%	84.6%	92.5%
Concentration Trend:		Stable	Decreasing			No Trend	Stable	Prob. Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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PHOTOGRAPH 1
COC-3 Monitoring Well -03A and Cap, Looking West

PHOTOGRAPH 2
COC- 3 Monitoring Well - 06

PHOTOGRAPH 3
COC- 3 Monitoring Wells – 04A and 04B

PHOTOGRAPH 4
COC- 3 Monitoring Wells 05A and 05B

PHOTOGRAPH 5
COC- 3 Monitoring Well - 07

PHOTOGRAPH 6
COC- 3 Monitoring Well – 08

PHOTOGRAPH 7
COC- 3 Monitoring Well - 09

PHOTOGRAPH 8
COC- 3 Monitoring Well – 10

PHOTOGRAPH 9
Looking North Across Cap

PHOTOGRAPH 10
Drainage Area North of Cap

PHOTOGRAPH 11
Looking Southwest Across Cap

PHOTOGRAPH 12
Access Control for COC3

PHOTOGRAPH 1
COP-4 Monitoring Well - 2R

PHOTOGRAPH 2
COP-4 Monitoring Well 05A and 05B

PHOTOGRAPH 3
COP-4 Monitoring Well 06A and 06B

PHOTOGRAPH 4
COP-4 Monitoring Wells 07A and 07B

PHOTOGRAPH 5
COP-4 Monitoring Wells 08A and 08B

PHOTOGRAPH 6
COP-4 Monitoring Well – 09

PHOTOGRAPH 7
Looking South Across Cap

PHOTOGRAPH 8
Looking West Across Cap

PHOTOGRAPH 9
Access Control to COP4

PHOTOGRAPH 10
Restricted Entry Signage near COP4

TECHNICAL MEMO TO PROJECT RECORD – MARCH 23, 2016 (REVISED 22 MARCH 2021)
CRAB ORCHARD LAKE – AREA COC-3 TOXICITY AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) ANALYSIS
PREPARED BY DR. DAVID BRANCATO; REVISION BY WILLIAM CLABAUGH (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. The change in monitoring frequency is a minor change that does not alter the scope or performance of the remedy and does not significantly change the cost of the remedial action. In accordance with 40 CFR 300.435(c)(2) and EPA guidance (OSWER 9200.1-23P) an Explanation of Significant Differences is not required for this change.

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 respective to the Ill EPA GW criteria. However, in groundwater monitoring wells MW-06A and MW-07A for COP-4 there are exceedances for RDX and 1,3, 5-TNB above Ill EPA Class I and Class II 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, noting their respective groundwater criteria have remained constant from the time of post-remedy groundwater measurements to current (see table, below).

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 COP-4, along with the restricted access removes any concern of soil vapor, recognizing that that the Henry Law constant for RDX, aminodinitrotoluene(s), 2,4- and 2,6-dinitrotoluenes, and lead would preclude volatilization through the soil pores..

With no recharge of constituents from soil to groundwater and groundwater not connecting to the surface it is determined that the remedy remains effective.

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

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-2829
BRUCE RAUNER, GOVERNOR LISA BONNETT, DIRECTOR

217.785.7728

February 1, 2016

U.S. Army Engineer District
Louisville district Corps of Engineers
CELRL-ED-E-C (Mr. Quyet La, Room 351)
P.O. Box 59
Louisville, KY 40201-0059

Re: Long Term Monitoring Report, May 2015 Survey, Sites COC-3 and COP-4

1998620014 – Williamson Co.
Crab Orchard/EMMA OU
Superfund/Technical Reports

Dear Mr. La:

The Illinois Environmental Protection Agency is in receipt of the *Draft Long Term Groundwater Monitoring (LTM) Report, May 2015 Survey*, submitted for Sites Crab Orchard Cemetery (COC)-3 and Crab Orchard Plant (COP)-4 of the Explosives/Munitions Manufacturing Area (EMMA) Operable Unit (OU) at the Crab Orchard National Wildlife Refuge Superfund Site near Marion, IL. The May 2015 LTM Report was received on November 4, 2015.

