FIVE YEAR REVIEW REPORT

FIFTH FIVE-YEAR REVIEW REPORT
for
THE NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE

ARDEN HILLS, RAMSEY COUNTY, MINNESOTA
Site No. MN7213820908

AUGUST 2019
FINAL REPORT

Prepared for:

U.S. Army Corps of Engineers
Louisville District
Louisville, Kentucky

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Prepared for:
U.S. Army Corps of Engineers
Louisville District
Louisville, Kentucky

Prepared by:
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U.S. Army Environmental Command
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Reviewed and Approved by:

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Title: BRAC BRANCH CHIEF

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
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AUG 19 2019

Ms. Lisa Albrecht
Interim TCAAP Project Manager
U.S. Army environmental Command
West Branch, C&MRD
2450 Connell Road, Building 2264
JBSA Fort Sam Houston, 78234

Subject: **U.S. EPA Concurrence: Final Five-Year Review Report for the New Brighton/Arden Hills/Twin Cities Army Ammunition Plant Superfund Site, Arden Hills, Minnesota, August 2019**

Dear Ms. Albrecht:

The U.S. Environmental Protection Agency (USEPA) has completed review of the subject **Final Five-Year Review Report for the New Brighton/Arden Hills/Twin Cities Army Ammunition Plant (TCAAP) Superfund Site, Arden Hills, Minnesota, August 2019** (FYR Report). The FYR Report documents the following protectiveness determinations made by the U.S. Army for the remedies that have been implemented at the New Brighton/Arden Hills/TCAAP Superfund Site:

Operable Unit 1 (OU1) – The remedy at OU1 currently protects human health and the environment because the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur. However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure protectiveness in the long term: #3-Extracting groundwater from the North Plume using the NBCGRS; #4-Removal of VOCs by a pressurized GAC system, and #5-Discharging all the treated water to the New Brighton Municipal distribution system. In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.

Operable Unit 2 (OU2) – The remedy at OU2 is protective of human health and the environment. All remedy components are currently functioning, and data indicates progress towards achieving the RAOs. For soil sites where the remedy has been completed (Sites A, C, D, E, H, 129-3, 129-5, 129-15, the Grenade Range, and the Outdoor Firing Range), the site's availability for industrial use has been restored. Review of the toxicity data upon which the health risk assessments for these sites were based showed that no changes have occurred

that could potentially affect the protectiveness of the remedies. The protective soil covers at these soil sites, in conjunction with land use controls (LUCs), effectively prevent exposure to residual contaminated soils/debris. The remedy including LUCs is functioning as intended. The groundwater containment systems are meeting their containment objectives and the treatment systems are meeting their discharge requirements. For Site A shallow groundwater, the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. Also, at Site A, MNA is adequately controlling plume migration (in lieu of groundwater extraction system operation). Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater. Review of ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to Site C groundwater and had no short-term impacts to the groundwater cleanup levels for Sites A, I, and K shallow groundwater or OU2 deep groundwater. The Army is proactively addressing 1,4-dioxane contamination through an ESD that is currently underway.

Operable Unit 3 (OU3) – The OU3 remedy is protective of human health and the environment. The alternate water supply and well abandonment program, along with the SWBCA, are mitigating potential risks associated with private wells. Water quality trends indicate that progress towards aquifer restoration continues to occur.

By this letter, USEPA concurs with the U.S. Army's protectiveness determinations in the **Final Five-Year Review Report for the New Brighton/Arden Hills/Twin Cities Army Ammunition Plant Superfund Site, Arden Hills, Minnesota, August 2019.**

Sincerely,

Douglas Ballotti
Director
Superfund and Emergency Management Division
U.S. Environmental Protection Agency
Region 5

MINNESOTA POLLUTION CONTROL AGENCY

Signature: Kathryn J. Sather Date: 9/20/2019

Printed Name: Kathryn J. Sather

Title: Remediation Division Director

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Note: The figure listed here is provided within the text of this Five-Year Review. Figures found in Section 10.0 include 71 additional figures supporting the Five-Year Review.

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
µg/L	Micrograms per Liter
APR	Annual Performance Report
ARAR	Applicable or Relevant and Appropriate Requirement
Army	United States Army
AWC	Area Weighted Concentration
BGRS	Boundary Groundwater Recovery System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
DAWSON	Dawson Solutions, LLC
EBS	Environmental Baseline Survey
EE/CA	Engineering Evaluation/Cost Analysis
ESD	Explanation of Significant Difference
FS	Feasibility Study
FY	Fiscal Year
GAC	Granular Activated Carbon
gpm	Gallons per Minute
HBV	Health Based Value
HRL	Health Risk Limit
IRA	Interim Remedial Action
LUC	Land Use Control
LUCRD	Land Use Control Remedial Design
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDH	Minnesota Department of Health
MGD	Million Gallons per Day
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MNA	Monitored Natural Attenuation
MNARNG	Minnesota Army National Guard
MPCA	Minnesota Pollution Control Agency
NB/AH	New Brighton/Arden Hills
NBCGRS	New Brighton Contaminated Groundwater Recovery System
NBM	New Brighton Municipal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List

LIST OF ACRONYMS AND ABBREVIATIONS

O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PGAC	Permanent Granular Activated Carbon
PGRS	Plume Groundwater Recovery System
PIKA	PIKA Arcadis U.S., Inc. a Joint Venture
PM	Preventive Maintenance
POTW	Publicly-Owned Treatment Works
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
PTA	Primer/Tracer Area
QAPP	Quality Assurance Project Plan
RAA	Risk Assessment Advice
RAL	Recommended Allowable Limit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RCRTC	Rice Creek Regional Trail Corridor
RD/RA	Remedial Design/Remedial Action
RfDo	Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SRV	Soil Reference Value
SVE	Soil Vapor Extraction
SWCA	Special Well Construction Area
SWBCA	Special Well and Boring Construction Area
TBC	to be Considered
TCAAP	Twin Cities Army Ammunition Plant
TCE	Trichloroethene
TGRS	Twin Cities Army Ammunition Plant Groundwater Recovery System
U.S.	United States
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency

LIST OF ACRONYMS AND ABBREVIATIONS

USFWS	United States Fish and Wildlife Service
UU/UE	Unlimited Use/Unrestricted Exposure
UV	Ultraviolet
UVPhox	UV-photolysis and UV-oxidation
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level
VOC	Volatile Organic Compound
WTP1	Water Treatment Plant 1

EXECUTIVE SUMMARY

This is the fifth Five-Year Review completed for the New Brighton/Arden Hills (NB/AH) Superfund Site, which contains the former Twin Cities Army Ammunition Plant (TCAAP) and its associated area of affected groundwater contamination, located in Ramsey County, Minnesota. The purpose of a Five-Year Review is to evaluate the implementation and performance of the remedies in place to determine if the remedies are or will continue to be protective of human health and the environment.

The United States (U.S.) Army (Army) and the U.S. Army Corps of Engineers (USACE) conducted this Five-Year Review to meet the statutory mandate under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121(c) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), Section 300.430(f)(4)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); in which Five-Year Reviews are required when the selected remedial actions result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that permit unlimited use and unrestricted exposure. The NCP provides the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP established the National Priorities List (NPL) and in 1983, the Site was placed on the NPL as the NB/AH Superfund Site.

The NB/AH Superfund Site was subdivided into three Operable Units (OUs): OU1, OU2, and OU3 respective of the Records of Decision (RODs) signed between 1992 and 1997 (USEPA, 1992, 1993, and 1987). OU1 encompasses off-site deep contaminated groundwater referred to as the "North Plume." OU2 includes soil, sediment, surface water, and groundwater contamination in the area that comprised the TCAAP. OU2 also includes the Site A shallow contaminated groundwater that extends off the north end of the federally-owned property. OU3 consists of off-site deep contaminated groundwater referred to as the "South Plume."

ROD and ROD Amendments were developed and signed for each OU:

- OU1 ROD signed 1993, Amended 2006;
- OU2 ROD signed 1997, Amended 2007, 2009, 2012, 2014, and 2018; and
- OU3 ROD signed 1992, Amended 2006.

The RODs, subsequent Amendments, and Explanations of Significant Differences (ESDs) present the major components of the final remedies for the media of concern, including the applicable cleanup standards.

The previous Five-Year Review of the Site was signed by USEPA on August 19, 2014, and the passage of another five years has triggered this review. The review period for the data and events documented in this report is from April 1, 2013 through November 2, 2018. The scope of this review includes OUs and sites that at the end of the review period had remedies in place and have hazardous substances remaining at levels that do not allow for unlimited use and unrestricted exposure.

Issues and Recommendations

A "remedy time-out" has been in effect for OU1 since April 15, 2015. OU1 remedy components #3, #4, and #5 (extraction of groundwater, removal of volatile organic compounds [VOCs] by a permanent granular activated carbon (PGAC) system, and discharging treated water to the New Brighton Municipal distribution system) are not functioning as intended because the operation of the New Brighton Contaminated Groundwater Recovery System (NBCGRS) has been temporarily suspended since 2015 due to the detection of the emerging contaminant, 1,4-dioxane, in the treated water that was being discharged to New Brighton's water supply. Operation of the OU1 remedy components will resume once modification of the New Brighton treatment system is complete and online, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCGRS wells can be safely restored. Actions (new treatment train, resumption of extraction, and discharging of treated water) are necessary to resume the remedy. During the site inspection (October 29 to November 2, 2018), the site was still under construction, but the new treatment system was completely installed and undergoing procedural start up processes. There is currently no remedial decision document to incorporate the cleanup standards or treatment technology for 1,4-dioxane; however, the Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.

The emerging contaminant 1,4-dioxane was also discovered in the Site D and Site G wells in OU2 at concentrations exceeding the Minnesota Department of Health (MDH) Health Risk Level (HRL). There is currently no remedial decision document to incorporate the cleanup standards or treatment technology; however, an ESD is currently underway to address 1,4-dioxane contamination and is recommended to be finalized and implemented.

No issues or recommendations were identified for OU3.

Evaluation of Protectiveness

OU1: The remedy at OU1 currently protects human health and the environment because the alternate water supply and well abandonment program, along with the drilling advisories in the Special Well and Boring Construction Area (SWBCA), are mitigating potential risks associated

with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur.

However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure protectiveness in the long term:

#3 Extracting groundwater from the North Plume using the NBCGRS;

#4 Removal of VOCs by a pressurized GAC system, and

#5 Discharging all the treated water to the New Brighton Municipal (NBM) distribution system.

In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination and implement a remedy. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.

OU2: The remedy at OU2 is protective of human health and the environment.

All remedy components are currently functioning, and data indicates progress towards achieving the RAOs.

For soil sites where the remedy has been completed (Sites A, D, E, H, 129-3, 129-5,129-15, the Grenade Range, and the Outdoor Firing Range), the site's availability for industrial use has been restored. Review of the toxicity data upon which the health risk assessments for these sites were based showed that no changes have occurred that could potentially affect the protectiveness of the remedies. The protective soil covers at these soil sites, in conjunction with land use controls (LUCs), effectively prevent exposure to residual contaminated soils/debris. The remedy including LUCs are functioning as intended.

The groundwater containment systems are meeting their containment objectives and the treatment systems are meeting their discharge requirements. For Site A shallow groundwater, the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. Also, at Site A, monitored natural attenuation (MNA) is adequately controlling plume migration (in lieu of groundwater extraction system operation). Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater.

Review of applicable or relevant and appropriate requirements (ARARs) upon which the groundwater cleanup levels were based showed that six groundwater contaminants of concern (COCs) were potentially affected by health risk limit (HRL) revisions. The HRL revisions had no impacts to Site C groundwater and had no short-term impacts to the groundwater cleanup levels for Sites A, I, and K shallow groundwater or OU2 deep groundwater.

The Army is proactively addressing 1,4-dioxane contamination through an ESD that is currently underway.

OU3: The OU3 remedy is protective of human health and the environment.

The alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. Water quality trends indicate that progress towards aquifer restoration continues to occur.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: New Brighton/Arden Hills Superfund Site/Twin Cities Army Ammunition Plant		
EPA ID: MN7213820908		
Region: 5	**State:** MN	**City/County:** Ramsey

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

REVIEW STATUS
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Army
Author name (Federal or State Project Manager): Nick Smith
Author affiliation: U.S. Army (TCAAP)
Review period: October 15, 2018 – August 19, 2019
Date of site inspection: 10/29/2018-11/02/2018
Type of review: Statutory
Review number: 5
Triggering action date: 8/19/2014
Due date *(five years after triggering action date)*: 8/19/2019

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
No issues or recommendations were identified for OU2 or OU3

Issues and Recommendations Identified in the Five-Year Review:	
OU: 1	**Issue Category: Remedy Performance**
	Issue: The operation of the NBCGRS has been in a "remedy time-out" since April 15, 2015, which has suspended remedy components #3, #4, and #5 (extraction of groundwater, removal of VOCs by a pressurized GAC system, and

	discharge of treated water to the New Brighton Municipal distribution system). The remedy is not functioning as intended; this represents an issue affecting long-term protectiveness.
	Recommendation: Actions (new treatment train, resumption of extraction, and discharge of treated water) are necessary to resume the remedy.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Army	USEPA/State	09/30/2024

OU: 1	Issue Category: Changed Site Conditions
	Issue: 1,4-dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology.
	Recommendation: Issue a decision document to address 1,4-dioxane contamination and implement a remedy.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Army	USEPA/State	09/30/2024

OU: 2	Issue Category: Changed Site Conditions
	Issue: 1,4-dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology.
	Recommendation: Finalize and implement the currently proposed ESD to address 1,4-dioxane contamination.

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Army	USEPA/State	09/30/2024

Protectiveness Statement(s)		
Operable Unit: 1	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* NA
Protectiveness Statement: The remedy at OU1 currently protects human health and the environment because the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur. However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure		

protectiveness in the long term: #3-Extracting groundwater from the North Plume using the NBCGRS; #4-Removal of VOCs by a pressurized GAC system, and #5-Discharging all the treated water to the New Brighton Municipal distribution system. In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxan contamination and implement a remedy. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
2	Protective	NA

Protectiveness Statement:

The remedy at OU2 is protective of human health and the environment. All remedy components are currently functioning, and data indicates progress towards achieving the RAOs. For soil sites where the remedy has been completed (Sites A, D, E, H, 129-3, 129-5, 129-15, the Grenade Range, and the Outdoor Firing Range), the site's availability for industrial use has been restored. Review of the toxicity data upon which the health risk assessments for these sites were based showed that no changes have occurred that could potentially affect the protectiveness of the remedies. The protective soil covers at these soil sites, in conjunction with land use controls (LUCs), effectively prevent exposure to residual contaminated soils/debris. The remedy including LUCs is functioning as intended. The groundwater containment systems are meeting their containment objectives and the treatment systems are meeting their discharge requirements. For Site A shallow groundwater, the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. Also, at Site A, MNA is adequately controlling plume migration (in lieu of groundwater extraction system operation). Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater. Review of ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to Site C groundwater and had no short-term impacts to the groundwater cleanup levels for Sites A, I, and K shallow groundwater or OU2 deep groundwater. The Army is proactively addressing 1,4-dioxane contamination through an ESD that is currently underway.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
3	Protective	NA

Protectiveness Statement:

The OU3 remedy is protective of human health and the environment. The alternate water supply and well abandonment program, along with the SWBCA, are mitigating potential risks associated with private wells. Water quality trends indicate that progress towards aquifer restoration continues to occur.

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1.0 INTRODUCTION

A Five-Year Review was performed for the New Brighton/Arden Hills (NB/AH) Superfund Site, which contains the former Twin Cities Army Ammunition Plant (TCAAP) and its associated area of groundwater contamination. This Five-Year Review was conducted to meet the statutory mandate under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121(c). In general, Five-Year Reviews are required whenever a remedial action results in hazardous substances, pollutants, or contaminants remaining on site that are above levels allowing for unlimited use and unrestricted exposure (UU/UE). The purpose of the Five-Year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The NB/AH Superfund Site has three Operable Units (OUs) for which Records of Decision (RODs) were signed between 1992 and 1997. This is the fifth Five-Year Review to address hazardous substances, pollutants, and contaminants remaining at the Site above levels that allow for UU/UE. The previous Five-Year Review of the NB/AH Superfund Site was signed on August 26, 2014, and the passage of another five years has triggered this review. The prior report covered data from Fiscal Year (FY) 2009 through mid-FY 2014 (October 1, 2009, through March 31, 2013). This Five-Year Review covers the period from mid-FY 2014 through mid-FY 2019 (April 1, 2013 through November 2, 2018).

On behalf of the U.S. Army (Army), Dawson Solutions, LLC (DAWSON) prepared this Five-Year Review. The Agency is preparing this Five-Year Review report pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for UU/UE, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action."

The review was initiated in FY 2019, which included notification to United States Environmental Protection Agency (USEPA), Minnesota Pollution Control Agency (MPCA), Northrup Grumman Innovation Systems (formerly Orbital ATK Inc.), Minnesota Army National Guard (MNARNG), U.S. Army Environmental Command, U.S. Army Corps of Engineers (USACE), City of New Brighton, and the Restoration Advisory Board.

TCAAP was placed on the NPL in September 1983 and designated as the NB/AH Superfund Site. The Site consists of contaminated areas within the original TCAAP boundary and those areas outside of the plant that are affected by groundwater contamination from the plant. The NB/AH Superfund Site has been divided into three OUs, principally due to the nature and extent of the contaminated groundwater plume on and off TCAAP. This Five-Year Review evaluates the remedies specified in the RODs for the three OUs at the NB/AH Superfund Site: OU1, OU2, and OU3. The three OUs are depicted on Figure 1 (as related to the original TCAAP boundary) and are defined as follows:

- OU1 consists of the deep groundwater "North Plume" of off-TCAAP contaminated groundwater.
- OU2 consists of on-TCAAP soil and groundwater contamination, including 14 suspected source areas designated as Sites A, B, C, D, E, F, G, H, I, J, K, 129-3, 129-5, and 129-15 (see Figure 6). OU2 also includes the area of the Site A shallow groundwater contamination that extends off the north end of TCAAP. Remediation of Sites F and J was completed prior to the 1997 OU2 ROD with no further action required. The Grenade Range and Outdoor Firing Range were added to OU2 as part of the 2009 OU2 ROD Amendment #3. Building 102 groundwater, the Site K soils, the 535 PTA, and the aquatic sites (i.e., Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G) were added to OU2 as part of the 2012 ROD Amendment #4. Site A soils, the eastern portion of the 135 Primer/Tracer Area (PTA), and the MNARNG Environmental Baseline Survey (EBS) Areas were added to OU2 as part of the 2014 ROD Amendment #5.
- OU3 consists of the deep groundwater "South Plume" of off-TCAAP contaminated groundwater.

This Five-Year Review evaluates the remedies at the OU sites outlined in Table 1-1 below:

Table 1-1 Sites Evaluated I 5th Five-Year Review Report

Operable Unit	Site	Description
OU1	Deep Groundwater	Off-TCAAP deep groundwater North plume
OU2	A	Shallow soil
		Shallow groundwater
	C	Shallow soil
		Shallow groundwater
	D	Deep groundwater
		Deep soil
	E	Shallow soil
	G	Deep groundwater
		Deep soil
	H	Shallow soil
	I	Shallow soil
		Deep groundwater
	K	Shallow groundwater
	Building 102	Shallow groundwater
	129-3	Shallow soil
	129-5	Shallow soil
	129-15	Shallow soil
	Grenade Range	Shallow soil
	Outdoor Firing Range	Shallow soil
	MNARNG EBS	Shallow soil
	135 PTA	Shallow soil
OU3	Deep Groundwater	Off-TCAAP deep groundwater South plume

The following sites have been closed out with No Further Action required and are not included in this Five-Year Review:

- Sewage Sludge Disposal (Site B)
- Open Burn/Burial Area (Site F)
- Site J
- Water Tower Area
- Recreational Trap Shooting Range
- Aquatic Sites (OU2 Waterbodies)
- Building 535 PTA (535 PTA)

- AEC Phytoremediation Demo Areas
- All Uncharacterized Areas (TCAAP-26)

There are two areas that are being addressed but are not included in this Five-Year Review since the decision document was not signed and/or the remedy is not in-place: the western portion of 135 PTA and Round Lake. The western portion of 135 PTA is intended for transfer to Ramsey County for recreational use. Round Lake is located southwest of OU2 and was contaminated by storm water runoff from TCAAP. The western portion of 135-PTA has been cleaned up to allow for recreational use. As of the date of this Five-Year Review report, no remedy has been selected for Round Lake.

For additional information on the background, investigations, and remedial actions for the various OUs and individual sites, the reader may refer to other key documents such as the Annual Performance Reports (APRs), Installation Action Plans (produced annually), RODs (and subsequent modifications), site closeout reports, and other "Reviewed Documents" cited in the References section of this document.

2.0 SITE CHRONOLOGY

The following is a summary of the key events for the NB/AH Superfund Site. For this site, USEPA OU designations differ from Army OU designations. To avoid confusion, only the Army designation is referenced throughout this report; however, a crosswalk (Table 1, Section 9, Tables) is included as a guide when accessing NB/AH information through the USEPA's repository.

Table 2-1 Key Events

Date(s)	Event
1942	Twin Cities Army Ammunition Plant (TCAAP) ammunition production begins.
1978 - 1982	Contamination of the regional aquifer first discovered
September 1983	New Brighton/Arden Hills (NB/AH) Superfund Site placed on the National Priorities List (NPL)
August 1987	Federal Facility Agreement (FFA) signed
June 1989	Record of Decision (ROD) on Interim Removal Action for polychlorinated biphenyls (PCB)-contaminated soils near Site D (Operable Unit [OU] 2)
September 1992	OU3 ROD (Amendment #1 in 2006)
September 1993	OU1 ROD (Amendment #1 in 2006)
May 1994	Public Health Assessment for NB/AH Superfund Site finalized by Agency for Toxic Substances and Disease Registry
October 1997	OU2 ROD (Amendment #1 in 2007, Amendment #2 and #3 in 2009, Amendment #4 in 2012, Amendment #5 in 2014, and Amendment #6 in 2018)
February 1999	Action Memorandums for Outdoor Firing Range Removal Action and Grenade Range Removal Action
September 1999	First Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Review Report signed

Date(s)	Event
September 2004	Second CERCLA Five-Year Review Report signed
2005	Production of munitions ceased at TCAAP
October 2008	Action Memorandums for Building 102 Groundwater and Site K
May 2009	Explanation of Significant Differences (ESD) #1 for groundwater sites and ESD #2 for various soil sites
August 2009	Third CERCLA Five-Year Review Report signed
September 2010	Land Use Control Remedial Design (LUCRD) approved by USEPA and MPCA (revised in June 2011, March 2015, August 2016, and March 2018)
December 2012	Action Memorandum for 135 PTA (eastern portion)
August 2014	Fourth CERCLA Five-Year Review Report signed
Early 2015	City of New Brighton was notified by the Minnesota Department of Health that 1,4-dioxane had been detected
April 15, 2015	Remedy Time-Out due to discovery of 1,4-dioxane
2017	Ultraviolet / Peroxide Advanced Oxidation Potential Pilot Study
2018	Installation of a new UVPhox treatment system
June 22, 2018	TCAAP Operable Unit Remedy Review (Optimization Report)

3.0 BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

TCAAP is a government-owned facility located in the northern portion of the Minneapolis – St. Paul metropolitan area in Ramsey County and is surrounded by the cities of New Brighton, Arden Hills, Mounds View, and Shoreview, Minnesota (Figure 1 Section 10). For purposes of the Army's restoration program for the NB/AH Superfund Site, TCAAP formerly occupied an approximately four-square mile area east of U.S. Interstate Highway 35W and north of Ramsey County Highway 96 (i.e., this was the original TCAAP boundary as shown on Figure 2).

Remedial Investigations (RIs) performed at TCAAP and the surrounding areas identified four geologic units of importance on and around TCAAP (Figure 3). Unit 1 is an unconsolidated unit with intermixed beds of sand and clay found on the surface at many locations at TCAAP. Groundwater is encountered in Unit 1, but the aquifer yield is low, and the water is not used as a municipal water supply source by any of the surrounding communities. Sites A, C, I, K, and Building 102 are nominally referred to as "shallow groundwater sites," since impacted groundwater is limited to Unit 1.

Unit 2 lies beneath Unit 1 and is a glacial till deposit that behaves as an aquitard at TCAAP and as an upper confining layer off-TCAAP to the southwest. Unit 3, the Hillside Sand and the Arsenal Sand, lies beneath Unit 2 and is exposed at the surface in several areas of TCAAP. Unit 3 is a water-bearing formation with high water yield and historically has been utilized as a potable groundwater supply formation.

Unit 4 (located directly below Unit 3) is a major aquifer for the Twin Cities area, including the communities surrounding TCAAP. It consists of two bedrock units: the Prairie du Chien Group (referred to as Upper Unit 4), and the underlying Jordan Formation (referred to as Lower Unit 4). Groundwater contamination that exists in these deeper geologic Units 3 and 4 below TCAAP and to the southwest, is nominally referred to as "deep groundwater" contamination. Figures 4 and 5 present a geologic cross section through TCAAP, along a line parallel to the direction of groundwater flow in the Unit 3 and 4 aquifers. The line of this section is labeled as A-A' on plume maps discussed in Section 4, such as Figure 4. In addition to the geologic units, the cross section shows the vertical distribution of trichloroethene (TCE) and 1,4-dioxane concentrations. Since Unit 3 is relatively thick, monitoring wells constructed within this unit are designated as "upper" (U), "middle" (M), or "lower" (L) to represent their relative depth. This labeling convention is used on various figures in this report.

3.2 LAND AND RESOURCE USE

Construction on TCAAP began in 1941 with a primary mission to produce small-caliber ammunition and related materials. TCAAP was constructed on federally-owned land controlled by the Army. Production levels varied over time and ceased in 2005.

The size of TCAAP has periodically shrunk as a result of property ownership transfers and reassignment of control. Since placement on the NPL in 1983, control of over 1,500 acres has been reassigned to the National Guard Bureau and Army Reserve. This property is still federally-owned and controlled by the Army but is no longer controlled by TCAAP or considered part of TCAAP. The following transfers have also recently taken place:

- Prior to 2013, the Army transferred more than 270 acres out of federal ownership to Ramsey County and the City of Arden Hills (without any use restrictions).

- In 2013, the Army transferred 397 acres to Ramsey County and leased an additional 30 acres to Ramsey County in 2013. The 30 acres were subsequently transferred to Ramsey County in 2017 (427 total acres).

The Army prepared an OU2 Land Use Control Remedial Design that was approved by USEPA and MPCA in September 2010. Revisions to the LUCRD occurred in June 2011, March 2015, August 2016, and March 2018. Following soil cleanup to levels consistent with UU/UE, the 2016 revision eliminated soil land use controls (LUCs) from 380 acres of the 427 acres transferred/leased to Ramsey County in 2013. LUCs remained in place for other shallow soil sites.

Ramsey County identified 108 acres for use as part of the Rice Creek Regional Trail Corridor (RCRTC). This acreage included three parcels (A, B, and D) that will be transferred to Ramsey County and another parcel (C) that will remain under federal ownership. Ramsey County will be granted a perpetual easement for Parcel C to allow its use as part of the RCRTC.

Ramsey County completed additional soil investigation and cleanup on the 108 acres to achieve cleanup levels suitable for recreational use and unrestricted exposure. The 2018 revision to the OU2 LUCRD revised LUCs to allow recreational use on the 108 acres identified for use as part of the RCRTC. As a condition of transfer or lease, the Army requires that equivalent LUCs will be put into terms and conditions of an environmental covenant (or deed) or lease that are no less restrictive than the LUC objectives described in the LUCRD.

The remaining acreage of TCAAP (approximately 160 acres) are surplus to the needs of the federal government and are in the process of being transferred out of federal ownership. These 160 acres are currently controlled by the Base Realignment and Closure Division of the Army, the organization to which TCAAP presently reports. Over time, property ownership and/or control

have changed, and what is considered TCAAP has changed, but the area defined as OU2 of the NB/AH Superfund Site remains unchanged.

The MNARNG uses land held by the National Guard Bureau for military training purposes. For the remaining acreage of TCAAP proposed for transfer, the future property use is unknown at this time, but will potentially be a mixture of recreational, residential, commercial, and industrial uses.

Groundwater beneath the original TCAAP boundary is not being used for potable water supply or other commercial/industrial uses. Groundwater flowing away from TCAAP is utilized for residential, commercial, industrial, and municipal water supply with the Prairie du Chien-Jordan aquifer serving as a major source for municipal water supplies, such as for the cities of New Brighton and Saint Anthony.

3.3 HISTORY OF CONTAMINATION

During the years of ammunition production, TCAAP generated industrial wastes that were disposed of using the accepted practices of the times that included on-site dumping, burial, and open-burning. Between 1978 and 1982, contamination of the regional aquifer was discovered beyond the original TCAAP boundary. In the early 1980s, 14 different areas were identified at TCAAP as potential sources for groundwater contamination, soil contamination, or both. The contaminants included volatile organic compounds (VOCs), PCBs, and ammunition-related heavy metals. The drinking water supply of local communities, with a total population of approximately 33,000, was directly impacted by VOCs. Refer to previous investigation reports for a more detailed description of the history of contamination.[1]

3.4 INITIAL RESPONSE

A number of actions were taken at each OU prior to signing the RODs, as discussed below:

- OU1
    - A temporary, followed by a permanent, granular activated carbon (PGAC) treatment system was constructed for the City of New Brighton to treat the municipal water supply. The permanent system was completed in June 1990.
    - A temporary, followed by a PGAC treatment system was constructed for the Village of St. Anthony to treat the municipal water supply.
    - The Army provided municipal water supply hookup for the Lowry Grove Trailer Park and Arden Manor Trailer Park.

[1] The public information repository for TCAAP is located at 4761 Hamline Avenue, Arden Hills, Minnesota 55112.

- OU2
    - Implementation of Interim Remedial Actions (IRAs) at Sites D and G in January 1986 and February 1986, respectively, included the installation of soil vapor extraction (SVE) systems at both sites to remove VOCs from soils, effectively reducing VOC migration to groundwater. During the periods of operation, the SVE systems at Sites D and G removed more than 220,000 pounds of VOCs from soil.

    - Excavation of PCB-contaminated soils east of Building 502 occurred in 1986 with these soils being stored in a storage building built as part of the PCB IRA at Site I. During August and September 1996, these soils were removed and disposed of at a Toxic Substances Control Act (TSCA) landfill, with approval of USEPA and MPCA.

    - Completion of the thermal treatment of 1,400 cubic yards of PCB-contaminated soil from Site D occurred in September 1989. As part of this Site D work, the remedy allowed for soils with less than 50 milligrams per kilogram (mg/kg) of PCBs to be "secured in-place," in that they were backfilled into the lower part of the PCB excavation area, with approximately 4 to 6 feet of clean soils placed over the contaminated soil. A protective soil cover with a minimum thickness of two feet is maintained over the soils that were "secured in-place" to prevent exposure to these soils.

    - Cleanup of Site F occurred in 1995 under the Resource Conservation and Recovery Act (RCRA) with more than 25,000 tons of metal-contaminated soils treated over a period of three years. MPCA (as the lead for RCRA actions) approved the *Site F Closure Report* (1999) and documented Site F as available for UU/UE.

    - Clean out of Site J, which is a portion of TCAAP's underground sanitary sewer, and subsequent soil and groundwater sampling along the sewer location found no contamination. MPCA and USEPA approved the *Final Site J Closure Report* (1994) and documented the absence of contaminants above background levels and recommended no further action.

    - Installation of groundwater extraction treatment systems at Sites I and K as IRAs occurred in 1986. In October 1987, the installation constructed the Boundary Groundwater Recovery System (BGRS) to contain and treat VOC-contaminated groundwater at TCAAP's southwest boundary. In January 1989, the system was modified and expanded and became the TCAAP Groundwater Recovery System (TGRS).

    - Recovery of shallow VOC-contaminated groundwater via a single extraction well located near the source area occurred in September 1988 as an IRA at Site A In 1994,

the installation replaced the Site A IRA remedy with a boundary plume containment system designed to prevent the off-TCAAP migration of VOCs in shallow groundwater.

- OU3
  - There were no cleanup activities prior to signing the OU3 ROD.

3.5 BASIS FOR TAKING ACTION

The contaminants of concern (COCs) present at each site and specific to each media of concern are summarized in Table 2 (Section 9, Tables).

A human health risk assessment for TCAAP was completed by USEPA in April 1991. For groundwater contamination, potential receptors included TCAAP workers and local residents who rely on private or municipal wells that extract contaminated groundwater for water supply. The risk assessment evaluated the carcinogenic and non-carcinogenic risks associated with exposure to contaminated groundwater through exposure pathways of ingestion, inhalation during showering, and absorption through the skin during showering or bathing. Estimated increases in carcinogenic and/or non-carcinogenic risks that would result from exposure to contaminated groundwater exceeded acceptable levels as defined by USEPA and MPCA.

For contaminated soils, the exposure pathways evaluated were based on an industrial use scenario, with potential receptors being TCAAP workers or occupants. Incidental ingestion and dermal contact were assumed to be the only routes for receptors to be exposed to contaminants in surface soils at the site (it was also noted that, during excavation activities, workers could also be exposed to contaminants by inhaling vapors or dust, as well as through incidental ingestion and dermal contact). The health risk assessment found that carcinogenic and non-carcinogenic risks exceeded acceptable levels at most soil sites in OU2.

The Army conducted an Ecological Risk Assessment for terrestrial habitats at the original TCAAP (Army Environmental Hygiene Agency, October 1991). The risk assessment addressed on-TCAAP risks to plants and animals and concluded that no risks exist.

In December 2012, MPCA requested that soil vapor sampling be conducted due to their new 2008/2010 vapor intrusion (VI) guidance. The *Site A Vapor Intrusion Investigation Report* (Wenck, 2014) concluded there is no soil vapor risk north of County Road I (within OU2).

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4.0 OPERABLE UNIT 1

4.1 OU1 REMEDIAL ACTIONS

4.1.1 OU1 Remedial Action Objectives

Remedial Action Objectives (RAOs) were developed for groundwater as part of the OU1 Feasibility Study (FS) in 1993 and were addressed by the September 1993 OU1 ROD. The OU1 ROD, referred to as "ROD" throughout this section, has been modified by a ROD Amendment in 2006. The ROD Amendment did not affect the RAOs. The RAOs identified in Table 4-1 for OU1 groundwater are designed to protect human health and the environment from exposure to site contaminants.

Table 4-1 OU1 Remedial Action Objectives

Site	Media	Remedial Action Objectives
OU1	Deep Groundwater: Off-site deep groundwater -North Plume	a) Prevent human exposure to water contaminated with carcinogens in excess of the Maximum Contaminant Levels (MCLs), Recommended Allowable Limits (RALs), and Health Risk Limits (HRLs) and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than MCLs, RALs, and HRLs or having a threshold noncancer hazard index greater than 1.0. c) Restore the aquifer to its highest use, i.e., potability, as defined by the most stringent and promulgated state and federal standards. d) Contain the plume within the boundary of County Road E (to the extent practicable) while also maximizing mass removal. e) Prevent ecological exposure to contaminants.

4.1.2 OU1 Remedy Selection

The OU1 ROD was signed in September 1993 and prescribed six major remedy components to address the deep "North Plume" groundwater contamination located off-TCAAP. The ROD was amended in 2006. The primary COC is trichloroethene (TCE) with other related compounds in

lower concentrations.[2] The OU1 ROD Amendment formalized the adoption of statistical analysis of the groundwater monitoring data to show the progress of the aquifer restoration, in lieu of demonstrating the hydraulic containment in the vicinity of County Road E. Progress toward remedial goals (aquifer restoration) is demonstrated by utilizing statistical analyses of the groundwater monitoring data to show control and reduction in plume size. The amended ROD requires USEPA and MPCA approved aggregate groundwater extraction rates at the New Brighton Contaminated Groundwater Recovery System (NBCGRS), and removed the requirement for demonstrating hydraulic containment at County Road E. The location of OU1 is illustrated on Figure 1 (Section 10). The following are the six components of the OU1 selected remedy, with the components changed in the 2006 ROD Amendment shown in italics:

1. Providing alternative water supplies to residents with private wells within the North Plume.

2. Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a Special Well Construction Area (SWCA).

3. *Extracting groundwater from the North Plume using the NBCGRS, subject to the following:*

    a. *the initial aggregate groundwater extraction rate shall be consistent with the long-term operating history of the NBCGRS;*

    b. *future decreases in the aggregate extraction rate shall be determined by the Army, USEPA, and MPCA using a transparent public process and rational engineering, scientific, and economic analyses at least as rigorous as those employed in the FS that was the basis for the original remedy selection;*

    c. *future changes to the aggregate or individual well extraction rates shall be made so as to assure that the rate of restoration of the aquifer will not be slowed or result in a duration of remedy longer than was contemplated by the original ROD* (the original ROD predicted the remedy would remove an estimated 68% of the mass of contaminants after 30 years of operation, and an estimated 77% after 100 years)*; and*

    d. *the facilities comprising the NBCGRS may be modified as necessary to assure the restoration of the full areal and vertical extent of the aquifer in a timeframe as contemplated in 3.c, above. (2006 OU1 ROD Amendment, page 5-3 and 5-4).*

4. Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs by a pressurized GAC system.

[2] A list of contaminants of concern can be found on Table 2 (Section 9, Tables).

5. Discharging all of the treated water to the New Brighton Municipal (NBM) distribution system.

6. *Monitoring the groundwater to verify effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations*.

4.1.3 OU1 Remedy Implementation

The Alternate Water Supply and Well Abandonment Program (remedy component #1) has been implemented and is an ongoing program maintained by the Army. The process of identifying wells eligible for alternate water supply and/or abandonment is accomplished by maintaining a "well inventory." The well inventory is a database initially developed in 1992, and is currently updated annually as part of the APR. For the purposes of the well inventory, a study area was established that encompasses the groundwater plume. The well inventory is intended to include all wells within the study area. Within the study area, areas of concern are defined by the edge of the groundwater plume, plus an additional buffer area. The wells are grouped into categories based on factors such as location relative to the area of concern, type of use, active/non-active status, sealed, etc. The well inventory database identifies the water supply wells within the study area, of which 27 are currently in categories with the potential to be impacted. These 27 wells are sampled every four years to determine if they qualify for alternate water supply and/or abandonment. Since inception of the program, two well owners have been provided an alternate water supply and eighteen wells have been properly abandoned.

Drilling advisories have been implemented through the Special Well and Boring Construction Area (SWBCA), formerly known as the SWCA, to regulate the installation of new private wells within the North Plume (remedy component #2). The SWBCA was originally issued in 1996, and implementation of the SWBCA is ongoing.

The remedial system for OU1, known as the NBCGRS, consists of the New Brighton well field, a PGAC treatment system, and connection into the City of New Brighton municipal water system. The permanent system was completed in April 1991. The extracted groundwater is used as part of the New Brighton water supply system, and as such, New Brighton took the lead on design and construction of the system and is responsible for operation of the system. The City of New Brighton operates the NBCGRS under an agreement with the Army, and the Army is paying for the OU1 remedy. The PGAC water treatment facility is located approximately one-third mile south of Interstate 694 near Silver Lake Road and consists of 16 contactor vessels, each 24 feet high and filled with 20,000 pounds of carbon. Figure 7 shows the layout of the PGAC Water Treatment Plant #1 (WTP1). Figure 8 shows a schematic of the three-way valve piping and control stand in place at each contactor pair.

Groundwater extraction (remedy component #3) is provided by pumping six municipal wells: NBM #3, #4, #5, #6, #14, and #15. Collectively, these extraction wells comprise the extraction

points of the NBCGRS. The extracted water is treated in the PGAC water treatment facility for removal of VOCs (remedy component #4) and is then discharged (remedy component #5) to the NBM distribution system to be used as part of the municipal water supply. The remedy components of groundwater extraction, removal of VOCs by GAC, and discharge of treated water have not been implemented since April 15, 2015 (refer to Section 4.1.5 for additional discussion).

Groundwater monitoring to verify the effectiveness of the remedy (remedy component #6) is conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. The Army conducts the sampling related to OU1 performance monitoring and the private well sampling related to the Alternate Water Supply and Well Abandonment Program. When operating, monthly monitoring of the extraction wells and treatment system effluent is performed by Barr Engineering on behalf of the City of New Brighton, the results of which are also provided to and used by the Army. However, samples have not been collected since the "remedy time-out." The OU1 sampling plan requires a major sampling event every other year and a small number of wells to be sampled during the minor years. Major sampling events during the timeframe of this Five-Year Review were conducted in FYs 2013, 2015, and 2016; major sampling was performed in FY 2016 due to the detection of 1,4-dioxane in 2015. Refer to Table 10 (Section 9, Tables) for the FY 2016 groundwater quality sampling event data.

Remedy component #6 is met by evaluating groundwater monitoring data according to statistical methods contained in the *"OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, Operable Unit 1,"* dated December 2004 (and any subsequent addendums or revisions approved by USEPA and MPCA). The statistical analysis is conducted annually and is reported in the APRs.

The OU1 Technical Group Technical Memorandum identified five issues that need to be statistically evaluated with respect to the above objective:

1. Measure changing concentrations immediately downgradient of the TCAAP Groundwater Recovery System (TGRS), as this area is the first to be affected by any potential contaminant migration via TCAAP.

2. Measure changes in the geographical size of the plume over time.

3. Measure changes in concentrations immediately downgradient of the NBCGRS, as this is the first area to be affected by any potential contaminant migration outside of NBCGRS capture.

4. Measure any unforeseen changes in plume configuration. This addresses the possibility that changing flow patterns may cause a shift in the plume but not necessarily any change in size. A plume shift may require a redistribution of pumping.

5. Measure the long-term trends in overall VOC concentrations (as an indicator of contaminant mass). This provides an overall picture of remedial progress.

The OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, OU 1 (Army 2004) developed a series of five well groups designed to address each of the issues listed above. For each well group, appropriate statistical tools were specified, and a threshold identified that would trigger closer scrutiny by the Army and regulators (USEPA and MPCA). An additional well group (well Group 6) was added in the 2005 Modification #1. These well groups are discussed in Section 4.3.4.

4.1.4 OU1 System Operations/Operation and Maintenance

During normal operations (1990 until 2015), the City of New Brighton operates and maintains the PGAC water treatment facility, associated extraction wells, and distribution system. The primary maintenance item for the PGAC water treatment facility is changing out the spent GAC (each of the 16 treatment vessels contains 20,000 pounds of GAC, and the GAC in eight of these vessels is replaced in each change-out event). The most recent carbon change-out occurred in FY 2015 in October 2014 (Table 3, Section 9, Tables).

In early 2015, MDH notified the City of New Brighton that 1,4-dioxane had been detected in New Brighton's water supply with detections up to 6.8 micrograms per liter (µg/L). NBCGRS operations were shut down on April 15, 2015, including the Fridley Interconnection.[3] The City of New Brighton originally switched to pumping water primarily from their deep aquifer wells that did not have detectable 1,4-dioxane and has subsequently switched to getting its drinking water from the City of Minneapolis. This shutdown of the NBCGRS has been referred to as a "remedy time-out." An email from Mike Fix to USEPA dated April 17, 2015, informed USEPA the City of New Brighton stopped pumping and treating TCAAP-contaminated wells on April 15, 2015 (Appendix G). An "acknowledgement/shutdown approval" letter could not be located. Normal OU1 remedy pumping will resume once modification of the New Brighton water supply treatment system is constructed and online, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCGRS wells can be safely restored.

Based on an extensive pilot study, the City of New Brighton identified ultraviolet (UV)/Peroxide advanced oxidation as the treatment process for removal of 1,4-dioxane via a Trojan UV-photolysis and UV-oxidation (Trojan UVPhox) patented technology system. The "remedy time-out" continued throughout FY 2016, FY 2017, and FY 2018. As of the 2018 site inspection (November 1, 2018), the system was still in "remedy time-out;" however, construction of the treatment system had been completed, and the system testing and startup process had begun. The

[3] New Brighton had previously entered into an agreement with Fridley to take excess water that was pumped as part of the NBCGRS. A 20-inch interconnecting pipeline between the City of New Brighton and Fridley was completed in 1995 and is known as the Fridley Interconnection.

Army is providing funding for the implementation of these changes.

After the remedy time-out in 2015, some very limited pumping of the extraction wells occurred for non-supply plant operations, such as filter backwashing.

4.1.5 OU1 Land Use Controls

LUCs are required to ensure the protectiveness of the OU1 remedy, until such time that the groundwater cleanup levels are achieved. The ROD prescribed the following LUC: "implementing drilling advisories that would regulate the installation of new private wells within the north plume as a SWCA." In Minnesota, the drilling of wells is regulated by MDH, including the legal authority to create a Special Well and Boring Construction Area (SWBCA) to prohibit water supply wells within contaminated portions of aquifers. MDH created the SWBCA for the NB/AH Superfund Site in June 1996. Minnesota Rules, Part 4725.3650, details the requirements for construction, repair, and sealing of wells and borings within a designated SWBCA, including plan review and approval, water quality monitoring, and other measures to protect public health and prevent degradation of groundwater.[4]

Figures 9 through 11 show the physical area of groundwater contamination within OU1 – the area that does not support UU/UE of the groundwater due to the contaminant plume. The current SWBCA boundary is shown on Figure 12, which encompasses the entire OU1 groundwater plume. The objective of the LUC is to prevent uses of contaminated groundwater that poses an unacceptable risk to human health. The long-term stewardship for the LUC rests with MDH, within its authority to regulate the construction and use of wells. The LUC for OU1 is summarized in Table 4 (Section 9, Tables).

4.2 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The 2014 Five-Year Review stated that "the remedy at OU1 is protective of human health and the environment. The alternate water supply and well abandonment program, along with the SWCA, are mitigating potential risks associated with private wells. The PGAC treatment system is reliably providing a safe municipal water supply. Water quality trends indicate that progress towards aquifer restoration continues to occur."

No issues, recommendations, or follow-up actions were noted in the 2014 Five-Year Review for OU1.

[4] More information regarding the SWBCA can be found on the MDH webpage at: https://www.health.state.mn.us/communities/environment/water/wells/swbca/tcaap.html and information from this website is also included in Appendix E.

4.3 FIVE-YEAR REVIEW PROCESS

4.3.1 Administrative Components

This Five-Year Review was initiated in early FY 2019 and began with notification to USEPA, MPCA, Northrup Grumman Innovation Systems (formerly Orbital ATK Inc.), Army National Guard, USAEC, USACE, City of New Brighton, and the Restoration Advisory Board.

4.3.2 Community Notification and Involvement

A notice indicating that a Five-Year Review was to be performed for the NB/AH Superfund Site was published on October 28 and 31, 2018; November 2, 2018; and November 13, 2018 in the following newspapers, respectively: Minneapolis Star Tribune, Mounds View/New Brighton Sun Focus, and the Shoreview Press (Appendix B). The notice invited anyone interested in this process to contact the Army.

A notice indicating the Five-Year Review has been completed, including contact information and the location of the public repository for the report (4761 Hamline Avenue, Arden Hills, Minnesota 55112) will be sent to these same newspapers after the report is finalized.

4.3.3 Document Review

The primary documents reviewed for OU1 included:

- *Record of Decision - Groundwater Remediation, Operable Unit 1*, September 1993;
- *Record of Decision Amendment - Operable Unit 1*, May 2006;
- *TCAAP Final APRs* for FYs 2013, 2014, 2015, 2016, and 2017;
- Previous *Five-Year Review Report*, August 2014.

The OU1 ROD (and amendment) was the source of information for the RAOs and cleanup levels.

4.3.4 Data Review

OU1 data is presented by remedy component then by chronological order by fiscal year below. The status of OU1 remedial actions is summarized in Table 5 (Section 9, Tables).

Groundwater Extraction, Removal of VOCs, and Discharge (Component #3, #4, & #5)

Due to detections of 1,4-dioxane in the NBCGRS wells, the NBCGRS was shut down on April 15, 2015.[5] The only data presented and analyzed in this report for groundwater extraction (component #3) is from FY 2013 to FY 2015 for trends. For FY 2016 to FY 2018 the groundwater extraction remedy component is in a "remedy time-out." The table below shows the volume of water pumped

[5] 1,4 dioxane is not a contaminant listed in the ROD.

by the NBCGRS was achieving all of the monthly target rates from the data analyzed from FY 2013 to FY 2015. Table 4-2 below highlights the daily average and volume of water extracted before the shut down in 2015.

Table 4-2 NBCGRS Groundwater Extraction Data

Year	Volume of Water Pumped (Annually)	Volume of Water Pumped (Daily Average)	Monthly Target Rate
FY 2013	1,196 MG	3.3 million gallons per day (MGD)	96.4 MG
FY 2014	1,241 MG	3.4 MGD	96.4 MG
FY 2015	602 MG	1.6 MGD	96.4 MG
FY 2016	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data
FY 2017	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data
FY 2018	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data	"Remedy Time-Out"/ No Data

NBCGRS pumping in FY 2013 and FY 2014 exceeded the monthly target rate. Due to the "remedy time-out" during half of FY 2015, FY 2015 did not meet the target average daily pumping rate of 3.168 MGD. Pumping volumes and VOC mass removal for FY 2013, FY 2014, and FY 2015 are shown in Tables 6, 7, and 8, respectively (Section 9, Tables). No water was pumped from the extraction wells in FY 2016, FY 2017, or FY 2018. Approximately 187 pounds of VOCs were removed during FY 2015, for a total of 23,644 pounds of VOCs removed since system startup. Historical annual mass removal and gallons pumped by the NBCGRS are shown on Figure 13. Mass removal has been on a general decreasing trend since FY 1998, when the last extraction well was brought online.

Prior to implementation of the "remedy time-out" on April 15, 2015, the PGAC water treatment facility effluent met the MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) established by the Safe Drinking Water Act (SDWA) for OU1 COCs. Following the "remedy time-out," the NBCGRS wells were not used for water supply, and no treated water samples could be collected and evaluated for compliance with the performance standard. No water has been discharged to the NBM distribution system since the "remedy time-out."

Groundwater Monitoring (Component #6)

Regulators requested the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations during the summer FY 2015, FY 2016, and FY 2017 sampling events.

Based on OU1 groundwater quality data presented in the FY 2015, FY 2016, and FY 2017 APRs, two VOCs exceed the cleanup levels specified in the OU1 ROD: TCE and 1,1-dichloroethene (FY 2015 and FY 2016 were major sampling events). The maximum concentrations and the corresponding well ID are outlined in Table 4-3 below. OU1 groundwater quality data for FY 2015, 2016, and 2017 is presented in Tables 9, 10, and 11, respectively (Section 9, Tables).

Table 4-3 Maximum COC Exceedances OU1 ROD Cleanup Levels for FY 2015, FY 2016, and FY 2017

Fiscal Year	TCE concentration (µg/L)	Well ID	1,1-dichloroethene concentration (µg/L)	Well ID
	OU1 Cleanup Level: 5		OU1 Cleanup Level: 6	
FY 2015	960	04U847	57	04J847[a]
FY 2016	910	04J847[a]	57	04J847[a]
FY 2017	780	04J847[a]	51	04J847[a]

[a]This well is located downgradient of the TGRS, near the plume center.

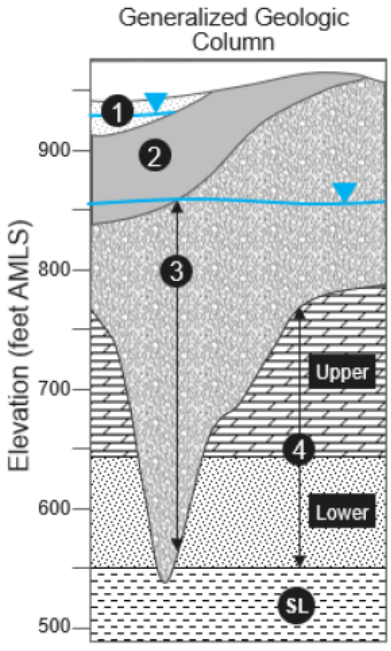
No groundwater samples were collected from the NBM wells in FY 2016 or FY 2017. Trend graphs for TCE in NBM #3, #4, #5, #6, #14, and #15 from FY 2015 are shown in Figure 14 (Section 10, Figures). At both NBM #3 and #4, TCE decreased between the start of pumping and 1998, increased slightly until approximately 2010, and have been relatively stable to slightly decreasing since then. At NBM #5, TCE appears to be relatively stable since 2013, after earlier decreases. At NBM #6, TCE also appears to be relatively stable since 2013, with a gradually declining trend overall. At NBM #14, the TCE trend remained at or below the cleanup level for OU1 (5 µg/L), with the exception of the April 2015 sampling event. At NBM #15, after earlier declines, the TCE trend appeared to be relatively stable since 2009; however, it appears to be trending slightly upward in FY 2015. The NBM well trends were analyzed using a linear regression for data since 1998; the linear regression showed downward concentration trends for all the NBM wells, with the exception of NBM #3 and #4, which show a slight upward trend (see Figure 15).

The FY 2017 APR concluded this is likely a result of gradual plume shifting due to changes in NBCGRS pumping.

The area of concern for TCE (the 1 µg/L contour line) did not change during FY 2016, except for a slight northward shift in the Upper Unit 4 contour line on the north side due to increases in TCE concentrations in wells 04U855, 04U879, and 04U839. Ten water supply wells within the area of concern for OU1, but outside of the OU1 performance monitoring plan, were sampled during FY 2016. Of these, all were non-detect for VOCs, except 1,2-dichloroethane, which was detected below the MDH HRL at unique well number 200523 (used for pond refilling at Windsor Green Association townhomes).

The geological units for OU1 are presented below in Figure 4-1. The graphic column is generalized to illustrate erosional relationships, and discontinuities of units. Figures 16, 17, and 18 show TCE in the Upper Unit 3, Lower Unit 3, and Upper Unit 4 portions of the aquifer for FY 2016. Cross sections showing the plumes are presented in Figures 19, 20, and 21. Figure 22 shows the 1 µg/L TCE contour for Upper Unit 4 to illustrate how the plume has changed over time. Figure 23 illustrates how the 100 µg/L TCE contour in Upper Unit 4 has changed over the past decade. The water level data from June 2016 for Upper Unit 4 are presented as a potentiometric map on Figure 24.

Figure 4-1 Sequence of Geological Units



	Unit No.	Name	Dominant Material	Aquifer Type
Unconsolidated Units	1	Fridley Formation	Alluvial sand	Perched sand aquifer
	2	Twin Cities Formation	Glacial till	Aquitard
	3	Hillside and Arsenal Sand Units	Glacial outwash sand and gravel	Sand and gravel aquifer
Bedrock Units	Upper 4	Prairie du Chien Group	Dolomite	Karst and fractured rock aquifer
	Lower 4	Jordan Formation	Sandstone	Porous fractured rock aquifer
	SL	St. Lawrence Formation	Dolomitic Shale	Bedrock aquitard

* Elevations are based on western area of TCAAP; actual contact elevations vary. The figure presents the geologic column that omits both shallower and deeper bedrock units present in the TCAAP vicinity but not directly relevant to the Optimization program, including the St. Peter Sandstone that lies above the Prairie du Chien in portions of OU1.

The OU1 Technical Group developed a series of five well groups designed to address each of the five issues that need to be statistically evaluated. For each group, appropriate statistical tools were specified and a threshold identified that would trigger closer scrutiny by the Army and regulators. Threshold triggers are outlined in Table 12 (Section 9, Tables). Wells in each well group are defined in Table 13 (Section 9, Tables). The locations of the wells are illustrated on Figure 25. The first two characters of the well ID represent the hydrogeologic unit in which the well is completed, as follows:

01 – Unit 1
02 – Unit 2
04 – Unit 4: Prairie du Chien Group or Jordan Formation
PJ – Unit 4: Prairie du Chien Group and Jordan Formation.

Well groups with their functions and trends in FY 2016 and FY 2017 are presented below in Table 4-4. The FY 2016 trends discussed in Table 4-3 includes an assessment of the statistical thresholds that were triggered in the analysis. The FY 2017 trends discussed below only include wells that were sampled in FY 2017 and had "increasing" or "no significant" trends. For information regarding wells with decreasing trends or other details, refer to the FY 2016 and FY 2017 APRs. Table 14 and Table 15 (Section 9, Tables) summarize the statistical results for all monitoring wells reflecting the data collected for overall VOCs through FY 2016 and FY 2017, respectively. These tables include an assessment of the statistical thresholds that were triggered in the analysis and brief comments addressing these threshold triggers for overall VOCs.

Table 4-4 Well Group Trends

Well Group	Function	FY 2016 and FY 2017 Trends
Group 1: Downgradient of the TGRS Capture Zone	This zone should show reductions over time in response to TGRS mass removal and containment. However, it is also theorized as the TGRS stagnation zone where groundwater velocities are reduced and response may be slow. Individual wells near the stagnation zone may show increases in contaminant concentrations during some points in time, as the plume shifts in response to changes in pumping.	2016: The Group 1 response threshold was triggered for the North Plume subgroup, with a no significant trend outcome. The Area Weighted Concentration (AWC) concentration for the Group 1 North Plume was 27 µg/L in FY 2016, down from 37 µg/L in FY 2015. This value represents a weighted estimate of the average total VOC concentration just downgradient of the TGRS. The Group 1 response threshold was triggered for the South Plume subgroup, with a stable outcome. The AWC for the South Plume was 4 µg/L and has been 4 µg/L over the analysis period (since 2007).
Group 2: Plume Edge Wells	This zone includes wells that define the edges of the plume downgradient of the TGRS. These are wells with low concentrations of VOCs (<100 µg/L) that will indicate a reduction in overall	2016: Nine wells exhibited "increasing" or "no significant trend" trends in FY 2016, which triggered the thresholds identified for Group 2.

Well Group	Function	FY 2016 and FY 2017 Trends
	plume size if VOC concentrations continue to decline.	2017: Well 04U877 exhibited "no significant trend." The trend at this well has previously been identified as stable. While results have varied less than 1.0 µg/L (between 0.34 µg/L and 1.2 µg/L) since 2005, the erratic increases and decreases in TCE concentrations over the years has resulted in a high "p-value" and no significant trend outcome for this well.
Group 3: Downgradient Sentinel Wells	This is a zone downgradient of the NBCGRS stagnation zone. This group includes three wells but more accurately is defined as a geographic area immediately downgradient of the NBCGRS. This group should help demonstrate improvement due to the VOC mass removal by the NBCGRS over time, analogous to Group 1 and the TGRS.	2016: The trend in the AWC for the Group 3 (downgradient sentinel wells) was probably decreasing. The Group 3 AWC was 17 µg/L in FY 2016, down slightly from 19 µg/L in FY 2015.
Group 4: Lateral Sentinel Wells	These are "clean" wells downgradient of the TGRS that are beyond the current plume boundaries. These wells should help identify large, unexpected, lateral changes in plume configuration, such as a shifting or expansion of the plume boundary.	2016: In Group 4, four wells exceeded the TCE cleanup level during FY 2016: 03L811 at 9.3 µg/L in June 2016; 04U839 at 43 µg/L in February 2016 and 50 µg/L in June 2016; 04U855 at 21 µg/L in June 2016; and 04U879 at 17 µg/L in February 2016 and 20 µg/L in June 2016. All four wells exceeded the cleanup level in FY 2015 as well; however, there appears to be an increasing trend at all four wells since 2011. The four wells are all located on the west/northwest edge of the plume between TCAAP and the NBCGRS. The higher detections in FY 2016 may have been influenced by shutting down the NBCGRS, which may allow a slight shifting and/or widening of the plume to the west. All other Group 4 wells were below the TCE cleanup level during FY 2016.
Group 5: Global Plume Mass Wells	This group includes all the monitoring wells necessary to construct a contour map of the VOC plume. Production wells are not used in Group 5 since the data may not be comparable to monitoring well data. Some wells located within OU2 are included in Group 5 to support the contouring near the OU2 boundary. This group reflects the overall VOC mass in the aquifer and should show an overall reduction in VOC mass over time.	2016: The trend in the Group 5 (global plume mass wells) was probably increasing with an AWC of 44 µg/L, a slight increase from the FY 2015 result of 41 µg/L. The AWC represents a weighted average of the overall Unit 4 plume concentration. For Group 5 Unit 3 wells, wells already in Group 2 were not included. Three wells in this group triggered a threshold: 409550, 03U822, and 03L809 (all had no significant trend). Other wells included in this group had a conclusion of decreasing, except for the three abandoned wells included in the group (409597, 409596, and 03U831).

Well Group	Function	FY 2016 and FY 2017 Trends
Group 6: Jordan Wells	The group includes all Jordan monitoring wells, the Prairie du Chien wells nested with them, and NBM Wells #3, #4, #5, and #6. The inclusion of the Prairie du Chien wells is to facilitate comparing the trends between it and the Jordan at these locations. This group will help identify any changes in the plume occurring in the Jordan portion of the aquifer.	2016: In total, eight OU1 Jordan wells exhibited "Stable," "No Significant Trend," "Probably Increasing," or "Increasing" trends in FY 2016, which triggered the thresholds identified for Group 6. 2017: 04J847 (Increasing): This well is located just downgradient of the TGRS. TCE concentration increased from 790 µg/L in FY 2014 to 910 µg/L in FY 2016 and decreased to 780 µg/L in FY 2017. The 2017 APR determined the overall trend is still increasing and continued annual monitoring is appropriate given its central plume location. 04J849 (Increasing): This well had historically been a non-detect well. TCE was 0.7 µg/L in FY 2016 and jumped to 59 µg/L in FY 2017. The 2017 APR determined that continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

The area weighted analysis for Group 1 wells shows continuing overall improvement or stability in the plume. The trend in the Group 5 wells (global plume mass wells) show a slight increase of AWC at 44 µg/L, since the FY 2015 AWC of 41 µg/L; this still represents an overall decrease from an AWC of 51 µg/L over the past 20 years. Trend graphs for the OU1 monitoring wells that are routinely monitored are included in Appendix B of the FY 2016 APR. These graphs illustrate the long-term changes that have occurred throughout OU1.

The statistical analysis of groundwater quality for FY 2016 indicated there is continuing overall improvement or stability within the plume for overall VOCs.[6] Individual threshold triggers suggest movement within the established plumes, but do not suggest any problems with the remedial systems. Overall, the FY 2016 monitoring data indicates that aquifer restoration is occurring in the Prairie du Chien Group and Jordan Formation. No additional threshold triggers were identified in FY 2017. The 2017 APR found the statistical analysis of groundwater data shows continuing improvement in the OU1 plume through FY 2017. Refer to Table 14 and Table 15 (Section 9, Tables) for the statistical results for all monitoring wells reflecting the data collected for overall VOCs through FY 2016 and FY 2017, respectively.

Figure 9, Figure 10, and Figure 11 show the TCE plume depicted by depth and geology (5 µg/L for TCE) in the Upper and Lower Unit 3 Combined, Upper Unit 4, and Lower Unit 4 portions of the aquifer for FY 2017, along with cross-section lines, based on the summer 2016 and 2017 sampling events. Figure 9 presents the combined Upper and Lower Unit 3 TCE plume with the highest concentrations residing near the OU2 source areas. According to the FY 2017 APR,

[6] The VOC contaminants of concern are outlined in Table 2 (Section 9, Tables).

concentrations decline as the plume moves toward the southwest due to mass removal by the TGRS. Figures 10 and 11 present TCE plumes in the Upper and Lower Unit 4 bedrock including a conceptual representation of bedrock geology. Geologic and hydrogeologic studies performed for the area indicate eroded bedrock valleys are filled with overburden in proximity to the Site and TCE concentration isocontours follow the bedrock topography; however, data reviewed indicate the current groundwater monitoring system is capturing these apparent preferential pathways.

The FY 2016 APR found there were potentially a few well trends that may have been influenced by the NBCGRS shutdown on April 15, 2015; however, future monitoring results will need to be reviewed to determine whether a shift and/or widening of the OU1 plume to the west is occurring, and whether any other plume changes are occurring in response to the NBCGRS "remedy time-out." The 1 µg/L and 100 µg/L TCE plume outline has slightly shifted to the northwest since 2009. The FY 2017 APR concluded this was likely due to the "remedy time-out." Figure 26 shows the 1 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2017. Figures 27 and 28 depict cross-sections showing both the OU1 and OU3 plumes, which overlap to some extent and should be viewed together. Figure 29 depicts the 100 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2017. Other differences between 2009 and 2017 plumes are due to plume reinterpretation by Pika Arcadis U.S., Inc. (JV) as part of the OU Remedy Review (June 2018). According to the OU Remedy Review report, the trends show a steady OU1 TCE plume footprint. Comparison of the OU1 TCE plume footprint over the past 20 years, as summarized in the last four five-year reviews, indicates a stable OU1 bedrock TCE plume footprint. The OU Remedy Review was conducted to evaluate optimization strategies for the TGRS (a review of new technologies is a remedy component for deep groundwater in OU2). The OU Remedy Review is further discussed in Sections 5.1.3 and 5.4.1.

4.3.5 Site Inspection – 2018

Two representatives of DAWSON, Amir Matin and David Boyes, participated in a site inspection of the newly renovated New Brighton water treatment facility on November 1, 2018. A tour of the facility was given by Scott Boller, the New Brighton Public Works Superintendent, and Julia Macejkovic, the project engineer from Barr Engineering (contracted by New Brighton to provide design and construction oversight services). Although the site was still under construction, the new 1,4-dioxane treatment system was completely installed and undergoing procedural start up processes. A complete description of the Trojan UVPhox patented technology system, as well as the existing PGAC system was provided. Given the remedy time-out, no problems were noted that would affect remedy protectiveness during the site inspection; the existing PGAC system was being maintained and functional while the UVPhOx system was being installed. A site inspection checklist for OU1 was completed and is included as Appendix B.1.

4.3.6 Interviews

The following individuals were contacted prior to and during the site visit conducted during the period of October 29 to November 2, 2018 and voluntarily provided in person interviews:

- Katy Grant, Geologist, Arcadis
- Rich Straumann, Chair Person, Arden Hills Parks and Recreation
- Scott Boller, Public Works Superintendent, City of New Brighton
- Rob Field, Plant Operator, GHD
- Shawn Horn, Vice President, GHD
- Mary Lee, Environmental Protection Specialist, MNARNG
- Amy Hadiaris, Hydrogeologist, MPCA
- David Brown, Project Manager, Northrup Grumman Innovation Systems
- Lyle Salmela, Restoration Advisory Board Chair
- Josh Olson, Ramsey County Development Program
- Paul Bloom, Professor, University of Minnesota
- Nick Smith, Environmental Engineer, USAEC

Interview questions and responses are included in Appendix F. In general, interviewees had a positive overall impression of the project with respect to human health and environmental protection and felt remedies were being well maintained. In addition, all interviewees felt well informed of project activities. Amy Hadiaris, a hydrogeologist with MPCA, stated that she was aware of the proposed schedule for the New Brighton treatment system coming back on line with the 1,4-dioxane treatment in place. Scott Boller, the superintendent of the New Brighton water treatment plant, discussed the challenges associated with the discovery of 1,4-dioxane and subsequent plant closure and was pleased the Trojan UVPhOx system was now installed and the plant would be back on line very soon.

4.4 TECHNICAL ASSESSMENT

4.4.1 *Question A:* Is the Remedy functioning as intended by the ROD?

No, the OU1 remedy is not functioning as intended by the ROD (as amended in 2006). The review of RAOs, documents, and monitoring data indicate three of the six OU1 remedy components have been functioning as intended by the ROD (as amended in 2006). The three OU1 remedy components that are functioning as intended by the ROD (as amended in 2006) are listed below in Table 4-5, along with the RAOs that they are meeting.

Table 4-5 Functioning Remedy Components and Associated RAOs

Remedial Action Components	Remedial Action Objectives
#1–Alternate water supply/well abandonment, #2 – Drilling advisories, and #6 – Groundwater monitoring to verify effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations.	a) Prevent human exposure to water contaminated with carcinogens in excess of the MCLs, RALs, and HRLs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than MCLs, RALs, and HRLs or having a threshold noncancer hazard index greater than 1.0.

The Alternate Water Supply and Well Abandonment Program (remedy component #1) has been implemented and is ongoing. For this Five-Year Review period, no new recommendations for well abandonment or alternate water supply were made for the OU1 remedy.

The LUC for OU1 is the MDH Special Well Construction Area Advisory (#2), which continues to function as intended.

Groundwater sampling was conducted in accordance to the monitoring plan in the APR. Groundwater samples were analyzed at all programmed OU1 sampling locations under remedy component #6. Table 4-7 (Arcadis, 2017; Section 9, Tables) summarizes the statistical results for all monitoring wells reflecting the data collected through FY 2017. A statistical assessment was performed annually to verify the effectiveness of the remedy through measurements of overall plume shrinkage and decreasing contaminant concentrations. Table 4-7 includes an assessment of the statistical thresholds that were triggered in the analysis and brief comments addressing these threshold triggers. Analysis of the NBM well trends using a linear regression for data since 1998 showed downward concentration trends for all the New Brighton wells, except NBM #3 and #4, which show a slight upward trend (see Figure 25).

A slight northward shift of TCE contours north of the NBCGRS can be seen on the northwest edge of the plume; the FY 2017 APR concluded this was likely a result of the NBCGRS "remedy time-out" since April 2015. The FY 2017 APR found the statistical analysis of groundwater data shows continuing improvement in the OU1 plume through FY 2017.

After the remedy time-out in 2015, only limited operation and maintenance (O&M) operations took place: limited pumping of the extraction wells occurred for non-supply plant operations, such as filter backwashing. No opportunities for OU1 remedy optimization were identified.

The review of RAOs, documents, and monitoring data indicate three of the six OU1 remedy components have not been functioning as intended by the ROD (as amended in 2006). The three OU1 remedy components that are **not** functioning as intended are listed below, along with the RAOs that they are **not** meeting.

Table 4-6 Non-Functioning Remedy Components and Associated RAOs

Remedial Action Components	Remedial Action Objectives
#3 – Extracting groundwater from the North Plume using the NBCGRS, #4 – Removal of VOCs by a pressurized GAC system, and #5 – Discharging all of the treated water to the NBM distribution system.	c) Restore the aquifer to its highest use, i.e., potability, as defined by the most stringent and promulgated state and federal standards. d) Contain the plume within the boundary of County Road E (to the extent practicable) while also maximizing mass removal. e) Prevent ecological exposure to contaminants.

These three OU1 remedy components are not functioning as intended because the operation of the NBCGRS has been suspended since April 15, 2015, due to the detection of the emerging contaminant, 1,4-dioxane, in New Brighton's water supply. Operation of the OU1 remedy will resume with the completion of the construction modification to the NBCGRS treatment plant which includes installation of a new UVPhox treatment system. At the time of the site visit, the new treatment system, which will address ROD COCs and 1,4-dioxane, was installed and undergoing procedural start up processes.

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

Yes. The assumed route of exposure to contaminated groundwater (through ingestion, inhalation during showering, and absorption through the skin during showering or bathing) remains valid. VI as a potential exposure route was considered. The deep groundwater plume, which occurs in Units 3 and 4, is blanketed by Units 1 and 2 (Fridley and Twin Cities Formations), which are alluvial sand and glacial till. Within Units 1 and 2 there is a perched groundwater aquifer system which together with the Unit 2 glacial till form an impermeable boundary for vapor diffusion/migration. These units and the perched aquifer system occur above of the off-Site plumes (OU1 and OU3).

The perched groundwater is not connected to the deep groundwater plume and is not considered to be a source for VI risk. There is no exposure route for VI in OU1 deep groundwater. In other words, the VI pathway for contaminated groundwater degassing is incomplete for the deep groundwater plume in OU1. No new exposure routes are applicable. No changes in land use have occurred that would have a bearing on the remedy. An emerging contaminant, 1,4-dioxane, was identified in 2015; 1,4-dioxane is not a contaminant that was addressed in the OU1 ROD or ROD Amendment.

The cleanup levels for OU1 listed in the OU1 ROD are in Table 16 (Arcadis, 2017; Section 9, Tables), and Table 4-7 below. The cleanup levels were based on consideration of the following Applicable or Relevant and Appropriate Requirements (ARARs), as identified in the OU1 ROD:

- MCLs and non-zero MCLGs specified in the National Primary Drinking Water Regulations (40 CFR Part 141), which apply to public water supplies, and which were established by USEPA in accordance with the SDWA.

- HRLs specified in Minnesota Rules (4717.7100 to 4717.7800), which can be applied to private water supplies, and which were established by the MDH in accordance with Minnesota's Groundwater Protection Act of 1989.

- RALs for Drinking Water Contaminants, Release 3, January 1991, prepared by the MDH.

The cleanup levels developed in the OU1 ROD utilized the lowest value among the MCL, non-zero MCLG, HRL, and RAL. At the time of the OU1 ROD, two of the MCLs were identified as proposed, and only two HRLs were available (both identified as proposed). The review of the current regulations revealed that, five of the six OU1 COCs have either MCLs, MCLGs, and/or HRLs that have been established (none of which are qualified as proposed). One COC, 1,1-dichloroethane, does not have an MCL, MCLG, or HRL. The 1,1-dichloroethane cleanup level was based on the RAL of 70 µg/L, which is no longer in use by MDH (MDH has replaced RALs with HRLs); however, the ROD has set the cleanup standards and does not need to coincide with MDH and HRL standards. In 2016, the MDH published a guidance value of 80 µg/L as the chronic Risk Assessment Advice (RAA) for 1,1-dichloroethane. Please see Table 4-7 below for more information.

Table 4-7 ROD Cleanup Standards and Current Agency Limits

Chemical Name	ROD Cleanup Standards (µg/L)	ROD Cleanup Standards Basis	Current USEPA MCL [a] (µg/L)	MDH Standard (µg/L)	Type and Date of MDH Value
1,1-Dichloroethane	70	RAL[b]	none	80	RAA16[c]
1,1-Dichloroethene	6	HRL	7	200	HRL11[d]
cis-l,2-Dichloroethene	70	MCL, RAL	70	6	HRL18[d]
1,1,1-Trichloroethane	200	MCL	200	5,000	HRL18[d]
1,1,2-Trichloroethane	3	MCLG (proposed), HRL	5	3	HRL93[d]
TCE	5	MCL	5	0.4	HRL15[d]

Notes:
[a]The Maximum Contaminant Level (MCL) values were taken from Environmental Protection Agency's (EPA)'s Regional Screening Level (RSL) Summary Table (November 2018) which can be found here: https://semspub.epa.gov/work/HQ/197414.pdf
[b]RAL = Recommended Allowable Limit were replaced with the HRLs.
[c]RAA = Risk Assessment Advice. The digit refers to the year.
[d]HRL = Health Risk Limit. The digit refers to the year. The MDH HRL standards "Comparison of State Water Guidance and Federal Drinking Water Standards" on the MDH website (September 2018), can be found here: https://www.health.state.mn.us/communities/environment/risk/guidance/gw/table.html
MCLG = Maximum Contaminant Level Goal
MDH = Minnesota Department of Health
ROD = Record of Decision
µg/L = Micrograms/Liter

In 2015, MDH updated the drinking water guidance for TCE due to new toxicity and health effects information. The updated HRL for TCE is 0.4 µg/L, which is lower than the Federal MCL of 5 µg/L. The TCE values do not affect current protectiveness because the OU1 remedy components of Alternate Water Supply combined with LUCs (SWBCA) prevent the use of contaminated groundwater.

MDH has also updated HRL standards since the publication of the ROD, for 1,1,2-tricloroethane (3 µg/L) and cis-l,2-dichloroethene (6 µg/L) in 2015 and 2018, respectively. The new HRL for 1,1,2-tricloroethane is set equal to the MCL. However, the HRL for cis-l,2-dichloroethene is now lower than the previous ROD cleanup standard (MCL) of 70 µg/L. The OU1 remedy components #1 (Alternate Water Supply) combined with LUCs OU1 remedy components #2 (drilling Advisory) prevent the use of contaminated groundwater, meeting the RAO.

The 2006 ROD Amendment did not change the ARARs for OU1. The cleanup levels are still valid. Since the remedy cleanup standards are ARARs, changes in toxicity, containment characteristics,

and risk assessment methodology would not result in risk estimates that could affect the protectiveness of the remedy.

The RAOs for OU1 remain valid and were unchanged by the ROD Amendment in 2006. No new objectives have been proposed. Due to the discovery of 1,4-dioxane in 2015, three of the six remedy components have been suspended and are not meeting the following RAOs:

f) Restore the aquifer to its highest use, i.e., potability, as defined by the most stringent and promulgated state and federal standards.

g) Contain the plume within the boundary of County Road E (to the extent practicable) while also maximizing mass removal.

h) Prevent ecological exposure to contaminants.

The remedy components will resume operations once modification of the New Brighton treatment system is complete and online, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCGRS wells can be safely restored. The system is anticipated to continue to meet the above RAOs at that time, to ensure protectiveness of human health and the environment. The remaining remedy components (Alternate water supply/well abandonment, drilling advisories, and groundwater monitoring with verification of aquifer restoration) are meeting the RAOs.

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

No other information has come to light that could call into question the protectiveness of the remedy.

4.4.4 Technical Assessment Summary

The OU1 remedy is not functioning as intended by the OU1 ROD and ROD Amendment. Three OU1 remedy components have been suspended in a "remedy time-out" since April 15, 2015, due to the detection of the emerging contaminant, 1,4-dioxane, in New Brighton's water supply:

#3 – Extracting groundwater from the North Plume using the NBCGRS,

#4 – Removal of VOCs by a pressurized GAC system, and

#5 – Discharging all the treated water to the NBM distribution system.

The "remedy time-out" has affected the protectiveness of the remedy, as the suspended remedy components are not meeting the RAOs. The NBCGRS will resume operations once modification of the New Brighton treatment system is complete and online, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCGRS wells can be safely restored. As noted previously, the new treatment system was installed and undergoing procedural start up processes

during the site visit. The system is anticipated to continue to meet the RAOs once pumping resumes. The remaining remedy components (Alternate water supply/well abandonment, drilling advisories, and groundwater monitoring with verification of aquifer restoration) are ongoing and are functioning as intended.

The assumed route of exposure to contaminated groundwater remains valid. No new exposure routes are applicable. No changes in land use have occurred that would have a bearing on the remedy. Since the remedy cleanup standards are ARARs, changes in toxicity, containment characteristics, and risk assessment methodology would not result in risk estimates that could affect the protectiveness of the remedy. The RAOs for OU1 remain valid

Currently, the LUCs that are in place prevent use of groundwater and assure protectiveness. No other information has been obtained that could call into question the protectiveness of the OU1 remedy.

4.5 ISSUES

Issues	Affects Protectiveness (Y/N)	
	Current	**Future**
The operation of the NBCGRS has been in a "remedy time-out" since 2015, which has suspended remedy components #3, #4, and #5 (extraction of groundwater, removal of VOCs by a pressurized GAC system, and discharging of treated water to the NBM distribution system). The remedy is not functioning as intended; this represents an issue affecting long-term protectiveness.	No	Yes
1,4-Dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology.	No	Yes

4.6 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affects Protectiveness (Y/N)	
				Current	Future
Actions (new treatment train, resumption of extraction, and discharging of treated water) are necessary to resume the remedy.	Army	MPCA & USEPA	End of FY 2024	No	Yes
Issue a decision document to address 1,4-dioxane contamination and implement a remedy.	Army	MPCA & USEPA	End of FY 2024	No	Yes

4.7 PROTECTIVENESS STATEMENT

The remedy at OU1 currently protects human health and the environment because the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur.

However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure protectiveness in the long term:

#3 Extracting groundwater from the North Plume using the NBCGRS;

#4 Removal of VOCs by a pressurized GAC system, and

#5 Discharging all the treated water to the NBM distribution system.

In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination and implement a remedy. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.

5.0 OPERABLE UNIT 2

5.1 OU2 REMEDIAL ACTIONS

5.1.1 OU2 Remedy Action Objectives

RAOs were developed for OU2 shallow soil sites, deep soil sites, and groundwater in the OU2 FS (March 1997) and were addressed by the OU2 ROD (December 1997). The OU2 ROD, which is referred to as "ROD" throughout this section, has been modified by two Explanations of Significant Difference (ESDs) and six ROD Amendments, most recently in 2017. The RAOs are designed to protect human health and the environment under the current and most probable future land use (industrial) scenario from exposure to contaminants in shallow soils, deep soils, and groundwater beneath the TCAAP site. During the timeframe of this Five-Year Review, the 2014 ROD Amendment #5 addressed the RAOs for the 135 Primer Tracer Area (PTA) and the MNARNG EBS Area. These were previously developed as part of the 2012 Engineering Evaluation/Cost Analysis (EE/CA). The RAOs for shallow soil sites, deep soil sites, and groundwater sites are outlined in Table 5-1 below. The RAOs that were added by ROD Amendment are show in italics.

Table 5-1 OU2 Remedial Action Objectives

Site	Media	Remedial Action Objectives
Sites A, C, E, H, 129-15, 129-3, 129-5, the Grenade Range, and the Outdoor Firing Range	On-TCAAP surface soils (0-12 feet below ground surface)	a) Prevent on-site human exposure by means of ingestion and dermal contact with contaminants in the surface soils *(or surface water sediments at Site C)*. b) Prevent human exposure by means of ingestion, dermal contact, and inhalation of contaminants in shallow soils *(or surface water sediments at Site C)* during any future construction activities at the site. c) Prevent the migration of contaminants from shallow soils to waters of the state that would result in dissolved contaminant concentrations in excess of ARARs and To Be Considered (TBCs).

Site	Media	Remedial Action Objectives
Site A, 135 PTA, and MNARNG EBS Area	On-TCAAP surface soils (0-12 feet below ground surface)	*d) Protect human receptors from unacceptable risk associated with ingestion and dermal contact exposure to contaminants in shallow soils.* ***(Amendment #5)*** *e) Prevent the leaching of contaminants from shallow soils to groundwater at levels that would cause unacceptable risk to human groundwater receptors.* ***(Amendment #5)***
Sites D and G	on-TCAAP Deep soils (12 feet below ground surface to water table)	Prevent the migration of contaminants from deep soils to groundwater that would result in dissolved contaminant concentrations in excess of groundwater ARARs and TBCs.
Sites A, C, D, G, I, K, 102	on-TCAAP groundwater	a) Prevent human exposure to water contaminated with carcinogens in excess of ARARs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than ARARs and having a threshold noncancer hazard index greater than 1.0. c) Contain and control contaminated groundwater in the shallow Unit 1[a] groundwater aquifer to prevent further spreading and minimize the level of contaminants through mass removal. d) *For Site C, protect human and ecological receptors from unacceptable risk associated with ingestion and dermal exposure to surface water above surface water chronic standards (****Amendment #1****)* e) Restore the contaminated aquifer to concentrations below ARARs and to-be-considered guidance (TBCs) with regulator approval. f) Contain the deep Units 3[b] and 4[c] groundwater plume source area while also maximizing mass removal.

Site	Media	Remedial Action Objectives
Sites A, C, D, G, I, K, 102 (Continued)	on-TCAAP groundwater (Continued)	*g) For Building 102 Groundwater: Protect human receptors from exposure to contaminated groundwater above acceptable risk levels* ***(Amendment #4).*** *h) For Building 102 Groundwater: *Prevent contaminated groundwater from discharging into surface water above regulatory limits.* ***(Amendment #4).*** *i) For Building 102 Groundwater: Minimize further degradation of the shallow Unit 1[1] groundwater* ***(Amendment #4).***

[a]: Unit 1 is an unconsolidated geologic unit with intermixed beds of sand and clay found on the surface at many locations at TCAAP. Unit 1 contains groundwater, but the aquifer yield is low, and the water is not used as a municipal source by any of the surrounding communities.

[b]: Unit 3, the Hillside Sand and the Arsenal Sand, lies beneath Unit 2 (a glacial till deposit) but is exposed at the surface in some areas of TCAAP. Unit 3 is a water bearing formation with high water yield; groundwater from Unit 3 has historically been utilized as a potable water supply.

[c]: Unit 4 is located directly below Unit 3 and consists of two bedrock units: the Prairie du Chien Group (Upper Unit 4), which overlies the Jordan Sandstone (Lower Unit 4). Unit 4 is a major aquifer for the Twin Cities area.

5.1.2 Remedy Selection

The ROD was signed in December 1997 and prescribed various components for each site's selected remedy. The ROD was amended six times starting in 2007 with ROD Amendment #1; in 2009 with ROD Amendment #2; in 2009 with ROD Amendment #3; through ESDs #1 and #2 also issued in 2009; in 2012 with ROD Amendment #4; in 2014 with ROD Amendment # 5; and then in 2017 with ROD Amendment #6. The applicable ROD Amendments and ESDs for each site in OU2, as well as the current remedy components and their implementation status are summarized in Table 5-2 below. The location of OU2 and the sites within OU2 are illustrated on Figure 1 (Section 10). These site types and remedy components are discussed in greater detail in the sections below.

ROD Amendments #5 and #6 were implemented during the timeframe of this Five-Year Review (2014 and 2017, respectively) and are the primary focus of this report. The components of the remedy implemented prior to this Five-Year Review are discussed in previous reports.

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Table 5-2 OU2 ROD Amendments and Remedy Components

SITE	TYPE	COCs	APPLICABLE ROD AND ROD AMENDMENTS			REMEDY COMPONENTS	IMPLEMENTATION
A	Shallow Soil Site	Metals & VOCs	OU2 ROD ESD #2 ROD AMENDMENT #5	1997 2009 2014	Specified nine remedy components Specified LUCs as an additional remedy component Documented previously completed soil removal actions and specified LUCs at Site A	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Remedy components #1 through #9 have been completed.* Implementation of remedy component #10, LUCs, is ongoing.
	Shallow Groundwater	Metals and VOCs	OU2 ROD ESD #1 ROD AMENDMENT #6	1997 2009 2017	Specified five remedy components Clarified the LUC component of OU2 ROD Documented that MNA will be utilized in lieu of two remedy components from the OU2 ROD	#1: Groundwater monitoring, #2A: LUCs, #2B: Alternate Water Supply/Well Abandonment, #3: Source Characterization/ Remediation, and #4 MNA	Remedy component #3 has been completed.* Implementation of remedy components #1, #2A, #2B, and #4 are ongoing.
C	Shallow Soil Site	Metals & VOCs	OU2 ROD ROD AMENDMENT #1 ESD #2	1997 2007 2009	Specified nine remedy components Specified LUCs as an additional remedy component at Site C-2 Specified LUCs as an additional remedy component at Site C-1	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Remedy components #1 through #9 have been completed.* Implementation of remedy component #10, LUCs, is ongoing.
	Shallow Groundwater	Lead	ROD AMENDMENT #1	2007	Specified four remedy components and incorporated the existing groundwater extraction system as the final remedy	#1: Groundwater and Surface Water Monitoring, #2: Groundwater Containment, #3: Discharge of Extracted Water, and #4: LUCs.	Remedy components #2 and #3 have been completed.* Implementation of remedy components # 1 and #4 are ongoing.
D	Deep Groundwater	VOCs (including TCE	OU2 ROD ESD #1	1997 2009	Specified five remedy components Clarified the LUC component of the OU2 ROD	#1: Hydraulic Containment and Contaminant Removal from the Source Area, #2: Groundwater Treatment, #3: Treated Water Discharge, #4: Institutional Controls #5: Review of New Technologies, and #6: Groundwater Monitoring.	Implementation of remedy components #1 through #6 are ongoing.
	Deep Soil Site	VOCs (including TCE)	OU2 ROD ROD AMENDMENT #3	1997 2009	Specified seven remedy components Documented the removal of shallow soils at Site D	#1: Groundwater Monitoring; #2: Restrict Site Access (During Remedial Actions), #3: SVE Systems, #4: Enhancements to the SVE Systems, #5: Maintain Existing Site Caps, #6: Maintain Surface Drainage Controls, and #7: Characterize Shallow Soils and Dump.	Remedy components #2 through #7 have been completed.* Implementation of remedy component #1 is ongoing as part of OU2 Deep Groundwater Monitoring.

Table 5-2. OU2 ROD Amendments and Remedy Components (Continued)

SITE	TYPE	COCs	APPLICABLE ROD AND ROD AMENDMENTS			REMEDY COMPONENTS	IMPLEMENTATION
E	Shallow Soil Site	Metals	OU2 ROD ROD AMENDMENT #3	1997 2009	Specified nine remedy components Documented the use of a soil cover at Site E	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Active remedy components #1 through #9 have been completed. Implementation of remedy component #10, LUCs, is ongoing.
G	Deep Groundwater (Unit 3, Lower Unit 3, & Unit 4)	VOCs including TCE	OU2 ROD ESD #1	1997 2009	Specified five remedy components Clarified the LUC component of the OU2 ROD	#1: Hydraulic Containment and Contaminant Removal from the Source Area, #2: Groundwater Treatment, #3: Treated Water Discharge, #4: Institutional Controls #5: Review of New Technologies, and #6: Groundwater Monitoring.	Implementation of remedy components #1 through #6 are ongoing.
	Deep Soil Site	VOCs including TCE	OU2 ROD ROD AMENDMENT #3	1997 2009	Specified seven remedy components Documented the additional actions performed for the dump at Site G and the use of a soil cover at Site G	#1: Groundwater Monitoring; #2: Restrict Site Access (During Remedial Actions), #3: SVE Systems, #4: Enhancements to the SVE Systems, #5: Maintain Existing Site Caps, #6: Maintain Surface Drainage Controls, and #7: Characterize Shallow Soils and Dump.	Active remedy components #2 through #7 have been completed. Implementation of remedy component #1 is ongoing as part of OU2 Deep Groundwater Monitoring.
H	Shallow Soil Site	Metals	OU2 ROD ROD AMENDMENT #3	1997 2009	Specified nine remedy components Documented the use of a soil cover at Site H	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Active remedy components #1 through #9 have been completed. Implementation of remedy component #10, LUCs, is ongoing.
I	Shallow Groundwater (Unit 1)	VOCs	OU2 ROD ROD AMENDMENT #2	1997 2009	Specified four remedy components Revised the OU2 ROD remedy components to three remedy components.	#1: Groundwater Monitoring, #2: Additional Investigation, and #3: LUCs.	Active remedy component #2 has been completed. Implementation of remedy components #1 and #3 are ongoing.
	Deep Groundwater (Unit 3, Lower Unit 3, & Unit 4)	VOCs	OU2 ROD ESD #1	1997 2009	Specified five remedy components Clarified the LUC component of the OU2 ROD	#1: Hydraulic Containment and Contaminant Removal from the Source Area, #2: Groundwater Treatment, #3: Treated Water Discharge, #4: Institutional Controls #5: Review of New Technologies, and #6: Groundwater Monitoring.	Implementation of remedy components #1 through #6 are ongoing.

Table 5-2. OU2 ROD Amendments and Remedy Components (Continued)

SITE	TYPE	COCs	APPLICABLE ROD AND ROD AMENDMENTS			REMEDY COMPONENTS	IMPLEMENTATION
K	Shallow Groundwater (Unit 1)	VOCs including TCE	OU2 ROD ESD #1	1997 2009	Specified seven components Added LUCs as a remedy component	#1: Groundwater Monitoring, #2: Sentinel Wells, #3: Hydraulic Containment, #4: Groundwater Treatment, #5: Treated Water Discharge, #6: Discharge Monitoring, #7: Additional Investigation, and #8: LUCs.	Active remedy component #2 and #7 have been completed. Implementation of remedy components #1, #3 through #6, and #8 are ongoing.
129-3	Shallow Soil Site	Metals, nitroglycerin, and VOCs	OU2 ROD ESD #2	1997 2009	Specified nine remedy components Specified LUCs as an additional remedy component	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Active remedy components #1 through #9 have been completed. Implementation of remedy component #10, LUCs, is ongoing.
129-5	Shallow Soil Site	Metals	OU2 ROD ESD #2	1997 2009	Specified nine remedy components Specified LUCs as an additional remedy component	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Active remedy components #1 through #9 have been completed. Implementation of remedy component #10, LUCs, is ongoing.
129-15	Shallow Soil Site	Lead and PAHs	OU2 ROD ROD AMENDMENT #3	1997 2009	Specified nine remedy components Documented the use of a soil cover at Site 129-15	#1: Characterization, #2: Excavation, #3: Sorting, #4: Treatment, #5: Disposal, #6: Site Restoration, #7: Site Access Restrictions, #8: Limited Post-Remediation Groundwater Monitoring, #9: Characterization of Dumps (Sites B & 129-15), and #10: LUCs.	Active remedy components #1 through #9 have been completed. Implementation of remedy component #10, LUCs, is ongoing.
Grenade Range	Shallow Soil Site	Metals	ROD AMENDMENT #3	2009	Documented the final remedy for this site that was not included in the original OU2 ROD and specified LUCs as an additional remedy	#1: LUCs.	Implementation of remedy component #10, LUCs, is ongoing.
Outdoor Firing Range	Shallow Soil Site	Metals and PAHs	ROD AMENDMENT #3	2009	Documented the final remedy for this site that was not included in the original OU2 ROD and specified LUCs as an additional remedy	#1: LUCs.	Implementation of remedy component #10, LUCs, is ongoing.
Building 102	Shallow Groundwater (Unit 1)	VOCs	ROD AMENDMENT #4	2012	Selected MNA and LUCs as the remedy for Building 102 groundwater	#1: MNA, #2: Groundwater Monitoring, and #3: LUCs.	Implementation of remedy components #1 through #3 are ongoing.

Table 5-2. OU2 ROD Amendments and Remedy Components (Continued)

SITE	TYPE	COCs	APPLICABLE ROD AND ROD AMENDMENTS			REMEDY COMPONENTS	IMPLEMENTATION
MNARNG EBS	Shallow Soil Site	PAHs	ROD AMENDMENT #5	2014	Documents previously-completed soil removal actions and selected LUCs as the remedy	#1: LUCs.	Implementation of remedy component #1, LUCs, is ongoing.
135 PTA	Shallow Soil Site	PAHs	ROD AMENDMENT #5	2014	Documents previously-completed soil removal actions and selected LUCs as the remedy	#1: LUCs.	Implementation of remedy component #1, LUCs, is ongoing.

5.1.2.1 Shallow Soil Sites

There are nine (9) shallow soil sites with inorganic and/or organic contaminants above site cleanup goals; Sites A, C, E, H, 129-3, 129-5, 129-15, the Grenade Range, and the Outdoor Firing Range. ROD Amendment #5 added sites MNARNG EBS and 135 PTA to OU2, increasing this number to eleven (11). Unpermitted landfills, or dumps, exist within Sites A, B, E, H, and 129-15. Sites B and 129-15 are included solely as dumps. The selected remedy for the shallow soil sites will attain the site cleanup levels specified in the OU2 ROD (outlined in Table 16 of this report, Section 9, Tables). Remedy components 1 through 9 of the OU2 ROD have been completed, but the following components are currently being implemented.

- The OU2 ROD Amendments and ESDs made LUCs a part of the remedy for shallow soil and dump sites where contamination remains in-place above levels that allow for UU/UE. LUCs also are necessary to protect the integrity of the soil covers constructed at various sites (ROD Amendment #3 and ESDs).

- OU2 ROD Amendment #5 addresses soil areas of concern (AOCs) where a removal action has been completed (Site A, 135 PTA, and EBS Areas), and industrial use cleanup levels were met. Since the removal action has already been implemented, Amendment #5 documents the completed Removal Action constitutes the final remedy for these soil areas of concern and that the only additional remedial action required is implementation of a LUC. The selected remedy for the soil AOCs is NFA with LUCs. This LUC restricts property uses to those that are compatible with the exposure assumptions used to derive the cleanup levels.

5.1.2.2 Deep Soil Sites (D and G)

These sites were designated as such because they were impacted primarily by VOC contaminants at depths of 50 to 170 feet. Some additional shallow soil contaminants existed at Site D. Site G also contains a dump. The selected remedy for these sites will attain the site cleanup levels specified in the OU2 ROD. The deep soil requirements of the OU2 ROD have been completed; however, the following remedy component is ongoing:

- Groundwater monitoring. This is being done as part of OU2 Deep Groundwater Monitoring (see Subsection 5.1.1.5).

5.1.2.3 Shallow Groundwater Sites (A, C, I, K, and Building 102)

Sites A, I, K, and Building 102 have been primarily impacted by VOCs, and Site C has been impacted by lead. Site cleanup levels are outlined in Table 16 (Section 9, Tables). The following paragraphs address these five sites.

Site A

The selected remedy for Site A shallow groundwater will attain the site cleanup levels specified in the OU2 ROD and includes the following components that are currently being implemented:

- Groundwater monitoring to track plume migration and remedy performance;
- Institutional controls to restrict new well installations and provide alternate water supplies and well abandonment as necessary (OU2 ESD #1 clarified the LUC component affecting Unit 1 to include protection of the groundwater monitoring and extraction system infrastructure);
- Monitored natural attenuation (MNA) will be utilized in lieu of two remedy components specified in the 1997 ROD: (1) Groundwater containment and mass removal, and (2) Discharge of extracted groundwater to a POTW (ROD Amendment #6).

Site C

The selected remedy for Site C shallow groundwater will attain the site cleanup levels specified in the 2007 ROD Amendment #1 and includes the following components that are currently being implemented:

- Groundwater and surface water monitoring to verify plume containment and remedy performance, and with a contingency plan to contain and treat contaminated surface water, if necessary (ROD Amendment #1);
- LUCs to restrict new well installations within the plume area and to protect the extraction, treatment, and monitoring systems (ROD Amendment #1).

Site I

The selected remedy for Site I shallow groundwater will attain the site cleanup levels specified in the OU2 ROD and includes the following components that are currently being implemented:

- Groundwater monitoring to track remedy performance[7];
- LUCs to protect the groundwater monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer (ROD Amendment #1).

Site K

The selected remedy for Site K shallow groundwater will attain the site cleanup levels specified in the OU2 ROD and will include the following components that are currently being implemented:

[7] All Site I monitoring wells were sealed prior to the demolition of Building 502; only one well is scheduled to be replaced, which could be delayed beyond FY 2018 due to the extent of pending regrading associated with planned site redevelopment.

- Groundwater monitoring to track remedy performance;
- Use of the existing interceptor/recovery trench to contain the plume and remove impacted groundwater;
- Treatment of extracted groundwater using air stripping;
- Discharge of treated groundwater to Rice Creek;
- Monitoring to track compliance with discharge requirements;
- Additional characterization of the unsaturated Unit 1 soil; and
- LUCs to protect the groundwater extraction, treatment, and monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer (ROD Amendment #1).

Building 102

The selected remedy for Building 102 shallow groundwater will attain the site cleanup levels specified in the 2012 OU2 ROD Amendment #4 and will include the following components that are currently being implemented:

- Use of naturally-occurring abiotic degradation to limit plume mobility and to ultimately restore the aquifer (ROD Amendment #4);
- Groundwater monitoring to track remedy performance and to verify that groundwater reaching Rice Creek does not exceed state surface water standards (ROD Amendment #4); and
- LUCs to restrict installation of water supply wells into the contaminated portion of the Unit 1 aquifer and to protect the infrastructure related to this alternative (monitoring wells) (ROD Amendment #4).

5.1.2.4 Deep Groundwater

Includes the deep groundwater plume that underlies the southwestern portion of OU2 and originated primarily from Sites D, G, and I. The selected remedy for Deep Groundwater will attain the site cleanup levels specified in the OU2 ROD and includes the following components that are currently being implemented:

- Groundwater extraction to hydraulically contain the contaminated groundwater source area to the 5 µg/L TCE concentration contour and optimize the removal of contaminants from the source area through pumping of selected wells;
- Groundwater treatment using air stripping;
- Discharge of treated groundwater to the on-site gravel pit;

- Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater;
- Reviews of new and emerging technologies that have the potential to cost-effectively accelerate the timeframe for aquifer restoration. Reviews shall be performed by the Army and reported on annually in accordance with the consistency provisions of the TCAAP FFA; and
- Groundwater monitoring to track remedy performance.

5.1.3 Remedy Implementation

5.1.3.1 Shallow Soil Sites

All active remedy components have been completed for the shallow soils and dumps at the eleven sites. LUCs will continue to be enforced. Please refer to the previous Five-Year Review for historical remedy implementation activities specific to these sites.

During the timeframe covered by this Five-Year Review, shallow soil sites Site A, MNARNG, and 135 PTA had removal actions that were addressed through the ROD Amendment #5. The soil cleanup levels for the three sites were based on soil reference values (SRVs) for an industrial use scenario. Because the 2013 removal action at Site A was in such close proximity to the earlier Site A soil remediation work, the previously established site-specific cleanup levels for Site A were used. Soil excavation and off-site disposal work was implemented in May and June 2013, with a total of 1,846 tons of contaminated soils removed from the various soil AOCs, collectively (Site A, the eastern portion of the 135 PTA, and the MNARNG EBS areas). A portion of these soils (711 tons) were stabilized prior to transport to the landfill and the excavation areas were backfilled to the approximate pre-excavation grades. The Removal Action Completion Report documenting this work was approved by USEPA and MPCA on November 15, 2013. ROD Amendment #5 documented the Removal Action constitutes the final remedy for these soil areas of concern and the only additional remedial action required is the continued implementation of a LUC. The LUC restricted property uses to those that are compatible with the exposure assumptions used to derive the cleanup levels. The same type of LUCs are already being implemented at other TCAAP sites and the OU2 LUCRD is already approved and being implemented. The status at the end of FY 2018 was as follows below.

Table 5-3 Shallow Soil Sites Data Review

Shallow Soil Sites	Remedy Component #10 LUCs	Excavated, Treated (Stabilized), and Transported
A	Implemented	16,226 cubic yards metals- contaminated soil
C	Implemented	21,450 cubic yards of metals- and VOC-contaminated soil

Shallow Soil Sites	Remedy Component #10 LUCs	Excavated, Treated (Stabilized), and Transported
E	Implemented	21,097 cubic yards of metals-contaminated soil
H	Implemented	8,615 cubic yards of metals-contaminated soil
129-3	Implemented	3,460 cubic yards of metals-, nitroglycerine-, and VOC-contaminated soil
129-5	Implemented	100 cubic yards of metals-contaminated soil
129-15	Implemented	Protective soil cover only (no excavation)
Grenade Range	Implemented	2,179 cubic yards of metals-contaminated soil
Outdoor Firing Range	Implemented	990 cubic yards of metals-contaminated soil
135 PTA Eastern Portion MNARNG EBS Areas	Implemented	1,846 tons of metals- contaminated soil (To Industrial Standards)

5.1.3.2 Deep Soil Sites (D&G)

Groundwater monitoring for VOCs near the vicinity of these sites is being conducted as part of OU2 Deep Groundwater Monitoring in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR as seen in Figures 33 and 34. The remaining active remedy components have been completed.

5.1.3.3 Shallow Groundwater (Site A)

The containment system, which began operation May 31, 1994, originally consisted of a series of extraction wells as seen in Figure 35. The extraction wells, however, were shut off in FY 2008 and MNA was recommended to be implemented. Based on an Army Technical Memorandum, dated November 11, 2015, the Army recommended changing the remedy from extraction to MNA; both USEPA and MPCA approved this change. In FY 2017, the Army prepared a proposed plan and ROD Amendment #6 to formally document this change. The Source characterization/remediation component of the remedy has been completed. Sampling is conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. LUCs are being implemented by the Army.

5.1.3.4 Shallow Groundwater (Site C)

The 2007 ROD Amendment #1 prescribed four remedy components, of which only two (2) are currently being implemented: groundwater and surface water monitoring, and LUCs. Sampling is conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR.

Ramsey County completed additional soil investigation and cleanup on the 108 acres and achieved cleanup levels suitable for recreational use and unrestricted exposure. Therefore, the FY 2018 LUCRD Revision 5 changes the soil LUCs for the 108 acres to allow recreational use and documented that Site C is part of the 108 acres planned for transfer to Ramsey County. The LUCs for groundwater and a soil cover for Site C will remain in place. Site inspections for LUCs are conducted annually.

5.1.3.5 Shallow Groundwater (Site I Former Building 502)

The 2009 ROD Amendment #2 changed the preferred remedy from groundwater pump and treat to a groundwater monitoring based remedy. Additional investigation work is complete. The groundwater monitoring and implementation of LUCs components are ongoing.

Building 502 was the last building to be demolished in 2014 from the forty-four buildings that made up the former TCAAP. In FY 2014, all Site I (Building 502) Unit 1 monitoring wells were abandoned prior to the demolition of Building 502. Well abandonment was previously approved by USEPA and MPCA. Only one well was scheduled to be replaced, which was delayed beyond FY 2018 due to a delay in construction activities associated with planned site redevelopment by Ramsey County. No groundwater sampling was conducted from FY 2014 through FY 2017. Once reinstalled, the well will be sampled annually in accordance with the groundwater monitoring plan. LUCs are being implemented by the Army.

5.1.3.6 Shallow Groundwater (Site K Former Building 103)

Site K consists of seven remedy components that incorporated the existing groundwater extraction trench and air stripper that began operation in August 1986. The sentinel well installation component and additional investigation component have been completed. Extracted groundwater is treated by air stripping prior to discharge to a storm sewer that, in turn, discharges to Rice Creek. Effluent water quality must meet the substantive requirements of Document Number MNU000579 (MPCA), which contains the state-accepted discharge limits for surface water.[8] Sampling continues to be conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. The groundwater collection system continues to provide capture of the Unit 1 groundwater as designed. LUCs are being implemented by the Army.

In FY 2014, 15 monitoring wells in Unit 1 were permanently abandoned, as approved by both USEPA and MPCA on August 14, 2013, and May 7, 2014. Three of these wells were scheduled to be reinstalled in spring 2017; however, the scheduling was pushed to 2018 due to a delay in construction activities associated with site redevelopment by Ramsey County. The Building 103

[8] For state-accepted discharge limits (MDH Health Risk Limits), refer to Table 5-15, ROD Cleanup Standards & Current Agency (FEDERAL & STATE) Limits for Groundwater COCs on page 5-52.

slab was removed as part of these site redevelopment activities. An additional monitoring well was permanently abandoned in FY 2017.

5.1.3.7 Shallow Groundwater (Building 102)

Groundwater sampling is conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. There has been no change in the remedy since MNA. LUCs are being implemented by the Army.

5.1.3.8 Deep Groundwater

The TGRS system operates with 11 wells, including eight boundary extraction wells and three source control wells. Water from the extraction wells discharge into a common pressurized 12-inch force main that carries the extracted groundwater to the TGRS air stripping treatment system. The TGRS discharges treated water to the former Arsenal Sand and Gravel Pit. New and emerging technologies that have the potential to cost-effectively accelerate the timeframe for aquifer restoration are discussed in the APR. Optimization is an ongoing progress throughout the life of the active remediation. The Army evaluated optimization strategies for the TGRS and presented the results in a Deep Groundwater Characterization Report in January 2018 and a TCAAP OU Remedy Review in July 2018. The objective of the remedy review was to understand what changes can be made to source control operations and the TCAAP TGRS within OU2 that could help facilitate greater improvement in OU1 groundwater currently addressed via the NBCGRS. Opportunities for optimization that were identified by these reports are discussed in Section 5.4.1.

Sampling is conducted in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. LUCs are being implemented by the Army. On April 20, 2016, the MDH issued a memorandum updating the SWBCA that noted the rezoning of the TCAAP facility for future development and updated the SWBCA boundary to include the entirety of TCAAP.

5.1.4 Land Use Controls

LUCs are required to ensure the protectiveness of the various OU2 remedies. LUCs include any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, real property to prevent or reduce risks to human health and the environment (Department of Defense Policy on LUCs Associated with Restoration Activities, 2001). The OU2 ROD prescribed the following LUCs:

- For soil sites: “Restrict site access and use during remedy implementation.”
- For shallow groundwater Site A: “Institutional controls to restrict new well installations.”
- For deep groundwater: “Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater.”

The OU2 ESDs and ROD Amendments #2 and #3 to the OU2 ROD clarified the requirement for LUCs as part of the OU2 remedies. ROD Amendment #4 selected LUCs for Building 102 shallow groundwater. ROD Amendment #5 selected LUCs for sites Site A, the MNARNG EBS, and 135-PTA. Annual LUC inspections of OU2 sites are being conducted by the Army, MNARG, and PIKA; the most recent inspection checklist is included in Appendix C.

A LUCRD was prepared and approved by USEPA and MPCA in September 2010 and revised in June 2011, March 2015, August 2016, and March 2018. The 2016 Revision 4 of the OU2 LUCRD eliminated soil LUCs from 380 acres of the 427 acres transferred/leased to Ramsey County in 2013, following soil cleanup to levels consistent with UU/UE. This area includes Sites I, K, and Building 102. LUCs for other shallow soil sites were not affected by this revision. The 2018 Revision 5 of the OU2 LUCRD revised LUCs to allow recreational use on 108 acres in the western portion of OU2 to be used as part of the RCRTC; it was documented that Site C is part of the 108 acres planned for transfer to Ramsey County.

The LUCRD includes the LUC areas (with maps), the LUC objectives, and LUC implementation mechanisms. Monitoring of the LUCs in the form of site inspections are conducted by the Army or its designated representative to confirm whether the LUCs remain effective and meet LUC objectives for continued remedy protectiveness. The LUCRD outlines the process for modifications related to leases and property transfers. As a condition of transfer or lease, the Army will require that equivalent LUCs will be put into terms and conditions of an environmental covenant (or deed) or lease, which are no less restrictive than the LUC objectives described in the LUCRD. The transferee or lessee will be responsible for ensuring that any users comply with the LUCs.

The LUCRD also addresses "blanket" soil and groundwater LUCs for the remaining federally-owned property within OU2. "Blanket LUCs" were implemented because past investigative work focused on areas suspected to have had a release of hazardous substances to the environment, and not the entire OU2 land area. Although there is not a decision document for the land outside the individual investigated/remediated areas, the Army has elected to implement "blanket LUCs" for soil and groundwater across a majority of the federally-owned property as a practical way to address this matter. The following exceptions are made with respect to the "blanket" soil LUCs:

- Site F was remediated to unrestricted use levels.
- An area known as the "watchable wildlife area" was cleared for unrestricted use (Revision 2 of the OU2 LUCRD).
- The cantonment area within the Arden Hills Army Training Site, and the Army Reserve Center where the soil LUC was revised to allow uses compatible with a restricted commercial exposure scenario (Revisions 2 and 3 of the OU2 LUCRD).

- Soil LUCs were removed from the 380-acre area transferred/leased to Ramsey County in 2013 (Revision 4 of the OU2 LUCRD).
- Soil LUCs were changed on the 108-acre portion of OU2 to allow recreational use and unrestricted exposure as part of the RCRTC (Revision 5 of the OU2 LUCRD).

The remaining LUCs for OU2 are summarized in Table 5-4 below. All LUCs were implemented when the USEPA and MPCA approved the OU2 LUCRD document in 2010, unless otherwise noted in Table 5-4.

Table 5-4 Land Use Controls Summary

Media, Engineered Controls, & Areas That Do Not Support Unlimited Use/Unrestricted Exposure	Land Use Control Objective	Land Use Control
OU2 – Deep Groundwater: Plume of deep groundwater contamination on the installation as depicted in Figures 50 to 52. **And** **OU2 – Shallow Groundwater:** Plumes of shallow groundwater contamination at Site A (Figure 36), Site C (Figure 38), Site I (Figure 42), Site K (Figure 45), and Building 102 (Figures 46 to 48).	Prevent uses of contaminated groundwater that pose an unacceptable risk to human health, until cleanup levels are achieved. Prevent activities that would reduce the effectiveness of groundwater remedial actions set forth in decision documents and subsequent design or monitoring plans for each individual area.	"Blanket LUCs" require approval prior to installation of any well that withdraws water from a contaminated aquifer, so as to prevent interference with the hydraulic performance of the groundwater remedies and prevent unacceptable human exposure. Such wells must first be approved by the MDH, MPCA, and USEPA. Wells or other devices that do not withdraw water (e.g., geothermal heat exchangers) are not restricted (but still require the normal MDH permit).* "Blanket LUCs" restrict activities that would interfere with or disrupt the effectiveness of the infrastructure needed for the groundwater remedies. Such infrastructure includes, but is not limited to monitoring wells, extraction wells, treatment equipment, and water conveyances.
OU2 – Soil: Areas remediated to site- specific cleanup levels (all or portions of Sites A, C, D, E, G H, 129-3, 129-5, 129-15, Grenade Range, Outdoor Firing Range, 135 Primer/Tracer Area, 535 Primer/Tracer Area), and the EBS Areas on AHATS. (See Note)	Prevent exposure to contaminated soil at levels that pose an unacceptable risk to human health.	"Blanket LUCs" restrict typical, day-to-day use to activities by adults that involve being on-site 250 days or less per year, and do not involve contact with bare soil on a routine basis. For the cantonment area within AHATS and the Army Reserve Center, as changed through

Media, Engineered Controls, & Areas That Do Not Support Unlimited Use/Unrestricted Exposure	Land Use Control Objective	Land Use Control
		Revisions 2 and 3 of the OU2 LUCRD (2011 and 2015), a LUC restricts use to activities compatible with a restricted commercial exposure scenario, where "exposure is largely limited to an adult worker and access by the general public is restricted or infrequent" (MPCA Draft Guidelines, Guidance on Incorporation of Planned Property Use Into Site Decisions, September 1998). For the 108-acre portion of the RCRTC, as changed through Revision 5 of the OU2 LUCRD (2018), a LUC restricts use to activities compatible with a recreational use exposure scenario.
OU2 – Soil Covers: Areas with soil contamination remaining in-place that have a soil cover to prevent exposure (all or portions of Sites C, D, E, G, H, 129-15, and Outdoor Firing Range). At Site G only, the cover is also designed to minimize infiltration.	Prevent disturbance of soil covers which would result in exposure to the underlying contaminated soil of sufficient magnitude as to pose an unacceptable risk to human health.	For individual areas that have a soil cover as part of the remedy, LUCs restrict activities that would disrupt the effectiveness of the cover. Activities that would penetrate through the cover (e.g., utility work) must first be approved by the MPCA and USEPA.

*A 'blanket LUC' is one considered to apply to a significant portion of the federally-owned property, or a significant portion of the Ramsey County property (with respect to groundwater LUCs).

5.1.5 System Operations/Operation and Maintenance

5.1.5.1 Soil Sites

O&M procedures are limited to maintaining the cautionary signs around the perimeter of each protective soil cover. These signs are in place at all the soil cover sites. O&M includes repair of any damage that compromises the thickness requirements for the protective soil covers; however, no such damage occurred during the period of this Five-Year Review.

5.1.5.2 Groundwater (Site A)

For the groundwater at Site A, the Army maintains groundwater recovery systems; however, these systems have been shut off since 2008 to evaluate MNA effectiveness. The 2017 ROD Amendment #6 documents that MNA will be utilized in lieu of groundwater containment and mass removal,

and discharge of extracted groundwater to a POTW as specified in the ROD. Therefore, O&M costs will remain lower going forward.

5.1.5.3 Groundwater (Site C)

For the groundwater at Site C, the Army maintains groundwater recovery systems; however, these systems have been shut off since 2008 to evaluate MNA effectiveness. If MNA eventually becomes the approved remedy for Site C shallow groundwater, the O&M costs will remain lower going forward. Given that groundwater cleanup levels may be reached throughout Site C within a few years, it may not be necessary to go through the process of formally changing the remedy.

5.1.5.4 Groundwater (Site K and Deep Groundwater)

Northrup Grumman Innovation Systems operates and maintains the Site K groundwater recovery system. They also operate and maintain the TGRS in accordance with an Army/ Northrup Grumman Innovation Systems apportionment agreement. The O&M procedures at both sites have been enough to ensure reliable water treatment to the applicable standards and to ensure the pumping targets for groundwater extraction rates are met with adequate consistency.

At Site K, the groundwater extraction trench and treatment system continue to operate as designed and no O&M problems are evident. Minimal maintenance had been required that resulted in very limited operational downtime. Most downtime appeared to be related to flow valve adjustment procedures, which were quickly remedied. No O&M problems are evident. Annual O&M costs are proprietary and, therefore, not included in the site inspection checklists.

The TGRS continues to operate at a rate deemed sufficient for complete capture of the 5 µg/L TCE contour and to maintain hydraulic containment. APRs since 2007 have noted that annual TGRS extraction averaging greater than 1,745 gallons per minute (gpm) (the GOS total operation minimum) is a point "where the Army and agencies agree that capture is achieved with an adequate safety factor.

Based on recorded inspections performed and O&M activities conducted at the treatment system and extraction wells, most of the downtime resulted primarily from failure and subsequent repair or scheduled maintenance of components in the pumphouses, treatment center, and electrical service. All necessary replacement parts were, in most instances, readily available helping to minimize downtime. Examples of treatment center component failures and repairs that caused pumphouse down time are electric check valve maintenance, flow meter replacement, malfunctions and repairs, and electrical control equipment failures and subsequent repairs. Power outages due to storms and accidental disruptions also contributed to down time. Repairs and subsequent downtime have not affected the operations necessary to capture and treat groundwater above the global operating minimum flow of 1,745 gpm. No O&M problems are evident. Annual

O&M costs are summarized in the site inspection checklists (Appendix A). O&M costs for this site have been less than or comparable to the original O&M cost estimates.

5.2 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The protectiveness statement from the prior Five-Year Review is as follows:

> *"Protectiveness Statement:*
> The remedy at OU2 is protective of human health and the environment in the short term, based on the following: 1) For soil sites where the remedy has been completed (Sites A, C, D, E, H, 129-3, 129-5, 129-15), the site's availability for industrial use has been restored. Review of the toxicity data upon which the health risk assessments for these sites were based showed that no changes have occurred that could potentially affect the protectiveness of the remedies. The protective soil covers at Sites C, D, E, G, H, and 129-15, in conjunction with land use controls, effectively prevent exposure to contaminated soils/debris. 2) The groundwater containment systems are meeting their containment objectives and the treatment systems are meeting their discharge requirements. For Site A shallow groundwater, the alternate water supply and well abandonment program, along with the SWCA, are mitigating potential risks associated with private wells. Also, at Site A, MNA is adequately controlling plume migration (in lieu of groundwater extraction system operation). Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater. Review of the ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to Site C groundwater and had no short-term impacts to the groundwater cleanup levels for Sites A, I, and K shallow groundwater or OU2 deep groundwater; however, if any of these four sites approach the point of site closure, then a change in cleanup level(s) may be appropriate. No changes to the cleanup levels are needed in the short term. However, in order for the remedy to be protective in the long term, additional investigation work needs to be performed at Building 102 to assess whether an acceptable level of attenuation is still occurring prior to groundwater reaching Rice Creek [see Note 1 below]; monitoring needs to continue at Site A to determine if MNA will adequately control plume migration; and VI risk needs to be assessed at Site A in the area north of County Road I [see Note 2 below]. [Note 1: Although the following described work was conducted beyond the cutoff date for this Five-Year Review (March 31, 2013), due to the importance of this work relative to the remedy protectiveness determination, the following should be noted: upon approval of the QAPP addendum by the USEPA and MPCA in June 2013, the groundwater investigation work at Building 102 was conducted in July 2013 and then documented in Supplemental Investigation Report for Building 102 Groundwater, which was approved by the USEPA and MPCA in March 2014. The report concluded that a significant level of attenuation was occurring at the point groundwater had travelled halfway from 01L582 to Rice Creek. A

more detailed discussion of these results will appear in the next Five-Year Review. [Note 2: Although the following described work was conducted beyond the cutoff date for this five-year review (March 31, 2013), due to the importance of this work relative to the remedy protectiveness determination, the following should be noted: upon approval of the QAPP by the USEPA and MPCA in June 2013, the Site A soil VI work was conducted in July 2013 and then documented in Site A Vapor Intrusion Investigation Report, which was approved by the USEPA and MPCA in February 2014. The report concluded that no significant vapor intrusion risk existed for the homes along County Road I. A more detailed discussion of these results will appear in the next Five-Year Review.]"

The prior Five-Year Review concluded the components of the OU2 remedy remained protective of human health and the environment in the short term. However, there were three issues noted for OU2 in the prior Five-Year Review.

Table 5-5 Progress Since Last Five-Year Review

Issue	Recommendation	Current Status
For Building 102 shallow groundwater, uncertain if an acceptable level of attenuation is occurring prior to groundwater reaching Rice Creek.	For Building 102 shallow groundwater, evaluate if an acceptable level of attenuation is occurring prior to groundwater reaching Rice Creek.	MPCA and USEPA requested the Army conduct supplemental groundwater investigation work. The purpose of the investigation was to acquire additional VOC data in groundwater at a location approximately halfway between 01L582 and 01U048, which is located adjacent to Rice Creek. The *Supplemental Investigation Report for Building 102 Groundwater* was approved in FY 2014 and concluded that a significant level of attenuation of the VOCs in shallow groundwater is occurring prior to travelling half the distance from well 01L582 to Rice Creek. The recommendation was completed on March 3, 2014.

Issue	Recommendation	Current Status
For Site A shallow groundwater, uncertain if MNA will adequately control plume migration.	For Site A shallow groundwater, evaluate if MNA will adequately control plume migration.	ROD Amendment #6 documents that MNA will be utilized for Site A shallow groundwater in lieu of two remedy components specified in the 1997 ROD: (1) Groundwater containment and mass removal, and (2) Discharge of extracted groundwater to a POTW. The other remedy components that were specified in the 1997 ROD were not changed. The recommendation was completed in June 2017.
For Site A shallow groundwater, uncertain if a VI risk exists north of County Road I.	For Site A shallow groundwater, evaluate whether a VI risk exists north of County Road I.	Based on the potentially increasing VOC groundwater concentrations, the MPCA requested the Army performed a soil vapor investigation. The 2014 report determined that no significant VI risk existed for the homes along County Road I. The recommendation was completed in February 2014.

5.3 FIVE-YEAR REVIEW PROCESS

5.3.1 Administrative Components

Administrative components are the same as described for OU1 (see Section 4.3.1).

5.3.2 Community Notification and Involvement

Community notification was conducted as described for OU1 (see Section 4.3.2).

5.3.3 Document Review

The primary documents reviewed for OU2 were the following:

- Record of Decision - Operable Unit 2, 1997;
- Record of Decision Amendment #1 - Operable Unit 2, Site C-2, 2007;
- Record of Decision Amendment #2 - Operable Unit 2, Site I Groundwater, 2009;
- Record of Decision Amendment #3 - Operable Unit 2, 2009;

- Record of Decision Amendment #4 - Operable Unit 2, 2012;
- Record of Decision Amendment #5 - Operable Unit 2, 2014;
- Record of Decision Amendment #6 - Operable Unit 2, 2017;
- Explanation of Significant Differences #1 - Operable Unit 2, Changes for Groundwater Sites, 2009;
- Explanation of Significant Differences #2 - Operable Unit 2, Changes for Soil Sites, 2009;
- TCAAP Final APRs for FYs 2013, 2014, 2015, 2016, and 2017;
- Previous Five-Year Review Report, July 2014;
- TGRS Operating Strategy, 2003 (and subsequent modifications); and
- Land Use Control Remedial Design - Operable Unit 2, 2017.

The OU2 ROD and amendments were the source of information for RAOs and cleanup levels. The FY 2017 APR was the primary source for determining status at the end of this Five-Year Review period and for monitoring data at the sites which are monitored annually. The FY 2016 APR was the primary source for monitoring data for OU2 shallow and deep groundwater, since this report contains the most recent major sampling event. Site closeout reports were also reviewed, as necessary.

5.3.4 Data Review

OU2 data is presented by sites, ongoing remedy, and then chronologically below. The status of OU2 remedial actions is summarized in Table 5 (Section 9, Tables).

5.3.4.1 Shallow Soil Sites

Active shallow soil site remediation has been completed. After the OU2 LUCRD was approved in 2010, closeout reports were finalized after the LUC agreement was formalized; LUCs are ongoing at OU2 soil sites. Historical data can be found in the last Five-Year Review.

5.3.4.2 Deep Soil Sites (D and G)

Remedy component #1 is the only active component. It is groundwater monitoring for deep soil sites. Table 17 (Section 9, Tables) presents the FY 2016 data for the deep groundwater COCs, including the well nearest Site D (03U093) and the well nearest Site G (03U094). Table 17 shows the cleanup level for TCE is exceeded in these two wells. The cleanup level for 1,1,1-trichloroethane is exceeded only in the Site G well (03U094). In 2016, a second full round of samples were collected for 1,4-dioxane.[9] No Federal MCL has been established for 1,4-dioxane; however, the MDH has established an HRL value of 1.0 µg/L. Given this, the HRL for 1,4-dioxane

[9] 1,4 dioxane is not a contaminant listed in the ROD.

is exceeded in the Site D and Site G wells, and 56 percent (%) of the monitoring wells sampled in FY 2016 had 1,4-dioxane concentrations exceeding the HRL. The groundwater monitoring data remained constant between FY 2016 and FY 2017. The 2017 data also show consistent results for the Site D well (03U093). (03U093) was not sampled in FY 2017 due to reduced sampling frequency.

During the years of SVE operation (1986 to 1998), TCE concentrations in groundwater (in units of µg/L) decreased from the 10,000's to the 100's. TCE concentrations have remained within the approximate 100 µg/L range since SVE operation ceased. Improvement has been noted at well 03U093 (Figure 32). The downward trend at well 03U093 over the past ten years has been stable. Overall, these results indicate that SVE systems at Sites D and G effectively minimized (or eliminated) further contamination of the deep groundwater beneath these sites. From 2005 to 2013, TCE concentrations decreased to 80 µg/L in 2013, a historical low concentration. In 2015, the concentration increased to 610 µg/L, the highest concentration since 1996, then decreased to 360 µg/L in 2016. According to the APR report, the source has not been defined and could be in either the saturated or unsaturated zone.

5.3.4.3 Site A Shallow Groundwater

Groundwater monitoring (remedy component #1) continues to be conducted to evaluate plume migration and remedy performance. The plume extent in FY 2017 is shown on Figures 35 and 36 (Section 10, Figures), and recent groundwater quality data is shown in Table 18 (Section 9, Tables). As first proposed in the FY 2015 APR, the Army ceased monitoring of wells 01U350, 01U351 (EW-1), and 01U354 (EW-4) ceased in FY 2017. As represented on Figure 59 (Section 10, Figures), these wells are monitoring points to nearby wells 01U108, 01U116, and 01U138. Well 01U350 will be used as a temporary monitoring point in place of well 01U108 until the obstruction that prevented monitoring in FY 2017 can be removed.

In the 2017 sampling event the cis-1,2-dichloroethene(cis-1,2-DCE) cleanup level of 70 µg/L was exceeded in wells 01U139 (260 µg/L), 01U158 (80 µg/L), and 01U356/EW-6 (340 µg/L). The cleanup level of antimony (6.0 µg/L) exceeded at well 01U103 (8.0 µg/L). None of the other COCs exceeded their respective cleanup levels in FY 2017. As seen in Figure 60 (Section 10, Figures), the respective cleanup levels were exceeded by concentrations of cis-1,2-DCE at 01U139 (540 µg/L), 01U157 (380 µg/L), 01U355/EW-5 (200 µg/L), and 01U356/EW-6 (290 µg/L), and of antimony at 01U103 (7.6 µg/L) in FY 2017. None of the other COCs exceeded their respective cleanup levels in FY 2017.

Figure 61 (Section 10, Figures) presents the Site A Unit 1 plume, sealed wells, extraction wells, monitoring wells, and, piezometer locations with contaminant concentrations. The cis-1,2-dichloroethene plume has largely stabilized following shutdown of Extraction Wells (EW-1 through EW-4) in 2008. Most importantly, contingency location monitoring wells 01U901,

01U903, and 01U904 along the north side of County Road I show stable or decreasing trends at concentrations below the cis-1,2-DCE cleanup level of 70 µg/L. Monitoring wells 01U901 and 01U903 have been at or near non-detect for cis-1,2-DCE since 2008. The data indicates that data is changing at 01U902. The monitoring wells are important in capturing primary flow data. They are work effectively as sentry wells. From 2008 through June 2013, cis-1,2 DCE were holding steady between 15- 20 µg/L. The 2016 and 2017 data for this well reveal cis1,2 DCE at 29 µg/L and 35 µg/L, respectively. This is an almost doubling of contamination and an upward trend: it is still below the cleanup criteria. The concentration of cis-1,2-DCE in well 01U904, which increased to a peak of 57 µg/L in June 2013, decreased steadily through FY 2014 and now appears to have stabilized between approximately 20 and 30 µg/L; the cis-1,2-DCE concentration at well 01U904 was 27 µg/L in June 2017. Well 01U904 is located directly downgradient of the two highest-concentration wells: monitoring wells 01U157 and 01U139 (monitoring wells located between the two rows of extraction wells). Monitoring well 01U139, currently the well with the highest concentration of cis-1,2-DCE at Site A, had a peak concentration of 510 µg/L in June 2013, but 2016 and 2017 data noted 240 and 350 µg/L. Monitoring well 01U157 had two slight exceedances of the cis-1,2-DCE cleanup level in 2011 and 2012, but has since stabilized between 18 and 25 µg/L, respectively. The collective trend suggests the slight uptrend at EW-6 reflects a slight shifting of the axis of the plume in the "cross-plume" direction.

In June 2017, ROD Amendment #6 documented that MNA will be utilized at Site A in lieu of two remedy components specified in the 1997 ROD: (1) groundwater containment and mass removal, and (2) discharge of extracted groundwater to a POTW. This is based on the monitoring conducted since the groundwater extraction system was shut down on September 24, 2008, which indicates the cis-1,2-dicloroethene plume has essentially stabilized, and that plume migration is being adequately controlled through naturally-occurring abiotic degradation without the need for active groundwater extraction. Changing the remedy to MNA in lieu of groundwater extraction and discharge can provide essentially the same level of protection of human health and the environment at considerable cost and energy savings.

5.3.4.4 Site C Shallow Groundwater

Groundwater and surface water monitoring (remedy component #1) continue to be conducted to evaluate plume migration and remedy performance. Groundwater elevation contours from summer 2017 are shown on Figure 37(Section 10, Figures). Dissolved Lead concentrations in groundwater from 2017 are shown on Figure 38(Section 10, Figures), and groundwater quality data is shown in Table 19 (Section 9, Tables). In FY 2016, the lead concentration at MW-14 was detected at 140 µg/L in February and dropped to 4.9 µg/L in July. At MW-3, a concentration of 6.6 µg/L was observed in February 2016 and spiked to 27 µg/L in July 2016. In FY 2017, lead was above the cleanup goal in two wells located near the source area (MW-13 at 140 µg/L and MW-14 at 170 µg/L, versus the cleanup level of 15 µg/L). Inorganic colloidal suspended solids like lead in water can cause the fluctuation in levels. The water quality trends for MW-13 and MW-14 are shown on

Figure 39 (Section 10, Figures). The variable concentrations observed at individual wells in FY 2017 has occurred throughout recent years for the four source area wells. Despite this, overall lead concentrations at source area wells have decreased in the last 10 years indicating substantial progress towards reaching groundwater cleanup levels. The three extraction wells have all been below the cleanup level since March 2008, indicating the plume has attenuated to a degree in which the area of concern for Site C groundwater no longer extends to the extraction wells and is receding towards the source area.

Surface water monitoring is conducted to verify that no State of Minnesota chronic surface water standards are being exceeded. Surface water locations were inadvertently missed during the FY 2017 event and samples were not collected. Therefore, FY 2016 surface water data shall be discussed, and the monitoring event completed in FY 2018.[10] These monitoring locations are shown on Figures 40 and 41 (Section 10, Figures). Throughout the period of this Five-Year Review, except for FY 2017, surface water monitoring results have shown compliance with the surface water standard for lead. The contingency trigger for containing and treating contaminated surface water has never been reached.

The second remedy component, use of gradient control wells to contain the contaminant plume. The area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells. The extraction system is no longer operating, and this remedy component is not currently being implemented.

Remedy components #2 and # 3 (groundwater containment and discharge of extracted water) have been completed.

5.3.4.5 Site I Shallow Groundwater

Groundwater monitoring continues to be required by remedy component #1. However, as previously approved by USEPA and MPCA, all Site I (Building 502) Unit 1 monitoring wells were abandoned in FY 2014 prior to the demolition of Building 502. Only well 01U667 is scheduled to be replaced, which could be delayed beyond FY 2018 due to the extent of pending regrading associated with planned site redevelopment. Because well 01U667 has yet to be replaced, no groundwater sampling has been conducted since the wells were abandoned. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2017 - FY 2021 Monitoring Plan.

Groundwater monitoring was not conducted in FY 2017 due to the abandonment of all Unit 1 wells related to site I demolition activities. The most recent groundwater quality data is from FY 2013. Table 20 (Section 9, Tables) presents FY 2013 data and highlights values which exceeded the cleanup level. The concentration of TCE in former well 01U632 had decreased over time but was

[10]FY 2018 data was not available to review.

still above the cleanup level in FY 2013. Results from the sampling of well 01U667 indicated concentrations of 1,2-dichloroethene and vinyl chloride remained above the cleanup levels.

Figure 42 (Section 10, Figures) presents a site plan for Site I, including the former locations of the now abandoned monitoring wells. Figure 43 (Section 10, Figures) presents the FY 2013 Site I shallow groundwater TCE and vinyl chloride sample results. The most recent groundwater quality data from FY 2013 suggests that cleanup levels have not been attained.

Remedy component #2, additional characterization of soil and groundwater, has been completed. The additional investigation resulted in a pilot study to evaluate the applicability of dual-phase vacuum extraction technology (combining groundwater extraction and soil vapor extraction) at the site. The report on the dual-phase vacuum extraction pilot test, approved by USEPA and MPCA, concluded that neither dual-phase extraction nor groundwater extraction is feasible. The pilot test found the soil permeability is low. The report recommended that no further remedial action be considered until the building is demolished. The 2009 OU2 ROD Amendment #2 revised the preferred remedy from groundwater pump and treat to a groundwater monitoring based remedy.

5.3.4.6 Site K Shallow Groundwater

Groundwater monitoring continues to be conducted at Site K (remedy component #1). Water levels continue to be collected annually from the monitoring wells and piezometers located near the groundwater collection and treatment system as shown in Figure 44 (Section 10, Figures) and listed in Table 31 (Section 9, Tables). Groundwater quality is monitored through a series of Unit 1 monitoring wells (and Unit 3 sentinel monitoring well) and the plume established for Site K during the 2017 APR is presented in Figure 45 (Section 10, Figures). The two monitoring wells (01U628 and 01U604) historically used to monitor hydraulic capture were abandoned in 2014 because of site redevelopment activities.

In May 2014, TCE was detected at a 2,000 µg/L in well 01U603. Well 01U603 was resampled in July 2014 (5,600 µg/L) and September 2014 (4,600 µg/L). The July and September results confirmed that elevated concentrations of TCE and other VOCs are present in groundwater at the Well 01U603 location. Groundwater samples collected downgradient of well 01U603 as part of a Site K geoprobe investigation in September 2014 were non-detect for TCE and confirmed the collection trench is adequately capturing contaminants. The geoprobe investigation in FY 2014 demonstrated that historically high groundwater levels in April and May 2014 likely mobilized TCE in the former storm sewer bedding that was present underneath the former building footprint as seen in Figure 65 (Section 10, Figures). In September 2014, 25 temporary PVC wells were installed to depths between 10 and 15 feet below the ground surface using direct push technology to define the width of the plume. Groundwater samples were collected from each temporary well and analyzed for VOCs. The geoprobe results were submitted to USEPA and MPCA in a letter dated February 3, 2015. Since that time, TCE concentrations in 01U603 have steadily declined to

3.3 µg/L (FY 2017). The treatment system captured and treated 6,187,096 gallons of water resulting in the removal of 42.85 pounds of VOCs from the aquifer in FY 2014. The cumulative mass removal in FY 2014 was 351.9 pounds of VOCs and the treatment system functioned and was operational 91.7% of the time.

MPCA and USEPA requested the Army conduct supplemental groundwater investigation work. The purpose of the investigation was to acquire additional VOC data in groundwater at a location approximately halfway between 01L582 and 01U048, which is located adjacent to Rice Creek. The Supplemental Investigation Report for Building 102 Groundwater was approved in FY 2014. It concluded that a significant level of attenuation of the VOCs in shallow groundwater is occurring prior to travelling half the distance from well 01L582 to Rice Creek.

In FY 2015, there were no COCs detected in Unit 3 sentinel well (03U621) at concentrations above the method detection limit. Evaluation of the groundwater collection system in FY 2015 showed it continued to provide capture for Unit 1 groundwater. Vertical capture was also effective. Due to the drawdown from the trench, groundwater both upgradient and formerly downgradient of the trench is captured and collected. The monitoring coverage provided by the bundle piezometers, demonstrates complete vertical and horizontal hydraulic capture. The treatment system captured and treated 5,444,776 gallons of water resulting in the removal of 11.59 pounds of VOCs from the aquifer in FY 2015. The FY 2015 cumulative mass removal was 363.4 pounds of VOCs and the treatment system functioned and was operational 95.9% of the time.

The Unit 3 sentinel well (03U621) was sampled in June 2016 shown in Figures 45, 46, and 65 (Section 10, Figures). The results of the sample collected during FY 2016 showed there were no COCs detected in the Unit 3 sentinel well at concentrations above the method detection limit; however, 1,4-dioxane exceeded the HRL in this well in 2015 and 2016, and decreased from 9.3 ug/L in FY 2016 to 8.4 ug/L in FY 2017.[11] The FY 2017 APR states that this is likely related to the presence of 1,4-dioxane in Unit 3 groundwater throughout the western portion of TCAAP, as opposed to a release from Site K.. In FY 2016, the monitoring coverage provided by the bundle piezometers, demonstrates complete vertical and horizontal hydraulic capture. Evaluation of the groundwater collection system in FY 2016 showed it continued to provide capture for Unit 1 groundwater. The treatment system captured and treated 5,861,506 gallons of water resulting in the removal of 9.25 pounds of VOCs from the aquifer in FY 2016 and the cumulative mass removal was 372.7 pounds of VOCs. In FY 2016, the treatment system functioned and was operational 96% of the time

In FY 2017, the treatment system functioned and was operational 96% of the time. The FY 2017 concentration of TCE at 01U615 (1,200 µg/L; well at the core of the plume) is a ten-year low, but is comparable with historical concentrations from the last ten years of sampling, that have ranged

[11] 1,4 dioxane is not a contaminant listed in the ROD.

from 1,200 µg/L to 6,500 µg/L. Sentinel wells at the bottom of Unit 1 and the top of Unit 3 determine if any vertical migration is occurring as seen in Figure 65 (Section 10, Figures). The figure lays out the hydrogeologic cross section and the Unit 3 sentinel well location. As stated in Section 3.1, Unit 1 is an unconsolidated unit, Unit 2 is comprised of glacial till and acts as an aquitard, and Unit 3 is comprised of the Hillside Sand and the Arsenal Sand and is a water-bearing formation with high water yield. To best monitor shallow groundwater contamination, four piezometers (01U625D, 01U626D, 01U627D and 01U628D) are screened at the Unit 1/Unit 2 interface, as shown on Figure 66 (Section 10, Figures), and are used to accomplish the deep Unit 1 sentry monitoring since 2000. These piezometers monitor the base of the Unit 1 aquifer and the top of the Unit 2 aquitard near the trench. Additionally, wells 01U603, 01U617, and 01U621 monitor groundwater quality in Unit 1 downgradient from the collection trench. Monitoring of sentinel well 03U621 over the last five years confirms contamination has not migrated into Unit 3, as VOCs have not been detected. Based upon the well network established for this site and documents reviewed for this five-year review, the monitoring system in place is adequate to effectively monitor Site K.

Discharge of treated water to Rice Creek and the associated discharge monitoring are required by remedy components #5 and #6. The treated water meets the substantive requirements of Document Number MNU000579 (MPCA), except for total phosphorus and zinc in FY 2017. On June 8, 2017 the effluent sample contained zinc (230 µg/L) and phosphorus (7.5 milligrams per liter [mg/L]) greater than the respective discharge limits of 134 µg/L and 1.0 mg/L. The effluent was resampled on June 29, 2017 and contained lower zinc and phosphorus concentrations of 13 µg/L and 1.4 mg/L, respectively. Additional influent and effluent sampling in July, August and September 2017 was undertaken to see if zinc and phosphorus were dissolved phase, or if they were mainly associated with solids that may periodically and infrequently be released by the air stripping tower. Based on sampling results, no clear evidence was found to correlate the earlier and infrequent exceedances of phosphorus and zinc discharge limits for the Site K treatment system effluent with particulate accumulation in the treatment system; review of operation data was unsuccessful in determining the cause of the exceedances. Sampling procedures were modified in FY 2017 to ensure a thorough flushing of all sampling piping before effluent samples are collected to minimize the potential that particles accumulating on the piping are being carried over into the samples. Influent and effluent analytical data for FY 2017 are shown in Table 21 (Section 9, Tables). The treatment system captured and treated 5,370,496 gallons of water resulting in the removal of 8.5 pounds of VOCs from the aquifer in FY 2017. The cumulative mass removal through the end of FY 2017 is 381.2 pounds of VOCs (Table 22, Section 9, Tables).

In FY 2018, three of the wells abandoned in 2014 (01U608, 01U609, and 01U611) are scheduled to be reinstalled.[12] However, this reinstallation has been pushed to 2019 due to onsite construction

[12] Final 2018 sampling data was not available at the time of report.

by Ramsey County. The wells will have the same monitoring requirements they had prior to abandonment; wells 01U608 and 01U609, once reinstalled, will be added to the water level monitoring list and well 01U611 will be added to the annual water quality sampling list. Based on this remedy component #1 is working. Historically, two sampled wells, 01U615 and 01U603, were impacted with VOCs above cleanup levels. Today only one sampled well, 01U615, is currently impacted with VOCs above cleanup levels.

5.3.4.7 Building 102 Shallow Groundwater

MNA (remedy component #1) is being implemented at Building 102 shown in Figure 68 & 69 (Section 10, Figures). Groundwater monitoring (remedy component #2) to track MNA and verify that contaminated groundwater is not reaching Rice Creek is being performed. Groundwater quality data collected in FY 2017 is shown in Table 23 (Section 9, Tables). Groundwater quality data for June 2017 is also shown on plume maps for three COCs: TCE (Figure 46), cis-1,2-dichloroethene (Figure 47), and vinyl chloride (Figure 48). Natural attenuation continues to occur at this site, with TCE being the primary VOC evident in the source area vicinity (wells 01U579 and 01U580), and with primarily degradation products being present in downgradient wells. Plume maps verify that contaminated groundwater is not reaching Rice Creek. One 1,4-dioxane detection in Building 102 shallow groundwater exceeded the MDH HRL but was deemed an anomaly. Future monitoring will be conducted to assess if it is a COC in Building 102 shallow groundwater.

Figure 69 (Section 10, Figures) lays out the wells for groundwater monitoring (remedy component #2). The concentration of cis-1,2-DCE decreased from 14 to 8 µg/L in well 01L582 in 2017, and the vinyl chloride concentration decreased (0.41 to 0.21 J µg/L) in FY 2016 and was non-detect in 2017, continuing the downward trend that was observed between FY 2014 and FY 2016.Well 01L584 had a vinyl chloride detection of 0.50 µg/L, which is above the cleanup level of 0.18 µg/L.

In Figure 48, the geologic cross-section line noted as B-B' consists of wells 01U584, 01U581, and 01U583 (Figure 47). Natural attenuation continues to occur at Building 102, with TCE being the primary VOC present in the source area vicinity, and primary degradation products being present in downgradient wells (e.g., primarily cis-1,2- DCE and vinyl chloride in 01L584 and 01U584).

Changes were noted in the FY 2017 groundwater quality results. TCE concentration decreased slightly in 01U579 and 01U580 from 1.7 µg/L and 4.3 µg/L to 0.71 µg/L and 1.1 µg/L. 01L582 is further downgradient of the source area and has a concentration of cis-1,2-DCE that decreased (14 to 8 µg/L). The vinyl chloride Method 8260C-SIM analysis was inadvertently collected from the 584 well nest in FY 2017, but vinyl chloride was not detected in the 01L582 sample run with a higher detection limit. The vinyl chloride concentration has historically shown a decreasing trend. 01L584 (downgradient) well was inadvertently sampled for the Method 8260C-SIM analysis and had a vinyl chloride detection of 0.50 µg/L, which is above the cleanup level of 0.18 µg/L. 01L584

& 01L581 relate because they are located within the TCE cis-1,2-DCE concentration contours (µg/L).

5.3.4.8 Deep Groundwater

Hydraulic containment and source area contaminant removal (remedy component #1) are being accomplished through operation of the TGRS. The TGRS layout is shown on Figure 49 (Section 10, Figures). Plume maps for Upper Unit 3, Lower Unit 3, and Upper Unit 4 are shown on Figures 50, 51, and 52 (Section 10, Figures). Groundwater contour maps showing the capture boundary in the three impacted hydrogeologic units are shown on Figures 53, 54, and 55 (Section 10, Figures). These maps are based on the last full round of monitoring conducted in FY 2016. Comparison of capture boundaries with the plume maps shows the TGRS achieves containment at the TCAAP boundary. The flow rates at individual wells have been modified from time to time due to plume configuration changes, operational issues, and to maintain the Operating Strategy.

During FY 2017, the average flow rate for the extraction wells was approximately 1,769 gpm (Table 24, Section 9, Tables). At this flow rate, the total extraction well water pumped was above the Global Operating Strategy Total System Operational Minimum (1,745 gpm) where the Army and the agencies agree that capture is achieved with an adequate safety factor. The TGRS operated above the Operational Minimum for the majority of the time (301 days or 82% of the time) as indicated in FY 2017 data (Figure 56).

The TGRS extracted and treated approximately 929,926,100 gallons of water from October 2016 through September 2017 (as shown in Table 24, Section 9, Tables).

Annual mass removal totals are shown in Table 25 (Section 9, Tables), with a well-by-well breakdown for FY 2017. Eight wells (B1, B4, B5, B6, B9, B13, SC1 and SC5) that are in the centers of the plume, achieve the largest rates of VOC removal. Together, these eight wells accounted for nearly 99% of the VOC mass removed. The source control wells, SC5 and SC1, accounted for over 87.7% of the VOC mass removed, while accounting for only 8.4% of the water pumped by the system. SC5 removed over 72.6% of the total VOC mass at a rate of only approximately 86 gpm (4.9% of the total water pumped by the system). This illustrates the efficiency of extracting groundwater from near the source areas. Annual mass removal has been on a declining trend.

Groundwater treatment is accomplished through treatment using air strippers, (remedy component #2). Treatment has been very effective as shown on the influent/effluent TCE trend in concentration graphs (Figure 57). This figure also shows the average FY 2017 influent TCE concentration was 209 µg/L, which is an 11% increase from 187 µg/L in FY 2016. The influent TCE concentrations had been steadily decreasing for several years, likely due to the overall decrease in plume concentration. The increased influent TCE concentrations observed in FY 2017 are due, in part, to the higher flow rate that resulted from the cleaning of the force main later in

FY 2016 and FY 2017. FY 2017 represents the fifteenth year since the TGRS was reconfigured to achieve greater pumping in the center of the VOC plumes and less pumping on the edges of the plumes where VOC concentrations are lower. The overall decreasing TCE concentration could be due in part to the overall decrease in plume concentration.

Figure 57 (Section 10, Figures) also indicates the effluent TCE is below 5 µg/L. Results from the FY 2017 database indicate the effluent has also remained below the treatment requirements for all other VOC compounds specified in the OU2 ROD. Comparison of influent/effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.4%.

Table 5-6 Wells and Trends Observations for Deep Groundwater

Well	Wells and Trends Observations for Deep Groundwater
03L806	Trend identified in FY 2001 APR. Dropped from 1,000s of µg/L in early 1990s. Trichloroethene (TCE) decreased steadily from 410 µg/L in 2001 to 140 µg/L in 2005. From 2006 to 2011, TCE concentrations varied between 120 µg/L and 240 µg/L with no apparent trend. TCE increased to 490 µg/L in 2012 and 620 µg/L in 2013. Decreased to 440 µg/L in 2014, 330 µg/L in 2015, 120 µg/L in 2016, and 42 µg/L in 2017. The overall increase in 2012 through 2014 coincided with a decrease in TCE concentration at well 03M806. However, in 2016 and 2017 the TCE levels dropped to pre-2012 concentrations. Maintain annual sampling frequency to determine if this downward trend continues.
04U806	Trend identified in FY 2001 APR. Dropped from 1,000's of µg/L in early to mid-1990s. TCE steadily decreased from 470 µg/L in 2001 to 96 µg/L in 2007. In2008, TCE spiked at 380 µg/L, but concentrations decreased the next year and have varied between 52 µg/L and 220 µg/L since 2009 with a notable steadily decreasing trend (52 µg/L in 2017). Maintain annual sampling frequency.
03U094	Trend identified during FY 2004 data review. TCE increased from 170 µg/L in 2003 to 470 µg/L in 2005. From 2005 to 2013, TCE concentrations decreased to 80 µg/L in 2013, a historical low concentration. Increased to 610 µg/L in 2015, the highest concentration since 1996, then decreased to 360 µg/L in 2016. Maintain biennial sampling frequency. (2018 sampling data not available at the time of review).
03M806	Trend identified during FY 2003 data review. TCE concentrations dropped from approximately 900 µg/L in 1987, to less than 100 µg/L from 1993 through 1996. In 2003, TCE increased to 1,300 µg/L, a historical high concentration. TCE concentrations decreased from 680 µg/L in 2008 to 250 µg/L in 2015 but increased to 410 µg/L in 2017. Maintain annual sampling frequency. (2018 sampling data not available at the time of review)

Well	Wells and Trends Observations for Deep Groundwater
03U711	Trend identified in FY 2001 APR. TCE concentrations decreased from approximately 1,000 µg/L in 1994 to 75 µg/L in 1999 but rebounded to 250 µg/L by 2004. Since 2004, concentrations have steadily decreased to 27 µg/L in 2016. Maintain biennial sampling frequency. (2018 sampling data not available at the time of review). Well 03U711 steady decrease from 250 µg/L in 2004 to 27 µg/L in 2016.
03L806	Notable decrease at well 03L806 (620 µg/L in 2013, 440 µg/L in 2014, 330 µg/L in 2015, 120 µg/L in 2016, 42 µg/L in 2017). Ending a steady upward trend observed since 2010.
03L809	Trend identified in FY 2001 APR. TCE concentrations decreased from over 3,000 µg/L to 67 µg/L through 1998 but rebounded to 520 µg/L by 2001. Since 2001, concentrations have decreased to 140 µg/L in 2016. Maintain biennial sampling frequency. (2018 sampling data not available at the time of review)
04U843	Trend identified in FY 2001 APR. TCE concentrations were below 15 µg/L from late 1980s through 1997, and then increased to between 22 µg/L and 38 µg/L from 1998 through 2001. In 2003, TCE dropped below 1 µg/L, but steadily increasing since it was 180 µg/L in 2016. This well is nearly one mile from TGRS and is part of the OU 1 sampling program; also see Section 3. Maintain biennial sampling frequency. (2018 sampling data not available at the time of review)
04U841	Trend identified in FY 2001 APR. TCE concentrations were below 10 µg/L through 1995, and then increased to 25 µg/L in 2001. In 2003, TCE decreased to 5 µg/L, but rebounded to 19 µg/L in 2005. TCE appears stabilized around 20 µg/L, with concentrations ranging between 14 and 24 µg/L since 2005 (14 µg/L in 2016). Well is nearly 0.5 miles from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency. (2018 sampling data not available at the time of review)
03U822	Trend identified during FY 2003 data review. TCE concentrations were below 25 µg/L through 1998, and then peaked at 375 µg/L in 1999. Concentrations have ranged between 120 and 160 µg/L from 2005 to 2015 (150 µg/L in 2016). Well is approximately one mile from TGRS and is part of the OU1 sampling program; also see Section 4. Maintain biennial sampling frequency (2018 sampling data not available at the time of review)

Well	Wells and Trends Observations for Deep Groundwater
03U030	The most notable decreases were at well 03U030 (steady decrease from 43 µg/L in 2007 to 4.6 µg/L in 2016).
03U708	Well 03U708 (steady decrease from 120 µg/L in 2005 to 23 µg/L in 2017).
03U709	Well 03U709 (steady decrease from 61 µg/L in 2005 to 18 µg/L in 2016).
04U077	Well 04U077 (steady decrease from 98 µg/L in 2005 to 32 µg/L in 2016).
04U806	In FY 2017, notable steadily decreasing trends were observed at well 04U806 (decrease from 725 µg/L in 2000 to 52 µg/L in 2017).
03L822	Trend identified in FY 2001 APR. TCE concentration increased from less than 5 µg/L during early 1990s to over 600 µg/L from 1999 through 2003. Concentrations steadily decreased from 620 µg/L in 2003 to 180 µg/L in 2011 but rebounded slightly in 2013 to 220 µg/L. Concentration decreased slightly in 2016 to 190 µg/L. Well is approximately one mile from TGRS and is part of the OU1 sampling program; also see Section 3. Well historically showed 1,1,1-trichloroethane as major contaminant. Maintain biennial sampling frequency (2018 sampling data not available at the time of review)

Groundwater monitoring (remedy component #6) continues to be conducted to track remedy performance. Results from the 2016 and 2017 groundwater sampling showed that most of the wells sampled continued to have declining or stable TCE concentrations. The well trends are summarized in Table 5.6 above. Based on FY 2106 data, both well 03M806 and well 03L806 are likely located in a hydraulic stagnation zone, which may explain their shifting upward and downward trends. Several wells showed a slight increase in TCE concentration in 2016 and 2017; however, the general trend at most wells since 1999 appears to be declining or stable.

The TGRS operating strategy estimated the width of the 5 µg/L TCE plume at the source area to be 3,600 feet based on FY 2001 analytical data. TCE concentrations are decreasing across the site, especially at the following wells that have been below 5 µg/L since 2001: B10, SC4, 03L021, 03L833, 03U701, 04J702, 04U701, 04U702, and 04U833. Monitoring well 03U672 along the southern end outside of the 5 µg/L TCE plume has decreased from 3.1 µg/L in 2001 to not detectable (below 1 µg/L) since 2003 until it was abandoned in 2014. Well 03U677 replaced well 03U672 in September 2014 and has never contained detectable concentrations of VOCs (including TCE). In addition, well B11, which is no longer operating, reported a June 2015 TCE concentration

of non-detect. As a result, the width of the TCE plume is narrowing. Figure 58 (Section 10, Figures) shows FY 2016 TRCLE data with the 5 µg/L TCE contours for FY 2016 compared to historical data. Based on these contours, the estimated width of the source area TCE plume has decreased approximately 17% from 3,600 feet to 3,000 feet or approximately 83% of the width since 2001. According to the TGRS operating strategy, the overall TGRS operating goals will be reviewed if the source area plume width shrinks to 75% of the width (2,700 feet). At the boundary, the TCE plume narrowing is more pronounced, having decreased approximately 24% from 4,600 feet to 3,500 feet or approximately 76% width.

Because monitoring has shown the plume width to be shrinking, extraction wells B-7, B-10, and B-12 have been shut down in response to this shrinking plume width.

5.3.5 Site Inspection

Over the course of four days from October 29, 2018 to November 1, 2018, representatives from the Army (Nick Smith), USACE (Joan Cullen and Tanner Reliford), MNARNG (Mary Lee), and DAWSON (Amir Matin, Staci Herring, David Boyes and Chris Bredehoeft) participated in multiple site inspections of the sites within OU2. Site inspection checklists for the OU2 sites are included in Appendix A.

All the OU2 shallow soil sites (Sites A, C, E, H, 129-3, 129-5, Dump Site 129-15, Grenade Range, Outdoor Firing Range, 135 PTA and MNARNG EBS); deep soil sites D and G; shallow groundwater sites A, C, I, and K and OU2 deep groundwater (TGRS) were observed during the site inspections. The TGRS and Site K treatment systems were visited and discussed, and no O&M problems were identified for these systems.

At Site K, the groundwater extraction trench and treatment system continued to operate as designed to capture, treat, and maintain a continuous zone of capture downgradient of former Building 103. Minimal maintenance had been required which resulted in very limited operational downtime. Most downtime appeared to be related to flow valve adjustment procedures which were quickly remedied.

At the TGRS, the two (2) air stripping treatment mode continues to adequately treat groundwater pumped from the extraction well field by meeting the cleanup requirements (as reported in APRs) before being discharged to the Arsenal Sand and Gravel Pit. Based on recorded inspections performed and O&M activities conducted at the treatment system and extraction wells, most of the downtime resulted primarily from failure and subsequent repair or scheduled maintenance of components in the pumphouses, treatment center, and electrical service. All necessary replacement parts were, in most instances, readily available helping to minimize downtime. Examples of treatment center component failures and repairs that caused pumphouse down time are electric check valve maintenance, flow meter replacement, malfunctions and repairs, and electrical control

equipment failures and subsequent repairs. Power outages due to storms and accidental disruptions also contributed to down time. Repairs and subsequent downtime have not affected the operations necessary to capture and treat groundwater above the global operating minimum flow of 1,745 gpm.

Both Site K and the TGRS groundwater containment and treatment systems are meeting their containment objectives, and the treatment systems are meeting their discharge requirements. For the shallow sites with covers, vegetative cover was observed to be adequate and no problems with cover erosion or disturbance were observed. The signs located around the perimeters of the soil covers (to warn against digging or disturbing the soil) were observed to be in place and in good condition. Monitoring wells were observed to be secure and in good condition with a few exceptions. One monitoring well was found to have a broken cover that could easily be removed. Well nomenclature was mostly legible and casings in good order. Except for one break, fencing and gates throughout the installation were in good order with evidence of ongoing maintenance and repair activities.

Photographs from the site inspection are included in Appendix D. No problems or issues were identified as a result of any of the site inspections.

5.3.6 Interviews

Interviews were conducted, as discussed previously under the OU1 discussion (Section 4.3.6).

Several interviewees spoke specifically to remedy effectiveness associated with OU 2. David Brown, Project Manager with Northrup Grumman Innovation Systems, Shawn Horn, Vice President with GHD and Rob Field, the TGRS Plant Operator with GHD all spoke to the collection of data and operation and maintenance of the TGRS. Mary Lee, an Environmental Protection Specialist with the MNARNG and Nick Smith, an Environmental Engineer with USAEC spoke to the inspection and maintenance of LUCs associated with OU 2. Amy Hadiaris, a hydrogeologist with MPCA spoke to the various component sites within OU 2 and the effectiveness of containment strategies. Both Nick Smith and Katy Grant a geologist with Arcadis recognized the need for the future treatment of 1,4-dioxane. Nick Smith stated that an ESD was in progress to address 1,4-dioxane. Instances of vandalism and trespassing were acknowledged, primarily to steal copper and other scrap metal; however, these instances have not impacted restoration activities. Interview questions and responses are included in Appendix F. In general, interviewees had a positive overall impression of the project with respect to human health and environmental protection and felt remedies were being well maintained.

5.4 TECHNICAL ASSESSMENT

5.4.1 *Question A:* Is the Remedy functioning as intended by the decision documents?

Yes. The review of RAOs and data from the available documents indicate the OU2 remedy is functioning as intended by the OU2 ROD, subsequent ESDs and amendments. Table 5-2 in Section 5.1.2 outlines the remedy components that are currently ongoing for each site or site grouping. Active remedy components that have been completed prior to the timeframe of this Five-Year Review will not be discussed.

5.4.1.1 Shallow Soil Sites and Dump Sites

The nine active remedy components specified in the OU2 ROD have been completed for the eleven shallow soil and dump sites, and have effectively achieved RAOs, outlined below in Table 5-7. LUCs are the only remaining remedy component that are currently ongoing at these eleven shallow soil and dump sites. The use of soil covers is part of the final remedy at Sites C, D, E, G, H, 129-15, and Outdoor Firing Range. The Army, MNARNG, and PIKA conducted the annual inspection of OU2 sites on August 24, 2017. Revision 5 of the OU2 LUCRD changed the soil LUCs for Site C to allow recreational use; the LUCs for groundwater and a soil cover for Site C will remain in place

No follow-up actions were identified as necessary to maintain the protectiveness of the LUCs. The signs help ensure the short- and long-term protectiveness of the remedy by helping to prevent disturbance of protective soil covers. All sites were visited, and no problems or issues were identified as a result of any of the site inspections.

The protective soil covers and LUCs in place are effectively achieving the RAOs outlined in Table 5-7 below.

Table 5-7 Remedial Action Objectives for Shallow Soil Sites

Site	Media	Remedial Action Objectives
Sites A, C, E, H, 129-15, 129-3, 129-5, the Grenade Range, and the Outdoor Firing Range	On-TCAAP surface soils (0-12 feet below ground surface)	a) Prevent on-site human exposure by means of ingestion and dermal contact with contaminants in the surface soils *(or surface water sediments at Site C)*. b) Prevent human exposure by means of ingestion, dermal contact, and inhalation of contaminants in shallow soils *(or surface water sediments at Site C)* during any future construction activities at the site.

Site	Media	Remedial Action Objectives
		c) Prevent the migration of contaminants from shallow soils to waters of the state that would result in dissolved contaminant concentrations in excess of ARARs and (TBCs).
Site A, 135 PTA, and MNARNG EBS Area	On-TCAAP surface soils (0-12 feet below ground surface)	*d) Protect human receptors from unacceptable risk associated with ingestion and dermal contact exposure to contaminants in shallow soils.* ***(Amendment #5)*** *e) Prevent the leaching of contaminants from shallow soils to groundwater at levels that would cause unacceptable risk to human groundwater receptors.* ***(Amendment #5)***

O&M procedures include maintaining the cautionary signs around the perimeter of each protective soil cover. These signs are in place at all the soil cover sites. These signs help ensure the short- and long-term protectiveness of the remedy by helping to prevent disturbance of protective soil covers. O&M would also include repair of any damage that compromises the thickness requirements for the protective soil covers; however, no such damage occurred during the period of this Five-Year Review.

5.4.1.2 Deep Soil Sites

The remedy for "Deep Soil Sites," Sites D and G, consists of seven remedy components specified in the ROD and ROD Amendment #3. The active deep soil remedy components #2 through #7 have been completed. Remedy component #1, groundwater monitoring, is ongoing. Groundwater monitoring (for VOCs) near the vicinity of Sites D (well 03U093) and G (well 03U094) is being conducted as part of OU2 Deep Groundwater Monitoring in accordance with groundwater monitoring plans that are reviewed and updated annually as part of the APR. Overall, the TCE groundwater monitoring results over the past decade have shown a downward trend; however, the emerging contaminant 1,4-dioxane was discovered in the Site D and Site G wells, and 56 percent (%) of the monitoring wells sampled in FY 2016 had 1,4-dioxane concentrations exceeding the MDH HRL value of 1.0 µg/L. The groundwater monitoring data remained constant between FY 2016 and FY 2017. As discussed during the site visit, the currently proposed ESD for OU2 will be finalized to address 1,4-dioxane contamination. The RAOs (outlined in Table 5-8 below) have been achieved through the operation of the SVE system (not in operation) and the ongoing groundwater monitoring component. All sites were visited, and no problems or issues were identified as a result of any of the site inspections.

There are ongoing LUC requirements for the shallow soil at Site D and the dump at Site G, as discussed in Section 5.4.1.1.

Table 5-8 Remedial Action Objectives for Shallow Soil Sites

Site	Media	Remedial Action Objectives
Sites D and G	on-TCAAP Deep soils (12 feet below ground surface to water table)	Prevent the migration of contaminants from deep soils to groundwater that would result in dissolved contaminant concentrations in excess of groundwater ARARs and TBCs.

O&M procedures are limited to two items. The first is maintaining the cautionary signs around the perimeter of each protective soil cover. These signs help ensure the short- and long-term protectiveness of the remedy by helping to prevent disturbance of protective soil covers. The second item is to remove any woody vegetation (greater than 2-inches in diameter) annually to prevent deep rooting into the Site G cover. This procedure helps maintain the integrity of the cover, minimize infiltration of precipitation, and help to ensure the short- and long-term protectiveness of the remedy. O&M also includes repairs of any damage that could compromise the thickness requirements for the protective soil covers; however, no such damage occurred during the period of this Five-Year Review.

5.4.1.3 Site A Shallow Groundwater

ROD Amendment #6 selected MNA in lieu of the groundwater extraction system to achieve groundwater containment and mass removal. The source characterization/remediation component of the remedy (component #3) has been completed. The active remedy components: #1 groundwater monitoring, #2A LUCs, #2B alternate water supply and abandonment program, and #4 MNA are effectively achieving the RAOs outlined in Table 5-9 below.

Groundwater monitoring requirements for this program were met and are summarized in Table 26 (Section 9, Tables). The LUCs, alternate water supply and well abandonment program, and the MDH SWBCA continue to function as intended. As of April 2016, the SWBCA covers all OU2. Revisions to the OU2 LUCRD have not changed the LUCs for Site A. The annual LUC inspection (Appendix C) did not reveal any items that required additional action. No follow-up actions have been identified as necessary to maintain the protectiveness of the LUCs. MNA is adequately controlling plume migration. No problems or issues were identified as a result of the site inspection.

Overall, the remedy components for Site A continued to operate consistent with past years and in compliance with the required performance criteria, but the remedy is not yet complete. No additional changes or actions are required for the remedy at Site C at this time.

Table 5-9 Remedial Action Objectives for Site A Shallow Groundwater

Site	Media	Remedial Action Objectives
Sites A	on-TCAAP groundwater	a) Prevent human exposure to water contaminated with carcinogens in excess of ARARs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than ARARs and having a threshold noncancer hazard index greater than 1.0. c) Contain and control contaminated groundwater in the shallow Unit 1[a] groundwater aquifer to prevent further spreading and minimize the level of contaminants through mass removal. e) Restore the contaminated aquifer to concentrations below ARARs and to-be-considered guidance (TBCs) with regulator approval. f) Contain the deep Units 3[b] and 4[c] groundwater plume source area while also maximizing mass removal.

For the groundwater at Site A, the Army maintains groundwater recovery systems; however, these systems have been shut off since 2008 to evaluate MNA effectiveness. The 2017 ROD Amendment #6 documents that MNA will be utilized in lieu of groundwater containment and mass removal, and discharge of extracted groundwater to a POTW as specified in the ROD. Therefore, O&M costs will remain lower going forward.

5.4.1.4 Site C Shallow Groundwater

The 2007 OU2 ROD Amendment #1 specified four remedy components and incorporated the existing groundwater extraction system as the final remedy. Active remedy components #2: Groundwater Containment and #3: Discharge of extracted water, have been completed. The active remedy components: # 1 groundwater monitoring and #4 LUCs are effectively achieving the RAOs outlined in Table 5-10 below.

Requirements for groundwater monitoring were met and are summarized in Table 27 (Section 9, Tables); however, surface water locations were inadvertently missed in FY 2017. These locations

were sampled in FY 2018.[13] Overall, lead concentrations at source area wells have decreased in the last 10 years indicating substantial progress towards reaching groundwater cleanup levels. For remedy component #4, the LUCs continue to function as intended. As of April 2016, the SWBCA covers all OU2. Revision 5 of the OU2 LUCRD was approved in FY 2018 and documented that Site C is part of the 108 acres planned for transfer to Ramsey County. The LUCs for groundwater will remain in place. The annual LUC inspection (Appendix C) did not reveal any items that required additional action.

Overall, the remedy components for Site C continued to operate consistent with past years and in compliance with the required performance criteria, but the remedy is not yet complete. No additional changes or actions are required for the remedy at Site C at this time. No problems or issues were identified because of the site inspection.

Table 5-10 Remedial Action Objectives for Site C Shallow Groundwater

Site	Media	Remedial Action Objectives
Site C	on-TCAAP groundwater	d) *For Site C, protect human and ecological receptors from unacceptable risk associated with ingestion and dermal exposure to surface water above surface water chronic standards (**Amendment #1**)*

For the groundwater at Site C, the Army maintains groundwater recovery systems; however, these systems have been shut off since 2008 to evaluate MNA effectiveness. If MNA eventually becomes the approved remedy for Site C shallow groundwater, the O&M costs will remain lower going forward. Given that groundwater cleanup levels may be reached throughout Site C within a few years, it may not be necessary to go through the process of formally changing the remedy.

5.4.1.5 Site I Shallow Groundwater

Per the OU2 ROD Amendment #2, signed in 2009, a three-component groundwater monitoring-based remedy is being implemented at Site I. Active remedy component #2, additional investigation, has been completed. Remedy component #1, groundwater monitoring, continues to be required; however, groundwater monitoring was not conducted from FY 2014 through FY 2017. As previously approved by both USEPA and MPCA, all Site I (Building 502) Unit 1 monitoring wells were abandoned in FY 2014 prior to the demolition of Building 502. Only well 01U667 is scheduled to be replaced, which has been delayed beyond FY 2018 due to a delay in construction activities associated with planned site redevelopment by Ramsey County. Because well 01U667 has yet to be replaced, no groundwater sampling has been conducted since FY 2013. Prior to the well abandonment, the site was in compliance with the groundwater monitoring component. The

[13] The FY 2018 groundwater monitoring data was not available to evaluate.

FY 2013 data suggests that cleanup levels have not been attained. For remedy component #2, the LUCs continue to function as intended. Revisions to the OU2 LUCRD have not changed the groundwater LUCs for Site I. The annual LUC inspection (Appendix C) did not reveal any items that required additional action. No follow-up actions have been identified as necessary to maintain the protectiveness of the LUCs.

The groundwater monitoring component and LUCs in place are effectively achieving the RAOs outlined in Table 5-11 below. The remedy is not yet complete. Monitor well 01U667 will be reinstalled at the same location and depth following completion of redevelopment-related regrading to occur at Building 502. It will continue to be in compliance after being reinstalled. No problems or issues were identified as a result of the site inspection.

Table 5-11 Remedial Action Objectives for Site I Shallow Groundwater

Site	Media	Remedial Action Objectives
Site I	on-TCAAP groundwater	a) Prevent human exposure to water contaminated with carcinogens in excess of ARARs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than ARARs and having a threshold noncancer hazard index greater than 1.0. c) Contain and control contaminated groundwater in the shallow Unit 1[a] groundwater aquifer to prevent further spreading and minimize the level of contaminants through mass removal. e) Restore the contaminated aquifer to concentrations below ARARs and TBCs with regulator approval. f) Contain the deep Units 3[b] and 4[c] groundwater plume source area while also maximizing mass removal.

5.4.1.6 Site K Shallow Groundwater

Active remedy component #2 Sentinel Wells specified in the ROD has been completed for the shallow groundwater at Site K. The active remedy components: #1 groundwater monitoring, #3 hydraulic containment, #4 groundwater treatment, #5 treated water discharge, #6 discharge monitoring, #7 additional investigation, and #8 LUCs are effectively achieving the RAOs outlined in Table 5-12 below.

The groundwater monitoring (component #1) requirements at Site K were met. For this site, water levels are collected annually from monitoring wells and bundle piezometers around the groundwater collection and treatment system for groundwater monitoring. The hydraulic containment (component #3) portion of the remedy involves removing contaminated groundwater through use of a recovery trench. Vertical capture was effective as illustrated on Figure 66 (Section 10, Figures). As seen in the figure, groundwater both upgradient and downgradient of the trench is captured and collected. The remedy component groundwater treatment (component #4) is based on treating contaminated groundwater to cleanup standards using air stripping. During FY 2017, the treatment system functioned and was operational 96% of the time, and a regular maintenance schedule was maintained. Treated water is currently being discharged (component #5) into Rice Creek and is required to meet the substantive requirements of Document Number MNU0009579 (MPCA). In accordance with the ROD, a monitoring plan (component #6) has been established and is currently being implemented in compliance with discharge requirements. Additional investigations (component #7) and characterization are being implemented at the site. ESD #1 added LUCs (component #8) as a remedy component. The annual LUC inspection (Appendix C) did not reveal any items that required additional action. No follow-up actions have been identified as necessary to maintain the protectiveness of the LUCs.

Overall, the remedy components for Site K continued to operate consistent with past years and in compliance with the required performance criteria, but the remedy is not yet complete. No additional changes or actions are required for the remedy at Site K at this time. No problems or issues were identified as a result of the site inspection.

Table 5-12 Remedial Action Objectives for Site K Shallow Groundwater

Site	Media	Remedial Action Objectives
Sites K	on-TCAAP groundwater	a) Prevent human exposure to water contaminated with carcinogens in excess of ARARs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than ARARs and having a threshold noncancer hazard index greater than 1.0. c) Contain and control contaminated groundwater in the shallow Unit 1[a] groundwater aquifer to prevent further spreading and minimize the level of contaminants through mass removal.

Site	Media	Remedial Action Objectives
		e) Restore the contaminated aquifer to concentrations below ARARs and TBCs with regulator approval. f) Contain the deep Units 3[b] and 4[c] groundwater plume source area while also maximizing mass removal.

The O&M procedures remain adequate, given the extraction system is effectively containing contamination and the surface water discharge limits continue to be met. No changes to O&M procedures appear to be necessary. There have not been frequent equipment breakdowns, large periods of unanticipated downtime, or O&M cost issues that would suggest any potential remedy problems.

5.4.1.7 Building 102 Shallow Groundwater

OU2 ROD Amendment #4 formally documented selection of remedy components for the Building 102 groundwater remedy and added this site to the OU2 remedy. The active remedy components are #1 MNA, #2 groundwater monitoring, and #3 LUCs for Building 102 They are effectively achieving the RAOs outlined in Table 5-13 below.

The remedy components are addressing the RAOs listed below. The decision to proceed with MNA (component #1) was based on strong evidence from water quality monitoring (i.e., degradation products) and on the MPCA Microcosm Studies that verified abiotic degradation of VOCs in Building 102 groundwater is occurring at substantial rates. The decision to proceed with MNA was based on the absence of any groundwater receptors. Overall, lead concentrations at source area wells have decreased in the last 10 years indicating substantial progress towards reaching groundwater cleanup levels. Natural occurring abiotic degradation attenuation continues to occur at the site. The groundwater monitoring (component #2) requirements for this site have been met and are summarized in Table 34 (Section 9, Tables). The remedy component #3, LUCs, continue to function as prescribed. The annual LUC inspection (Appendix C) did not reveal any items that required additional action. No follow-up actions have been identified as necessary to maintain the protectiveness of the LUCs.

Overall, the remedy components for Building 102 continued to operate consistent with past years and in compliance with the required performance criteria, but the remedy is not yet complete. No additional changes or actions are required for the remedy at Building 102 at this time. No problems or issues were identified as a result of the site inspection. One 1,4-dioxane detection in Building 102 shallow groundwater exceeded the MDH HRL, but was deemed an anomaly. Future monitoring will be conducted to assess if it is a COC in Building 102 shallow groundwater.

Table 5-13 Remedial Action Objectives for Site 102 Shallow Groundwater

Site	Media	Remedial Action Objectives
Sites 102	on-TCAAP groundwater	*g) For Building 102 Groundwater: Protect human receptors from exposure to contaminated groundwater above acceptable risk levels* ***(Amendment #4).*** *h) For Building 102 Groundwater: *Prevent contaminated groundwater from discharging into surface water above regulatory limits.* ***(Amendment #4).*** *i) For Building 102 Groundwater: Minimize further degradation of the shallow Unit 1[1] groundwater* ***(Amendment #4).***

5.4.1.8 Deep Groundwater

The active remedy components: #1 hydraulic containment and contaminant removal from the source area, #2: groundwater treatment, #3: treated water discharge, #4: institutional controls #5: review of new technologies, and #6 groundwater monitoring are effectively achieving the RAOs outlined in Table 5-14 below.

Groundwater extraction to hydraulically contain (component #1) the contaminant source area to the 5 µg/L TCE concentration contour and optimize the removal of contaminants from the source area, pumping of select wells is in place to achieve the RAOs. As of 2017, the TGRS operates with 11 wells including eight boundary extraction wells and three source control wells with treated effluent discharged to the Arsenal Sand and Gravel Pit where it recharges overburden sands (Upper and Lower Unit 3). The TGRS was designed to operate at a maximum theoretical capacity of 2,900 gpm, which includes a safety margin above its current operational flow rate to accommodate potential fluctuations in system operation. As discussed in the 5.3.4 Data Review section, the TGRS extracted and treated an average of approximately 900 million gallons of water annually. With regards to long-term trends, most of the monitoring wells on and off TCAAP exhibit decreasing trends in TCE concentration, indicating an overall improvement in water quality both upgradient and downgradient of the TGRS. Long-term trends are discussed further in 5.3.4 Data Review.

Groundwater treatment (component #2) is based on treating contaminated groundwater to cleanup standards using air stripping. The system is currently meeting the treatment requirements as specified by the ROD. The air stripping towers remove VOCs with an efficiency of approximately 99.4%. The air emissions are equal to the VOC mass removal rates presented in Table 25 (Section

9, Tables). No additional changes or actions are required for this remedy component #2 at this time.

Treated water (component #3) is currently discharged to the on-site gravel pit, which allows it to recharge to the aquifer. There were no noticeable changes in Gravel Pit performance based on visual observation during FY 2017. The Gravel Pit is accommodating the TGRS discharge as designed.

Institutional controls (component #4) were implemented to restrict access to aquifers that had been contaminated, as well as prevent exposure to contaminated groundwater. The alternate water supply and well abandonment program, and the MDH SWBCA continue to function as intended. As of April 2016, the SWBCA covers all OU2.

The review of new technologies (component #5) consists of annual reviews of new and emerging technologies that have the potential to cost-effectively accelerate the timeframe for aquifer restoration. The Army has reported annually on the status of any reviews of emerging technologies since FY 1997. The Deep Groundwater Characterization Report and a TCAAP Operable Unit Remedy Review were completed in January 2018 and July 2018, respectively. The data collected during the deep groundwater characterization were integrated with other historical site information to refine the conceptual site model (CSM) and develop recommendations of future optimization or recovery operations. The recommendations were provided in the OU Remedy Review, which enhanced the understanding of COC transport within OU1, OU2, and OU3. The objective of the remedy review was to understand what changes can be made to source control operations and the TCAAP TGRS within OU2 that could help facilitate greater improvement in OU1 groundwater currently addressed via the NBCGRS. The report concluded that enhancing COC capture and groundwater control of the shallower sand and gravel overburden unit offers the greatest opportunities for plume control and remedy optimization within OU2. The OU Remedy Review identified the following opportunities for optimization:

- Adopt an optimized capture approach based on overall plume mass recovery opposed to the existing TGRS operating strategy prescriptive flow rate;
- Rebalance the TGRS pumping operations to target the groundwater plume core;
- Enhance source control and source mass recovery via new supplemental source zone wells;
- Incorporate targeted 1,4-dioxane treatment to address areas where 1,4-dioxane is most concentrated and treatment can provide the most significant OU2 benefit;
- Under the optimized program, continue to leverage performance monitoring data to optimize extraction rates, maximize mass recovery, and eliminate redundant wells from the extraction program; and
- As supplemental source control extraction results in additional OU2 improvement, discontinue TGRS operations entirely and rely only on source control extraction wells.

The groundwater monitoring (component #6) is conducted in accordance with ROD specifications.

Further discussion of the TGRS can be found 5.3.4 Data Review. Overall conclusions regarding remedy performance for deep groundwater meeting their RAOs and all requirements of the OU2 ROD are listed below:

- Hydraulic influence in Units 3 and 4 extends upgradient within OU2 beyond the 5 µg/L contour, meeting VOC criteria in the OU2 ROD.
- The total average extraction well water pumped exceeded Total System Operational Minimum (1,745 gpm). The FY 2017 annual average extraction rate was 1,769 gpm.
- The TGRS extracted and treated 929,926,100 gallons of water and removed 1,988 pounds of VOCs from October 2016 to September 2017. Average VOC influent concentrations increased by 12.9% from FY 2016.
- Groundwater analytical data of the source area show a general decrease in TCE concentration. This concentration decrease demonstrates the TGRS is effectively removing VOC mass from the aquifer.
- Effluent VOC concentrations were below contaminant-specific requirements for all sampling events.

Overall, the remedy components for Deep Groundwater continued to operate consistent with past years and in compliance with the required performance criteria, but the remedy is not yet complete. No additional changes or actions are required for the remedy at Site D & G at this time. No problems or issues were identified as a result of the site inspection.

Table 5-14 Remedial Action Objectives for Deep Groundwater

Site	Media	Remedial Action Objectives
Sites D & G	on-TCAAP groundwater	a) Prevent human exposure to water contaminated with carcinogens in excess of ARARs and having a total excess cancer risk for all contaminants of greater than 10^{-4} to 10^{-6}. b) Prevent human exposure to water with concentrations of noncarcinogens greater than ARARs and having a threshold noncancer hazard index greater than 1.0.

Site	Media	Remedial Action Objectives
		c) Contain and control contaminated groundwater in the shallow Unit 1[a] groundwater aquifer to prevent further spreading and minimize the level of contaminants through mass removal. e) Restore the contaminated aquifer to concentrations below ARARs and TBCs with regulator approval. f) Contain the deep Units 3[b] and 4[c] groundwater plume source area while also maximizing mass removal.

The O&M procedures remain adequate, given the extraction system is effectively containing the contamination and the treatment system reliably treats recovered groundwater to meet discharge requirements. No changes to O&M procedures appear to be necessary. Since FY 2011, system operation downtime has decreased due to preventative maintenance. Based off FY 2018 O&M monthly reports, preventative measures like pumphouse troubleshooting has been key to PM. According to Table 35 (Section 9, Tables), the pumphouse downtime has decreased on an average of 70% from FY 2013 to FY 2017. There have not been frequent equipment breakdowns, significant periods of unanticipated downtime, or elevated O&M cost issues that would suggest any potential remedy problems. According to Table 36 (Section 9, Tables), downtime of a pumphouse component is lower at an average of 1.9 days compared to the 10 days based off the historical data of five years ago.

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

Yes. The RAOs for OU2 sites remain valid, subject to objectives in the OU2 ROD, ESDs, and ROD Amendments.

A human health risk assessment was performed for TCAAP by USEPA in 1991, prior to cleanup of source areas. For a methodology of the 1991 risk assessment, please refer to the 2014 FYR. Remediation goals reflecting human health criteria developed as part of the TCAAP RODs were reviewed against currently used health-based levels for OU2 soil and groundwater sites. As part of the ROD, health-based levels in soil were established based on industrial and limited construction exposures, and health-based levels in groundwater were established based on receptors and routes of exposure. The exposure assumptions, cleanup levels, toxicity data, and RAOs for soil and groundwater sites are discussed below.

Exposure Assumptions: Soils

The current land use for the federally-controlled portion of TCAAP, which is the area that contains all the contaminant source areas with LUCs, is a military facility. The risk evaluation developed for TCAAP (in the OU2 ROD) assumed a continued "industrial use scenario." The following assumptions were made relative to potential receptors and exposure routes, as stated in the OU2 ROD, page 14:

> *People who might be at risk from exposure to contaminated soil include TCAAP workers or occupants. Incidental ingestion and dermal contact are the only significant routes for receptors to be exposed to contaminants in surface soils at the site. If future activities require excavation, however, workers may be exposed to contaminants by inhalation, as well as through incidental ingestion and dermal contact.*

Note that when considering exposure routes at sites where the cleanup levels were based on health risk-based values, the ROD noted that contaminated soils existing at depths greater than 12 feet did not require excavation/remediation, since soils below that depth are not considered accessible.

Both cancer and non-cancer effects were evaluated. The cancer risk evaluation was based on the exposure assumption that an individual would be exposed to contaminated soils via dermal contact and ingestion over an exposure period equal to 25 years. The calculation of soil cleanup levels under the industrial scenario was based on an adult receptor (body weight of 70 kilograms), with a soil ingestion rate of 50 milligrams per day and a dermal exposure on 0.31 square meters of body surface, both occurring 250 days out of each year. A chemical was identified as a COC when the increased cancer risk reached one in one million. For non-cancer risk, a chemical was identified as a COC when the Hazard Index was greater than one.

The potential receptors and routes of exposure remain valid. Exposure routes were evaluated in the following section and there are no current exposure pathways. Currently, no changes in land use have occurred that would have a bearing on the remedy. No new soil COCs have been added to any of the previously existing soil sites and no cleanup levels for COCs have been modified since the OU2 ROD was signed. However, as discussed previously, Amendment #5 in 2014 added sites MNARNG EBS and 135 PTA, and addressed AOCs at Site A.

Exposure Assumptions: Groundwater

For groundwater, The ROD identified the following potential receptors and exposure routes for contamination:

> *People who might be at risk from exposure to contaminated groundwater include TCAAP workers and local residents who rely on private drinking wells that extract*

contaminated groundwater. The potential pathways by which these receptors might be exposed include ingestion, inhalation during showering, and adsorption through the skin (dermal contact) during showering or bathing with contaminated groundwater.

The potential receptors and routes of exposure remain valid, with one clarification: the TCAAP potable water treatment plant (which utilized treated effluent from the TGRS system as its water supply) is no longer in operation and it is not being offered as a drinking source.

Exposure routes for VI potential for OU2 sites was evaluated and results are as follows:

1) Shallow soil sites – have all been remediated and closed out. There is no potential VI pathway.

2) Deep soils (Sites D and G) – SVE operations, soil remediation and clay caps with LUCs have been performed and sites have been closed out with respect to soil contamination. There is no potential VI pathway.

3) Shallow Groundwater Sites:

    a. Site A – Per MPCA request in 2012, the Army competed soil vapor sampling and VI investigation in 2013, the report concluded that there is no significant VI risk for Site A. Nonetheless, we used the EPA VI screening level (VISL) calculator to evaluate potential risk at this site. The potential risk was calculated to be 1.35 E-6. We also used the Department of Toxic Substances Control (Cal EPA) VI model, version 3. The model inputs are groundwater concentrations for VOCs, which in this case is TCE, depth to water table from a building, vadose zone soil properties such as density and porosities and VOC's chemical properties such as air diffusivity and Henry's Law Constant. The Johnson and Ettinger formula for subsurface VI into a building is used to calculate the VI risk and the risk was computed to be 4.0 E-7. The closest habitable building, which is north of County Road I, is over 700 feet down gradient. Based upon these calculations, we agree with the 2013 report and conclude that there is no VI concern or pathway for Site A at this time.

    b. Site K – The EPA VISL calculator was used to evaluate potential risk at this site. The potential risk was calculated to be 1.01 E-3. We also used the Cal EPA VI model, version 3. The model calculated the VI risk to be 3.70 E-4. There is VI risk at this site; however. Presently, there are no habitable buildings at this site, and because the LUCs are in place the exposure pathway is incomplete.

    c. Building 102 – The EPA VISL calculator was used to evaluate potential risk at this site. The potential risk was calculated to be 2.44 E-5. We also used the Cal EPA VI

model, version 3. The model calculated the VI risk to be 8.90 E-6. There is VI risk at this site; however, there are no habitable buildings at this site, and because the LUCs are in place the exposure pathway is incomplete.

d. Site I – Building 502 was demolished in 2014 and all Site I monitoring wells were abandoned with USEPA and MPCA approval. Only well 01U667 was scheduled to be replaced, which was delayed beyond FY 2018 due to the pending planned site redevelopment. Because well 01U667 has yet to be replaced, no groundwater sampling has been conducted since 2013. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2017 - FY 2021 Monitoring Plan. VI risk evaluation is deferred until the well 01U667 replacement is installed and sampled. Currently the LUCs are in place and the exposure pathway is incomplete.

4) Deep Groundwater Plume — deep groundwater plume, which occurs in Unit 3 (Hillside and Arsenal Sand) and Unit 4 (Prairie du Chien and Jordan) is blanketed by Units 1 and 2 (Fridley and Twin Cities Formations), which are alluvial sand and glacial till. Within these units, 1 and 2, there is a perched groundwater aquifer system, which together with the Unit 2 glacial till form an impermeable boundary for vapor diffusion/migration. Although these units and the perched aquifer system are discontinuous, they are present in most of OU2. The perched groundwater is not connected to the deep groundwater plume, and it is not considered the source of any VI risk. It is unlikely to have exposure routes for VI in OU2 from the deep groundwater plume; the VI pathway from degassing of deep groundwater VOC contamination is incomplete.

Currently, no changes in land use have occurred that would have a bearing on the remedy. No new groundwater COCs have been added to any of the groundwater sites and no cleanup levels for COCs have been modified since the OU2 ROD was signed. As discussed previously, the approval of ROD Amendment #6 in 2017 selected MNA for Site A groundwater remediation, and did not change the cleanup levels established in the OU2 ROD. Since ARARs had been established for the OU2 groundwater COCs, health risk-based remediation goals were not developed for this medium.

Soil and Groundwater Cleanup Levels

The RAOs for OU2 sites remain valid as they continue to meet the objectives in the OU2 ROD, ESDs, and ROD Amendments. In accordance with these documents, the ROD cleanup standards in effect do not need to coincide with updated HRL standards and the LUCs in place are preventing the use of groundwater, which assures protectiveness of human health. The MDH continues to evaluate revisions to HRLs and has not identified issues with the ROD cleanup levels; however, as the sites approach the point of site closure, the MDH could request an evaluation of current

cleanup levels and request changes through an additional ROD Amendment. Recommendations addressing the cleanup level(s) are further discussed in Section 5.7.

Table 5-15 ROD Cleanup Standards & Current Agency Limits for Groundwater COCs

Site	Chemical Name	ROD Cleanup Standards (µg/L)	Current USEPA MCL (µg/L)[a]	Current MDH Standard (µg/L)b
A	Antimony	6	6	6
	1,1-Dichloroethene	6	7	200
	1,2-Dichloroethane	4	70	6
	Benzene	10	5	2
	Chloroform	60	70	20
	cis-1,2-Dichloroethene	70	70	6
	Tetrachloroethene	7	5	5
	TCE	30	5	0.4
C	Lead (Dissolved)	15	15	15
I	1,2-Dichloroethene (cis and trans)	70	70 (cis); 100 (trans)	6 (cis); 40 (trans)
	TCE	30	5	0.4
	Vinyl Chloride	0.2	2	0.2
K	1,2-Dichloroethene (cis and trans)	70	70 (cis); 100 (trans)	6 (cis); 40 (trans)
	TCE	30	5	0.4
Building 102	Vinyl Chloride	0.18	2	0.2
	Cis-1,2-Dichloroethene	70	5	6
	TCE	5	5	0.4
	1,1-Dichloroethene	6	none	200

Site	Chemical Name	ROD Cleanup Standards (µg/L)	Current USEPA MCL (µg/L)[a]	Current MDH Standard (µg/L)b
Deep Groundwater	1,1,1-Trichloroethane	200	200	5,000
	1,1-Dichloroethane	70	none	80
	1,1-Dichloroethene	6	7	200
	1,2-Dichloroethane	4	5	1
	cis-1,2-Dichloroethene	70	70	6
	Tetrachloroethene	5	5	5
	TCE	5	5	0.4

[a]The MCL values were taken from USEPA's Regional Screening Level (RSL) Summary Table (November 2018) which can be found here: <https://semspub.epa.gov/work/HQ/197414.pdf>

As part of the ROD, soil health risk levels were calculated that were considered protective of industrial and construction workers and included the ingestion and dermal exposure pathways. Since the preparation of the original HRLs, USEPA has routinely (bi-annually) published Regional Screening Levels (RSLs) that are protective of industrial exposures (oral, dermal, and inhalation exposures) and are updated to reflect current exposure factors and toxicity criteria. The most current RSLs are presented in Table 5-16.