The May 2015 groundwater sampling results for both COC-3 and COP-4 are similar to previous groundwater results dating back to 2004 when low-flow sampling was first used at these sites. At COC-3, explosive compounds were detected in three out of the ten wells sampled (MW-04A, MW-05A, MW07). Total ADNT (combined concentration of 4-amino-2,6-dintirotoluene (4-a-2,6-DNT) and 2-amino-4,6-dinitrotoluene (2-a-4,6-DNT)) exceeded its standard in each of the three wells with the maximum being 13.3 µg/L in well MW-04A. All eleven metals tested at COC-3 were detected at concentrations greater than at least one of their respective Illinois groundwater standards or U.S. EPA Maximum Contaminant Levels (MCLs). Ten of the eleven metals measured in filtered COC-3 samples exceeded their groundwater standards, but the unfiltered samples generally showed decreased inorganic concentrations as compared to the unfiltered samples. Down-gradient COC-3 wells displayed statistically significant higher aluminum, arsenic, beryllium, cadmium, iron, lead, manganese, nickel, vanadium, thallium, and zinc.

At COP-4, three explosive compounds were found above their Illinois groundwater quality standards in two wells (MW-06A and MW-07A). The highest concentrations were found in COP-4 well MW-06A: RDX (cyclotrimethylenetrinitramine) at 620 µg/L; ADNTs at 22.9 µg/L. RDX was also present in COP-4 well MW-07A at 280 µg/L. Overall, four out of the ten COP-4 wells evidenced two or more

explosives constituents (RDX, ADNTs and/or HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)). Groundwater from nine out of ten COP-4 wells sampled had inorganic concentrations greater than the respective groundwater standard for at least one metal. Aluminum, arsenic and lead were the inorganics found above their groundwater quality standards and at statistically significant higher down-gradient concentrations.

The LTM Report recommends continued collection of filtered and unfiltered groundwater samples at Sites COC-3 and COP-4, but at a greatly reduced frequency. Instead of semi-annual groundwater sampling, the LTM Report requests groundwater sampling be done only once every five years in conjunction with the statutorily required 5-Year Review for COC-3 and COP-4. Twenty-nine sampling events have been completed since May 2001 at both COC-3 and COP-4. The analytical results of explosives and metals have been relatively stable over time. No evidence of plume expansion has been observed. Reducing the frequency of groundwater sampling should not affect the integrity of the information gathered for these two sites.

Illinois EPA concurs with the request to reduce the groundwater sampling frequency. Soils containing nitroaromatic compounds up to 100,000 mg/kg were left in the ground at COC-3 and COP-4. Routine inspections aimed at maintaining the integrity of the 24-inch thick soil covers on these sites are required by the EMMA OU Record of Decision and should continue.

Should you have any question or require further assistance concerning this letter, do not hesitate to contact me at the number above or by e-mail at Paul.Lake@illinois.gov.

Sincerely,

Paul T. Lake, Remedial Project Manager
Federal Site Remediation Section
Bureau of Land

PTL:cah:rac:h:\site files\CONWR\EMMAOU\LTM Reports\160201 – May 2015 LTM Rpt apr.doc

cc: Mike Coffey, USFWS
Nanjunda Gowda, USEPA
Valerie Doss, USACE

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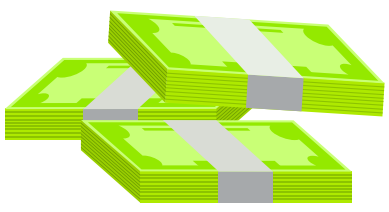

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Send resume to: info@dxrgroup.com

JOURNEYMAN LINEMAN POSITION:

Job Opportunity: SouthEastern Illinois Electric Cooperative, Inc. is now accepting applications for the position of Journeyman Lineman at the Shawnee Hills Headquarter in Golconda, IL. Position is responsible for the construction and maintenance of overhead and underground distribution lines. Applicant must have knowledge in working with energized equipment up to 12 kV and maintaining 69 kV lines. Job requirements are, but not limited to the following:

- A high school diploma or equivalent, completion of a 4-year certified apprenticeship program, proof of certification, advanced training is preferred.
- Candidate must demonstrate skill in pole and tower climbing, splicing wires, using hotline tools and working in aerial devices.
- Ability to interpret electrical plans and prints.
- Possess a Class A Commercial Drivers License.
- Candidate will be required to live within a 25-mile radius of the principle place of work.