Table 5-16 ROD Cleanup Standards & Current USEPA Limits for Soil COCs

Site	Chemical Name	ROD Cleanup Standards (mg/kg)[a]	Current USEPA RSL (mg/kg)[b]	Current USEPA MCL (µg/L)
A	Antimony	33.6	4.70E+02	6.00E+00
	Barium	21,745	2.20E+05	2.00E+03
	Copper	19,593	4.70E+04	1.30E+03
	Lead[c]	1,200	8.00E+02	1.50E+01
C	Antimony	67.2	4.70E+02	6.00E+00
	Arsenic	4	3.00E+00	1.00E+01
	Beryllium	0.7	2.30E+03	4.00E+00
	Dissolved Lead	1,200	8.00E+02	1.50E+01
	Manganese	2,503	2.60E+04	none
	Thallium[d]	11.8	1.20E+01	2.00E+00

Site	Chemical Name	ROD Cleanup Standards (mg/kg)[a]	Current USEPA RSL (mg/kg)[b]	Current USEPA MCL (µg/L)
D	TCE	0.4	6.00E+00	5.00E+00
E	Antimony	22.4	4.70E+02	6.00E+00
	Barium	21,745	2.20E+05	2.00E+03
	Copper	13,062	4.70E+04	1.30E+03
	Lead	1,200	8.00E+02	1.50E+01
	Manganese	834	2.60E+04	none
G	TCE	3.95	6.00E+00	5.00E+00
H	Antimony	33.6	4.70E+02	6.00E+00
	Arsenic	4	3.00E+00	1.00E+01
	Copper	19,593	4.70E+04	1.30E+03
	Lead	1,200	8.00E+02	1.50E+01
	Manganese	2,503	2.60E+04	none
129-3	Antimony	22.4	4.70E+02	6.00E+00
	Lead	1,200	8.00E+02	1.50E+01
	Manganese	834	2.60E+04	none
	Nitroglycerine	Not Established	8.20E+01	none
	TCE	4.43	6.00E+00	5.00E+00
129-5	Antimony	67.2	4.70E+02	6.00E+00
	Barium	21,745	2.20E+05	2.00E+03
	Lead	1,200	8.00E+02	1.50E+01
129-15	Arsenic	4	3.00E+00	1.00E+01
	Benzo[a]anthracene	0.22	2.10E+01	none
	Benzo[a]pyrene	0.02	2.10E+00	2.00E-01
MNARNG EBS	Antimony	100	4.70E+02	6.00E+00
	Copper	19,593	4.70E+04	1.30E+03
	cPAHs	3	NA	0.1E+01
	Lead	700	8.00E+02	1.50E+01
	Mercury	1.5	4.6E+01	0.2E+01

Site	Chemical Name	ROD Cleanup Standards (mg/kg)[a]	Current USEPA RSL (mg/kg)[b]	Current USEPA MCL (µg/L)
135 PTA	cPAHs	3	NA	0.1E+01
	Naphthalene	7.5	1.7E+01	NA

[a]These recommendations were developed using the background level as the minimum remediation goal, ARARs for the remaining criteria, and giving precedence to the more stringent of health risk-based or leaching-based goals.
[b]The RSL values were taken from USEPA's guidance for industrial soils in the RSL Summary Table (November 2018) which can be found here: <https://semspub.epa.gov/work/HQ/197414.pdf>. USEPA RSLs are based on carcinogenic risk of $1x10^{-6}$, and noncancer hazard quotients of 1.0.
[c]The RSL used for Lead was for Lead and Compounds.
[d]The RSL used for Thallium was for Thallium Soluble Salts.

In addition to consideration of health risk-based remediation goals, cleanup levels were selected based on consideration of background soil concentrations, ARARs (if available), and soil leaching-based goals. Leaching based-goals were calculated by the MPCA using a soil model, as documented in Appendix C of the OU2 ROD, for those constituents for which evidence of soil leaching existed (specifically, if a constituent existed in groundwater above drinking water or health-based standards). Cleanup levels were selected using the following hierarchy of precedence:

1) The background level takes precedence as the minimum remediation goal.

2) ARARs take precedence over the remaining criteria.

3) The more stringent of health risk-based or leaching-based goals takes precedence.

For health risk-based goals, the lower of the cancer and non-cancer values were used (including adjustment for multiple contaminants, where necessary). The methodology for selection of cleanup levels is documented in the OU2 ROD. USEPA RSLs, MDH SRVs, as well as USEPA MCLs and MDH standards were used in the ROD to come up with the leaching-based cleanup standards. For a comparison of ROD cleanup levels to current USEPA RSLs and USEPA MCLs, please see Table 5-15.

Based on additional site investigation work conducted following the release of the ROD, COCs were added at Site A (tetrachloroethene and TCE), Site D (antimony, lead, and nitroglycerine), and 129-15 (lead). PCBs were not listed as a COC at Site D in the OU2 ROD; however, PCBs that were "secured in-place" (as discussed previously) are known to exist at concentrations that exceed the ARAR of 10 mg/kg that was cited in the OU2 ROD, which led to the Army's designation of a protective soil cover over the area of PCB-contaminated soils at Site D.

Nitroglycerine was listed as a COC for Site 129-3 in the OU2 ROD; however, no cleanup level was established. This cleanup level was calculated at the time of soil remediation work at Site 129-3. The background number for arsenic in TCAAP soils was raised from 4 to 10 mg/kg, as documented in a June 14, 1999 MPCA letter to the Army, and this resulted in the cleanup levels at Sites C, H, and 129-15 being raised to 10 mg/kg. However, at Site 129-15, the highest arsenic concentration detected in soils was 5 mg/kg, and arsenic was dropped as a COC. Lastly, the Site G cleanup level for TCE in soil was raised to 36.1 mg/kg, which was based on a revised soil leaching analysis that specifically accounted for the lower permeability of the Site G cover (regulatory concurrence for this change was provided July 24, 2002). For cleanup levels that were established following the OU2 ROD, the health risk calculations were noted to be based on the same methodology and input parameters that were documented in Appendix C of the OU2 ROD.

In 2013, MDH updated its drinking water guidance for TCE due to new toxicity and health effects information. Although not an ARAR, the updated HBV for TCE is 0.4 µg/L, which is lower than the HRL and Federal MCL of 5 µg/L. The new guidance value does not affect current protectiveness because LUCs prevent use of contaminated groundwater.

Current health-based levels were checked, and the toxicity values used in risk review calculations were checked for any changes.

At the time of the ROD, lead and PCBs were the only COCs for which health-based guidance could be utilized to establish TBC values, due to the lack of regulations in this area at the time. The lead cleanup level of 1,200 mg/kg (industrial scenario) was calculated by USEPA using the Exposure Model for Assessing Risks Associated with Adult Exposure to lead in Soil, as documented in Appendix C of the OU2 ROD. Currently, USEPA recognizes a concentration of 800 mg/kg as being protective of industrial workers. The MDH recognizes a concentration of 700 mg/kg as being protective of industrial workers. For PCBs, because there is a protective soil cover being maintained at Site D where PCB-contaminated soils were “secured in-place” (i.e., soils are known to contain PCBs at concentrations higher than the cleanup level of 10 mg/kg), the PCB guidance that was used to establish the TBC value was not reviewed, however the 10 mg/kg concentration is consistent with USEPA Toxic Substances Control Act (TSCA).The LUCs in place provide the protective soil cover preventing any exposure to the COCs.

Currently, MDH Soil Reference Values (SRVs) are derived based on a carcinogenic risk of $1x10^{-5}$ (one in 100,0000), and a noncarcinogenic hazard quotient of 0.2. Compared to USEPA RSLs, that are based on a cancer risk of $1x10^{-6}$ (one in a million), and a hazard quotient of one, the MDH SRVs may differ. This difference is highlighted in the thallium screening levels. The ROD value for thallium is 11.8 mg/kg, consistent with the current USEPA RSL of 12 mg/kg, but greater than the MDH SRV of 2.3 mg/kg.

Toxicity Value Review

The toxicity values used in risk assessment calculations were checked. To perform this check, the current toxicity data was obtained from USEPA RSLs (November 2018). The RSL documentation compiles with toxicity criteria recognized by USEPA, including the Integrated Risk Information System, and is updated twice yearly.

For Sites A, C, D, E, G, H, 129-3, 129-5, and 129-15, toxicity data that was used to calculate health-risk based goals is presented in Tables I-1 and I-3 through I-10 in Appendix C of the OU2 ROD. For the Grenade Range and the Outdoor Firing Range, the toxicity data that was used to calculate health-risk based goals is presented in the EE/CAs for each site. The oral reference doses (RfDo) and/or oral slope factors listed in these documents were checked against RSL toxicity values. The following changes in values were found:

Sites A, C, E, H, 129-5, 129-15, K: Barium: the RfDo in the RSLs was found to be 0.2, versus the value in the OU2 ROD of 0.07. Given the RfDo value is higher, the calculated non-cancer PRG would also increase, and no change to the barium cleanup level needs to be considered.

Sites A, B, C, D, E, G, H, 129-3, 129-15, 1, K: Chromium: the RfDo in the RSLs was found to be 1.5E+0, versus the value in the OU2 ROD of 1.0E+0. Given the RfDo value is higher, the calculated non-cancer PRG would also increase, and no change to the chromium cleanup level needs to be considered.

Sites A, C, E, G, H, 129-3, 129-5, 129-15, 1, K: Copper: the RfDo in the RSLs was found to be 4E-2, versus the value in the OU2 ROD of 3.7E-2. Given the RfDo value is higher, the calculated non-cancer PRG would also increase, and no change to the copper cleanup level needs to be considered.

Site C: Beryllium: the RfDo in the RSLs was found to be 2E-03, versus the value in the OU2 ROD of 5E-03. Recalculation of the non-cancer PRG results in lowering the PRG from 180 to 72 mg/kg. However, since the beryllium cleanup level is 0.7 mg/kg, no change to the beryllium cleanup level needs to be considered.

Site C: Thallium: several RfDos are listed in the RSLs for the different salts of thallium, ranging from 8E-05 to 9E-05, versus the value in the OU2 ROD of 7E-05. Given these RfDo values are higher, the calculated non-cancer PRG would also increase, and no change to the thallium cleanup level needs to be considered.

Site H and 129-15: DDD and DDE. The OU2 ROD does not identify the currently available RfDo values for DDD and DDE. However, the current carcinogenic slope factors of 2.4E-1 and 3.4E-1, respectively, are the same as those identified in the OU2 ROD.

135 PTA and MNARNG EBS: Polycyclic Aromatic Hydrocarbons (PAHs) (Benz(a)anthracene, Benzo(a)pyrene, Chrysene, Indeno(1,2,3-cd)pyrene): With respect to carcinogenic PAHS , on January 19, 2017 USEPA IRIS program released its final assessment of benzo[a]pyrene and identified a carcinogenic slope factor for BaP several times less potent than when assessed in the original HRA and subsequent development of health-based cleanup standards. Given the revised carcinogenic potency is less, the calculated cancer risks of the HRA would decrease.

Site I: Cis-1,2-Dichloroethylene: The RfDo in the RSLs was found to be 2E-03, versus the value in the OU2 ROD of 1E-02. The value would result in higher estimated noncarcinogenic hazard for this chemical.

The potential health risks associated with exposure to the source areas on TCAAP as well as the contaminated groundwater both on and off the original TCAAP were evaluated. Based on the above review, no changes to any of the cleanup levels for OU2 soils or groundwater need to be considered.

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

No other information has been obtained that could call into question the protectiveness of the remedy for the current land use.

5.5 TECHNICAL ASSESSMENT SUMMARY

Based on the RAOs, data reviewed, and the site inspection, the remedies are functioning as intended by the 1997 OU2 ROD and its subsequent ESDs and Amendments.

The following has been noted about the TGRS:

- COC concentration reduction has occurred during the early pump and treat system operations, the latest data shows continued concentration reduction as referenced from Tables 5-15 & 5-16.

The following MNA sites have additional features following the issuance of the original ROD that should be noted:

- Site A: The need to operate the Site A groundwater extraction system to achieve groundwater containment and mass removal was evaluated. The USEPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. MNA will adequately control plume migration. MNA was approved in ROD Amendment #6 (2017).

- Building 102: Groundwater MNA was selected as the final remedy for this site in an Army Action Memorandum in 2008, based on recommendations in an EE/CA prepared by Wenck in that year. This is documented in ROD Amendment #4 (2012). Groundwater monitoring will continue to evaluate the success of MNA and decontamination at the site.

Soil VI in the previous Five-Year Review was investigated and no significant VI risk existed for the homes along County Road I for Site A.

O&M information and costs do not suggest problems.

No changes in land use or exposure scenarios have occurred that would affect the protectiveness of the remedy.

The RAOs for OU2 sites remain valid as they continue to meet the objectives in the OU2 ROD, ESDs, and ROD Amendments. In accordance with these documents, the ROD cleanup standards in effect do not need to coincide with updated HRL standards and the LUCs in place result in incomplete exposure pathways, which assures protectiveness of human health. The MDH continues to evaluate revisions to HRLs and has not identified issues with the ROD cleanup levels; however, as the sites approach the point of site closure, the MDH could request an evaluation of current cleanup levels and request changes through an additional ROD Amendment.

5.6 ISSUES

Issues	Affects Protectiveness (Y/N)	
	Current	Future
1,4-Dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology.	No	No

5.7 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions Affects Protectiveness (Y/N)	
				Current	Future
Finalize and implement the currently proposed ESD to address 1,4-dioxane contamination.	Army	MPCA & USEPA	End of FY 2024	No	No

5.8 PROTECTIVENESS STATEMENT

The remedy at OU2 is protective of human health and the environment.

All remedy components are currently functioning, and data indicates progress towards achieving the RAOs.

For soil sites where the remedy has been completed (Sites A, C, D, E, H, 129-3, 129-5,129-15, the Grenade Range, and the Outdoor Firing Range), the site's availability for industrial use has been restored. Review of the toxicity data upon which the health risk assessments for these sites were based showed that no changes have occurred that could potentially affect the protectiveness of the remedies. The protective soil covers at these soil sites, in conjunction with LUCs, effectively prevent exposure to contaminated soils/debris. The remedy including LUCs are functioning as intended.

The groundwater containment systems are meeting their containment objectives and the treatment systems are meeting their discharge requirements. For Site A shallow groundwater, the alternate water supply and well abandonment program, along with the SWBCA, are mitigating potential risks associated with private wells. Also, at Site A, MNA is adequately controlling plume migration (in lieu of groundwater extraction system operation). Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater.

Review of the ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to Site C groundwater and had no short-term impacts to the groundwater cleanup levels for Sites A, I, and K shallow groundwater or OU2 deep groundwater.

The Army is proactively addressing 1,4-dioxane contamination through an ESD that is currently underway.

6.0 OPERABLE UNIT 3

6.1 OU3 REMEDIAL ACTIONS

6.1.1 OU3 Remedial Action Objectives

RAOs were developed for OU 3 groundwater as part of the OU3 FS in 1992 and were addressed by the OU3 ROD (September 1992). The OU3 ROD, which is referred to as "ROD" throughout this section, has been modified by a ROD Amendment in 2006. The ROD Amendment did not affect the RAOs. The following RAOs for OU3 groundwater are designed to protect human health and the environment from exposure to contaminants:

Table 6-1 OU3 Remedial Action Objectives

Site	Media	Remedial Action Objectives
OU3	Deep Groundwater: Off-site deep groundwater -South Plume	1. Restore the contaminated aquifer for future use by reducing contaminant levels to those which will adequately protect human health and the environment; 2. Control contaminant migration to prevent further spread of VOC plumes; 3. Prevent the near term and future exposure of human receptors to contaminated groundwater above MCLs both on and off site; and 4. Monitor groundwater in a manner to verify effectiveness of remedial measures.

6.1.2 Remedy Selection

The OU3 ROD, signed September 1992, prescribed four major remedy components, including the extraction and treatment of groundwater for the removal of VOCs by a pressurized GAC system. The primary contaminant of concern is trichloroethene (TCE). A ROD Amendment was finalized in August 2006 changed the remedy for OU3. The basis for the OU3 ROD Amendment was the *"Groundwater Statistical Evaluation, OU3" Technical Memorandum*, which received regulatory approval on May 2, 2005. This document presented a statistical evaluation showing the South Plume has been receding since at least 1996, including the period after the Plume Groundwater Recovery System (PGRS) was shut off in 2001. The South Plume had receded upstream of the PGRS such that it was basically pumping clean water. The ROD Amendment removed the need for a pump and treat remedy, eliminating the PGRS extraction well and treatment train.

The OU3 ROD Amendment, signed August 2006, prescribes the following components for the selected remedy:

1. MNA;

2. Monitoring of the groundwater for VOCs to verify the effectiveness of the selected remedy and the natural attenuation of the South Plume; and

3. Continued implementation of the drilling advisory that regulates the installation of new private wells within OU3 through a SWCA.

6.1.3 Remedy Implementation

The Alternate Water Supply and Well Abandonment Program has been implemented and is an ongoing program maintained by the Army. See Section 4.1.2 under OU1 for additional information on the program.

Groundwater monitoring is conducted in accordance with plans that are reviewed and updated annually as part of the APR. Northrup Grumman Innovation Systems (formerly Orbital ATK Inc.) conducts the sampling related to OU3 performance monitoring, and the Army conducts private well sampling related to the Alternate Water Supply and Well Abandonment Program. Due to the discovery of 1,4-dioxane at TCAAP in FY 2015, the contaminant was included for analysis during groundwater monitoring.[14]

6.1.4 Land Use Controls

LUCs are required to ensure the protectiveness of the OU3 remedy until such time the groundwater cleanup levels are achieved. The original OU3 ROD (1992) did not prescribe any LUCs; however, the OU3 plume was contained within the SWBCA that was established for OU1. The OU3 ROD Amendment (2006) formally adopted the need for a LUC as part of the remedy and prescribed the following: "Continued implementation of the drilling advisory that regulates the installation of new private wells within OU3 through a Special Well Construction Area."

In Minnesota, the drilling of wells is regulated by the MDH, including the legal authority to create a SWBCA to prohibit water supply wells within contaminated portions of aquifers. The MDH created the SWBCA for the NB/AH Superfund Site in June 1996. Minnesota Rules, Part 4725.3650, details the requirements for construction, repair, and sealing of wells and borings within a designated SWBCA, including plan review and approval, water quality monitoring, and

[14] 1,4 dioxane is not a contaminant listed in the ROD.

other measures to protect public health and prevent degradation of groundwater[15].

Figures 9 through 11 (Section 10, Figures) show the physical area of groundwater contamination within OU3-the area that does not support UU/UE of the groundwater within the contaminant plume. The current SWBCA boundary is shown on Figure 12 (Section 10, Figures), which encompasses the entire OU3 groundwater plume. The objective of the LUC is to prevent use of contaminated groundwater that poses an unacceptable risk to human health. The long-term stewardship for the LUC rests with the MDH, within its authority to regulate the construction and use of wells. The LUC for OU3 is summarized in Table 4 (Section 9, Tables).

6.1.5 System Operations/Operation and Maintenance

The City of New Brighton operated and maintained the OU3 treatment facility (PGRS) and associated extraction well. The PGRS was dismantled and NBM #13 was abandoned in FY 2007, so there are no O&M procedures. The OU3 ROD Amendment (2006) formally adopted the need for a LUC as part of the remedy.

The annual O&M costs to operate the PGRS were approximately $200,000 per year from 1999 to 2001 (when the PGRS was operational) versus the original O&M cost estimate of $276,000. With the PGRS in standby status, the costs dropped to about $30,000 per year. Now that the PGRS has been dismantled, there are no costs associated with O&M.

6.2 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

The 2014 Five-Year Review stated that "the OU3 remedy is protective of human health and the environment. The alternate water supply and well abandonment program, along with the SWBCA, are mitigating potential risks associated with private wells. Water quality trends indicate that progress towards aquifer restoration continues to occur."

No issues, recommendations, or follow-up actions were noted in the 2014 Five-Year Review for OU3.

6.3 FIVE-YEAR REVIEW PROCESS

6.3.1 Administrative Components

Administrative components were as described for OU1(see Section 4.3.1).

[15] Information regarding the SWBCA can be found on the MDH webpage at the following location: https://www.health.state.mn.us/communities/environment/water/wells/swbca/tcaap.html and information from this website is also included in Appendix E.

6.3.2 Community Notification and Involvement

Community notification was conducted as described for OU1 (see Section 4.3.2).

6.3.3 Document Review

The primary documents reviewed for OU3 were the following:

- *Record of Decision - Groundwater Remediation, Operable Unit 3*, September 1992;
- *Record of Decision Amendment, Operable Unit 3*, August 2006;
- *TCAAP Final APRs* for FYs 2013, 2014, 2015, 2016, and 2017;
- *Plume History Evaluation, Operable Unit 3*, October 2000;
- Previous *Five-Year Review Report*, July 2014;
- *TCAAP Operable Unit Remedy Review*, June 2018; and
- *Groundwater Statistical Evaluation, Operable Unit 3*, May 2005.

The OU3 ROD Amendment was the source of information for RAOs and cleanup levels.

6.3.4 Data Review

The status of the OU3 remedial action components is summarized in Table 5 (Section 9, Tables).

6.3.4.1 Groundwater Sampling

Groundwater monitoring, as required by remedy components #1 and #2, is conducted to verify performance of the remedy. Each FY, a revolving, five-year monitoring plan is prepared by the Army and submitted to USEPA and MPCA for approval via the APR. Although it covers five years, it is submitted on an annual basis to allow for minor changes to be made that streamline or improve the quality of the monitoring data to be collected.

In FY 2016, groundwater samples were collected from 16 wells as part of the comprehensive biennial sampling round. All the wells sampled contained TCE concentrations similar to those reported for the previous sampling event (either 2013 or 2014). TCE concentrations in the downgradient sentry well, 04U863, remained not detectable (less than 1.0 µg/L) for the fourth consecutive year after rising above 1.0 µg/L for the first time since December 1999 in 2012 (1.2 µg/L). TCE concentrations were also less than 1.0 µg/L in wells 03L854, 03U673, 04J866, 04U860, and 04U866. Two wells, 03L848 and 04U848, had TCE concentrations greater than 1.0 µg/L, but below the cleanup standard of 5 µg/L. The other eight wells had TCE concentrations

above the cleanup standard of 5 µg/L, ranging from 6.0 µg/L to 110 µg/L. 1,1,1-trichloroethane or its degradation products, 1,1-dichloroethane and 1,1-dichloroethene, were present in three wells at the boundary between OU1 and OU3 (03L859, 04U859, and 04U832), indicating a commingling of the North Plume and the South Plume at these locations. These parameters have also been detected at low concentrations at 03M848 and 03L673, center-of-plume wells, for several years, including FY 2016.

A supplemental, full sampling round was collected in FY 2016 for 1,4-dioxane. As stated, an MDH HRL of 1 µg/L is used for impact determination, with three of the 18 locations sampled (03L673, 04U832, and 04U859) showing HRL exceedances and the highest 1,4-dioxane concentrations at 5.4 µg/L. Concentrations in samples from nine wells were less than the HRL and concentrations in samples from six locations were non-detect for 1,4-dioxane. 1,4-dioxane impacts are not perceived within OU3, as the 5.4 µg/L appears to be from re-spreading through Unit 3 groundwater.

In FY 2017, groundwater samples were collected from two wells as part of the annual sampling round. The wells sampled contained TCE concentrations like those reported for the previous sampling events. Downgradient sentry well 04U863 TCE concentration remained less than 1.0 µg/L or not detectable (less than 1.0 µg/L) for the fifth consecutive year after rising above 1.0 µg/L for the first time since December 1999 in 2012 (1.2 µg/L). The other well sampled in FY 2017, 03M848, had TCE concentrations above the cleanup standard of 5 µg/L at 110 µg/L. In 2017, samples from two wells were collected for 1,4-dioxane for OU3 annual sampling; both locations (03M848 and 04U863) were below the HRL.

6.3.4.2 Plume Analysis

The OU3 ROD Amendment requires contingency actions to be considered when the Mann-Kendall statistical analysis shows that a well at the edge of the South Plume has an increasing trend in TCE and its degradation products. The wells analyzed in FY 2016 and FY 2017 showed decreasing trends in these compounds as discussed further below. The Mann-Kendall statistical analysis was updated for ten edge-of-plume and center-of-plume wells in FY 2016 and for center-of-plume well 03M848 in FY 2017. The statistical analyses for 2016 and 2017 focused primarily on TCE are presented in Table 41 (Section 9, Tables), and a spreadsheet presenting the Mann-Kendall test results for the wells are provided in Appendix I of the FY 2017 APR. Based on the most recent 2017 statistical analysis, the trend for 03M848 changed from no trend or stable to decreasing as concentrations have decreased over the last five sampling events. The downgradient sentry well 04U863 TCE concentration remained less than 1.0 µg/L or not detectable for the fifth consecutive year. The TCE concentrations at 03M848 have steadily decreased from 1,400 µg/L in FY 1996 to 700 µg/L in FY 1999 to 450 µg/L as recently as FY 2003 to 110 µg/L in FY 2016 to the current concentration of 100 µg/L in FY 2017. However, recent low-level detections of degradation products associated with 1,1,1-trichloroethane (i.e., 1,1-dichloroethane) at 03M848

may indicate the North Plume is not only beginning to mingle with the South Plume at the OU1-OU3 boundary but may be present even toward the center of the South Plume. The possible mingling of these two plumes at this well may be a factor in future statistical trends.

The statistical analysis for well 04U859, which is classified as a center-of-plume well and is at the boundary with OU1, shows a decreasing trend; it had previously showed a stable trend. The presence of 1,1,1-trichloroethane, and its degradation products, which have historically been present in 04U859, indicates the North Plume is present at this location and may be a factor in analysis. The trends for wells 03L848, 04U832, and 04U848 located at the edge-of-plume remained unchanged since the last statistical analysis. Well 03L848 has a decreasing trend and well 04U832 is unchanged at no trend. The trend at well 04U848 remains unchanged with a probable decreasing trend. The trends for wells 03L673, 03L859, 04U673, and 04U854 remained unchanged from the last statistical analysis and continue to have a decreasing trend. A stable trend was again noted at well 04U845.

In summary, based on the data collected in FY 2016 and 2017, the center of the South Plume, represented by 03M848, indicates decreasing concentration trends, which is consistent with wells 03L859 and 04U859, also classified as center-of-plume wells. The edge of the South Plume appears to be decreasing or stable. A stable or decreasing trend at the edge of the plume indicates the South Plume is not expanding. In addition, the presence of 1,1,1-trichloroethane and its degradation products near the OU1-OU3 boundary indicates the North Plume may be commingling with the South Plume and may be a factor in the trends noted at the wells near the boundary. Recent data show the North Plume may be present even toward the center of the South Plume and may also be a factor in the trends noted there. The OU3 plume is shown on Figures 9, 10, and 11.

The SWBCA designated by MDH (and as amended in 1999) satisfies remedy component #3 and is accomplishing its purpose of notifying water well installers of the contaminated groundwater in the area and preventing the installation of water supply wells into the contaminated portion of the aquifer through the well construction permitting controlled by the MDH.

6.3.5 Site Inspection

On November 2, 2018, Amir Martin, David Boyes, and Mary Lee conducted a widespread inspection of monitoring wells associated with both OU1 and OU3. All wells visited in association with OU 3 were in good order and examples of monitoring well condition are provided in the accompanying Photo Log (Appendix D).

6.3.6 Interviews

Interviews were conducted, as discussed previously under OU1 (see Section 4.3.6).

One of the interviewees spoke specifically to remedy effectiveness associated with OU 3. Amy Hadiaris, a hydrogeologist with MPCA spoke to the extensive removal of Site I as a contamination source for OU3 and that the state was satisfied with MNA as long as monitoring reports continued to demonstrate there is no plume rebound and no changes to the remedy required. Interview questions and responses are included in Appendix F. In general, interviewees had a positive overall impression of the project with respect to human health and environmental protection and felt remedies were being well maintained.

6.4 TECHNICAL ASSESSMENT

6.4.1 *Question A:* Is the Remedy functioning as intended by the decision documents?

Yes. The review of RAOs, documents, and monitoring data suggest the remedy is functioning as intended by the ROD and is effectively progressing towards meeting the RAOs outlined in Table 6-1. The center of the South Plume is showing decreasing TCE concentrations over the last five sampling events. Decreasing contaminant concentrations indicate that aquifer restoration is occurring. The alternate water supply program continues to function as intended.

There are no O&M procedures, given that the treatment system has been dismantled.

The LUC for OU3 is the MDH SWBCA, which continues to function as intended. No changes are necessary for this remedy component.

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

Yes. The assumed route of exposure to contaminated groundwater remains valid (i.e., ingestion, inhalation during showering, and absorption through the skin during showering or bathing). VI as a potential exposure route was considered. The deep groundwater plume, which occurs in Units 3 and 4, is blanketed by Units 1 and 2 (Fridley and Twin Cities Formations), which are alluvial sand and glacial till. Within Units 1 and 2, there is a perched groundwater aquifer system, which together with the Unit 2 glacial till form an impermeable boundary for vapor diffusion/migration. These units and the perched aquifer system occur above much of the off-Site plumes (OU1 and OU3). The perched groundwater is not connected to the deep groundwater plume and is not considered to be a source for VI risk. There is no exposure route for VI in OU3 deep groundwater. In other words, the VI pathway for contaminated groundwater degassing is incomplete for the deep groundwater plume OU3. No new exposure routes are applicable. No changes in land use have occurred that would have a bearing on the remedy.

The cleanup levels for OU3 are listed in Table 16 (Section 9, Tables) and Table 6-1 below. These were based on consideration of the following ARARs, as identified in the OU3 ROD:

- MCLs and non-zero MCLGs specified in the National Primary Drinking Water Regulations (40 CFR Part 141), which apply to public water supplies, and which were established by USEPA in accordance with the SDWA.

- RALs for Drinking Water Contaminants, Release 3, January 1991, prepared by the MDH.

The cleanup levels developed in the OU3 ROD utilized the lowest value among the MCL, non-zero MCLG, and RAL. The review of the current regulations revealed that for five of the six OU3 COCs, there are MCLs, MCLGs, or HRLs that have been established. One COC, 1,1-dichloroethane, does not have an MCL, MCLG, or HRL. The cleanup level was based on the RAL of 70 µg/L, which is no longer in use by MDH; however, the ROD has set the cleanup standards and does not need to coincide with MDH and HRL standards. In 2016, the MDH published a guidance value of 80 µg/L as the chronic RAA for 1,1-dichloroethane. Please see Table 6-2 below for more information.

Table 6-2 OU3 Remedy Cleanup Standards & Current Agency Limits

Chemical Name	ROD Cleanup Standards (µg/L)	ROD Cleanup Standards Basis	Current USEPA MCL (µg/L)	MDH Standard (µg/L)	Type and Date of MDH Value
1,1-Dichloroethane	70	RAL[b]	none	80	RAA16[c]
1,1-Dichloroethene	6	HRL	7	200	HRL11[d]
cis-l,2-Dichloroethene	70	MCL, RAL[b]	70	6	HRL18[d]
1,1,1-Trichloroethane	200	MCL	200	5000	HRL18[d]
1,1,2-Trichloroethane	3	MCLG (proposed), HRL	5	3	HRL93[d]
TCE	5	MCL	5	0.4	HRL15[d]

[a] The Maximum Contaminant Level (MCL) values were taken from Environmental Protection Agency's (EPA)'s Regional Screening Level (RSL) Summary Table (November 2018) which can be found here: https://semspub.epa.gov/work/HQ/197414.pdf
[b]RAL = Recommended Allowable Limit were replaced with the HRLs.
[c]RAA = Risk Assessment Advice. The digit refers to the year.
[d]HRL = Health Risk Limit. The digit refers to the year. The MDH HRL standards "Comparison of State Water Guidance and Federal Drinking Water Standards" on the MDH website (September 2018), can be found here:
http://www.health.state.mn.us/divs/eh/risk/guidance/waterguidance.html
MCLG = Maximum Contaminant Level Goal
MDH = Minnesota Department of Health

It was noted that on July 1, 2007, the MDH HRLs were revised such that for any HRL that was set higher than the MCL, the new HRL is set equal to the MCL. For OU3, this affected two COCs: TCE and 1,1,1-trichloroethane. The HRL for TCE was revised from 30 to 5 µg/L and the HRL for

1,1,1-trichloroethane was revised from 600 to 200 µg/L. However, since the OU3 cleanup levels were already equal to the MCL for these two chemicals, there was no impact to the established cleanup levels.

The 2006 ROD Amendment did not change the ARARs for OU3. Since the remedy cleanup standards are ARARs, changes in toxicity, containment characteristics, and risk assessment methodology would not result in risk estimates that could affect the protectiveness of the remedy.

The RAOs for OU3 remain valid and were unchanged by the ROD Amendment in 2006. No new objectives have been proposed. The detection of 1,4-dixoane has not impacted the remedy components or remedy protectiveness, and the remedy is progressing towards meeting the RAOs.

In 2013, MDH updated its drinking water guidance for TCE due to new toxicity and health effects information. Although not an ARAR, the updated HBV for TCE is 0.4 µg/L, which is lower than the HRL and Federal MCL of 5 µg/L. The new guidance value does not affect current protectiveness because LUCs prevent use of contaminated groundwater.

The MDH has updated their HRL standards since the publication of the ROD, with HRLs for cis-1,2-dichloroethene and TCE that are now lower than the cleanup standards prescribed in the OU1 ROD. Please see Table 6-2 for more information.

In March 2015, USEPA and MPCA requested sampling and analysis for 1,4-dioxane to be included in the June 2015 annual sampling event for OU3. The analysis was added to all regularly scheduled monitoring wells. No Federal MCL has been established for 1,4-dioxane; however, the MDH has established an HRL value of 1.0 µg/L. Four of the sixteen locations sampled (03L673, 03L859, 04U832, and 04U859) had 1,4-dioxane concentrations exceeding the HRL. The highest concentration was detected at 04U859 at 5.1 µg/L. Ten of the monitoring wells sampled had 1,4-dioxane detections below the HRL and 1,4-dioxane was not detected at two wells. The 2016 sampling event demonstrated similar results with three of the 18 locations sampled (03L673, 04U832, and 04U859) displaying 1,4-dioxane concentrations exceeding the HRL. The highest concentration was again detected at 04U859 at 5.4 µg/L. Nine of the monitoring wells sampled had 1,4- dioxane detections below the HRL and 1,4-dioxane was not detected at six wells. Figures 9 through 11 present plan views of the 1,4-dioxane plumes in the OU3 area. The 2015 and 2016 1,4-dioxane concentrations were lower (less than 1.0 µg/L) near the center and eastern side of the OU3 plume area and higher (greater than 3.0 µg/L) along the western edge. Since the LUC for OU3 is the MDH SWBCA, which continues to function as intended, current 1,4-dioxane contamination does not affect current protectiveness because the prescribed LUCs prevent use of contaminated groundwater.

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

No information has been obtained that could call into question the protectiveness of the remedy.

6.4.4 Technical Assessment Summary

Based on the RAOs and data reviewed, the remedy is functioning as intended by the OU3 ROD (as amended). No changes in land use or exposure scenarios have occurred that would affect the protectiveness of the remedy. Over time, the ARARs used in establishing cleanup levels have undergone some changes (MDH RALs are no longer applicable, more MDH HRLs have been established, and some HRLs have been revised); however, none of these changes suggest that a change to the cleanup levels should be considered. No information has been obtained that could call into question the protectiveness of the remedy.

6.5 ISSUES

None.

6.6 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

There are no recommendation or follow-up actions at this time.

6.7 STATEMENT OF PROTECTIVENESS

The OU3 remedy is protective of human health and the environment.

The alternate water supply and well abandonment program, along with the SWBCA, are mitigating potential risks associated with private wells. Water quality trends indicate that progress towards aquifer restoration continues to occur.

7.0 NEXT REVIEW

The next Five-Year Review is due August 19, 2024.

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9.0 TABLES

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LIST OF TABLES

Table 1
Crosswalk, Operable Unit (OU) Designations
New Brighton / Arden Hills Superfund Site

EPA OU#	Description	Date	EPA Remarks	TCAAP OU#
1	St. Anthony Water Pipeline ROD	08/02/1984	Interim action ROD	
2	RI/FS (Sewer line/Round Lake) ROD	08/12/1987	Interim action ROD	
3	St. Anthony Alternate Water Supply ROD	03/31/1987	Interim action ROD	
4	Off-Base RI	03/31/1991	MPCA performed	
5	New Brighton Well #7 ROD	06/30/1986	ROD was amended 09/30/1989, rescinding construction of Well #7	
6	BGRS ROD	09/25/1987	Interim action ROD	
7	On-TCAAP RI	07/02/1983	NBCGRS (TCAAP OU1) and On-TCAAP Cleanup (OU2), and all of their amendments, are tracked under this OU	1,2
	NBCGRS ROD	09/30/1993	(OU 7 is where the 'final remedy' designation for the Site has been tracked)	
	On-TCAAP Cleanup ROD	12/11/1997		
	Site A, 135 Primer/Tracer Area, EBS Sites	?	OU7 ROD Amendment #5	
8	PCB Burn	08/11/1989	Interim action ROD	
9	PGRS ROD	09/30/1992	(TCAAP OU3)	3
10	Round Lake ROD	?		

Table 2
Chemicals of Concern (COCs) and Selected Cleanup Levels
New Brighton/Arden Hills Superfund Site

		Soil COC	Cleanup Level (mg/kg)	Groundwater COC	Cleanup Level (µg/l) and Basis [1]	Surface Water COC	Cleanup Level (µg/l) and Basis [1]
OU1							
	Deep Groundwater	*None*		1,1-Dichloroethane	70 (RAL)	*None*	
				1,1-Dichloroethene	6 (HRL)		
				cis-1,2-Dichloroethene	70 (MCL,RAL)		
				1,1,1-Trichloroethane	200 (MCL)		
				1,1,2-Trichloroethane	3 (HRL)		
				Trichloroethene	5 (MCL)		
OU2							
	A	Antimony	33.6	Antimony	6 (HRL)	*None*	
		Barium	21,745	1,1-Dichloroethene	6 (HRL)		
		Copper	19,593	1,2-Dichloroethane	4 (HRL)		
		Lead	1200	Benzene	10 (HRL)		
		Tetrachloroethene	0.5[2]	Chloroform	60 (HRL)		
		Trichloroethene	1.44[2]	cis- 1,2-Dichloroethene	70 (HRL)		
				Tetrachloroethene	7 (HRL)		
				Trichloroethene	30 (HRL)		
	C	Antimony	67.2	Lead	15 (NPDWR)	*None*	
		Arsenic	10				
		Beryllium	0.7				
		Lead	1200				
		Manganese	2503				
		Thallium	11.8				
	D	Trichloroethene	0.416[2]	*Refer to OU2 Deep Groundwater*		*None*	
		PCBs	10				
		Antimony	67.2				
		Lead	1200				
		Nitroglycerine	61.2				
	E	Antimony	22.4	*None*		*None*	
		Barium	21,745				
		Copper	13,062				
		Lead	1200				
		Manganese	834				
	G	Trichloroethene	36.1[2]	*Refer to OU2 Deep Groundwater*		*None*	
	H	Antimony	33.6	*None*		*None*	
		Arsenic	10				
		Copper	19,593				
		Lead	1200				
		Manganese	2503				
	I	*None*		1,2-Dichloroethene (cis and trans)	70 (HRL)	*None*	
				Trichloroethene	30 (HRL)		
				Vinyl Chloride	0.2 (HRL)		
	K	*None*		1,2-Dichloroethene (cis and trans)	70 (HRL)		
				Trichlorothene	30 (HRL)		
	129-3	Antimony	22.4	*None*		*None*	
		Lead	1200				
		Manganese	834				
		Nitroglycerine	61.2				
		Trichloroethene	4.43[2]				
	129-5	Antimony	67.2	*None*		*None*	
		Barium	21,745				
		Lead	1200				
	129-15	Benzo(a)anthracene	0.215	*None*		*None*	
		Benzo(a)pyrene	0.021				
		Lead	1200				
	Grenade Range	Antimony	33	*None*		*None*	
		Cadmium					
		0-1 ft above GW*	1.4[2]				
		1-2 ft above GW	2.3[2]				
		2-3 ft above GW	7[2]				
		> 3 ft above GW	50				
		Lead					
		0-1 ft above GW	270[2]				
		> 1 ft above GW	1200				

Table 3
OU1, PGAC Effluent Water Quality

Fiscal Year 2015

	Influent Well Monitoring						Operational Performance Monitoring															
Sampling Date	Well #3	Well #4	Well #5	Well #6	Well #14	Well #15	Contactor #1 A	Contactor #1 B	Contactor #2 A	Contactor #2 B	Contactor #3 A	Contactor #3 B	Contactor #4 A	Contactor #4 B	Contactor #5 A	Contactor #5 B	Contactor #6 A	Contactor #6 B	Contactor #7 A	Contactor #7 B	Contactor #8 A	Contactor #8 B
GAC replaced in contactors 1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A September 16 - October 3, 2014. "B" Vessels become the Lead Vessels.																						
6-Oct-14	62	56	49	39	3	16	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
3-Nov-14	62	61	49	NS	2	24	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
1-Dec-14	72	66	42	NS	2	26	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
12-Jan-15	65	67	41	NS	3	33	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
2-Feb-15	70	74	47	43	3	30	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
2-Mar-15	63	NS	45	40	2	25	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
6-Apr-15	65	NS	47	37	10	49	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0
See Note 3 with regard to the discovery of 1,4-dioxane in the NBCGRS wells.																						
May-15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Jun-15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Jul-15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Aug-15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sep-15	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

1) All water quality results shown are for Total VOCs (µg/L).

2) NS = Not Sampled.

3) Routine pumping of the NBCGRS was ceased on April 15, 2015, with notice to the USEPA/MPCA, due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the granular activated carbon (GAC) does not remove 1,4-dioxane, New Brighton is preferentially pumping deep aquifer wells that have no detectable 1,4-dioxane while the City evaluates the feasibility of 1,4-dioxane removal technologies. This has been referred to as a "Remedy Time-Out," and normal pumping of the NBCGRS will not be resumed until a technology is selected and modification of the NBCGRS is designed and constructed. Limited, intermittent pumping of the NBCGRS wells will occur only when necessary to provide the incremental volume of water (beyond what deep aquifer pumping can provide) that is necessary to meet peak demand periods in the summer. The Fridley Interconnection was also closed on April 15, 2015.

Table 4

Land Use Controls Summary

Media, Engineered Controls, & Areas That Do Not Support Unlimited Use/Unrestricted Exposure	Land Use Control Objective	Title of Land Use Control Instrument Implemented
OU1 – Deep Groundwater: North plume of deep groundwater contamination off the installation as depicted in Figures 9 to 11.	Prevent uses of contaminated groundwater that pose an unacceptable risk to human health, until cleanup levels are achieved.	Special Well Construction Area administered by the Minnesota Department of Health.
OU2 – Deep Groundwater: Plume of deep groundwater contamination on the installation as depicted in Figures 51 to 53. (See Note)	Prevent uses of contaminated groundwater that pose an unacceptable risk to human health, until cleanup levels are achieved. Prevent activities that would reduce the effectiveness of groundwater remedial actions set forth in decision documents and subsequent design or monitoring plans for each individual area.	Land Use Control Remedial Design (LUCRD)
OU2 – Shallow Groundwater: Plumes of shallow groundwater contamination at Site A (Figure 37), Site C (Figure 39), Site I (Figure 43), Site K (Figure 46), and Building 102 (Figures 47 to 49). (See Note)	Prevent uses of contaminated groundwater that pose an unacceptable risk to human health, until cleanup levels are achieved. Prevent activities that would reduce the effectiveness of groundwater remedial actions set forth in decision documents and subsequent design or monitoring plans for each individual area.	LUCRD
OU2 – Soil: Areas remediated to site-specific cleanup levels (all or portions of Sites A, C, D, E, G H, 129-3, 129-5, 129-15, Grenade Range, Outdoor Firing Range, 135 Primer/Tracer Area, 535 Primer/Tracer Area), and the EBS Areas on AHATS. (See Note)	Prevent exposure to contaminated soil at levels that pose an unacceptable risk to human health.	LUCRD
OU2 – Covers: Areas with soil contamination remaining in-place that have a soil cover to prevent exposure (all or portions of Sites C, D, E, G, H, 129-15, and Outdoor Firing Range). At Site G only, the cover is also designed to minimize infiltration.	Prevent disturbance of soil covers which would result in exposure to the underlying contaminated soil of sufficient magnitude as to pose an unacceptable risk to human health.	LUCRD
OU3 – Deep Groundwater: South plume of deep groundwater contamination off the installation as depicted in Figures 9 to 11.	Prevent uses of contaminated groundwater that pose an unacceptable risk to human health, until cleanup levels are achieved.	Special Well Construction Area administered by the Minnesota Department of Health.

Note: In addition to the individual areas shown above, the OU2 LUCRD also addresses soil and groundwater LUCs for the remaining federally-owned property within OU2 and addresses groundwater LUCs for the applicable portion (380 acres) of the 427 acres of property that was transferred to Ramsey County for redevelopment in 2013/2017. Past investigation work focused on areas suspected to have had a release of hazardous substances to the environment, and not the entire OU2 land area. Although there is not a decision document for the land outside the individual areas, the U.S. Army and Ramsey County have elected to implement “blanket” LUCs for soil and groundwater (as applicable) across a significant portion of these properties as a practical way to address this matter. The “blanket” soil LUCs include the following excepted areas: Site F, which was remediated to unrestricted use levels for soils; the “watchable wildlife area” that was cleared for unrestricted public use for soils; the cantonment area within the Arden Hills Army Training Site (AHATS) and the Army Reserve Center, where the soil LUC was revised to allow uses compatible with a restricted commercial exposure scenario; soil LUCs were removed from the 380-acre area referred to as the “California-shaped area”; and soil LUCs were changed on the 108-acre portion of OU2 to allow recreational use and unrestricted exposure as part of the RCRTC.

Table 5
Status of Remedial Actions
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 1: Deep Groundwater					
#1	Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#2	Drilling Advisories	Yes	Yes	No	
#3	Extract Groundwater	No	No	No	NBCGRS pumping has temporarily been suspended (referred to as a "Remedy Time-out") to allow the City of New Brighton to design and construct a 1,4-dioxane treatment system, which will allow a return to normal pumping.
#4	Removal of VOCs by GAC (Discharge Quality)	No	No	No	See comment for Remedy Component #3.
#5	Discharge of Treated Water	No	No	No	See comment for Remedy Component #3.
#6	Groundwater Monitoring with Verification of Continuing Aquifer Restoration	Yes	Yes	No	
	Overall Remedy	Partially	Not Applicable	No	Yes for components being implemented
Operable Unit 2: Shallow Soil Sites					
#1-7	Soil Remediation				
	Site A	Yes	Yes	Yes	
	Site C	Yes	Yes	Yes	
	Site E	Yes	Yes	Yes	
	Site H	Yes	Yes	Yes	
	Site 129-3	Yes	Yes	Yes	
	Site 129-5	Yes	Yes	Yes	
	Grenade Range	Yes	Yes	Yes	
	Outdoor Firing Range	Yes	Yes	Yes	
	135 PTA Stormwater Ditch	Yes	Yes	Yes	
	535 Primer/Tracer Area	Yes	Yes	Yes	
	Site K Soils	Yes	Yes	Yes	
	Water Tower Area	Yes	Yes	Yes	
	Soil AOCs (Site A, 135 PTA, EBS Areas)	Yes	Yes	Yes	
#8	Groundwater Monitoring	Yes	Yes	Yes	
#9	Characterization of Dumps	Yes	Yes	Yes	
	Site B	Yes	Yes	Yes	
	Site 129-15	Yes	Yes	Yes	
#10	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	Partially	

Table 5 Continued
Status of Remedial Actions
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Twin Cities Army Ammunitions Plant
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PIKA ARCADIS a joint venture

	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Deep Soil Sites					
#1	Groundwater Monitoring	Yes	Yes	Yes	
#2	Restrict Site Access During Remediation	Yes	Yes	Yes	Long-term land use controls are addressed by Remedy Component #8
#3	SVE Systems	Yes	Yes	Yes	Systems were turned off in 1998.
#4	Enhancements to SVE Systems	Yes	Yes	Yes	Neither system required operation with enhancements. Both SVE systems have been dismantled.
#5	Maintain Existing Site Caps	Yes	Yes	Yes	This remedy component was intended to minimize short-circuiting of airflow when the SVE systems were operating. The long-term land use controls for the cap/cover that must be maintained at Sites D and G (due to shallow soil contamination at Site D and the Site G dump) are addressed by Remedy Component #8.
#6	Maintain Surface Drainage Controls	Yes	Yes	Yes	
#7	Characterize Shallow Soils and Dump	Yes	Yes	Yes	
#8	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	Partially	
Operable Unit 2: Site A Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Groundwater Containment/Mass Removal	No	Not Applicable	No	The groundwater extraction system was shut off on 9/24/08 and was in standby while implementation of MNA was evaluated. In late 2015, MNA was deemed an acceptable remedy, and therefore a ROD amendment was prepared in FY2017 to document the change in this remedy component.
#3A	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
#3B	Drilling Advisory/Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#4	Discharge of Extracted Water	No	Not Applicable	No	See comment for Remedy Component #2.
#5	Source Characterization Remediation	Yes	Yes	Yes	
	Overall Remedy	Yes	Yes	No	USEPA and MPCA have approved a formal change of the remedy to MNA. A ROD amendment was prepared and approved in FY 2017

Table 5 Continued
Status of Remedial Actions
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	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Site C Shallow Groundwater					
#1	Groundwater and Surface Water Monitoring	Yes	Yes	No	
#2	Groundwater Containment	No	Not Applicable	No	Since the lead plume no longer extends to the extraction wells, the groundwater extraction system was shut off on 11/13/08. Future monitoring will determine whether a ROD modification will be prepared to document the change in this remedy component, or whether the Site can be closed.
#3	Discharge of Extracted Water	No	Not Applicable	No	See comment for Remedy Component #2.
#4	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Site I Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Additional Investigation	Yes	Yes	Yes	
#3	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Site K Shallow Groundwater					
#1	Groundwater Monitoring	Yes	Yes	No	
#2	Sentinel Wells	Yes	Yes	Yes	
#3	Hydraulic Containment	Yes	Yes	No	
#4	Groundwater Treatment	Yes	Yes	No	
#5	Treated Water Discharge	Yes	Yes	No	
#6	Discharge Monitoring	Yes	Yes	No	
#7	Additional Investigation	Yes	Yes	Yes	
#8	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Building 102 Shallow Groundwater					
#1	Monitored Natural Attenuation	Yes	Yes	No	
#2	Groundwater Monitoring	Yes	Yes	No	
#3	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
	Overall Remedy	Yes	Yes	No	

Table 5 Continued
Status of Remedial Actions
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	Remedy Component	Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
Operable Unit 2: Aquatic Sites					
#1	Pond G Surface Water Treatment	Yes	Yes	Yes	
#2	Pond G Surface Water Monitoring	Yes	Yes	Yes	
	Overall Remedy	Yes	Yes	Partially	
Operable Unit 2: Deep Groundwater					
#1	Hydraulic Containment and Contaminant Mass Removal	Yes	Yes	No	
#2	Groundwater Treatment	Yes	Yes	No	
#3	Treated Water Discharge	Yes	Yes	No	
#4	Land Use Controls	Yes	Yes	No	Implementation of the OU2 LUCRD is an ongoing requirement.
#5	Review of New Technologies	Yes	Yes	No	Currently evaluating optimization strategies for the TGRS
#6	Groundwater Monitoring	Yes	Yes	No	
	Overall Remedy	Yes	Yes	No	
Operable Unit 3: Deep Groundwater					
#1	Monitored Natural Attenuation	Yes	Yes	No	
#2	Groundwater Monitoring	Yes	Yes	No	Long-term land use controls are addressed by Remedy Component #8
#3	Drilling Advisories	Yes	Yes	No	
	Overall Remedy	Yes	Yes	No	

Acronyms and Abbreviations:
GAC - granular activated carbon
MNA - monitored natural attenuation
NBCGRS - New Brighton Contaminated Groundwater Recovery System
OU2 LUCRD - Operable Unit 2 Land Use Control Remedial Design
ROD - Record of Decision
SVE - soil vapor extraction
TGRS - TCAAP Groundwater Recovery System
VOC - volatile organic compound

Table 6
OU1 Pumping / VOC Mass Removal Data

Fiscal Year 2013

	WELL #3			WELL #4			WELL #5			WELL #6			WELL #14			WELL #15			System Totals	
MONTH	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	TOTAL WATER TREATED BY EXTRACTION SYSTEM (Mgallons)	TOTAL VOC'S REMOVED BY EXTRACTION SYSTEM (lbs)
TOTAL GALLONS PUMPED AND VOC'S REMOVED THROUGH SEPTEMBER 30, 2012																			25,219	22,619
OCTOBER	66	24.778	13.649	69	3.537	2.037	52	32.615	14.155	53	1.588	0.702	4.8	0.194	0.008	35	41.757	12.198	104	42.75
NOVEMBER	65	29.642	16.080	61	9.040	4.602	49	22.404	9.162	51	5.002	2.129	2.6	0.157	0.003	25	38.576	8.049	105	40.03
DECEMBER	62	26.201	13.558	57	11.623	5.529	47	14.478	5.679	47	13.011	5.104	2.3	1.806	0.035	23	40.648	7.803	108	37.71
JANUARY	63	28.842	15.165	57	14.304	6.805	50	16.041	6.694	45	8.398	3.154	2.4	0.293	0.006	22	41.032	7.534	109	39.36
FEBRUARY	67	20.649	11.547	61	12.586	6.408	53	14.360	6.352	47	14.336	5.623	2.7	0.189	0.004	23	36.081	6.926	98	36.86
MARCH	0	0.000	0.000	63	17.438	9.169	48	20.631	8.265	37	17.641	5.448	2.6	0.242	0.005	24	44.416	8.897	100	31.79
APRIL	0	0.000	0.000	0	0.260	0.000	53	26.003	11.502	46	12.846	4.932	2.7	3.082	0.069	29	41.689	10.090	84	26.60
MAY	0	11.418	0.000	0	0.274	0.000	48	18.225	7.301	44	10.139	3.723	2.7	2.586	0.058	28	29.175	6.818	72	17.90
JUNE	67	10.725	5.997	72	0.269	0.162	43	19.737	7.083	43	14.185	5.091	2.3	0.218	0.004	24	30.075	6.024	75	24.36
JULY	77	17.606	11.314	86	6.104	4.381	54	34.866	15.714	42	34.131	11.964	1.9	0.138	0.002	4	14.900	0.473	108	43.85
AUGUST	76	12.747	8.085	79	4.517	2.978	49	34.731	14.203	40	42.893	14.319	2.6	0.239	0.005	18	34.112	5.125	129	44.72
SEPTEMBER	77	18.023	11.582	83	1.767	1.224	53	21.816	9.650	41	39.356	13.467	3.5	0.167	0.005	24	22.523	4.511	104	40.44
Subtotal			106.978			43.295			115.760			75.657			0.205			84.447		
% of Total Mass			25.1			10.2			27.2			17.7			0.0			19.8		
TOTAL GALLONS TREATED AND VOC'S REMOVED FOR FISCAL YEAR 2013																			1,196	426.37
TOTAL GALLONS TREATED AND VOC'S REMOVED SINCE SYSTEM START UP																			26,415	23,045

Table 7
OU1 Pumping / VOC Mass Removal Data

Fiscal Year 2014

	WELL #3			WELL #4			WELL #5			WELL #6			WELL #14			WELL #15			System Totals	
MONTH	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (ug/l)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	TOTAL WATER TREATED BY EXTRACTION SYSTEM (Mgallons)	TOTAL VOC'S REMOVED BY EXTRACTION SYSTEM (lbs)
TOTAL GALLONS PUMPED AND VOC'S REMOVED THROUGH SEPTEMBER 30, 2013																			26,415	23,045
OCTOBER	69	26.755	15.408	65	7.339	3.981	0	0.000	0.000	39	30.610	9.963	2.2	5.365	0.099	4	15.687	0.563	86	30.02
NOVEMBER	68	23.665	13.431	59	11.607	5.715	47	14.256	5.592	44	2.413	0.886	2.7	7.789	0.176	25	38.670	8.068	98	33.87
DECEMBER	66	40.271	22.183	65	8.685	4.712	49	16.090	6.580	38	11.804	3.744	2.2	0.435	0.008	21	57.679	10.109	135	47.34
JANUARY	66	25.252	13.910	60	16.321	8.173	48	14.851	5.949	41	14.214	4.864	2.0	0.176	0.003	18	39.902	5.994	111	38.90
FEBRUARY	73	19.657	11.976	61	16.982	8.646	48	17.097	6.849	39	17.443	5.678	2.6	18.741	0.407	0	15.695	0.000	106	33.56
MARCH	61	20.062	10.214	63	17.912	9.418	50	18.814	7.851	40	18.032	6.020	3.0	27.712	0.694	26	13.243	2.874	116	37.07
APRIL	63	20.798	10.936	59	7.049	3.471	45	8.258	3.101	39	7.982	2.598	9.8	45.134	3.692	0	0.000	0.000	89	23.80
MAY	72	22.262	13.378	69	15.897	9.155	48	18.115	7.257	41	18.520	6.337	15.0	40.836	5.112	0	0.000	0.000	116	41.24
JUNE	62	23.061	11.933	60	15.520	7.772	45	7.999	3.004	38	9.261	2.937	11.0	8.743	0.803	0	32.463	0.000	97	26.45
JULY	63	22.750	11.962	64	15.410	8.231	52	8.127	3.527	40	14.725	4.916	2.6	0.146	0.003	28	40.476	9.459	102	38.10
AUGUST	53	29.324	12.971	50	16.189	6.756	0	0.365	0.000	36	18.274	5.491	3.6	0.167	0.005	29	43.906	10.627	108	35.85
SEPTEMBER	56	25.256	11.804	52	5.676	2.463	47	0.393	0.154	37	5.890	1.819	2.8	0.185	0.004	27	40.838	9.203	78	25.45
Subtotal			160.103			78.493			49.866			55.252			11.004			56.897		
% of Total Mass			38.9			19.1			12.1			13.4			2.7			13.8		
TOTAL GALLONS TREATED AND VOC'S REMOVED FOR FISCAL YEAR 2014																			1,241	411.64
TOTAL GALLONS TREATED AND VOC'S REMOVED SINCE SYSTEM START UP																			27,656	23,457

Table 8
OU1 Pumping / VOC Mass Removal Data

Fiscal Year 2015

	WELL #3			WELL #4			WELL #5			WELL #6			WELL #14			WELL #15			System Totals	
MONTH	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	VOC (µg/L)	WATER TREATED (mgallons)	VOC Mass Removed (lbs)	TOTAL WATER TREATED BY EXTRACTION SYSTEM (Mgallons)	TOTAL VOC'S REMOVED BY EXTRACTION SYSTEM (lbs)
TOTAL GALLONS PUMPED AND VOC'S REMOVED THROUGH SEPTEMBER 30, 2014																			27,656	23,457
OCTOBER	62	23.026	11.915	56	3.513	1.642	49	4.632	1.894	39	2.742	0.893	2.6	0.147	0.003	16	41.583	5.553	76	21.90
NOVEMBER	62	16.049	8.305	61	15.001	7.637	49	22.016	9.004	0	0.000	0.000	2.3	0.185	0.004	24	24.000	4.808	77	29.76
DECEMBER	72	1.750	1.052	66	14.337	7.897	42	21.567	7.560	0	0.000	0.000	2.0	19.628	0.328	26	43.193	9.373	100	26.21
JANUARY	65	13.409	7.274	67	17.968	10.047	41	17.868	6.114	0	8.518	0.000	3.1	0.211	0.005	33	42.761	11.777	101	35.22
FEBRUARY	70	12.543	7.328	74	17.586	10.861	47	11.292	4.429	43	13.893	4.986	2.7	0.199	0.004	30	35.923	8.994	91	36.61
MARCH	63	3.733	1.963	0	0.000	0.000	45	20.299	7.624	40	22.862	7.632	2.1	28.615	0.502	25	36.270	7.568	112	25.29
APRIL	65	0.116	0.063	0	0.000	0.000	47	5.196	2.038	37	5.834	1.802	10.0	13.670	1.141	49	17.496	7.155	42	12.20
MAY	0	0.000	0.000	0	0.000	0.000	0	0.234	0.000	0	0.000	0.000	0.0	0.000	0.000	0	0.000	0.000	0	0.00
JUNE	0	0.000	0.000	0	0.000	0.000	0	0.001	0.000	0	0.000	0.000	0.0	0.214	0.000	0	0.000	0.000	0	0.00
JULY	0	0.122	0.000	0	0.026	0.000	0	0.434	0.000	0	0.000	0.000	0.0	0.000	0.000	0	0.000	0.000	1	0.00
AUGUST	0	0.000	0.000	0	0.000	0.000	0	0.420	0.000	0	0.000	0.000	0.0	0.000	0.000	0	0.000	0.000	0	0.00
SEPTEMBER	0	0.138	0.000	0	0.194	0.000	0	0.289	0.000	0	0.085	0.000	0.0	0.176	0.000	0	0.154	0.000	1	0.00
Subtotal			37.900			38.084			38.663			15.313			1.987			55.228		
% of Total Mass			20.2			20.3			20.7			8.2			1.1			29.5		
TOTAL GALLONS TREATED AND VOC'S REMOVED FOR FISCAL YEAR 2015																			602	187.19
TOTAL GALLONS TREATED AND VOC'S REMOVED SINCE SYSTEM START UP																			28,259	23,644

Note: Routine pumping of the NBCGRS was ceased on April 15, 2015, with notice to the USEPA/MPCA, due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the granular activated carbon (GAC) does not remove 1,4-dioxane, New Brighton is preferentially pumping deep aquifer wells that have no detectable 1,4-dioxane while the City evaluates the feasibility of 1,4-dioxane removal technologies. This has been referred to as a "Remedy Time-Out," and normal pumping of the NBCGRS will not be resumed until a technology is selected and modification of the NBCGRS is designed and constructed. Limited, intermittent pumping of the NBCGRS wells will occur only when necessary to provide the incremental volume of water (beyond what deep aquifer pumping can provide) that is necessary to meet peak demand periods in the summer. The Fridley Interconnection was also closed on April 15, 2015.

Table 9
OU1 Groundwater Quality Data

Fiscal Year 2015

			Trichloro-ethene (µg/L)	1,1,1-Trichloro-ethane (µg/L)	1,4 Dioxane (µg/L)	1,1-Dichloro-ethene (µg/L)	cis-1,2-Dichloro-ethene (µg/L)	1,1,2-Trichloro-ethane (µg/L)	1,1-Dichloro-ethane (µg/L)
OU1 Cleanup Level [1]			5	200	---	6	70	3	70
MDH HRL [2]			---	---	1	---	---	---	---
03U811		6/10/15	<1	<1	**11.4**	<1	<1	<1	<1
03U821		6/17/15	**14**	JP 0.74	**11.3**	JP 0.77	<1	<1	JP 0.56
03U822		6/23/15	**150**	1.3	**14.7**	4.5	1.7	<1	6.3
03M843		6/10/15	<1	<1	**11.8**	<1	<1	<1	<1
03L811		6/12/15	**7.6**	<1	**15.9**	1.0	<1	<1	JP 0.86
03L822		6/23/15	**190**	3.0	**15**	5.0	2.8	<1	3.3
03L832		6/16/15	1.5	<1	0.20	<1	<1	<1	<1
03L841		6/10/15	<1	<1	**2.1**	JP 0.38	JP 0.81	<1	<1
03L846		6/10/15	JP 0.55	<1	**15.3**	**12**	35	<1	14
04U821		6/18/15	**20**	1.0	**12.5**	1.3	<1	<1	1.3
04U834		6/8/15	<1	<1	JP 0.046 UFB0.036	<1	<1	<1	<1
04U836		6/9/15	**77**	2.6	**6.8**	**6.1**	2.2	<1	4.9
04U837		6/10/15	**6.6**	<1	0.79	JP 0.53	JP 0.47	<1	JP 0.58
04U838		6/10/15	2.7	<1	0.31	<1	JP 0.47	<1	<1
04U839		6/9/15	**15**	JP 0.57	**1.6**	1.2	<1	<1	1.0
04U841		6/17/15	**15**	1.6	**4.0**	2.0	JP 0.68	<1	1.5
04U843		6/23/15	**180** JMS135	11 JMS126	**14.7**	**16**	2.0	<1	10
04U844		6/23/15	**220**	16	**11.9**	**19**	4.2	<1	13
04U846		6/17/15	**25**	<1	**15**	**6.4**	13	<1	10
04U847		6/24/15	**940**	11	**50.2**	**51**	7.9	<2	45
04U847	D	6/24/15	**960**	12	**60.4**	**53**	8.3	<2	45
04U849		6/22/15	**79**	3.5	**9.0**	**6.7**	JP 0.96	<1	5.1
04U849	D	6/22/15	**85**	3.7	**9.4**	**7.2**	1.1	<1	5.5
04U850		6/22/15	**45**	JP 0.63	**4.6**	3.2	3.3	<1	3.2
04U855		6/16/15	**7.4**	<1	**1.6**	JP 0.39	<1	<1	JP 0.45
04U871		6/17/15	**19**	JP 0.89	**2.9**	1.3	<1	<1	2.5

Table 9 Continued
OU1 Groundwater Quality Data

Fiscal Year 2015

			Trichloro-ethene (µg/L)	1,1,1-Trichloro-ethane (µg/L)	1,4 Dioxane (µg/L)	1,1-Dichloro-ethene (µg/L)	cis-1,2-Dichloro-ethene (µg/L)	1,1,2-Trichloro-ethane (µg/L)	1,1-Dichloro-ethane (µg/L)
OU1 Cleanup Level [1]			5	200	---	6	70	3	70
MDH HRL [2]			---	---	1	---	---	---	---
04U872		6/16/15	3.1	<1	0.59	<1	<1	<1	<1
04U872	D	6/16/15	3.1	<1	0.58	<1	<1	<1	<1
04U875		6/5/15	<1	<1	JP 0.058	<1	<1	<1	<1
04U877		6/8/15	JP 0.34	<1	0.31	<1	<1	<1	<1
04U877	D	6/8/15	<1	<1	0.28	<1	<1	<1	<1
04U879		6/11/15	**7.0**	<1	1.0	JP 0.56	<1	<1	JP 0.46
04U879	D	6/11/15	**6.9**	<1	1.0	JP 0.52	<1	<1	JP 0.49
04U880		6/5/15	<1	<1	JP 0.048 UFB0.036	<1	<1	<1	<1
04U881		6/16/15	**13**	JP 0.49	**1.4**	JP 0.93	<1	<1	1.3
04U882		6/17/15	**20**	1.1	**1.5**	1.3	<1	<1	1.1
04U883		6/5/15	<1	<1	JP 0.036	<1	<1	<1	<1
04J822		6/18/15	**42**	7.0	**2.0**	**7.1**	1.3	<1	4.5
04J834		6/4/15	<1	<1	<0.07	<1	<1	<1	<1
04J836		6/9/15	**23**	JP 0.78	**2.9**	1.7	JP 0.45	<1	1.5
04J837		6/15/15	**12**	<1	**1.7**	JP 0.82	JP 0.81	<1	1.2
04J838		6/17/15	**42**	JP 0.62	**1.8**	2.2	JP 0.37	<1	2.0
04J839		6/9/15	2.1	<1	0.086 UFB0.036	<1	<1	<1	<1
04J847		6/24/15	**840**	32	**39.3**	**57**	8.9	<2	43
04J849		6/11/15	JP 0.42	JP 0.40	0.22	JP 0.30	<1	<1	<1
04J882		6/4/15	<1	<1	<0.07	<1	<1	<1	<1
PJ#318		6/10/15	1.2	<1	0.11 UFB0.041	<1	<1	<1	<1
200154		6/18/15	JP 0.37	<1	0.085	<1	<1	<1	<1
234546		6/25/15	**8.8**	<1	1.0	JP 0.45	<1	<1	JP 0.74
409547		6/22/15	2.7	1.6	**5.0**	3.5	1.4	<1	4.6
409548		6/12/15	JP 0.76	<1	**3.1**	<1	JP 0.79	<1	JP 0.38
409549		6/19/15	**66**	3.5	**8.7**	5.7	JP 0.89	<1	4.7

Table 9 Continued
OU1 Groundwater Quality Data

Fiscal Year 2015

			Trichloro-ethene (µg/L)	1,1,1-Trichloro-ethane (µg/L)	1,4 Dioxane (µg/L)	1,1-Dichloro-ethene (µg/L)	cis-1,2-Dichloro-ethene (µg/L)	1,1,2-Trichloro-ethane (µg/L)	1,1-Dichloro-ethane (µg/L)
OU1 Cleanup Level [1]			5	200	---	6	70	3	70
MDH HRL [2]			---	---	1	---	---	---	---
409550		6/19/15	**35**	2.0	**7.4**	JP 0.61	<1	<1	<1
409555		6/4/15	<1	<1	0.098 UFB0.036	<1	<1	<1	<1
409556		6/8/15	<1	<1	<0.07	<1	<1	<1	<1
409556	D	6/8/15	<1	<1	<0.07	<1	<1	<1	<1
409557		6/12/15	**77**	5.9	**12.3**	**17**	4.5	<1	15
512761		6/18/15	2.9	<1	0.26	<1	<1	<1	<1

Notes:

(1) Cleanup levels for OU1 deep groundwater are from page 18 of the OU1 ROD. Bolding (in red color) indicates exceedance of the cleanup level.

(2) No OU1 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Bolding (in red color) indicates exceedance of the HRL.

D Duplicate sample.

JMS The percent recovery for the matrix spike was above or below the QC limits (the percent recovery is listed after "JMS"). The sample result could be biased high (if over 100 percent recovery) or low (if below 100 percent recovery).

JP The value is below the Reporting Limit, but above the Method Detection Limit. Results should be considered estimated.

UFB The sample result was less than 5 times the level detected in a field blank (the result for the blank is listed after "UFB"). The sample result can be considered non detect at an elevated detection limit.

Table 10
OU1 Groundwater Quality Data
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Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sample Location	Date Collected	Trichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	1,4-Dioxane (µg/L)	1,1-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)
OU1 Cleanup Level(1)		5	200	---	6	70	3	70
MDH HRL(2)		---	---	1	---	---	---	---
03U811	6/21/16	< 1.0	< 1.0	12.0	< 1.0	< 1.0	< 1.0	< 1.0
03U821	6/24/16	14	0.63 J	13.6	0.58 J	< 1.0	< 1.0	0.54 J
03U822	7/5/16	150	1.1	17.0	4.3	1.4	< 1.0	6.1
03M843	6/21/16	< 1.0	< 1.0	15.6	< 1.0	< 1.0	< 1.0	< 1.0
03L811	6/24/16	9.3	< 1.0	16.0	0.69 J	< 1.0	< 1.0	0.59 J
03L822	7/5/16	190	2.4	17.4	4.0	3.1	< 1.0	2.9
03L832	6/23/16	1.1	< 1.0	0.15	< 1.0	< 1.0	< 1.0	< 1.0
03L841	6/21/16	< 1.0	< 1.0	4.0	< 1.0	0.58 J	< 1.0	< 1.0
03L846	6/22/16	2.0	< 1.0	16.8	10	34	< 1.0	12
04U821	6/29/16	19	0.81 J	14.0	1.1	< 1.0	< 1.0	1.0
04U834	6/23/16	< 1.0	< 1.0	0.16	< 1.0	< 1.0	< 1.0	< 1.0
04U836	2/23/16	43	1.1	4.1	3.4	1.3	< 1.0	2.7
04U836 (Dup)	2/23/16	44	1.2	4.1	3.5	1.3	< 1.0	2.8
04U836	6/28/16	43	1.0	5.7	3.1	1.1	< 1.0	2.6
04U837	2/16/16	2.6	< 1.0	0.31	< 1.0	< 1.0	< 1.0	< 1.0
04U837	6/23/16	2.6	< 1.0	0.37*	< 1.0	< 1.0	< 1.0	< 1.0
04U838	6/22/16	2.9	< 1.0	0.51	< 1.0	0.58 J	< 1.0	< 1.0
04U839	2/24/16	43	0.93 J	4.4	3.4	1.6	< 1.0	2.9
04U839	6/29/16	50	0.88 J	5.4	3.6	2.1	< 1.0	3.4
04U841	6/29/16	14	1.1	4.3	1.7	0.64 J	< 1.0	1.4
04U843	7/5/16	180	9.0	18.1	15	1.8	< 1.0	10
04U844	7/5/16	230	13	12.8	18	3.9	< 1.0	13
04U846	6/30/16	26	< 1.0	18.8	7.9	17	< 1.0	12
04U847	7/6/16	720	6.5	50.5	34	6.1	< 2.0	34
04U847 (Dup)	7/6/16	720	6.8	48.5	36	6.0	< 2.0	35
04U849	7/5/16	75	2.7	10.8	5.9	1.0	< 1.0	5.2
04U849 (Dup)	7/5/16	76	2.8	10.8	5.9	0.92 J	< 1.0	5.1
04U850	7/1/16	33	< 1.0	4.5	2.7	3.9	< 1.0	3.0
04U855	6/23/16	21	0.35 J	4.5*	1.1	< 1.0	< 1.0	1.1
04U871	2/22/16	14	0.63 J	1.8	1.0	< 1.0	< 1.0	1.5
04U871	6/29/16	14	0.58 J	1.9	0.82 J	< 1.0	< 1.0	1.3
04U872	2/16/16	2.7	< 1.0	0.73	< 1.0	< 1.0	< 1.0	0.61 J
04U872	6/30/16	3.6	< 1.0	1.1	< 1.0	< 1.0	< 1.0	0.70 J
04U872 (Dup)	6/30/16	4.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	0.68 J

Notes and Abbreviations on Page 3.

Table 10 Continued
OU1 Groundwater Quality Data
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PIKA ARCADIS a joint venture

Sample Location	Date Collected	Trichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	1,4-Dioxane (µg/L)	1,1-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)
OU1 Cleanup Level(1)		5	200	---	6	70	3	70
MDH HRL(2)		---	---	1	---	---	---	---
04U875	2/17/16	< 1.0	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	< 1.0
04U875 (Dup)	2/17/16	< 1.0	< 1.0	0.048 J	< 1.0	< 1.0	< 1.0	< 1.0
04U875	6/22/16	< 1.0	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	< 1.0
04U877	6/27/16	0.4 J	< 1.0	3.4 JFD(3.18)	< 1.0	< 1.0	< 1.0	< 1.0
04U877 (Dup)	6/27/16	0.42 J	< 1.0	0.22 JFD(3.18)	< 1.0	< 1.0	< 1.0	< 1.0
04U879	2/15/16	17	0.6 J	2.2	1.5	< 1.0	< 1.0	1.2
04U879	6/24/16	20	0.68 J	3.1	1.5	< 1.0	< 1.0	1.3
04U879 (Dup)	6/24/16	18	0.62 J	3.0	1.3	< 1.0	< 1.0	1.2
04U880	2/17/16	< 1.0	< 1.0	0.078	< 1.0	< 1.0	< 1.0	< 1.0
04U880	6/22/16	< 1.0	< 1.0	0.11	< 1.0	< 1.0	< 1.0	< 1.0
04U881	2/22/16	19	0.78J	2.1	1.3	< 1.0	< 1.0	2.0
04U881	6/23/16	16	0.62 J	2.3	1.0	< 1.0	< 1.0	1.6
04U882	6/27/16	< 1.0	< 1.0	2.5	< 1.0	< 1.0	< 1.0	< 1.0
04U883	6/21/16	< 1.0	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	< 1.0
04J822	6/30/16	42	5.8	2.3	6.8	1.1	< 1.0	4.4
04J834	6/28/16	< 1.0	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	< 1.0
04J836	2/23/16	40	1.0	4.3	3.3	0.95 J	< 1.0	2.6
04J836	6/28/16	35	0.79 J	4.0	2.3	1.2	< 1.0	2.1
04J837	2/16/16	3.6	< 1.0	0.46	< 1.0	0.30J	< 1.0	0.35J
04J837	6/24/16	2.2	< 1.0	0.48	< 1.0	< 1.0	< 1.0	< 1.0
04J838	6/24/16	38	0.56 J	2.2	2.1	< 1.0	< 1.0	1.7
04J839	2/23/16	2.8	< 1.0	0.11	< 1.0	< 1.0	< 1.0	< 1.0
04J839	6/29/16	3.0	< 1.0	0.19	< 1.0	< 1.0	< 1.0	< 1.0
04J847	7/6/16	910	28	55.1	57	10	< 2.0	51
04J849	6/22/16	0.7 J	0.57 J	0.21	0.45 J	< 1.0	< 1.0	0.32 J
04J882	6/20/16	< 1.0	< 1.0	2.8	< 1.0	< 1.0	< 1.0	< 1.0
PJ#318	2/19/16	0.4 J	< 1.0	0.099	< 1.0	< 1.0	< 1.0	< 1.0
PJ#318	6/24/16	0.34 J	< 1.0	0.15	< 1.0	< 1.0	< 1.0	< 1.0
200154	6/24/16	< 1.0	< 1.0	0.12	< 1.0	< 1.0	< 1.0	< 1.0
234546	6/28/16	5.5	< 1.0	0.92	< 1.0	< 1.0	< 1.0	0.37 J
409547	6/23/16	2.7	1.3	5.6	3.4	1.4	< 1.0	4.6
409548	6/22/16	0.91 J	< 1.0	3.4	< 1.0	1.0	< 1.0	0.44 J
409548 (Dup)	6/22/16	0.88 J	< 1.0	3.3	< 1.0	1.0	< 1.0	0.45 J
409549	7/1/16	77	3.4	12.2	5.8	1.1	< 1.0	5.1

Notes and Abbreviations on Page 3.

Table 10 Continued
OU1 Groundwater Quality Data
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Sample Location	Date Collected	Trichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	1,4-Dioxane (µg/L)	1,1-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)
OU1 Cleanup Level(1)		5	200	---	6	70	3	70
MDH HRL(2)		---	---	1	---	---	---	---
409550	6/30/16	37	1.8	8.4	0.47 J	< 1.0	< 1.0	0.31 J
409555	6/20/16	< 1.0	< 1.0	0.15	< 1.0	< 1.0	< 1.0	< 1.0
409556	6/20/16	< 1.0	< 1.0	0.064 J	< 1.0	< 1.0	< 1.0	< 1.0
409556 (Dup)	6/20/16	< 1.0	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	< 1.0
409557	7/5/16	79	4.9	13.5	16	4.3	< 1.0	15
512761	6/29/16	2.6	< 1.0	0.24	< 1.0	< 1.0	< 1.0	< 1.0

Footnotes:

1. The cleanup level for Site C Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of the cleanup level.

2. No OU1 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Gray shading indicates exceedance of the HRL.

Acronyms and Abbreviations:

--- = no relevant cleanup level or HRL for this compound.

< X.XX = analyte was not detected above the Method Detection Limit (MDL)

* = 1,4-Dioxane sample containers broke in transit; this location was resampled for 1,4-dioxane on August 3, 2016.

Dup = duplicate

J = reported value is between the MDL and the Reporting Limit

JFD = the sample result for a field duplicate exceeded the QC limit (the numerical difference between the two sample results is listed after " JFD* "). The sample result should be considered estimated.

OU = Operable Unit

µg/L = micrograms per liter

Table 11
OU1 Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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a joint venture

Sample Location	Date	Trichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	1,4-Dioxane (µg/L)	1,1-Dichloroethene (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1,2-Trichloroethane (µg/L)	1,1-Dichloroethane (µg/L)
OU1 Cleanup Level [a]		5	200	--	6	70	3	70
MDH HRL [b]		--	--	1	--	--	--	--
04U871	6/22/2017	13	0.52 J	1.6	0.80 J	< 1.0 U	< 1.0 U	0.95 J
04U872	6/21/2017	3.5	< 1.0 U	1.1	< 1.0 U	< 1.0 U	< 1.0 U	0.68 J
04U877	6/22/2017	0.75 J	< 1.0 U	0.2	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
04U877 (Dup)	6/22/2017	0.71 J	< 1.0 U	0.29	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
04J822	6/23/2017	29	3.7	2.1	4.6	0.82 J	< 1.0 U	2.9
04J847	6/23/2017	780	23	48.3	51	8.8	< 2.0 U	42
04J849	6/22/2017	59	2.1	9.9	4.7	0.83 J	< 1.0 U	3.8

Footnotes:

a. The cleanup level for OU1 Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of the cleanup level.

b. No OU1 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Gray shading indicates exceedance of the HRL or cleanup level.

Acronyms and Abbreviations:

-- = no relevant cleanup level or HRL for this compound.
< X.X U = analyte was not detected above the Method Detection Limit (MDL)
Dup = duplicate
J = reported value is between the MDL and the Reporting Limit
OU = Operable Unit
µg/L = micrograms per liter

Table 12
Response Thresholds by Group FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Well Group	Purpose	Measure	Time Window/ Monitoring Frequency	Test	Response Threshold
Group 1	AWC Immediately Downgradient of TGRS	AWC Trend	6 years/annual	Mann-Kendall	Stable, Increasing, or No Trend
Group 2	Defining Plume Size (Low Concentration Edges)	Individual Well Trend for TCE	12 years/biennial	Mann-Kendall	Increasing or No Trend
Group 3	AWC Immediately Downgradient of NBCGRS	AWC Trend	12 years/biennial	Mann-Kendall	Stable, Increasing, or No Trend
Group 4	Lateral (Clean) Sentinel Wells	Individual Well Concentration	12 years/biennial	Individual Concentrations	Greater than ROD goals
Group 5	Global Plume Mass Reduction	AWC Trend	12 years/biennial	Mann-Kendall	Stable, Increasing, or No Trend
Group 6	Evaluating and comparing trends in Jordan Aquifer	Individual Well Trend for TCE	12 years/biennial	Mann-Kendall	Stable, Increasing or No Trend

General Notes:
A Response Threshold is the test result(s) that triggers further response. See text for additional explanation of response process.
Acronyms and Abbreviations:
AWC = Area-Weighted Concentration

Table 13
Statistical Evaluation – Well Groups Fiscal Year 2016
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Group 1 – Downgradient of TGRS

03U806	04U806	03L802	03U801
03M806	PJ#806	04U802	03U711
03L806	03M802	PJ#802*	04U711

Group 2 – Areal Extent of Plume

03U805	409557	04U841	04U875
03U672	04U673	04U843	04U877
03L848	04U832	04U833	206688 out of service
03L673	04U845	04U846	04U849
03L833	04U854	04U861 abandoned	04U821
03L859	04U859	409549	191942 abandoned

Group 3 ** – Downgradient Sentinel

04U871	04U875	04U851	

Group 4 – Lateral Sentinel

03U831 abandoned	03L846	409556	409548
03U811	03L832	04U855	04U839
03U804	03L861 abandoned	04U879	04U838
03U673	03L854	04U860	04U848
03U672 abandoned	03L841	409547	04J839
03M843	03L811	04U863	03U677

Group 5 – Global Plume

04J077	04U702	04U848	04U877
04J702	04U709	04U851	04U879
04J708	04U711	04U852 abandoned	04U880
04J713	04U713	04U855	04U881
04J834	04U802	04U859	04U882
04J864 abandoned	04U806	04U860	200154
04J866	04U832	04U861 abandoned	234546
04J882	04U833	04U863	234549 out of service
04U002	04U834	04U864 abandoned	409547
04U020	04U841	04U865 abandoned	409548
04U027abandoned	04U843	04U866	409549
04U077	04U844	04U871	409555
04U673	04U845	04U872	512761
04U701	04U846	04U875	PJ#318

Group 5 Unit 3 wells (evaluated as individual trends)

03L822	03U821	03U822	03L822
409550	409596	409597	03U831abandoned

Group 6 – Jordan Aquifer

04J077	04J838	04U713	04U882
04J702	04J839	04U834	NBM#3
04J708	04J882	04U836	NBM#4
04J713	04J847	04U837	NBM#5
04J822	04J849	04U838	NBM#6
04J834	04U077	04U839	
04J836	04U702	04U847	
04J837	04U708	04U849	

* PJ#802 will not be monitored or used for evaluation unless 04U802 shows TCE concentrations greater than 1 ppb.

** Group 3 is analyzed as a rectangular area taken from the Group 5 contouring.

Table 14
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
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Arden Hills, Minnesota

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Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 2 Wells:							
409549	18	0.0034	0.854	7 / 7	Increasing	Yes	Near plume center, plume shifted slightly
409557	19	0.0014	0.958	7 / 7	Increasing	Yes	Between north & south plume, lateral dispersion
03L673	-18	0.0034	0.814	7 / 7	Decreasing	No	
03L833	-13	0.0350	0.465	7 / 7	Decreasing	No	
03L848	-17	0.0054	0.776	7 / 7	Decreasing	No	
03L859	-17	0.0054	0.854	7 / 7	Decreasing	No	
03U677	NA	NA	NA	0 / 8	NA	No	All ND
03U805	15	0.0150	0.580	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04U673	-9	0.1190	0.00155	7 / 7	No Significant Trend	Yes	Near south plume center, plume shifted slightly
04U821	-11	0.0680	0.423	7 / 7	Probably Decreasing	No	
04U832	-2	0.4430	0.00364	7 / 7	No Significant Trend	Yes	Relatively stable, between 46 and 56 µg/L since 2007
04U833	-15	0.0150	0.586	7 / 7	Decreasing	No	
04U841	-14	0.0250	0.585	7 / 7	Decreasing	No	
04U843	20	<0.001	0.965	7 / 7	Increasing	Yes	Near plume center
04U845	-12	0.0515	0.317	7 / 7	Probably Decreasing	No	
04U846	20	<0.001	0.942	7 / 7	Increasing	Yes	Near plume center, historically erratic
04U849							See Group 6 summary.
04U854	-16	0.0102	0.738	7 / 7	Decreasing	No	
04U859	-20	<0.001	0.891	7 / 7	Decreasing	No	
04U861 (abandoned)	11	0.0280	0.752	6 / 6	NA	NA	Abandoned after 2006 sample, in New Brighton Development
04U875	-16	0.0310	0.299	4 / 8	Decreasing	No	
04U877	-4	0.3340	0.0104	7 / 7	No Significant Trend	Yes	
206688	-4	0.2980	0.007	6 / 6	No Significant Trend	Yes	
Group 1 NP	-5	0.281	0.0971	7 / 7	No Significant Trend	Yes	
Group 1 SP	0	0.563	2010	7 / 7	Stable	Yes	
Group 3	-10	0.0935	0.335	7 / 7	Probably Decreasing	No	
Group 5	11	0.068	0.463	7 / 7	Probably Increasing	Yes	
Group 5 Unit 3 Wells:							
409550	-6	0.2360	0.442	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
409597 (abandoned)	-11	0.0280	0.809	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
409596 (abandoned)	-8	0.1020	0.633	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U831 (abandoned)	9	0.0680	0.405	2 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U821	-19	0.0014	0.951	7 / 7	Decreasing	No	
03U822	2	0.4430	0.0259	7 / 7	No Significant Trend	Yes	Between 120 and 160 µg/L since 2003
03L822	-14	0.0250	0.69	7 / 7	Decreasing	No	
03L809	-8	0.1550	0.499	7 / 7	No Significant Trend	Yes	Raw trend is decreasing

Notes and Abbreviations on Page 2.

Table 14 Continued
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2016 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 6 OU1 Jordan Wells:							
04J822	-5	0.2810	0.364	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
04J834	-16	0.0102	0.702	4 / 7	Decreasing	No	
04J836	18	0.0160	0.683	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J838	13	0.0350	0.700	7 / 7	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J837	-9	0.1690	0.294	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J839	0	0.5480	0.034	8 / 8	Stable	Yes	Below 5 µg/L
04J847	25	0.0301	0.332	11 / 11	Increasing	Yes	Near plume center
04J849	11	0.0680	0.422	2 / 7	Probably Increasing	Yes	Below 1 µg/L
04J882	NA	NA	NA	0 / 7	NA	No	All ND
04J077	-11	0.0680	0.612	7 / 7	Probably Decreasing	No	
04J702	-18	0.0034	0.595	7 / 7	Decreasing	No	
04J708	13	0.0350	0.565	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04J713	NA	NA	NA	0 / 7	NA	No	All ND
Group 6 Nested Unit 4 Wells:							
04U077	-21	<0.001	0.889	7 / 7	Decreasing	No	
04U702	-2	0.4430	0.0000324	7 / 7	No Significant Trend	Yes	Below 3 µg/L
04U708	-16	0.0102	0.721	4 / 7	Decreasing	No	
04U713	-11	0.0680	0.350	5 / 7	Probably Decreasing	No	
04U834	-20	<0.001	0.869	5 / 7	Decreasing	No	
04U836	1	0.5000	0.0117	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U837	-5	0.3170	0.357	8 / 8	No Significant Trend	Yes	Raw trend is decreasing
04U838	0	0.5630	0.374	7 / 7	Stable	Yes	Below 3 µg/L since 2009
04U839	22	0.0028	0.566	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U847	-5	0.2810	0.0923	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
04U849	12	0.0515	0.781	7 / 7	Probably Increasing	Yes	Near plume center, appears relatively stable since 2011
04U882	-10	0.0935	0.234	6 / 7	Probably Decreasing	No	

General Notes:
Response Threshold triggers are defined in Table D.2.1.3.
Acronyms and Abbreviations:
NA = not applicable; trend analysis not performed at this location
ND = non-detect
NBCGRS = New Brighton Contaminated Groundwater Recovery System
P Value = represents uncertainty in the trend
R^2 Value = represents the fit of the data to the regression
S Value = indicates increasing (positive S) or decreasing (negative S) trend
µg/L = micrograms per liter

Table 15
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 2 Wells:							
409549	18	0.0034	0.854	7 / 7	Increasing	Yes	Near plume center, plume shifted slightly
409557	19	0.0014	0.958	7 / 7	Increasing	Yes	Between north & south plume, lateral dispersion
03L673	-18	0.0034	0.814	7 / 7	Decreasing	No	
03L833	-13	0.0350	0.465	7 / 7	Decreasing	No	
03L848	-17	0.0054	0.776	7 / 7	Decreasing	No	
03L859	-17	0.0054	0.854	7 / 7	Decreasing	No	
03U677	NA	NA	NA	0 / 9	NA	No	All ND
03U805	15	0.0150	0.580	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04U673	-9	0.1190	0.00155	7 / 7	No Significant Trend	Yes	Near south plume center, plume shifted slightly
04U821	-11	0.0680	0.423	7 / 7	Probably Decreasing	No	
04U832	-2	0.4430	0.00364	7 / 7	No Significant Trend	Yes	Relatively stable, between 46 and 56 µg/L since 2007
04U833	-22	0.0028	0.6075	8 / 8	Decreasing	No	
04U841	-14	0.0250	0.585	7 / 7	Decreasing	No	
04U843	20	<0.001	0.965	7 / 7	Increasing	Yes	Near plume center
04U845	-12	0.0515	0.317	7 / 7	Probably Decreasing	No	
04U846	20	<0.001	0.942	7 / 7	Increasing	Yes	Near plume center, historically erratic
04U849							See Group 6 summary.
04U854	-16	0.0102	0.738	7 / 7	Decreasing	No	
04U859	-20	<0.001	0.891	7 / 7	Decreasing	No	
04U861 (abandoned)	11	0.0280	0.752	6 / 6	NA	NA	Abandoned after 2006 sample, in New Brighton Development
04U875	-16	0.0310	0.299	4 / 8	Decreasing	No	
04U877	-1	0.5000	0.0004	8 / 8	No Significant Trend	Yes	
206688	-4	0.2980	0.007	6 / 6	No Significant Trend	Yes	
Group 1 NP	-5	0.281	0.0971	7 / 7	No Significant Trend	Yes	
Group 1 SP	0	0.563	2010	7 / 7	Stable	Yes	
Group 3	-10	0.0935	0.335	7 / 7	Probably Decreasing	No	
Group 5	11	0.068	0.463	7 / 7	Probably Increasing	Yes	
Group 5 Unit 3 Wells:							
409550	-6	0.2360	0.442	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
409597 (abandoned)	-11	0.0280	0.809	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
409596 (abandoned)	-8	0.1020	0.633	6 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U831 (abandoned)	9	0.0680	0.405	2 / 6	NA	NA	Abandoned due to constr. After 2007 sampling
03U821	-19	0.0014	0.951	7 / 7	Decreasing	No	
03U822	2	0.4430	0.0259	7 / 7	No Significant Trend	Yes	Between 120 and 160 µg/L since 2003
03L822	-14	0.0250	0.69	7 / 7	Decreasing	No	
03L809	-8	0.1550	0.499	7 / 7	No Significant Trend	Yes	Raw trend is decreasing

Notes and Abbreviations on Page 2.

Table 15 Continued
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Group	S Value	P Value	R^2 Value	Fraction of Detections	Results Trend	Threshold Triggered?	Comments
Group 6 OU1 Jordan Wells:							
04J822	-12	0.0890	0.364	8 / 8	Decreasing	No	
04J834	-16	0.0102	0.702	4 / 7	Decreasing	No	
04J836	18	0.0160	0.683	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J838	13	0.0350	0.700	7 / 7	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J837	-9	0.1690	0.294	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04J839	0	0.5480	0.034	8 / 8	Stable	Yes	Below 5 µg/L
04J847	24	0.0565	0.218	12 / 12	Increasing	Yes	Near plume center
04J849	18	0.0160	0.337	3 / 8	Increasing	Yes	Below 1 µg/L
04J882	NA	NA	NA	0 / 7	NA	No	All ND
04J077	-18	0.0160	0.653	8 / 8	Decreasing	No	
04J702	-18	0.0034	0.595	7 / 7	Decreasing	No	
04J708	13	0.0350	0.565	7 / 7	Increasing	Yes	Southern edge of north plume, plume shifted slightly
04J713	NA	NA	NA	0 / 7	NA	No	All ND
Group 6 Nested Unit 4 Wells:							
04U077	-21	<0.001	0.889	7 / 7	Decreasing	No	
04U702	-2	0.4430	0.0000324	7 / 7	No Significant Trend	Yes	Below 3 µg/L
04U708	-16	0.0102	0.721	4 / 7	Decreasing	No	
04U713	-11	0.0680	0.350	5 / 7	Probably Decreasing	No	
04U834	-20	<0.001	0.869	5 / 7	Decreasing	No	
04U836	1	0.5000	0.0117	8 / 8	No Significant Trend	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U837	-5	0.3170	0.357	8 / 8	No Significant Trend	Yes	Raw trend is decreasing
04U838	0	0.5630	0.374	7 / 7	Stable	Yes	Below 3 µg/L since 2009
04U839	22	0.0028	0.566	8 / 8	Increasing	Yes	Close proximity to NBCGRS wells, likely influenced by shutdown
04U847	-5	0.2810	0.0923	7 / 7	No Significant Trend	Yes	Raw trend is decreasing
04U849	12	0.0515	0.781	7 / 7	Probably Increasing	Yes	Near plume center, appears relatively stable since 2011
04U882	-10	0.0935	0.234	6 / 7	Probably Decreasing	No	

General Notes:
Response Threshold triggers are defined in Table D.2.1.3.

Acronyms and Abbreviations:
NA = not applicable; trend analysis not performed at this location
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NBCGRS = New Brighton Contaminated Groundwater Recovery System
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R^2 Value = represents the fit of the data to the regression
S Value = indicates increasing (positive S) or decreasing (negative S) trend
µg/L = micrograms per liter

Table 16
Site Specific Lists of Required Analytes
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Note: Cleanup Levels (in µg/L) from each Record of Decision are shown below for use in determining the required method detection limits. Also note that these lists represent the minimum list of analytes. A larger analyte list may be utilized by the monitoring organization, if so desired. In FY 2017,1,4-dioxane (Method 522) was also analyzed for at all June VOC sampling locations. December TGRS extraction well sampling and treatment system influent/effluent sampling in months other than June were analyzed for VOCs only.1,4-dioxane will continue to be monitored in OU1, OU2, and OU3 Deep Groundwater, Site A, Site K Unit 3, and TGRS extraction wells.

OU1 (DEEP GROUNDWATER) (1)

1,1-Dichloroethane	70
1,1-Dichloroethene	6
cis-1,2-Dichloroethene	70
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	3
Trichloroethene	5

SITE A (SHALLOW GROUNDWATER) (2)

Antimony*	6
1,1-Dichloroethene	6
1,2-Dichloroethane	4
Benzene	10
Chloroform	60
cis-1,2-Dichloroethene	70
Tetrachloroethene	7
Trichloroethene	30

*Antimony is only monitored at these 3 wells: 01U103, 01U902 and 01U904 (June only)

SITE C (SHALLOW GROUNDWATER) (3)

Lead	15

SITE I (SHALLOW GROUNDWATER) (2)

1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30
Vinyl Chloride	0.2

BLDG 102 SHALLOW GROUNDWATER (4)

Vinyl Chloride(5)	0.18
cis-1,2-Dichloroethene	70
Trichloroethene	5
1,1-Dichloroethene	6

SITE K (SHALLOW GROUNDWATER) (2)

1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30

OU2 (DEEP GROUNDWATER) (2)

1,1,1-Trichloroethane	200
1,1-Dichloroethane	70
1,1-Dichloroethene	6
1,2-Dichloroethane	4
cis-1,2-Dichloroethene	70
Tetrachloroethene	5
Trichloroethene	5

OU3 (DEEP GROUNDWATER) (6)

1,1-Dichloroethane	70
1,1-Dichloroethene	6
cis-1,2-Dichloroethene	70
1,1,1-Trichloroethane	200
1,1,2-Trichloroethane	3
Trichloroethene	5

WELL INVENTORY SAMPLING

VOCs (report full VOC list)

Notes:

(1) From Page 18 of the OU1 Record of Decision.
(2) From Table 1 of the OU2 Record of Decision.
(3) From Table 1 of Amendment #1 to the OU2 Record of Decision.
(4) From Page 2-13 of Amendment #4 to the OU2 Record of Decision.
(5) Vinyl chloride is also analyzed by SW-846 Method 8260C - SIM at wells 01U048, 01U582, and 01L582.
(6) From Page 26 of the OU3 Record of Decision.

Analytical Methods:

VOCs: SW-846 Method 8260C
Antimony & Lead: SW-846 Method 602

Table 17

Groundwater Quality Data
Fiscal Year 2016
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
TGRS Cleanup Level[(1)]			**200**	**70**	**6.0**	**4.0**	**70**	**5.0**	**5.0**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
03L001	2/5/2016		<1	<1	<1	<1	<1	<1	<1
03L002	7/15/2016		JP 0.41	JP 0.45	JP 0.62	< 1.0	< 1.0	< 1.0	13
03L007	7/25/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03L013	2/2/2016		<1	<1	<1	<1	<1	<1	<1
03L014	7/19/2016		32	2.5	1.5	< 1.0	JP 0.66	< 1.0	86
03L017	7/7/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.55
03L018	7/20/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03L020	7/8/2016		JP 0.41	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	8.2
03L021	7/7/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.2
03L077	7/13/2016		1.4	<1	JP 0.85	< 1.0	< 1.0	< 1.0	22
03L078	7/11/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03L078	7/11/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03L079	8/3/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.91
03L080	2/4/2016		<1	<1	<1	<1	<1	<1	<1
03L081	1/26/2016		<1	<1	<1	<1	<1	<1	<1
03L113	1/27/2016		<1	<1	<1	<1	<1	<1	<1
03L802	6/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.5
03L802	6/13/2016	D	< 1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
03L806	6/10/2016		1.3	0.68 JP	1	< 1.0	0.46 JP	< 1.0	120.0
03L809	7/22/2016		2.1	3.2	3.0	< 1.0	1.4	< 1.0	140
03L809	7/22/2016	D	2.3	3.4	3.3	< 1.0	1.5	< 1.0	150
03L833	7/22/2016		<1	<1	<1	< 1.0	< 1.0	< 1.0	1.8
03M001	2/8/2016		<1	<1	<1	<1	<1	<1	<1
03M001	2/8/2016	D	<1	<1	<1	<1	<1	<1	<1
03M002	7/9/2016		JP 0.88	1.4	1.4	< 1.0	JP 0.41	< 1.0	23
03M013	2/3/2016		<1	<1	<1	<1	<1	<1	<1
03M020	7/8/2016		1.7	JP 0.46	< 1.0	< 1.0	< 1.0	< 1.0	23
03M713	2/5/2016		<1	<1	<1	<1	<1	<1	<1
03M802	6/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	5.2
03M806	6/10/2016		0.61 JP	51	29	0.69 JP	8.1	< 1.0	380.0
03U001	1/29/2016		<1	<1	<1	<1	<1	<1	<1

Table 17 Continued

Groundwater Quality Data
Fiscal Year 2016
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
TGRS Cleanup Level[(1)]			**200**	**70**	**6.0**	**4.0**	**70**	**5.0**	**5.0**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
03U001	1/29/2016	D	<1	<1	<1	<1	<1	<1	<1
03U002	7/20/2016		1.4	JP 0.39	JP 0.53	< 1.0	JP 0.40	< 1.0	14
03U003	7/10/2016		20	2.1	3.2	< 1.0	7.8	< 1.0	120
03U005	7/11/2016		< 1.0	< 1.0	< 1.0	< 1.0	JP 0.31	< 1.0	< 1.0
03U007	7/25/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U008	1/27/2016		<1	<1	<1	<1	<1	<1	<1
03U009	7/19/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U013	2/4/2016		<1	<1	<1	<1	<1	<1	<1
03U014	7/18/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U015	1/28/2016		<1	<1	<1	<1	<1	<1	<1
03U016	1/26/2016		<1	<1	<1	<1	<1	<1	<1
03U017	7/7/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.9
03U018	7/19/2016		16	JP 0.35	1.3	< 1.0	5.1	< 1.0	28
03U019	1/22/2016		<1	<1	<1	<1	<1	<1	<1
03U020	7/8/2016		14	1.1	2.2	< 1.0	JP 0.83	< 1.0	52
03U021	7/7/2016		50	11	9.4	< 1.0	6.2	< 1.0	210
03U023	1/25/2016		<1	<1	<1	<1	<1	<1	<1
03U023	1/25/2016	D	<1	<1	<1	<1	<1	<1	<1
03U024	2/1/2016		<1	<1	<1	<1	<1	<1	<1
03U025	2/1/2016		<1	<1	<1	<1	<1	<1	<1
03U027	7/20/2016		JP 0.53	< 1.0	< 1.0	< 1.0	JP 0.48	< 1.0	8.4
03U028	7/20/2016		1.1	< 1.0	< 1.0	< 1.0	1.6	< 1.0	26
03U029	7/20/2016		JP 0.36	< 1.0	< 1.0	< 1.0	2.1	< 1.0	10
03U030	7/25/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	4.6
03U032	7/21/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U077	7/13/2016		JP 0.56	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	10
03U078	7/10/2016		2.2	< 1.0	JP 0.83	< 1.0	1.2	14	70
03U079	7/15/2016		8.2	JP 0.50	1.4	< 1.0	1.9	< 1.0	55
03U082	1/25/2016		<1	<1	<1	<1	<1	<1	<1
03U083	2/1/2016		<1	<1	<1	<1	<1	<1	<1
03U087	1/29/2016		<1	<1	<1	<1	<1	<1	<1
03U089	1/29/2016		<1	<1	<1	<1	<1	<1	<1
03U092	7/21/2016		< 1.0	< 1.0	< 1.0	< 1.0	JP 0.88	< 1.0	8.0
03U092	7/21/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.96	< 1.0	8.0
03U093	6/9/2016		53	0.32 JP	3.7	< 1.0	1.7	< 1.0	140.0

Table 17 Continued

Groundwater Quality Data
Fiscal Year 2016
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
TGRS Cleanup Level[(1)]			**200**	**70**	**6.0**	**4.0**	**70**	**5.0**	**5.0**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
03U093	6/9/2016	D	56	< 1.0	3.8	< 1.0	1.9	< 1.0	140.0
03U094	7/20/2016		210	14	6.1	< 1.0	25	< 1.0	360
03U096	7/20/2016		2.5	JP 0.68	JP 0.57	< 1.0	< 1.0	< 1.0	10
03U096	7/20/2016		2.7	JP 0.57	JP 0.55	< 1.0	< 1.0	< 1.0	10
03U099	6/9/2016		0.35 JP	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.0
03U111	1/27/2016		<1	<1	<1	<1	<1	<1	<1
03U113	1/28/2016		<1	<1	<1	<1	<1	<1	<1
03U114	7/20/2016		JP 0.49	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.3
03U315	7/22/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.33
03U316	7/22/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.7
03U659	7/14/2016		45	< 1.0	7.8	JP 0.38	220	< 1.0	880
03U671	7/25/2016		1.4	< 1.0	JP 0.41	< 1.0	< 1.0	18	39
03U677	6/8/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U701	7/18/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.1
03U702	7/14/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.62
03U703	7/25/2016		JP 0.78	< 1.0	< 1.0	< 1.0	< 1.0	5.4	12
03U704	1/28/2016		<1	<1	<1	<1	<1	<1	JP 0.31
03U705	1/28/2016		<1	<1	<1	<1	<1	<1	<1
03U706	1/27/2016		<1	<1	<1	<1	<1	<1	JP 0.32
03U707	1/25/2016		<1	<1	<1	<1	<1	<1	<1
03U708	6/8/2016		2.2	< 1.0	0.63 JP	< 1.0	< 1.0	2.7	37
03U708	6/8/2016	D	2.2	< 1.0	0.57 JP	< 1.0	0.32 JP	2.6	36
03U709	7/12/2016		1.8	JP 0.56	JP 0.72	< 1.0	JP 0.39	< 1.0	18
03U710	7/21/2016		2.4	< 1.0	JP 0.45	< 1.0	JP 0.67	< 1.0	33
03U711	7/21/2016		2.7	JP 0.78	JP 0.98	< 1.0	JP 0.36	JP 0.57	27
03U715	7/18/2016		8.8	< 1.0	1.2	< 1.0	< 1.0	< 1.0	35
03U801	6/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	0.57 JP	< 1.0	16
03U803	7/29/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U804	7/26/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03U805	7/22/2016		JP 0.54	14	11	< 1.0	5.7	1.7	49
03U806	6/10/2016		< 1.0	0.63 JP	0.41 JP	< 1.0	< 1.0	0.9 JP	42
04J077	6/8/2016		1.5	3.2	2.9	< 1.0	0.83 JP	< 1.0	69
04J702	7/14/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4
04J702	7/14/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4
04J708	7/12/2016		JP 0.64	JP 0.82	JP 0.62	< 1.0	< 1.0	< 1.0	7.2

Table 17 Continued

Groundwater Quality Data
Fiscal Year 2016
TGRS, OU2
Arden Hills, Minnesota

			1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
TGRS Cleanup Level[(1)]			**200**	**70**	**6.0**	**4.0**	**70**	**5.0**	**5.0**
Location	**Date**	**Dup**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
04J708	7/12/2016	D	JP 0.66	JP 0.78	JP 0.63	< 1.0	< 1.0	< 1.0	7.3
04J713	7/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
04J714	2/8/2016		<1	<1	<1	<1	<1	<1	<1
04U001	2/9/2016		<1	<1	<1	<1	<1	<1	JP 0.42
04U002	7/9/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
04U007	7/25/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
04U020	7/7/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	JP 0.96
04U077	7/15/2016		1.6	JP 0.69	1.5	< 1.0	JP 0.33	< 1.0	32
04U510	7/19/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1
04U701	7/18/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.7
04U702	7/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
04U702	7/13/2016	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3
04U708	7/11/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
04U709	7/12/2016		JP 0.62	JP 0.48	JP 0.92	< 1.0	< 1.0	< 1.0	14
04U711	6/9/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
04U713	7/14/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
04U714	2/5/2016		<1	<1	<1	<1	<1	<1	<1
04U802	6/13/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.32 JP
04U806	6/10/2016		1.1	4.3	3.8	< 1.0	1.4	< 1.0	130
04U833	6/9/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	0.61 JP
PJ#311	7/21/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PJ#313	7/21/2016		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
PJ#806	6/10/2016		0.3 JP	0.76 JP	0.62 JP	< 1.0	< 1.0	< 1.0	21

Notes:

[(1)] Cleanup levels for TGRS are from the OU2 ROD. Shading indicates exceedence of the cleanup level.
D - Field Duplicate
JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 18
Site A Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sample Location	Date	Tetrachloroethene ug/L	Trichloroethene ug/L	1,4-Dioxane ug/L	cis-1,2-Dichloroethene ug/L	1,1-Dichloroethene ug/L	1,2-Dichloroethane ug/L	Chloroform ug/L	Benzene ug/L	Antimony ug/L
Site A Cleanup Level [a]		7	30	--	70	6	4	60	10	6
MDH HRL [b]		--	--	1	--	--	--	--	--	--
01U039	6/16/2017	< 1.0 U	< 1.0 U	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U102	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U103	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	7.6
01U108 [c]	--	NS	NS	NS	NS	NS	NS	NS	NS	NS
01U115	6/14/2017	< 1.0 U	1.6	NA	23	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U116	6/15/2017	< 1.0 U	1	< 0.07 U	1.4	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U117	6/15/2017	1.8	0.63 J	0.11	5.4	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U126	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U138	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U139	6/14 & 6/16/2017	< 1.0 U	0.66 J	< 0.07 U	540	0.46 J	< 1.0 U	< 1.0 U	3	NA
01U140	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	< 0.07 U	5.3	< 1.0 U	< 1.0 U	< 1.0 U	0.31 J	NA
01U157	6/15/2017	0.32 J	1.2	< 0.07 U	380	0.36 J	< 1.0 U	< 1.0 U	4.1	NA
01U158	6/16/2017	< 1.0 U	0.79 J	< 0.07 U	13	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U352	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U353	6/15/2017	< 1.0 U	< 1.0 U	< 0.07 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U355	6/14/2017	< 1.0 U	0.54 J	NA	200	< 1.0 U	< 1.0 U	< 1.0 U	1.4	NA
01U356	6/14 & 6/20/2017	< 1.0 U	0.68 J	< 0.07 U	290	< 1.0 U	< 1.0 U	< 1.0 U	1.5	NA
01U356 (Dup)	6/14/2017	< 1.0 U	0.65 J	NA	280	< 1.0 U	< 1.0 U	< 1.0 U	1.5	NA
01U357	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	< 0.07 U	11	< 1.0 U	< 1.0 U	< 1.0 U	0.54 J	NA
01U358	6/16/2017	< 1.0 U	< 1.0 U	< 0.07 U	0.40 J	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U901	6/14 & 6/20/2017	< 1.0 U	< 1.0 U	0.017 J	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U902	6/13/2017	< 1.0 U	0.30 J	NA	35	< 1.0 U	< 1.0 U	< 1.0 U	0.49 J	< 2.0 U
01U903	6/13/2017	< 1.0 U	< 1.0 U	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	NA
01U904	6/14/2017	< 1.0 U	< 1.0 U	NA	27	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U

Footnotes:

a. The extraction wells are currently in standby (not operating) while Monitored Natural Attenuation (MNA) is being evaluated.

b. No Site A cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L. Gray shading indicates exceedance of the HRL or cleanup level.

3. The extraction wells are currently in standby (not operating) while MNA is being evaluated.

c. 01U108 was not sampled due to an obstruction in the well.

Acronyms and Abbreviations:

-- = no relevant cleanup level or HRL for this compound

< X.XX U = analyte was not detected above the Method Detection Limit (MDL)

D = duplicate

J = reported value is between the MDL and the Reporting Limit

NA = sample was not analyzed for compound

µg/L = micrograms per liter

Table 19
Water Quality Data for Site C Groundwater
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Sample Location	Date Collected	Lead (Dissolved) (µg/L)
Groundwater Cleanup Level[(1)]:		15
01U561 (MW1)	6/19/2017	< 1.0
01U562 (MW2)	6/19/2017	< 1.0
01U561 (MW2 - Dup)	6/19/2017	< 1.0
01U563 (MW3)	6/19/2017	3.1
01U564 (MW4)	6/19/2017	< 1.0
01U567 (MW7)	6/19/2017	< 1.0
01U571 (MW11)	6/19/2017	< 1.0
01U573 (MW13)	6/19/2017	140
01U574 (MW14)	6/19/2017	170
01U575 (MW15)	6/19/2017	5.8
01U576 (MW16)	6/19/2017	< 1.0
01U046	6/19/2017	< 1.0

Footnotes:
1. The cleanup level for Site C Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of the cleanup level.

Acronyms and Abbreviations:

< X.X = analyte was not detected above the Method Detection Limit (MDL)

Dup = duplicate

J = reported value is between the MDL and the Reporting Limit

µg/L = micrograms per liter

TABLE 20

GROUNDWATER QUALITY DATA
FISCAL YEAR 2013
SITE I, TCAAP
ARDEN HILLS, MINNESOTA

		Trichloroethene	*cis-1,2-Dichloroethylene*	*trans-1,2-Dichloroethylene*	*Vinyl chloride*
Site I Cleanup Level [1]		30	70 (total)		0.2
Location	**Date**	**TRCLE**	**C12DCE**	**T12DCE**	**C2H3CL**
01U064	4/26/2013	0.94 (JP)	4.2	<1	<1
01U632	4/26/2013	**120**	27	0.35 (JP)	<1
01U636	4/26/2013	<1	<1	<1	<1
01U639	4/26/2013	9.5	<1	<1	<1
01U640	4/26/2013	<1	<1	<1	<1
I01MW	4/26/2013	0.33 (JP)	<1	<1	<1
I02MW	4/26/2013	0.62 (JP)	<1	<1	<1
I02MW D	4/26/2013	0.76 (JP)	<1	<1	<1
I04MW	4/26/2013	NS	NS	NS	NS
I05MW	4/26/2013	1.6	<1	<1	<1
01U667 [2]	8/13/2013	4.7	**500**	1.4	**300**

Notes:
Concentrations in ug/L.
D - Duplicate Sample
JP - Analyte value is between the Method Detection Limit and the Reporting Limit
NS - Not sampled, primary well 01U639 was sampled instead
(1) Cleanup levels for Site I Shallow Groundwater are from the OU2 ROD
(2) On August 13, 2013, monitoring well 01U667 was sampled at the request of EPA/MPCA
Bolding indicates exceedances of cleanup levels

Table 21

Treatment System Concentrations (Organics)
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

			1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
Effluent Limit[(1)]			**--**	**7.0**	**3.8**	**70**	**100**	**10**	**0.18**
Location	**Date**		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
Effluent	12/8/2016		< 1.0	< 1.0	< 1.0	2.7	< 1.0	0.89 JP	< 1.0
Effluent	12/8/2016	D	< 1.0	< 1.0	< 1.0	2.8	< 1.0	0.91 JP	< 1.0
Effluent	3/2/2017		< 1.0	< 1.0	< 1.0	3.0	< 1.0	1.0	< 1.0
Effluent	3/2/2017	D	< 1.0	< 1.0	< 1.0	3.0	< 1.0	1.1	< 1.0
Effluent	6/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Effluent	6/8/2017	D	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Effluent	9/12/2017		< 1.0	< 1.0	< 1.0	2.9	< 1.0	0.72 JP	< 1.0
Effluent	9/12/2017	D	< 1.0	< 1.0	< 1.0	2.7	< 1.0	0.73 JP	< 1.0
Influent	12/8/2016		< 1.0	< 1.0	< 1.0	130	13	79	0.88 JP
Influent	3/2/2017		< 1.0	< 1.0	< 1.0	100	15	65	0.91 JP
Influent	6/8/2017		< 1.0	< 1.0	< 1.0	89	10	54	0.59 JP
Influent	9/12/2017		< 1.0	< 1.0	< 1.0	120	13	66	1.0

Notes:

(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration

D - Field Duplicate

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit

Table 22

Summary Of Monthly VOC Removal
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Month	Total Monthly Flow (gallons)	Total VOC Influent (µg/L)	Total VOC Effluent (µg/L)	Total VOCs Treated (lbs)	Total VOCs Remaining (lbs)	Total VOC Mass Removed (lbs)
Cumulative as of September 30, 2016						372.7
October[(1)]	509,493	223	0	0.95	0.00	0.95
November[(1)]	454,595	223	0	0.85	0.00	0.85
December	494,440	223	0	0.92	0.00	0.92
January[(1)]	467,660	181	0	0.71	0.00	0.71
February[(1)]	357,760	181	0	0.54	0.00	0.54
March	442,100	181	0	0.67	0.00	0.67
April[(1)]	439,890	154	0	0.56	0.00	0.56
May[(1)]	507,245	154	0	0.65	0.00	0.65
June	447,136	154	0	0.57	0.00	0.57
July[(1)]	453,869	200	0	0.76	0.00	0.76
August[(1)]	394,936	200	0	0.66	0.00	0.66
September	401,372	200	0	0.67	0.00	0.67
Total - FY 2017						8.50
Cumulative To Date						381.2

Notes:

[(1)] Influent and Effluent VOC concentrations from the quarterly VOC samples collected on 12/8/2016, 3/2/2017 and 6/8/2017 and 9/12/2017.

Table 23
Building 102 Groundwater Quality Data
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sample Location	Date Sampled	Trichloroethene (µg/L)	1,4 Dioxane (µg/L)	cis-1,2-Dichloroethene (µg/L)	1,1-Dichloroethene (µg/L)	Vinyl Chloride (µg/L)	Vinyl Chloride(3) (µg/L)
Building 102 Cleanup Level(1)		5	---	70	6	0.18	0.18
MDH HRL(2)		---	1	---	---	---	---
01U048	6/20/17	< 1.0	1.1	< 1.0	< 1.0	< 1.0	0.039 J
01U579	6/19/17	0.71 J	0.05 J	< 1.0	< 1.0	< 1.0	NA
01U580	6/19/17	1.1	< 0.070	0.35 J	< 1.0	< 1.0	NA
01U581	6/16/17	29	< 0.070	7.7	< 1.0	< 1.0	NA
01L581	6/16/17	6.9	0.12	3.2	< 1.0	< 1.0	NA
01L581 - Dup	6/16/17	7.2	NA	3.5	< 1.0	< 1.0	NA
01U582	6/20/17	0.34 J	< 0.070	0.72 J	< 1.0	< 1.0	NA
01L582	6/20/17	< 1.0	0.11	8.8	< 1.0	< 1.0	NA
01U583	6/16/17	< 1.0	< 0.070	0.72 J	< 1.0	< 1.0	NA
01L583	6/16/17	< 1.0	< 0.070	< 1.0	< 1.0	< 1.0	NA
01U584	6/20/17	< 1.0	0.061 J	0.67 J	< 1.0	< 1.0	0.050
01L584	6/20/17	13	< 0.070	6.7	< 1.0	< 1.0	0.520

Footnotes:

1. The cleanup level for Building 102 Groundwater are from pages 2-13 of OU2 ROD Amendment #4. Gray shading indicates exceedance of the cleanup level.

2. No Building 102 cleanup level has been established for 1,4-dioxane. For reference, the Minnesota Department of Health (MDH) Health Risk Limit (HRL) for 1,4-dioxane is 1 µg/L.

3. This analysis of vinyl chloride is by Method 8260C-SIM to obtain a lower reporting limit for vinyl chloride.

Acronyms and Abbreviations:

--- = no relevant cleanup level or HRL for this compound
< X.XX = analyte was not detected above the indicated Method Detection Limit (MDL)
Dup = duplicate
J = reported value is between the MDL and the Reporting Limit
NA = sample not analyzed for this compound
µg/L = micrograms per liter

Table 24

Extraction Well Water Pumped
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Volume of Water Pumped (gallons)													
	B1	**B3**	**B4**	**B5**	**B6**	**B8**	**B9**	**B11**	**B13**	**SC1**	**SC2**	**SC5**	**Total**
October 2016	9,113,100	9,888,500	9,985,600	9,742,300	8,391,400	8,411,200	11,509,300	0	4,191,900	1,048,700	3,326,500	3,160,400	78,768,900
(gpm)	204	222	224	218	188	188	258	0	94	23	75	71	1,765
November 2016	8,937,600	9,108,000	9,763,500	11,617,800	8,332,900	9,832,900	11,593,000	0	4,213,200	996,200	2,044,800	2,950,400	79,390,300
(gpm)	207	211	226	269	193	228	268	0	98	23	47	68	1,838
December 2016	9,080,300	9,407,300	9,913,600	12,056,300	8,410,800	9,771,700	11,807,700	0	4,310,800	1,074,500	2,618,900	2,943,400	81,395,300
(gpm)	203	211	222	270	188	219	265	0	97	24	59	66	1,823
January 2017	9,017,800	9,396,500	9,860,600	11,791,200	7,457,000	9,059,600	11,713,500	0	4,241,800	1,062,500	2,877,800	3,643,700	80,122,000
(gpm)	202	210	221	264	167	203	262	0	95	24	64	82	1,795
February 2017	7,654,700	9,274,900	9,039,200	10,443,200	6,638,300	7,350,400	10,123,900	0	2,958,800	970,000	2,690,900	3,720,000	70,864,300
(gpm)	190	230	224	259	165	182	251	0	73	24	67	92	1,758
March 2017	7,953,500	10,097,900	9,763,800	11,813,700	7,240,600	8,851,200	13,181,900	0	3,113,900	1,046,000	1,666,800	2,879,600	77,608,900
(gpm)	178	226	219	265	162	198	295	0	70	23	37	65	1,739
April 2017	7,390,100	11,070,200	9,541,600	11,536,600	6,213,100	9,482,000	12,947,700	0	2,974,200	992,800	1,580,600	2,180,900	75,909,800
(gpm)	171	256	221	267	144	219	300	0	69	23	37	50	1,757
May 2017	7,843,100	9,918,800	9,630,100	11,488,800	9,057,500	7,151,400	13,149,900	0	3,092,000	1,022,400	1,537,700	5,655,900	79,547,600
(gpm)	176	222	216	257	203	160	295	0	69	23	34	127	1,782
June 2017	7,480,400	9,101,800	9,182,500	10,714,100	10,689,700	7,805,100	12,113,100	0	2,869,400	976,900	1,107,700	3,885,800	75,926,500
(gpm)	173	211	213	248	247	181	280	0	66	23	26	90	1,758
July 2017	7,720,400	11,039,600	9,446,200	11,199,300	11,499,300	7,849,400	11,680,300	0	2,699,400	950,300	682,500	4,698,700	79,465,400
(gpm)	173	247	212	251	258	176	262	0	60	21	15	105	1,780
August 2017	8,074,700	9,027,600	8,327,600	9,648,700	10,648,500	7,694,100	11,275,500	0	2,600,000	936,500	539,600	4,825,300	73,598,100
(gpm)	181	202	187	216	239	172	253	0	58	21	12	108	1,649
September 2017	9,067,700	9,171,500	9,025,500	10,908,600	10,195,500	8,102,400	11,849,600	0	2,784,300	914,700	401,800	4,907,400	77,329,000
(gpm)	210	212	209	253	236	188	274	0	64	21	9	114	1,790
Total FY 2017	**99,333,400**	**116,502,600**	**113,479,800**	**132,960,600**	**104,774,600**	**101,361,400**	**142,945,400**	**0**	**40,049,700**	**11,991,500**	**21,075,600**	**45,451,500**	**929,926,100**
Operational Minimum (gpm)	225	170	195	195	210	135	275	80	110	20	30	100	1,745

	B1, B11, B13	B4, B5, B6	B4, B5, B6, B8, B9	Total System
FY17 Average Flow Rate (gpm)	265	668	1,133	1,769
MOS Operational Minimum (gpm)	415	600	1,010	1,745

Table 25

VOC Mass Loading Summary
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Well	Percent Contribution to VOC Mass Removal	FY 2017 Total Pounds VOCs Mass Removed
B1	2.3%	45.1
B2[1]	0.0%	0.00
B3	0.1%	2.73
B4	2.3%	45.2
B5	3.2%	64.3
B6	0.9%	17.8
B7[1]	0.0%	0.00
B8	0.4%	7.00
B9	2.0%	40.6
B10[1]	0.0%	0.00
B11[1]	0.0%	0.00
B12[1]	0.0%	0.00
B13	1.1%	21.1
SC1	14.7%	292
SC2	0.5%	10.04
SC3[1]	0.0%	0.00
SC4[1]	0.0%	0.00
SC5	72.6%	1,443
Fiscal Year 2017 Total (lbs)		**1,988**
Daily Average (lbs/day)		**5.4**

Notes:

[1] Extraction well was not in operation during the fiscal year.

Table 25 Continued

VOC Mass Loading Summary
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Historical Total

Fiscal Year		Pounds VOC Mass Removed
2017		1,988
2016		1,731
2015		1,748
2014		2,020
2013		2,082
2012		1,801
2011		1,834
2010		2,096
2009		2,167
2008		2,292
2007		2,507
2006		2,552
2005		2,663
2004		3,291
2003	(First year of reconfigured system)	3,041
2002		2,852
2001		3,418
2000		4,499
1999		4,878
1998		6,132
1997		6,210
1996		10,655
1995		13,355
1994		15,070
1993		20,165
1992		24,527
1991		26,760
1990		18,005
1989	(First year of full scale system)	19,510
1988		4,800
1987		2,100
Total		**216,749**

Table 26
Summary of Site A Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Groundwater Monitoring	a. Outlined below		
#2: Containment and Mass Removal	a. None. The groundwater extraction system was shut down in September 2008 allowing implementation of Monitored Natural Attenuation (MNA) to be evaluated. In late 2015, MNA was deemed an acceptable remedy, and therefore a Record of Decision amendment will be prepared in FY2016 to document the change in this remedy component.		
#3A: Land Use Controls	a. None		
#3B: Alternate Water Supply / Well Abandonment	See Operable Unit 1, Remedy Component #1 which also includes the area north of Site A		
#4: Discharge of Extracted Water	a. None (see #2 above)		
#5: Source Characterization / Remediation	a. None. volatile organic compound-contaminated soils in the source area (1945 Trench) were excavated and transported to a permitted offsite disposal facility in FY 2003.		
OR: Overall Remedy (Attainment of Cleanup Goals)	a. Water quality data throughout the Site A plume to evaluate attainment and to verify that Natural Attenuation is adequately controlling plume migration.	Army	Site A Monitoring Plan in the Annual Performance Report

Table 27
Summary of Site C Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Remedy Component		Monitoring Requirements		Implementing Party	Documents Containing the Monitoring Plan
#1:	Groundwater and Surface Water Monitoring	a.	Outlined below		
#2:	Groundwater Containment	a.	None. The groundwater extraction system was shut down in November 2008, since the area of groundwater that exceeded the groundwater cleanup level no longer extended to the extraction wells.		
#3:	Discharge of Extracted Water	a.	None (see #2 above)		
#4:	Land use controls to Restrict Well Installation and to Protect the Remedy Infrastructure	a.	None.		
OR:	Overall Remedy (Attainment of Cleanup Goals)	a.	Groundwater quality data throughout the Site C plume to evaluate attainment and to verify that operation of a groundwater extraction system is not required. Also surface water data in the plume vicinity to verify that groundwater does not impact surface water above surface water standards.	Army	Site C Monitoring Plan in the Annual Performance Report

Table 28
Contingency Locations for Site C Monitoring
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS a joint venture

Sampling Location	CONTINGENCY ROLE	
	Trigger for Contingency Action[(1)]	Contingency Action
MW-4	If 3-event moving average > 15 µg/L	Note 3
MW-7	If 3-event moving average > 15 µg/L	Note 3
MW-11	If 3-event moving average > 15 µg/L	Note 3
MW-16	If 3-event moving average > 15 µg/L	Note 3
01U046	If 3-event moving average > 6.9 µg/L	Note 4
SW5(2)	If one sampling event > 6.9 µg/L	Note 4
SW6(2)	If one sampling event > 6.9 µg/L	Note 5
NE Wetland (2)	If one sampling event > 6.9 µg/L	Note 4

Footnotes:
1. Water quality monitoring is for dissolved lead in monitoring wells and surface water.
2. Surface water sampling is performed on three consecutive days and results are averaged for comparison to the trigger.
3. Army notify USEPA/MPCA within 1 week from receipt of data and submit an evaluation report within 30 days from notification.
4. Army notify USEPA/MPCA within 1 week from receipt of data; initiate monthly sampling of SW-5, SW-6, the NE Wetland, and the replacement wetland; and submit an evaluation report within 30 days from notification.
5. Army notify USEPA/MPCA within 1 week from receipt of data; initiate monthly sampling of SW-5, SW-6, the NE Wetland, and the replacement wetland; and submit an evaluation report within 30 days from notification. If SW-6 exceedance continues for 3 consecutive months, contain the surface water at SW-6, treat (if necessary) and discharge to sanitary sewer.

Acronyms and Abbreviations:
MPCA - Minnesota Pollution Control Agency
USEPA - United States Environmental Protection Agency

Table 29

Summary Of Groundwater Monitoring Requirements
Fiscal Year 2017
Site I, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Responsible Party	Documents Containing the Monitoring Plan
#1 Groundwater Monitoring	a. Groundwater quality and water levels to track remedy progress	Orbital ATK	Site I Monitoring Plan in Annual Performance Report
#2 Additional Investigation	a. None (completed)		
#3 Land Use Controls	a. None		
OR Overall Remedy	a. Water quality data to evaluate attainment	Orbital ATK	Site I Monitoring Plan in Annual Performance Report

Table 30

Summary Of Groundwater Monitoring Requirements
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Responsible Party	Documents Containing the Monitoring Plan
#1 Groundwater Monitoring	• Outlined below		
#2 Sentinel Wells	a. Water quality to monitor potential migration	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#3 Hydraulic Containment	a. Water levels for use in drawing contour maps showing capture	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
	b. Pumping volumes and rates for reporting	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#4 Groundwater Treatment	• None		
#5 Treated Water Discharge	• None		
#6 Discharge Monitoring	a. Treated effluent water quality for comparison to substantive requirements criteria for discharge maximum daily concentration	Orbital ATK	Site K Monitoring Plan in Annual Performance Report
#7 Additional Investigation	a. None (completed)		

Table 31

Groundwater Elevation Monitoring
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Well ID	Groundwater Elevation (June 2016)	Groundwater Elevation (Historical Maximum)	Groundwater Elevation (June 2017)
01U047	873.56	875.75	Abandoned
01U048	873.46	876.61	875.50
01U052	875.51	876.64	876.26
01U065	Abandoned	874.91	Abandoned
01U128	874.53	877.07	876.23
01U601	Abandoned	886.65	Abandoned
01U602	Abandoned	886.37	Abandoned
01U603	878.54	882.86	879.81
01U604	Abandoned	879.79	Abandoned
01U605	Abandoned	879.61	Abandoned
01U607	886.46	887.56	885.81
01U608	Abandoned	888.06	Abandoned
01U609	Abandoned	886.83	Abandoned
01U611	Abandoned	887.16	Abandoned
01U612	879.66	884.70	880.04
01U613	Abandoned	886.15	Abandoned
01U615	878.50	883.71	880.96
01U616	Abandoned	882.75	Abandoned
01U617	877.67	883.22	879.11
01U618	881.98	885.58	882.70
01U619	Abandoned	886.60	Abandoned
01U620	Abandoned	881.93	Abandoned
01U621	878.96	883.87	880.15
01U624A	Abandoned	881.66	Abandoned
01U624B	Abandoned	881.63	Abandoned
01U624C	Abandoned	881.64	Abandoned
01U624D	Abandoned	881.64	Abandoned
01U625A	878.72	883.95	879.92
01U625B	878.70	883.90	879.51
01U625C	Obstructed	887.91	Obstructed
01U625D	878.69	883.91	879.87
01U626A	878.28	882.77	879.53
01U626B	877.99	883.50	879.30
01U626C	878.07	883.58	879.33
01U626D	878.14	883.61	879.39
01U627A	879.32	882.67	880.24
01U627B	878.23	883.57	879.45
01U627C	878.16	883.56	879.38
01U627D	878.16	883.57	879.39
01U628A	Abandoned	880.39	Abandoned

Table 31 Continued

Groundwater Elevation Monitoring
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

Well ID	Groundwater Elevation (June 2016)	Groundwater Elevation (Historical Maximum)	Groundwater Elevation (June 2017)
01U628B	Abandoned	880.34	Abandoned
01U628C	Abandoned	880.25	Abandoned
01U628D	Abandoned	880.25	Abandoned
482085 (K01MW)	Abandoned	887.09	Abandoned
482084 (K02MW)	Abandoned	887.41	Abandoned
482083 (K04MW)	881.93	885.38	881.96
03U621	858.96	856.63	859.12

Table 32

Treatment System Concentrations (Inorganics)
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

			Copper	Cyanide	Lead	Mercury	Silver	Zinc	Total Phosphorus
Effluent Limit[(1)]			**21**	**17**	**106**	**0.20**	**3.4**	**134**	**1.0**
Location	**Date**		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**
Effluent	12/8/2016		2.2	< 10	0.44 JP	< 0.10	< 1.0	9.1	0.37 JP
Effluent	3/2/2017		7.0	< 10	0.86 JP	< 0.10	< 1.0	53	1.9
Effluent	6/8/2017		4.0	6.9 JP	< 1.0	< 0.10	< 1.0	230	7.5
Effluent	6/29/2017		--	--	--	--	--	13	1.4
Effluent	9/12/2017		3.5	4.9 JP	< 1.0	< 0.10	< 1.0	5.1	1.0

Notes:

(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration.

JP - Result is qualified as estimated since the detection is below the laboratory quantitation limit.

Table 33

1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2017
Site K, OU2
Arden Hills, Minnesota

		1,4-Dioxane
Screening Criteria (HRL)		**1.0**
Location	**Date**	**µg/L**
03U621	6/8/2017	8.4

Notes:

HRL Health Risk Limit (Minnesota Department of Health). Shad indicates exceedence of the HRL.

Table 34
Summary of Building 102 Shallow Groundwater Monitoring Requirements
FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

Remedy Component		Monitoring Requirements		Implementing Party	Documents Containing the Monitoring Plan
#1:	Monitored Natural Attenuation (abiotic degradation)	a.	Outlined below		
#2:	Groundwater Monitoring	a.	Outlined below		
#3:	Land Use Controls to Restrict Well Installation and to Protect the Remedy Infrastructure	a.	None.		
OR:	Overall Remedy (Attainment of Cleanup Goals)	a.	Groundwater quality data throughout the Building 102 plume to evaluate attainment and to verify that groundwater reaching Rice Creek does not exceed state surface water standards.	Army	Building 102 Monitoring Plan in the Annual Performance Report

Table 35

Pumphouse Down Time
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Well Name	FY17 Down Time (Days)	FY16 Down Time (Days)	FY15 Down Time (Days)	FY14 Down Time (Days)	FY13 Down Time (Days)
B1	3.3	4.2	2.7	3.4	10.7
B2	(1)	(1)	(1)	(1)	(1)
B3	3.7	9.7	5.4	3.0	4.3
B4	3.3	6.5	10.2	9.2	4.0
B5	4.0	9.1	8.7	2.0	13.0
B6	8.7	7.8	2.4	9.6	2.8
B7	(1)	(1)	(1)	(1)	(1)
B8	7.1	8.9	8.5	2.4	2.9
B9	11.2	21.7	9.5	6.8	9.4
B10	(1)	(1)	(1)	(1)	(1)
B11	(1)	(1)	(1)	(1)	16.4(2)
B12	(1)	(1)	(1)	(1)	(1)
B13	4.3	3.9	4.5	2.9	9.3
SC1	3.9	10.7	2.6	17.0	14.0
SC2	3.7	81.3	4.4	4.4	20.3
SC3	(1)	(1)	(1)	(1)	(1)
SC4	(1)	(1)	(1)	(1)	(1)
SC5	20.2	11.7	6.6	9.4	32.5

Note:

(1) The extraction well was not in operation during the fiscal year.

(2) The extraction well was in operation for only part of the fiscal year.

Table 36

Down Time By Category
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Category	Down Time (Days)
Pumphouse Component	1.9
Treatment Center Component	0.4
Electrical Service	0.6
Miscellaneous	0.6
Preventive Maintenance	0.9
System Modification	0.0
Forcemain	2.3
Total System Equivalent	6.7

Anticipated Down Time for Fiscal Year 2017

Pumphouse Component	4.0
Treatment Center Component	1.5
Electrical Service	2.0
Miscellaneous	1.0
Preventive Maintenance	1.0
System Modification	0.5
Forcemain	1.0

Table 37

VOC Concentrations in TGRS Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Location	Alias	Date	Dup	1,1,1-Trichloroethane µg/L	1,1-Dichloroethane µg/L	1,1-Dichloroethene µg/L	1,2-Dichloroethane µg/L	cis-1,2-Dichloroethene µg/L	Tetrachloroethene µg/L	Trichloroethene µg/L
03F302	B1	12/7/2016		2.8	0.58 JP	0.91 JP	< 1.0	3.2	1.1	53
03F302	B1	6/7/2017		3.0	0.56 JP	0.74 JP	< 1.0	3.4	0.90 JP	56
03F303	B2	6/8/2017		< 1.0	< 1.0	0.83 JP	0.44 JP	1.2	0.94 JP	27
03F304	B3	12/7/2016		< 1.0	0.32 JP	0.41 JP	< 1.0	< 1.0	< 1.0	3.1
03F304	B3	6/7/2017		< 1.0	0.30 JP	0.38 JP	< 1.0	< 1.0	< 1.0	3.2
03F305	B4	12/7/2016		6.5	3.5	3.2	< 1.0	2.0	< 1.0	87 JMS140
03F305	B4	6/6/2017		6.2	3.1	2.6	< 1.0	1.8	< 1.0	81
03F305	B4	6/6/2017	D	6.3	3.1	2.7	< 1.0	1.8	< 1.0	80
03F306	B5	12/7/2016		2.2	2.8	1.4	< 1.0	0.98 JP	4.5	75
03F306	B5	6/6/2017		2.3	2.6	2.4	< 1.0	0.89 JP	4.4	75
03F307	B6	12/7/2016		0.54 JP	< 1.0	0.43 JP	< 1.0	< 1.0	< 1.0	26
03F307	B6	6/6/2017		0.46 JP	< 1.0	0.36 JP	< 1.0	< 1.0	< 1.0	22
03F307	B6	6/6/2017	D	0.45 JP	< 1.0	0.38 JP	< 1.0	< 1.0	< 1.0	22
03F312	B11	6/8/2017		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03F319	B13	12/7/2016		1.5	0.62 JP	0.58 JP	< 1.0	3.4	< 1.0	76
03F319	B13	6/7/2017		0.87 JP	0.34 JP	< 1.0	< 1.0	2.2	< 1.0	55
03U301	SC1	12/7/2016		17	2.9	4.3	< 1.0	120	0.59 JP	3600
03U301	SC1	6/7/2017		21	3.7 JP	3.9 JP	< 5.0	150	< 5.0	2600

Table 37 Continued

VOC Concentrations in TGRS Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

Location	Alias	Date	Dup	1,1,1-Trichloroethane µg/L	1,1-Dichloroethane µg/L	1,1-Dichloroethene µg/L	1,2-Dichloroethane µg/L	cis-1,2-Dichloroethene µg/L	Tetrachloroethene µg/L	Trichloroethene µg/L
03U314	SC2	12/7/2016		19	1.3	2.1	< 1.0	1.2	< 1.0	45
03U314	SC2	6/8/2017		13	1.1	0.83 JP	< 1.0	1.1	< 1.0	38
03U314	SC2	6/8/2017	D	13	1.0	0.92 JP	< 1.0	1.1	< 1.0	37
03U317	SC5	12/7/2016		980	26	78	2.0	6.2	5.6	3300
03U317	SC5	6/12/2017		800	20	37	1.5 JP	5.8	5.9	3100
PJ#309	B8	12/7/2016		< 1.0	0.40 JP	0.46 JP	< 1.0	< 1.0	< 1.0	9.9
PJ#309	B8	12/7/2016	D	0.43 JP	0.41 JP	0.50 JP	< 1.0	< 1.0	< 1.0	9.4
PJ#309	B8	6/6/2017		0.39 JP	0.36 JP	0.40 JP	< 1.0	< 1.0	< 1.0	8.9
PJ#310	B9	12/7/2016		1.6	1.8	1.9	< 1.0	0.71 JP	< 1.0	33
PJ#310	B9	6/6/2017		1.6	1.8	1.8	< 1.0	0.62 JP	< 1.0	33

Notes:

D - Field Duplicate
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
JMS - Result is qualified as estimated based on outlying matrix spike sample recovery (# following JMS is actual % reco

Table 38

Summary Of OU2 Deep Groundwater Monitoring Requirements
TGRS, OU2
Arden Hills, Minnesota

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1 Hydraulic Containment and Mass Removal	a. Water levels to draw contour maps showing hydraulic zone of capture	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	b. Pumping volumes and rates for comparison to design rates	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	c. Influent and extraction well water quality for overall mass removal calculations	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
#2 Groundwater Treatment	• Outlined below		
#3 Treated Water Discharge	• Effluent monitoring to verify attainment of treatment requirements	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
#4 Land Use Controls	• None		
#5 Review of New Technologies	• None		
#6 Groundwater Monitoring	a. Water levels to draw contour maps showing hydraulic zone of capture	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
	b. Groundwater quality to verify attainment of clean up goals	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report
Overall Remedy	a. Groundwater quality to verify attainment of clean up goals	Orbital ATK/Army	Deep groundwater monitoring plan in Annual Report

Table 39

1,4-Dioxane Concentrations in TGRS and Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

				1,4-Dioxane
Screening Criteria (HRL)				**1.0**
Location	**Alias**	**Date**	**Dup**	**µg/L**
03F302	B1	6/7/2017		1.7
03F303	B2	6/8/2017		0.67
03F304	B3	6/7/2017		6.3
03F305	B4	6/6/2017		29.1
03F305	B4	6/6/2017	D	28.4
03F306	B5	6/6/2017		13.5
03F307	B6	6/6/2017		12.5
03F307	B6	6/6/2017	D	12.3
03F312	B11	6/8/2017		0.66
03F319	B13	6/7/2017		2
03U301	SC1	6/7/2017		16.4
03U314	SC2	6/8/2017		18.6
03U314	SC2	6/8/2017	D	18.9
03U317	SC5	6/12/2017		16.7
PJ#309	B8	6/6/2017		11.4
PJ#310	B9	6/6/2017		14
TGRSE		6/12/2017		11.6
TGRSE		6/12/2017	D	11.1
TGRSI		6/12/2017		11.4

Notes:

HRL - Health Risk Limit (Minnesota Department of Health). Shading indicates exceedence of the HRL

D - Field Duplicate

Table 40

1,4-Dioxane Concentrations in TGRS and Extraction Wells
Fiscal Year 2017
TGRS, OU2
Arden Hills, Minnesota

			1,4-Dioxane
Screening Criteria (HRL)			**1.0**
Location	**Date**	**Dup**	**µg/L**
03L802	6/7/2017		0.26
03L806	6/6/2017		14.2
03M802	6/7/2017		0.13
03M806	6/6/2017		15.4
03U093	6/8/2017		1.6
03U099	6/7/2017		< 0.070
03U677	6/6/2017		0.29
03U708	6/5/2017		0.19
03U801	6/7/2017		0.13
03U806	6/6/2017		4.2
04J077	6/5/2017		13.0
04U711	6/6/2017		7.5
04U802	6/7/2017		0.36
04U806	6/6/2017		13.2
04U833	6/5/2017		13.3
PJ#806	6/6/2017		14.0

Notes:

HRL - Health Risk Limit (Minnesota Department of Health). Sh
indicates exceedence of the HRL.
D - Field Duplicate
FB - Field Blank
UB - Blank contamination, #= highest concentration of
blank affecting data

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10.0 FIGURES

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Spring Lake Park
Mounds View
Brooklyn Park
North Oaks
Fridley
10
Shoreview
Brooklyn Center
694
Arden Hills
694
New Brighton
65
Hilltop
94
47
Columbia Heights
35W
51
Saint Anthony
Minneapolis
Roseville
36

LEGEND:

- Operable Unit 1 (North Plume)
- Operable Unit 2 of the New Brighton/ Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)
- Operable Unit 3 (South Plume)
- Municipal Boundary

0 4,000 8,000 Feet

GRAPHIC SCALE

Twin Cities
(Minneapolis - St. Paul)

NOTES:

1. Operable Unit Areas adapted from Figure 2 of the OU2 ROD.
2. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

ANNUAL PERFORMANCE REPORT

Conceptual Illustration of Operable Units

PIKA ARCADIS a joint venture

FIGURE 1

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU1_OU2_SiteMap_20180131.mxd 2/1/2018 8:24:59 AM

TWIN CITIES ARMY AMMUNITION PLANT

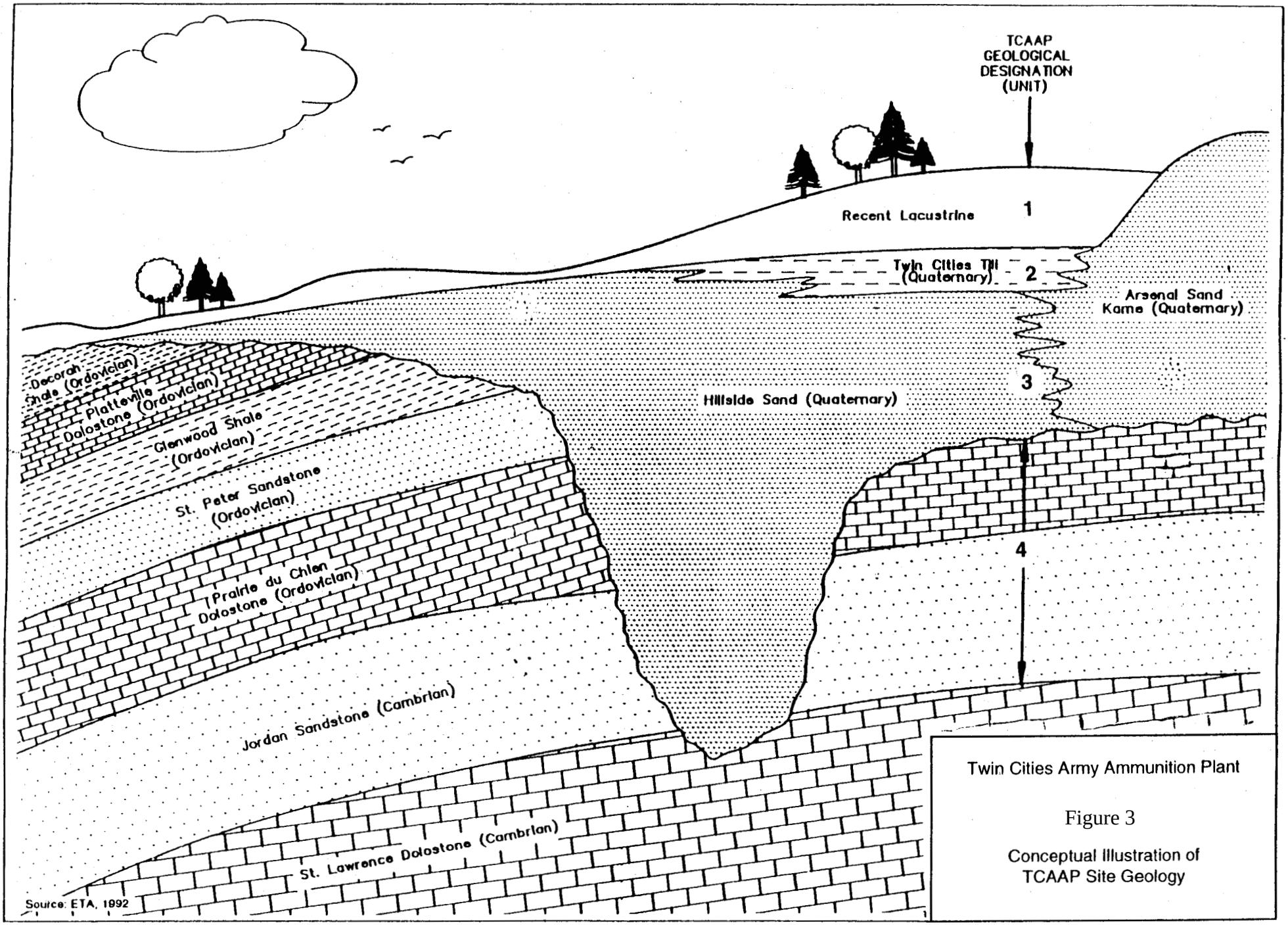
Original TCAAP Boundary

Wenck

Wenck Associates, Inc. 1800 Pioneer Creek Center
Environmental Engineers Maple Plain, MN 55359-0429

AUG 2009

Figure 2



Twin Cities Army Ammunition Plant

Figure 3

Conceptual Illustration of
TCAAP Site Geology

Figure 4
OU2-OU1 Trichloroethene
Cross Section A-A' (North Half)

U.S Army - TCAAP
Arden Hills, Minnesota

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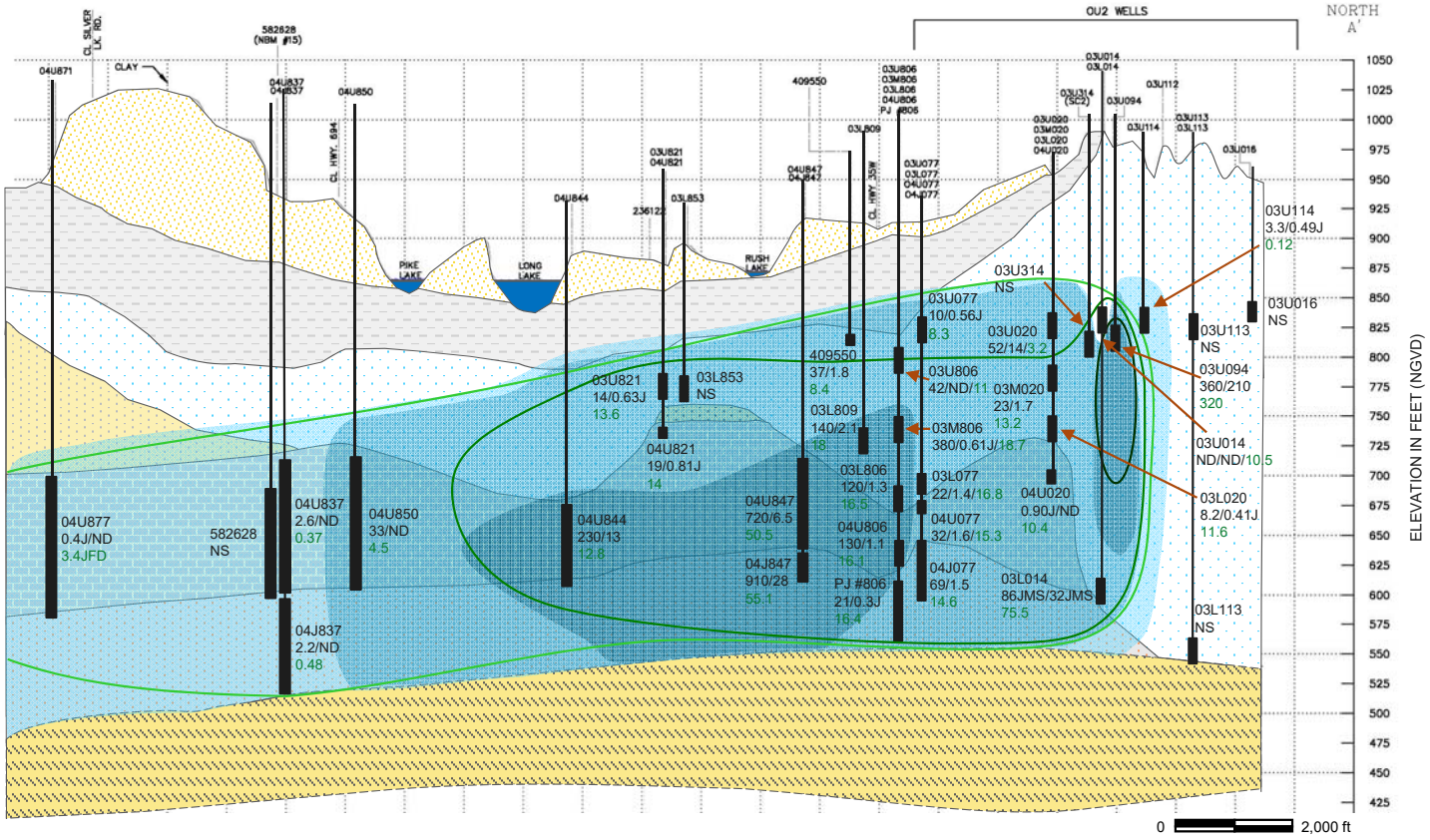

Legend

04J077	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
69/1.5	Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)
14.6	1,4-Dioxane concentration* (µg/L)

J	Reported value is between the method detection limit and reporting limit
JMS	The percent recovery for the matrix spike was below the QC limits. The sample result could be biased low.

Geologic Contact (inferred where dashed)
Screened Interval

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

1,4-Dioxane Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

- Unit 1
- Unit 2
- Unit 3
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 sampling event

Figure 5
OU2-OU1 Trichloroethene
Cross Section A-A' (South Half)

U.S Army - TCAAP
Arden Hills, Minnesota

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ARCADIS
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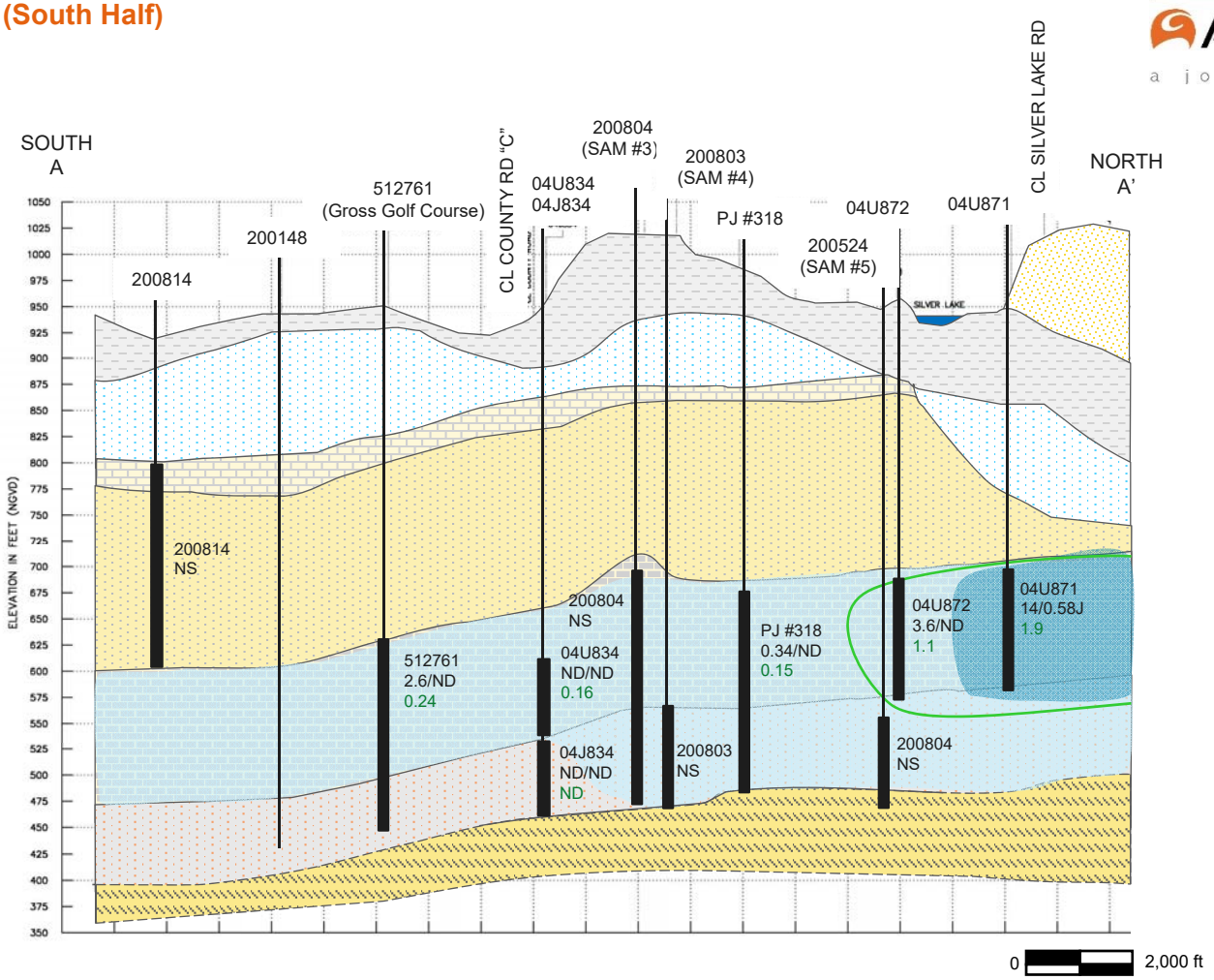


Legend

512761	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
J	Reported value is between the method detection limit and reporting limit

2.6/ND — Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)

0.24 — 1,4-Dioxane concentration* (µg/L)

Geologic Contact (inferred where dashed)

Screened Interval

Trichloroethene Concentration* (µg/L)

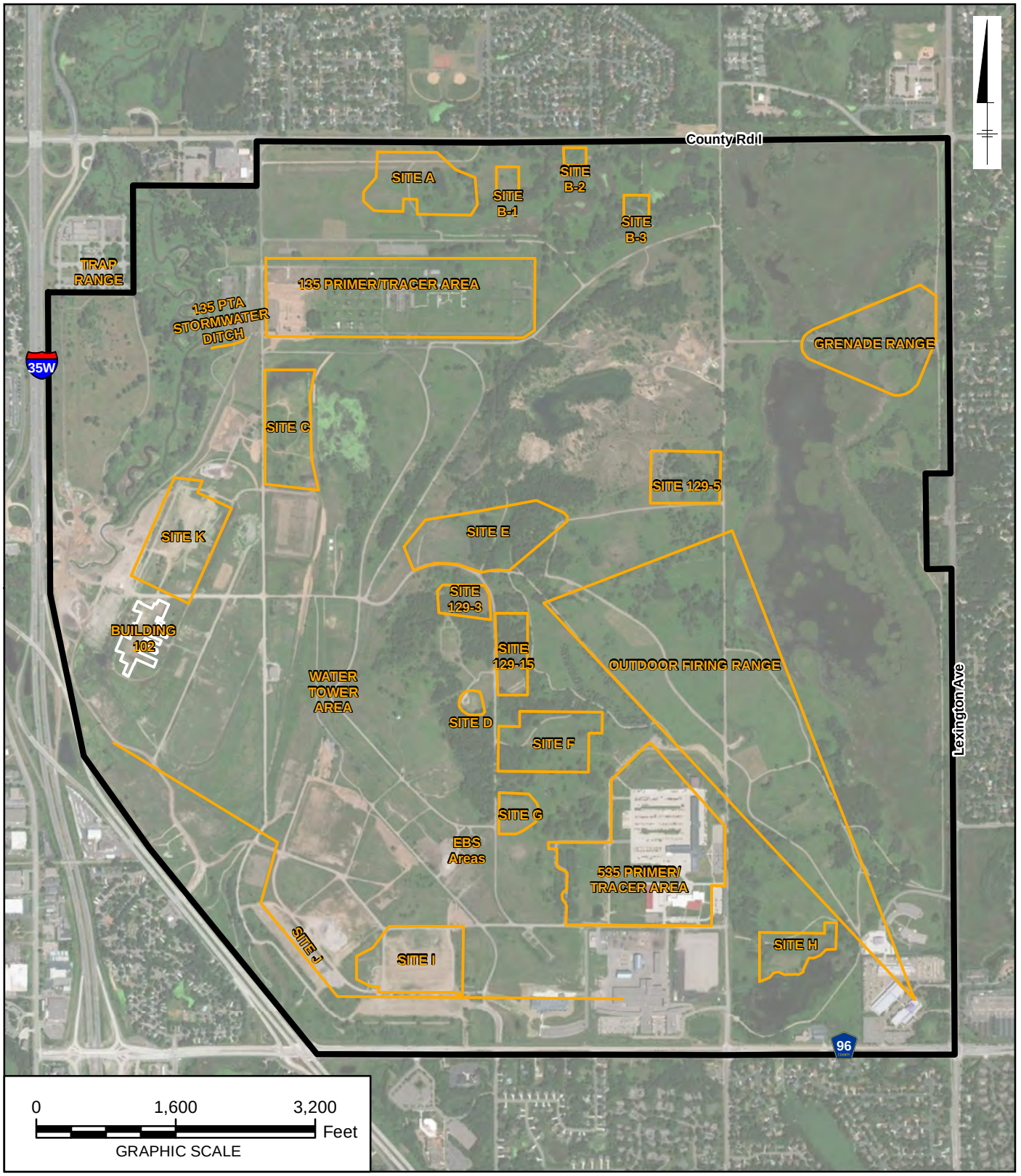
- 1-10
- 10-100

1,4-Dioxane Concentration* (µg/L)

- 1-10

- Unit 1
- Unit 2
- Unit 3
- Platteville Limestone
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 sampling event



LEGEND:

- Operable Unit 2
- General NPL Site Boundary (See Note 1)

NOTES:

1. General NPL site boundaries determined during the initial site investigations. Please refer to the latest site reports for the current boundary definitions.
2. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

ANNUAL PERFORMANCE REPORT

Operable Unit 2 Site Boundaries

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FIGURE
6

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
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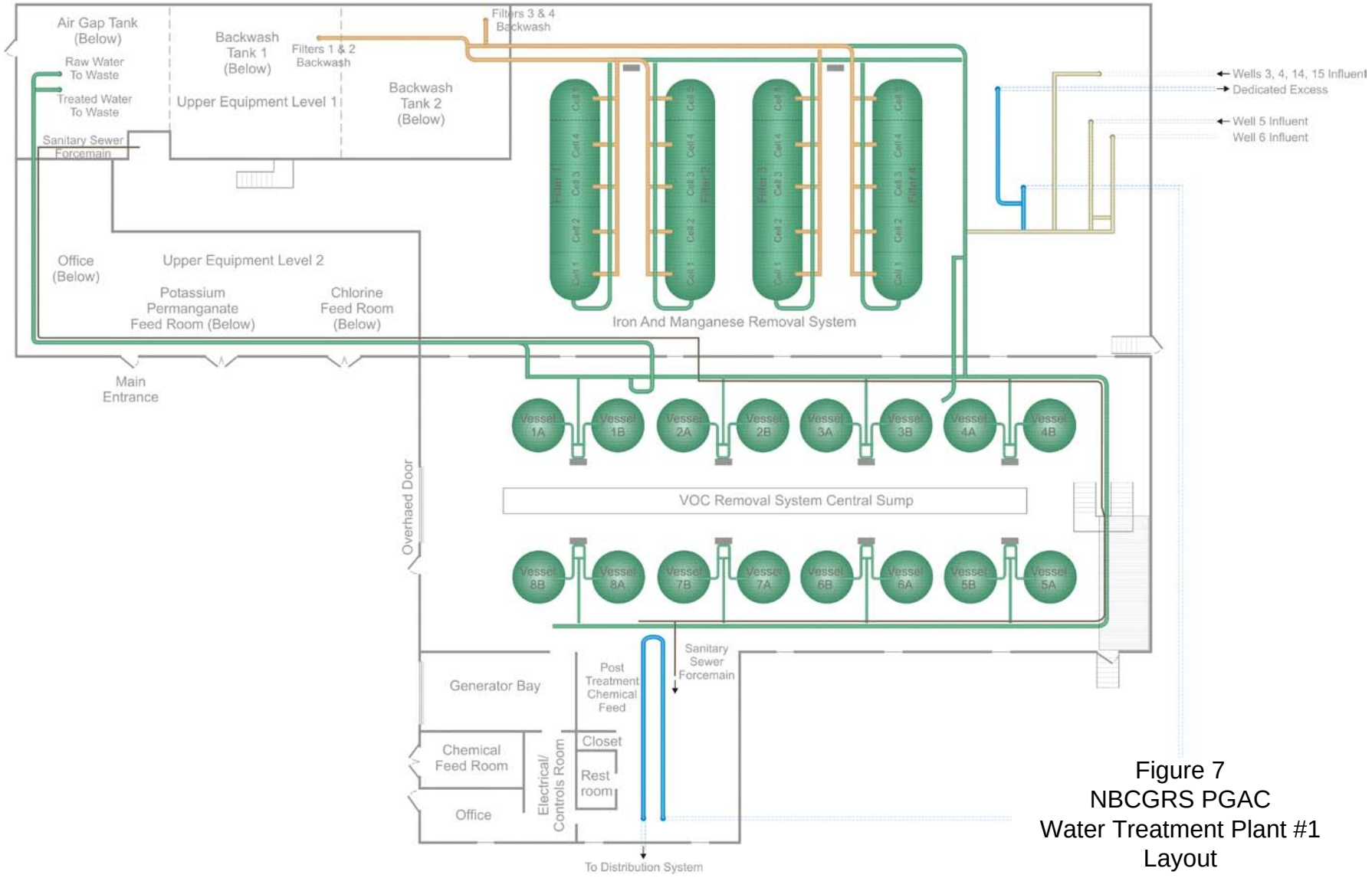


Figure 7
NBCGRS PGAC
Water Treatment Plant #1
Layout

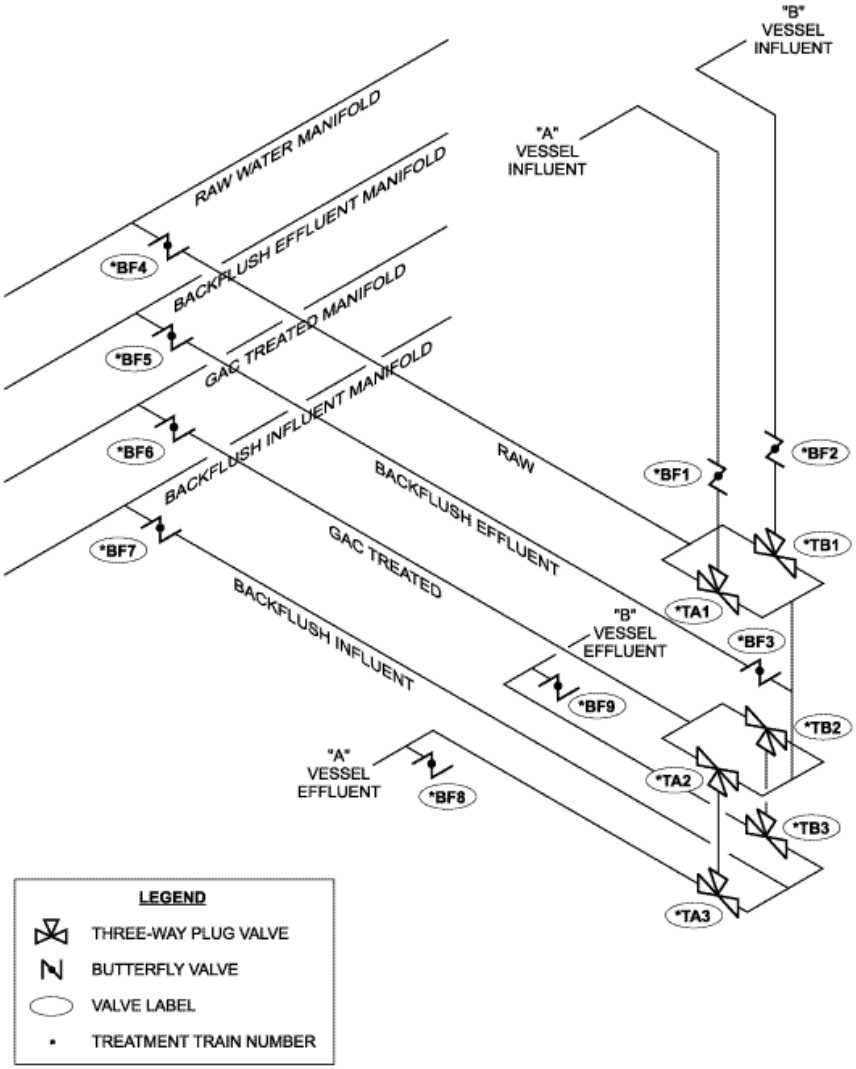
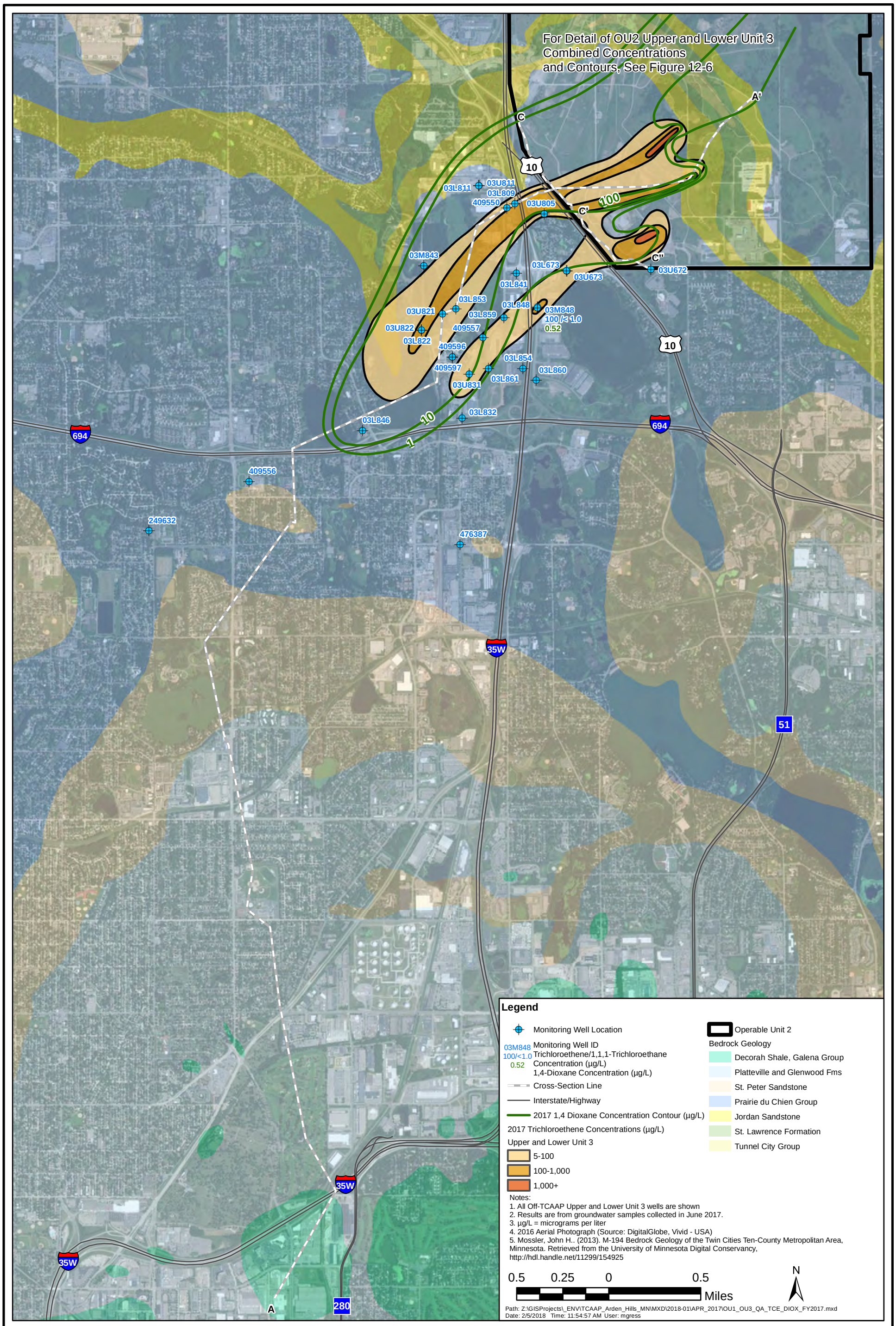


Figure 8
NBCGRS PGAC
Water Treatment Plant #1
Contactor Vessel Pair Control Stand Arrangement



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OU1 & OU3, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

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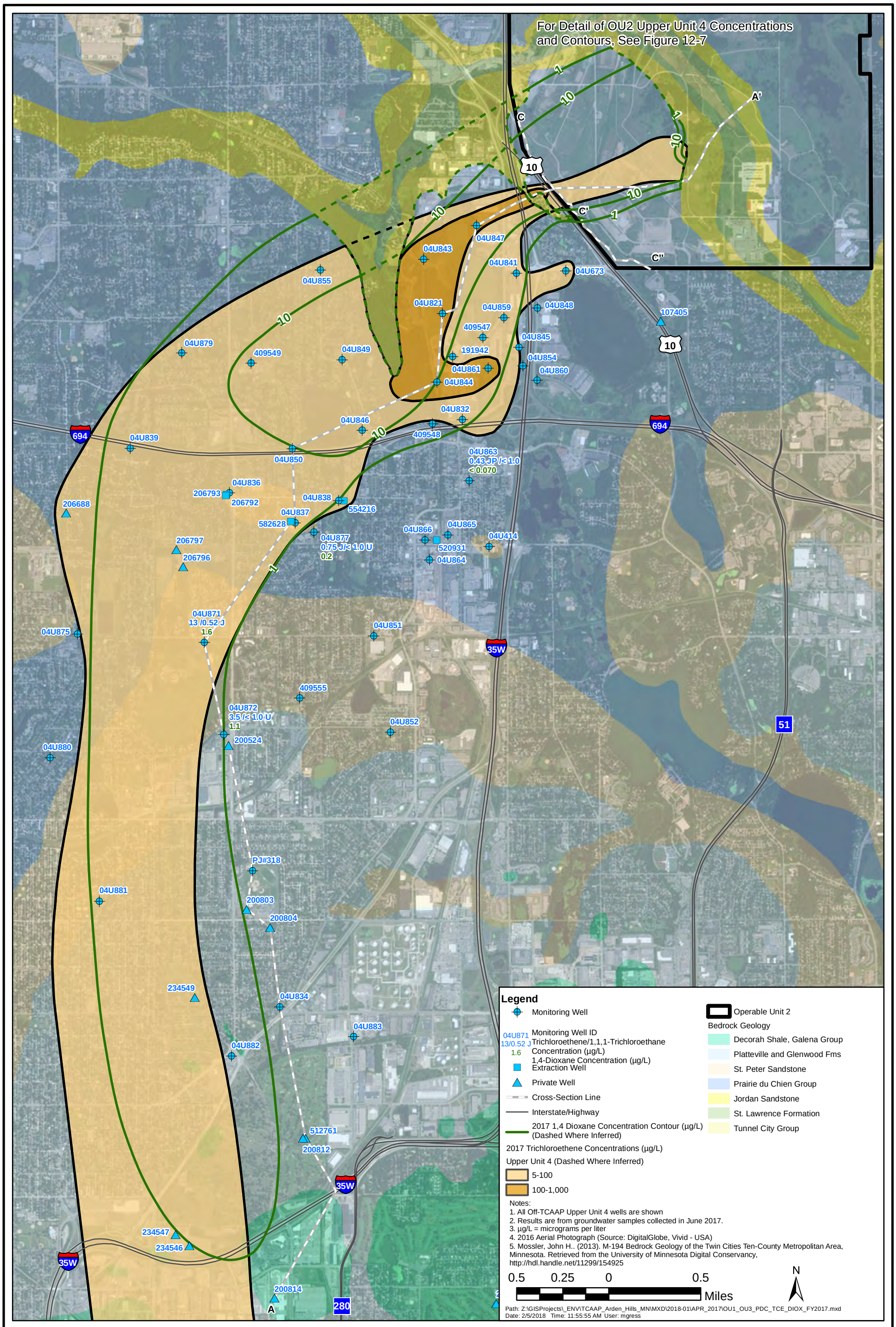
FY 2017

Figure 9



ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

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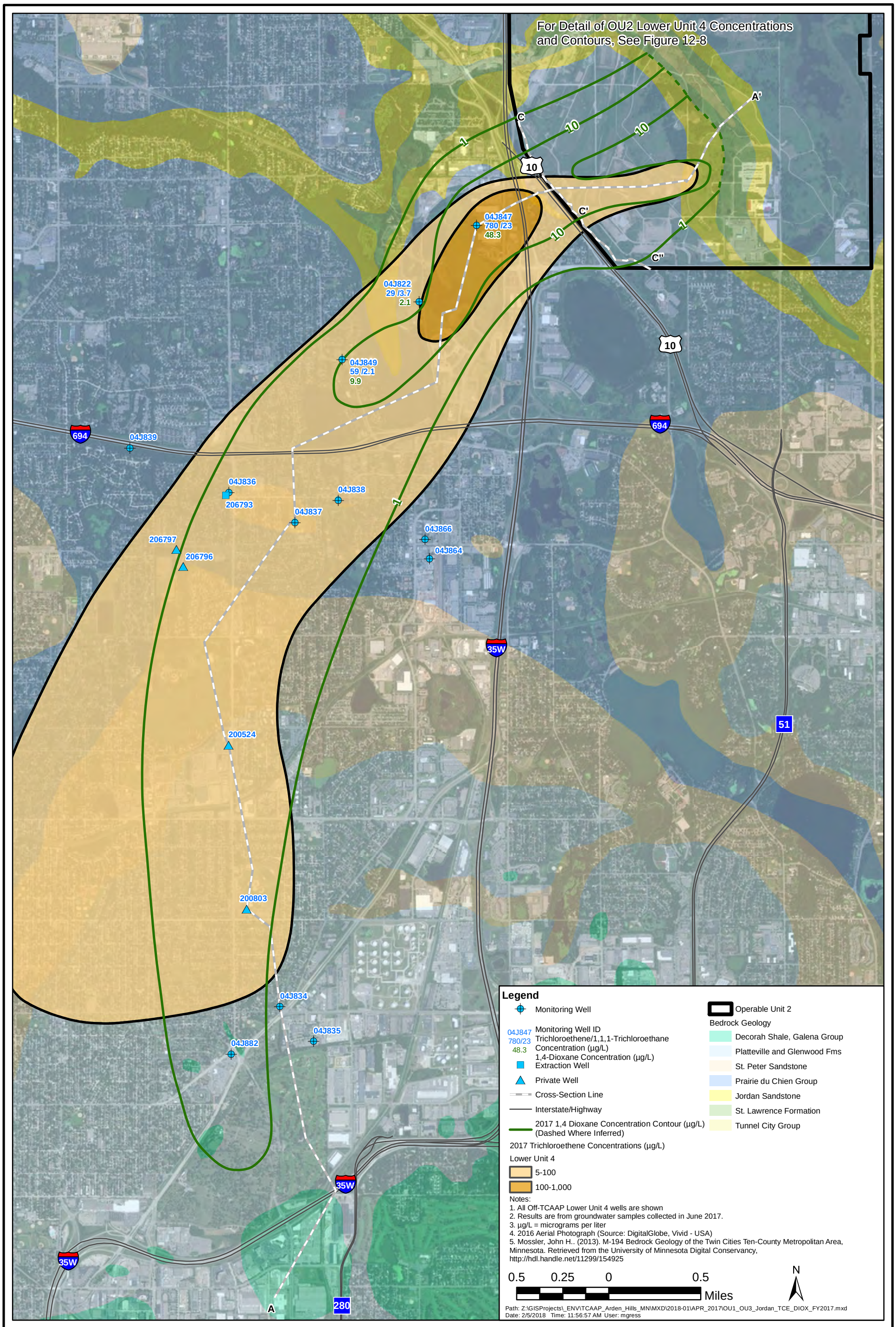
FY 2017

Figure 10



ANNUAL PERFORMANCE REPORT

OU1 & OU3, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017

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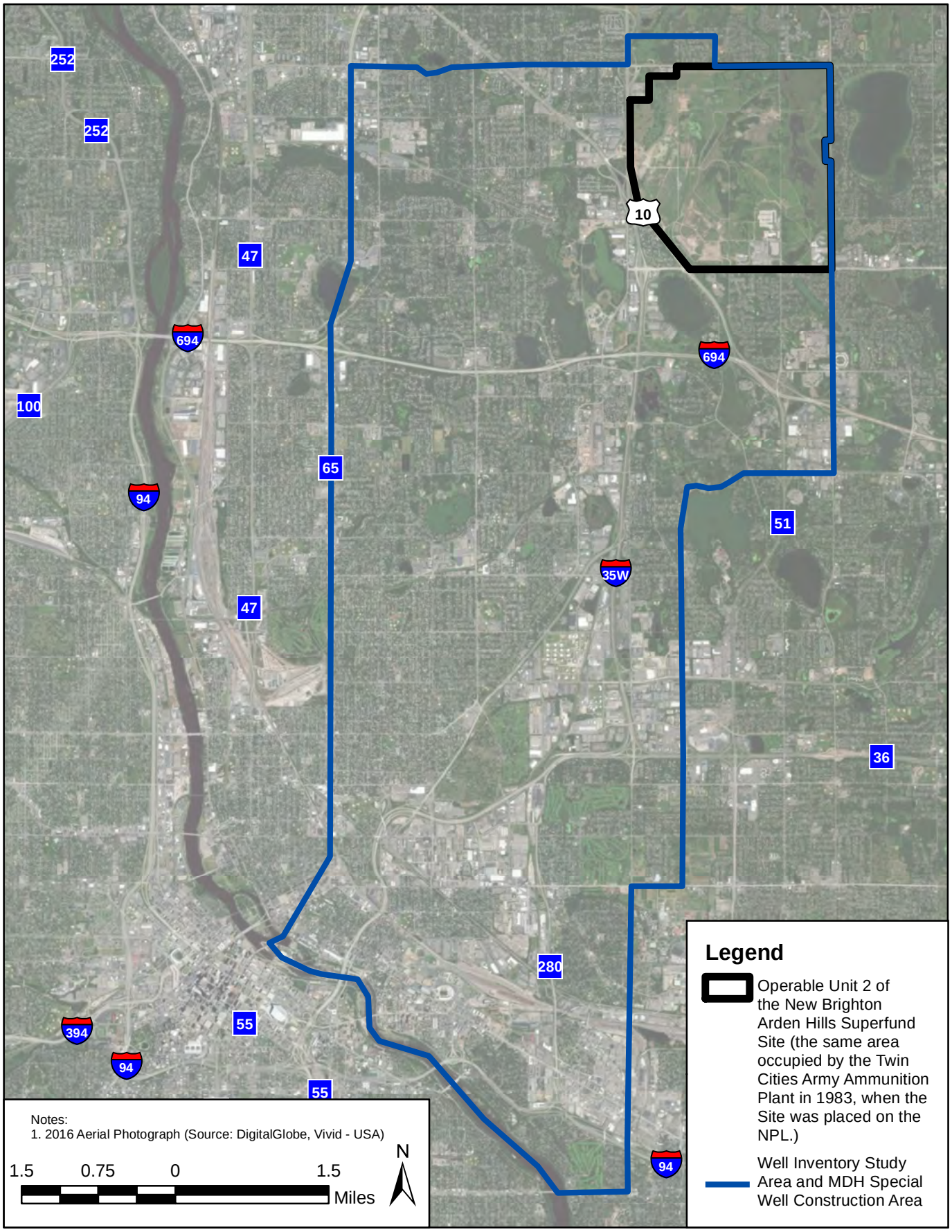
FY 2017

Figure 11



ANNUAL PERFORMANCE REPORT

Well Inventory Study Area

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FY 2017

Figure 12

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Figure 13
NBCGRS History

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

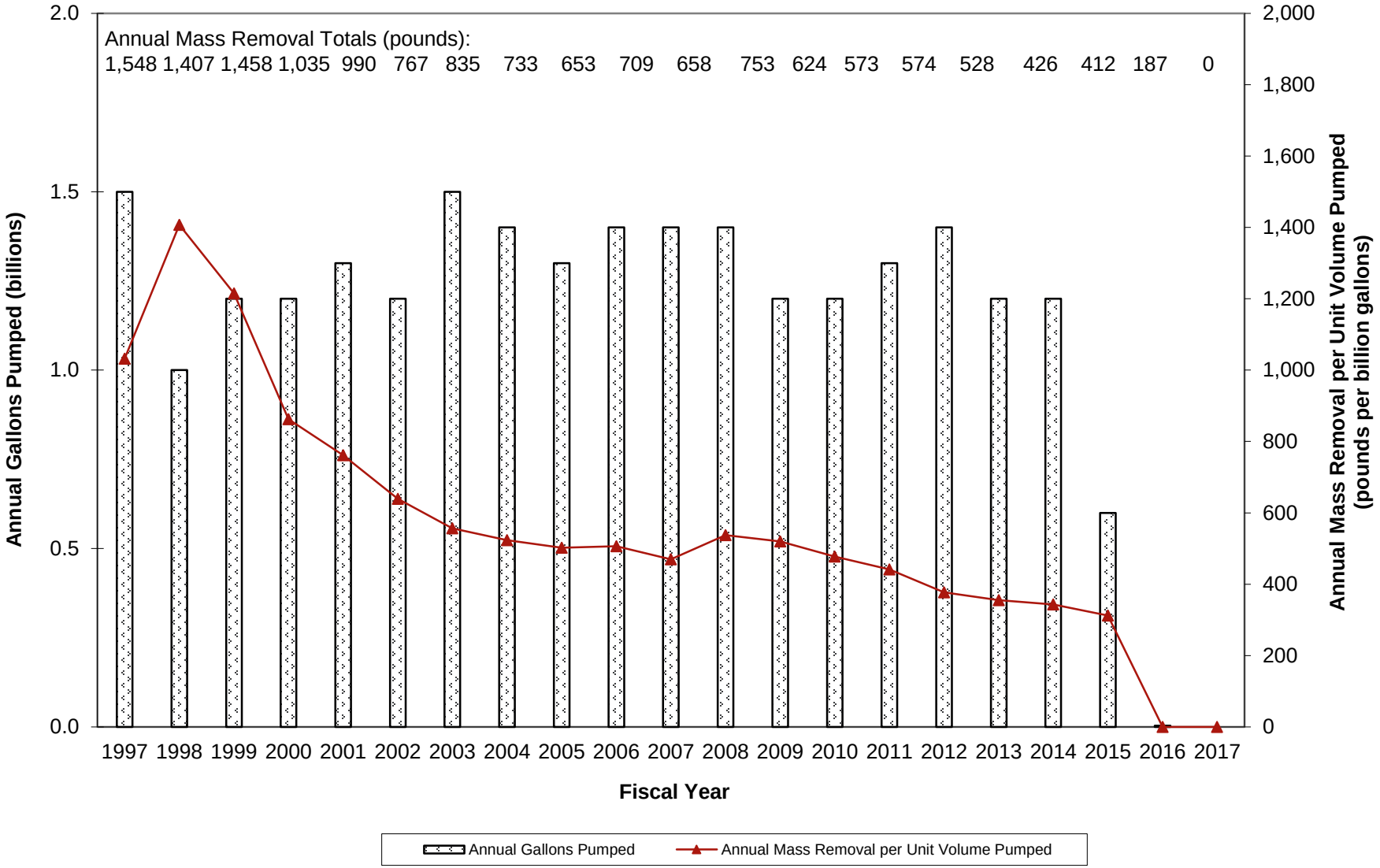
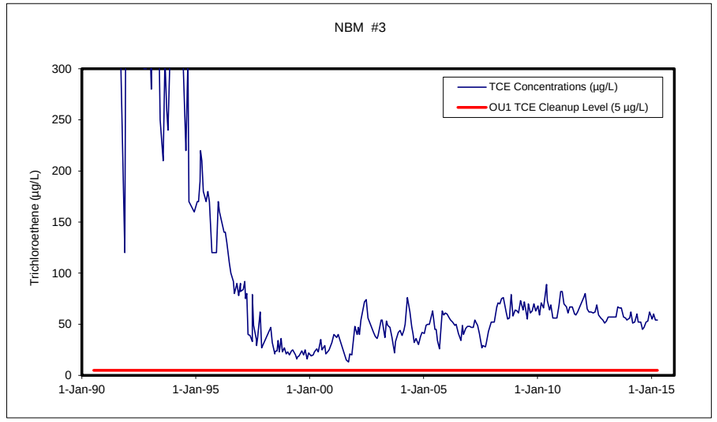
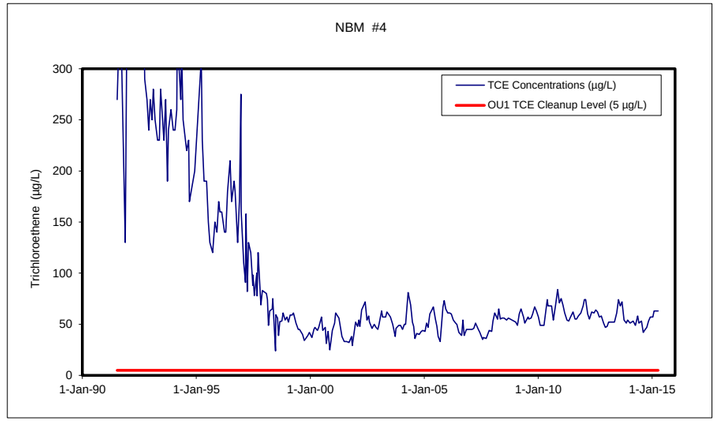
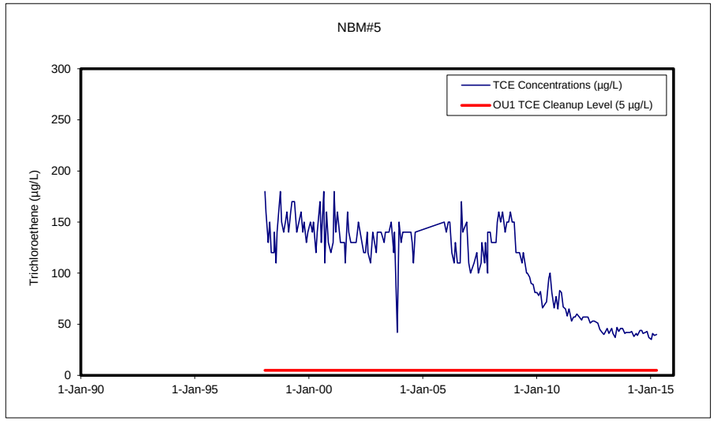


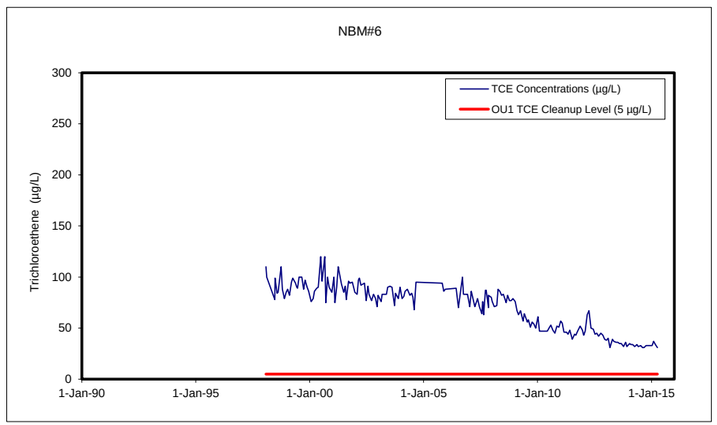
FIGURE 14
NEW BRIGHTON MUNICIPAL WELLS: TRICHLOROETHENE WATER QUALITY TRENDS

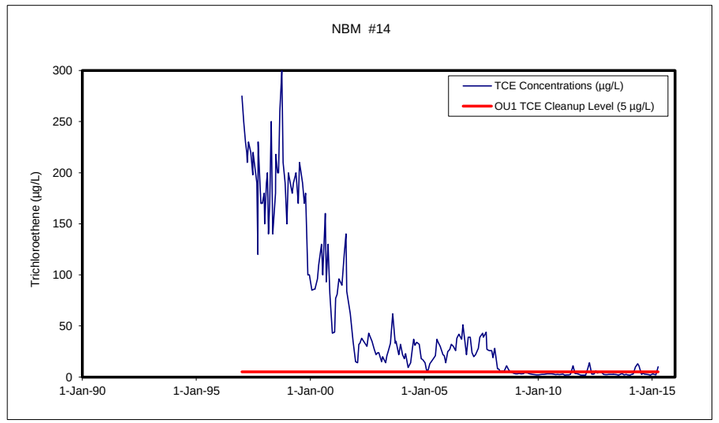
FY 2015 Annual Performance Report

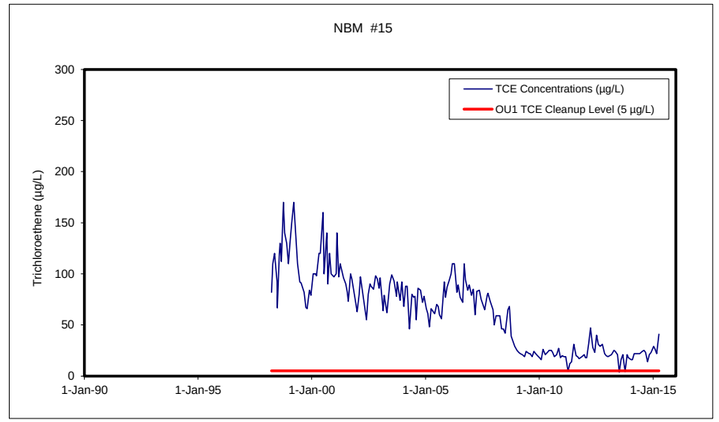












Note: Routine pumping of the NBCGRS was ceased on April 15, 2015, with notice to the USEPA/MPCA, due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the granular activated carbon (GAC) does not remove 1,4-dioxane, New Brighton is preferentially pumping deep aquifer wells that have no detectable 1,4-dioxane while the City evaluates the feasibility of 1,4-dioxane removal technologies. This has been referred to as a "Remedy Time-Out," and normal pumping of the NBCGRS will not be resumed until a technology is selected and modification of the NBCGRS is designed and constructed. The Fridley Interconnection was also closed on April 15, 2015.