The Cooperative offers an excellent benefits package with competitive wages. Applications are available on our web site at www.seiec.com or at our Carrier Mills location. Please submit application and resume to: SEIEC, Human Resource Manager, P.O. Box 1001, Carrier Mills, IL 62917 by Friday, November 13, 2020. An Equal Opportunity Employer.

The Cobden Police Department
is seeking a Police Officer. Submit application to Village of Cobden, 112 East Maple Street, P O Box 218, Cobden, IL 62920 or email cobdenvillage@gmail.com. Call 618-893-2425 for information.

The Southern Illinoisan is seeking a Full Time Classified Advertising Sales Rep

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We are looking for dependable people that know their way around a computer, have a good phone presence, are detail oriented and take pride in their work. Previous sales and customer service experience a plus.

Position pays hourly wage plus commission and will work Monday through Friday business hours.

We offer a competitive benefits package, including medical, dental, vision and life insurance, short and long term disability, 401k retirement plan and paid time off.

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LAND & ACREAGE

FOR SALE: 2 side by side grave sites in Pleasant Groves Memorial Park. (Off old Rt. 13). In old section of cementary where tombstones can still be placed. Please call 618-521-0641.

APARTMENTS

HERRIN: 1115 N. Park. 1 or 2 bedroom, 1 bath. Rent starting as low as $400/mo + dep. No pets please. Available Now! Call 618-303-5723

MURPHYSBORO Apartment for rent. 2431 New Era Rd. Available now!! $490/month plus $490 deposit 1 bd room, no pets (618)303-5723

HOUSES

CARBONDALE AREA: 2 bd. c/a, large living room, carport, sm. shed. large yard and deck, quiet area, no pets, lease and references $325 /mo. 618 319-0642.

Carbondale- 517 E. Fisher. 3bdrm, 1 bath, spacious home, central air, large lawn, new stove and refrigerator included. Very quiet neighborhood, nice for families. Please call 773-428-7009.

YARD & RUMMAGE SALES

CARBONDALE- 1413 Dogwood Rd. Nov 6 & 7, 9-4pm. Huge downsizing business sale. Tons of JEWELRY,antiques,art glass,art pottery,vintage lighting,old S&P shakers,sugar & creamer sets. Great sale for collectors, setting up house!

CARBONDALE- 806 W. Pecan-Sat. 11/7-8am -? Antiques,collectibles,books,puzzles,furniture, lots of old stuff, toys, clothes. Too much to list!

CARTERVILLE- 2 family yard sale! 715 Pear St. 8 am to 4, Fri. & Sat. lots of baby furniture, baby items, rustic Christmas crafts, all ages and sizes of name brand clothing and shoes for children , Barbie Doll House, Journey Dolls, Household decor, books, Too much to mention!

CHRISTMAS OPEN HOUSE.
PRIMITIVES AT THE CABIN- Lamaster Rd, Marion.11/6 & 11/7, 9am to 5pm. . Antiques, Collectable's, Furniture, Vintage clothing, farmhouse, vintage, lace. Primitive Christmas, cash & carry, please wear mask.

COBDEN, Annual Christmas Shop, 117 S. Appleknocker. Weekends Nov. 7 through Dec. 19, Sat. 9-4, Sun 1-4. Trees, wreaths, nativities, Willow Tree, lights, Santas,Vintage, Historical Society 893-2865/893-2567

Energy 112b McVicker Friday Nov.6 and Saturday Nov.7 8 am till 2 pm Winter clothing,household items,Christmas, Snowbabies,Possible Dreams Santas and much more.

ENERGY FIRST BAPTIST CHURCH
Corner of Rt. 148 & College St.

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THURS. 11/5, FRI. 11/6, AND SAT. 11/7
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MARION, 3 family Yard Sale! 617 N. Saluki Dr.(Behind Westernaire)Thurs- Noon to 5, Fri. 7-5, Sat 7-5.Women's/men's/coats/clothes. girls jeans, exercise trampoline, shoes, cookbooks, reg. books, wooden desk, & TV stand.

Murphysboro, 253 Cinnamon Ln,Everything must go. Sat. & Sun. 9-? gardening supplies and plants, Furniture, clothing SM to XL, Household items, paint,electronics, collectables,lots of misc.

SPORTING GOODS

Elk and Mule Deer Mounts, Striped Bass, Musky, White Tails, etc. $175 up. 618-319-0642

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Murphysboro- Wooden Book Case, $100, TV Stand- Honey color, $100, Light weight vacuum cleaner, $50, Samsung Phones- Note 3 & Note 5, $100 a piece. Please text 618-201-4478 for more information.

New full size bed, box spring & frame. Carbondale pickup only. $300 618-534-0081

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ENGLISH SHEPARD/PYRENEES mix puppies. Beautiful, fluffy & very loving. $35. Message or call 618-713-6146

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LEGALS

Board of Education
Herrin Community Unit School District No. 4
Notice of Public Hearing
November 19, 2020
Notice is Hereby Given that the President of the Board of Education of Herrin Community Unit School District No. 4, Williamson, Franklin, and Jackson Counties, Illinois has called a Public Hearing on Thursday, November 19, 2020 at 5:00 p.m., in the Unit Office Conference Room, 500 North Tenth Street, Herrin, Illinois.
The purpose of the Public Hearing will be pertaining to E-Learning use in lieu of emergency days.
Dave Loucks, President
Board of Education
Herrin Community Unit School District No. 4

DATE: November 5, 2020
POSTED: Herrin Community Unit School District No. 4
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HEA President
18120 11/7

EPA Begins Review of the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund Site
Carterville, Illinois

U. S. Environmental Protection Agency is conducting a five-year review of the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund site located east of state route 148 in Carterville, Illinois. The Superfund law requires regular checkups of sites that have been cleaned up – with waste managed on-site – to make sure the cleanup continues to protect people and the environment. This is the sixth five-year review of this site.

Cleanup and ongoing maintenance at the Sangamo Electric Dump/Crab Orchard National Wildlife Refuge Superfund site have been performed under EPA oversight by the legally responsible parties, consisting of the U.S. Dept. of Defense, U.S. Dept. of the Interior, and private parties.

Cleanup has been divided into distinct areas, called Operable Units (OUs), due to the complexity of the site. The focus of this five-year review is on those OUs where waste has been left in-place above levels permissible for unrestricted use/unlimited exposure, which are OU1, OU2, OU3, OU4, and OU5.

More information is available at the EPA Records Center, Metcalfe Federal Building Seventh Floor, EPA Region 5, 77 W. Jackson Blvd., Chicago, Ill.; and online at www.epa.gov/superfund/sangamo-dump-craborchard. The review should be completed by June 30, 2021.

This is an opportunity for you to tell EPA about site conditions and any concerns you have.