Figure 15
New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene

FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, MN

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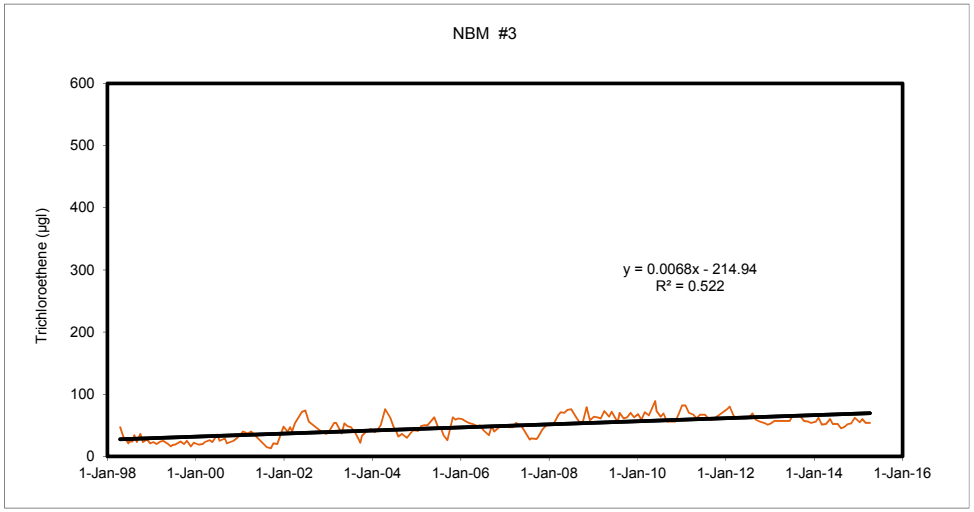
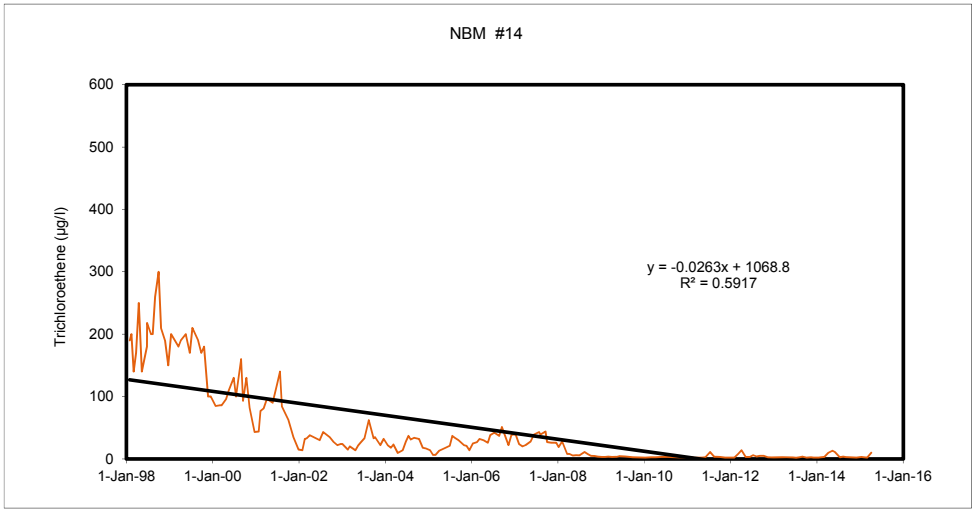
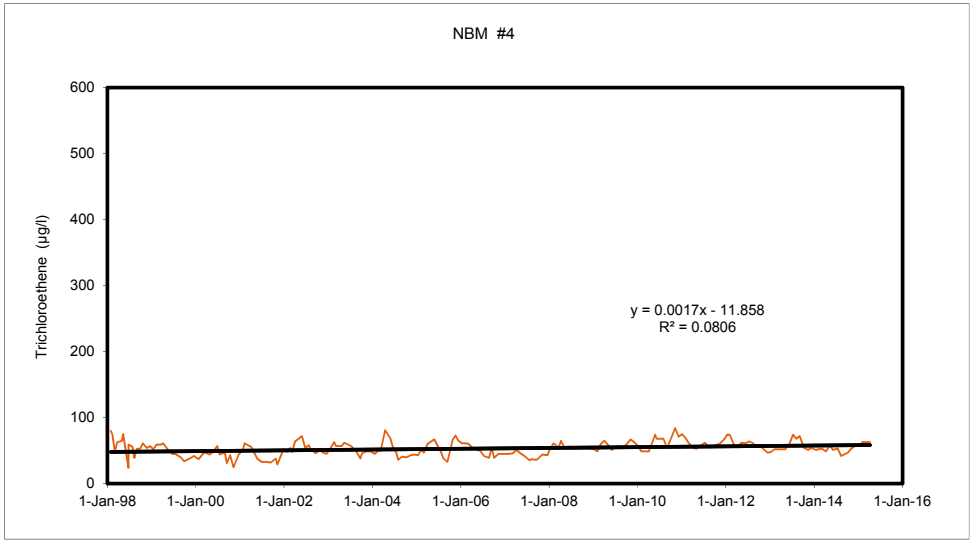






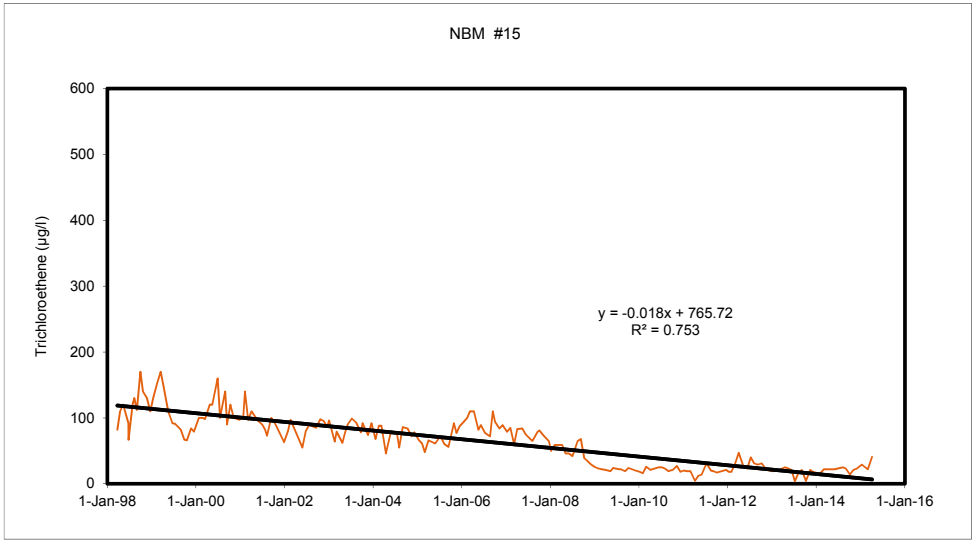
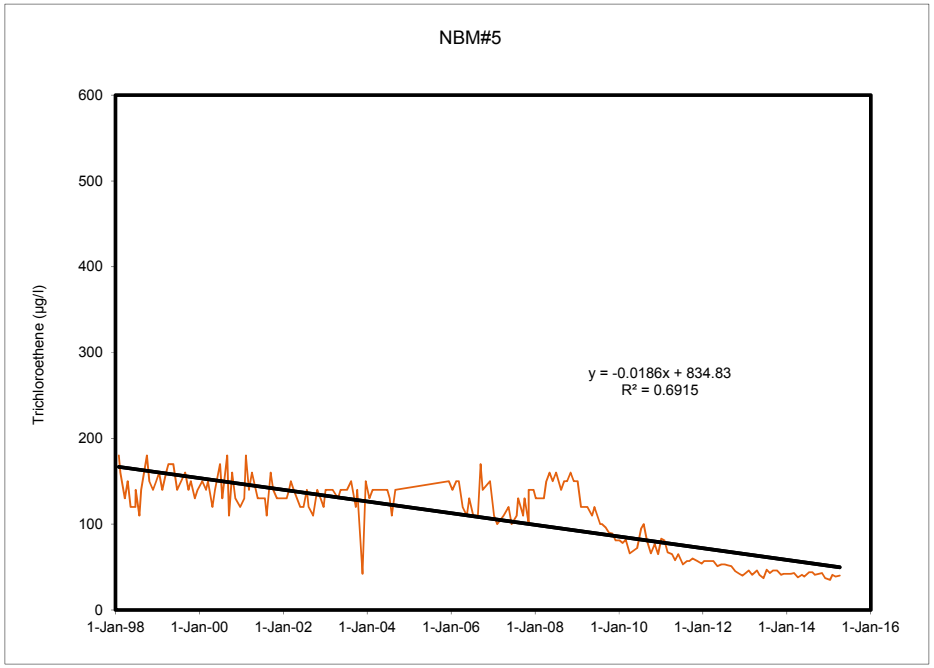
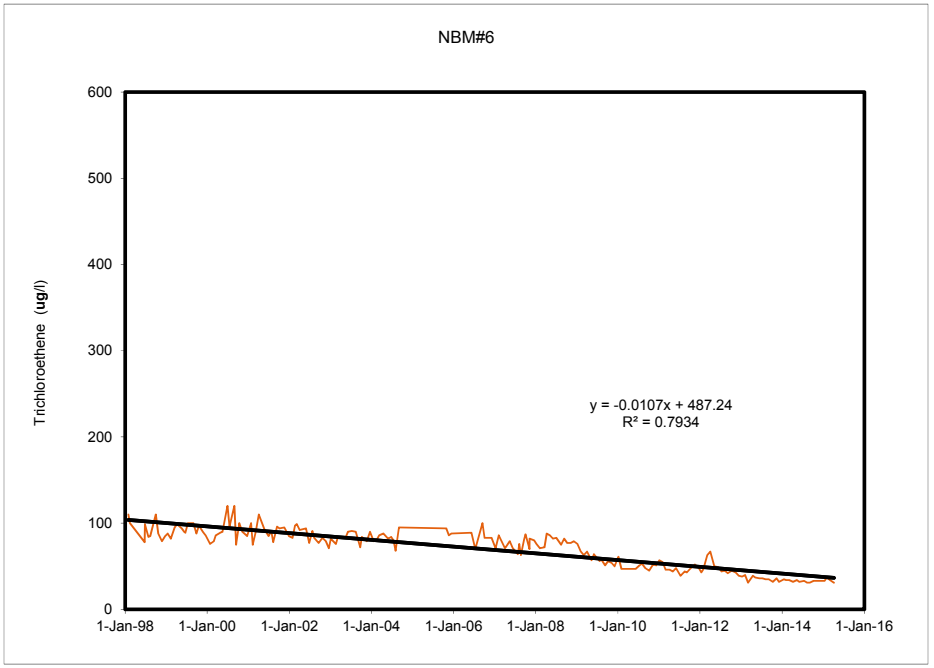
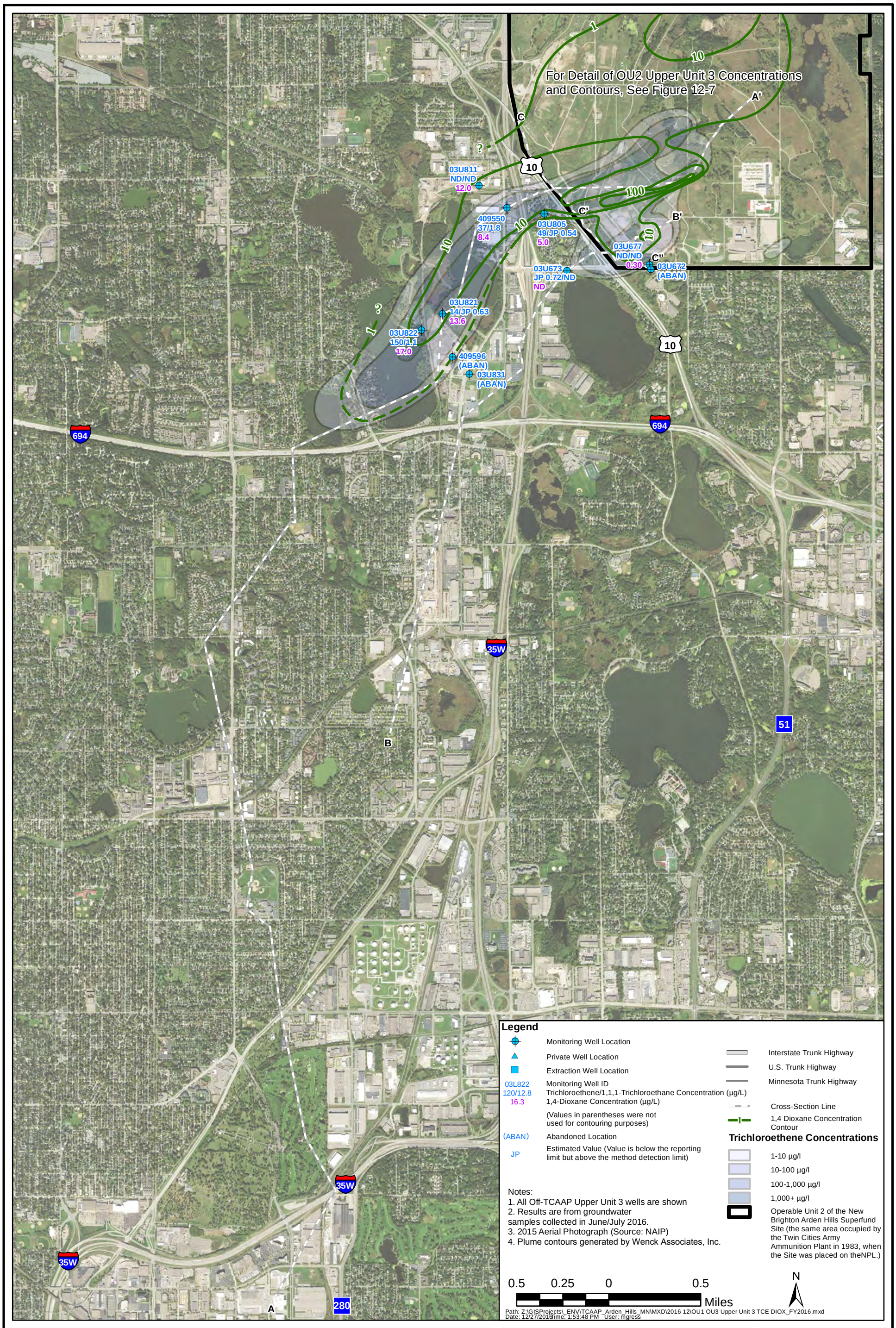


Figure 15 Continued
New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene

FY 2017 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, MN







ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 3, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016

PIKA ARCADIS a joint venture

FY 2016

Figure 16

For Detail of OU2 Lower Unit 3 Concentrations and Contours, See Figure 12-8

A'
C
C'
B'
C''
B
A

03L811 9.3/ND 16.0
03L809 150/2.3 18.6
03M843 (ND/ND) (15.6)
03L841 ND/ND 4.0
03L673 63/ND 2.4
03L848 3.3/ND 0.86
03M848 (110/ND) (0.81)
03L859 4.8/1.2 3.8
03L853
03L822 190/2.4 17.4
409557 79/4.9 13.5
409597 (ABAN)
03L854 ND/ND ND
03L861 (ABAN)
03L860
03L846 2.0/ND 16.8
03L832 1.1/ND 0.15
409556 ND/ND JP 0.064
249632 ND/ND ND
476387

694
10
35W
51
280

Legend

- Monitoring Well Location
- Private Well Location
- Extraction Well Location
- 03L822 — Monitoring Well ID
- 120/12.8 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 16.3 — 1,4-Dioxane Concentration (µg/L)
- (Values in parentheses were not used for contouring purposes)
- (ABAN) — Abandoned Location
- JP — Estimated Value (Value is below the reporting limit but above the method detection limit)

- Interstate Trunk Highway
- U.S. Trunk Highway
- Minnesota Trunk Highway
- Cross-Section Line
- 1 — 1,4 Dioxane Concentration Contour

Trichloroethene Concentrations

- 1-10 µg/l
- 10-100 µg/l
- 100-1,000 µg/l
- 1,000+ µg/l
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on theNPL.)

Notes:
1. All Off-TCAAP Lower Unit 3 wells are shown
2. Off-TCAAP Middle Unit 3 wells with data are shown with data in parenthesis, but were not used for contouring
3. Results are from groundwater samples collected in June/July 2016.
4. 2015 Aerial Photograph (Source: NAIP)
5. Plume contours generated by Wenck Associates, Inc.

0.5 0.25 0 0.5 Miles

N

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2016-12\OU1 OU3 Lower Unit 3 TCE DIOX_FY2016.mxd
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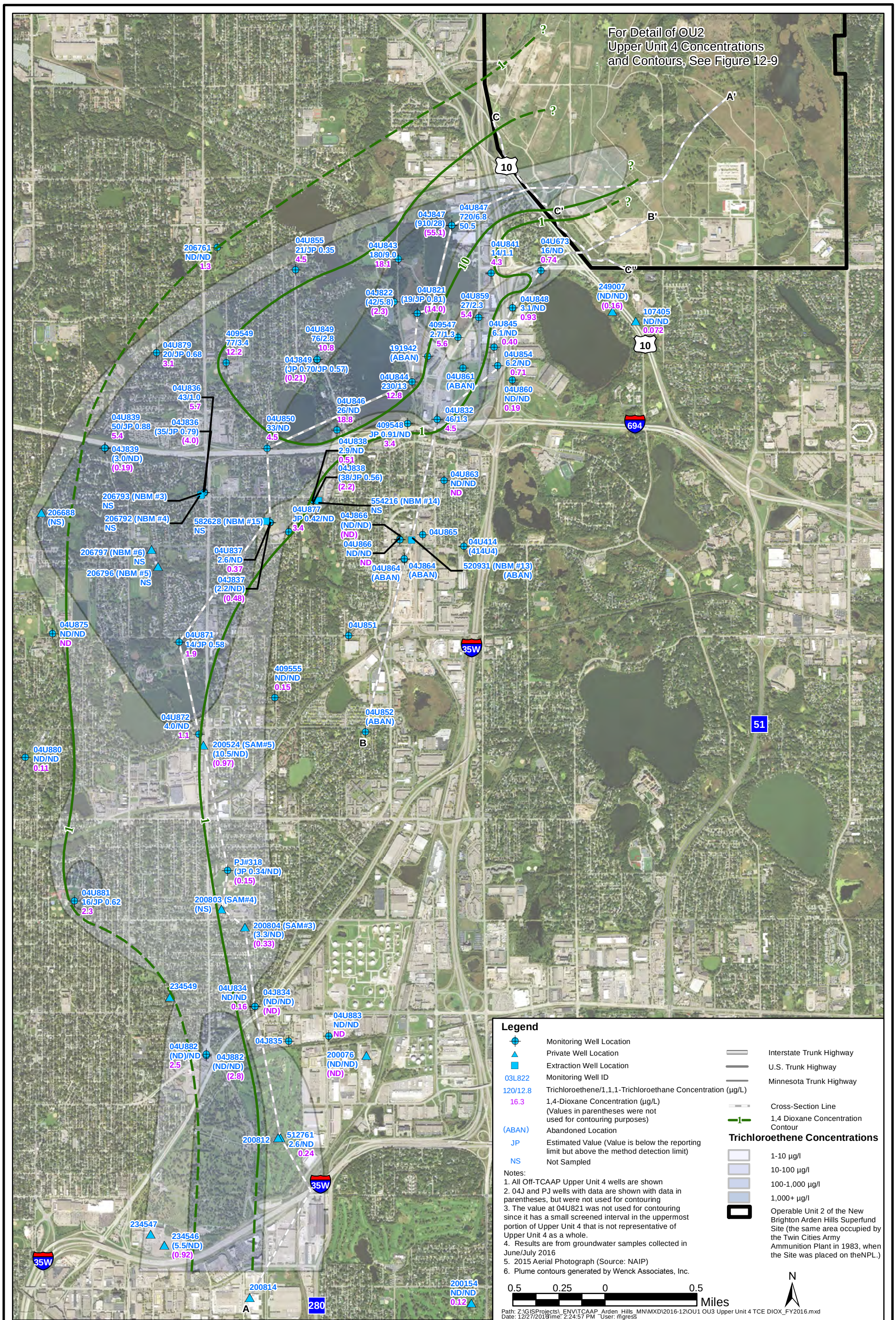
ANNUAL PERFORMANCE REPORT

OU1 & OU3, Lower Unit 3, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016

PIKA ARCADIS a joint venture

FY 2016

Figure 17



ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016

PIKA ARCADIS a joint venture

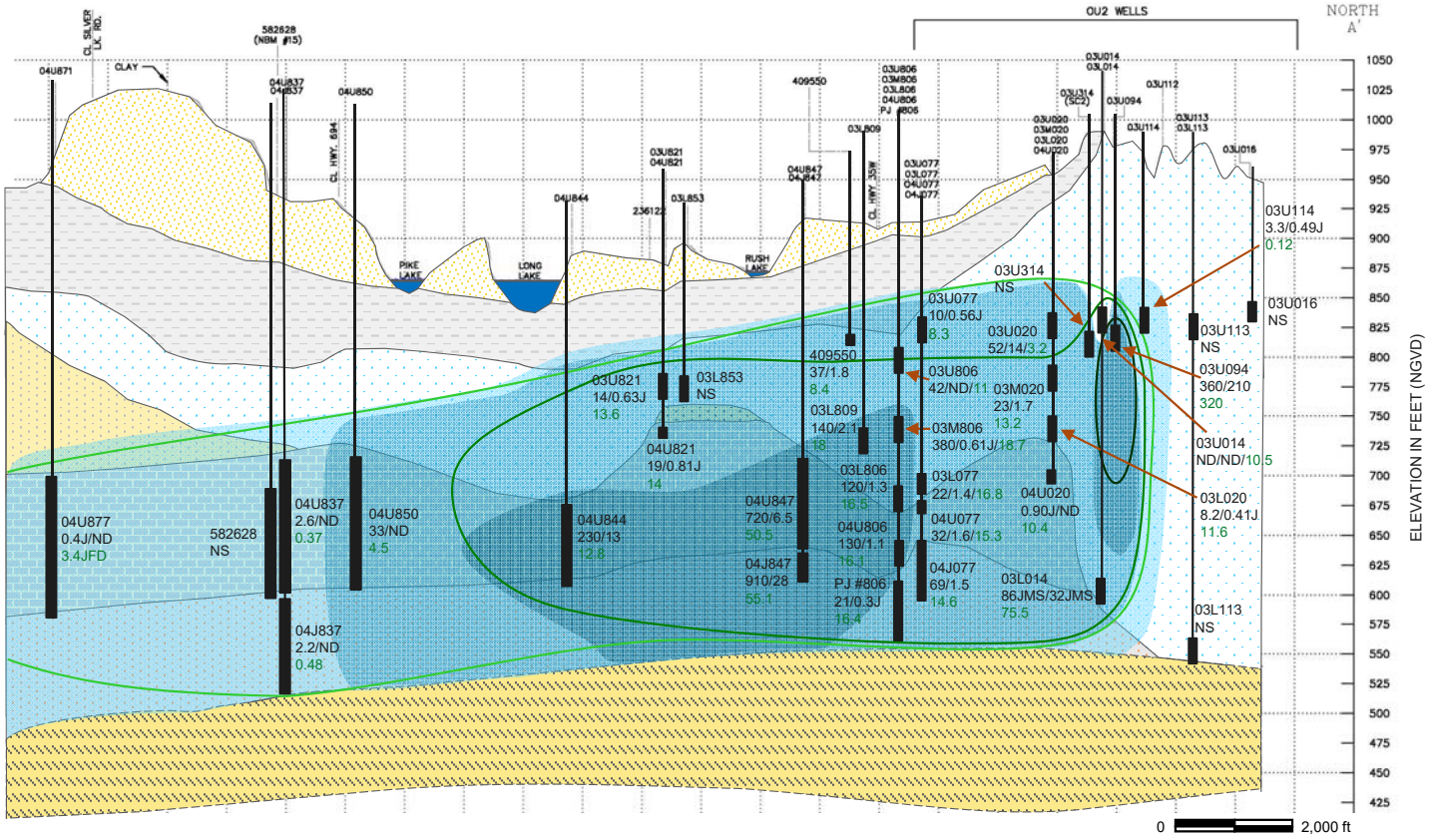
FY 2016

Figure 18

Figure 19
OU2-OU1 Trichloroethene
Cross Section A-A' (North Half)

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA ARCADIS a joint venture



Legend

04J077	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
69/1.5	Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)
14.6	1,4-Dioxane concentration* (µg/L)
J	Reported value is between the method detection limit and reporting limit
JMS	The percent recovery for the matrix spike was below the QC limits. The sample result could be biased low.

Geologic Contact (inferred where dashed)
Screened Interval

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

1,4-Dioxane Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

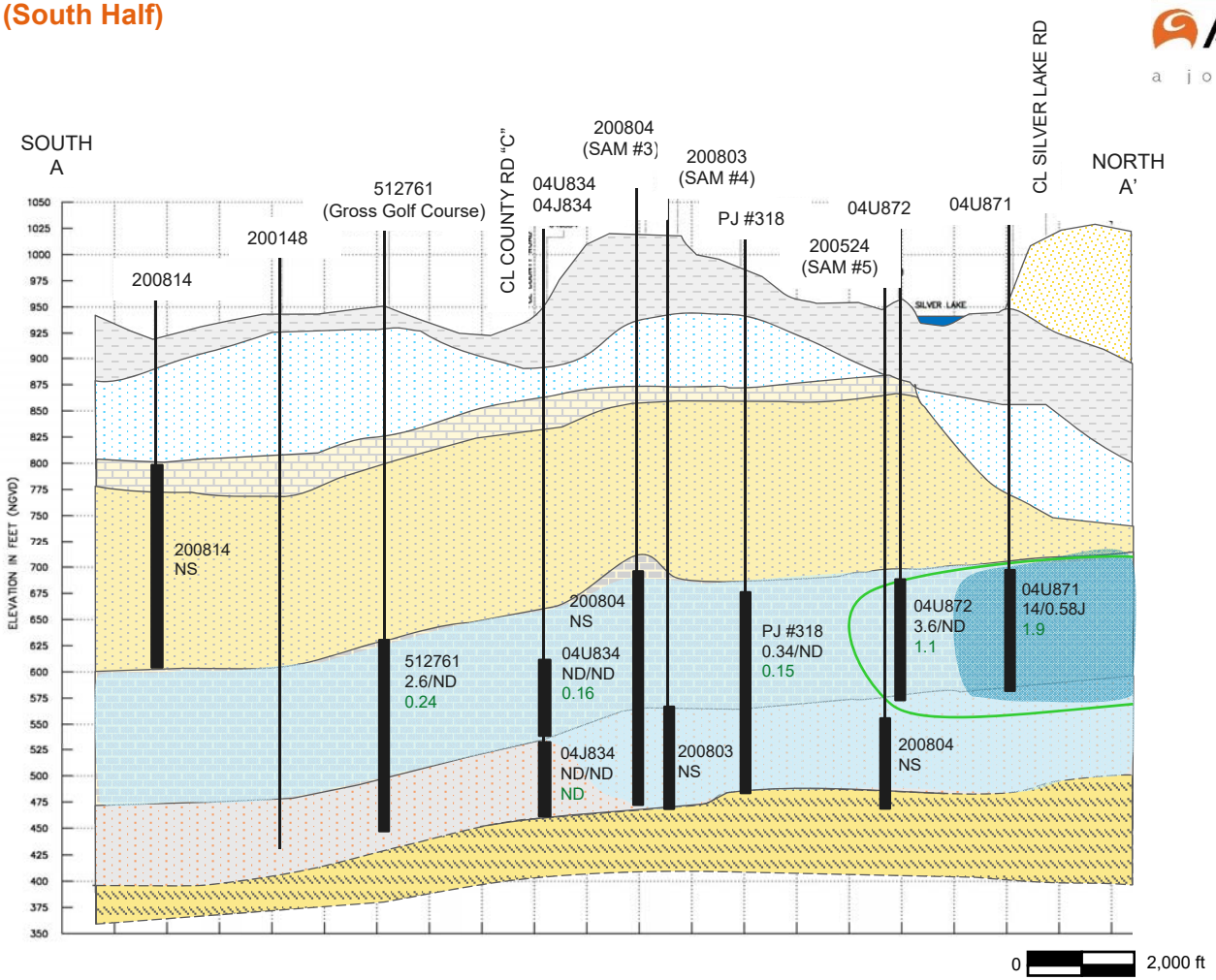
- Unit 1
- Unit 2
- Unit 3
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 sampling event

Figure 20
OU2-OU1 Trichloroethene
Cross Section A-A' (South Half)

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



Legend

512761	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
J	Reported value is between the method detection limit and reporting limit

2.6/ND — Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)

0.24 — 1,4-Dioxane concentration* (µg/L)

Geologic Contact (inferred where dashed)

Screened Interval

Trichloroethene Concentration* (µg/L)

- 1-10
- 10-100

1,4-Dioxane Concentration* (µg/L)

- 1-10

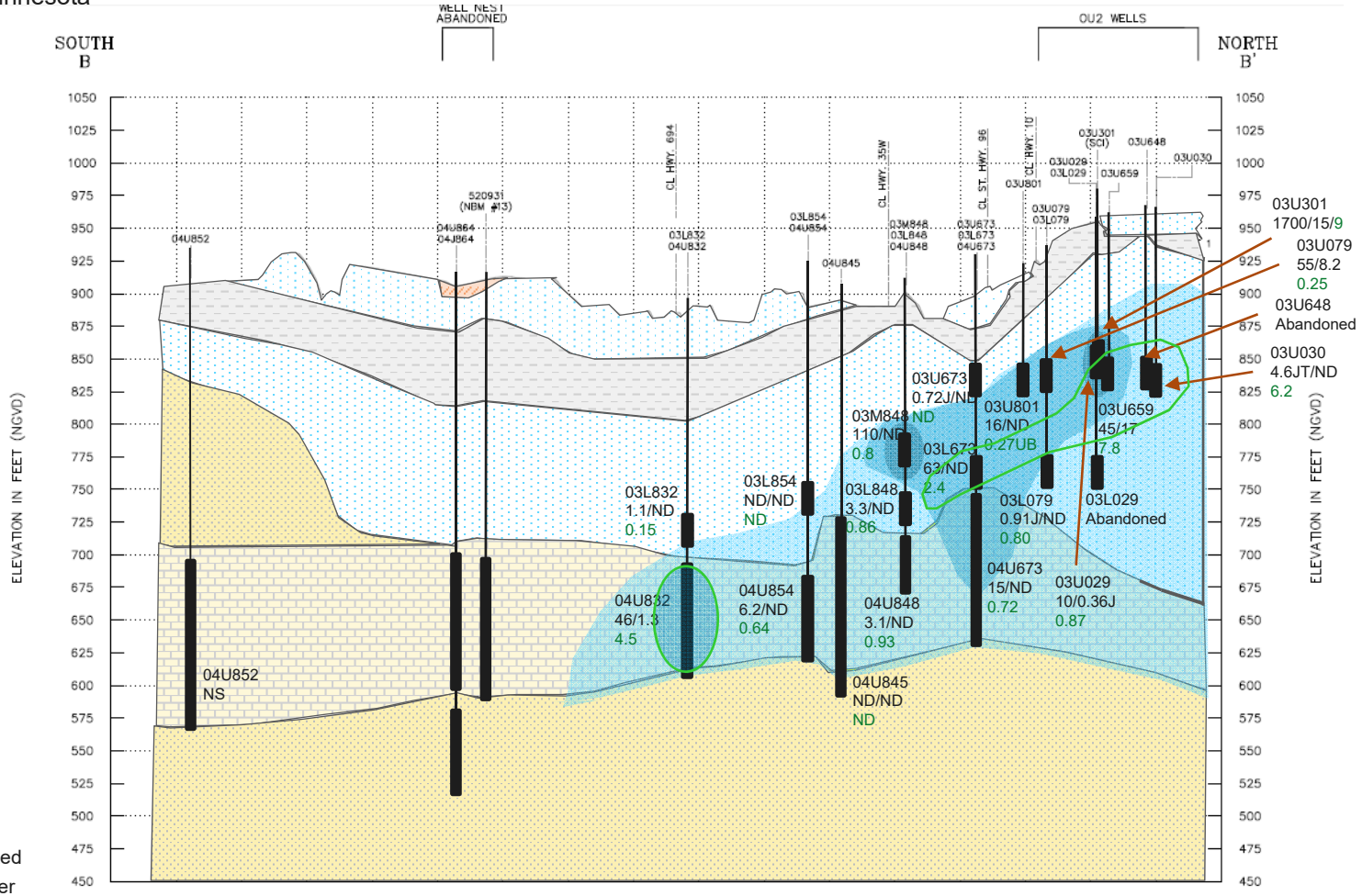
- Unit 1
- Unit 2
- Unit 3
- Platteville Limestone
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 sampling event

Figure 21
OU2-OU3 Trichloroethene
Cross Section B-B'

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



Legend

03U079	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
55/8.2	Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)
0.25	1,4-Dioxane concentration* (µg/L)
—	Geologic Contact (inferred where dashed)
▮	Screened Interval

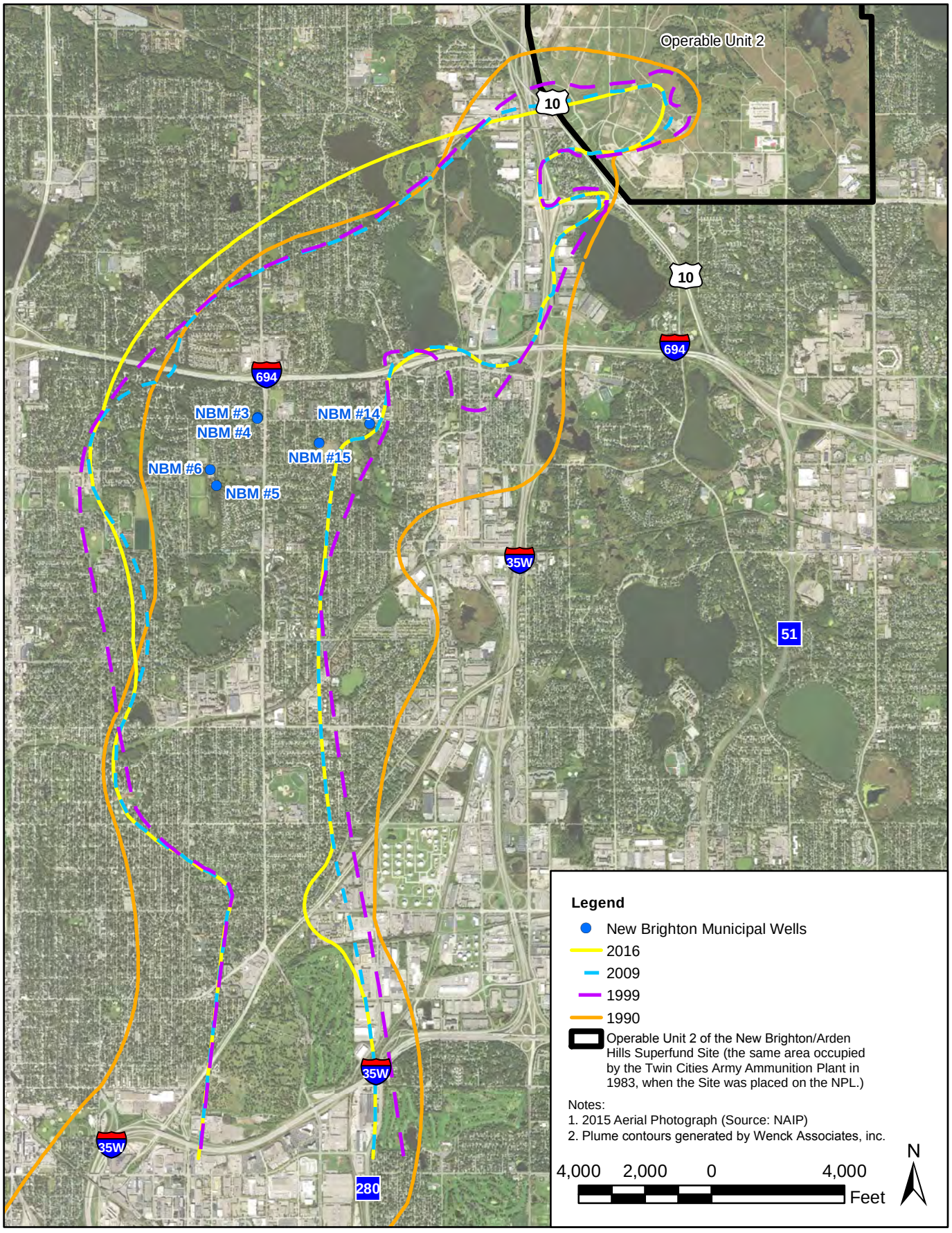
J	Reported value is between the method detection limit and reporting limit
JT	The laboratory sample receipt temperature was above the QC limit. The sample result could be biased low.

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100
- 100-1000

1,4-Dioxane Concentration* (µg/L)
- 1-10

- Fill
- Unit 1
- Unit 2
- Unit 3
- Platteville Limestone
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 sampling event



ANNUAL PERFORMANCE REPORT

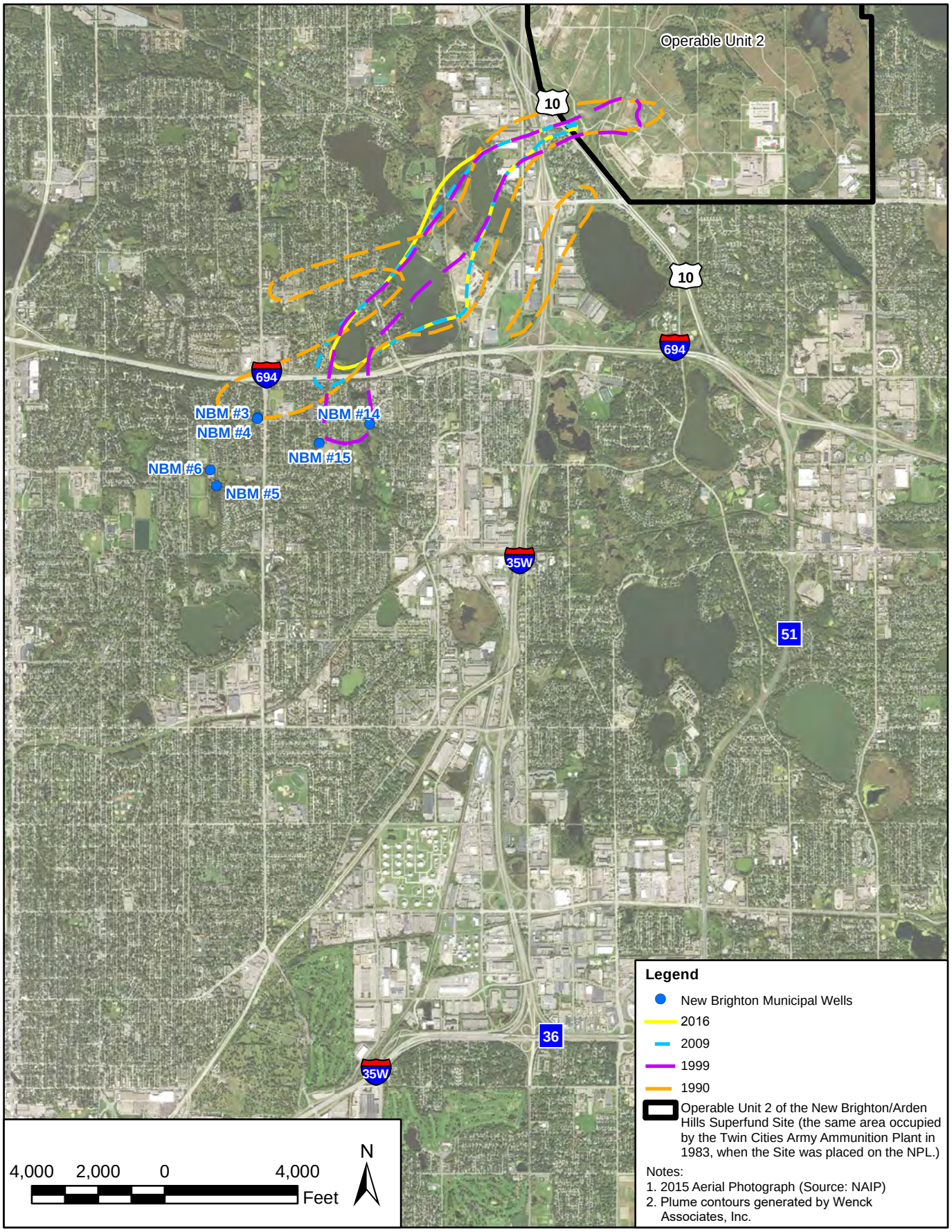
Upper Unit 4,
1 µg/L Trichloroethene Isoconcentration Map

PIKA
ARCADIS
a joint venture

FY 2016

Figure 22

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2016-12\Upper Unit 4 1ug TCE_FY2016.mxd
Date: 12/27/2016 Time: 10:29:40 AM User: mgress



ANNUAL PERFORMANCE REPORT

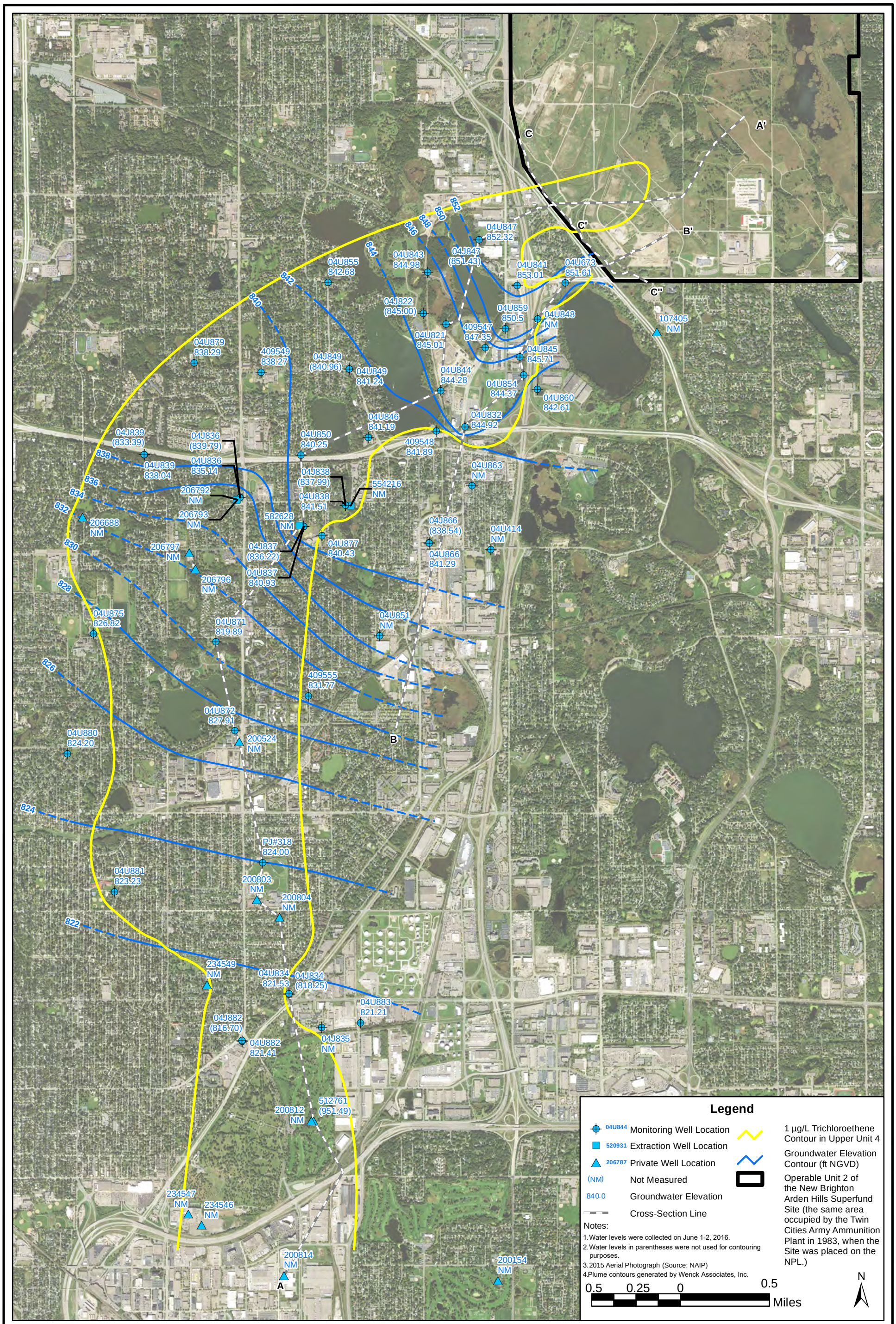
Upper Unit 4,
100 µg/L Trichloroethene Isoconcentration Map

PIKA
ARCADIS
a joint venture

FY 2016

Figure 23

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2016-12\Upper Unit 4 100ug TCE_FY2016.mxd
Date: 12/27/2016 Time: 10:31:23 AM User: mgress



Legend

- 04U844 Monitoring Well Location
- 520931 Extraction Well Location
- 206787 Private Well Location
- (NM) Not Measured
- 840.0 Groundwater Elevation
- Cross-Section Line
- 1 µg/L Trichloroethene Contour in Upper Unit 4
- Groundwater Elevation Contour (ft NGVD)
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)

Notes:

1. Water levels were collected on June 1-2, 2016.
2. Water levels in parentheses were not used for contouring purposes.
3. 2015 Aerial Photograph (Source: NAIP)
4. Plume contours generated by Wenck Associates, Inc.

0.5 0.25 0 0.5 Miles

N

ANNUAL PERFORMANCE REPORT

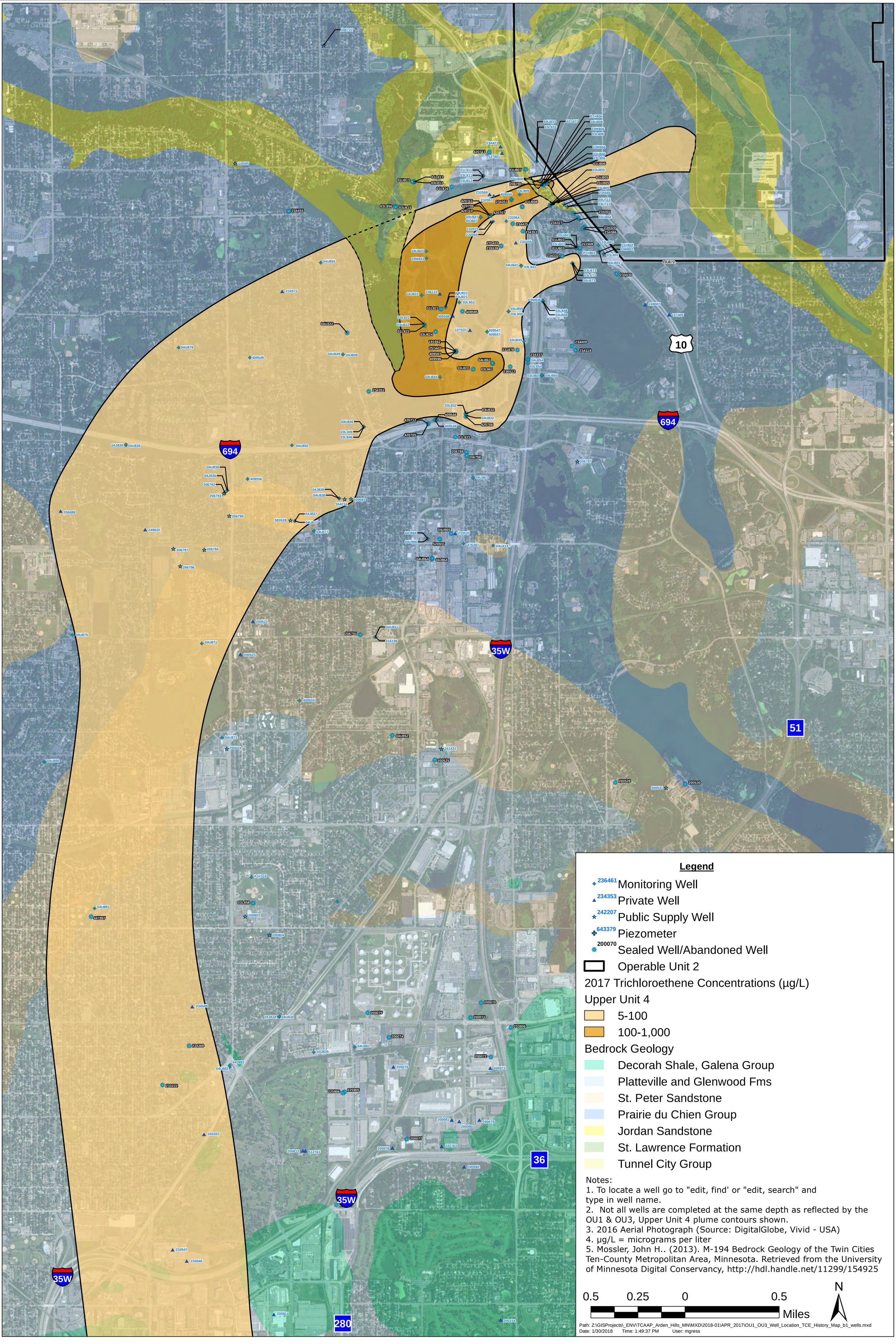
OU1 & OU3, Upper Unit 4, Potentiometric Map, June 2016

PIKA ARCADIS a joint venture

FY 2016

Figure 24

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2016-12\OU1 OU3 Upper Unit 4 Potentiometric_FY2016.mxd
Date: 12/28/2016 Time: 8:17:59 AM User: mgress



ANNUAL PERFORMANCE REPORT

OU1 & OU3 Well Location

PIKA

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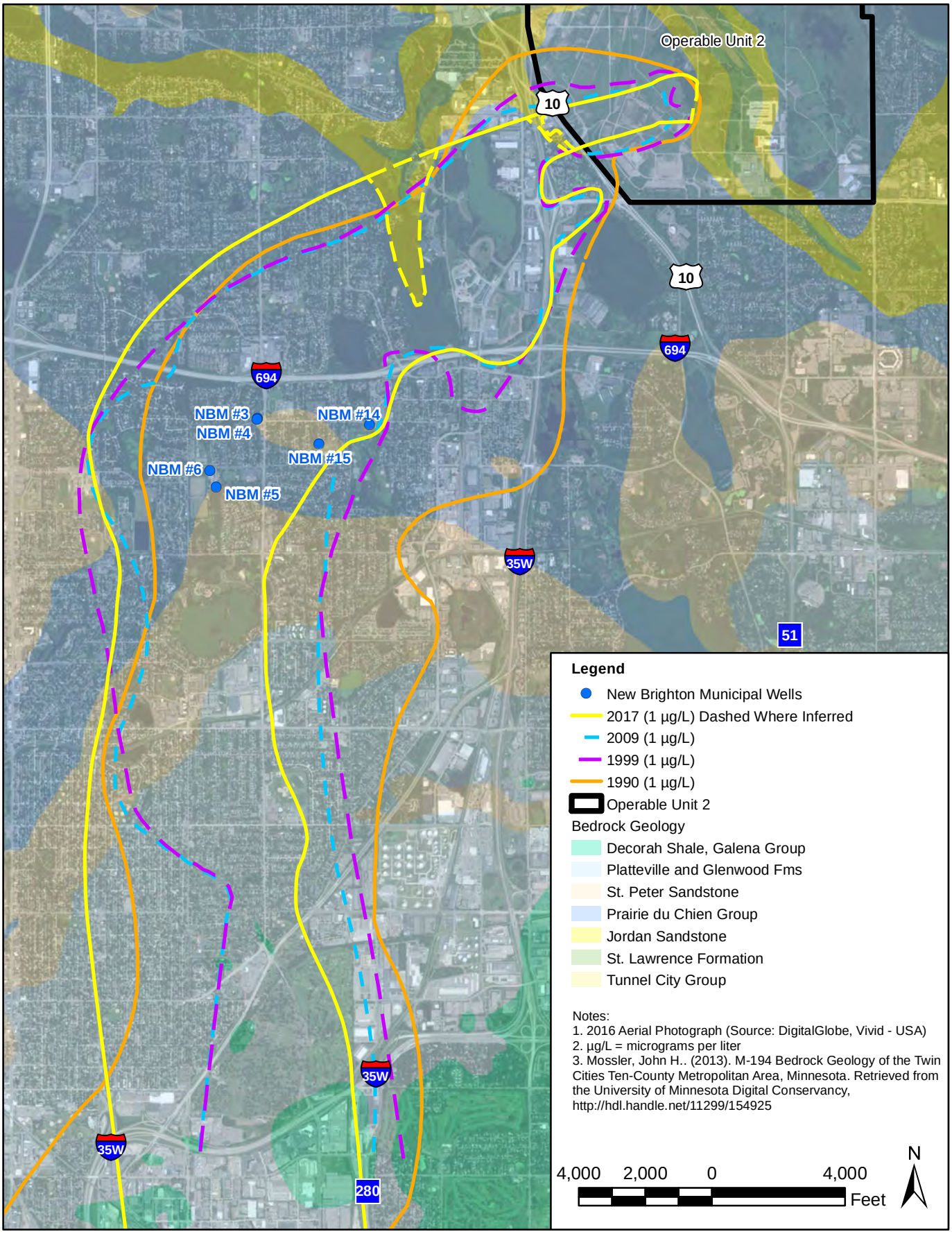
a joint venture

FY 2017

Figure 25



ANNUAL PERFORMANCE REPORT
Upper Unit 4,
1 µg/L Trichloroethene Isoconcentration Map

PIKA
ARCADIS
a joint venture

FY 2017

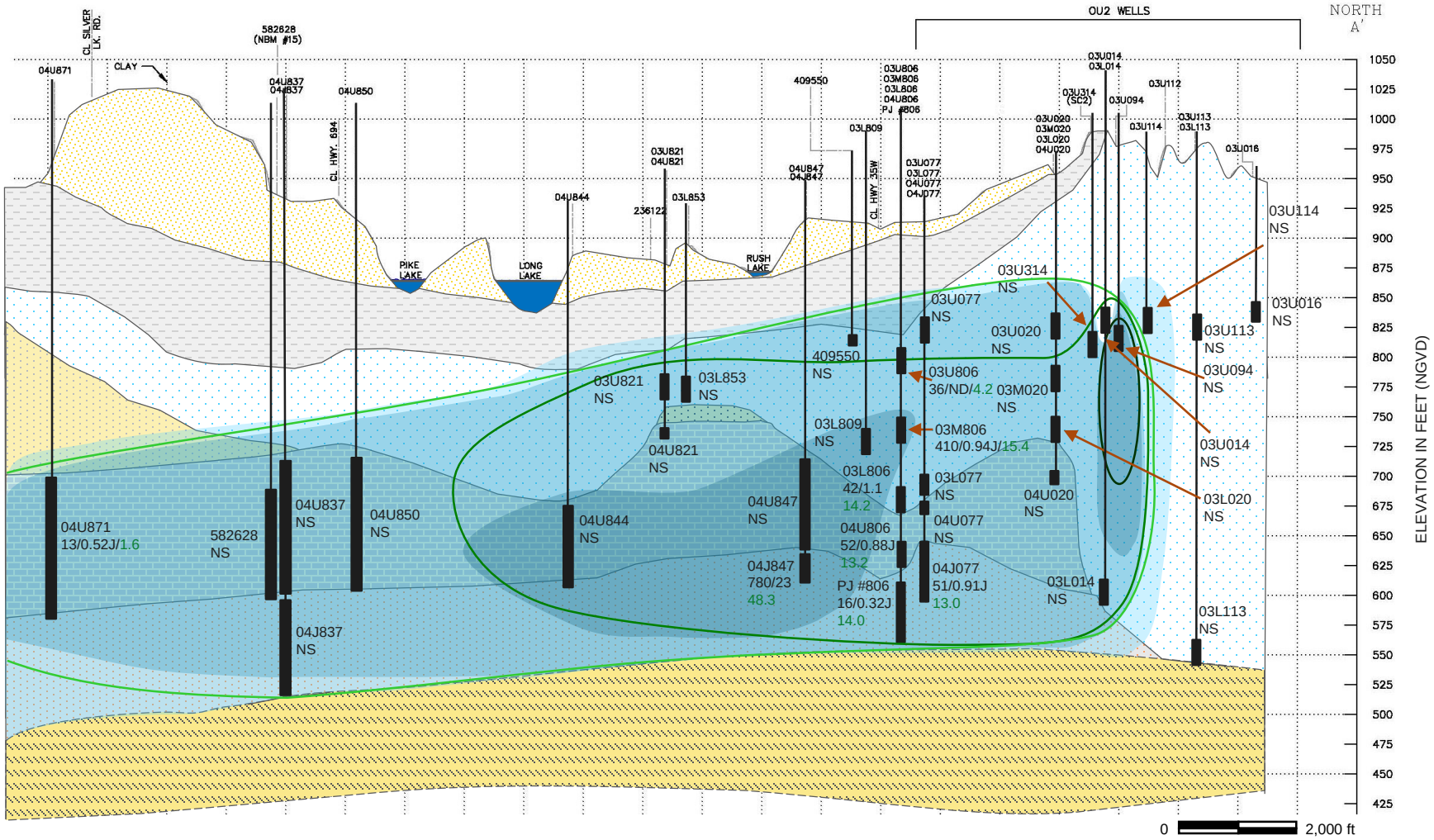
Figure 26

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Upper Unit 4 1ug TCE_FY2017.mxd
Date: 5/11/2018 Time: 10:48:03 AM User: mgress

Figure 27
OU2-OU1 Trichloroethene
Cross Section A-A' (North Half)

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



Legend

04J077	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
69/1.5	Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)
14.6	1,4-Dioxane concentration* (µg/L)
J	Reported value is between the method detection limit and reporting limit

Geologic Contact (inferred where dashed)

Screened Interval

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

1,4-Dioxane Concentration* (µg/L)
- 1-10
- 10-100
- 100-1,000

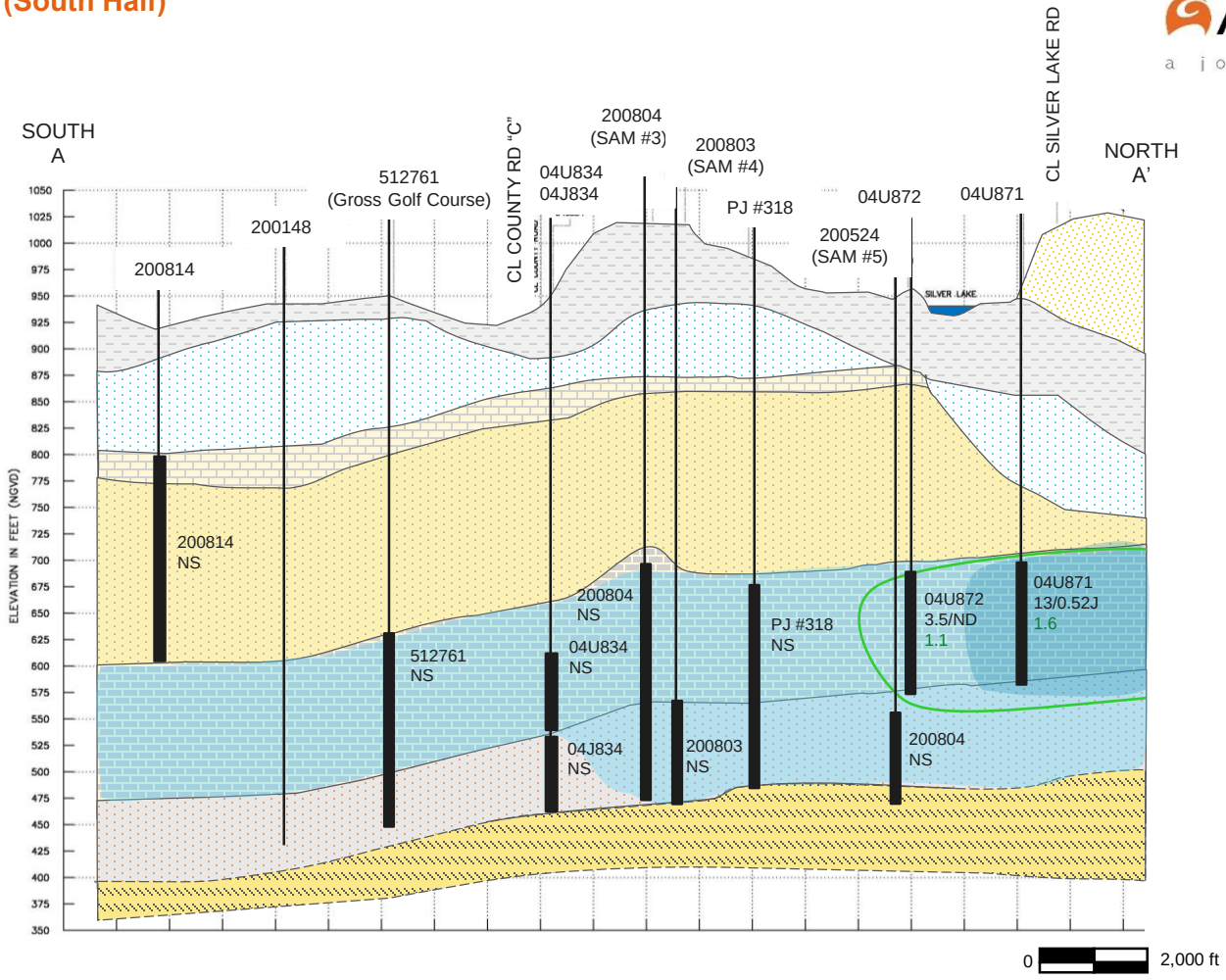
- Unit 1
- Unit 2
- Unit 3
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 and FY 2017 sampling events

Figure 28
OU2-OU1 Trichloroethene
Cross Section A-A' (South Half)

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



Legend

512761	Well ID
NS	Not Sampled
ND	Analyte Not Detected
µg/L	Micrograms per Liter
NGVD	National Geodetic Vertical Datum
J	Reported value is between the method detection limit and reporting limit

2.6/ND — Trichloroethene/1,1,1-Trichloroethane Concentration* (µg/L)

0.24 — 1,4-Dioxane concentration* (µg/L)

— Geologic Contact (inferred where dashed)

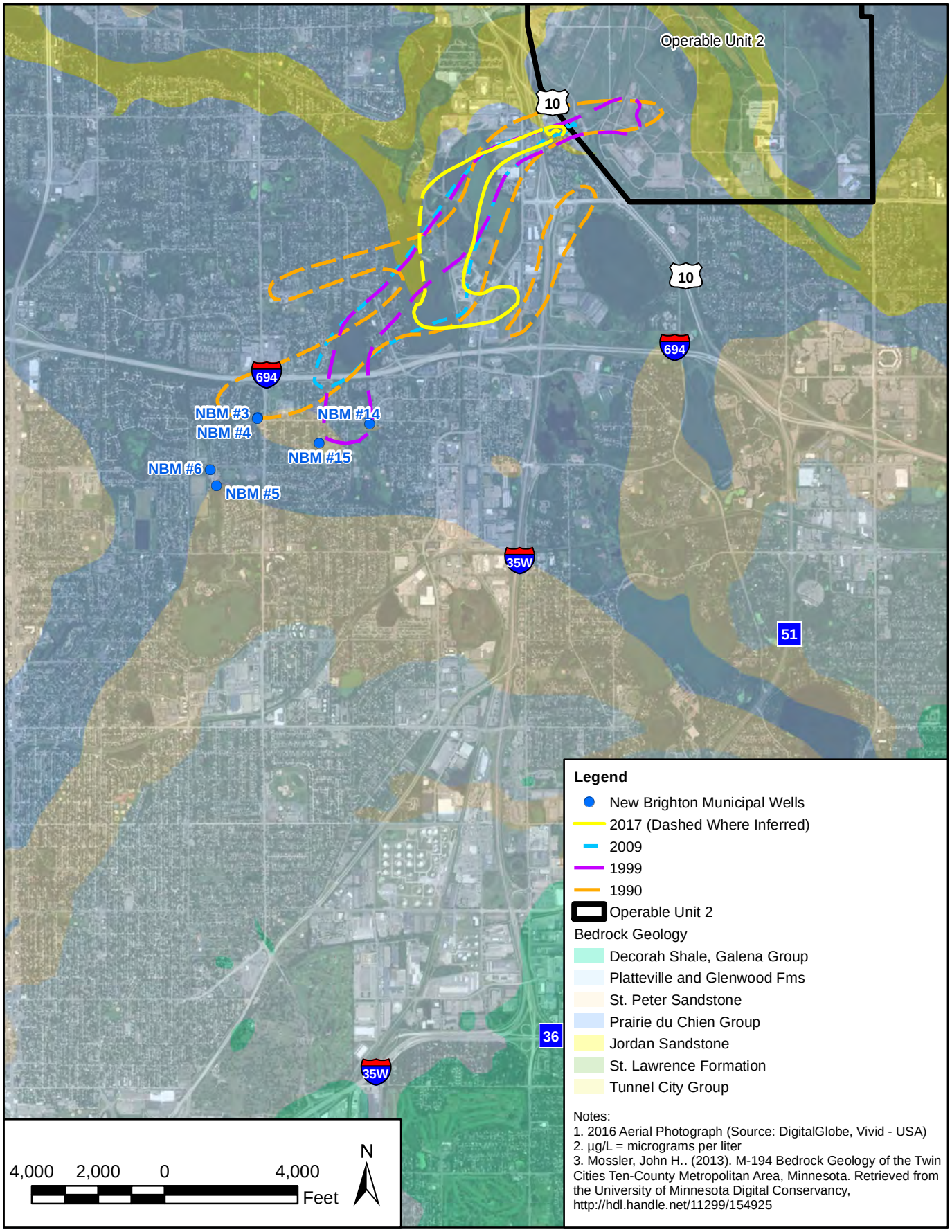
▌ Screened Interval

Trichloroethene Concentration* (µg/L)
- 1-10
- 10-100

1,4-Dioxane Concentration* (µg/L)
- 1-10

- Unit 1
- Unit 2
- Unit 3
- Platteville Limestone
- St. Peter Sandstone
- Upper Unit 4
- Lower Unit 4
- St. Lawrence Formation

*Based on analytical results for samples collected in the summer FY 2016 and FY 2017 sampling events



ANNUAL PERFORMANCE REPORT

Upper Unit 4,

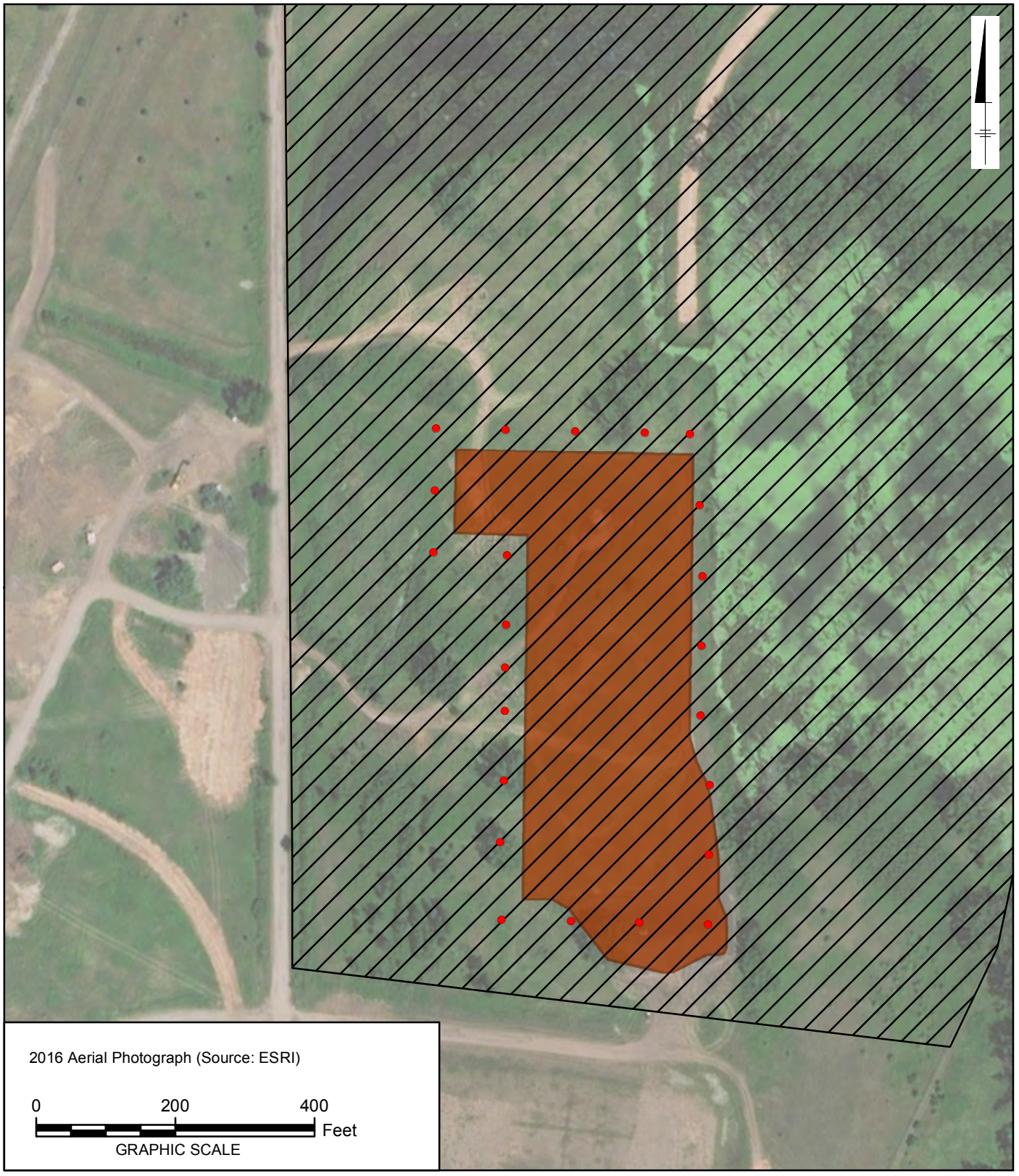
100 µg/L Trichloroethene Isoconcentration Map

PIKA ARCADIS a joint venture

FY 2017

Figure 29

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Upper Unit 4 100ug TCE_FY2017.mxd
Date: 1/30/2018 Time: 11:27:38 AM User: mgress



LEGEND:

- Location of Soil Cover
- 4-Foot Soil Disturbance Restriction
- Caution Sign Locations

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

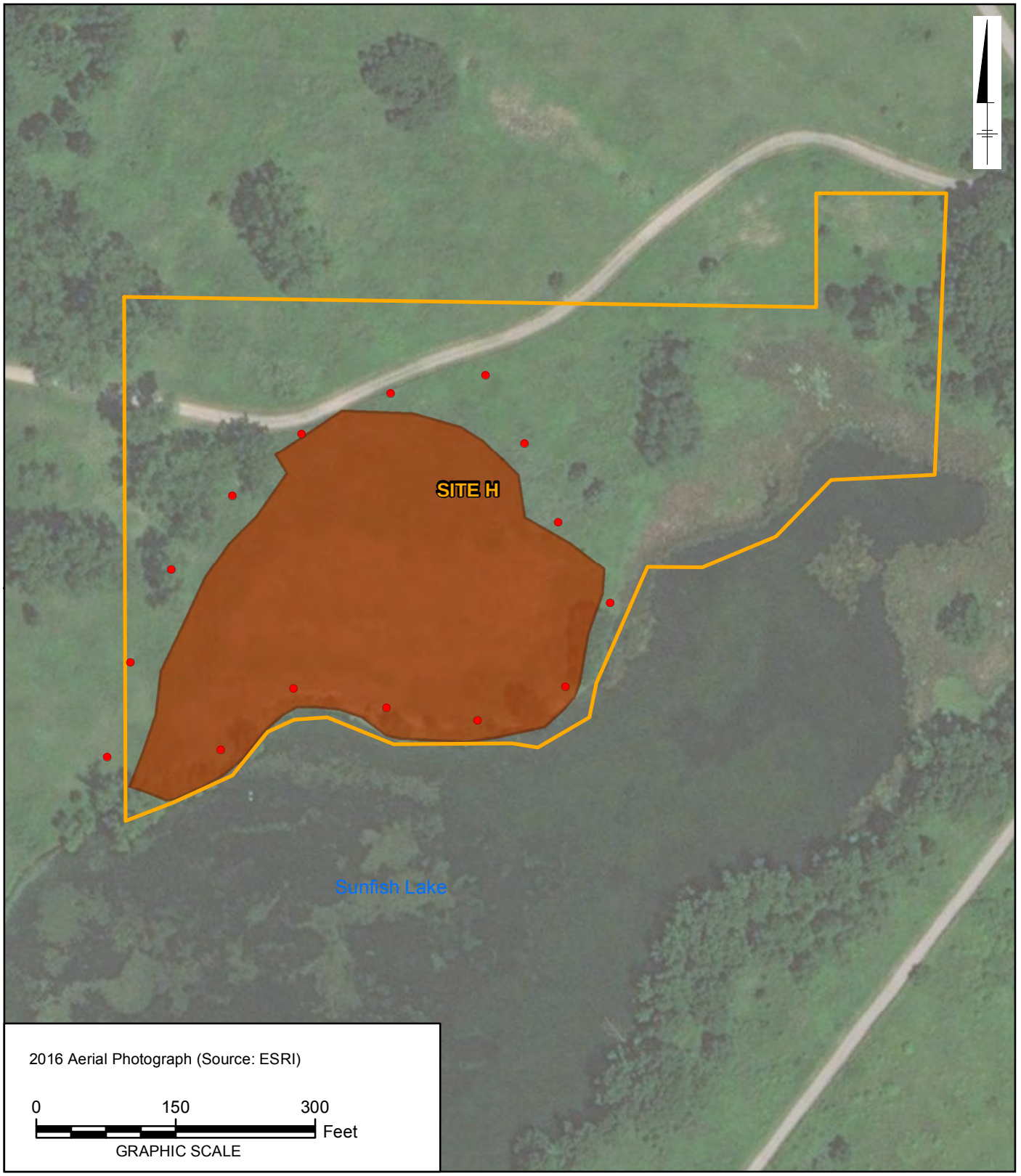
OPERABLE UNIT 2 LUCRD

Site C Soil Cover Location

PIKA
ARCADIS
a joint venture

FIGURE
30

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MNMXD\2017-11\LUCRD_2017\Site_C_Soil_Cover_Locations_20171129.mxd 3/2/2018 2:02:04 PM



2016 Aerial Photograph (Source: ESRI)

0 150 300 Feet

GRAPHIC SCALE

LEGEND:

- Location of Soil Cover
- Caution Sign Locations
- General location of a soil area with LUCs (see note below)

(Note: The area boundaries are only intended to illustrate the general locations and should not be interpreted as representing areas of contamination or areas needing LUCs.)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

OPERABLE UNIT 2 LUCRD

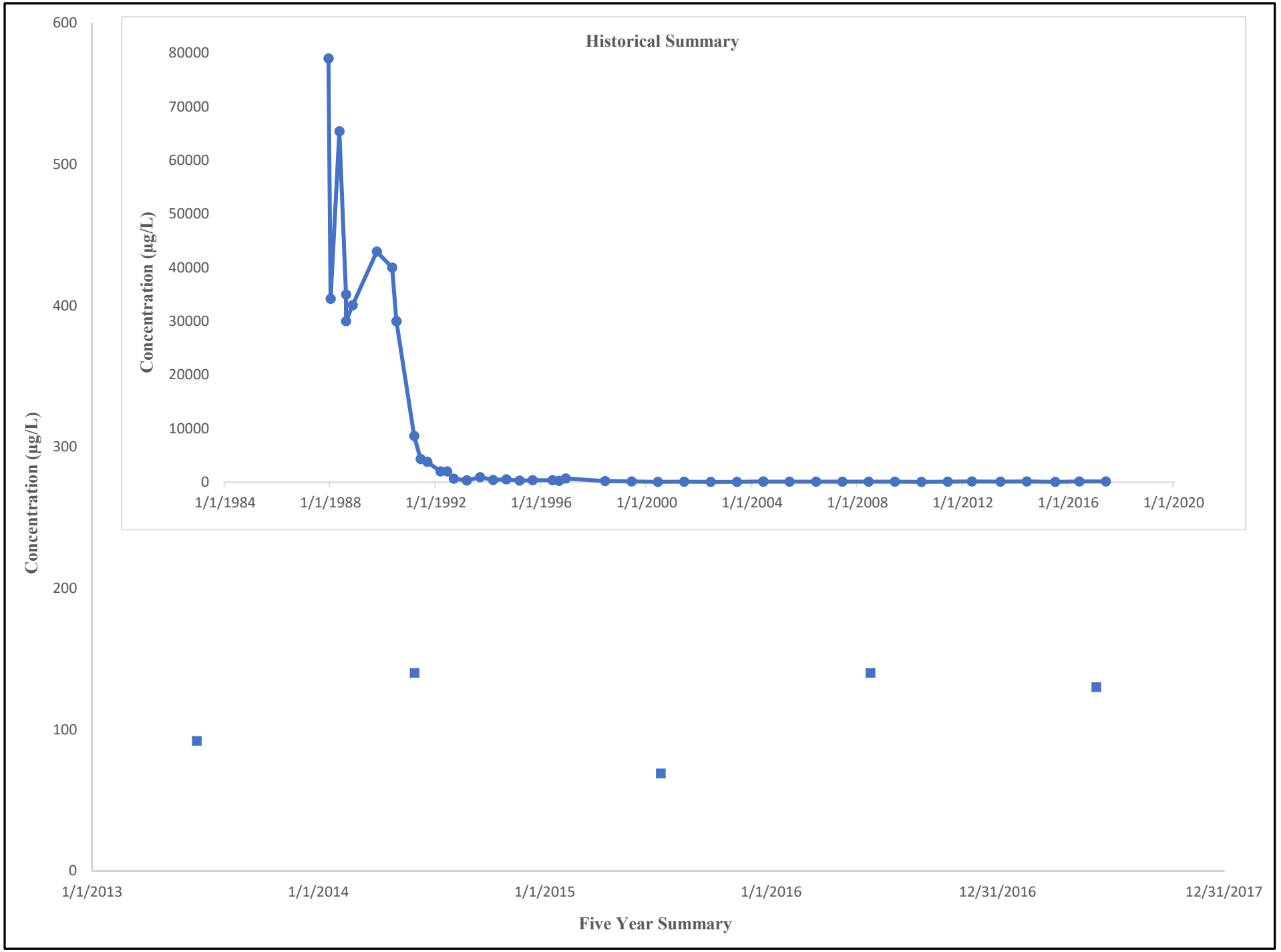
Site H Soil Cover Location

PIKA ARCADIS a joint venture

FIGURE 31

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2017-11\LUCRD_2017\Site_H_Soil_Cover_Locations_20171129.mxd 11/29/2017 1:49:11 PM

Figure 32
Site D, Well 03U093, Trichloroethene Water Quality Trend
Twin Cities Army Ammunition Plant



2016 Aerial Photograph (Source: ESRI)

0 80 160 Feet

GRAPHIC SCALE

LEGEND:

- Location of Soil Cover
- Caution Sign Locations
- General location of a soil area with LUCs (see note below)

(Note: The area boundaries are only intended to illustrate the general locations and should not be interpreted as representing areas of contamination or areas needing LUCs.)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

OPERABLE UNIT 2 LUCRD

Site D Soil Cover Location

PIKA
ARCADIS
a joint venture

FIGURE
33

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2017-11\LUCRD_2017\Site_D_Soil_Cover_Locations_20171129.mxd 11/29/2017 1:21:14 PM

2016 Aerial Photograph (Source: ESRI)

0 100 200 Feet

GRAPHIC SCALE

LEGEND:

- Location of Soil Cover
- Caution Sign Locations
- General location of a soil area with LUCs (see note below)

(Note: The area boundaries are only intended to illustrate the general locations and should not be interpreted as representing areas of contamination or areas needing LUCs.)