Contact:
Viral Patel
Remedial Project Manager
312-886-6943
patel.viral@epa.gov

Cheryl Allen
Community Involvement Coordinator
312-353-6196
allen.cheryl@epa.gov

You may also call EPA toll-free, 800-621-8431, 8:30 a.m. to 4:30 p.m., weekdays.
17324 10/24, 10/31, 11/7

IN THE CIRCUIT COURT FOR THE FIRST JUDICIAL CIRCUIT
JACKSON COUNTY, ILLINOIS
In the Matter of the Estate of:
GILLIAN G. HARRISON
Deceased.
2020-P-71
NOTICE FOR CLAIMS
NOTICE is given of the death of GILLIAN G. HARRISON. Letters of Office were issued on September 18, 2020, to James Chapman, 1127 W. Walkup Avenue, Carbondale, IL 62901, as Administrator, and whose attorney is Tiffanny Sievers at SI Elder Law LLC, 201 West Main, Marion, Illinois 62959.
Claims against the estate may be filed in the office of the Circuit Clerk at the Jackson County Court House, Murphysboro, Illinois, or with the representative, or both, on or before April 24, 2021, which date shall not be less than 6 months from the date of the first publication. Any claims not filed on or before that date are barred. Copies of a claim filed with the clerk must be mailed or delivered to the representative and to the attorney within 10 days after it has been filed.
/s/ Tiffanny H. Sievers
Attorney at Law
SI Elder Law, LLC
17784 10/24, 10/31, 11/7

INVITATION TO BID
Crab Orchard CUSD #3 will receive sealed bids for the purpose of selling a 2010 Honda Civic DX VP, Blue 4 door sedan, mileage 57,077. Vehicle may be inspected by contacting the school at 618-982-2181 ext. 1221 and requesting a time to inspect. Please submit your sealed bid to: Derek Hutchins, Superintendent, Crab Orchard CUSD #3, 19189 Cory Bailey Street, Marion, IL 62959, by noon, Monday, November 16, 2020. Crab Orchard CUSD #3 reserves to right to reject any and all bids.
18134 11/7

INVITATION TO BID
HVAC UPGRADES IN C & F AND ADMISSIONS RENOVATION
JOHN A. LOGAN COLLEGE
700 LOGAN COLLEGE ROAD
CARTERVILLE, ILLINOIS
JOHN A. LOGAN COLLEGE, CARTERVILLE, ILLINOIS issues the following Invitation to Bidders desiring to submit proposals for work at the above titled projects.
Sealed bids will be received from General Contractors for a combined GENERAL WORK package;
at 2:00pm on Tuesday November 17, 2020 in the Administration Building "A" Conference Room, John A. Logan College, Carterville, Illinois.
Pre-Bid Meeting: A pre-bid meeting will be held on Tuesday, November 10, 2020 at 2:00pm. The meeting will be held at the project site, in the Administration Building "A" Conference Room and will then proceed to the project location.
Immediately after closing time for receiving bids, they will be publicly opened, read aloud and taken under advisement. The Owner reserves the right to reject any and all bids or any part thereof, to waive any informality in bidding and to accept bids deemed most favorable to the Owner.
DESCRIPTION OF WORK
Work consists of removing existing, original AHUs in C and F buildings and replacing them with new high efficiency units that meet current Illinois Energy Code. Renovation of the existing 2,000 square foot Admissions office will include demolition of existing walls and finishes to construct new offices, conference and break rooms. New work will consist of construction of new walls, ceilings, electrical and finishes. Also included in the project is installing new flooring and ceiling grid and tile in portions of C Building where the existing was removed under a previous contract. All walls shall be repainted and vinyl wall coverings shall be removed. Reinstallation of existing lighting and mechanical diffusers into new ceilings is also included.
Drawings, Specifications, and Addenda will be shared free online through "Drop Box". Contact the office of Architechniques, Ltd and provide one (1) email per company to receive instructions on this free sharing service. Contractors obtaining drawings through this service will only be updated through this service and will not appear on the plan holders list. The drawings provided will not be stamped, and will include a disclaimer. This sharing service is provided free and for the convenience of the sub-contractors and vendors. The Architect and Engineers have no control over the software used to distribute and view the images and will therefore not include their seals on those documents.
Bid Security in amount and form specified in the INSTRUCTIONS TO BIDDERS will be required to be submitted with each bid. Bids may not be withdrawn until 30 days after the bid date and time.
Successful bidders shall be required to observe 820 ILCS 130/0.01 et. Seq., pertaining to wages and known as the "Prevailing Wage Act" as issued by the Illinois Department of Labor. Successful bidders shall also observe 30 ILCS 560 /0.01 et. Seq., pertaining to hiring Illinois labor and known as the "Public Work Preference Act". Furthermore, successful bidders shall observe the "Illinois Human Rights Act, as Amended", 775 ILCS 5 /1-101et. Seq., and the Rules and Regulations, Title 44, Section 750 of the Illinois Administrative Code, Illinois Department of Human Rights.
Successful bidders and their subcontractors shall be required to enter a project labor agreement with the Egyptian Building & Construction Trades Council.
The successful bidders and subcontractors shall comply with the Illinois Procurement Code, 30 ILCS 500/30-22, to determine their need for Apprenticeship and Training Program requirement as defined in Project Manual section 00 21 13 – INSTRUCTIONS TO BIDDERS.
The successful bidders and subcontractors shall comply with the Illinois Procurement Code, 30 ILCS 575/1, to endeavor to meet a goal of 20% of the total amount of the construction contract to be awarded to minority-owned (goal of 11%), female owned (goal of 7%), and persons with disabilities owned (2%) businesses.
BOARD OF TRUSTEES
JOHN A. LOGAN COLLEGE
CARTERVILLE, ILLINOIS
18118 11/7