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

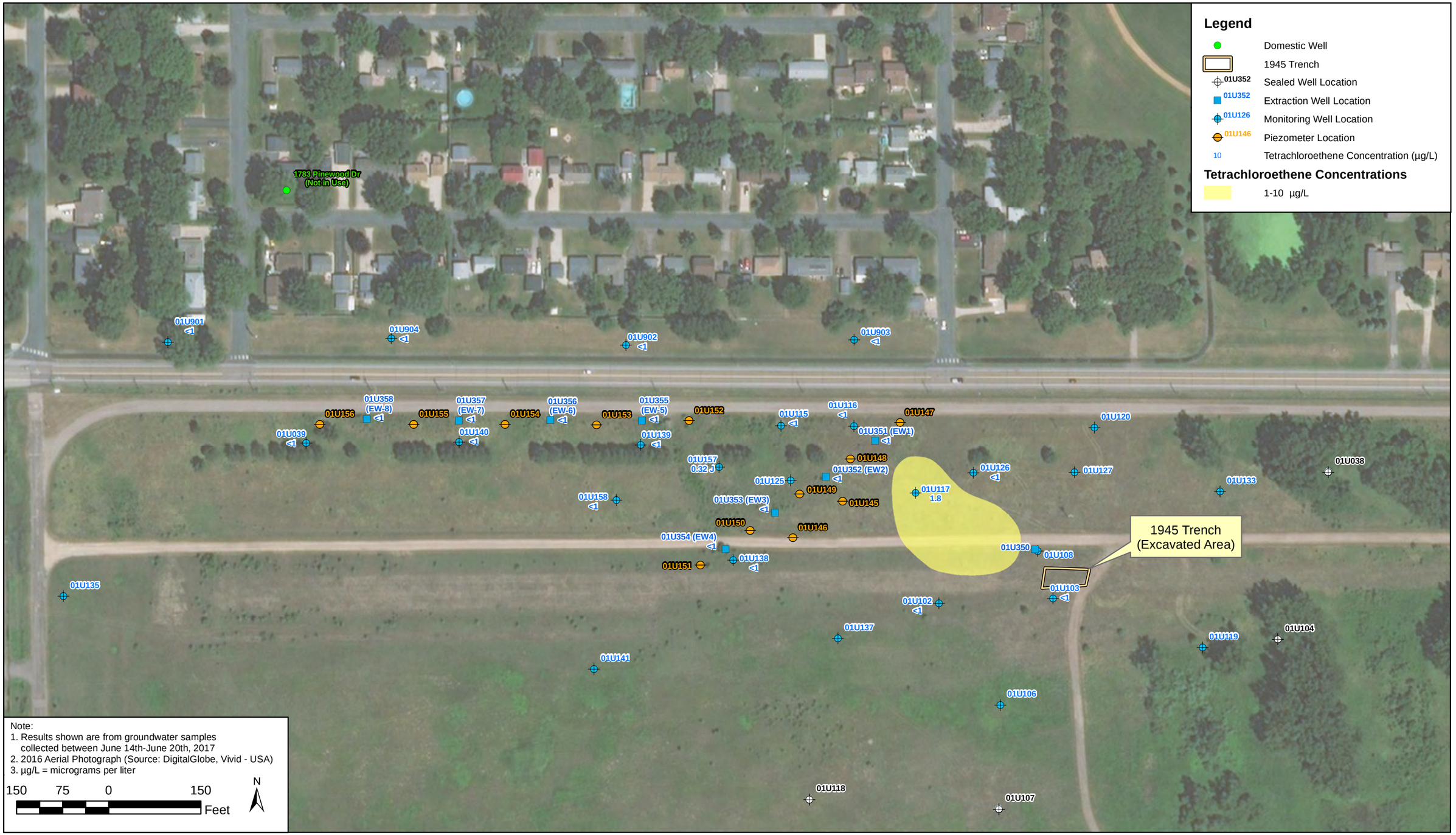
OPERABLE UNIT 2 LUCRD

Site G Soil Cover Location

PIKA ARCADIS a joint venture

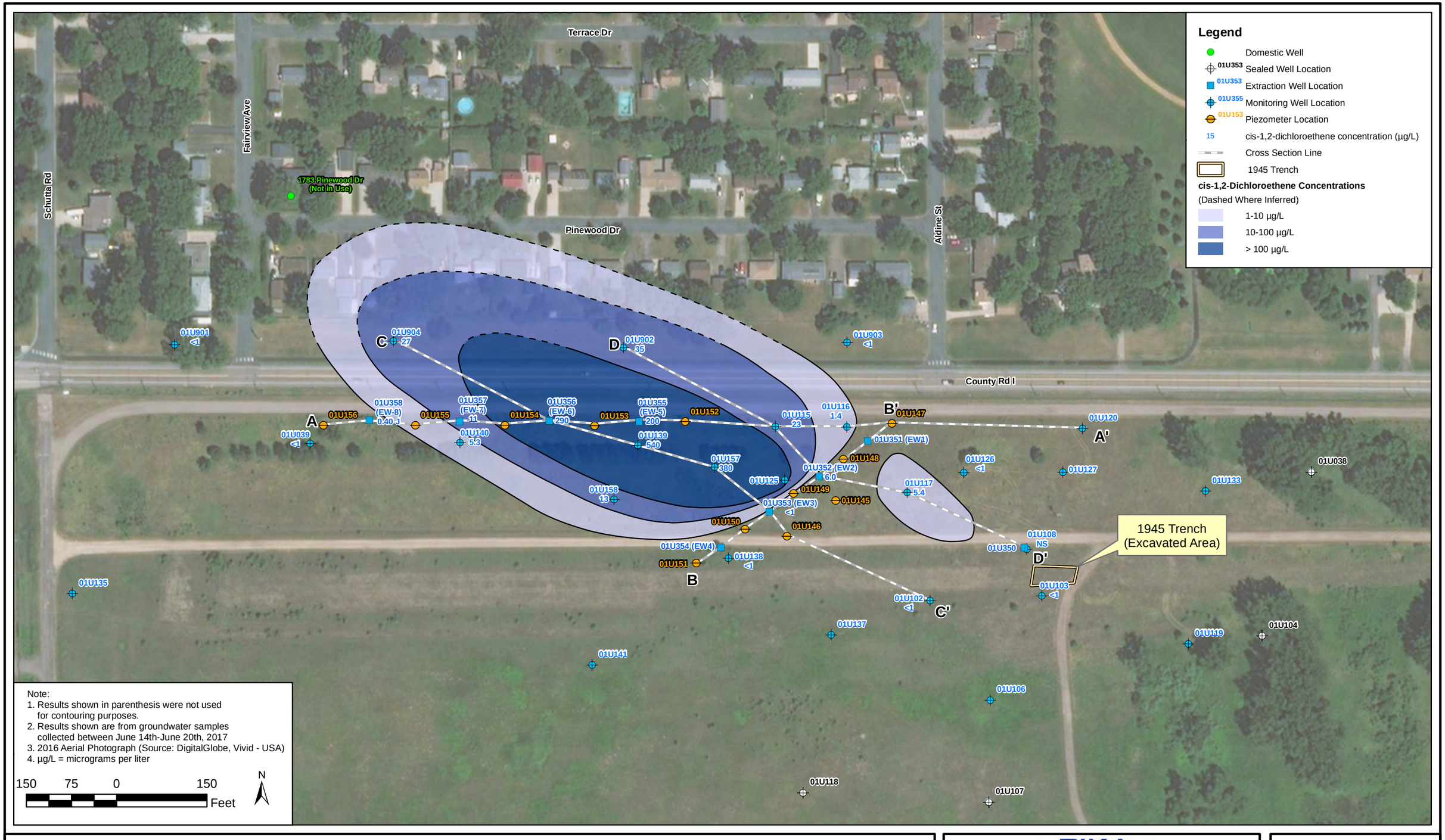
FIGURE 34

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MNMXD\2017-11\LUCRD_2017\Site_G_Soil_Cover_Locations_20171129.mxd 11/29/2017 1:44:21 PM



ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
Site A, Unit 1, Tetrachloroethene Isoconcentration Map, Summer 2017		Figure 35

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A Tetra Plume Map_FY2017.mxd
Date: 1/30/2018 Time: 2:21:55 PM User: mgress



ANNUAL PERFORMANCE REPORT

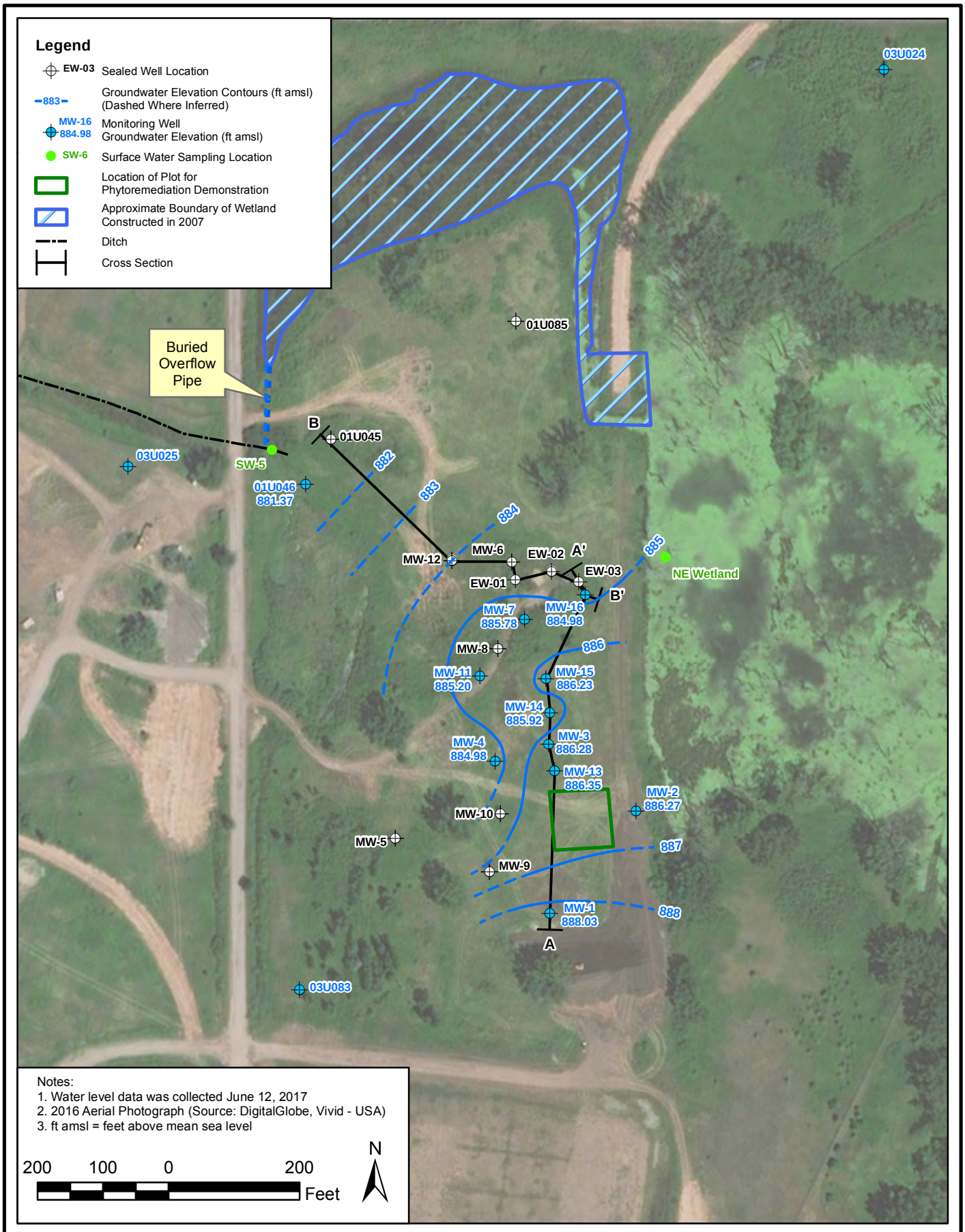
Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 36

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A cis-1,2 DCE Plume Map_FY2017.mxd
Date: 2/5/2018 Time: 12:01:20 PM User: mgress



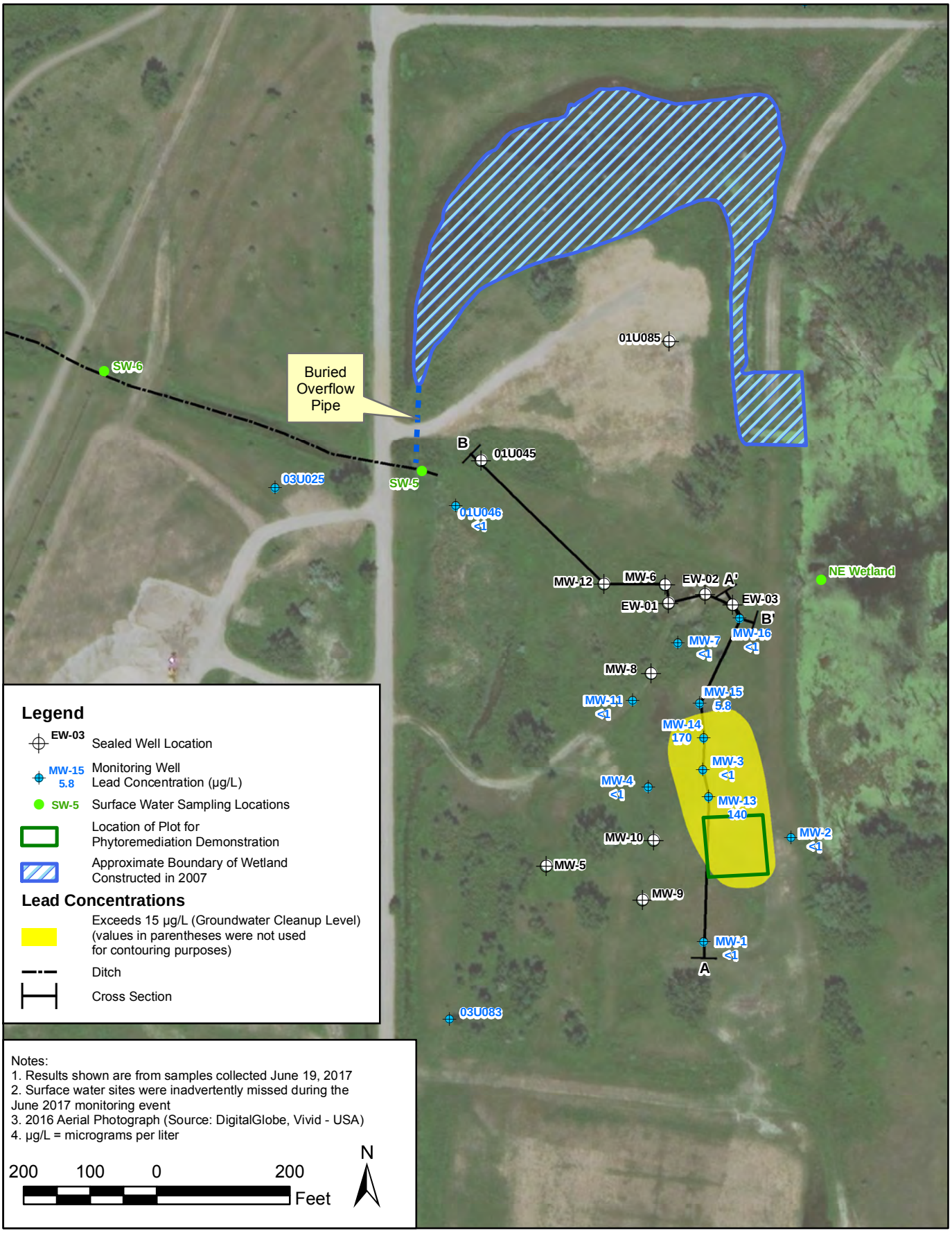
ANNUAL PERFORMANCE REPORT
Site C, Unit 1, Potentiometric Map, June 2017

PIKA ARCADIS a joint venture

FY 2017

Figure 37

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site C Potentiometric Map_FY2017.mxd
Date: 1/30/2018 Time: 2:54:55 PM User: mgress



ANNUAL PERFORMANCE REPORT

Site C, Unit 1, Lead Results, Summer 2017

PIKA ARCADIS a joint venture

FY 2017

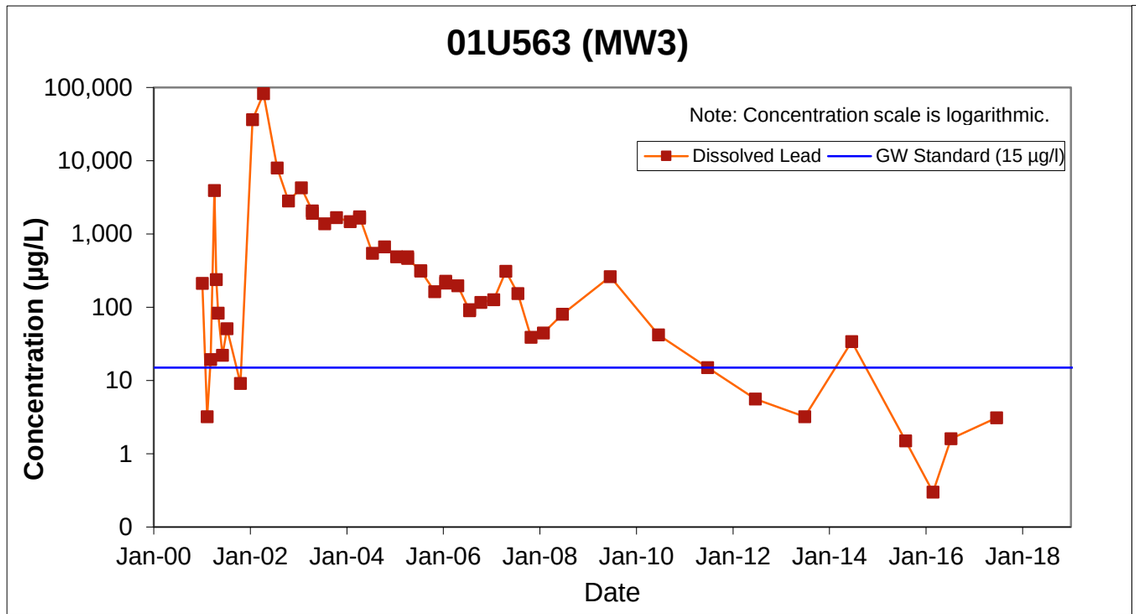
Figure 38

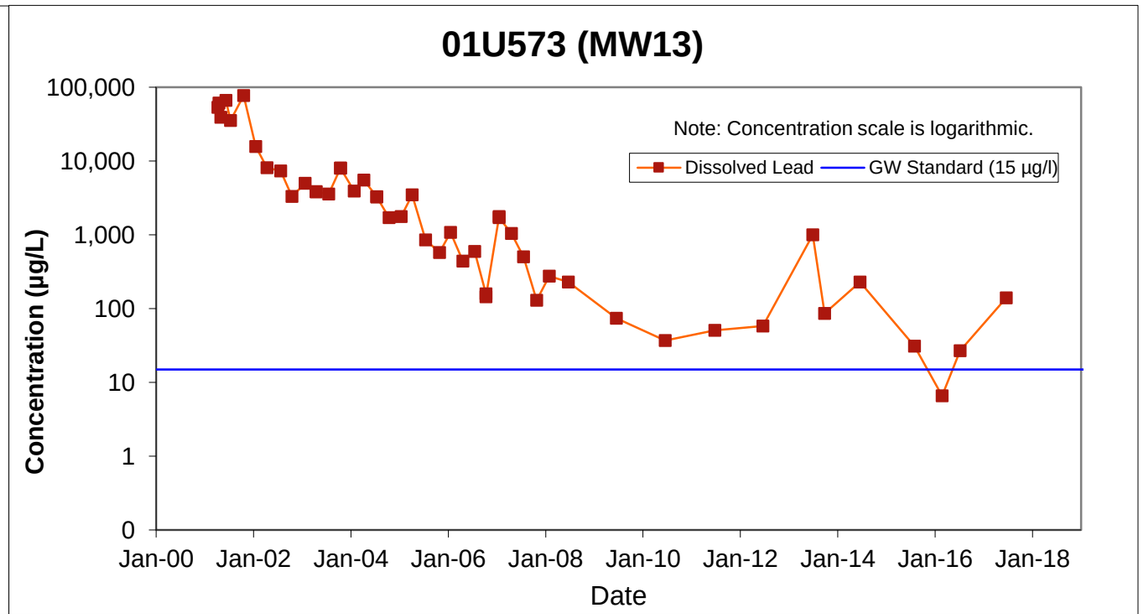
Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site C Lead in GW_FY2017.mxd
Date: 5/15/2018 Time: 12:51:54 PM User: mgress

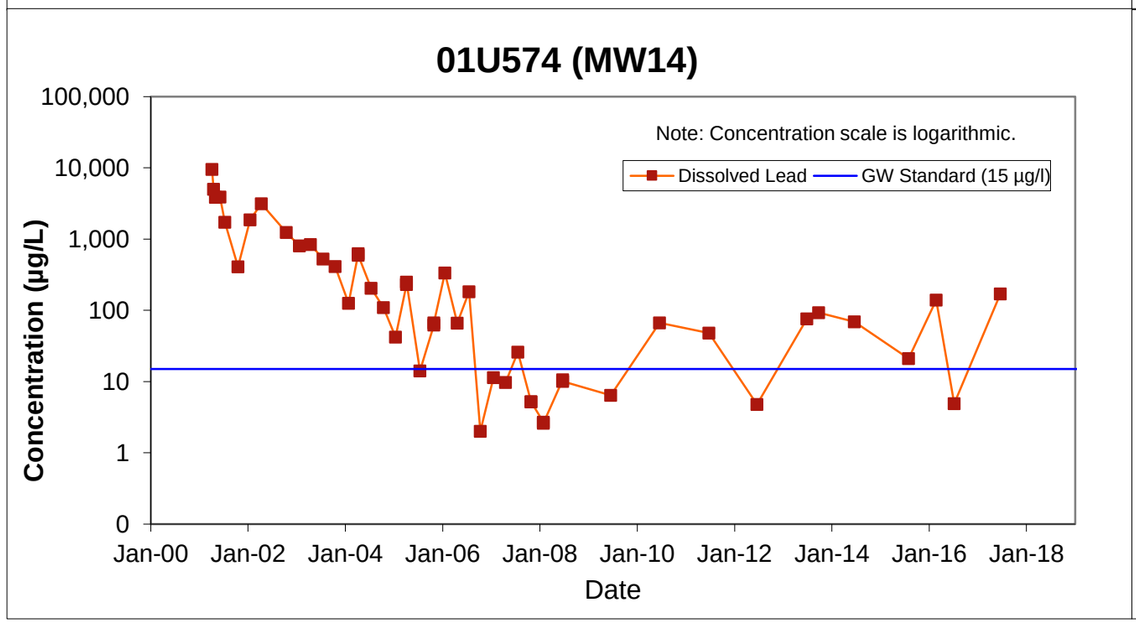
Figure 39
Dissolved Lead

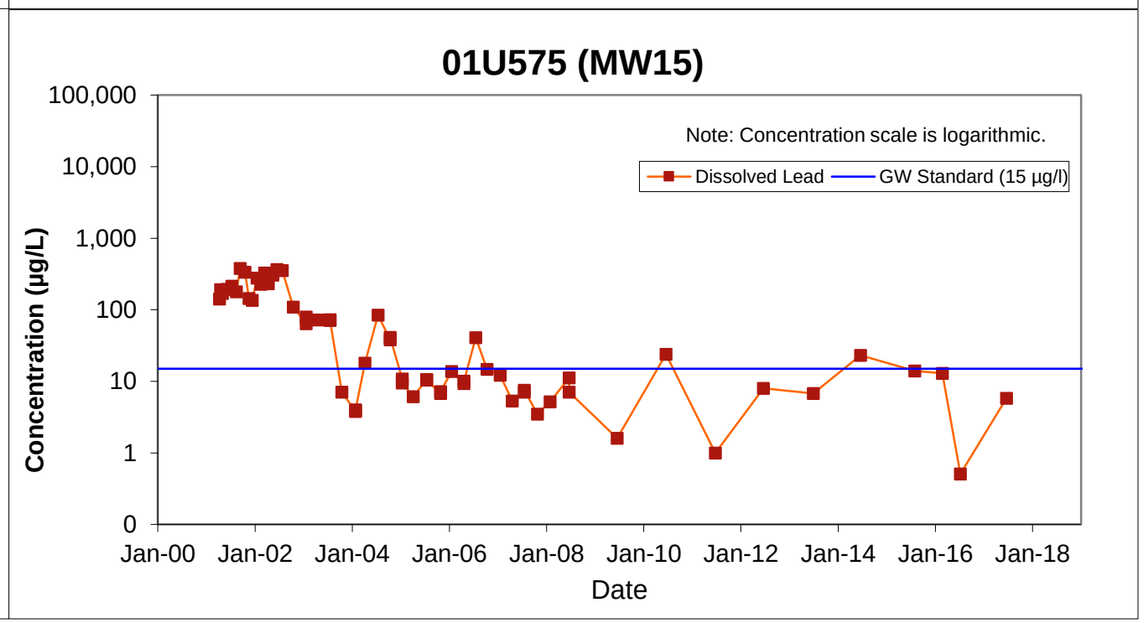
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



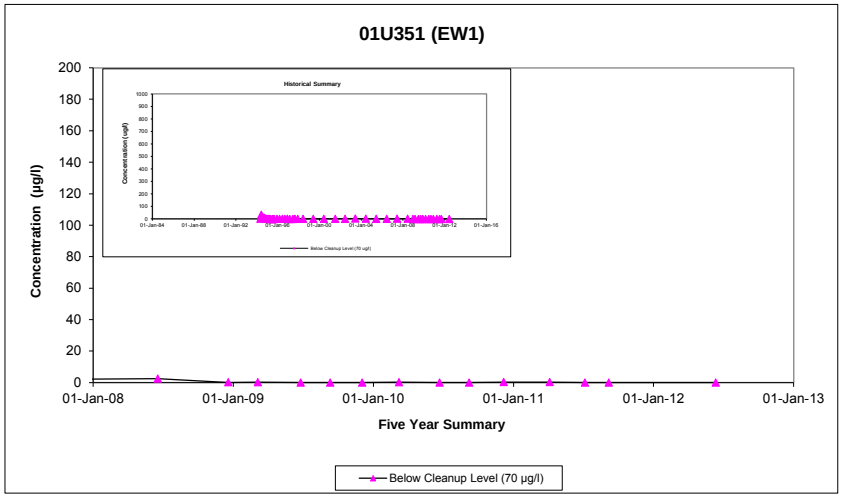


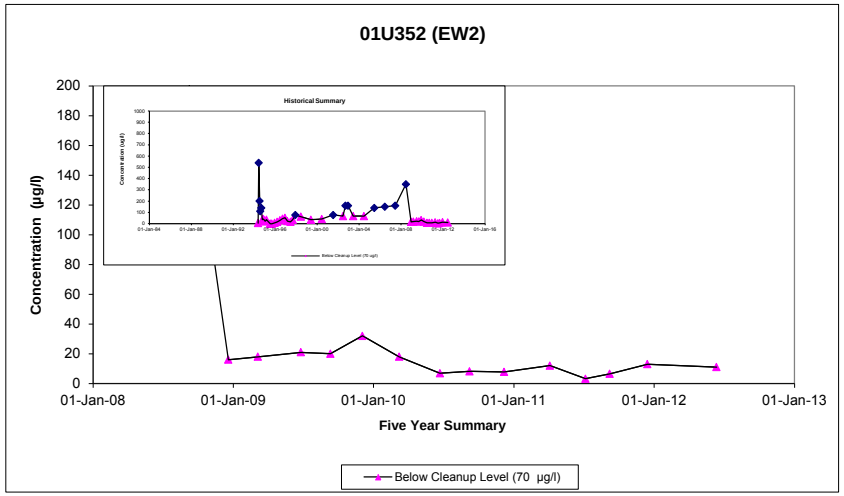


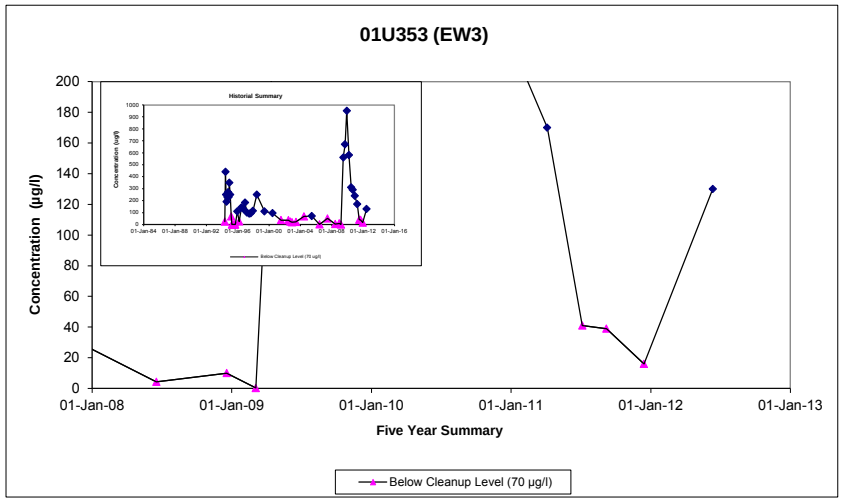


Acronyms and Abbreviations:
MW = monitoring well
µg/L = micrograms per liter

FIGURE 40
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: EXTRACTION WELLS
FY 2012 ANNUAL PERFORMANCE REPORT







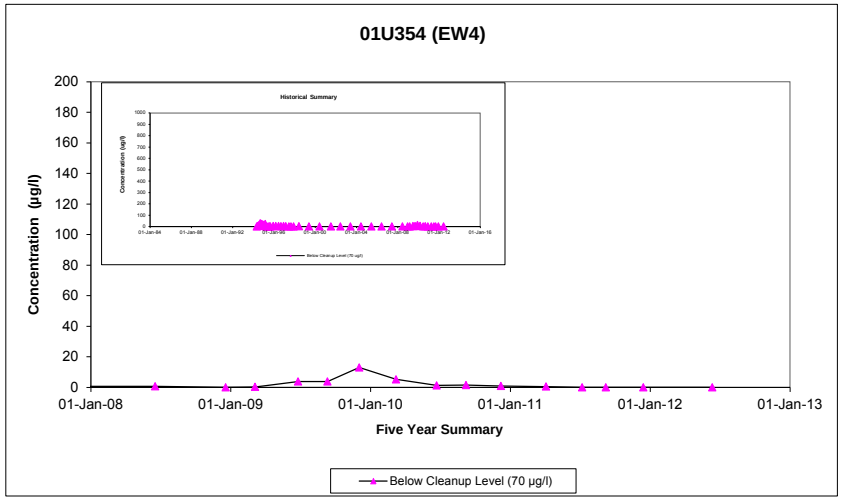
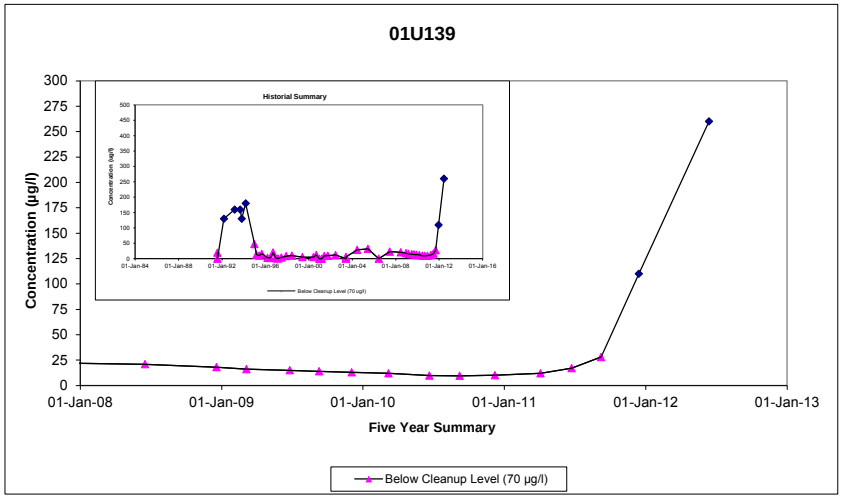
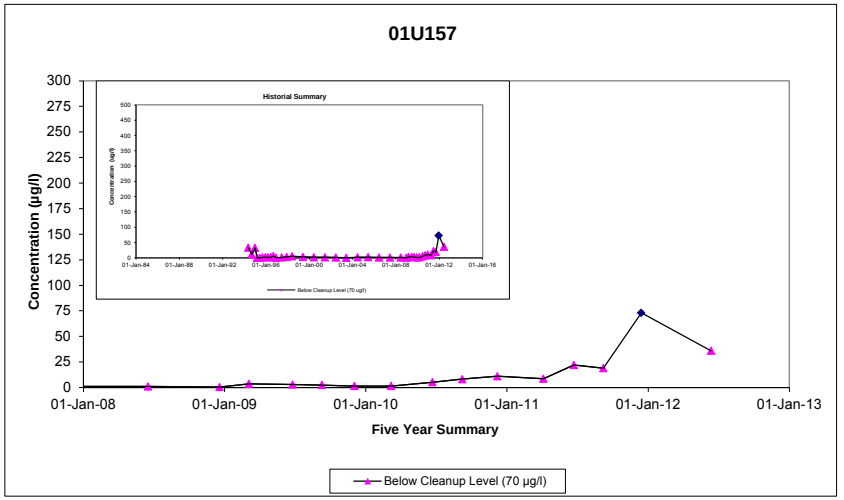
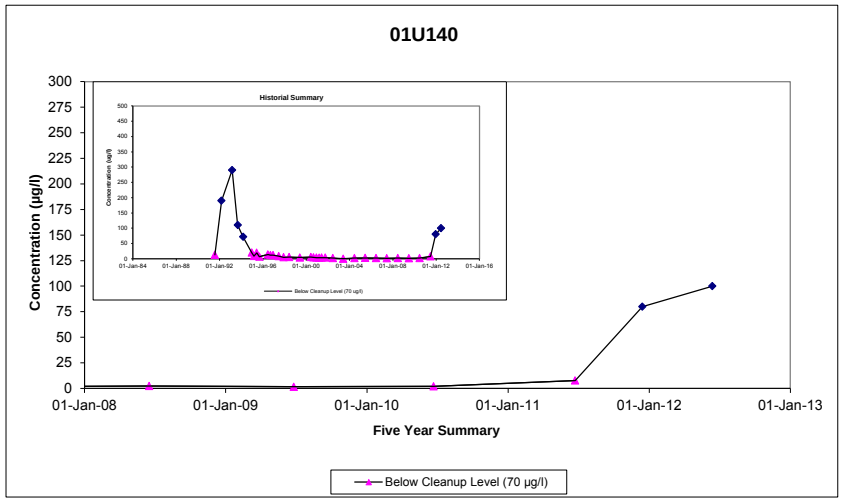
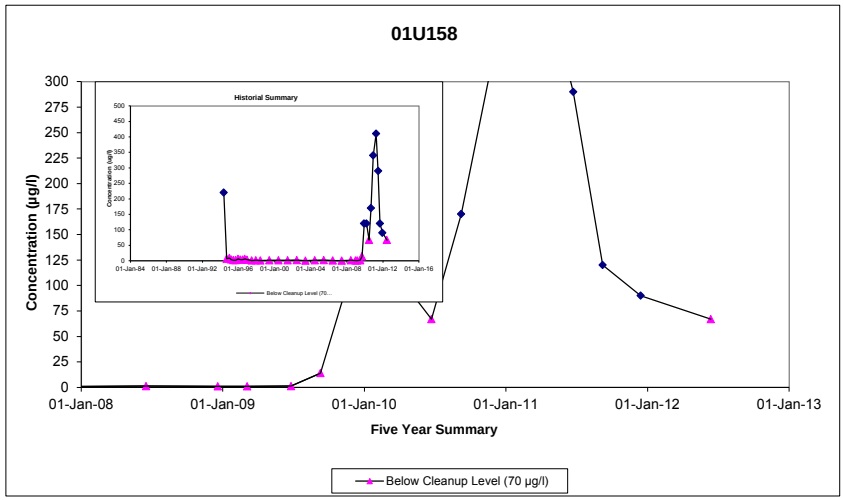


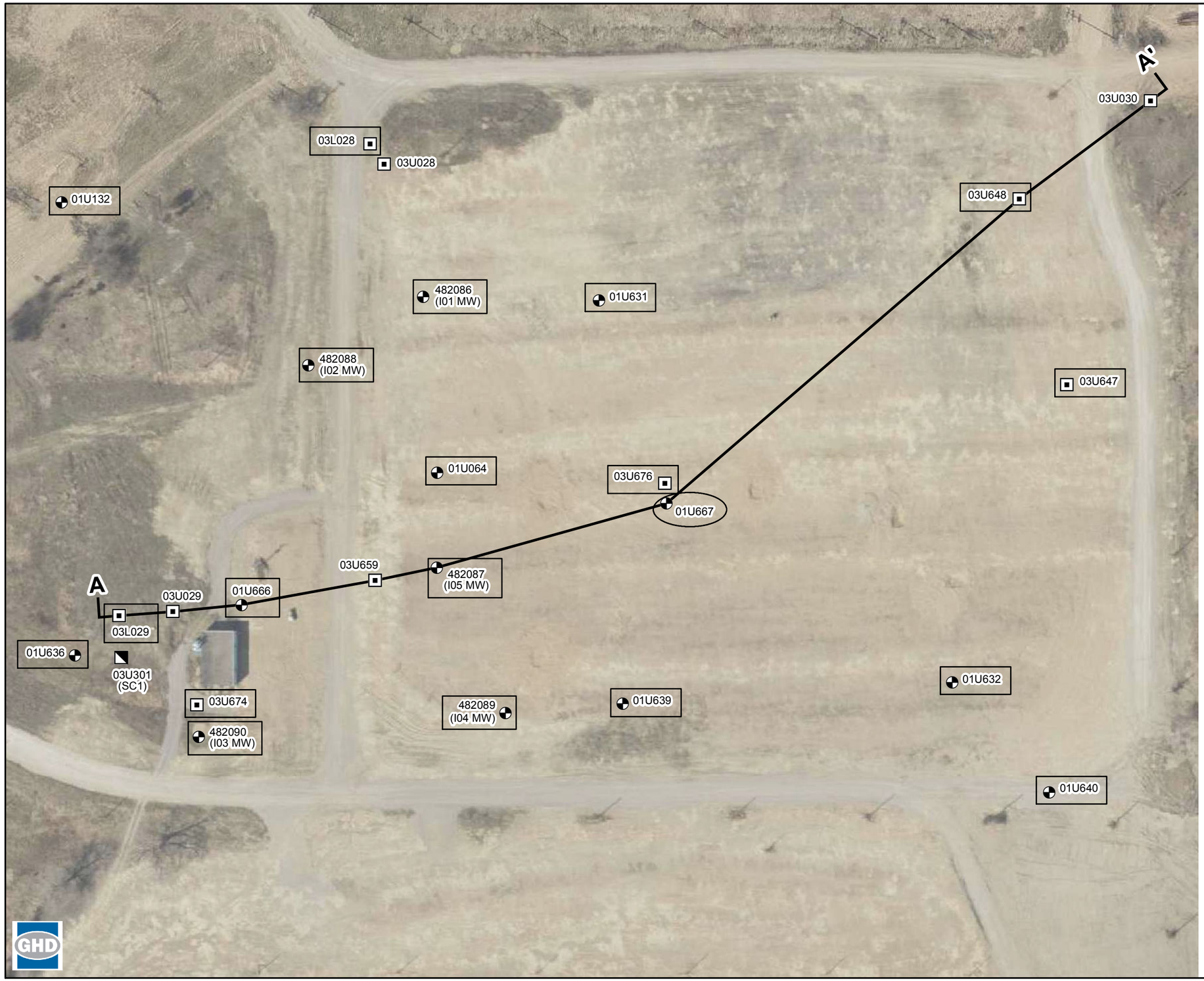
FIGURE 41
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: MONITORING WELLS
FY 2012 ANNUAL PERFORMANCE REPORT











LEGEND

- UNIT 1 MONITORING WELL LOCATION
- UNIT 3 MONITORING WELL LOCATION
- TGRS EXTRACTION WELL LOCATION
- WELL ABANDONED IN FY 2014 (TO BE REPLACED)
- WELL ABANDONED IN FY 2014
- GEOLOGIC CROSS SECTION LOCATION

NOTE: BUILDING 502 DEMOLISHED IN 2014

Figure 42

SITE PLAN
SITE I, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP001 JAN 09/2018

N

0 50 100 ft

LEGEND

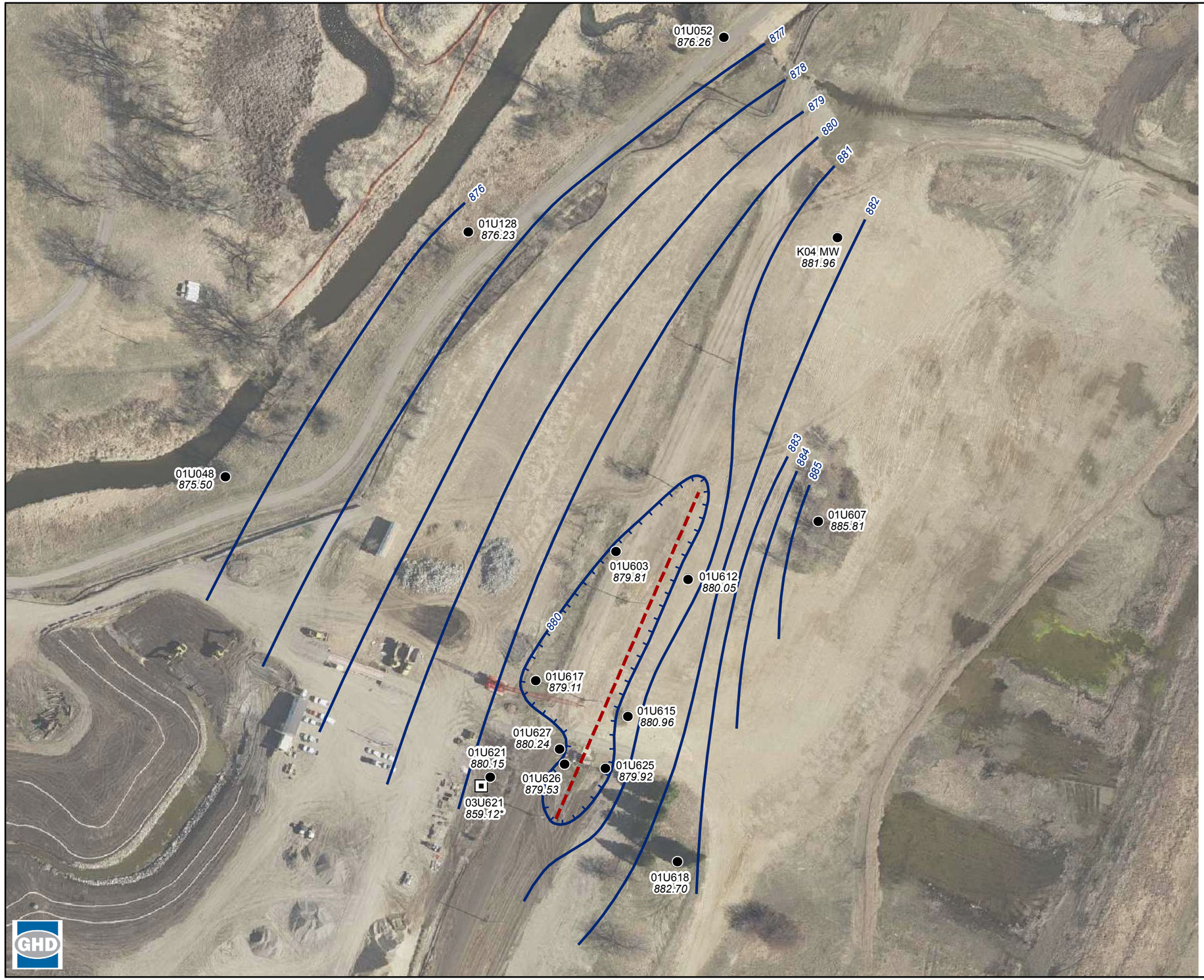
4.7/300	FY 2013 TCE / VINYL CHLORIDE CONCENTRATION (µg/L)
J	ESTIMATED CONCENTRATION
( )	DUPLICATE RESULTS
ND	ANALYTE NOT DETECTED
NS	WELL NOT SAMPLED
	UNIT 1 MONITORING WELL

Figure 43

TCE AND VINYL CHORIDE CONCENTRATIONS - FY 2013
SITE I, OU2
Arden Hills, Minnesota

GHD

11155360-43(001)GIS-SP002 JAN 22/2018



N

0 40 80 120 ft

LEGEND

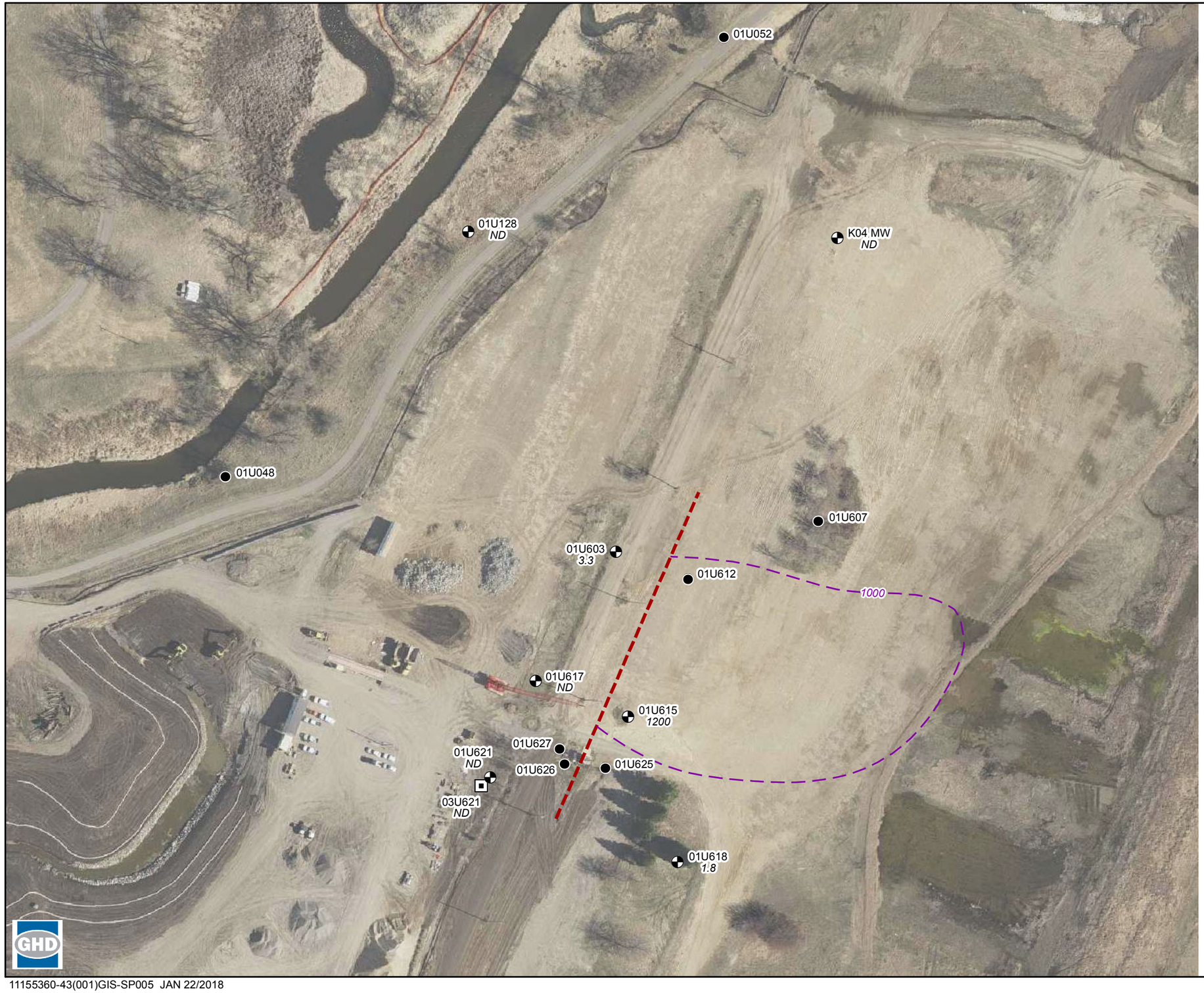
882.16	GROUNDWATER ELEVATION
*	NOT USED FOR CONTOURING
	GROUNDWATER ELEVATION CONTOUR
	ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
	UNIT 3 SENTINAL WELL LOCATION
	SITE K COLLECTION TRENCH LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

Figure 44

GROUNDWATER CONTOURS
UNIT 1 - JUNE 2017
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP004 JAN 09/2018



N

0 40 80 120 ft

LEGEND

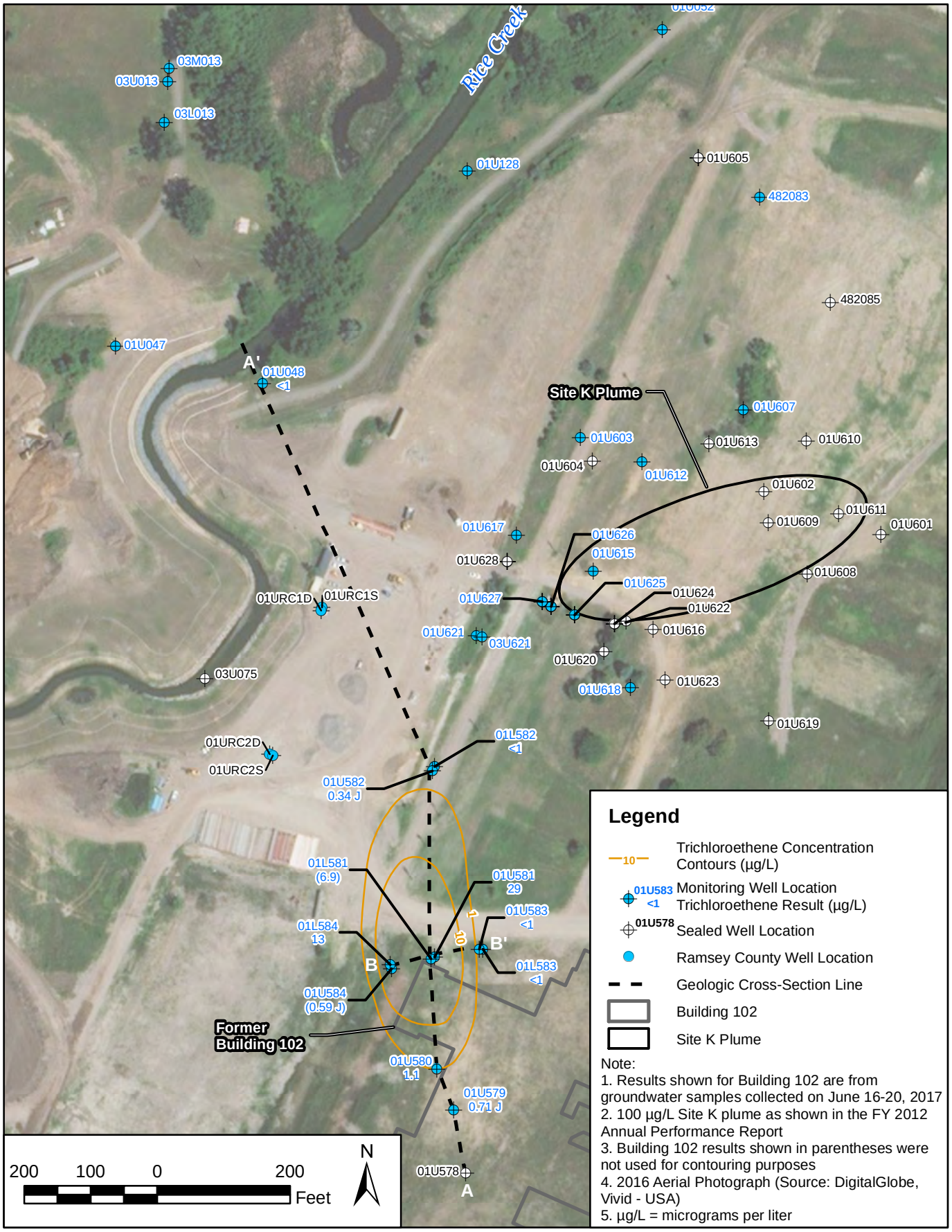
1200	TCE CONCENTRATION
ND	TCE NOT DETECTED
	1000 µg/L TCE PLUME LIMIT (ESTIMATED BASED ON 2014 DATA)
	ANNUAL WATER QUALITY MONITORING WELL LOCATION
	ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
	UNIT 3 SENTINAL WELL LOCATION
	SITE K COLLECTION TRENCH LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

Figure 45

TCE CONCENTRATIONS
UNIT 1 - JUNE 2017
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP005 JAN 22/2018



ANNUAL PERFORMANCE REPORT

Building 102, Unit 1,
Trichloroethene Results, Summer 2017

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FY 2017

Figure 46

Path: Z:\GISProjects_ENV\ITCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Trichloroethene Results_FY2017.mxd
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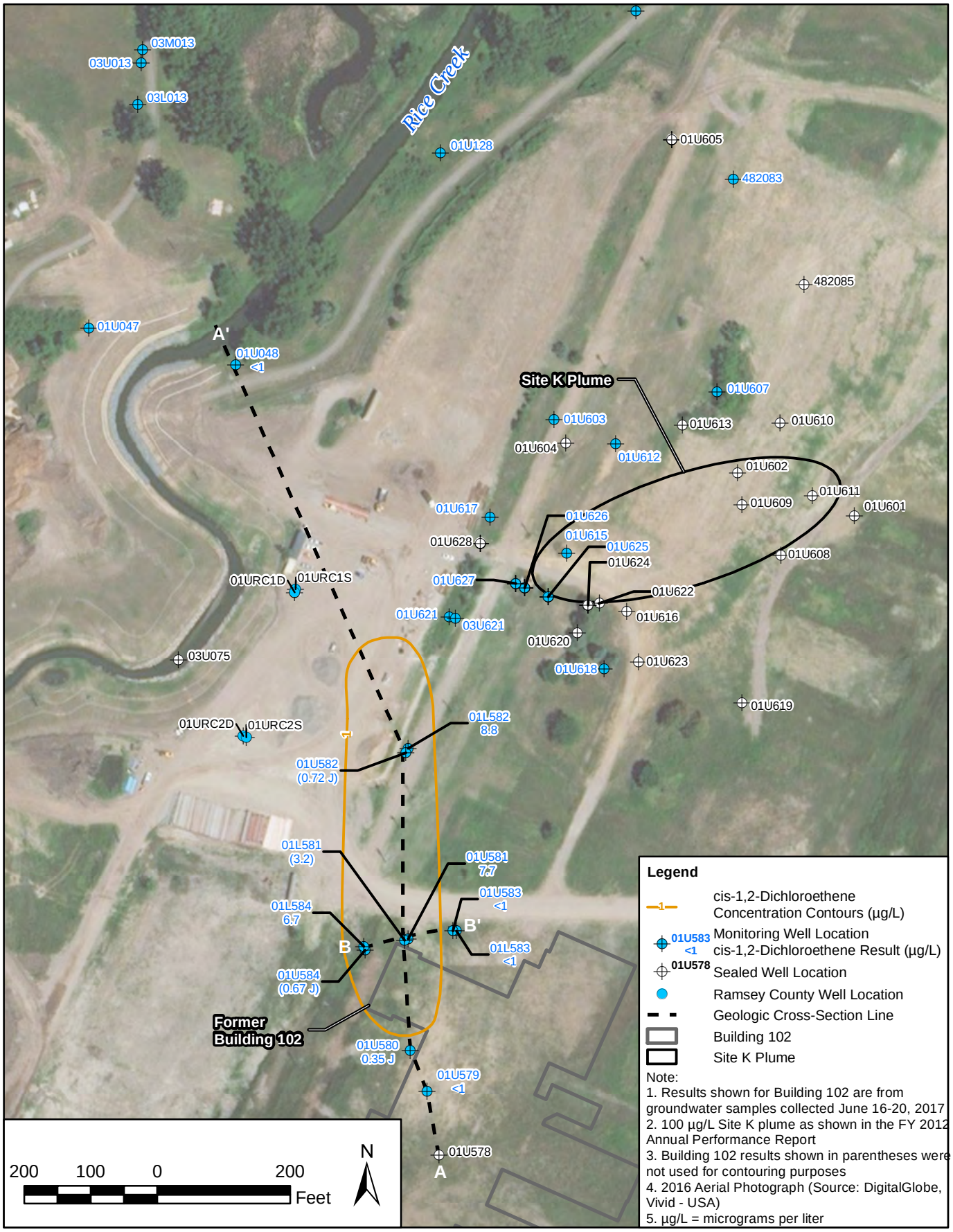

ANNUAL PERFORMANCE REPORT

Building 102, Unit 1,
cis-1,2-Dichloroethene Results, Summer 2017

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FY 2017

Figure 47

Path: Z:\GISProjects_ENV\ITCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Cis Results_FY2017.mxd
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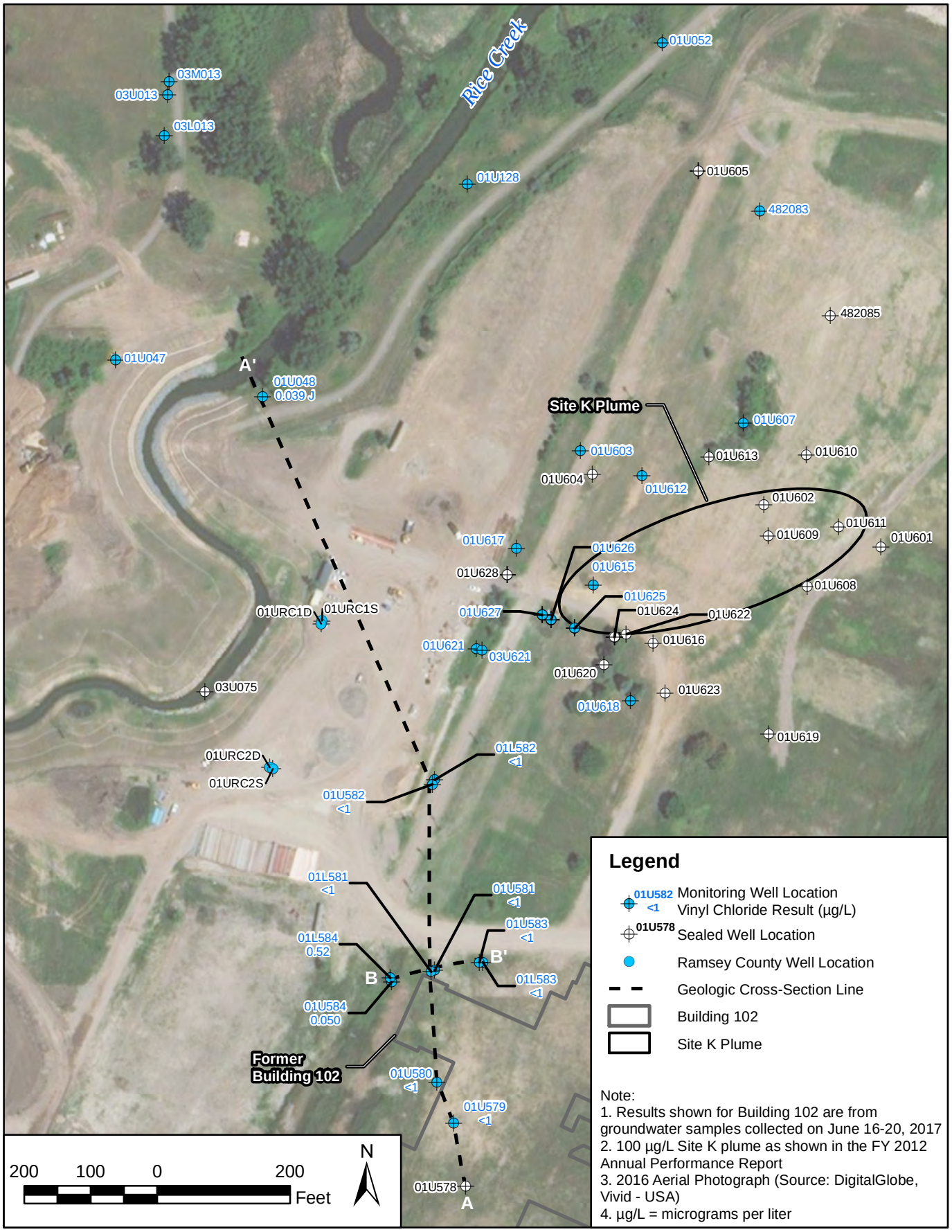

ANNUAL PERFORMANCE REPORT

Building 102, Unit 1,
Vinyl Chloride Results, Summer 2017

PIKA
ARCADIS
a joint venture

FY 2017

Figure 48

Path: Z:\GISProjects_ENV\ITCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Vinyl Results_FY2017.mxd
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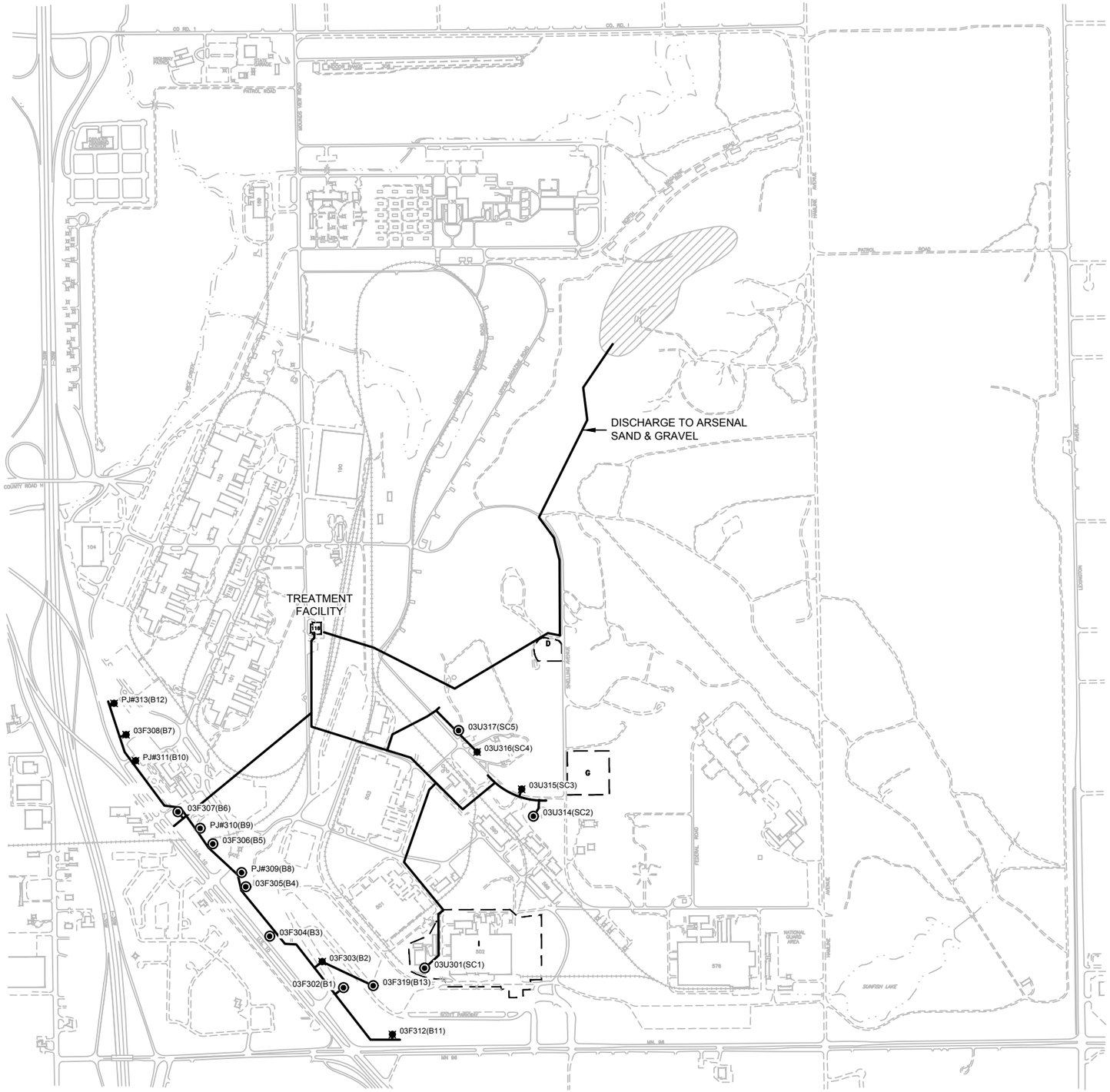
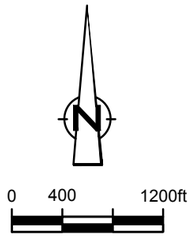




LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- ACTIVE EXTRACTION WELL LOCATION
- INACTIVE EXTRACTION WELL LOCATION

EXTRACTION WELL NAME CROSS REFERENCE

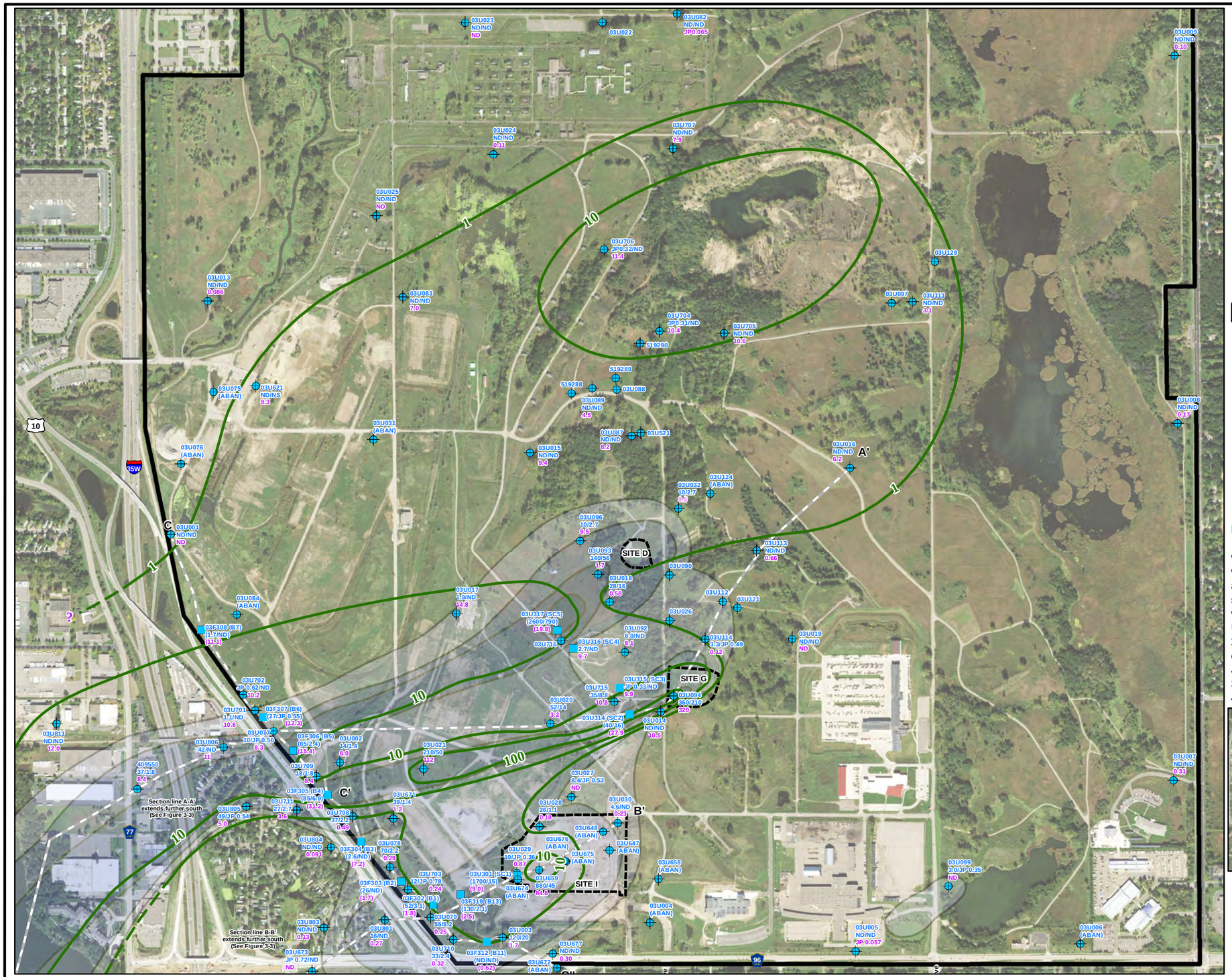
B1	03F302
B2	03F303
B3	03F304
B4	03F305
B5	03F306
B6	03F307
B7	03F308
B8	PJ#309
B9	PJ#310
B10	PJ#311
B11	03F312
B12	PJ#313
B13	03F319
SC1	03U301
SC2	03U314
SC3	03U315
SC4	03U316
SC5	03U317

Figure 49

TGRS LAYOUT

OPERABLE UNIT 2

Arden Hills, Minnesota



Legend

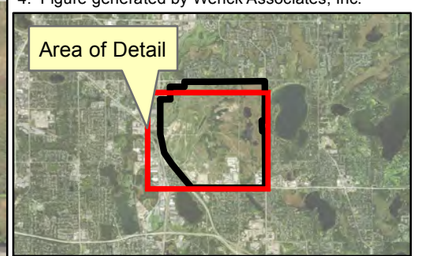
- Monitoring Well Location
- Extraction Well Location
- 03L822 — Monitoring Well ID
- 120/12.8 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 16.3 — 1,4-Dioxane Concentration (µg/L)
- (Values in parentheses were not used for contouring purposes)
- (ABAN) — Abandoned Location
- JP — Estimated Value (Value is below the reporting limit but above the method detection limit)
- Cross-Section Line
- Site Boundary
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)
- 1 — 1,4 Dioxane Concentration Contour

Trichloroethene Concentrations

- 1-10 µg/l
- 10-100 µg/l
- 100-1,000 µg/l
- 1,000+ µg/l

Notes:

1. 03F and 03U extraction wells are shown with data in parentheses, but concentrations were not used for contouring (except for SC-3 and SC-4, which were used for contouring since they are being sampled as monitoring wells and since they are screened only within Upper Unit 3).
2. Results are from groundwater samples collected in June/July 2016, and also in January/February 2016 for select wells.
3. 2015 Aerial Photograph (Source: NAIP)
4. Figure generated by Wenck Associates, Inc.



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2017-01\OU2 Upper Unit 3 TCE DIOX_2016.mxd

ANNUAL PERFORMANCE REPORT

OU2, Upper Unit 3, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016

PIKA

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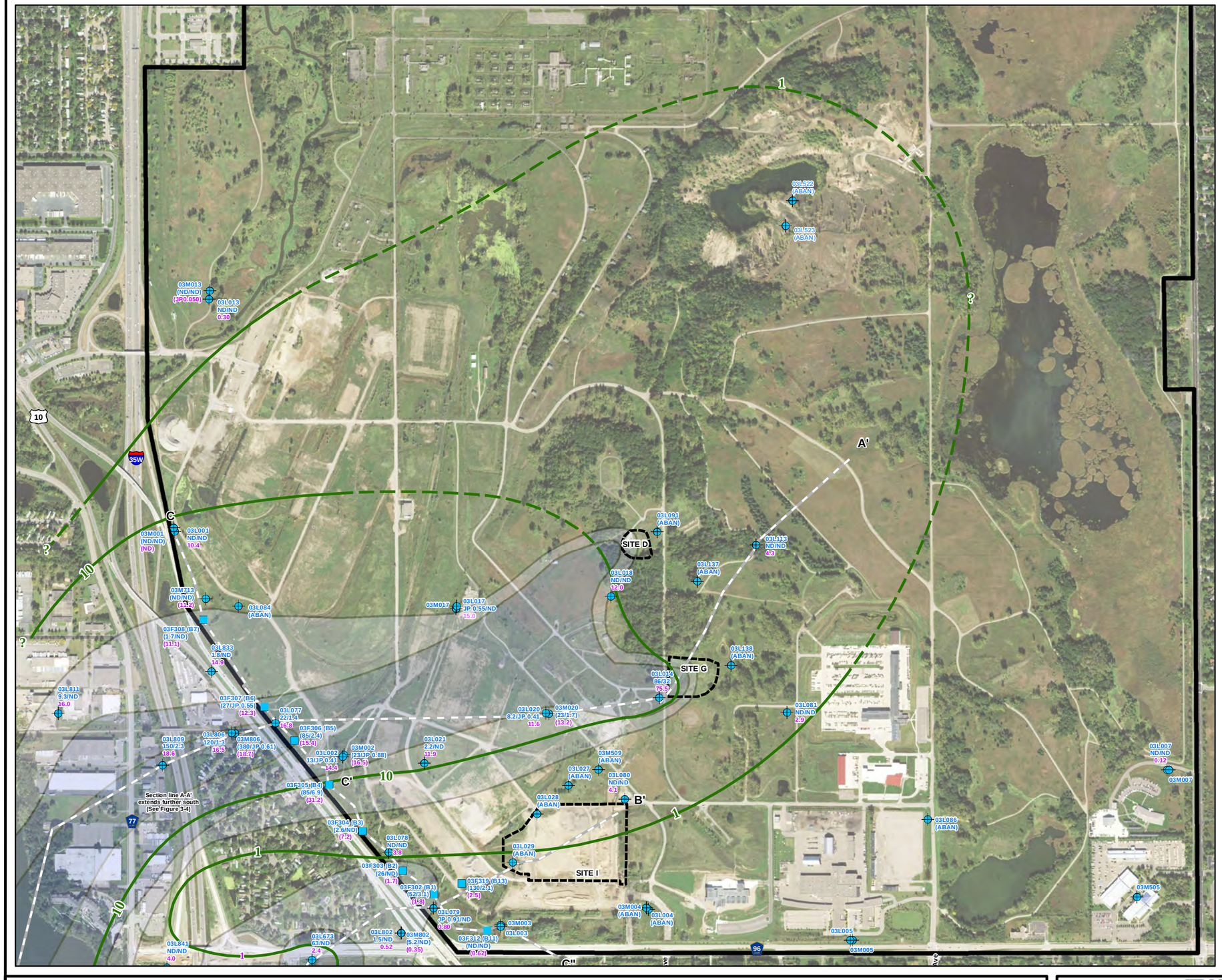
FY 2016

Figure 50



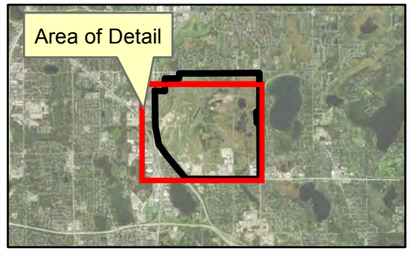
Legend

- Monitoring Well Location
- Extraction Well Location
- 03L822 / 120/12.8 / 16.3 — Monitoring Well ID; Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L); 1,4-Dioxane Concentration (µg/L)
- (Values in parentheses were not used for contouring purposes)
- (ABAN) — Abandoned Location
- JP — Estimated Value (Value is below the reporting limit but above the method detection limit)
- Cross-Section Line
- Site Boundary
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)
- 1 — 1,4 Dioxane Concentration Contour

Trichloroethene Concentrations

- 1-10 µg/l
- 10-100 µg/l
- 100-1,000 µg/l
- 1,000+ µg/l

Notes:
1. Middle Unit 3 wells with data are shown with data in parentheses, but were not used for contouring.
2. 03F extraction wells are shown with data in parentheses, but were not used for contouring.
3. Results are from groundwater samples collected in June/July 2016, and also in January/February 2016 for select wells.
4. 2015 Aerial Photograph (Source: NAIP)
5. Figure generated by Wenck Associates, Inc.



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2017-01\OU2 Lower Unit 3 TCE DIOX_2016.mxd

ANNUAL PERFORMANCE REPORT

OU2, Lower Unit 3, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016

PIKA ARCADIS a joint venture

FY 2016

Figure 51

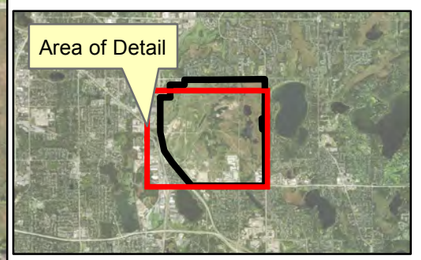
Legend

- Monitoring Well Location
- Extraction Well Location
- 03L822 — Monitoring Well ID
- 120/12.8 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 16.3 — 1,4-Dioxane Concentration (µg/L)
- (Values in parentheses were not used for contouring purposes)
- (ABAN) — Abandoned Location
- JP — Estimated Value (Value is below the reporting limit but above the method detection limit)
- Cross-Section Line
- Site Boundary
- Operable Unit 2 of the New Brighton Arden Hills Superfund Site (the same area occupied by the Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)
- 1 — 1,4 Dioxane Concentration Contour

Trichloroethene Concentrations

- 1-10 µg/l
- 10-100 µg/l
- 100-1,000 µg/l
- 1,000+ µg/l

Notes:
1. All 04J wells (Jordan Wells) with data are shown with data in parentheses, but were not used for contouring.
2. All PJ# extraction wells are shown with data in parentheses, but were not used for contouring.
3. PJ# monitoring wells are shown with data in parentheses, but were not used for contouring
4. Results are from groundwater samples collected in June/July 2016, and also in January/February 2016 for select wells.
5. 2015 Aerial Photograph (Source: NAIP)
6. Figure generated by Wenck Associates, Inc.

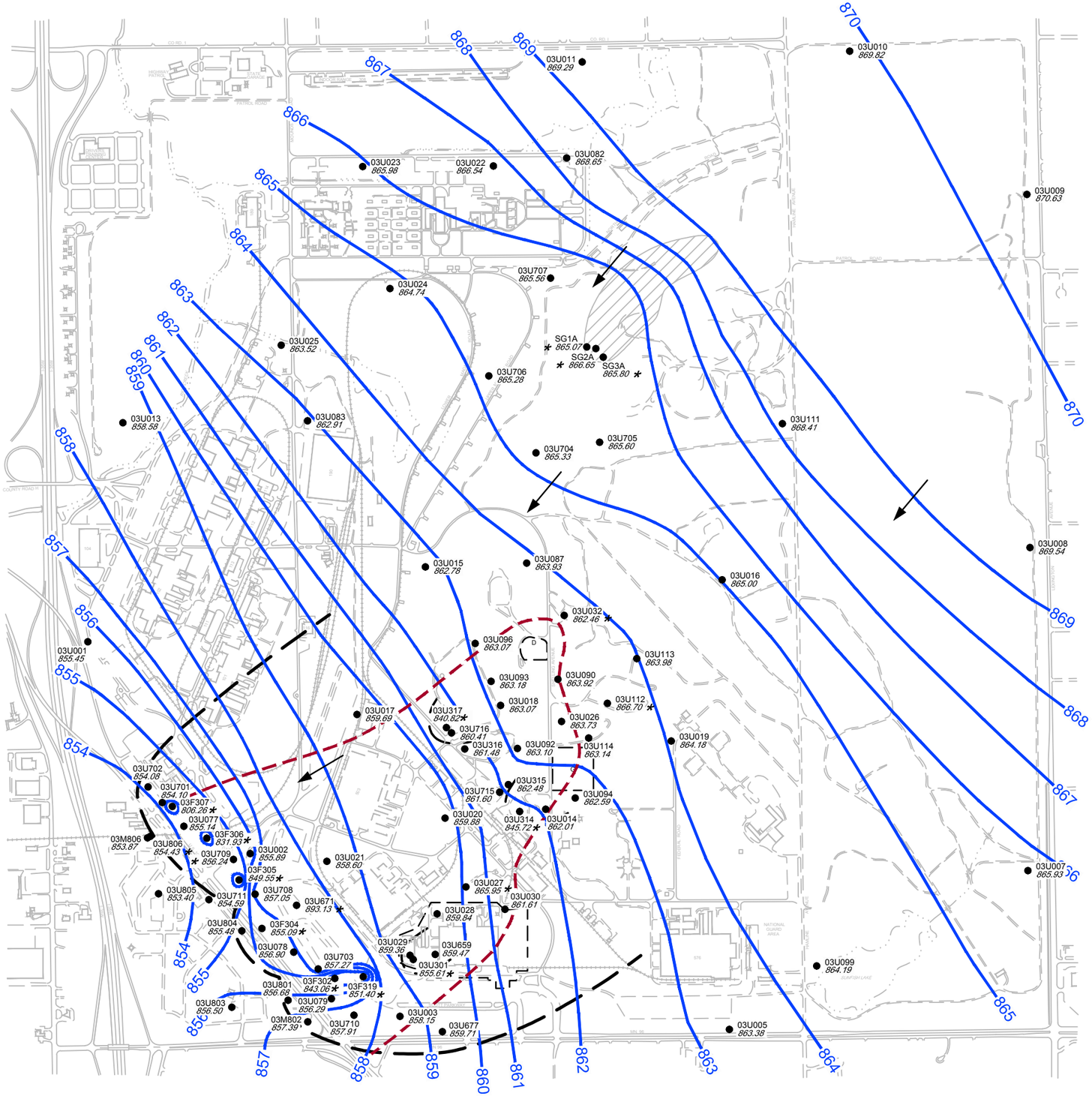


N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2017-01\OU2 Upper Unit 4 TCE DIOX_2016.mxd

ANNUAL PERFORMANCE REPORT		PIKA ARCADIS a joint venture	FY 2016
OU2, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2016			Figure 52

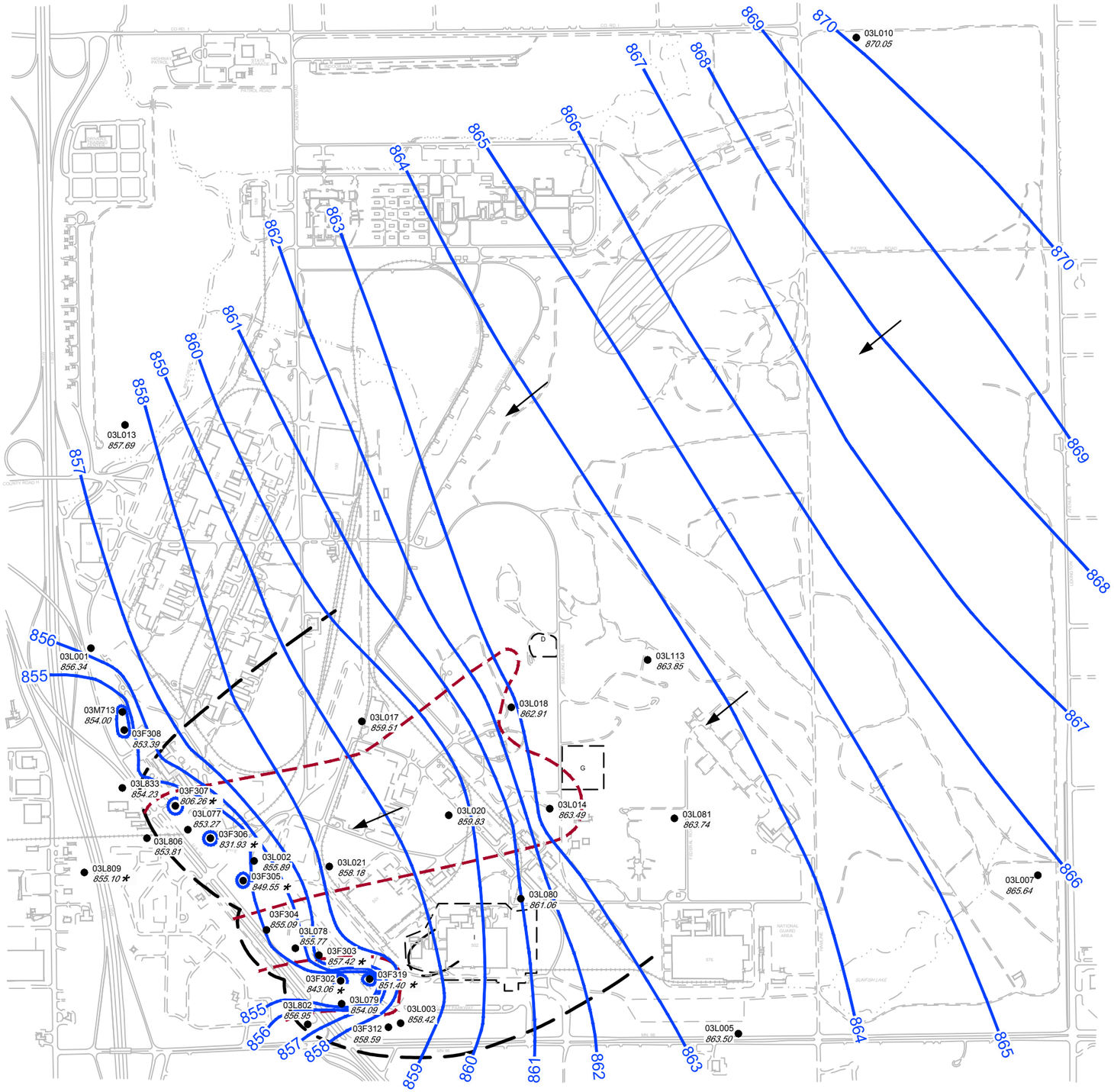


EXTRACTION WELL NAME CROSS REFERENCE

B1	03F302
B2	03F303
B3	03F304
B4	03F305
B5	03F306
B6	03F307
B7	03F308
B8	PJ#309
B9	PJ#310
B10	PJ#311
B11	03F312
B12	PJ#313
B13	03F319
SC1	03U301
SC2	03U314
SC3	03U315
SC4	03U316
SC5	03U317

Figure 53

OU2, UPPER UNIT 3, POTENTIOMETRIC MAP
6/7-9/2016
OPERABLE UNIT 2
Arden Hills, Minnesota



0 600 1200 ft

LEGEND

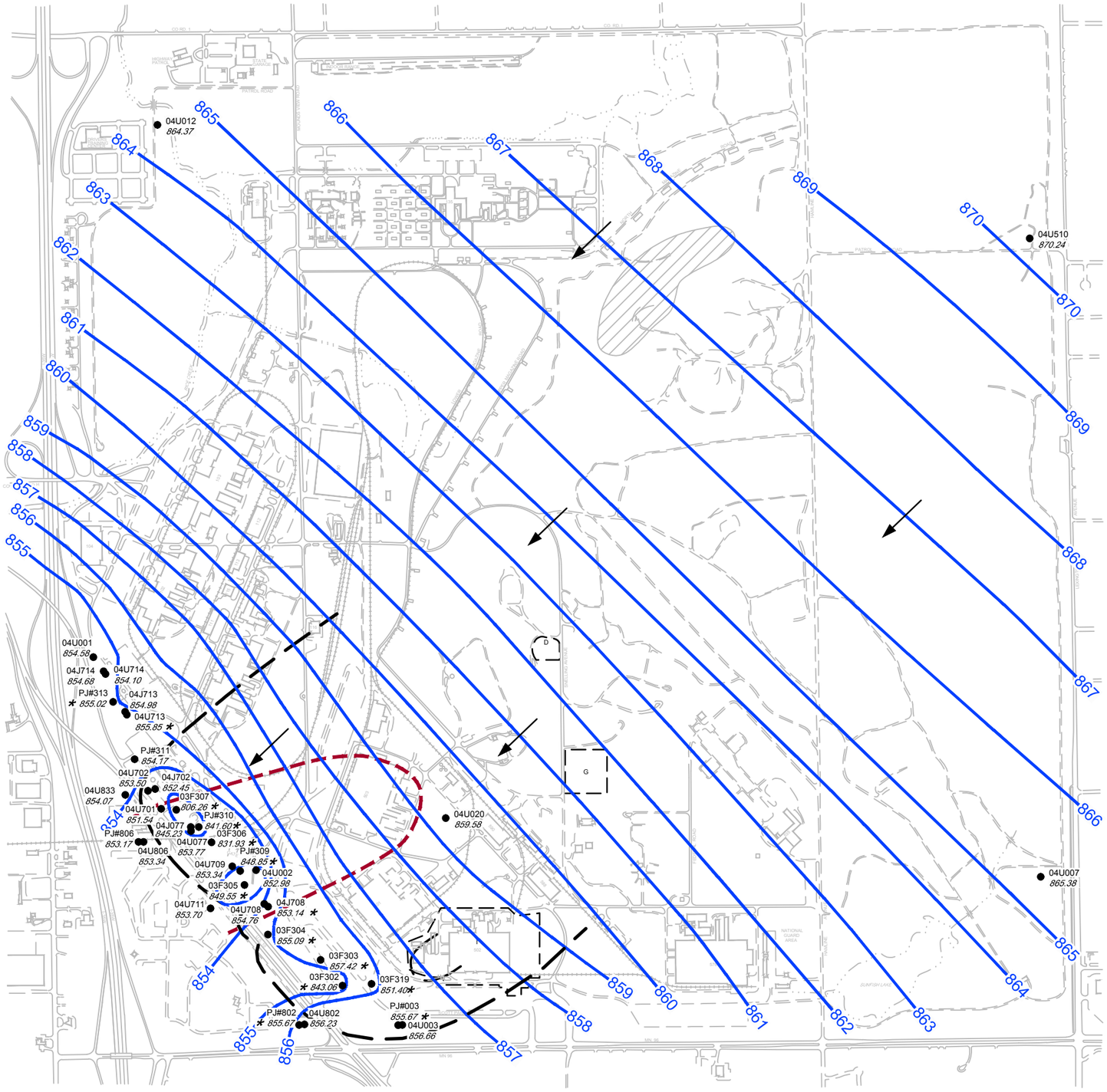
- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- WELL LOCATION
- 862.46 GROUNDWATER ELEVATION IN FEET AMSL
- 861 GROUNDWATER CONTOUR
- DIRECTION OF GROUNDWATER FLOW
- LIMIT OF CAPTURE
- NOTE: GROUNDWATER CONTOURS ARE INTERPOLATED FROM THE DATA POINTS SHOWN.
- * GROUNDWATER ELEVATION NOT USED IN CONTOURING
- ARSENAL SAND AND GRAVEL PIT TREATED WATER DISCHARGE AREA. (APPROXIMATE BOUNDARIES)
- 5 µg/L TCE PLUME BOUNDARY

EXTRACTION WELL NAME CROSS REFERENCE

B1	03F302
B2	03F303
B3	03F304
B4	03F305
B5	03F306
B6	03F307
B7	03F308
B8	PJ#309
B9	PJ#310
B10	PJ#311
B11	03F312
B12	PJ#313
B13	03F319
SC1	03U301
SC2	03U314
SC3	03U315
SC4	03U316
SC5	03U317

Figure 54

OU2, LOWER UNIT 3, POTENTIOMETRIC MAP
6/7-9/2016
OPERABLE UNIT 2
Arden Hills, Minnesota



LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- WELL LOCATION
- 869.67 GROUNDWATER ELEVATION IN FEET AMSL
- 858 GROUNDWATER CONTOUR
- DIRECTION OF GROUNDWATER FLOW
- LIMIT OF CAPTURE
- NOTE: GROUNDWATER CONTOURS ARE INTERPOLATED FROM THE DATA POINTS SHOWN.
- * GROUNDWATER ELEVATION NOT USED IN CONTOURING
- ARSENAL SAND AND GRAVEL PIT TREATED WATER DISCHARGE AREA. (APPROXIMATE BOUNDARIES)
- 5 µg/L TCE PLUME BOUNDARY

EXTRACTION WELL NAME CROSS REFERENCE

B1	03F302
B2	03F303
B3	03F304
B4	03F305
B5	03F306
B6	03F307
B7	03F308
B8	PJ#309
B9	PJ#310
B10	PJ#311
B11	03F312
B12	PJ#313
B13	03F319
SC1	03U301
SC2	03U314
SC3	03U315
SC4	03U316
SC5	03U317

Figure 55

OU2, UPPER UNIT 4, POTENTIOMETRIC MAP
6/7-9/2016
OPERABLE UNIT 2
Arden Hills, Minnesota

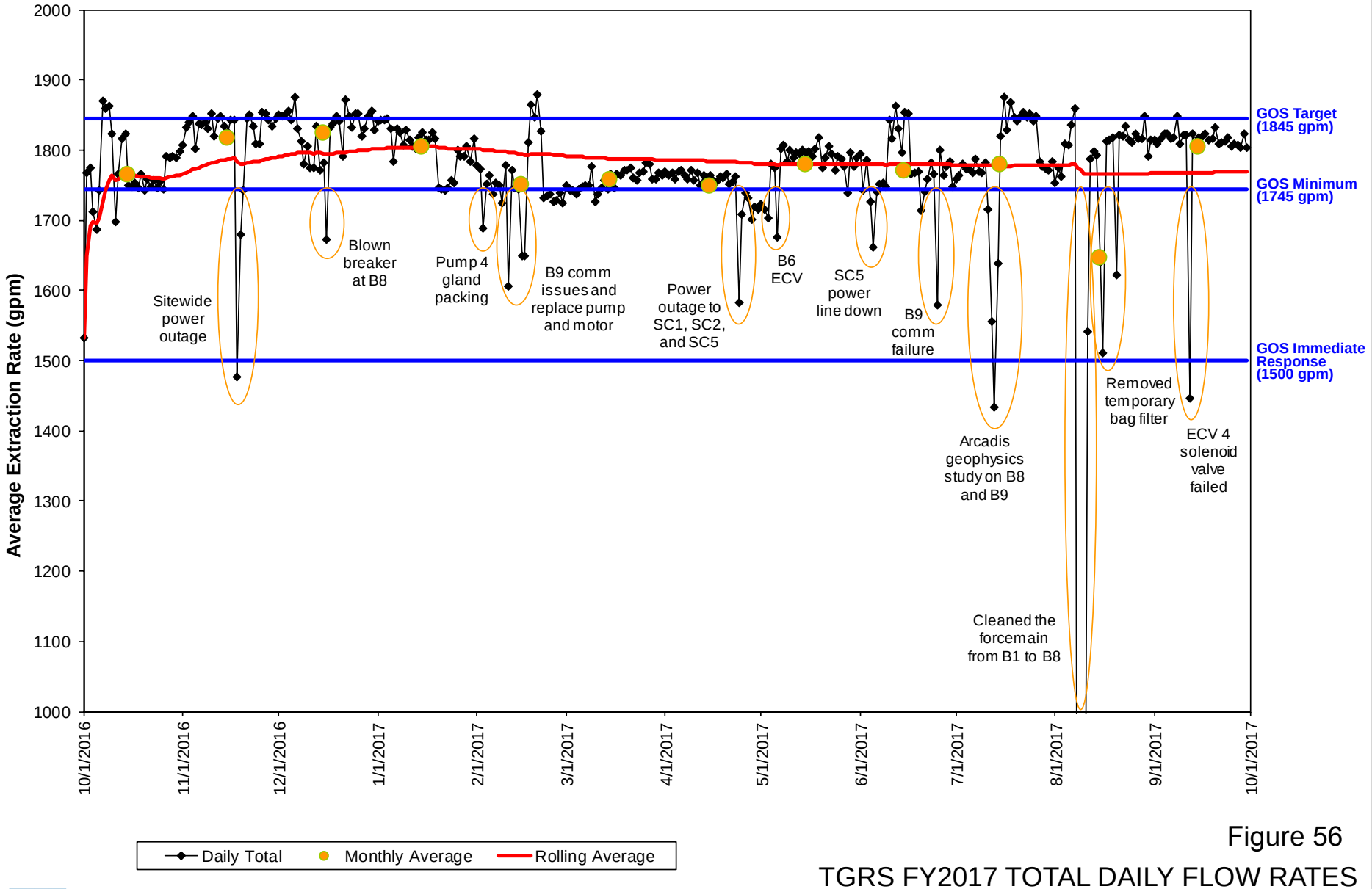
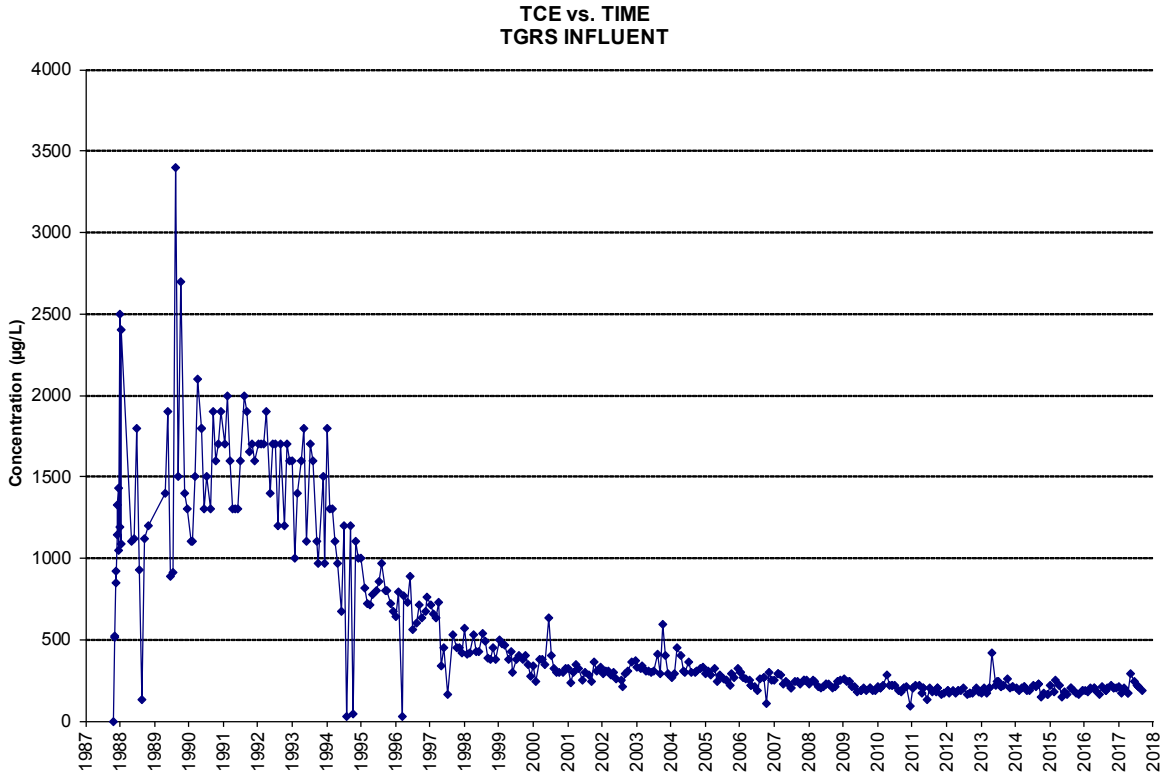
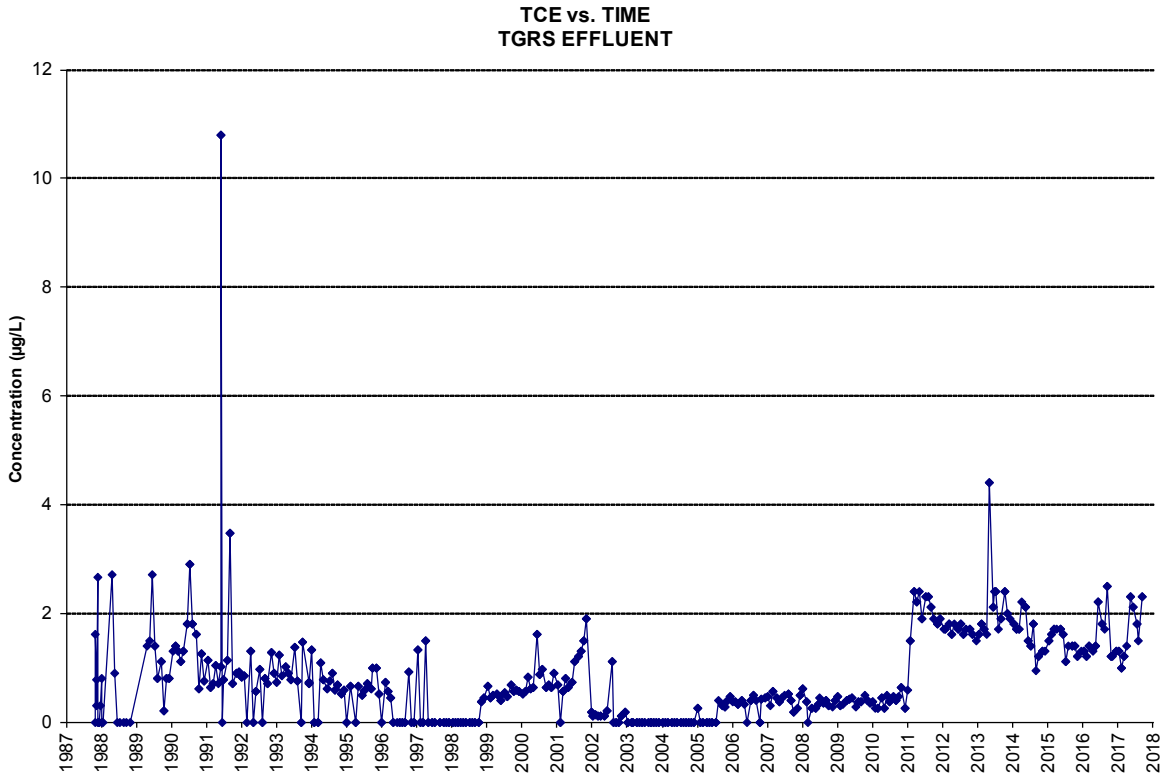


Figure 56

TGRS FY2017 TOTAL DAILY FLOW RATES
OPERABLE UNIT 2
Arden Hills, Minnesota





NOTE: SAMPLES REPORTING CONCENTRATIONS OF NON-DETECT WERE PLOTTED AS ZERO. WHEN DUPLICATE SAMPLES WERE COLLECTED, THE HIGHER CONCENTRATION WAS REPORTED.

Figure 57

TGRS TREATMENT SYSTEM PERFORMANCE
OPERABLE UNIT 2
Arden Hills, Minnesota

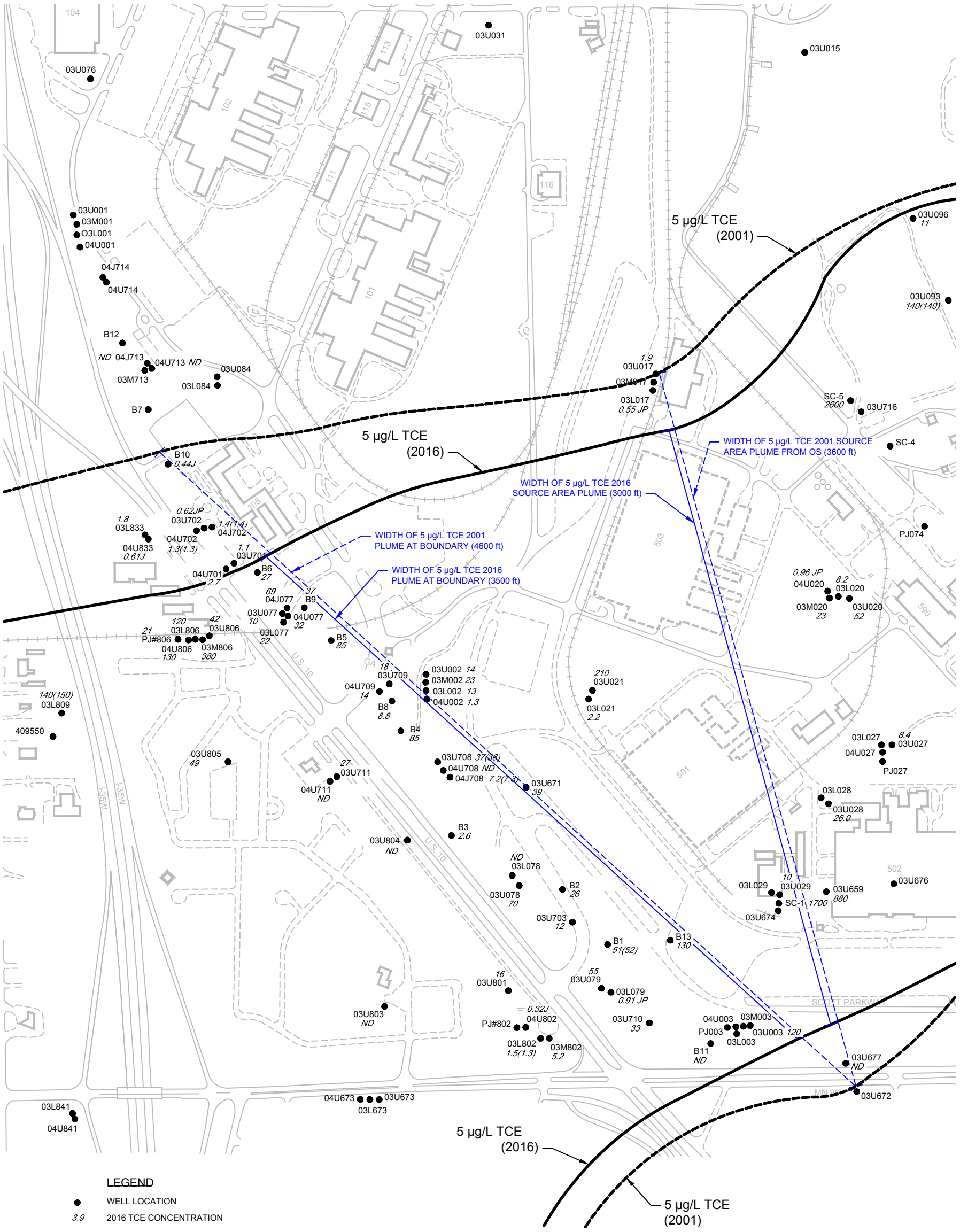


Figure 58

TGRS ANNUAL MONITORING DATA - WEST PORTION
TRCLE CONCENTRATIONS (µg/L) JUNE 2016
OPERABLE UNIT 2
Arden Hills, Minnesota

Figure 59
Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 1-4

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA
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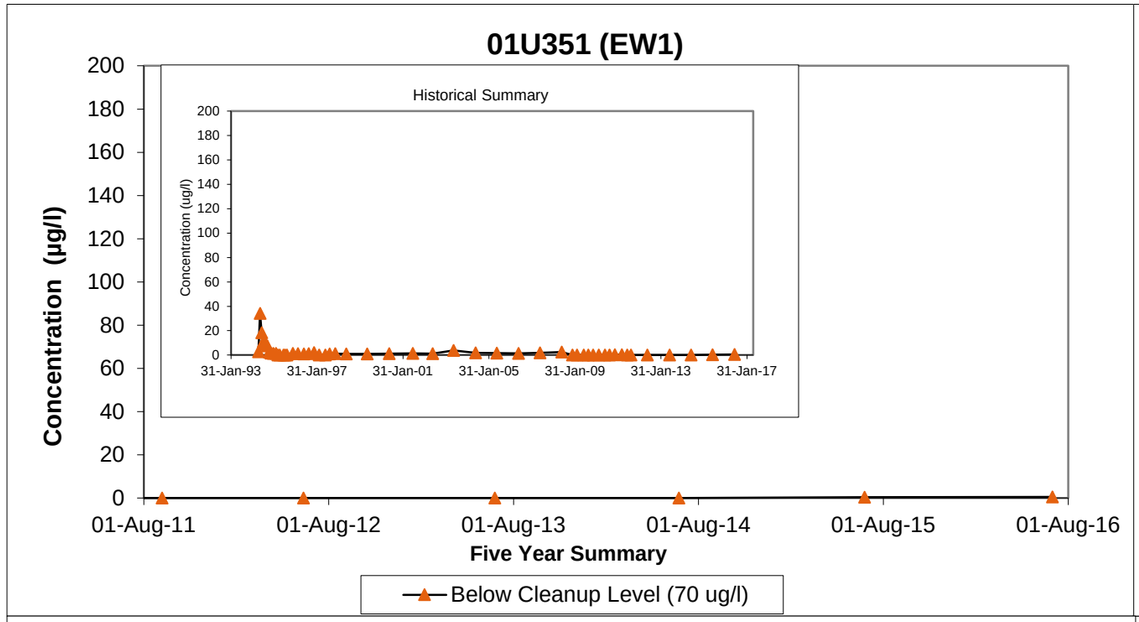

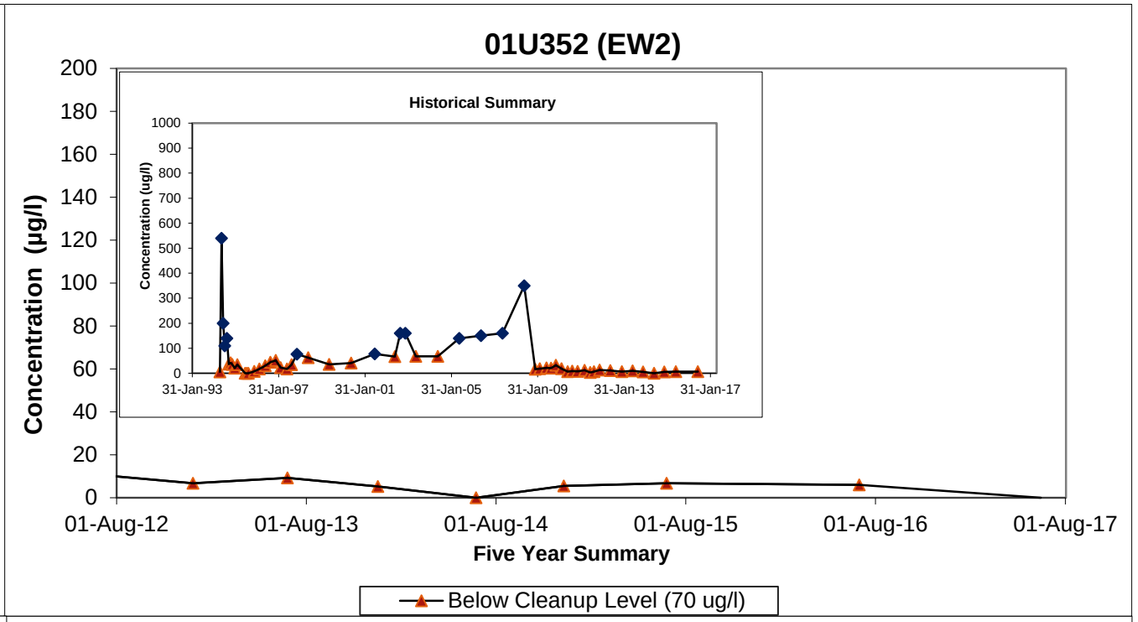

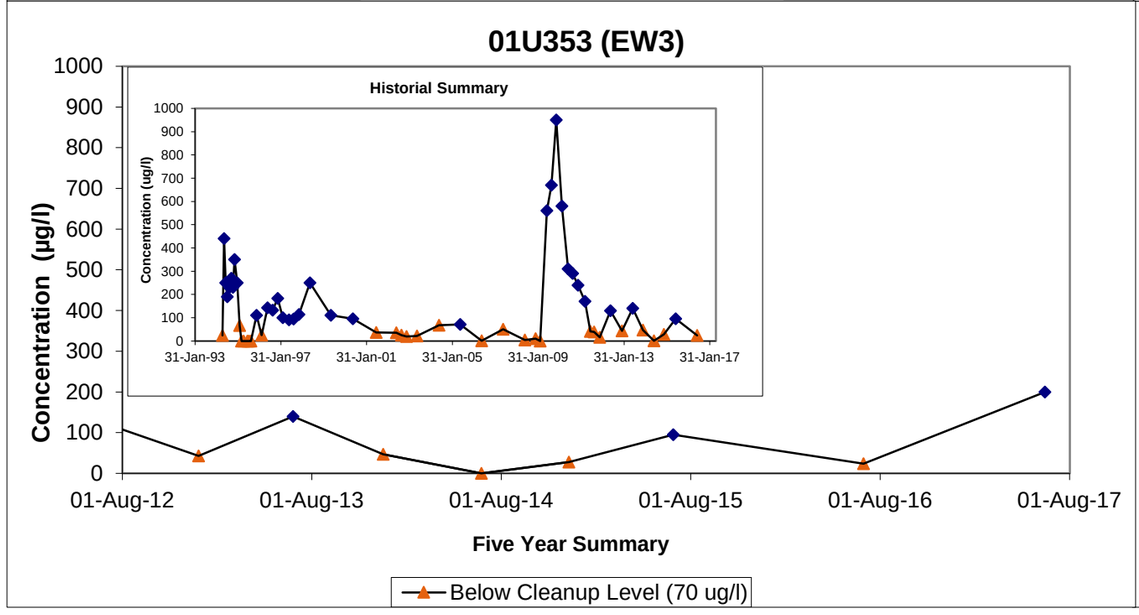

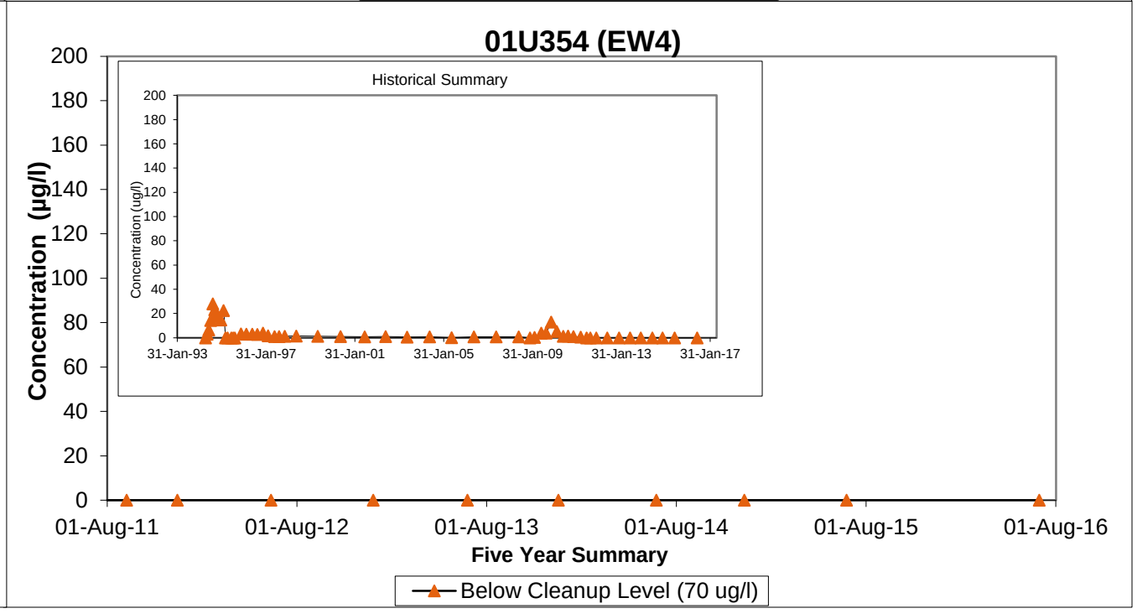

Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

Figure 60
Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 5-8
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA
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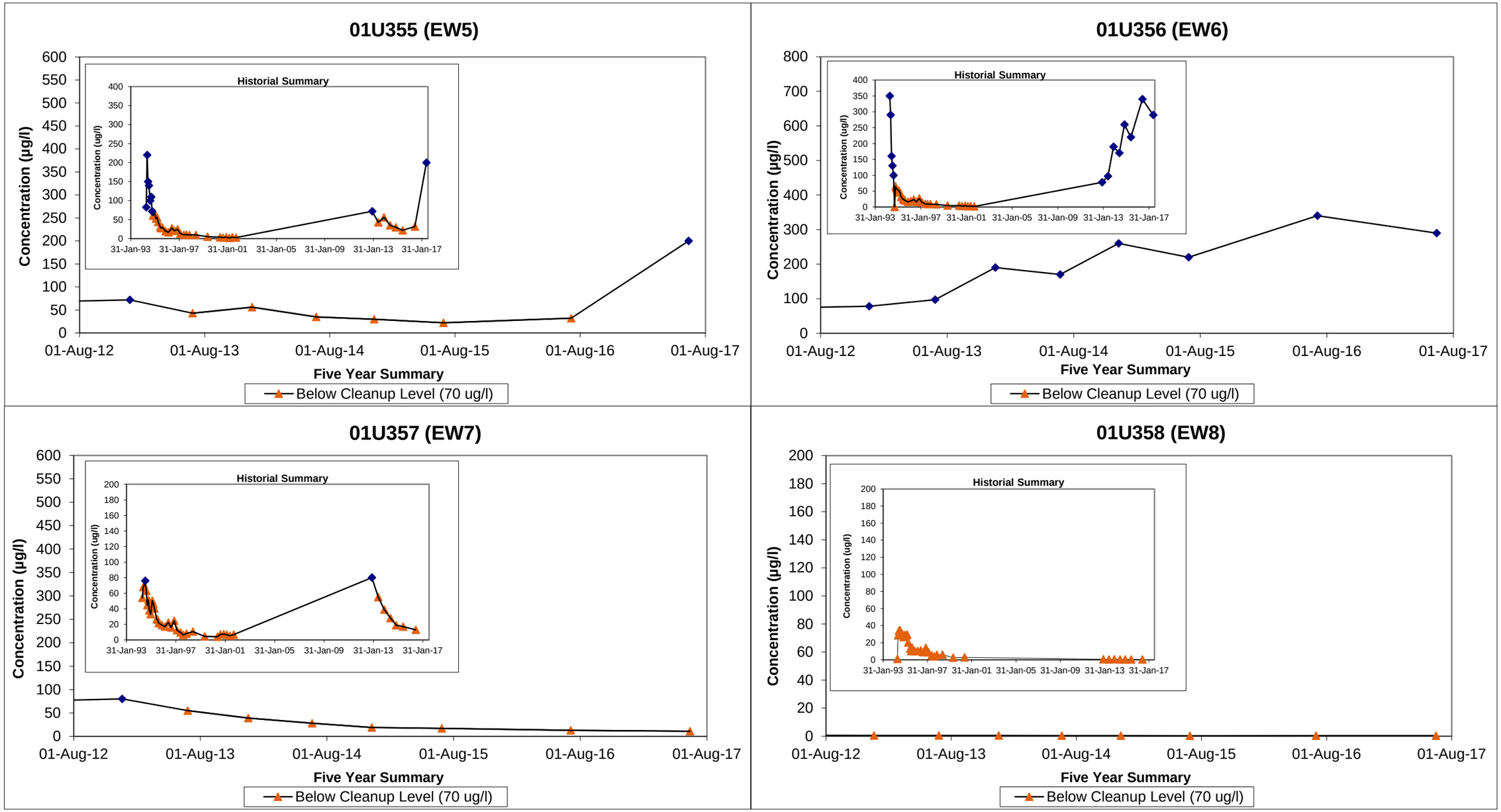
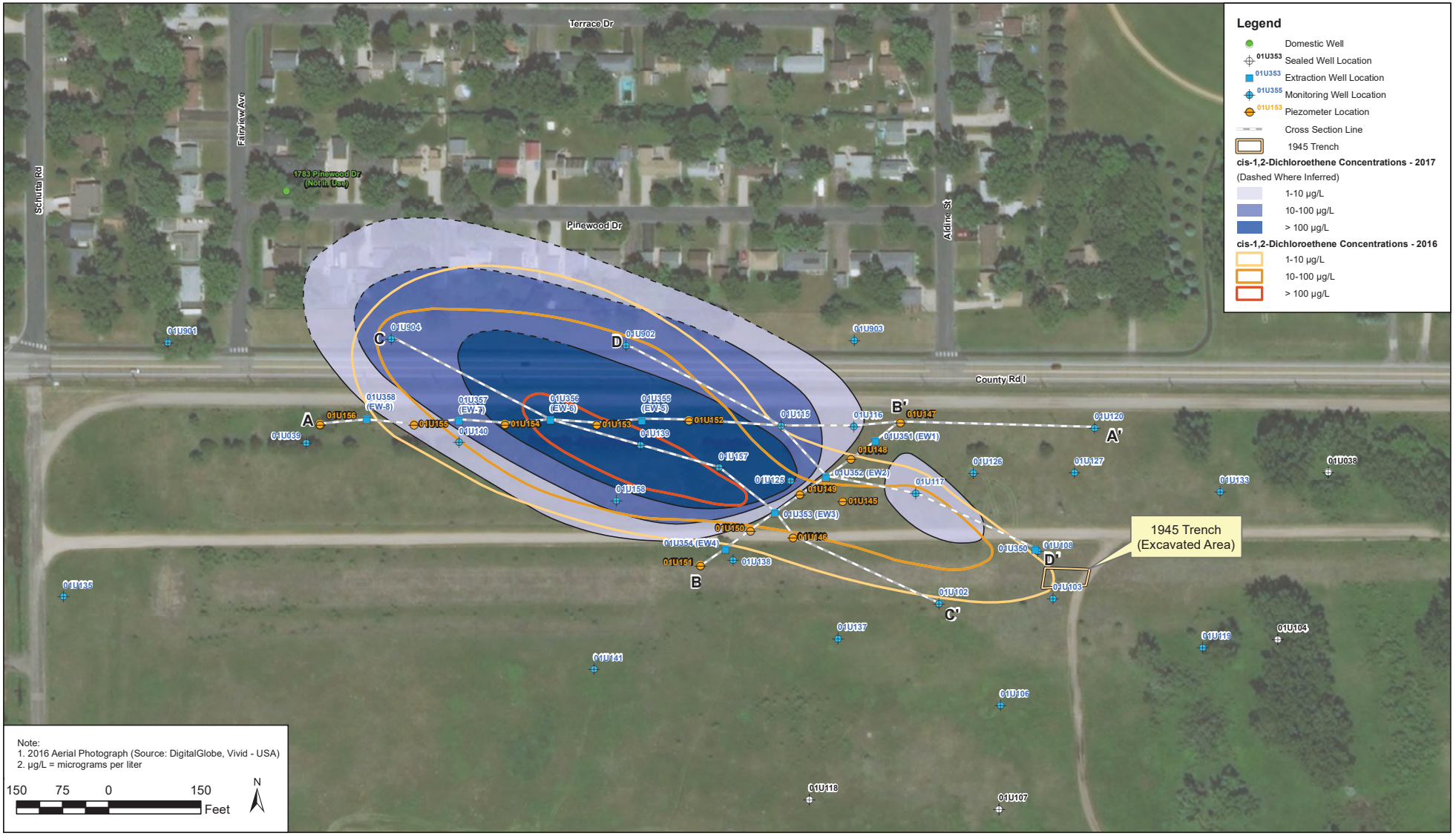
a joint venture



Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

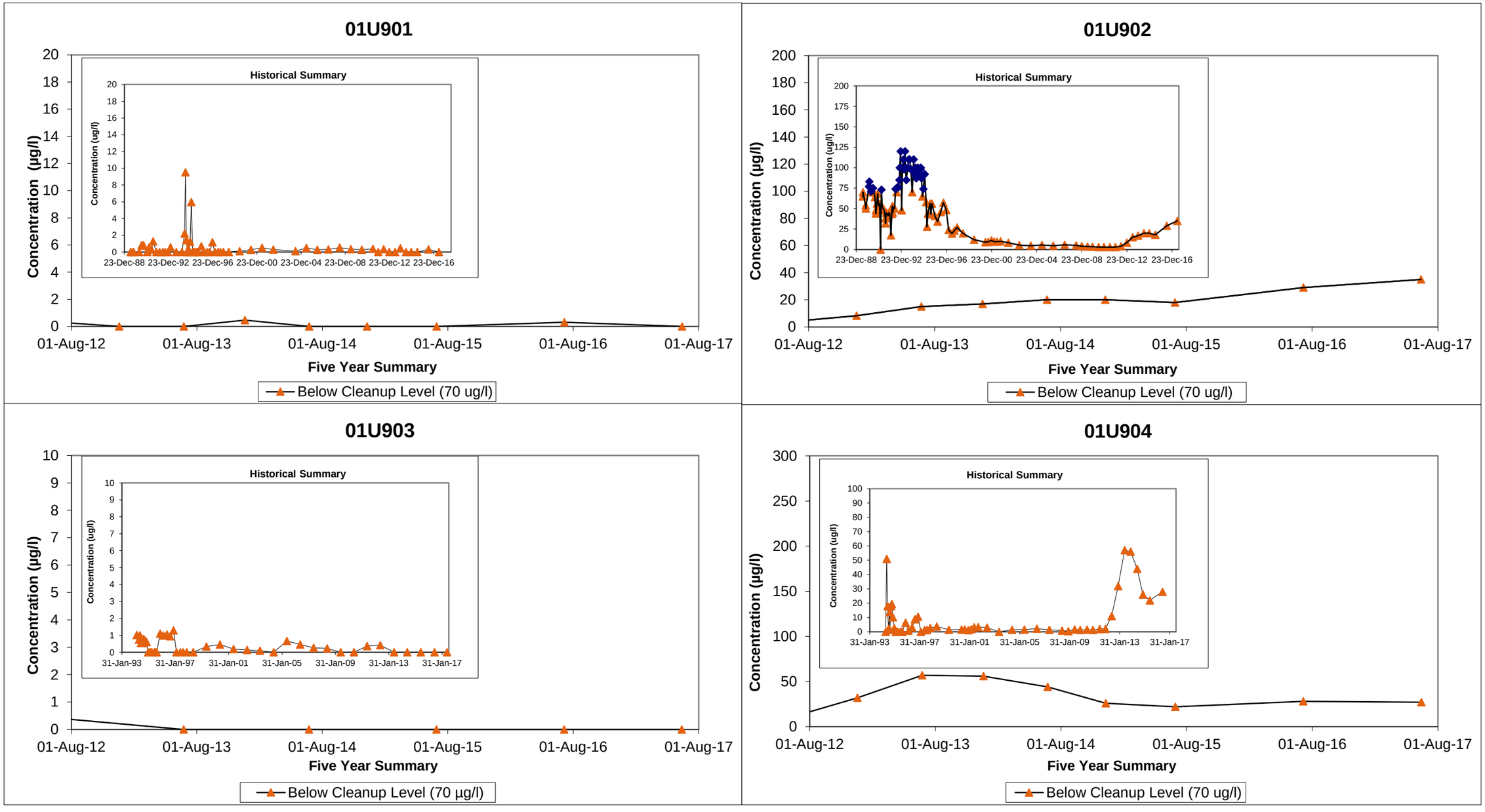


ANNUAL PERFORMANCE REPORT	PIKA ARCADIS a joint venture	FY 2017
Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison		Figure 61

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Site A cis-1,2 DCE Plume Comparison Map_FY2017.mxd
Date: 5/15/2018 Time: 12:44:07 PM User: mgress

Figure 62
Site A, cis-1,2-Dichloroethene Water Quality Trends: Contingency Locations
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture

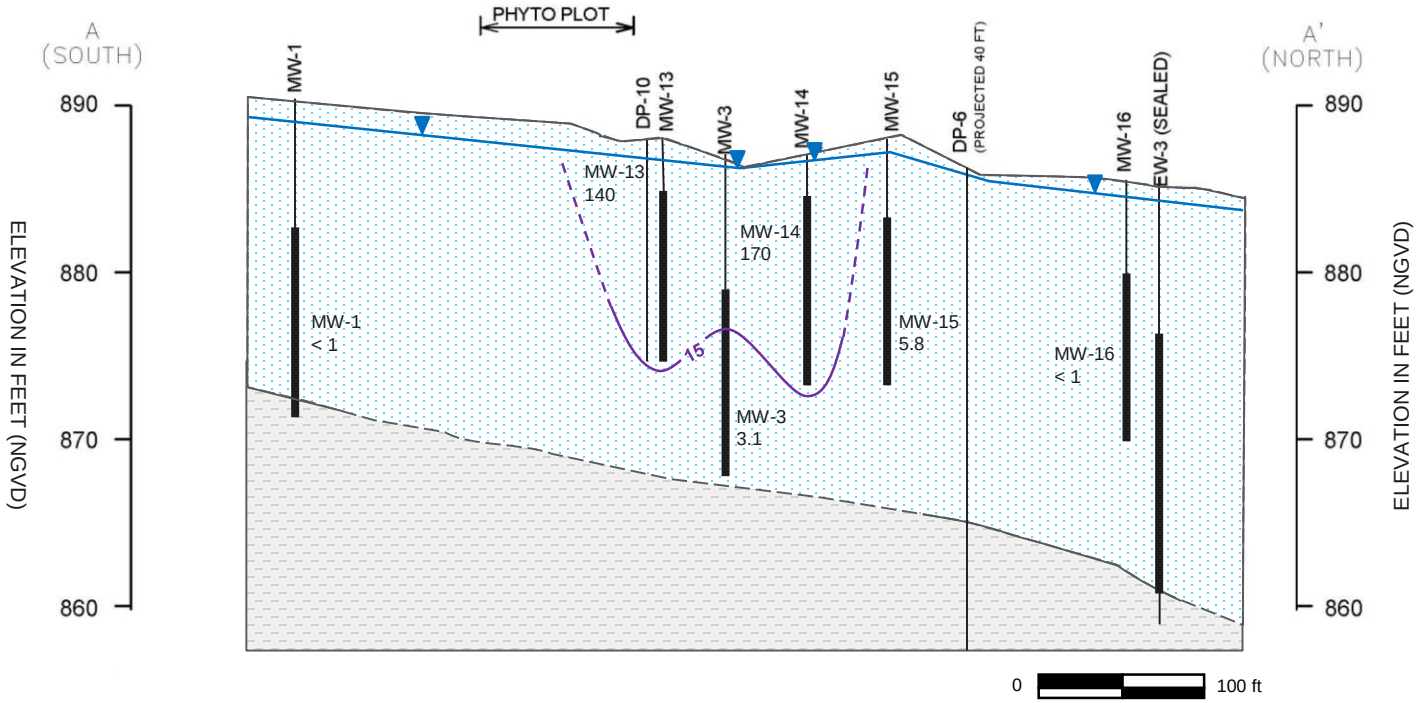


Acronyms and Abbreviations:
µg/L = micrograms per liter

Figure 63
Site C Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA ARCADIS a joint venture



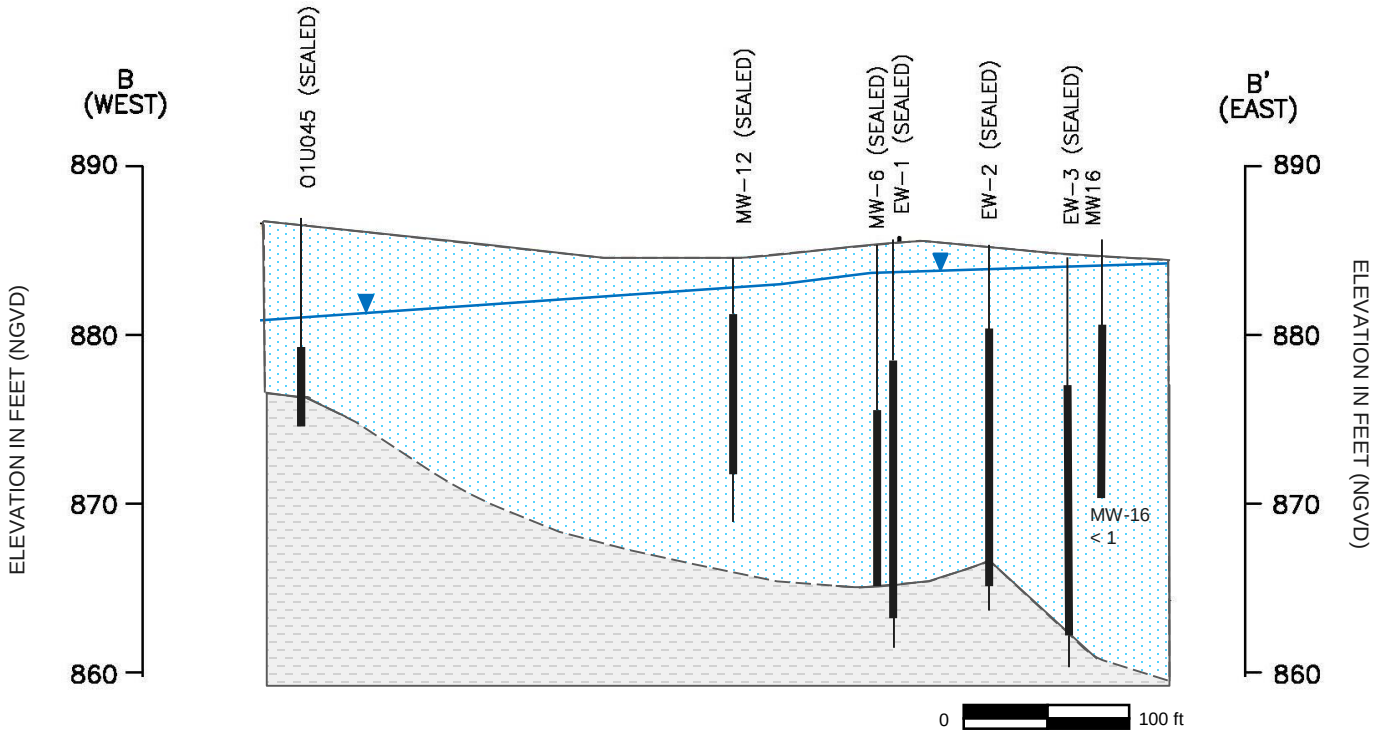
Legend

- Upper Unit 1
- Upper Unit 2
- Water Table
- Screened Interval
- Geologic Contact (inferred where dashed)
- MW-3 Well ID
- µg/L Micrograms per Liter
- 15 µg/L Dissolved Lead Concentration Contour (Groundwater Cleanup Level) dashed where inferred
- 1.6 Dissolved Lead (µg/L) – June 2017
- NGVD National Geodetic Vertical Datum

Figure 64
Site C Cross Section B-B'

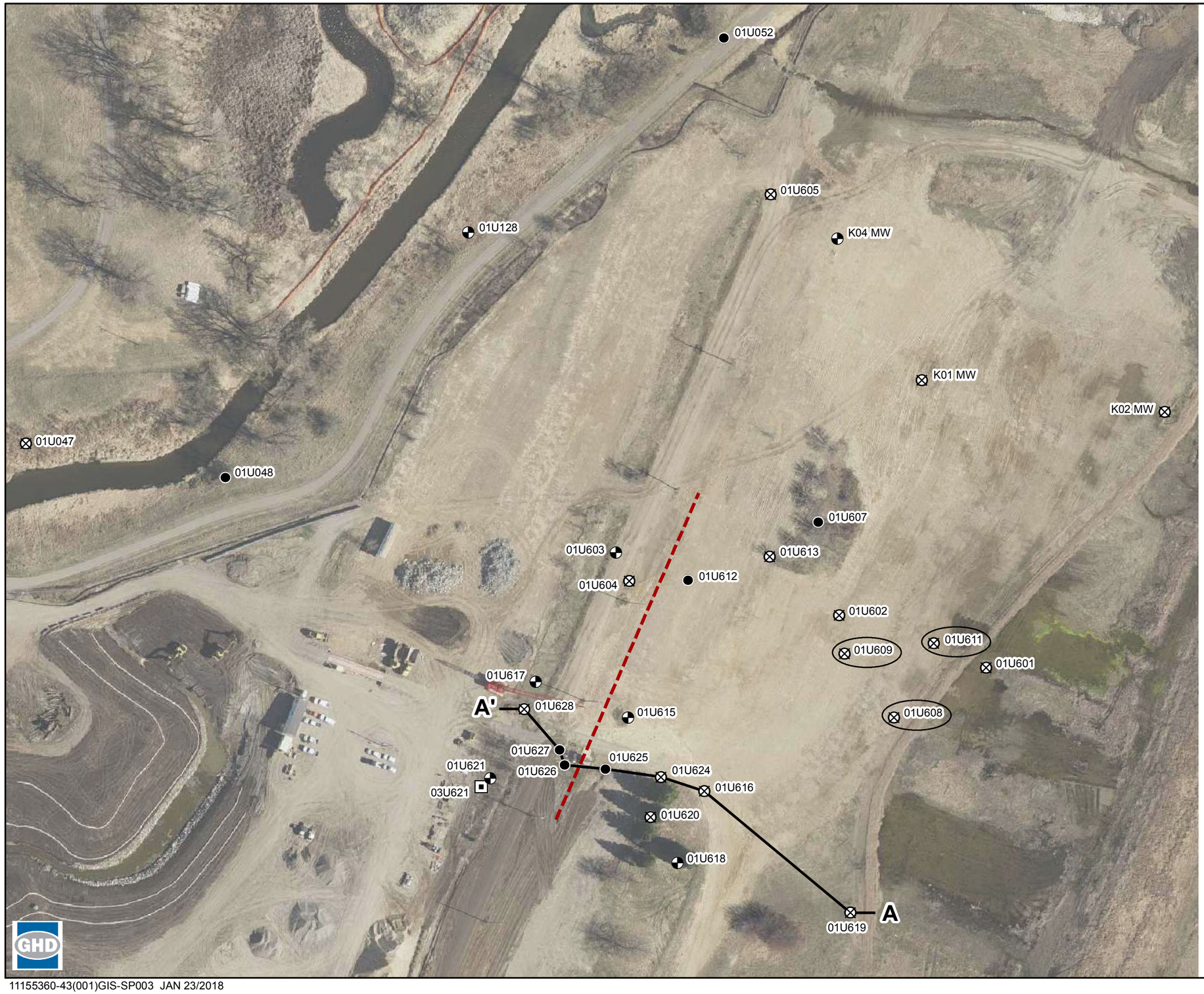
U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture



Legend

- Upper Unit 1
- Upper Unit 2
- Water Table
- Screened Interval
- Geologic Contact (inferred where dashed)
- MW-6 Well ID
- µg/L Micrograms per Liter
- 0.30 U Dissolved Lead (µg/L) – July 2017
- NGVD National Geodetic Vertical Datum



N

0 40 80 120 ft

LEGEND

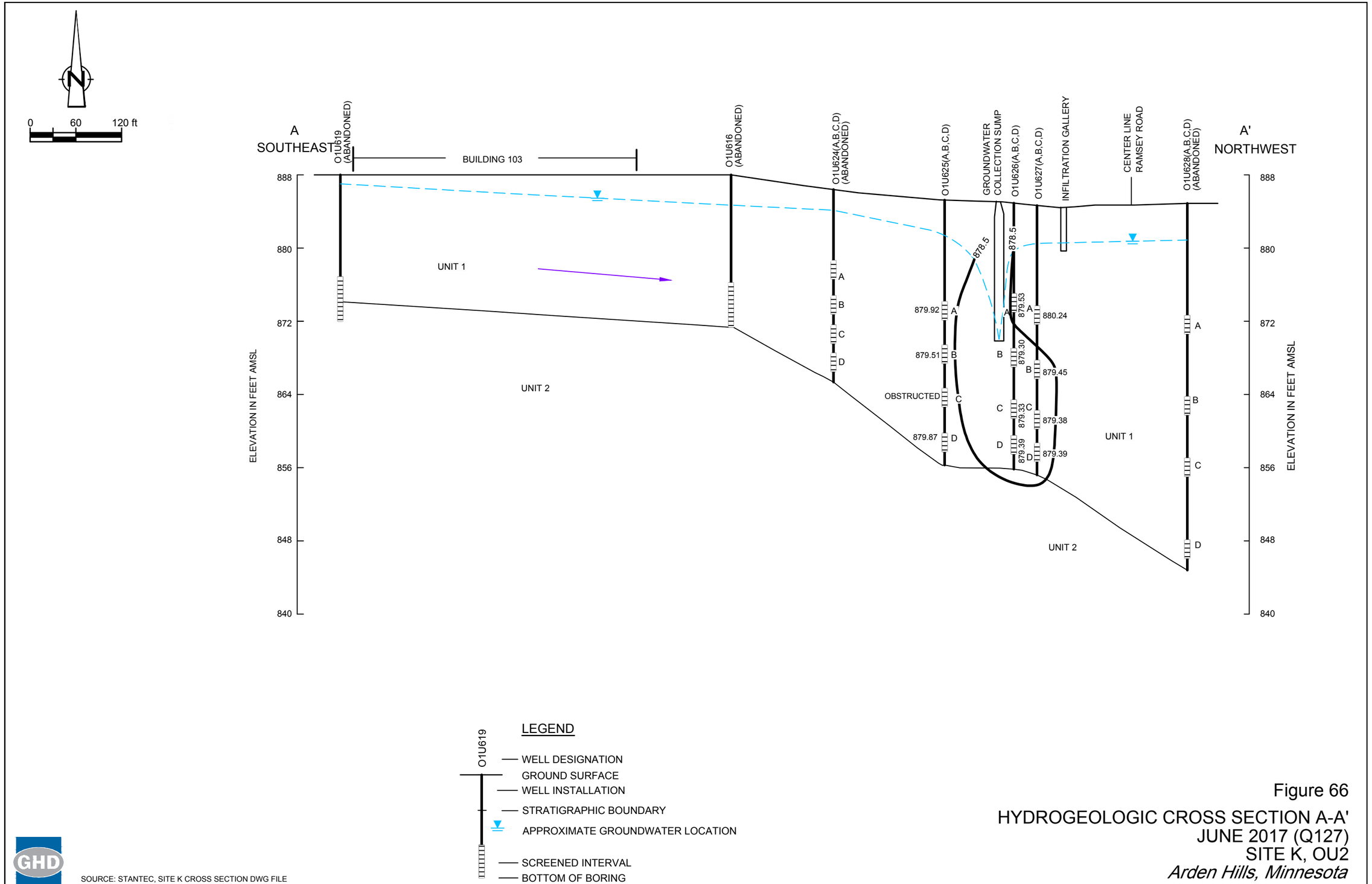
- ANNUAL UNIT 1 WATER QUALITY MONITORING WELL LOCATION
- ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
- UNIT 3 SENTINAL WELL LOCATION
- WELL ABANDONED DURING REDEVELOPMENT
- ABANDONED WELL TO BE REPLACED
- SITE K COLLECTION TRENCH LOCATION
- HYDROGEOLOGIC CROSS SECTION LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

Figure 65

SITE PLAN
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP003 JAN 23/2018



LEGEND

O1U619 — WELL DESIGNATION

GROUND SURFACE

WELL INSTALLATION

STRATIGRAPHIC BOUNDARY

APPROXIMATE GROUNDWATER LOCATION

SCREENED INTERVAL

BOTTOM OF BORING

SOURCE: STANTEC, SITE K CROSS SECTION DWG FILE

Figure 66

HYDROGEOLOGIC CROSS SECTION A-A'
JUNE 2017 (Q127)
SITE K, OU2
Arden Hills, Minnesota

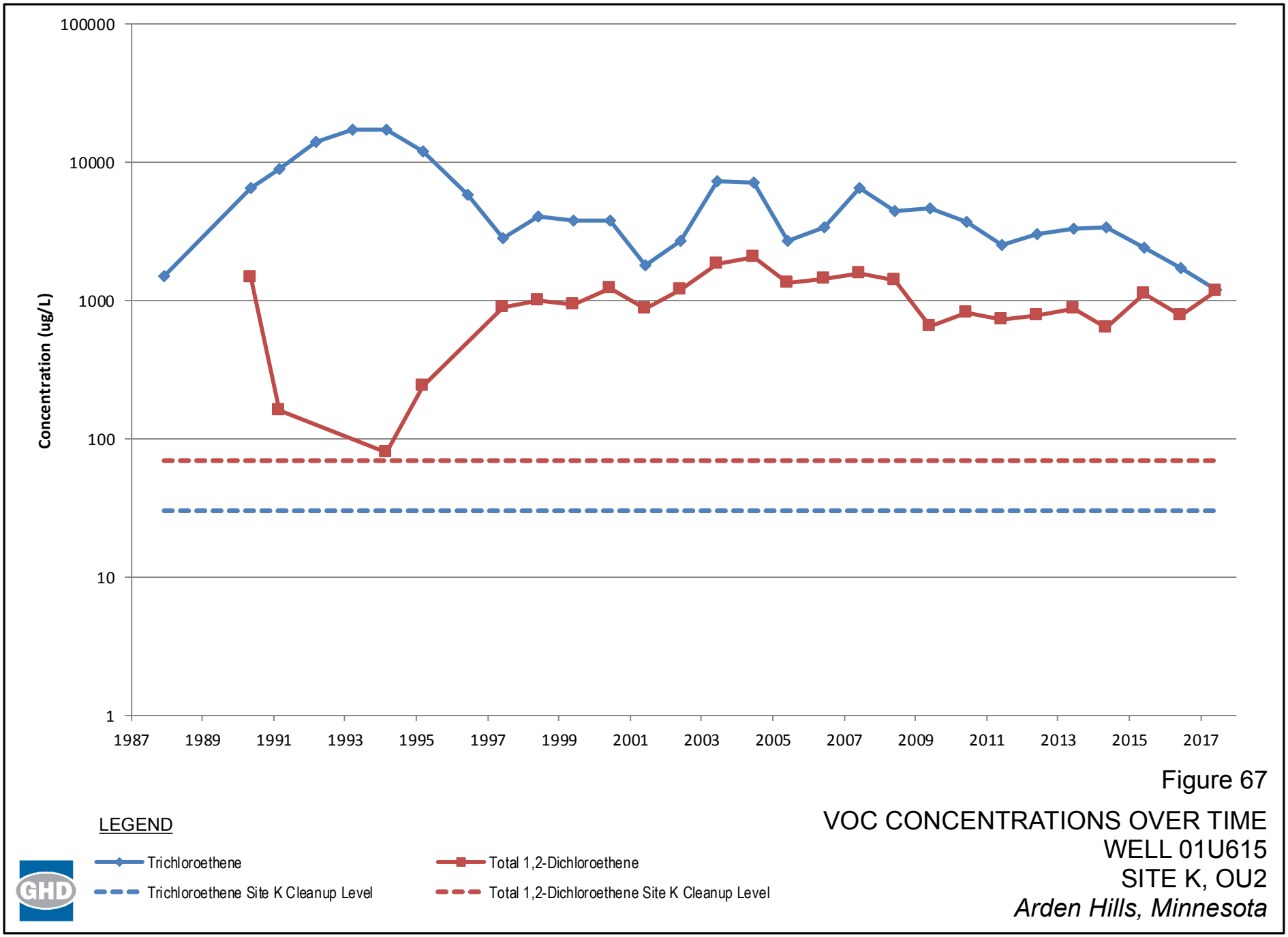
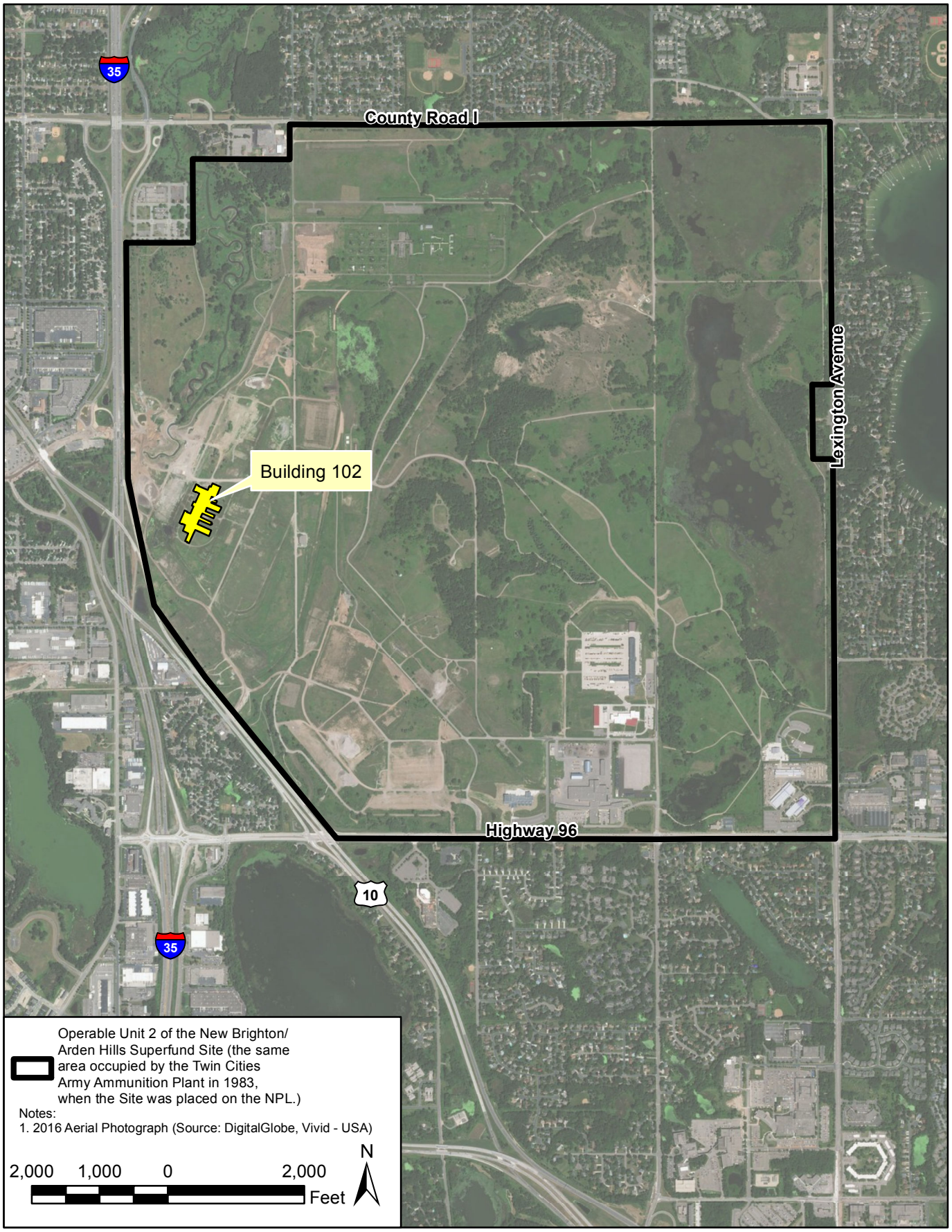


Figure 67

VOC CONCENTRATIONS OVER TIME
WELL 01U615
SITE K, OU2
Arden Hills, Minnesota

11155360-43(001)GIS-SP006 JAN 09/2018



ANNUAL PERFORMANCE REPORT

Location of Building 102

PIKA ARCADIS a joint venture

FY 2017

Figure 68

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Location Map_FY2017.mxd
Date: 1/24/2018 Time: 10:27:00 AM User: mgress

Legend

- 01U578 Sealed Well Location
- 01U048 / 875.27 Monitoring Well Location, Groundwater Elevation (ft amsl)
- 876 Groundwater Elevation Contour (ft amsl) (Dashed Where Inferred)
- Geologic Cross-Section Line
- Building 102

Notes:
1. Lowest well in well nests was used for contouring.
2. Water levels in parenthesis were not used for contouring.
3. Groundwater elevations measured June 12th and 13th, 2017 for Building 102 and June 8, 2017 for Site K.
4. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
5. ft amsl = feet above mean sea level

200 100 0 200 Feet

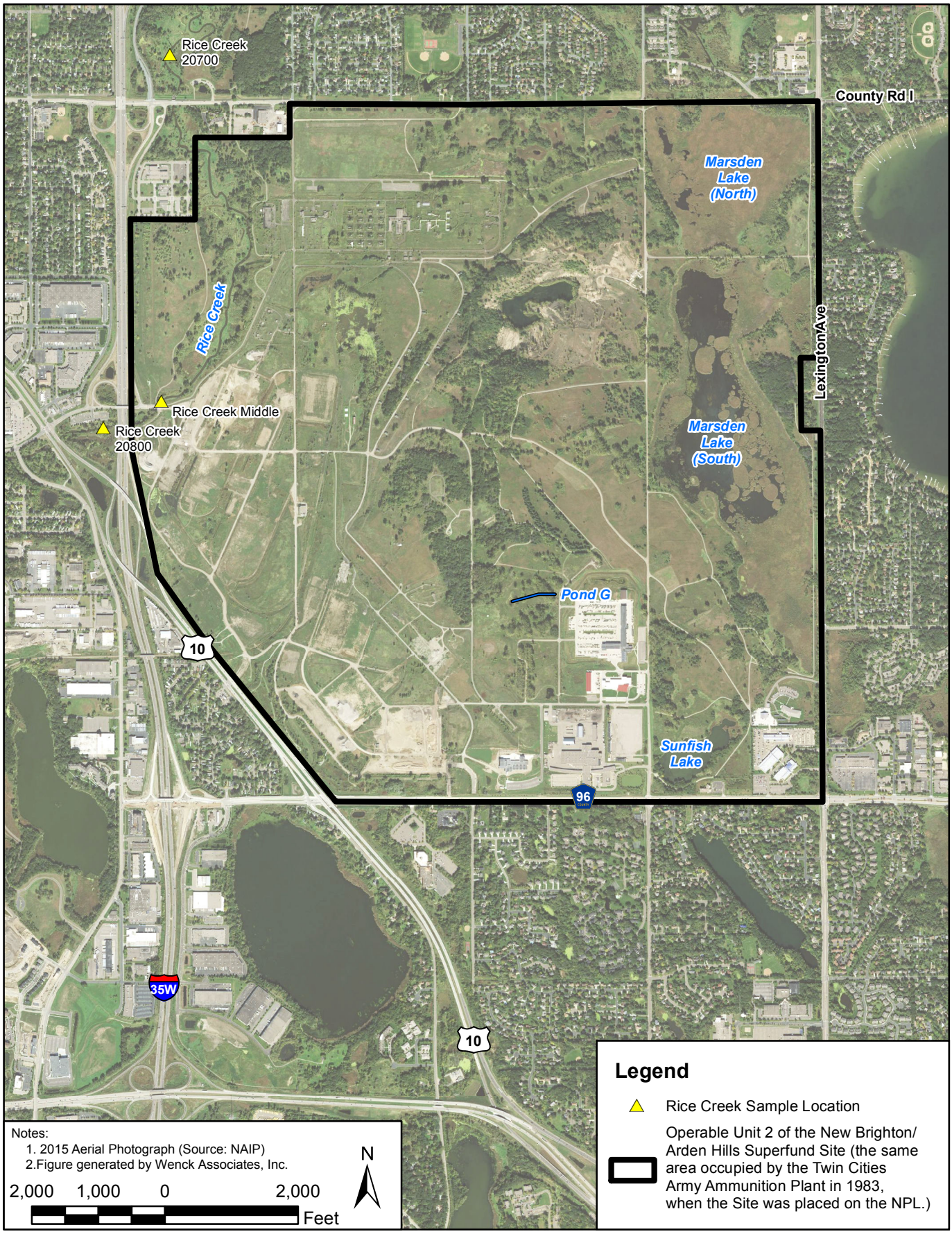
N

Former Building 102

ANNUAL PERFORMANCE REPORT	FY 2017
Building 102, Unit 1, Potentiometric Map, June 2017	Figure 69

PIKA ARCADIS a joint venture

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\Bldg 102 Potentiometric Map_FY2017.mxd
Date: 1/30/2018 Time: 3:46:43 PM User: mgress



ANNUAL PERFORMANCE REPORT

OU2 Aquatic Sites and Sampling Locations

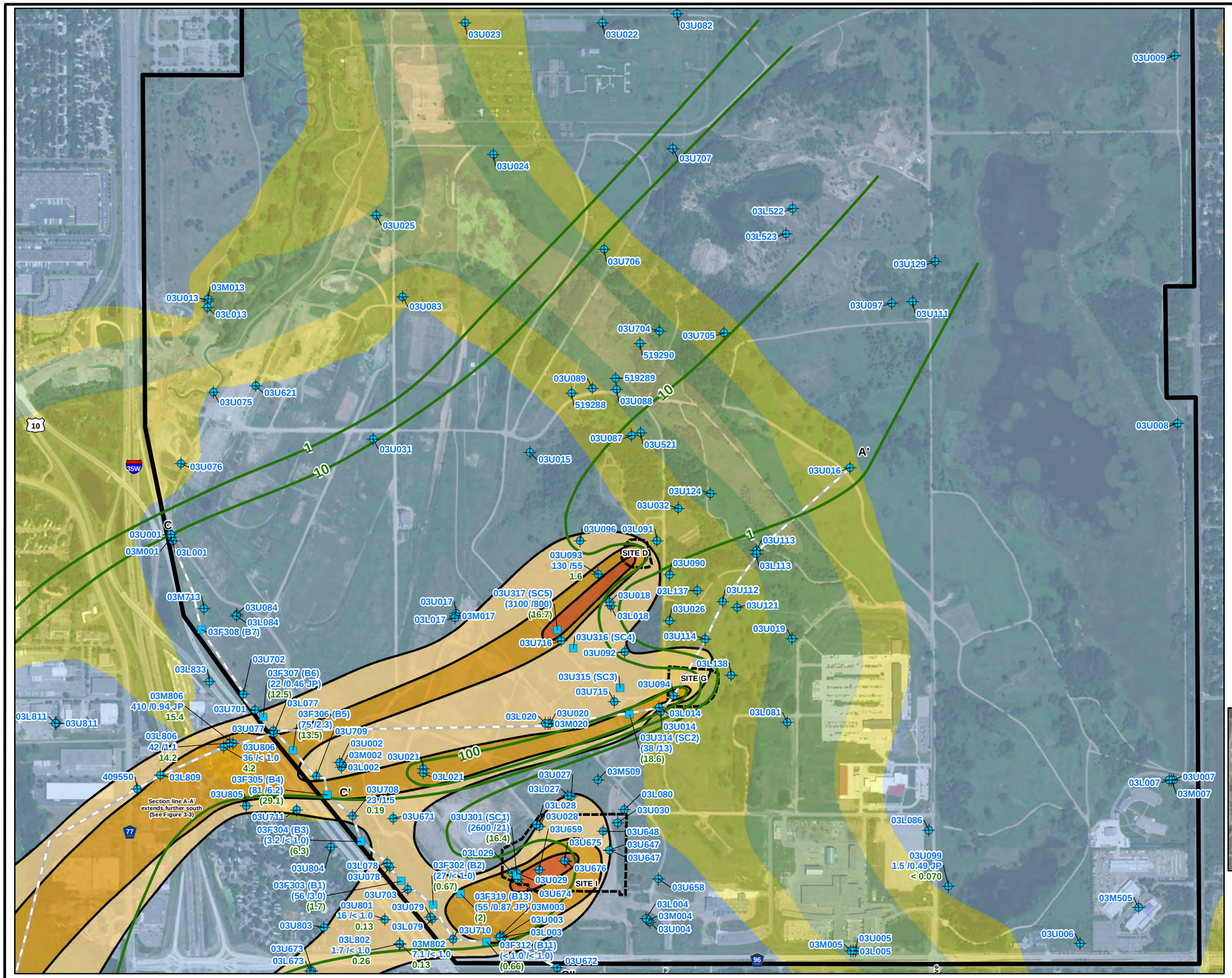
PIKA

ARCADIS

a joint venture

FY 2016

Figure 70



Legend

- Monitoring Well Location
- 03U093 — Monitoring Well ID
- 130/55 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 1.6 — 1,4-Dioxane Concentration (µg/L)
- Extraction Well Location
- Cross-Section Line
- Site Boundary
- 2017 1,4 Dioxane Concentration Contour (µg/L)

2017 Trichloroethene Concentrations (µg/L)

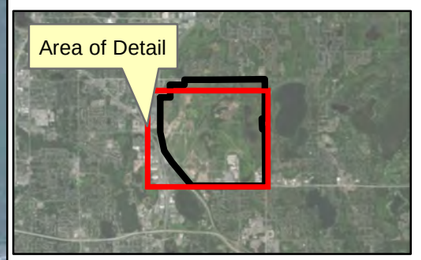
Upper and Lower Unit 3

- 5-100
- 100-1,000
- 1,000+
- Operable Unit 2

Bedrock Geology

- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Notes:
1. 03F and 03U extraction wells are shown with data in parentheses, but concentrations were not used for contouring (except for SC-3 and SC-4, which were used for contouring since they are being sampled as monitoring wells and since they are screened only within Upper Unit 3).
2. Results are from groundwater samples collected in June 2017.
3. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
4. Mossler, John H.. (2013). M-194 Bedrock Geology of the Twin Cities Ten-County Metropolitan Area, Minnesota. Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/154925
5. µg/L = micrograms per liter



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01\APR_2017\OU2_QA_TCE_DIOX_2017.mxd

ANNUAL PERFORMANCE REPORT	FY 2017
OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2017	Figure 71

PIKA ARCADIS a joint venture

Appendix A

Site Inspection Checklists

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: *Operable Unit 1 New Brighton/Arden Hills Superfund Site*	**Date of inspection:** *1 November 2018*
Location and Region: *Arden Hills/MN/EPA Region 5*	**EPA ID:** *MN 7213820908*
Agency, office, or company leading the five-year review: *U.S. Army*	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***Scott Boller, City of N.B.*** ***Public Works Superintendent*** ***11/01/18***
   Name Title Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***651-638-2119***
   Problems, suggestions; ☒ Report attached ***see interview***
   _____

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 _____***N/A***_____
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.

N/A

Operable Unit 1

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   O&M manual ☒ Readily available ☒ Up to date ☐ N/A
   As-built drawings ☒ Readily available ☒ Up to date ☐ N/A
   Maintenance logs ☒ Readily available ☒ Up to date ☐ N/A
   Remarks_ ***Assurances made that records continue to be maintained as required. Review was unavailable due to construction activity at site and records being inaccessible***

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A
   ☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☒ N/A
   Remarks***: See above***

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☐ N/A
   Remarks***: See above***

4. **Permits and Service Agreements**
   ☐ Air discharge permit ☐ Readily available ☐ Up to date ☒N/A
   ☐ Effluent discharge ☐ Readily available ☐ Up to date ☒N/A
   ☒ Waste disposal, POTW ☐ Readily available ☐ Up to date ☐ N/A
   ☒ Other permits See below ☒ Readily available ☒Up to date ☐ N/A
   Remarks
   A RCRA Hazardous Waste Generator permit is on file for the transportation and regeneration of spent granular activated carbon
   A MDNR permit is on file for the appropriation of groundwater

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks_____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks_____

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A
   Remarks_____
   Due to detection of 1,4-dioxane in the NBCGRS wells, the NBCGRS was shut down on April 15, 2015, including the Fridley Interconnection. The City had switched to pumping water primarily from their deep aquifer wells that did not have detectable 1,4-dioxane. The City of New Brighton has subsequently switched to getting it's drinking water from the City of Minneapolis. This has been referred to as a "remedy time-out," and normal OU1 remedy pumping will not be resumed until a technology is selected and modification of the New Brighton treatment system is designed and constructed, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCRS wells can be safely restored. The remedy time-out continued throughout FY 2016 FY 2017 and FY2018.

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A
   Remarks_____

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☒ Water (effluent)	☒ Readily available	☒ Up to date	☐ N/A

Remarks_____

_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒N/A

Remarks ***Site under construction security alarms in place***

_____

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***: City of New Brighton***

2. **O&M Cost Records**

☐ Readily available ☐ Up to date
☒ Funding mechanism/agreement in place
Original O&M cost estimate ***$705,000 (OU 1 ROD, 1993 dollars)*** ☐ Breakdown attached

Total annual cost by year for review period if available

From Date	To Date	Total cost	☐ Breakdown attached
From Date	To Date	Total cost	☐ Breakdown attached
From Date	To Date	Total cost	☐ Breakdown attached
From Date	To Date	Total cost	☐ Breakdown attached
From Date	To Date	Total cost	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

_____

_____

_____

_____

_____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

Operable Unit 1

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks ***Gates in place during construction***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks ***Access notices posted on gates; security system in place***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

LUCs: 1) Maintain the Minnesota Department of Health (MDH) Special Well Construction Area (SWCA)

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by)***Self reporting through the Annual Performance Report in which the Army reports on MDH SWCA status***
Frequency ***Annual***
Responsible party/agency ***Army***
Contact _____***Nick Smith Army*** ***Commander's Representative*** ***210-466-1707***
Name Title Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒No ☐ N/A
Other problems or suggestions: ☐ Report attached

_____
_____
_____
_____

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks ***The current SWCA boundary encompasses the entire OU1 groundwater plume. The objective of the LUC is to prevent uses of contaminated groundwater that pose an unacceptable risk to human health***.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks ***Site under construction but roads/access in good order***

B. Other Site Conditions

Remarks ***As previously stated, site is currently under construction, but facilities appeared in good order as operators prepared to restart system. Further information on startup will be available once commissioning report is prepared***

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ 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 ***Due to detection of 1,4-dioxane in the NBCGRS wells, the NBCGRS was shut down on April 15, 2015, including the Fridley Interconnection. The City had switched to pumping water primarily from their deep aquifer wells that did not have detectable 1,4-dioxane. The City of New Brighton has subsequently switched to getting it's drinking water from the City of Minneapolis. This has been referred to as a "remedy time-out," and normal OU1 remedy pumping will not be resumed until a technology is selected and modification of the New Brighton treatment system is designed and constructed, such that both VOCs and 1,4-dioxane are removed and primary pumping of the NBCRS wells can be safely restored. The remedy time-out continued throughout FY 2016 FY 2017 and FY2018.***

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 ☐ Is of acceptable quality

2. Monitoring data suggests:
☐ Groundwater plume is effectively contained ***See Report discussion***
☒ Contaminant concentrations are declining

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

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: *OU2, Deep Groundwater New Brighton/Arden Hills Superfund Site*	**Date of inspection:** *31October 2018*
Location and Region: *Arden Hills/MN/EPA Region 5*	**EPA ID:** *MN 7213820908*
Agency, office, or company leading the five-year review: *U.S. Army*	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***Shawn Horn, GHD*** (Name) ***Vice-President*** (Title) ***October 31st 2018*** (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ***612-524-6860***
   Problems, suggestions; ☐ Report attached _____

2. **O&M staff** ***Rob Field, GHD*** (Name) ***Plant Operator*** (Title) ***October 30th 2018*** (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ***952-210-7601***
   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 ***N/A***
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.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ As-built drawings — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ Maintenance logs — ☒ Readily available — ☒ Up to date — ☐ N/A

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Most recent monitoring reports are available in the 2017 Annual Performance Report.***

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

   Remarks_____

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

   Remarks ***Discharge Monitoring results are available in the 2017 APR.***

10. **Daily Access/Security Logs** — ☐ Readily available — ☐ Up to date — ☒ N/A

    Remarks ***Pump and treat system is a fenced facility under lock and key***

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 ***$732,000 (OU2 ROD, 1997 Dollars)*** ***$117.87/lb. VOCs***

   Total annual cost by year for review period if available

From ***October 2013***	***To September 2014***	***$590,868***	***$292.50***
Date	Date	Total cost	Cost per pound of VOCs
From ***October 2014***	***To September 2015***	***$628,282***	***$359.42***
Date	Date	Total cost	Cost per pound of VOCs
From ***October 2015***	***To September 2016***	***$703,828***	***$406.60***
Date	Date	Total cost	Cost per pound of VOCs
From ***October 2016***	***To September 2017***	***$719,273***	***$361.80***
Date	Date	Total cost	Cost per pound of VOCs
From ***October 2017***	***To September 2018***	***$805,917***	***TBD***
Date	Date	Total cost	Cost per pound of VOCs

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
   Remarks_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
   Remarks ***Site fenced and under lock and key***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**
Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ***Inspection***
Frequency ***Annual***
Responsible party/agency U.S. Army
Contact ***Nick Smith*** ***Commander's Representative*** ***210-466-1707***
Name Title Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks: ***On April 20, 2016, the MDH issued a memorandum updating the Special Well and Boring Construction Area (SWBCA) that noted the rezoning of the TCAAP facility for future development and updated the SWBCA boundary to include the entirety of TCAAP. As such, all wells and borings constructed or modified within the SWBCA must first be approved by the MDH.***

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks_____

B. Other Site Conditions

Remarks ***None***_____

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ 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

Operable Unit 2 Deep
Groundwater

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☒ Air stripping ☐ Carbon absorbers
   ☐ 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 ***929,926,100 gallons of water from October 2016 through September 2017.***
   ☐ 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 ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

Data is collected and submitted in APRs

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Hydraulic influence in Units 3 and 4 extends upgradient within OU2 beyond the 5 µg/L contour, meeting VOC criterion in the OU2 ROD.

The total average extraction well water pumped exceeded Total System Operational Minimum (1,745 gpm). The FY 2017 annual average extraction rate was 1,769 gpm.

The TGRS extracted and treated 929,926,100 gallons of water and removed 1,988 pounds of VOCs from October 2016 to September 2017. Average VOC influent concentrations increased by 12.9%from FY 2016.

Groundwater analytical data of the source area show a general decrease in TCE concentration. This concentration decrease demonstrates that the TGRS is effectively removing VOC mass from the aquifer.

Effluent VOC concentrations were below contaminant-specific requirements for all sampling events

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.

The extensive PM program permits the operations staff to identify and repair or replace equipment to avoid a downtime failure. The program consists of monthly, quarterly and annual maintenance tasks. When required, further repair work is scheduled rather than waiting for the failure to occur. A broad range of system-specific information is collected and this information is used to direct future repair work.

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***
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ***On behalf of the Army, the Arcadis/Pika Joint Venture completed a Remedy Review during the summer of 2018. Through this remedy review, the following combination of both short-term and long-term improvement steps have been identified to improve performance:*** • ***Adopt an optimized capture approach based on overall plume mass recovery opposed to the existing TGRS Operating Strategy prescriptive flow rate;*** • ***Rebalance the TGRS pumping operations to target the groundwater plume core;*** • ***Enhance source control and source mass recovery via new supplemental source zone wells;*** • ***Incorporate targeted 1,4-dioxane treatment to address areas where 1,4-dioxane is most concentrated and treatment can provide the most significant OU2 benefit;*** • ***Under the optimized program, continue to leverage performance monitoring data to optimize extraction rates, maximize mass recovery, and eliminate redundant wells from the extraction program; and*** • ***As supplemental source control extraction results in additional OU2 improvement, discontinue TGRS operations entirely and rely only on source control extraction wells.***

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ***Operable Unit 2, Deep Soil Sites (D and G) New Brighton/Arden Hills Superfund Site***	**Date of inspection:** ***31October 2018***
Location and Region: ***Arden Hills/MN/EPA Region 5***	**EPA ID:** ***MN 7213820908***
Agency, office, or company leading the five-year review: ***U.S. Army***	**Weather/temperature:** ***Partly Cloudy 53 degrees***

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

_____

Attachments: ☒ Inspection team roster identified in report ☒ Site map attached ***See Report***

II. INTERVIEWS (Check all that apply)

1. ***Protective Soil Cover***

O&M site manager ***Mary Lee, National Guard*** ***AHATS Coordinator*** ***29 October 2018***
Name Title Date

Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***651-282-4420***

Problems, suggestions; ☐ Report attached _____

_____

2. **O&M site manager** ***Nick Smith*** ***Commander's Representative*** ***29 October 2018***
Name Title Date

Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***210-466-1707***

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 _____***N/A***_____
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.

Nick Smith US Army Commander's Representative

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual ☐ Readily available ☒ Up to date ☐ N/A
   - ☐ As-built drawings ☐ Readily available ☒ Up to date ☐ N/A
   - ☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A

   Remarks_____

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

   Remarks

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Provided in relevant Annual Performance Reports***

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☐ N/A

    Remarks ***Sites D and G are on property controlled by the National Guard (AHATS) which is a secure facility***.

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 ☒ N/A ***Historically Minimal costs***
☒ 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: ***N/A***_____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks_____ ***Sites D and G are on property controlled by the National Guard (AHATS) which is a secure facility. A small hole in the fence was observed but repairs and maintenance were being undertaken in the area***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks ***See above. In addition, signage has been placed at the perimeter of both sites cautioning against disturbance of the site covers***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply LUCs not properly implemented ☐ Yes ☒No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Inspection
Frequency ***Required annually but performed on a routine basis***
Responsible party/agency ***National Guard***
Contact ***Mary Lee, National Guard*** ***AHATS Coordinator*** ***651-282-4420***
Name Title Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Have there been violations ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

_____
_____
_____
_____

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks_____
_____
_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks_____
_____

B. Other Site Conditions

Remarks ***None***

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Areal extent_____ Depth_____
   Remarks_____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ 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 ☒ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** ☒ 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 ☒ No evidence of slope instability Areal extent_____ Remarks_____ _____
B. Benches ☐ Applicable ☒ 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.)
C. Letdown Channels ☐ Applicable ☒ 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.)
D. Cover Penetrations ☐ **Applicable** ☒ **N/A**
E. Gas Collection and Treatment ☐ Applicable ☒ N/A
F. Cover Drainage Layer ☐ Applicable ☒ N/A
G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A
H. Retaining Walls ☐ **Applicable** ☒ **N/A**
I. Perimeter Ditches/Off-Site Discharge ☐ **Applicable** ☒ **N/A**
VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**
IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ **Applicable** ☒ **N/A**

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.-***See discussion below:***

For purposes of the OU2 ROD, Sites D and G were considered deep soil sites because VOC contamination extended to depths between 50 and 170 feet. Some additional shallow soil contaminants were also present at Site D, and Site G also contains a dump. The OU2 ROD describes seven remedy components to be implemented for these two sites:
Remedy Component #1: Groundwater Monitoring,
Remedy Component #2: Restrict Site Access (During Remedial Actions),
Remedy Component #3: Soil Vapor Extraction (SVE) Systems,
Remedy Component #4: Enhancements to the SVE Systems,
Remedy Component #5: Maintain Existing Site Caps,
Remedy Component #6: Maintain Surface Drainage Controls, and
Remedy Component #7: Characterize Shallow Soils and Dump.
For Remedy Component #1, ongoing groundwater monitoring near these two sites is completed as part of OU2 deep groundwater monitoring. Remedy Components #2 to #6 were related to continued operation of the SVE systems that had been installed in 1986, shut down in 1998 and subsequently removed completing Remedy Components #2 to #6. Regarding Remedy Component #7, additional shallow soil investigation work (for non-VOC contaminants) was completed at Site D, and characterization work of the dump was completed at Site G, which completed this remedy component. The investigation/characterization work led to removal of shallow soils at Site D and construction of a cover at Site G, which were documented through OU2 ROD Amendment #3.
In summary, the deep soil requirements of the OU2 ROD have been completed. There are ongoing LUC requirements for the shallow soil at Site D and the dump at Site G, as discussed previously

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.).

See discussion above

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.

As previously identified, O&M consists of ensuring that soil and cover at both sites remains undisturbed using perimeter signage and that the vegetative cover is maintained to avoid development of woody growth. Both practices are in good order and protective of soil covers.

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***
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ***None***

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ***Operable Unit 2, Shallow Soil Sites (Sites A, C, E, H, 129-3, 129-5, Dump Site 129-15, Grenade Range, and Outdoor Firing Range) New Brighton/Arden Hills Superfund Site***	**Date of inspection:** ***29 October 2018 – 1November 2018***
Location and Region:	**EPA ID:** ***MN 7213820908***
Agency, office, or company leading the five-year review:	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Land use controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***Nick Smith*** ***Commander's Representative*** ***29 October 2018***
   Name Title Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***210-466-1707***
   Problems, suggestions; ☐ Report attached _____

2. **O&M site manager** ***Mary Lee, National Guard*** ***AHATS Coordinator*** ***29 October 2018***
   Name Title Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***651-282-4420***
   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 _____***N/A***_____
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. ***N/A***

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual — ☒ Readily available — ☐ Up to date — ☐ N/A
   - ☐ As-built drawings — ☒ Readily available — ☐ Up to date — ☐ N/A
   - ☐ Maintenance logs — ☐ Readily available — ☐ Up to date — ☒ N/A

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** — ☐ Readily available — ☐ Up to date — ☐ N/A

    Remarks ***The sites are on property secured and controlled by the Army (TCAAP and AHATS)***

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: ***None***

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks ***Both TCAAP and AHATS are secured facilities with restricted access. . A small hole in the fence was observed but repairs and maintenance were being undertaken in the area***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks : ***The Army has installed signage around the perimeter of all applicable sites that caution against the disturbance of protective covers.***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**
Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Inspection
Frequency ***At a minimum annually however inspection is routine during normal site activity***
Responsible party/agency ***Army and MN Army National Guard***
Contact ***Mary Lee, National Guard Environmental Protection Specialist 651-282-4420***
Name Title Date Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks ***LUCs apply to all areas currently not cleaned to residential standards and will remain in force indefinitely with the exception of Site C which is part of Parcel A within the 108 acres to be used as part of the Rice Creek Regional Trail corridor and has been remediated to allow for recreational use,***

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks

B. Other Site Conditions

Remarks ***None***

VII. LANDFILL COVERS ☐ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent_____ Depth_____
Remarks_____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
Lengths_____ Widths_____ Depths_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_____ Depth_____
Remarks_____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
Areal extent_____ Depth_____
Remarks_____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks ***The rip rap at Sites H and 129-15 is in good condition.***

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Areal extent_____ Height_____
Remarks_____

8. **Wet Areas/Water Damage** ☒ 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 ☒ No evidence of slope instability
Areal extent_____
Remarks_____
_____

B. Benches ☐ Applicable ☒ 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.)

C. Letdown Channels ☐ Applicable ☒ 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.)

D. Cover Penetrations ☒ 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)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks_____
_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
Remarks_____
_____

E. Gas Collection and Treatment	☐ Applicable ☒ N/A
F. Cover Drainage Layer	☐ Applicable ☒ N/A
G. Detention/Sedimentation Ponds	☐ Applicable ☒ N/A
H. Retaining Walls	☐ Applicable ☒ N/A
I. Perimeter Ditches/Off-Site Discharge	☐ Applicable ☒ N/A
VIII. VERTICAL BARRIER WALLS	☐ Applicable ☒ N/A
IX. GROUNDWATER/SURFACE WATER REMEDIES	☐ **Applicable** ☒ **N/A**

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.

The nine remedy components specified in the OU2 ROD have been completed for the shallow soils and dumps at Sites A, C, D, E, G, H, K, 129-3, 129-5, 129-15, Grenade Range, Outdoor Firing Range, 135 PTA Stormwater Ditch, the eastern portion of the 135 PTA, 535 PTA, MNARNG EBS Areas, and Water Tower Area. Remedy Components #1 through #8 addressed the characterization, excavation, sorting, treatment, disposal, site restoration, site access restrictions (during remedial actions), and limited period of post-remediation groundwater monitoring. Remedy Component #9 addressed the characterization of dumps at Sites B and 129-15. The characterization work at both sites led to a determination that no further action was required at Site B and construction of a cover at Site 129-15, which were documented through ESD #2 and OU2 ROD Amendment #3, respectively. Site C is part of Parcel A within the 108 acres to be used as part of the Rice Creek Regional Trail corridor and has been remediated to allow for recreational use.

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.). ***See above***

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.

O&M activities previously described are protective of the remedy

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***
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ***None***

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ***OU2, Site A Shallow Groundwater New Brighton/Arden Hills Superfund Site***	**Date of inspection:** ***30 October 2018***
Location and Region: ***Arden Hills/MN/EPA Region 5***	**EPA ID:** ***MN 7213820908***
Agency, office, or company leading the five-year review: ***U.S. Army***	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Note: Based on a November 11, 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, the USEPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. In FY 2017, a proposed plan and ROD amendment was prepared by the Army to formally document this change. ROD Amendment #6 was signed and approved by MPCA and EPA Region 5 in March 2018.

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***Nick Smith*** (Name) ***Commander's Representative*** (Title) ***29 October 2018*** (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***210-466-1707***
   Problems, suggestions; ☐ Report attached _____

2. **O&M site manager** ***Mary Lee, National Guard*** (Name) ***AHATS Coordinator*** (Title) ***29 October 2018*** (Date)
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***651-282-4420***
   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 ***N/A*** 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.
N/A	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual ☒ Readily available ☒ Up to date ☐ N/A
   - ☐ As-built drawings ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A

   Remarks ***As-builts and old maintenance logs available but no longer required due to groundwater extraction system closure.***

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***No discharge permits required while extraction system not in operation.***

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Annual records maintained in Annual Performance Reports.***

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☐ N/A

    Remarks ***Site A is on property controlled by the Army (AHATS). AHATS is a secure facility.***

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: ***None***

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks ***AHATS is a secured facility with restricted access. . A small hole in the fence was observed but repairs and maintenance were being undertaken in the area***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks ***The Army has installed signage around the perimeter of all applicable sites that caution against the disturbance of protective covers.***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ***Inspections***
Frequency ***Routine as well as annual official inspections***
Responsible party/agency ***Army and MN Army National Guard***
Contact ***Mary Lee, National Guard Environmental Protection Specialist 651-282-4420***
Name Title Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident
Remarks ***Reports of copper theft and graffiti from structures in adjacent 135 PTA***

2. **Land use changes on site** ☒ N/A
Remarks

3. **Land use changes off site** ☒ N/A
Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks

B. Other Site Conditions

Remarks ***None***

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

Based on a November 11, 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, the USEPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. In FY 2017, a proposed plan and ROD amendment was prepared by the Army to formally document this change. ROD Amendment #6 was signed and approved by MPCA and EPA Region 5 in March 2018.

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

C. Treatment System ☐ Applicable ☒ N/A

1. **Treatment Train** (Check components that apply) ***Currently shut down and was not reviewed***
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon absorbers
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent) _____
☐ Others: ***Direct discharge to sanitary sewer when operable***
☐ 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: ***Approximately 8 million gallons when operating***
☐ 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 ***No longer operable***

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 ***Extraction wells and associated monitoring wells used in recording progress of MNA.***

D. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2.Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
Data suggests stabilization of the plume with an overall gradual reduction in concentrations,

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☒ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks ***All monitoring well data (including data from extraction wells) is included in Annual Performance Reports.***

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.).

Based on a November 11, 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, the USEPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. In FY 2017, a proposed plan and ROD amendment was prepared by the Army to formally document this change. ROD Amendment #6 was signed and approved by MPCA and EPA Region 5 in March 2018

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.

Monitoring of MNA is 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.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ***OU2, Site C Shallow Groundwater New Brighton/Arden Hills Superfund Site***	**Date of inspection:** ***31October 2018***
Location and Region: ***Arden Hills/MN/EPA Region 5***	**EPA ID:** ***MN 7213820908***
Agency, office, or company leading the five-year review: ***U.S. Army***	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment-***see note below***
- ☐ Surface water collection and treatment
- ☐ Other
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls-***see note below***

Note: ***Because the area of lead concentrations that exceed the groundwater cleanup level no longer extends to the extraction wells, the extraction system is no longer operating, and this remedy component is not currently being implemented.***

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***Nick Smith*** (Name) ***Commander's Representative*** (Title) ***29 October 2018*** (Date)

Interviewed ☒ at site ☐ at office ☐ by phone Phone no. ***210-466-1707***

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 ***N/A*** 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.
N/A	

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ As-built drawings — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ Maintenance logs — ☒ Readily available — ☒ Up to date — ☐ N/A

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Discharge system not in operation.***

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Most recent results appear in FY 2017 APR.***

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☐ N/A
Remarks ***Site C is now on property under the control of Ramsey Co. Property is currently fenced but will become part of a recreational trail system in the near future***

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: ***None***

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks ***Site C is now on property under the control of Ramsey Co. Property is currently fenced but will become part of a recreational trail system in the near future***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
   Remarks ***Signage will continue to be employed to protect the integrity of the soil cover to Site C.***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Ramsey Co. is committed to ensuring that LUCs remain protective of control over contaminated groundwater until such time that the groundwater concentrations are below the cleanup levels.

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by)***Inspection***
Frequency ***Annual inspection***
Responsible party/agency **U.S. Army**
Contact ***Nick Smith Commander's Representative 210-466-1707***

Name Title Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
   Remarks

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks_____
_____

B. Other Site Conditions

Remarks ***None***_____
_____
_____
_____
_____
_____

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ 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 ***System remains in place but is not in operation.***

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 absorbers
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☒ Others ***Direct discharge to sanitary sewer***
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date ***(log available if required)***
☐ Equipment properly identified
☐ Quantity of groundwater treated annually ***None during past 5 years***
☐ 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 ☐ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☒ N/A
Remarks_____
_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Site C is part of Parcel A within the 108 acres to be used as part of the Rice Creek Regional Trail corridor and has been remediated to allow for recreational use.
The 2007 ROD Amendment #1 prescribes four major components of the remedy, and until a decision is made to formally change the remedy, the original components of ROD Amendment #1 will be retained
Given that groundwater cleanup levels may be reached throughout Site C within a few years, it may not be necessary to go through the process of formally changing the remedy. Evaluation in future APRs will ultimately determine whether the USEPA, MPCA, and Army should formally change the remedy or, possibly, whether the site should just be closed.

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.
None

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

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.
None at this time

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: ***OU2, Site I Shallow Groundwater (Bldg. 502), New Brighton/Arden Hills Superfund Site***	**Date of inspection:** ***31October 2018***
Location and Region: ***Arden Hills/MN/EPA Region 5***	**EPA ID:** ***MN 7213820908***
Agency, office, or company leading the five-year review: ***U.S. Army***	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☐ Access controls
- ☒ Land Use controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***David Brown*** ***Northrup Grumman Innovation Systems*** ***Project Manager*** ***October 30th 2018***
Name Title Date

Interviewed ☐ at site ☒ at office ☐ by phone Phone no ***925-351-5536***

Problems, suggestions; ☐ Report attached _____

_____

2. **O&M staff** ***Shawn Horn, GHD*** ***Vice President*** ***October 30th 2018***
Name Title Date

Interviewed ☐ at site ☒ at office ☐ by phone Phone no. ***612-524-6860***

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 ***N/A***
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.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ As-built drawings ☐ Readily available ☐ Up to date ☒ N/A
   - ☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***As previously approved by the USEPA/MPCA, all Site I (Building 502) Unit 1 monitoring wells were abandoned in FY 2014 prior to the demolition of Building 502. Only well 01U667 is scheduled to be replaced, which has been delayed beyond FY 2018 due to the extent of pending regrading associated with planned site redevelopment.***

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** □ Readily available □ Up to date ☒ N/A
Remarks ***Access now under the control of Ramsey Co.-currently and active grading/restoration site.***

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_____ ***N/A***

2. **O&M Cost Records**

□ Readily available □ Up to date ☒ N/A

□ 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: ***N/A***

V. ACCESS AND LAND USE CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing damaged ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks ***Active site under control of Ramsey Co***.

B. Other Access Restrictions

1. Signs and other security measures ☐ Location shown on site map ☒ N/A

Remarks ***Active site under control of Ramsey Co***.

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Ramsey County will not allow installation of any well that withdraws water from a contaminated aquifer on the property it controls without first getting approval from the MDH, MPCA, and USEPA. Wells or other devices that do not withdraw water (e.g., geothermal heat exchangers) are not restricted (but still require the normal MDH permit).
In addition to controlling well installation, Ramsey County will not allow other activities that would reduce the effectiveness of the groundwater remedy at Site I. This includes activities that could cause damage to the monitoring well(s). It also includes activities involving recharge of groundwater in the vicinity of the contaminated groundwater.

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ***Inspection***
Frequency ***Annual***
Responsible party/agency ***Army***
Contact ***Nick Smith*** (Name) ***Commanders Representative*** (Title) ***210-466-1707*** (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐ Report attached

_____
_____
_____
_____

2.	**Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A Remarks ***Implementation of the OU 2 LUCRD will continue until such time that the groundwater concentrations are below the clean up levels***
D. General	
1.	**Vandalism/trespassing** ☐ Location shown on site map ☒ 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	☒ Applicable ☐ N/A
1.	**Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A Remarks_____ _____
B. Other Site Conditions	
	Remarks ***Active restoration Site***
VII. LANDFILL COVERS ☐ Applicable ☒ N/A	
IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A	
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.). ***As previously approved by the USEPA/MPCA, all Site I (Building 502) Unit 1 monitoring wells were abandoned in FY 2014 prior to the demolition of Building 502. Only well 01U667 is scheduled to be replaced, which was delayed beyond FY 2018 due to the extent of pending regrading associated with planned site redevelopment.***

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.

None

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 at this time

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Five-Year Review Site Inspection Checklist

I. SITE INFORMATION	
Site name: *OU2, Site K Shallow Groundwater New Brighton/Arden Hills Superfund Site*	**Date of inspection:** *31October 2018*
Location and Region: *Arden Hills/MN/EPA Region 5*	**EPA ID:** *MN 7213820908*
Agency, office, or company leading the five-year review: *U.S. Army*	**Weather/temperature:**

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Land Use Controls controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ***David Brown***

Northrup Grumman Innovation Systems ***Project Manager*** ***October 30th 20***
Name Title Date

Interviewed ☐ at site ☒ at office ☐ by phone Phone no. ***925-351-5536***
Problems, suggestions; ☐ Report attached _____

2. **O&M staff** ***Shawn Horn, GHD*** ***Vice President*** ***October 30th 2018***
Name Title Date

Interviewed ☐ at site ☒ at office ☐ by phone Phone no. ***612-524-6860***
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 ***N/A***
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.

N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ As-built drawings — ☒ Readily available — ☒ Up to date — ☐ N/A
   - ☐ Maintenance logs — ☒ Readily available — ☒ Up to date — ☐ N/A

   Remarks_____

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Air Permit not required.***

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

   Remarks_____

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

   Remarks_____

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

   Remarks ***Most recent records available in 2017 APR.***

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

   Remarks_____

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

   Remarks_____

10. **Daily Access/Security Logs** — ☐ Readily available — ☐ Up to date — ☒ N/A

    Remarks ***Property under the control of Ramsey Co. and their contractors***

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: ***None***

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks ***Fencing remains and is under repair by Ramsey Co. Pumphouse/Air stripper building under lock and key.***

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks_ ***Future security for Treatment system and discharge point will need to be identified.***

C. Land Use Controls (LUCs)

1. **Implementation and enforcement**

Per OU2 ROD Amendment #1, LUCs were established to protect the groundwater extraction, treatment, and monitoring system and to prohibit the drilling of water supply wells within the contaminated portion of the Unit 1 aquifer. Ramsey Co. is committed to ensuring that LUCs remain protective of control over contaminated groundwater until such time that the groundwater concentrations are below the cleanup levels.

Site conditions imply LUCs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply LUCs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): ***Inspection***
Frequency: ***Annual***
Responsible party/agency: ***U.S. Army***
Contact: ***Nick Smith*** (Name) ***Commanders Representative*** (Title) ***210-466-1707*** (Phone no.)

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

_____
_____
_____
_____

2. **Adequacy** ☒ LUCs are adequate ☐ LUCs are inadequate ☐ N/A
Remarks_____
_____
_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ 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 ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks_ ***Proposed Spine Rd. will impact current location of monitoring wells.***

B. Other Site Conditions

Remarks _____

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☐ 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-***available from GHD***
☐ Equipment properly identified
☒ Quantity of groundwater treated annually: ***The treatment system captured and treated 5,370,496 gallons of water resulting in the removal of 8.5 pounds of VOCs from the aquifer in FY 2017. The cumulative VOC mass removal is 381.2 pounds of VOCs***.
☐ 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 ☒ Is of acceptable quality

2. Monitoring data suggests:
   ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ All required wells located ☐ Needs Maintenance ☒ N/A
   Remarks_____
   _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria. In 2017 TCE concentrations ranged from non-detect to 1,200 µg/L. In general, Site wide TCE concentrations were lower than those reported in 2016. Monitoring wells 01U611 and 01U615 monitor the core of the plume. However, well 01U611 was abandoned in 2014 for site redevelopment activities and will be reinstalled once the redevelopment activities are completed; no 01U611 data is available for FY 2017. Prior to abandonment, TCE concentrations at monitoring well 01U611 had been relatively stable over the previous seven years.

_____
_____
_____
_____
_____

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.

During FY 2017, the treatment system functioned and was operational 96% of the time. Treated water continued to meet the substantive requirements of Document No. MNU0009579 (MPCA), which contains the state-accepted discharge limits for surface water.

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

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

None at this time

Appendix B

Community Notices

AFFIDAVIT OF PUBLICATION

STATE OF MINNESOTA)
) ss.
COUNTY OF RAMSEY)

Carter Johnson, being first duly sworn, on oath states as follows:

1. I am the publisher of the SHOREVIEW PRESS, or the publisher's designated agent. I have personal knowledge of the facts stated in this Affidavit, which is made pursuant of Minnesota Statutes §331A.07.

2. The newspaper has complied with all of the requirements to constitute a qualified newspaper under Minnesota law, including those requirements found in Minnesota Statutes §331A.02.

3. The dates of the month and the year and day of the week upon which the public notice attached was published in the newspaper are as follows:

Once a week, for one week, it was published on Tuesday, the 13th day of November, 2018.

4. The publisher's lowest classified rate paid by commercial users for comparable space, as determined pursuant to §331A.06, is as follows:

a) Lowest classified rate paid by commercial users for comparable space _____

b) Maximum rate allowed by law for the above matter _____

c) Rate actually charged for the above matter $ 5.20/inch

5. Mortgage Foreclosure Notices. Pursuant to Minnesota Statutes §580.033 relating to the publication of mortgage foreclosure notices: The newspaper's known office of issue is located in Ramsey County. The newspaper complies with the conditions described in §580.033, subd. 1, clause (1) or (2). If the newspaper's known office of issue is located in a county adjoining the county where the mortgaged premises or some part of the mortgaged premises described in the notice are located, a substantial portion of the newspaper's circulation is in the latter county.

FURTHER YOUR AFFIANT SAITH NOT.

BY:
TITLE: Carter Johnson, Publisher

Subscribed and sworn to before me on this 13th day of November, 2018.

Notary Public

IVY ILEEN CAVEGN
NOTARY PUBLIC - MINNESOTA
My Commission Expires
January 31, 2020

NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE
RAMSEY COUNTY, MINNESOTA
PUBLIC NOTICE
COMMENCEMENT OF FIVE-YEAR REVIEW
NOV. 2018

The U.S. Army, in conjunction with the U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) are conducting a review of the remedies selected for the New Brighton/Arden Hills Superfund Site, which includes the former Twin Cities Army Ammunition Plant (TCAAP). The purpose of the review is to confirm that the selected remedies continue to protect human health and the environment. The review will be presented in a draft report to be issued before the end of Mar. 2019. Another public notice will be published after the final report is issued. Once complete, the report will be available for public review at the TCAAP document repository: 4761 Hamline Avenue, Arden Hills, Minnesota 55112. The site was placed on the National Priorities List in 1983 and includes soil and shallow groundwater contamination on TCAAP and deep groundwater contamination both on and off TCAAP. Remedies were selected through Records of Decision (RODs) in 1992, 1993, and 1997, and along with subsequent ROD modifications are available for review at the TCAAP document repository. For soil, the remedies include soil vapor extraction; excavation, stabilization, and off-site disposal; construction of soil covers; and land use controls. For groundwater, the remedies include pump-and-treat systems, monitored natural attenuation, and land use controls. Should members of the community have questions or comments about the review of the remedies, or are interested in additional information, they may email: usarmy.jbsa.aec.mbx@mail.mil; or call: 210-466-1590.

Published one time in the Shoreview Press on November 13, 2018.

AFFIDAVIT OF PUBLICATION

STATE OF MINNESOTA) ss
COUNTY OF HENNEPIN

Darlene MacPherson being duly sworn on an oath, states or affirms that he/she is the Publisher's Designated Agent of the newspaper(s) known as:

SF Moundsview/New Brighton

with the known office of issue being located in the county of:

HENNEPIN

with additional circulation in the counties of:

RAMSEY

and has full knowledge of the facts stated below:

(A) The newspaper has complied with all of the requirements constituting qualification as a qualified newspaper as provided by Minn. Stat. §331A.02.

(B) This Public Notice was printed and published in said newspaper(s) once each week, for 1 successive week(s); the first insertion being on 11/02/2018 and the last insertion being on 11/02/2018.

MORTGAGE FORECLOSURE NOTICES Pursuant to Minnesota Stat. §580.033 relating to the publication of mortgage foreclosure notices: The newspaper complies with the conditions described in §580.033, subd. 1, clause (1) or (2). If the newspaper's known office of issue is located in a county adjoining the county where the mortgaged premises or some part of the mortgaged premises described in the notice are located, a substantial portion of the newspaper's circulation is in the latter county.

By: D MacPherson
Designated Agent

Subscribed and sworn to or affirmed before me on 11/02/2018 by Darlene MacPherson.

Notary Public

Jessica L Crabb
Notary Public
Minnesota
My Commission Expires January 31, 2023

Rate Information:
(1) Lowest classified rate paid by commercial users for comparable space:
$25.40 per column inch

Ad ID 873705

CITY OF NEW BRIGHTON/ ARDEN HILLS PUBLIC NOTICE NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE RAMSEY COUNTY, MINNESOTA COMMENCEMENT OF FIVE-YEAR REVIEW NOV. 2018

The U.S. Army, in conjunction with the U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) are conducting a review of the remedies selected for the New Brighton/Arden Hills Superfund Site, which includes the former Twin Cities Army Ammunition Plant (TCAAP). The purpose of the review is to confirm that the selected remedies continue to protect human health and the environment. The review will be presented in a draft report to be issued before the end of Mar. 2019. Another public notice will be published after the final report is issued. Once complete, the report will be available for public review at the TCAAP document repository: 4761 Hamline Avenue, Arden Hills, Minnesota 55112. The site was placed on the National Priorities List in 1983 and includes soil and shallow groundwater contamination on TCAAP and deep groundwater contamination both on and off TCAAP. Remedies were selected through Records of Decision (RODs) in 1992, 1993, and 1997, and along with subsequent ROD modifications are available for review at the TCAAP document repository. For soil, the remedies include soil vapor extraction; excavation, stabilization, and offsite disposal; construction of soil covers; and land use controls. For groundwater, the remedies include pump-and-treat systems, monitored natural attenuation, and land use controls. Should members of the community have questions or comments about the review of the remedies, or are interested in additional information, they may email: usarmy.jbsa.aec.mbx@mail.mil; or call: 210-466-1590.

Published in the
Mounds View-New Brtn Sun Focus
November 2, 2018
873705

AFFIDAVIT OF PUBLICATION

STATE OF MINNESOTA)
COUNTY OF HENNEPIN)

StarTribune

650 3rd Ave. S, Suite 1300 | Mineapolis, MN | 55488

Terri Swanson, being first duly sworn, on oath states as follows:

1. (S)He is and during all times herein stated has been an employee of the Star Tribune Media Company LLC, a Delaware limited liability company with offices at 650 Third Ave. S., Suite 1300, Minneapolis, Minnesota 55488, or the publisher's designated agent. I have personal knowledge of the facts stated in this Affidavit, which is made pursuant to Minnesota Statutes §331A.07.

2. The newspaper has complied with all of the requirements to constitute a qualified newspaper under Minnesota law, including those requirements found in Minnesota Statutes §331A.02.

3. The dates of the month and the year and day of the week upon which the public notice attached/copied below was published in the newspaper are as follows:

Dates of Publication		Advertiser	Account #	Order #
StarTribune	10/28/2018	DAWSON	1000361844	279268
StarTribune	10/31/2018	DAWSON	1000361844	279268

4. The publisher's lowest classified rate paid by commercial users for comparable space, as determined pursuant to § 331A.06, is as follows: **$694.40**

5. Mortgage Foreclosure Notices. Pursuant to Minnesota Statutes §580.033 relating to the publication of mortgage foreclosure notices: The newspaper's known office of issue is located in Hennepin County. The newspaper complies with the conditions described in §580.033, subd. 1, clause (1) or (2). If the newspaper's known office of issue is located in a county adjoining the county where the mortgaged premises or some part of the mortgaged premises described in the notice are located, a substantial portion of the newspaper's circulation is in the latter county.

FURTHER YOUR AFFIANT SAITH NOT.

Terri Swanson

Subscribed and sworn to before me on: 10/31/2018

Wilma L. Finn

WILMA L. FINN
NOTARY PUBLIC-MINNESOTA
My Commission Expires
January 31, 2020

Notary Public

Legal Notices

Public Notice

New Brighton/Arden Hills Superfund Site

Ramsey County, Minnesota

COMMENCEMENT OF FIVE-YEAR REVIEW

Oct. 2018

The U.S. Army, in conjunction with the U.S. Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) are conducting a review of the remedies selected for the New Brighton/Arden Hills Superfund Site, which includes the former Twin Cities Army Ammunition Plant (TCAAP). The purpose of the review is to confirm that the selected remedies continue to protect human health and the environment. The review will be presented in a draft report to be issued before the end of Mar. 2019. Another public notice will be published after the final report is issued. Once complete, the report will be available for public review at the TCAAP document repository: 4761 Hamline Avenue, Arden Hills, Minnesota 55112. The site was placed on the National Priorities List in 1983 and includes soil and shallow groundwater contamination on TCAAP and deep groundwater contamination both on and off TCAAP. Remedies were selected through Records of Decision (RODs) in 1992, 1993, and 1997, and along with subsequent ROD modifications are available for review at the TCAAP document repository. For soil, the remedies include soil vapor extraction; excavation, stabilization, and off-site disposal; construction of soil covers; and land use controls. For groundwater, the remedies include pump-and-treat systems, monitored natural attenuation, and land use controls. Should members of the community have questions or comments about the review of the remedies, or are interested in additional information, they may email: usarmy.jbsa.aec.mbx@mail.mil; or call: 210-466-1590.

Legal Notices

For Sale – MnDOT owned vacant land, located at the intersection of Old Crystal Bay Road and TH12, Orono, Hennepin County. Approximately 5.85 acres to be sold by sealed bid on 2/5/2019 at 2:00 at Waters Edge, 1500 C.R. B2, Roseville, MN 55113. Bid Form, http://www.dot.state.mn.us/row/propsales.html . Info LandSales.MN.DOT@state.mn.us

317 Estate Sales

Bloomington 10020 Drew Ave S .
Thu, Fri & Sat 9-4. Hot sale, many unique items. Svend at estatesales.net

324 Collectibles

POSTCARD & PAPER SHOW Bloomington Armory, 3300 W. 98th St. Sat Nov. 3, 9am-5, Sun Nov 4. 9-3.

****
WE BUY IT ALL! Paying Cash - not check. Mark 612-802-9686. WCCO TVs #1 Appraiser/Gemologist. House/Bank calls within 80 miles TC. Gold, dental gold, diamonds, silver coin, sterling, baseball cards, comics, QVC/costume/estate jewelry, militaria, much more. Free advice. 41 yrs in biz.

337 Firewood

PREMIUM DRY OAK OR MIXED
4'x8'x16" $175. Quick delivery.
Cash/Credit/Checks. 320-390-0217

340 Misc. Equipment & Supplies

SKID STEER ATTACHMENTS Snow plow, grapple bucket, brush clamp, grading planer, hoe arm, buckthorn puller, pallet fork. 651-269-5688

371 Jewelry & Precious Metals

MINNESOTA'S DIAMOND EXPERT
ContinentalDiamond.com St.Louis Park; top prices paid for Diamonds gold & platinum. 952-593-5602.