KINKAID-REED'S CREEK COMSERVANCY DISTRICT
SPECIAL BOARD OF TRUSTEES MEETING
NOVEMBER 12, 2020
The Kinkaid-Reed's Creek Conservancy District's Board of Trustees meeting will be held on Wednesday, November 12, 2020 7:00pm at the Knights of Columbus Hall, 606 Plum St, Murphysboro, IL. MASKS ARE REQUIRED. MAXIMUM NUMBER OF ATTENDEE'S IS 25.
The meeting is also a telephone conference call. The call in number is 1-866-906-9330 and the meeting code is 3086136.
18137 11/7

Notice of Self Storage Sale
Please take notice Red Dot Storage 173 - Carbondale located at 100 N. Illinois Ave., Carbondale, IL 62901 intends to hold an auction of the goods stored in the following units in default for non-payment of rent. The sale will occur as an online auction via www.storageauctions.com on 11/17/2020 at 9:30 am. Unless stated otherwise the description of the contents are household goods and furnishings. Chris Duffy Units #B048, #B054, #C110, #C120, #C121, #D254, #D256, #D258, #B046WT, #A016, #A041, #B047, #B058, #C125, #D239, #D248, #A002, #A003, #A004, #A005, #A015, #A019, #A037, #A038, #A039. All property is being stored at the above self-storage facility. This sale may be withdrawn at any time without notice. Certain terms and conditions apply. See manager for details.
17710 10/31 & 11/7

Public Notice is hereby given that on October 23, 2020 A.D., a certificate was filed in the Office of the County Clerk of Jackson County, Illinois setting forth the names and addresses of all of the persons owning, conducting and transacting the business known as: Haven Belle Boutique located at 239 Mac Drive, Murphysboro, IL 62966 dated this 23rd day of October 2020 A.D. Frank L Byrd, Jackson County Clerk. 17803, 10/24,10/31,11/7/20

2020-6075: Full-Time Evening Shift Registered Ultrasound Tech
2020-5909: Full-Time Telemetry Tech
2020-5904: Per Diem Switchboard Operator II
2020-5626: Per Diem Specimen Collection Tech
2020-6094: Full-Time Security Guard
2020-5835: Full-Time Respiratory Therapist/CRT
2020-6030: Per Diem Radiation Therapy Tech
2020-6048: Full-Time RN Patient Relations Specialist
2020-6109: Full-Time Certified OR Tech
2020-6046: Full-Time Certified OR Tech

SIH
Qualified candidates can view all of our open positions and apply directly online at **www.sih.net/careers**
Please contact the Employment Office at 618.503.9066 x 67802 to learn more about these positions.
SIH is an Equal Opportunity Employer