395 Misc. For Sale & Wanted

Accordion Wanted Older model OK, I will pay fair price and pick up. Also looking for amp 612-454-8713

CASH FOR RECORDS! Will buy your large collections of LPs, 45s & 78s. Rock, Pop, Jazz ETC 760-580-0884

FREON 12 WANTED Certified Buyer PAYS CASH For R-12 312-291-9169 refrigerantfinders.com

395 Misc. For Sale & Wanted

I BUY (working or not) lawn tractors, scooters, trailers, tools, old motorcycles, snow blowers. 612-423-3003

Wanted: Vintage Stereo Electronics I buy Large groups of radio vacuum tubes, testers, amps, speakers, stereos, 1960s or older. 612-454-8713

404 Dogs

Alaskan Malamute Pups AKC Blk & Wht; M & F Family Raised 763-493-2074; 763-257-5089 Ready Nov 9th

BEAGLE PUPPIES 10 wks. Shots, given, de-wormed. DNA chkd M/F avail. $350 Call Marie 763-957-2386

BULLDOGGE, OLDE ENGLISH rare color, shots, paper. Gargoyle/McMillian bloodline. F1200/M1400 612-669-0909

English Mastiff AKC AKC Family-raised English Mastiff puppies. Very gentle and kid friendly, The puppies are purebred and registered. Vet-checked and current on vaccinations and deworming. Bred to be very gentle and very large. $1,000. 712-330-0655

English Springer Spaniel Adorable puppy, 10 Wks, Top bench Bred, Health Guar. $1,500. 612-812-5160

FRENCH BULLDOG PUPS $1150, 2 M, 2 F. Pied/brindle Very sweet, family raised, health guarantee. 320-761-0284

French & Freedom Bulldog Pups Vac. UTD. $1100-$3500. 641-590-0770 freedompup.com

GERMAN SHEPHERD AKC, blk & tan pups, exc temp, OFA, shots, vet chk, guar, 33 yrs exp. $1500. 763-203-5725

GERMAN SHEPHERD PUPS
AKC. Exc temp. Genetic guar antee. 715-537-5413. **www.jerland.com**

German Shepherds, M & F AKC
shots, wrmed, vet ck, parents on-site. Can meet. $500 **507-360-6739**

Goldendoodles Home raised, vet ck, microchipped, current vaccinations. Ready now. $600-$900 605-265-0797

Golden Retriever AKC Pups-Champ Bloodline-Hunting/Conformation, & Agility Titled Sire *6 Pups, 9 wks. old. Call 612-268-0509 for price/to pick one. *Sire/Dam passed OFA Health. *Pups-Health Cert., Vacc., Deworm, AKC papers.*Raised at a home. goldenpuppies612@gmail.com

GOLDEN RETRIEVER AKC PUPS OFA, family rsd w/kids, shots, vet chkd. F $700, M $600. 651-249-6583

Golden Retriever Pups AKC. 4F/1 M. Cert stud, chkd, shots, wormed, $800 218-469-2466 ksaagge@gmail.com

404 Dogs

GREAT DANE PUPS AKC. Vet chkd, shots, wormed, health guar Large frame Call Tony. $600 763.786.4527

Lab AKC Pups Red/Yel/Blk, 1st shots dewormed, vet checked, dewclaws, Intro to wings. $700. 612-221-7335

Lab Puppies AKC Sire (pointer). Excellent bloodlines! Great for family pet or hunting. 651-202-1924

LAB PUPS AKC registered, Current on vaccinations & d/w. Blk, choc, ylw. M & F $500-$650 612-819-0968

Maltese puppy, Tiny female, 1st shots/wormer. Ref available, $950. bahoo@mtcnet.net

PEMBROKE WELSH CORGI AKC UTD shots. Fam/farm rsd & loved. Ready now! All colors. $1000 712-577-7677

POODLE AKC TOY PUPS 2 apricot M, 1 red F, 1st vacc, vet chkd, family raised. $850. 218-258-3362

Poodles, Standard AKC 1 Male, 4 Females, Family Raised, includes being Vet Checked, de-wormed, and lots of extras. 218-590-2050

Schnauzer Mini Purebred FAMILY raised, AKC, vet chkd, tails docked, kid&pet friendly. 763-428-7733

Soft Coated Wheaten Terrier Hypoallergenic/No shed, purebred, avail mid Nov, $800-850. 641-210-9006

Vizsla Puppies AKC/OFA
Born 9/15 champ hunting line family raised 5M 2F Tls dckd Dew claws rmvd. hlth guarantee $1,000 712-574-1440

404 Dogs

Teddy Bears, Maltipoos, Morkie, Maltese, Whoodle, Cavapoos Avail now. Non-shedding. $695 & up. I sell pups for several family breeders in WI. Shots etc. Brenda 608-574-7931 Lic#469088 **SpringGreenPups.com**

413 Horses & Livestock

COWS & HEIFERS FOR SALE Can butcher on farm. Looking for good saddle horse. 651-252-5115

430 Vacation Guide

Cozumel Mexico Escape MN to oceanfrom resort 1 or 2 wks. anytime. $450 per week 763-550-9330

Lg dec cndo Estero, FL 3BR/3BA Lg pool, wrk out rm, 8mi to beach. Dec or Jan $4000/mo 651-485-1046

N. MAPLES FLORIDA, 1BR CONDO
8 miles of beach. Inc ludes kayaks & bikes. $875-$1290/wk. **239-947-4157**

448 Hunting & Fishing Equipment

GUN & KNIFE SHOW
Nov. 10-11, Sat. 9-5pm, Sun. 9-3pm
HASTINGS ARMORY
3050 Hwy. 316
763-754-7140 $5 adm.
CrocodileProductionsInc.com

626 SENIOR LIVING

NEW HOPE Open House November 3, 11-3. 1BR special rate $895 (regular $950). 1st month free & waived application fee. 5700 Boone Ave N. 763-535-0607

633 APTS & CONDOS
UNFURN. NW, SW & WEST SUBURBS

★ LAKE MINNETONKA ★
LIVE ON THE LAKE! PETS WELCOME Garages, wood floors, docks, pool, great views $810 & up 952-471-9378

Plymouth Brand New 1BR & 2BR
Apts with underground parking.
$1200-$1400
612-669-1800

ANTIQUE, CLASSIC & CUSTOMIZED VEHICLES

1982 JEEP CJ-7 Call for pics & more infomation $13,900. 218-330-1139

VEHICLES WANTED

$$$$$ CASH FOR CARS $$$$$
Repairables or Junkers 612.414.4924

I BUY SCRAP CARS. A lso cheap towing available 612-226-0895

$150 to $800 for most junkers
and repairables. 612-781-1804

JOBS

technology/engineering

DATA ANALYSTS
(Cotiviti, Inc. fka Verscend Technologies, Inc., Bloomington, MN): Perform highly complex data analysis for medical analytical software using HEDIS specifications. Min. Reqs.: Requires bachelors degr. or foreign equiv. degr. in CS, IS, Comp. Applications, or a closely rel. fld. of study & 2 yrs. of exp. in any rel. occ. analyzing large, complex data sets w/in the medical or health insur. industries. In lieu of a bachelors degr. employer will accept 4 yrs. of exp. in any rel. occ. analyzing large, complex data sets w/in the medical or health insur. industries. Any suit. combination. of educ., train., or exp. is accept. Mail resumes to Robin Callahan, HR Business Partner, Cotiviti, Inc., 6802 Paragon Place, Suite 500, Richmond, VA 23230 with ref. to Job Code: CVSS18. No calls.

Mortgage Foreclosures

NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in the conditions of the following described mortgage:
Mortgagor: Tricia Anderson and Ryan Anderson, wife & husband, as Joint Tenants
Mortgagee: Mortgage Electronic Registration Systems, Inc. as nominee for GMAC Mortgage Corporation dba ditech.com
Dated: 11/23/2005
Recorded: 12/30/2005
Wright County Recorder Document No. A992822
Assigned To: The Bank of New York Mellon Trust Company, National Association fka The Bank of New York Trust Company, N.A. as successor to JP Morgan Chase Bank, National Association, as Trustee for Residential Asset Mortgage Products, Inc., GMACM Home Equity Loan Trust 2006-HE1
Dated: 07/27/2018
Recorded: 08/02/2018
Wright County Recorder Document No. A1376158
Transaction Agent: Mortgage Electronic Registration Systems, Inc.
Transaction Agent Mortgage Identification Number: 100037506558224136
Lender or Broker: GMAC Mortgage Corporation dba ditech.com
Residential Mortgage Servicer: Ocwen Loan Servicing, LLC
Mortgage Originator: GMAC Mortgage Corporation dba ditech.com
LEGAL DESCRIPTION OF PROPERTY: All that parcel of land in City of Wright County, Wright County, State of Minnesota, as more fully described in Deed Doc #716814, ID #114-170-003170, being known and designated as Lot 17, Block 3, Highwoods 3rd Addition. Abstract Property.
Real property in Wright County, Minnesota, described as follows: Lot 17, Block 3, Highwoods 3rd Addition. By fee simple deed from Shade Tree Construction, Inc., a Minnesota corporation as set forth in Doc #716814 dated 07/21/2000 and recorded 8/15/2000, Wright County Records, State of Minnesota.
This is Abstract Property.
TAX PARCEL NO.: 114170003170
ADDRESS OF PROPERTY:
4410 Mason Ave NE
Saint Michael, MN 55376
COUNTY IN WHICH PROPERTY IS LOCATED: Wright
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $50,500.00
AMOUNT DUE AND CLAIMED TO BE DUE AS OF DATE OF NOTICE: $34,344.28
That prior to the commencement of this mortgage foreclosure proceeding Mortgagee/Assignee of Mortgagee complied with all notice requirements as required by statute; that no action or proceeding has been instituted at law or otherwise to recover the debt secured by said mortgage, or any part thereof;
PURSUANT to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: December 12, 2018, 10:00 AM
PLACE OF SALE: Sheriff's Office, 3800 Braddock Avenue NE, Buffalo, MN
to pay the debt then secured by said Mortgage, and taxes, if any, on said premises, and the costs and disbursements, including attorneys' fees allowed by law subject to redemption within 6 Months from the date of said sale by the mortgagor(s), their personal representatives or assigns.
DATE TO VACATE PROPERTY: The date on or before which the mortgagor must vacate the property if the mortgage is not reinstated under Minnesota Statutes section 580.30 or the property redeemed under Minnesota Statutes section 580.23 is June 12, 2019 at 11:59 p.m. If the foregoing date is a Saturday, Sunday or legal holiday, then the date to vacate is the next business day at 11:59 p.m.
MORTGAGOR(S) RELEASED FROM FINANCIAL OBLIGATION ON MORTGAGE: NONE
THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES SECTION 582.032, DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN FIVE UNITS, ARE NOT PROPERTY USED IN AGRICULTURAL PRODUCTION, AND ARE ABANDONED.
Dated: October 29, 2018
The Bank of New York Mellon Trust Company, National Association fka The Bank of New York Trust Company, N.A. as successor to JP Morgan Chase Bank, National Association, as Trustee for Residential Asset Mortgage Products, Inc., GMACM Home Equity Loan Trust 2006-HE1, Assignee of Mortgagee
By: PFB LAW, PROFESSIONAL ASSOCIATION
Attorneys for:
The Bank of New York Mellon Trust Company, National Association fka The Bank of New York Trust Company, N.A. as successor to JP Morgan Chase Bank, National Association, as Trustee for Residential Asset Mortgage Products, Inc., GMACM Home Equity Loan Trust 2006-HE1, Assignee of Mortgagee
55 East Fifth Street, Suite 800
St. Paul, MN 55101-1718
651-209-7599
651-228-1753 (fax)

THIS COMMUNICATION IS FROM A DEBT COLLECTOR ATTEMPTING TO COLLECT A DEBT. ANY INFORMATION OBTAINED WILL BE USED FOR THAT PURPOSE.
17725-18-00267-1
10/31, 11/7, 11/14, 11/21, 11/28, 12/5/18 Star Tribune

NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in conditions of the following described mortgage:
DATE OF MORTGAGE: April 20, 2004
MORTGAGOR: James B. Nyberg and Rita Nyberg, husband and wife.
MORTGAGEE: Mortgage Electronic Registration Systems, Inc..
DATE AND PLACE OF RECORDING: Recorded May 27, 2004 Hennepin County Recorder, Document No. 8365898.
ASSIGNMENTS OF MORTGAGE: Assigned to: GMAC Mortgage, LLC. Dated September 28, 2012 Recorded October 4, 2012, as Document No. A9850233. And thereafter assigned to: Ocwen Loan Servicing, LLC. Dated June 17, 2013 Recorded June 21, 2013, as Document No. A09969230. And thereafter assigned to: Residential Credit Solutions, Inc.. Dated October 20, 2015 Recorded October 23, 2015, as Document No. A10251409. And thereafter assigned to: Ditech Financial LLC. Dated August 10, 2016 Recorded August 22, 2016, as Document No. A10350784.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
TRANSACTION AGENT'S MORTGAGE IDENTIFICATION NUMBER ON MORTGAGE:
100062604205133848
LENDER OR BROKER AND MORTGAGE ORIGINATOR STATED ON MORTGAGE: Homecomings Financial Network, Inc.
RESIDENTIAL MORTGAGE SERVICER: Ditech Financial LLC
MORTGAGED PROPERTY ADDRESS: 3601 Elliot Ave S, Minneapolis, MN 55407
TAX PARCEL I.D. #: 0202824340155
LEGAL DESCRIPTION OF PROPERTY:
Lot 26, Block 3, Estabrook's Addition to Minneapolis, Hennepin County, Minnesota.
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $143,000.00
AMOUNT DUE AND CLAIMED TO BE DUE AS OF DATE OF NOTICE, INCLUDING TAXES, IF ANY, PAID BY MORTGAGEE: $136,428.86
That prior to the commencement of this mortgage foreclosure proceeding Mortgagee/Assignee of Mortgagee complied with all notice requirements as required by statute; That no action or proceeding has been instituted at law or otherwise to recover the debt secured by said mortgage, or any part thereof;
PURSUANT to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: December 27, 2018 at 11:00 AM
PLACE OF SALE: Hennepin County Sheriff's Office, Civil Division, Room 30, 350 South 5th Street, Minneapolis, MN
to pay the debt then secured by said Mortgage, and taxes, if any, on said premises, and the costs and disbursements, including attorneys' fees allowed by law subject to redemption within six (6) months from the date of said sale by the mortgagor(s), their personal representatives or assigns unless reduced to Five (5) weeks under MN Stat. §580.07.
TIME AND DATE TO VACATE PROPERTY: If the real estate is an owner-occupied, single-family dwelling, unless otherwise provided by law, the date on or before which the mortgagor(s) must vacate the property if the mortgage is not reinstated under section 580.30 or the property is not redeemed under section 580.23 is 11:59 p.m. on June 27, 2019 unless that date falls on a weekend or legal holiday, in which case it is the next weekday, and unless the redemption period is reduced to 5 weeks under MN Stat. Secs. 580.07 or 582.032.
MORTGAGOR(S) RELEASED FROM FINANCIAL OBLIGATION ON MORTGAGE:None
"THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES, SECTION 582.032, DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN FIVE UNITS, ARE NOT PROPERTY USED IN AGRICULTURAL PRODUCTION, AND ARE ABANDONED."
Dated: October 24, 2018
Ditech Financial LLC
Mortgagee/Assignee of Mortgagee
USSET, WEINGARDEN AND LIEBO, P.L.L.P.
Attorneys for Mortgagee/Assignee of Mortgagee
4500 Park Glen Road #300
Minneapolis, MN 55416
(952) 925-6888
6 - 18-007896 FC
THIS IS A COMMUNICATION FROM A DEBT COLLECTOR.
10/31, 11/7, 11/14, 11/21. 11/28, 12/5/18 Star Tribune

NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in conditions of the following described mortgage:
DATE OF MORTGAGE: June 30, 2014
MORTGAGOR: Natasha Lee, a single person.
MORTGAGEE: Mortgage Electronic Registration Systems, Inc. as nominee for Marketplace Home Mortgage, LLC, a Limited Liability Company its successors and assigns.
DATE AND PLACE OF RECORDING: Filed July 8, 2014, Hennepin County Registrar of Titles, Document No. T05183359 on Certificate of Title No. 1389005.
ASSIGNMENTS OF MORTGAGE: Assigned to: Ditech Financial LLC. Dated September 17, 2018 Filed September 18, 2018 , as Document No. T05561493.
Said Mortgage being upon Registered Land.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
TRANSACTION AGENT'S MORTGAGE IDENTIFICATION NUMBER ON MORTGAGE: 100249120000600028
LENDER OR BROKER AND MORTGAGE ORIGINATOR STATED ON MORTGAGE: Marketplace Home Mortgage, LLC, a Limited Liability Company
RESIDENTIAL MORTGAGE SERVICER: Ditech Financial LLC
MORTGAGED PROPERTY ADDRESS: 5124 Dupont Avenue North, Minneapolis, MN 55430
TAX PARCEL I.D. #: 12-118-21-21-0176
LEGAL DESCRIPTION OF PROPERTY: Lot 19; and the West Half of the 14 foot alley adjoining said Lot on the East thereof, lying between extensions across it of the North and South line of said Lot 19, all in Block 1, Jenny Lind Homes Tract No. 1, Minneapolis Minn., Hennepin County, Minnesota.
PIN# 12-118-21-21-0176
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $114,488.00
AMOUNT DUE AND CLAIMED TO BE DUE AS OF DATE OF NOTICE, INCLUDING TAXES, IF ANY, PAID BY MORTGAGEE: $106,934.11
That prior to the commencement of this mortgage foreclosure proceeding Mortgagee/Assignee of Mortgagee complied with all notice requirements as required by statute; That no action or proceeding has been instituted at law or otherwise to recover the debt secured by said mortgage, or any part thereof;
PURSUANT to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: November 27, 2018 at 11:00 AM
PLACE OF SALE: Hennepin County Sheriff's Office, Civil Division, Room 30, 350 South 5th Street, Minneapolis, MN to pay the debt then secured by said Mortgage, and taxes, if any, on said premises, and the costs and disbursements, including attorneys' fees allowed by law subject to redemption within six (6) months from the date of said sale by the mortgagor(s), their personal representatives or assigns unless reduced to Five (5) weeks under MN Stat. §580.07.
TIME AND DATE TO VACATE PROPERTY: If the real estate is an owner-occupied, single-family dwelling, unless otherwise provided by law, the date on or before which the mortgagor(s) must vacate the property if the mortgage is not reinstated under section 580.30 or the property is not redeemed under section 580.23 is 11:59 p.m. on May 28, 2019 unless that date falls on a weekend or legal holiday, in which case it is the next weekday, and unless the redemption period is reduced to 5 weeks under MN Stat. Secs. 580.07 or 582.032.
MORTGAGOR(S) RELEASED FROM FINANCIAL OBLIGATION ON MORTGAGE:None
"THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES, SECTION 582.032, DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN FIVE UNITS, ARE NOT PROPERTY USED IN AGRICULTURAL PRODUCTION, AND ARE ABANDONED."
Dated: September 26, 2018
Ditech Financial LLC
Mortgagee/Assignee of Mortgagee
USSET, WEINGARDEN AND LIEBO, P.L.L.P.
Attorneys for Mortgagee/Assignee of Mortgagee
4500 Park Glen Road #300
Minneapolis, MN 55416
(952) 925-6888
6 - 18-006580 FC
THIS IS A COMMUNICATION FROM A DEBT COLLECTOR.
10/3, 10/10, 10/17, 10/24, 10/31, 11/7/18 Star Tribune

PUBLIC NOTICE
NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN: That default has occurred in the conditions of the following described mortgage:
DATE OF MORTGAGE: March 2, 2007
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $398,000.00
MORTGAGOR(S): Taylor L. Phillips and Pablo Murillo, wife and husband
MORTGAGEE: Mortgage Electronic Registration Systems, Inc. acting solely as nominee for Provident Funding Associates, L.P.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
MIN#: 1000179-3517020125-1
SERVICER: Bayview Loan Servicing, LLC
LENDER: Provident Funding Associates, L.P..
DATE AND PLACE OF FILING: Hennepin County Minnesota Recorder, on March 27, 2007, as Document No. 8955501. Said mortgage modified by Loan Modification Agreement dated August 10, 2011 and recorded on August 6, 2013 as Document Number A09990197 in the office of the Hennepin County Recorder
ASSIGNED TO: THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK, AS TRUSTEE FOR THE CERTIFICATEHOLDERS OF CWALT, INC., ALTERNATIVE LOAN TRUST 2007-15CB, MORTGAGE PASS-THROUGH CERTIFICATES, SERIES 2007-15CB by an Assignment of Mortgage dated March 1, 2010 and recorded on March 17, 2010 as Document No. A9490986.
LEGAL DESCRIPTION OF PROPERTY:
North 1/2 of that part of Lot 137, Auditor's Subdivision Number 149, lying East of Wentworth Avenue, and also the North 5 feet of South 1/2 of East 135.15 feet of Lot 137, Auditor's Subdivision Number 149, except the East 7.0 feet taken for alley, Hennepin County, Minnesota
PROPERTY ADDRESS: 5629 WENTWORTH AVE, MINNEAPOLIS, MN 55419
PROPERTY I.D: 22-028-24-24-0066
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
THE AMOUNT CLAIMED TO BE DUE ON THE MORTGAGE ON THE DATE OF THE NOTICE: Four Hundred Thirteen Thousand Seven Hundred Eleven and 62/100 ($413,711.62)
THAT no action or proceeding has been instituted at law to recover the debt secured by said mortgage, or any part thereof; that there has been compliance with all pre-foreclosure notice and acceleration requirements of said mortgage, and /or applicable statutes;
PURSUANT, to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: January 7, 2019 at 10:00 AM
PLACE OF SALE: Hennepin County Sheriff's Office-Civil Unit, Rm 30, Minneapolis City Hall, 350 South 5th Street, Minneapolis, MN 55415
to pay the debt then secured by said mortgage and taxes, if any actually paid by the mortgagee, on the premises and the costs and disbursements allowed by law. The time allowed by law for redemption by said mortgagor(s), their personal representatives or assigns is 6 months from the date of sale. If Mortgage is not reinstated under Minn. Stat. §580.30 or the property is not redeemed under Minn. Stat. § 580.23, the Mortgagor must vacate the property on or before 11:59 p.m. on July 7, 2019, or the next business day if July 7, 2019 falls on a Saturday, Sunday or legal holiday.
"THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES, SECTION 582.032, DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN FIVE UNITS, ARE NOT PROPERTY USED IN AGRICULTURAL PRODUCTION, AND ARE ABANDONED."
Dated: October 29, 2018
THE BANK OF NEW YORK MELLON FKA THE BANK OF NEW YORK, AS TRUSTEE FOR THE CERTIFICATEHOLDERS OF CWALT, INC., ALTERNATIVE LOAN TRUST 2007-15CB, MORTGAGE PASS-THROUGH CERTIFICATES, SERIES 2007-15CB
Randall S. Miller & Associates, PLLC
Attorneys for Assignee of Mortgage/Mortgagee
Canadian Pacific Plaza, 120 South Sixth Street, Suite 2050
Minneapolis, MN 55402
Phone: 952-232-0052
Our File No. 18MN00205-1
THIS IS A COMMUNICATION FROM A DEBT COLLECTOR
10/31, 11/7, 11/14, 11/21, 11/28, 12/5/18 Star Tribune

NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in conditions of the following described mortgage:
DATE OF MORTGAGE: April 24, 2003
MORTGAGOR: Donald J Dekarski and Terry L Dekarski, husband and wife as joint tenants.
MORTGAGEE: Mortgage Electronic Registration Systems, Inc. as nominee for America's Wholesale Lender its successors and assigns.
DATE AND PLACE OF RECORDING: Filed June 11, 2003, Hennepin County Registrar of Titles, Document No. 3754277 on Certificate of Title No. 835161.
ASSIGNMENTS OF MORTGAGE: Assigned to: Bank of America, N.A. . Dated February 17, 2017 Filed February 27, 2017 , as Document No. T05425352.
Said Mortgage being upon Registered Land.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
TRANSACTION AGENT'S MORTGAGE IDENTIFICATION NUMBER ON MORTGAGE: 100015700024517522
LENDER OR BROKER AND MORTGAGE ORIGINATOR STATED ON MORTGAGE: America's Wholesale Lender
RESIDENTIAL MORTGAGE SERVICER: Bank of America, N.A.
MORTGAGED PROPERTY ADDRESS: 2191 Cardinal Lane, Mound, MN 55364
TAX PARCEL I.D. #: 13-117-24-34-0010
LEGAL DESCRIPTION OF PROPERTY: Lots 11, 17, and 18, Block 8, "Abraham Lincoln Addition to Lake Side Park, Mound Minnetonka", Hennepin County, Minnesota
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $115,000.00
AMOUNT DUE AND CLAIMED TO BE DUE AS OF DATE OF NOTICE, INCLUDING TAXES, IF ANY, PAID BY MORTGAGEE: $55,306.24
That prior to the commencement of this mortgage foreclosure proceeding Mortgagee/Assignee of Mortgagee complied with all notice requirements as required by statute; That no action or proceeding has been instituted at law or otherwise to recover the debt secured by said mortgage, or any part thereof;
PURSUANT to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: November 20, 2018 at 11:00 AM
PLACE OF SALE: Hennepin County Sheriff's Office, Civil Division, Room 30, 350 South 5th Street, Minneapolis, MN to pay the debt then secured by said Mortgage, and taxes, if any, on said premises, and the costs and disbursements, including attorneys' fees allowed by law subject to redemption within twelve (12) months from the date of said sale by the mortgagor(s), their personal representatives or assigns unless reduced to Five (5) weeks under MN Stat. §580.07.
TIME AND DATE TO VACATE PROPERTY: If the real estate is an owner-occupied, single-family dwelling, unless otherwise provided by law, the date on or before which the mortgagor(s) must vacate the property if the mortgage is not reinstated under section 580.30 or the property is not redeemed under section 580.23 is 11:59 p.m. on November 20, 2019 unless that date falls on a weekend or legal holiday, in which case it is the next weekday, and unless the redemption period is reduced to 5 weeks under MN Stat. Secs. 580.07 or 582.032.
MORTGAGOR(S) RELEASED FROM FINANCIAL OBLIGATION ON MORTGAGE:None
"THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES, SECTION 582.032, DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN FIVE UNITS, ARE NOT PROPERTY USED IN AGRICULTURAL PRODUCTION, AND ARE ABANDONED."
Dated: September 20, 2018
Bank of America, N.A.
Mortgagee/Assignee of Mortgagee
USSET, WEINGARDEN AND LIEBO, P.L.L.P.
Attorneys for Mortgagee/Assignee of Mortgagee
4500 Park Glen Road #300
Minneapolis, MN 55416
(952) 925-6888
18 - 18-006578 FC
THIS IS A COMMUNICATION FROM A DEBT COLLECTOR.
9/26, 10/3, 10/10, 10/17, 10/24, 10/31/18 Star Tribune

18-110049
NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in the conditions of the following described mortgage:
DATE OF MORTGAGE: October 10, 2007
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $240,000.00
MORTGAGOR(S): George E. Wilson and Brenda Wilson, husband and wife
MORTGAGEE: Mortgage Electronic Registration Systems, Inc.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
MIN#: 100011520047606092
LENDER OR BROKER AND MORTGAGE ORIGINATOR STATED ON THE MORTGAGE: CitiMortgage, Inc.
SERVICER: Specialized Loan Servicing LLC
DATE AND PLACE OF FILING: Filed October 25, 2007, Hennepin County Recorder, as Document Number 9057075
ASSIGNMENTS OF MORTGAGE: Assigned to: CitiMortgage, Inc.; Dated: August 29, 2012 filed: August 31, 2012, recorded as document number A9836594; Thereafter assigned to Mortgage Electronic Registration Systems, Inc by Corrective Gap Assignment dated June 19, 2018 and recorded on June 25, 2018 as Document Number A10567041; Thereafter assigned to CitiMortgage, Inc. dated September 29, 2012 and recorded on October 1, 2012 as Document Number A9848979; Thereafter assigned to Green Tree Servicing LLC dated January 29, 2015 and recorded on January 30, 2015 as Document Number A10158938; Thereafter assigned to Specialized Loan Servicing, LLC dated June 22, 2018 and recorded on July 2, 2018 as Document Number A10570358.
LEGAL DESCRIPTION OF PROPERTY: Lot 16, Block 5, Vinton Park Addition to Minneapolis
PROPERTY ADDRESS: 3629 3rd Ave S, Minneapolis, MN 55409
PROPERTY IDENTIFICATION NUMBER: 03-028-24-44-0066
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
THE AMOUNT CLAIMED TO BE DUE ON THE MORTGAGE ON THE DATE OF THE NOTICE: $240,310.70
THAT all pre-foreclosure requirements have been complied with; that no action or proceeding has been instituted at law or otherwise to recover the debt secured by said mortgage, or any part thereof;
PURSUANT, to the power of sale contained in said mortgage, the above described property will be sold by the Sheriff of said county as follows:
DATE AND TIME OF SALE: December 7, 2018, 10:00am
PLACE OF SALE: Sheriff's Main Office, Civil Division, Room 30, Courthouse, 350 South Fifth St., Minneapolis, MN 55487 to pay the debt secured by said mortgage and taxes, if any, on said premises and the costs and disbursements, including attorneys fees allowed by law, subject to redemption within 6 months from the date of said sale by the mortgagor(s) the personal representatives or assigns.
TIME AND DATE TO VACATE PROPERTY: If the real estate is an owner-occupied, single-family dwelling, unless otherwise provided by law, the date on or before which the mortgagor(s) must vacate the property, if the mortgage is not reinstated under section 580.30 or the property is not redeemed under section 580.23, is 11:59 p.m. on June 7, 2019, or the next business day if June 7, 2019 falls on a Saturday, Sunday or legal holiday.
"THE TIME ALLOWED BY LAW FOR REDEMPTION BY THE MORTGAGOR, THE MORTGAGOR'S PERSONAL REPRESENTATIVES OR ASSIGNS, MAY BE REDUCED TO FIVE WEEKS IF A JUDICIAL ORDER IS ENTERED UNDER MINNESOTA STATUTES SECTION 582.032 DETERMINING, AMONG OTHER THINGS, THAT THE MORTGAGED PREMISES ARE IMPROVED WITH A RESIDENTIAL DWELLING OF LESS THAN 5 UNITS, ARE NOT PROPERTY USED FOR AGRICULTURAL PRODUCTION, AND ARE ABANDONED.
Dated: October 10, 2018
Specialized Loan Servicing LLC
Assignee of Mortgagee
SHAPIRO & ZIELKE, LLP
BY Lawrence P. Zielke - 152559
Melissa L. B. Porter - 0337778
Randolph W. Dawdy - 2160X
Gary J. Evers - 0134764
Tracy J. Halliday - 034610X
Attorneys for Mortgagee
Shapiro & Zielke, LLP
12550 West Frontage Road, Suite 200 Burnsville, MN 55337
(952) 831-4060
THIS IS A COMMUNICATION FROM A DEBT COLLECTOR
10/17, 10/24, 10/31, 11/7, 11/14, 11/21/18 Star Tribune

NOTICE OF MORTGAGE FORECLOSURE SALE
THE RIGHT TO VERIFICATION OF THE DEBT AND IDENTITY OF THE ORIGINAL CREDITOR WITHIN THE TIME PROVIDED BY LAW IS NOT AFFECTED BY THIS ACTION.
NOTICE IS HEREBY GIVEN, that default has occurred in conditions of the following described mortgage:
DATE OF MORTGAGE: June 20, 2016
MORTGAGOR: Jennifer K Leeson and Brett M Leeson, wife and husband as joint tenants.
MORTGAGEE: Mortgage Electronic Registration Systems, Inc.
DATE AND PLACE OF RECORDING: Recorded June 23, 2016 Hennepin County Recorder, Document No. A10328750.
ASSIGNMENTS OF MORTGAGE: Assigned to: Freedom Mortgage Corporation. Dated August 30, 2018 Recorded August 30, 2018, as Document No. A10588049.
TRANSACTION AGENT: Mortgage Electronic Registration Systems, Inc.
TRANSACTION AGENT'S MORTGAGE IDENTIFICATION NUMBER ON MORTGAGE: 1000608-2100046491-1
LENDER OR BROKER AND MORTGAGE ORIGINATOR STATED ON MORTGAGE: Academy Mortgage Corporation
RESIDENTIAL MORTGAGE SERVICER: Freedom Mortgage Corporation
MORTGAGED PROPERTY ADDRESS: 3507 Upton Avenue North, Minneapolis, MN 55412
TAX PARCEL I.D. #: 0802924120056
LEGAL DESCRIPTION OF PROPERTY:
LOT 14, BLOCK 2, IN BERRY'S 1ST ADDITION TO MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA.
PIN# 08-029-24-12-0056
COUNTY IN WHICH PROPERTY IS LOCATED: Hennepin
ORIGINAL PRINCIPAL AMOUNT OF MORTGAGE: $216,015.00
AMOUNT DUE AND CLAIMED TO BE DUE AS OF DATE OF NOTICE, INCLUDING TAXES, IF ANY, PAID BY MORTGAGEE: $216,370.94
That prior to the commencement of this mortgage foreclosure proceeding Mortgagee/Assignee of Mortgagee complied with all notice requirements as required by statute; That no action or proceeding has been instituted at law or otherwise to recover the debt secured by said

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Appendix C

Annual Site Inspection Checklist

For OU2 Land Use Controls

ANNUAL SITE INSPECTION CHECKLIST FOR LAND USE CONTROLS

Operable Unit 2, New Brighton/Arden Hills Superfund Site

Date: August 24, 2017

Inspected by: Mary Lee, Roger Walton, Hoa Voscott, Katy Grant

Period Covered: From prior annual inspection (8/10/2016) to above date

	BLANKET LUCs				OTHER LUC AREAS	SITES WITH ADDITIONAL LUCs FOR SOIL COVERS							
					Area w/Restricted Commercial Use	C	D	E	G	H	I	129-15	Outdoor Firing Range
Property owner:	BRAC	N.G.	Reserve	R.C.	N.G.	BRAC	N.G.	N.G.	N.G.	N.G.	R.C.	N.G.	N.G.
Soil LUCs													
Are there any land uses that result in a non-compliant exposure versus the exposure assumptions described in the LUCRD?	No	No	No	No	No	(Soil LUCs are covered under the Blanket LUCs)							
Soil Cover LUCs													
Has there been any excavation activity or any other man-made soil disturbance at the site?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Are there any areas of the soil cover that have inadequate vegetative cover?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Has there been any damage to run-on/runoff controls (swales, berms, riprap, etc.)?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
Has there been any damage to or removal of the signs marking the edge of the soil cover?	N/A	N/A	N/A	N/A	N/A	No	No	No	No	No	N/A	No	No
If the soil cover has a permeability requirement, is there any woody vegetation present that exceeds 2-inch diameter?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A
Has there been any damage to or removal of the concrete slab that serves as a protective cover?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No*	N/A	N/A
Groundwater LUCs													
Have any wells been installed that withdraw water from a contaminated aquifer, without MDH/MPCA/USEPA approval?	No	No	No	No	(Groundwater LUCs are covered under the Blanket LUCs)								
Has there been any damage to or interference with any groundwater remedy infrastructure (wells, piping, treatment systems, etc.)?	No	No	No	No									

Comments (Attach additional pages as necessary):

BRAC = Base Realignment and Closure Division N.G. = MN Army National Guard/National Guard Bureau Reserve = U.S. Army Reserve R.C. = Ramsey County

*LUC to be removed following formal approval.

Certification:

Based on the annual site inspection, the undersigned hereby certifies that the above-named property owners and above-described land use controls have been complied with for the period noted. Alternatively, any known deficiences and completed or planned actions to address such deficiencies are described in the attached Explanation of Deficiency(ies).

Roger Walton, P.E., U.S. Army Environmental Command

Description of Deficiency(ies) attached? ☐ Yes ☑ No (none were identified)

Appendix D
Site Inspection Photographs

Photo 1. New Brighton Water Treatment Intake Plant.

Photo 2. Part of the New Brighton iron and manganese pressure filtration system.

Photo 3. New Brighton Treatment Plant piping.

Photo 4. The new Trojan UV PHox system at the New Brighton Treatment Plant.

Photo 5. Granulated Activated Carbon (GAC) tanks at New Brighton Water Treatment Plant.

Photo 6. Well 03U811 at OU1.

Photo 7. Well 04U821 at OU1.

Photo 8. Well 04U821 at OU1.

Photo 9. The TCAAP Groundwater Recovery System (TGRS).

Photo 10. TGRS pump.

Photo 11. The TGRS Control Panel.

Photo 12. TGRS tanks and piping.

Photo 13. TGRS piping.

Photo 14. Gravel pit effluent of the TCAAP TGRS System.

Photo 15. Well 01U354 at Site A, where monitoring was discontinued in FY 2017.

Photo 16. Well 01U138 at Site A.

Photo 17. Well 01U353 at Site A.

Photo 18. Well 01U035 near Site B in OU2.

Photo 19. Well 01U046 at Site C.

Photo 20. A Solid Waste Disposal Area sign at Site C.

Photo 21. An underground asbestos hazard warning sign at Site C.

Photo 22. An example of well vegetated cover at Site C.

Photo 23. DAWSON personnel shown in front of the Wetland Buffer Zone sign near Site C.

Photo 24. Well 03U093 at Site D.

Photo 25. An example of well vegetated cover at Site D.

Photo 26. Well 03U088 at Site E.

Photo 27. Well 03U090 at Site F shown with a broken lid.

Photo 28. A Solid Waste Disposal Area sign near Site F.

Photo 29. The existing site cap at Site G.

Photo 30. A Solid Waste Disposal Area sign shown at Site G.

Photo 31. Well 03U094 at Site G.

Photo 32. A Solid Waste Disposal Area sign at Site H.

Photo 33. Well 03U030 at Site I.

Photo 34. A foundry located at Site I.

Photo 35. Drainage control at Site K.

Photo 36. Inside the pumphouse at Site K.

Photo 37. Well 01U052 at Site K.

Photo 38. Well 03U521 at Site 129-3.

Photo 39. A water line sign at Site 129-15.

Photo 40. A Solid Waste Disposal Area sign at Site 129-15.

Photo 41. Rip rap for mitigation of run-off from an upper road at Site 129-15.

Photo 42. An example of well vegetated cover at Site 129-15.

Photo 43. Well 03U032 at Site 129-15.

Photo 44. Land Use Control signage at the Outdoor Firing Range site.

Photo 45. A construction trailer located at the Building 102 site.

Photo 46. Well 03M013 at Building 102.

Photo 47. An unknown rusted well located near Building 102.

Photo 48. Pump house S-5 at OU2.

Photo 49. Pumphouse S-3 at OU2.

Photo 50. Pumphouse B-9 at OU2.

Photo 51. Pumphouse SC-4 at OU2.

Photo 52. Well 03U716 near source control well SC5 in OU2.

Photo 53. Top of the water chamber in the Water Tower Area.

Photo 54. The Ben Franklin Gate at OU2.

Photo 55. Fencing throughout OU2.

Photo 56. Well 537801 at Midway Industrial.

Photo 57. Well 777181 at OU3.

Photo 58. Well 03L859 at OU3.

Photo 59. New fencing being installed at TCAAP.

Photo 60. Fencing with Important Bird Area signage at TCAAP.

Photo 61. A broken fence at TCAAP.

Photo 62. The multimeter that was utilized during the site inspection.

Appendix E
MDH Special Well Construction Area Information

Minnesota Department of Health

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

M E M O R A N D U M

DATE: April 20, 2016

TO: Licensed and Registered Well Contractors
Advisory Council on Wells and Borings

FROM: Thomas P. Hogan, Director
Environmental Health Division
P.O. Box 64975
St. Paul, Minnesota 55164-0975

PHONE: 651-201-4675

SUBJECT: Notice of Update to Special Well and Boring Construction Area in the Vicinity of the Twin Cities Army Ammunition Plant, Anoka, Hennepin, and Ramsey Counties, Minnesota

The Minnesota Department of Health (MDH) is updating the **Special Well and Boring Construction Area** (SWBCA), for the Twin Cities Army Ammunition Plant (TCAAP), as shown in the attached map (Figure 1). The update adds the land within the original TCAAP facility boundary to the SWBCA.

AUTHORITY

Minnesota Statutes, section 103I.101, subdivision 5, clause 7, grants the commissioner of health the authority to establish standards for the construction, maintenance, sealing, and water quality monitoring of wells in areas of known or suspected contamination. Minnesota Rules, part 4725.3650, details the requirements for construction, repair, and sealing of wells and borings within a designated SWBCA, including plan review and approval, water quality monitoring, and other measures to protect public health and prevent degradation of groundwater.

HISTORY AND DESCRIPTION

The MDH has made changes to the boundary of the TCAAP SWBCA. The SWBCA was initially implemented on July 1, 1996, and included the cities of New Brighton, St. Anthony, and portions of Fridley, Mounds View, Arden Hills, Shoreview, Columbia Heights, Minneapolis, Falcon Heights, Lauderdale, and Roseville, but did not include the TCAAP facility. The TCAAP facility was recently re-zoned to accommodate future development, and the SWBCA boundary is being updated to incorporate the TCAAP facility. The current extent of the SWBCA is shown in the attached map.

Groundwater in portions of the designated area has been contaminated with volatile organic compounds (VOCs) from solvents used and disposed at TCAAP in Arden Hills. There are two areas of contamination. The largest area of contamination extends several miles to the south and west of TCAAP, to depths of several hundred feet. Here, portions of the buried sand formation (Hillside Sand Formation) and the Prairie du Chien dolomite and Jordan sandstone bedrock formations have been contaminated with VOCs. A second, smaller area of VOCs contamination exists in the surficial sand and silt deposits (Fridley Formation) to the north and west of TCAAP, to depths of approximately 45 feet.

The unconsolidated hydrogeologic formations to the southwest of TCAAP consist of a discontinuous layer of alluvium and lacustrine deposits (Fridley Formation) over glacial till (Twin Cities Formation) over the Hillside Sand Formation. The combined thickness of these formations ranges from 50 to more than 300 feet. The Fridley and Twin Cities formations to the southwest of TCAAP are not contaminated by TCAAP contaminants; the Hillside Sand Formation is contaminated at the TCAAP facility and to the southwest of TCAAP. The unconsolidated formations immediately southwest of TCAAP are underlain by the contaminated Prairie du Chien and Jordan formations. Further to the south and west, the Platteville limestone, Glenwood shale, and St. Peter sandstone occur above the Prairie du Chien formation. Contamination from the TCAAP facility has not been found in the Platteville, Glenwood, or St. Peter formations.

Efforts to contain and clean up the contamination at the TCAAP facility and to the south of TCAAP have been underway for many years. For example, several wells are being used to contain and extract contaminated groundwater, which is then treated to remove the VOCs. The treated water is then used for the city of New Brighton's municipal water supply. Steps have also been taken to remove from service and permanently seal other water-supply wells which have been contaminated in excess of the MDH's Health Risk Limits (HRLs) and present a public health threat.

The MDH, the Minnesota Pollution Control Agency (MPCA), and the U.S. Army are concerned about the public health effects that could result from the use of water-supply wells in the contaminated aquifers. The MDH and MPCA are also concerned that the construction of new wells or borings or modification of existing wells or borings within the SWBCA may interfere with cleanup efforts, or may cause further spread of the contamination.

BOUNDARIES OF THE SWBCA

The designated SWBCA is bounded on the west by State Highway 65. The south boundary is represented by the Mississippi River and Marshall Avenue. The eastern boundary extends due north from the intersection of Cleveland Avenue and Marshall Avenue to Larpenteur Avenue, then follows Larpenteur Avenue east to Fairview Avenue, then follows Fairview Avenue north to

Lake Johanna Boulevard, then follows Lake Johanna Boulevard east, becoming County Road E, to Lexington Avenue, and then follows Lexington Avenue north to County Road I. The northern boundary extends due west of the intersection of Lexington Avenue and County Road I to Snelling Avenue North, then north on Snelling Avenue North to Lois Drive, then west on Lois Drive to Schutta Road, then west from the intersection of Lois Drive and Schutta Road to Rice Creek, then south on Rice Creek to County Road I, then west on County Road I to State Highway 65. This area includes portions of Anoka, Hennepin, and Ramsey Counties.

REQUIREMENTS OF THE SWBCA

1. All wells and borings regulated by the MDH are subject to the requirements of this SWBCA. Wells include potable water-supply wells, irrigation wells, commercial and industrial water-supply wells, wells for heating and cooling, remedial wells, monitoring wells, and dewatering wells. Borings include environmental bore holes, elevator borings, and bored geothermal heat exchangers.

2. Construction of a new well or boring, or modification of the depth of an existing well or boring, may not take place until after the MDH has reviewed and approved plans for the proposed construction. In addition to the required permit application or notification, the plan must include the following information: street address; well or boring depth; casing type, diameter, and depth; method of construction, including grout materials and grout method; pumping rate; and use.

3. If the proposed construction or reconstruction of a potable water-supply well is approved, the MDH may require that one or more water samples be collected and analyzed for VOCs before the well is grouted and put into service. If contamination is present in excess of the HRLs, the well must be permanently sealed or reconstructed. The New Brighton and St. Anthony municipal water-supply wells, which are treated to remove VOCs, are exempt from this requirement.

4. The permanent sealing of a well or boring completed in or below the Prairie du Chien formation may not take place until after the MDH has reviewed and approved plans for the proposed sealing. In addition to the sealing notification that is required prior to sealing a well, the plan must include the following information: street address; original well or boring depth; current well or boring depth; casing type(s), diameter(s) and depth(s); methods for identifying and sealing any open annular space; methods for identifying and removing any obstructions; and grout material and methods.

PERSONS TO CONTACT

For additional information regarding this SWBCA, please contact Mr. Edward Schneider of the MDH Well Management Section at 651-201-4586 or *Ed.Schneider@state.mn.us*.

Plans for the construction, modification (including repair), or sealing of wells or borings within the SWBCA must be submitted to:

Mr. Patrick Sarafolean
Minnesota Department of Health
Well Management Section – Metro District
P.O. Box 64975
St. Paul, Minnesota 55164-0975
651-201-3962
Patrick.Sarafolean@state.mn.us

Notifications/permit applications for either construction or sealing of wells and borings must still be mailed or faxed to the MDH Central Office at:

Minnesota Department of Health
Well Management Section
P.O. Box 64502
St. Paul, Minnesota 55164-0502
651-201-4599 (Fax)

Plans for well construction and well sealing in the city of Minneapolis may be submitted to:

City of Minneapolis – Public Health Center
250 South Fourth Street
Minneapolis, Minnesota 55415
Attn: Tom Frame
612-673-2635

For information regarding groundwater quality and the investigation, monitoring, and remediation of groundwater contamination, please contact:

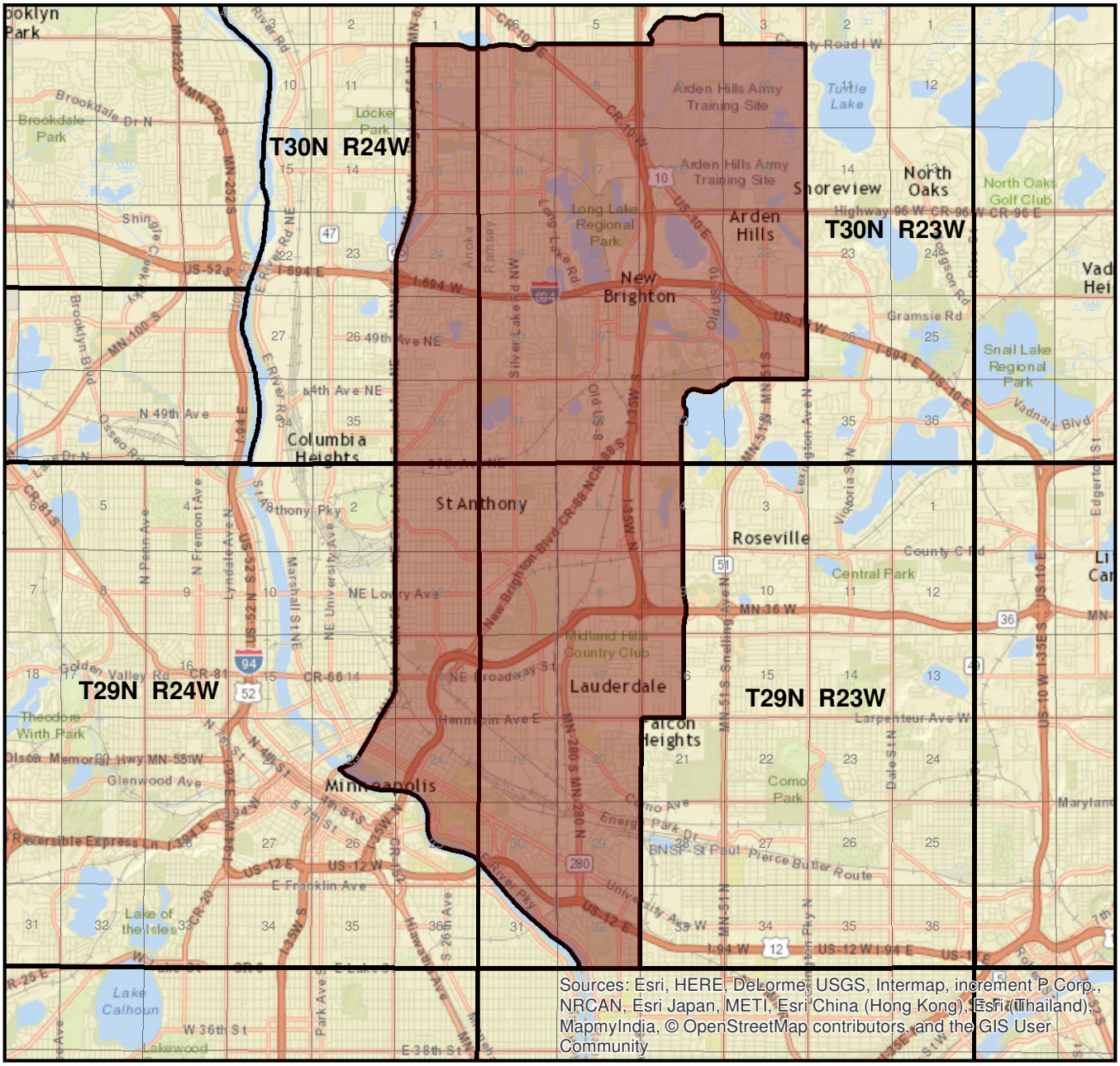
Ms. Amy Hadiaris 651-757-2402 *Amy.Hadiaris@state.mn.us*
Minnesota Pollution Control Agency
Site Remediation and Redevelopment Section
520 Lafayette Road
St. Paul, Minnesota 55155-4194

Tom Barounis 312-353-5577
U.S. EPA, Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

Mike Fix 651-268-8670
Department of the Army
Twin Cities Army Ammunition Plant
4761 Hamline Avenue North
Arden Hills, Minnesota 55112-5716

TPH:AMM:mj
Enclosure

Special Well and Boring Construction Areas
Twin Cities Army Ammunition Plant (TCAAP)



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MDH Minnesota Department *of* Health

Well Management Section

February 2016

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Appendix F
Interviews

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 7:40 AM **Date:** 30 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard, Arden Hills, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Amy Hadiaris **Title:** Hydrogeologist **Organization:** MPCA

Telephone No: 651-757-2402

E-Mail Address: amy.hadiaris@state.mn.us

Street Address: 520 Lafayette Blvd.

City: St. Paul **State:** MN **Zip:** 55155

Summary of Conversation:

1. *Are you familiar with all the TCAAP sites?*

Yes, some I am more familiar with than others, some were closed before my time, and others have ongoing opportunity.

2. *Have most of the soil issues been resolved?*

Yes.

3. *Is vapor intrusion still an issue?*

It's an issue for the redevelopment portion of it. For the redevelopment buildings, I imagine most of them will have some vapor control.

4. *Are there any sites you are concerned about vapor?*

No, since there's no shallow groundwater plume. Site I might have (VOCs that could be of concern for vapor intrusion) in the deep soil in the till. Site K and Site A would be mostly groundwater and Building 102 since these are the shallow groundwater plumes. For redevelopment, those areas in particular, we would expect to have vapor control. At the state level, whenever there's a redevelopment and VOCs are a potential contaminant of concern, we declare a vapor investigation specific to the building. So even if something is constructed in an area other than those four areas I mentioned, we would like some vapor data to confirm that building doesn't need vapor control. We need to look at data from real samples.

From an off-site perspective, OU1 and OU3 don't really come into the picture because they're so deep and there's perched water above; but we did look at the potential for vapor at off-site vapor detection

Site A and some samples were collected by the Army several years ago and we did not encounter any off-site vapor issues. Every once in a while, the state does get questions from the public about that and we usually address that by describing the hydrogeology that's been placed there which precludes vapor impacts.

5. *What about sites still bleeding contamination?*

I think they've done everything they can here. They did historically do vapor soil extraction. Site D and Site G are the main sources of the off-site plume in deep groundwater. Site I is a new source for OU3, but OU3 has been shrinking over the years and they dug some other contaminated soil out for redevelopment and remediation so what's left at Site I is pretty deep. If they saw the residual contamination here, it's 12 to 15 feet, maybe 18 feet. One thing I've got my eye on is if they lower the grade here by 10 feet, that brings the residual contamination a little bit further up but that's down in the till. The one unresolved issue I have in my mind that is related to redevelopment but strongly interfaces with Superfund; the Site K extraction trench and the effect that the County's storm water plan / management infrastructure is going to have on the Site K extraction trench. It is now, and I believe will continue to be, in the low area of the site, so the County is planning to have their storm water infrastructure in that area and I've been a little concerned about it flooding out the extraction trench or causing overflow. I'm still waiting on a plan.

In terms of optimization, I'd love to see an optimization study for Site K for more effective ways to speed up remediation. The responsible party hasn't been interested in doing anything in that regard. I think there's potential to do more interesting things there and get more at the source material that's left because the source material is trapped in the till. They've been trenching for decades and it's just going to continue that way for decades unless we speed it up with a more innovative approach. But they have not been receptive to that thus far.

6. *What statistical method was used in the optimization study?*

I don't know what they used. The Mann Kendall is what's used in the APRs I believe. I don't recall what they used in the optimization study. The optimization study that was provided was more conceptual and so we expect those design change details to be submitted in the future. They haven't been yet, to the regulators anyway, but may be the Army has internally. There's a proposal to put another extraction well closer to the source area, but we don't know exactly where yet. They're going to be changing some of the extraction wells and pumping rates and going to put in a treatment system for 1,4-dioxane. I don't think they did modeling.

7. *Any other innovations?*

I think it's good that they've moved from air stripping to GAC. Emissions in the past haven't been a big deal, but with people living and working nearby something needed to be done. The pump and treat is mainly to capture and contain because there are downgradient receptors.

8. *Any conceptual liquid phase carbon system?*

No, we haven't seen anything like that. They've indicated their intent to do that, but no date was provided.

9. *Are you happy with their capture of data?*

I think it has been good. We have proposed some changes and are going to be proposing specific changes such as targeting different depths. There's always room for improvement. I don't know any system that runs for a few years that doesn't need a fresh look or optimization. When the system was designed, we were capturing a lot of low hanging fruit. Now that it's been running, the plume has shrunk both in width and concentration, so it's a good time to take a fresh look and maybe tweak it a little bit.

10. Is the state okay with natural attenuation for shallow plumes?

There was a lot of specific research at the site that focused on MNA and the body of evidence was sufficient.

11. Is capture by pumping the only way to treat deep groundwater (layer 3 and 4) at this time?

I think so because of the off-site receptors. The idea would be eventually not to have to pump and treat off-site and continue to capture source material at the border. It may go on longer but that is the future goal.

12. Is the state satisfied with OU3 being shut down?

Yes, but we still want monitoring reports to ensure there is no rebound and no changes to the remedy.

13. What is your position on OU1?

I'm happy it's back online. It was off for three or three and half years; they discovered 1,4-dioxane in February 2013. There are the regular New Brighton municipal wells and it's my understanding they may be starting back up. If the OU1 remedy is up and running, I would expect all the New Brighton wells that were running before the dioxane was encountered are back up and running now because those are powered up with the OU1 remedy and so they would have been treated for the chlordane, solvents, and the dioxane. The treated water being put back in the municipal system for distribution; that's what the OU1 remedy is. Maybe there will be a transition period or maybe it will be fully operational.

14. What effects have site operations had on the surrounding community?

I wasn't part of the project back when impacts were affecting the community. During my tenure, I don't think there has been any impact on the community.

15. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

We have not been contacted by any members of the community regarding concerns, but there was a surge when the dioxane was detected, which was before the last 5-year review.

16. 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.

I am not aware of anything.

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

Yes, in general. Sometimes things I won't find out until later, like the OU1 remedy. When I don't feel so informed is usually when something's happening with New Brighton or Ramsey County, but from the Superfund perspective, I think the Army keeps me well informed.

18. *Do you have any comments, suggestions, or recommendations regarding the site's management or operation?*

No, other than Site K groundwater being optimized, which has its own treatment system; it's not a pumping well, it's an extraction trench since the groundwater is perched there and is very shallow. It has an air stripper. I'm concerned when that area becomes the focal point for all the storm water management for the whole development area that the extraction trench may become inundated. Also, I think there is source material trapped in the till, which is a continual source to re-contaminate the groundwater as it flows through. You can continue to extract and treat groundwater for decades, but that's probably not the most efficient thing to do. I think trying to take a crack at the source material would be good and would result in not needing to extract and treat the groundwater for the next 50 to 70 years. It seems like status quo is allowed, but it doesn't seem like the most efficient path forward with new technologies that have been developed. I know that they like the status quo because the operational cost is very predictable year after year.

19. *Do you have any ideas on new technologies?*

I would love to see some electric kinetics. I think it would be perfect for the till to try to breakdown the product since it's great for low-permeability chlorinated solvents and could potentially destroy some of the product that's continually contaminating the water. We had a professional come to the MPCA to give a talk on that and I invited GHD to attend.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 8:11 AM **Date:** 1 November 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard, Arden Hills, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Rich Straumann **Title:** Chair Person **Organization:** Arden Hills Parks & Rec.

Telephone No: 651-491-2660

E-Mail Address: straure@gmail.com

Street Address: 4380 Arden View Ct.

City: St. Paul **State:** MN **Zip:** 55112

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

From what I understand, the groundwater is still an issue and that will continue. I heard of the situation where they're going to redo the wells and that will be updated to hopefully take care of the situation for the next 20 years; I'm glad that study is done. From what I understand, the soil is all cleaned up to residential standards, so we can put the plan in for the 4,000 people in there to live and the 4,000 people that are coming to work. We also have 400 acres of land that's involved in that activity, but I'm concerned about the parks and trails that surround that, which is another 200 acres of land.

2. What effects have site operations had on the surrounding community?

I'm not aware of all the RAB type studies, but I know that some of the cleanup has affected water in New Brighton and the north end of things. My concern is more the effect on the community; I think the public still feels there are some issues about whether it's really cleaned up and what the effects of living there for a lifetime are.

From what I understand as a general citizen, and I worked at the University of Minnesota Environmental Health and Safety for many years, so I kind of have an understanding of hazardous materials. From my perspective I think things will work out fine. I think the EPA and the MPCA have strict standards and monitor things and we're not moving along without their approval. They are the expert and they have they technical expertise, so we should put our faith in them that things are being monitored.

We have Lyle, a local resident, and Paul Bloom who are carrying forward as citizen volunteers on the RAB to see that things happen. I have attended a couple RAB meetings as a general participant and I see that things are being monitored and cleaned up. Ramsey County came in and did that; if Ramsey County

wouldn't have done that, I don't think the city of Arden Hills would ever have got it done. We needed a developer to carry out the plan. Ramsey County owns the land and they cleaned up the land. We still have the Primer Tracer area and a couple areas up there to deal with but that 500-acre strip of land, as far as I know, is cleaned up and we're ready to put a trail across it. So, we can get the trail across there, across the wildlife corridor, and a trail that follows the AHATS fence.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

Some citizens are extreme on one side that it's never going to be cleaned up or livable and there are people like me; I'm in the middle and let's give this a try. We've monitored and cleaned it up and there will continue to be monitoring, especially from the water site which is underground. I don't think it's in the surface.

If I've seen the geothermal aspect and some of the stuff they've talked about, if that water is contained within its own system, I don't know why we couldn't use that for some energy type situation. From what I understand about the geothermal stuff, there would be a separate water line. I'm for sustainability and energy conservation and I know we're never going to get wind turbines because of the helicopters flying in for the National Guard; but why can't we have solar too, especially what's laid out in that Primer Tracer area, that would be the perfect spot. From what I understand, the AHATS people want to put a solar field up there too. Maybe they can be across the fence from each other and have a whole area up there that's solar fields. We need to use this land that's been sitting here for 40 years, or at least the last 20 years. We have great recreational opportunities out there with 200 acres. We have a trail out there already around the creek.

4. 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.

Somebody tried to take some copper out of there one night and got electrocuted and his mom was sitting in the car outside the fence. You can also tell by walking around Building 189 and the other Primer Tracer areas, or even from a distant, that the taggers have been in there, which I would probably think is a safety concern for the Ramsey County sheriff. I was a researcher for the Ramsey County sheriff last year and did 100 hours of service. The stories I've heard in some of the training about the copper and tagging; people can get in there and be tagging in the higher areas and fall and I think we need to, especially at Building 189 and the Tracer area, put those things back in use and secure the area. That's my general observation as a resident. We're putting ourselves up for a potential liability since the area isn't secure. There are holes in the fence all over the place; if you cover it up, the hole appears in the fence the next day 100 feet down. My perception is the security in the place hasn't been 100% effective but not that they haven't necessarily tried. If we get it back in service, we have to take care of that issue.

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

I think I'm probably one of the more informed people as chair of the committee. I try to keep up on that and keep my committee informed. We hang out all the time and we share information back and forth. One of the things I did find out is twelve years ago, there was a sheet of paper that said how we should use Building 189. We dug out that piece of paper and it still stands today that we should use it for cross country skiing and recreation. So, from the project perspective in the last dozen years or so, things

haven't changed much; they just kind of stalled and we need to move forward with plans that have been laid out. We're not going to have the Bruce Dental golf course out here because AHATS is taking care of that but were going to have other recreation areas nearby. I can't believe there is not a good trail on the other side of the fence near AHATS. The National Guard can use that too. We're not here to say this is Arden Hills Rice Creek Commons or whatever we're going to call it in the future; we want to cooperate with AHATS, but I think AHATS can also give some things; however, AHATS, I think, is community oriented.

We had an open house; it was small, only about a dozen families, and people have different ideas of military presence. With the Red Bulls moving and another 200 people coming in here on a daily basis, I think they'll see the activity. They can always read comments once it gets built, and they'll see what's happening and there will be a different awareness that something actually is happening. I know I participate and there are other concerned citizens out there, but I think that, in general, people have questions. We had a meeting about when can I buy a lot, who's going to move into the corporate cabinets? We have a grocery store planned out there and who's going to be the grocer, can we have a rec center in the downtown area? Those are all concerns that we're working on.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

I think if we can get the word out about what's happening out there, and once the developer buys the land, that will happen in the Rice Creek Commons Area. I think we will make sure that what's happening in the 200 acres on the recreation side with Building 189, which is basically Ramsey County land that's come through the National Parks Service. We'll get that publicity out. People have been using the loop trail already from either side; Arden Hills residents have to drive to get to it, but other County residents can walk to it. I think we'll have a relationship with AHATS that will continue and improve as the community works with them.

At the Ben Franklin Center we have a group called Beyond the Yellow Ribbon and we have representatives from Arden Hills on that committee too. So, we have Beyond the Yellow Ribbon and parks, trails, and rec committee people at the AHATS open house. We're trying to, from the citizen/volunteer side, work with AHATS and I think AHATS is allowing us to do that, so we have that cooperation on both sides which is important.

From 96-North is basically a third of the land of Arden Hills; we don't have the whole 2,000 acres but we do have access to 400 to 600 acres of it and the others we have to work with the National Guard because we would like to see more trail activity, like cross country skiing or mountain biking or hiking. The National Guard could benefit too; they have civil engineers that need to build roads, and can we do a biathlon? From the recreation side there are all kinds of ideas out there. Our parks, trails and rec committee has some pretty active people; we have someone who's on the board for the National Sports Center up the road which has a lot of soccer. If we get something, like the Civic Center in the Rice Creek Commons Area, people will see we have viable avenues for recreation. If we can provide recreation for people living and working there, I think that would be very good news for people. We're moving forward, and we haven't stalemated like the last 40 or 50 years.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 7:54 AM **Date:** 1 November 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard, Arden Hills, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Paul R. Bloom **Title:** Professor **Organization:** University of Minnesota

Telephone No: 651-646-1985

E-Mail Address: prb@umn.edu

Street Address: 1515 Hythe St.

City: St. Paul **State:** MN **Zip:** 55108

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

It's moving forward slowly. During the very active portion of the RAB, we had good interaction with the Army and cleanup. I was really impressed with the work getting it fixed and making sure there was input. We did have a major argument about cleanup goals and it was insisted that industrial cleanup goals for much of the site were the ROD goals. We said because eventually it would be housing, but the intention was that the Army Environmental Command was going to be in charge of the western part of the site.

I was most qualified to help on the soil sites and I think they did a good job. They were very thorough, and they got involved with some crazy schemes; it wasn't the fault of the local people when they got Army Environmental Command to do the remediation cleanup, which actually cost them because it was not well thought out and it was a big mistake actually. It cost a lot of rank within the Army because I understand a lot of people from the AEC were banned from coming back to the site. Those of use on the RAB had written a report saying that was a bad idea for the bioremediation plan. The Army's hands were tied, and they couldn't do much about it, and the MPCA and EPA went along with it. That was one of the major screwups.

I think the groundwater has been happening really remarkably well. I don't know where it is at this moment, but I know it's getting close; the last projection I saw was 2040 for completion and I know they're checking on that every so often. They've gotten the MPCA to do a lot of work on natural attenuation to shorten the timeline. I'm not quite sure what the timeline is right now. There's Round Lake, which is a big football that's being passed around; controversy among a wildlife refuge, people that hold the land now that was deeded to them by the Army, the Army, the MPCA, EPA and the local

residents. There a couple of us trying to see if we can help work out a compromise but it seems there's no compromise to be had, at least at this moment.

My personal opinion is that if it was developed into a really nice wetland; it's basically a degraded wetland and there are ways of rejuvenating it. I think the wildlife refuge people like it too because it would be a nice addition to the environmental destination idea and that is part of the development plan in some people's mind.

2. What effects have site operations had on the surrounding community?

The main effect is the groundwater and the supply of water to New Brighton and the supply of water to Fridley because that's the treated water for New Brighton.

The other effect was the population that was aware of what's going on was really worried about their groundwater supply and other environmental effects from the site. The cleanup is coming along and everyone's pretty satisfied that the cleanup is going well and there no health implications for people in Arden Hills or New Brighton.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

I think the main concern is the development since the implication is they only cleaned up to industrial standards. When the transfer took place, there was awareness that further cleanup needed to be done. The cost for the County and having to hire a contractor and so forth (is a concern).

4. 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, I don't live in this area; I live six or seven miles south of here in St. Paul, so I don't really keep up with the local news.

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

I get the annual reports but ever since the last discussions we've had on Round Lake, I only kept track of it casually to see how the groundwater cleanup is doing. Everything seems to be moving along quite well until something comes up that we need to talk about. I've been doing other things and haven't been keeping close track. For the last 15 or 20 years, though, I spent a lot of time keeping track; looking at the reports, writing responses, and at one point, we hired a graduate student who was working with me to help track technical aspects of the cleanup. So, I went through a very active period, but I am inactive now and more of a bystander paying attention to what's going on.

6. Do you have any comments, suggestions, or recommendations regarding the project?

I wish there was more effort to come to some kind of conclusion on Round Lake. As a person that's worked on wetlands, I have a particular interest on the result there. I hope they can do a better job of involving the local residents in the homes that border the lake.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 2:40 PM **Date:** 30 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard, Arden Hills, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Rob Field **Title:** Plant Operator **Organization:** GHD

Telephone No: 952-210-7601

E-Mail Address: rob.field@ghd.com

Street Address: 1801 Old Highway 8 Northwest, Suite 114

City: St. Paul **State:** MN **Zip:** 55112

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

I feel that the project is going very well, that the plume is shrinking with time, and I believe hydraulic capture is happening. I like to work on the project and operation and maintenance.

2. Is the remedy functioning as expected? How well is the remedy performing?

I actually brag about it to people that I tell what I do; that over the years the plume is shrinking and we're able to shut off extraction wells, and I personally believe we do have hydraulic containment. I think that it's going very well.

3. What do the monitoring data show? Are there any trends that show contaminant levels are decreasing?

Yes, there definitely are (trends), and I am not as up to speed on concentrations. I do the sampling, but I don't see the data. I see the influent and effluent data, but I don't see all the monitoring well data or put it on figures, but I do know that the influent concentrations have reduced greatly over the years.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Yes, there is. Operation and maintenance is required once monthly and includes treatment system O&M, which is to grease the blowers and pillow blocks; change filters on the electric check valves; climb up the towers and check all the scaffolding; check the building hardware, doors, and building controls, like heaters and vents; and turn the system on and off. Then I go around to each of the extraction wells that are operating, and I change all filter screens, clean the pump houses, and check pressure gauges,

electric check valves, solenoid, solenoid valves, and microswitches. Then I go and make sure that effluent water is making it down to the sand and gravel pit without any leaks and check the DPE pipes. I check all the pump houses that are now shut down and make sure none of them are leaking, and then I check the building hardware and building conditions and clean the pump houses.

5. Is there adequate staff?

Yes.

6. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

We have added 1,4-dioxane sampling. We put a bigger pump in extraction well P5, a 50-horsepower pump and motor. And we did install new connectors in the extraction well houses.

7. Is the protectiveness of the remedy intact?

Yes.

8. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

The data communication lines were hit by a contractor and destroyed so we had to hire a contractor to get those fixed. An animal burrowed into one of the hand holes and chewed on the wires, which was substantial down time and maintenance costs trying to figure out the problem with that. Those were communication wires because sometimes the pumps would work and sometimes they wouldn't. We cleaned the force main in 2016 and 2017 (the force main that carries the water out to the treatment system).

9. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Yes, optimizing P5 with a bigger pump. Other than that, I haven't thought too much about the optimization and I don't have a lot of input on that. It sounds like it's a good thing since they are going to go from hydraulic containment as the main idea to mass source removal.

10. Do you have any comments, suggestions, or recommendations regarding the project?

Maybe VFDs (variable frequency drives) and mag meters instead of cold water flow meters.

10a. VFDs to be able to change pumping rates?

Yes, and I won't need all the maintenance on electric check valves. Mag meters are current technology and so they would be able to be wired in, control wise, and they would require pretty much no maintenance. For the optimization of pump house P4 and P5, and I talked to Sean about this, I think we should go to VFDs on those and then get rid of those electric check valves which would give us more space for an RPV to be in line rather than currently with these RPZs. We have six elbows at 90 degrees, which reduces flow quite a bit, so if we can just have a straight shot out of the 90 coming through the piping I think we would be able to achieve our flow rate of 400 gallons per minute.

10b. What's the size of the conveyance pipe?

Three-inch. The RPZs cause a lot of friction too, so if we can just have the riser pipe with two elbows (90s), I think we could easily achieve 400 gallons per minute and then move to 4-inch piping.

10c. How long is the length?

It is about 7 feet.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 2:20 PM **Date:** 31 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: GHD Office, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Shawn Horn **Title:** Vice President **Organization:** GHD

Telephone No: 612-524-6860

E-Mail Address: shawn.horn@ghd.com

Street Address: 1801 Old Highway 8 Northwest, Suite 114

City: St. Paul **State:** MN **Zip:** 55112

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

It has been wonderful in reducing concentrations across the site and the southeast and the southwest property by orders of magnitude. It shrunk the plume and decreased the concentrations.

2. Is the remedy functioning as expected? How well is the remedy performing?

The remedy has met the OU2 ROD goals of hydraulic containment and mass removal.

3. What do the monitoring data show? Are there any trends that show contaminant levels are decreasing?

Yes, the contaminant trends are showing relay to volatile organic compounds, mainly TCE-(trichloroethene), that they have been reduced by orders of magnitude across the site. There are a few wells that are not necessarily decreasing, but stable.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Yes, our staff involves myself for project management, day to day issues with a junior engineer, a couple technicians relay to ongoing maintenance and troubleshooting of the groundwater extraction treatment system, daily inspections (except for Federal holidays), chemical sampling, and we have quality assurance chemist oversight.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Yes, but it has dealt mainly with the reduction of turning off wells due to concentrations and/or maintenance problems, which really isn't benefiting hydraulic containment or mass removal.

6. Have the changes affected the protectiveness or effectiveness?

No.

7. Has it improved it?

If you're not pumping relatively clean water, say you're pumping 20 ppb TCE, but you're only getting less than a pound a year because the wells that are operating produce massive amounts of silicon nitride.

8. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

Maybe not unexpected, but infrequent. Going forward with the force main cleaning; something that's been operating for years and then you're going to clean the force main, I would contend that is expected. We've only done it once in 20 to 30 years. We don't expect to do it for another 20 or 15 years.

9. That is to improve the flow through the pipe?

Correct and it was a great opportunity at the time because when we started getting residences and all that, it was a messy cleanup with all the sludge and stuff that can accumulate in a pipe.

10. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Yes, relay it to wells that you don't think you need for hydraulic containment and allowing them to be turned off for maintenance issues or they don't really need to be sampled for interpretation. In 2014, we had a list of wells that we thought could be eliminated from the monitoring program. That was carried through. This was done before all the soil removal and the grading by the developer. So, with that we might have to replace some wells that had been previously abandoned in similar locations.

11. Have there been cost savings due to turning off wells?

Absolutely, you're turning off a well so you're losing all, or for the most part, 20 to 30 horsepower pumps; so, you don't have the energy cost of that.

12. Do you have any comments, suggestions, or recommendations regarding the project?

I am looking forward to changing/updating the control system (communication/record system). And, if liquid phase carbon proves similar in effectiveness and cost to air stripping with vapor phase carbon; if they're known containment is more protective.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 11:43 AM **Date:** 1 November 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Water Treatment Plant, New Brighton, MN

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Scott Boller **Title:** Superintendent **Organization:** City of New Brighton

Telephone No: 651-638-2119

E-Mail Address: scott.boller@newbrightonmn.gov

Street Address: 700 5th Street NW

City: New Brighton **State:** MN **Zip:** 55112

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

Our project has done very well for us since we started in the early 90's. The plant has operated very efficiently, and we've had very little problems with the plant operation. The first issue that really came about was February of 2015 when we were notified of a new contaminant, 1-4 dioxane, in our water and that's created the challenge that we've been working on for the past few years.

2. Is the remedy functioning as expected? How well is the remedy performing?

It was functioning as expected very well. We're happy to always say that we had levels of no detect for any contaminants leaving this property. That all changed, again, in February 2015 when we were notified of the 1,4-dioxane.

3. What do the monitoring data show? Are there any trends that show contaminant levels are decreasing?

I don't see what the geologists see or what the people see in the plume. I have some knowledge of it, but I can't speak at any length. I've been told over the years that we've been able to contain the contaminant plume and keep it from spreading into the neighboring communities or further towards the river.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Yes, we staff this plant with one treatment plant operator and two other plant operators, as well as a supervisor part time to keep on top of the maintenance and the production of this plant. We do also

work with our engineering firm, Bar Engineering, to stay on top of annual maintenance. We have a Work Plan that we follow extensively to make sure that we repair/replace items timely and that they don't cause the plant to shut down by unforeseen malfunction. That Work Plan is looked at annually and followed throughout the year to determine if we have to make any changes to that Work Plan. If we find that some things are lasting longer than they should, we stretch that time out before we replace/repair those items. If we find that we have a pump, for instance, that isn't making the five years that we suspect, we'll move up the replacement time or maybe we'll look for a different manufacturer for the pump or something that will work better for us. A current example would be our chemical feed tubing. For years we had a chemical feed tubing that annually we had to replace because the chlorine would eat the hoses up. When we found out that for just a little bit more money you could buy a Teflon hose and install that, and that would last for many years and wouldn't require the annual cost or the annual labor to install those hoses; so, we're always looking for those kinds of things. Ways to streamline our operation, and ways to save money and allow it to go a little bit further than it currently does.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

Yes, in April of 2015 the Minnesota Department of Health indicated to us that we had another chemical contaminant in our water, 1,4-dioxane, or we call it DX. That required us to shut down this plant and six associated wells and start work on the selection and procurement of the process that would remove the DX from the water; that's where we're currently at in the construction phase. Hopefully, we'll have water coming from this plant as early as tomorrow.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

Just this last issue when we were notified of the 1,4-dioxane and that the treatment process we had available to us would not remove that contaminant. So that is the reason why we're where we're at now doing the addition to the plant and installing the TrojanUVPhox AOP equipment.

7. Have there been opportunities to optimize O&M, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

We're always studying what we do up here. Are there ways to save money, or streamline and conserve the money that we get from the Army to operate this plant? We don't take anything for granted; we treat this plant and operate it as if it was our own. On a daily basis, we look at things that we can do to save money and make the plant operate more efficiently. One thing I can think of off-hand is that when this plant was built we had huge dryers/dehumidification units and they were probably state of the art at the time. But we found out that they were big, maintenance headaches, and expensive to maintain, so we started looking for a solution to that. We found one called a high heat dry unit; they're a small and portable unit that you can place throughout the plant. They are much more affordable and we don't have to have a contractor come up annually and service them and spend a lot of money. I'm sure he's not happy, but in the long run we're going to save a lot of money. That's just one incidence of some things that we'll do when it is time to replace valves, pumps, etc. We always look at what's out there since we know the technology's changed and we don't always have to use what was here. We can look and find out if there is something better, something that isn't a maintenance headache.

8. Do you have any comments, suggestions, or recommendations regarding the project?

I really don't. I've been involved with this project since 2007. I'm very happy with the way things operate here, I'm very happy with our relationship with the Army and how we are allowed to operate this plant. We're very proud of this place. We love it and we want to take care of it like it's our own; we want to be able to show it off and we enjoy having the Army in town. We hope this is one of their projects they are very proud of.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 1:30 PM **Date:** 29 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard Building, Arden Hills

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Nick Smith **Title:** Environmental Engineer **Organization:** U.S. Army Environmental Command

Telephone No: (210) 466-1707

Fax No: (210) 793-7873 (Government Cell)

E-Mail Address: nicholas.b.smith56.civ@mail.mil

Street Address: 2450 Connell Road, Building 2264

City: JBSA Ft Sam Houston **State:** TX **Zip:** 78234-7664

Summary of Conversation:

1. *What is your overall impression of the project? (general sentiment)*

Good, the project is in a good place.

2. *Is the remedy functioning as expected? How well is the remedy performing?*

Yes, remedies are performing well with regards to VOCs in groundwater. VOC concentrations in groundwater show decreasing trends for most wells. Also, we are in the process of addressing 1, 4-dioxane contamination; a contract was awarded to Pika/Arcadis.

3. *Have there been any complaints, violations, or other incidents related to the site requiring a response by your office or state/local office? If so, please give details of events and results of responses.*

No violation or citation from the regulators and not aware of any issues or complaints.

4. *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.*

There have been issues with the theft of copper at the Primer/Tracer area with the illicit behavior resulting in a fatality. Also, extensive graffiti at the same location.

5. *Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.*

Not really been much community impact with respect to residents. Local Government (New Brighton and St. Anthony) are the ones with issues and their concerns are being addressed through capital improvement for VOC and 1,4-dioxane treatment, and in the case of New Brighton, which is a part of the remedy, providing for O&M costs.

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

Yes, I am very well informed.

7. What does the monitoring data look? Are there any trends that show contaminant levels are decreasing?

VOC concentrations in the groundwater show decreasing trends for most wells. The plume is decreasing resulting in well closures. The vision is to pump less clean water and more contaminated water.

8. Is there a continuous on-site O&M presence?

Yes, experienced and competent technical staff are working on the project.

9. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years?

Nothing I can think of. I am pleased with the maintenance schedule and the fact that there have been no citations to my knowledge.

10. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years?

No unusual costs; similar costs as before and budgeting has not been an issue.

11. Have there been opportunities to optimize O&M or sampling efforts?

Currently, we are implementing a remedy review which is being done by Pika/Arcadis. Ten (10) borings and three source control extraction wells are being planned for optimization purposes. We are also working on minimizing pumping down time.

12. Do you have any comments, suggestions, or recommendations regarding the project?

Recommendations include: 1) changing groundwater treatment technology from an air stripping system to a liquid granular activated carbon system, and 2) adding UV technology to treat 1,4-dioxane contamination. We are in the process of preparing an ESD that adds 1,4-dioxane as a COC being treated at the well head (SC 2 Well), as well as the switch to GAC. Only concern would be that there is flexibility in the ROD amendment that allows for it to be issued post-construction.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 1:30 PM **Date:** 29 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard Building, Arden Hills

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Mary Lee **Title:** Environmental Protection Specialist **Organization:** Minnesota Army National Guard

Telephone No: (651) 282-4420

Fax No: (651) 968-7076 (Cell)

E-Mail Address: mary.i.lee.civ@mail.mil

Street Address: 4761 Hamline Av. North

City: Arden Hills **State:** MN **Zip:** 55112-5794

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

Positive, a smoothly running operation. The AEC, GHD, and Arcadis have been very responsive and professional.

2. What effects have site operations had on the surrounding community?

The community has a positive perception of the site operations.

3. Are you aware of any community concerns regarding the site or its operations and administration?

No complaints made by the public to me. Inquiries are made from time to time, mostly by contractors wishing to review the repository. One councilwoman also makes inquiries.

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

Yes, the AEC and contractors keep me well informed.

5. 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.

Yes, holes were cut in the fence.

6. Do you have any comments, suggestions, or recommendations regarding the project?

Would like to see automation of the repository with a search function. Improved coordination in construction activities would also help us with our O&M.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 1:00 PM **Date:** 30 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard Building, Arden Hills

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: David Brown **Title:** Project Manager **Organization:** Northrup Grumman Innovation Systems

Telephone No: (925) 351-5536

Fax No: (651) 968-7076 (Cell)

E-Mail Address: David.brown@orbitalATK.com

Street Address: 601 Carlson Parkway, Suite 600

City: Minnetonka **State:** MN **Zip:** 55305

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

I think good progress is being made with the operating strategy. It's a very high visibility site, one of the largest still to be developed properties in Ramsey County. My impression of our progress has been that we're heading in the right direction.

2. Is the remedy functioning as expected? How well is the remedy performing?

Absolutely. I think it's being heavily monitored and I think on an annual basis, as our APR results show, that it's performing as designed.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

I don't directly get any input from the community, but it is a very high visibility site. I think there was a period of public input in the initial planning stages of the development of this project, but the answer to your question as to me directly, I don't have direct involvement with any of that kind of input.

3a. The community has not approached you personally to inquire or ask?

No, it has never happened.

3b. Are you aware of any concerns from the community that has not been addressed?

I am not aware.

4. 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.

Yes. That's why we put a fence in the last year around Building 116, which is the train system. We had some incidents of vandalism. Our answer to that was getting a security fence around it, which is now up.

4a. Is it working?

Yes.

5. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

We have, with a few exceptions of stagnating levels, overall declining trends in compounds of concern, in particular TCE. And we're now developing a strategy, as we told you, for 1-4 dioxane; that's more of an emerging compound.

5a. How is that going and being handled?

We are working in cooperative fashion with the Army to develop a strategy to reduce concentrations of 1,4-dioxane.

6. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Absolutely yes, daily site inspections and scheduled monitoring rounds. We discussed alternating years, big rounds and smaller rounds, twice-a-year extraction well sampling, very vigorous site inspections and maintenance, keeping inventory on site, keeping track of potential failing pumps and staying out ahead of those problems. Our chief consultant, GHD, is on site every day. They are literally on site every day, other than those few days.

6a. As I recall, they do daily inspections of the system?

Correct, that's right.

7. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

No, otherwise we wouldn't have taken those off line.

8. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

As we move forward we need to remediate 1,4-dioxane and that's a change; that's going to be increased O&M costs. I am aware it hasn't kicked in yet in this five-year period but yes, fully communicated and well aware that will increase our cost.

8a. It has not been implemented?

Correct.

9. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Absolutely. Reduction of frequency of sampling, no. We're entering into that optimization phase where we're going to be making full discussions with Pika/Arcadis and the Army moving forward.

9a. Have there been opportunities for optimization of O&M and sampling that you have acted on before?

Yes.

9b. The examples were SC2 and what else?

Other wells taken offline, I don't know, that was long before the last five years and more in the northwestern flag. All kinds of degrading, we've got wells that are going to have to be replaced.

10. Do you have any comments, suggestions, or recommendations regarding the project?

I do not. We go above and beyond, talking each and every day with our consultants.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 8:05 AM **Date:** 31 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Arcadis Office, Minneapolis

Contact Made By:

Name: Amir Matin **Title**: Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Katy Grant **Title:** Geologist **Organization:** Arcadis

Telephone No: 612-300-0196

E-Mail Address: katy.grant@arcadis.com

Street Address: 430 N. 1st Ave., Suite 720

City: Minneapolis **State:** MN **Zip:** 55401

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

We're making a lot of progress. We have done some good field work and added some good data in the last two years. I think we're making some good strides toward improving the overall situation on TCAAP.

2. Is the remedy functioning as expected? How well is the remedy performing?

I would say yes, I think it's functioning as expected at this point. It's doing well for the things we know it can do. It's removing TCE, which is what it was put in place to do. Obviously, 1, 4-dioxane is an issue at the site and that is not currently being addressed. In terms of the overall problem at the site, not everything is being addressed but that is in progress so as it stands now, things look as good as they could be.

3. What do the monitoring data show? Are there any trends that show contaminant levels are decreasing?

Yes, when you look at where the site was 10 to 15 years ago, contaminant levels are actually decreasing. It's stagnated in some areas; hence, the system optimization we are working on, but overall things are improving.

4. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Staffing is provided by GHD. What I know of their activity is routine O&M and tracking totalized readings, but for more detail we refer to GHD.

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.

As far as O&M requirements and maintenance schedules, that would be another question for GHD. For sampling routines, we have shifted the large-year/small-year schedules slightly to accommodate when they found 1-4 dioxane; they did an all-encompassing sampling event and so that did shift things slightly. We've obviously added 1-4 dioxane to the sampling list. Other than that, no changes.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.

You would have to refer to GHD.

7. Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

Yes, we are currently fully optimizing sampling efforts. As far as this year, we did a test run using hydro sleeves instead of large pumps for the deep groundwater wells to improve efficiency that way. Hopefully there are some cost savings on the Army side. As far as optimizing O&M, I do not believe so; I believe that has generally stayed the same.

7a. For the sampling effort, does the optimization include changing the frequency of sampling?

No, the frequency would stay the same. We are just trying to optimize the sampling method to be a little less arduous. Our field personnel kind of streamline things a little bit.

8. Do you have any comments, suggestions, or recommendations regarding the project?

I think all of my comments and suggestions are kind of captured in the remedy review. We need to address 1-4 dioxane, which we're currently working on. We need to be pumping at the source areas where we know there are greater amounts of mass; that is the right road to go down and that's what we are currently working on Work Plans for. Aside from those things, no, I think things are moving in a good direction.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 1:50 PM **Date:** 31 October 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: County Office

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Josh Olson

Telephone No: 612-758-0742

E-Mail Address: Josh.olson@co.ramsey.mn.us

Street Address: 15 W. Kellogg Blvd. 260 Courthouse

City: Saint Paul **State:** MN **Zip:** 55102

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

On behalf of Ramsey County, it's an extremely important project in terms of its future growth and prosperity. TCAAP represents the last and largest redevelopment opportunity within Ramsey County, so this is an opportunity to fulfill a number of project goals as it pertains to affordable housing, job creation, and increased tax base.

1a. What is your impression of the cleanup project?

My impression of that is it's a huge win for the County and the community. This has long been a challenging site for redevelopment because of its prior uses, so the County's decision to jump into this project and help facilitate cleanup of the soils is a significant milestone.

2. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office or state/local office? If so, give details of events and results of responses.

No.

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

Yes.

4. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

We recognize this is a large, complicated project that takes multiple levels of government to come to fruition. I think we've been impressed with our federal partners and their ability to provide us with both information and creative solutions that really have a long-term perspective in mind.

5. Do you have any comments, suggestions, or recommendations regarding the project?

I think the Army's decision to move from a vapor-based remediation to a liquid base represents a huge opportunity for Ramsey County on multiple levels and truly a much better solution moving forward.

6. Have there been any routine communication activities like site visits, inspections, or reporting conducted by your office regarding the site? If so, please provide the purpose and results.

Yes, we've been in regular communication with multiple levels of project partners, both at the City and County level and the state, but also regulators at the federal level and the Army. This project touches a lot of local, state, and federal agencies.

INTERVIEW RECORD

Site Name: Twin Cities Army Ammunition Plant

Subject: Five-Year Review **Time:** 7:37 AM **Date:** 1 November 2018

Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing

Location of Visit: Minnesota Army National Guard Building, Arden Hills

Contact Made By:

Name: Amir Matin **Title:** Senior Engineering Geologist **Organization:** DAWSON

Individual Contacted:

Name: Lyle Salmela **Title:** RAB Chair **Organization:** RAB

Telephone No: (651) 636-6461

E-Mail Address: lrsalmela.com

Street Address: 1480 Arden Vista Court

City: Arden Hills **State:** MN **Zip:** 55112

Summary of Conversation:

1. What is your overall impression of the project? (general sentiment)

Really good, restoration is accomplished. It's clean to residential and recreational standards. The Primer/Tracer area still needs attention. The Primer/Tracer area is really an asset to the community and very little is being done about it; it should be cleaned up further. My goal is that it becomes a microgrid solar array approximating 60 acres; 40 acres should be a solar array and 20 acres should be where the homeland security and emergency services operations for the state of Minnesota should be relocated to. There has been a state budget to develop those facilities, but it hasn't passed legislature. I have lobbied to try to get that established.

2. What effects have site operations had on the surrounding community?

Really positive. Many residents and people from outside the area have wanted to move there once it's developed. It's becoming a welcoming energy sustainable community of the future. It's my goal as chair of the energy advisory board for the direct development authority that its many things in development are developed on the site.

3. Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.

There is some concern with public and government people that there may be contamination still present; 1-4 dioxane and the VOCs have come up as concerns. The TDRS groundwater issue, I think, is a big one. The energy foresight is to make a geothermal loop system with the 2 million gallons of water that is being pumped every day that will be a loop in the residential areas. Everybody would have a heat pump and they would recover getting a cooling from that similar to the National Guard Readiness

Facility and upcoming Red Bull headquarters where they take 45-degree groundwater. It goes through five or more heat pumps and returns to the ground at about 42 degrees. That is a concern. I've asked Amy with the MPCA and Mr. Smith with the Army on whether the water needs to go through a heat exchanger after it goes through the air stripper, or whether that water can be circulated in the geothermal loop without going through the heat exchanger before it's on its way to the gravel pit that it's now being discharged to. I would say it is a big asset to the community. There's enough energy in that water to heat and cool all the residential facility sites in the plant.

4. 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.

Virtually all the copper has been stripped not only from the development area but the Primer/Tracer area. There has been vandalism of all the remaining buildings and the windows have been broken out; all the copper has been removed from the building. Whatever is left from the Primer/Tracer area is ready for leveling demolition. I would like to see that Primer/Tracer area developed for solar. The information is that it would take about $3.5 million to clean it up, level it, and top it off. I think that would be a big asset not only to the military but to the state, county, and the city to take excess land that could be put on the tax roll producing 68 megawatts of electricity for the community. It should be become a microgrid system that would be shared or collaborated with AHATS, all the Army facilities and with Rice Creek Commons. We should also collaborate with homeland security and develop the cyber security system. A pilot cyber security system for this area that included the military and the Rice Creek Commons development; there's a model for the whole state of Minnesota. It was designed by Jacobs Engineering. It was to model the military site for the whole nation. Jacobs designs military sites around the world for the U.S. It was supposed to be a model site for military sites around the world. This was to be an expansion for how we can make an electric microgrid system that could actually be piloted by itself off the grid if there were emergencies, which is a requirement of the military for this site.

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

Yes, I've been involved with the RAB for about 20 years. I'm still listed as chair of it. I've been working with the city and the county with developing the site for the past 20 years. They asked me to be the chair of the energy advisory board, which is now progressing to a pilot program with a public utilities commission. Ramsey County, Xcel Energy, Evergreen Energy, and the Center for Energy and Environment would all be involved in developing an energy integration plan that has been agreed to between the parties. Everything is moving quite rapidly and hopefully we could have a pilot program on the site in 2020/2021 to develop the microgrid. Xcel has the Time of use rate and smart meters. They also have customers and the microgrid storage plus software to manage that. So, this could be a model microgrid site for the whole nation. When I worked with NSP/Xcel, I won the Innovator Award, so I know what you have to do to get to that point.

I believe this site has that potential. We really need the military to work with all these entities and make this a showcase. My major concerns are with the Primer/Tracer area, the use of the underground 2 million gallons of water, and there's a lot of recreational potential being with the Kane that's 200 feet higher than the Rice Creek Commons. My family has been involved with the Olympic cross-country venues. It's a military sport; they have cross-country skiing at Camp Ripley. I think this site at one time was looked at for a world class cross-country skiing venue using water off the creek for snowmaking given the fact there's the 200-foot elevation difference between the Kane and Rice Creek. This site has a

lot of potential and I think this would be a plus for the government, Army, military, homeland security, cybersecurity, and the whole energy situation of developing microgrids as a development of what future electric utilities are going to look like with microgrids feeding into the larger grid and being able to pilot themselves if there are cyberattacks or grid outages. I think there is a lot of potential here that a lot of people don't know about. We just hope the military and Army can be an asset and assist with the development.

6. Do you have any comments, suggestions, or recommendations regarding the project?

I would say just clean up that Primer/Tracer area. I know it's going to cost about $3.5 million; however, the military or Army can work with the County and the developer and Xcel Energy. To do that would just be a plus for everybody. The collaboration between cybersecurity use, emergency response, and recreation potential; I think this could be a model for the whole country and worldwide.

Tiffany LaPlume

To: Krista O'Hara
Cc: David Boyes; Staci Herring
Subject: RE: Interview for New Brighton/Arden Hills Superfund Site 5 year review

From: Barounis, Thomas <barounis.thomas@epa.gov>
Sent: Monday, February 4, 2019 1:33 PM
To: David Boyes <dboyes@dawson8a.com>; Amy Hadiaris <Amy.Hadiaris@pca.state.mn.us>; Linda Albrecht <linda.b.albrecht.civ@mail.mil>
Cc: Amir Matin <amatin@dawson8a.com>; Staci Herring <sherring@dawson8a.com>
Subject: RE: Interview for New Brighton/Arden Hills Superfund Site 5 year review

Good afternoon Mr. Boyes.

Please see the below responses to your questions for the NB/AH/TCAAP five Year Review.

Let me know if you have any questions.

Thank you.

Tom Barounis, RPM
U.S. EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604
312-353-5577

From: David Boyes <dboyes@dawson8a.com>
Sent: Tuesday, January 01, 2019 8:54 PM
To: Barounis, Thomas <barounis.thomas@epa.gov>
Cc: Amir Matin <amatin@dawson8a.com>; Staci Herring <sherring@dawson8a.com>
Subject: Interview for New Brighton/Arden Hills Superfund Site 5 year review

Dear Mr. Barounis

On behalf of the U.S. Army and the Louisville District U.S. Army Corps of Engineers, DAWSON is conducting the 5th Five-Year Review of remedial actions at the New Brighton/Arden Hills Superfund Site (NB/AH site) which includes the Twin Cities Army Ammunition Plant (TCAAP). The purpose of the Five-Year Review is to determine whether the remedy at a site is/remains protective of human health and the environment and to evaluate the implementation and performance of the selected remedy.

For the NB/AH site, remedies have been selected for Operable Unit (OU) 1, OU2, and OU3. OU1 consists of the large north plume of contaminated groundwater outside the boundaries of the TCAAP facility. OU2 consists of affected soil, sediment, surface water, and groundwater within the boundaries of the TCAAP facility. OU3 consists of the south plume of groundwater contamination outside the boundaries of the TCAAP facility. Implementation of the remedies selected for these OUs comprises the final remedy for the NB/AH site.

As the USEPA Remedial Project Manager for the NB/AH/TCAAP Site, you have been identified as an individual who may be key to better understanding site status. As such, your participation in the Five-Year Review Interview process is requested.

Below is a list of questions DAWSON has prepared based upon your intimate knowledge of the NB/AH/TCAAP Site. If you are willing to participate, please take some time to consider each question and provide answers. Your answers can be provided by responding in writing to each question by replying directly to this e-mail or contacting me by e-mail or phone and scheduling a time to conduct a telephone interview.

1. *Are you familiar with all the TCAAP sites?*

   Yes.

2. *Have most of the soil issues been resolved?*

   Yes.

3. *Is vapor intrusion still an issue?*

   No.

4. *Are there any sites where you are concerned about vapor Intrusion?*

   No.

5. *Are there any sites that soil vapor extraction should be considered?*

   SVE was performed at Sites D and G on TCAAP. Based upon the most recent information, there are no other sites where it needs to be considered.

6. *What statistical method do you recommend for the optimization of the pump and treat (P&T) system?*

   EPA will evaluate statistical method(s) proposed by the U.S. Army for optimization of the P&T systems, for technical acceptability and conformance with EPA policy and guidance.

7. *Should other technologies be considered for deep groundwater contamination?*

   EPA will consider technologies that have the potential to optimize the effectiveness, implementibility, cost, and time to achieve cleanup standards for deep groundwater contamination.

8. *Are you happy with the capture zone data and evaluation?*

   The capture zone data and evaluations that have been performed have been acceptable to EPA.

9. *Does the EPA still approve of natural attenuation as a remedy for shallow plumes?*

   EPA approves of monitored natural attenuation for shallow plumes where the supporting data meet EPA's MNA guidelines.

10. *Is contaminant capture by pumping the only way to treat deep groundwater (layer 3 and 4) at this time?*

For the groundwater contamination in geological units 3 and 4, an alternative method of providing contaminant capture has not been demonstrated at this time.

11. *Does the EPA remain satisfied with the OU3 remedy being shut down?*

    Yes.

12. *What is your position on the OU1 remedy now that they have added UV OX?*

    EPA has not evaluated the addition of UV OX treatment to the OU1 remedy. This treatment technology has been added to address 1,4-dioxane in the groundwater. It is our understanding that UV OX technology can effectively treat 1,4-dioxane.

13. *Are you aware of any community concerns regarding the site or its operations?*

    The U.S. Army and the City of New Brighton have been addressing the concerns that arise as a result of the discovery of 1,4-dioxane in the OU1 plume. EPA has not been approached with any concerns regarding site operations since the actions by the Army and the City began.

14. *Do you feel well informed about the site's activities and progress?*

    Yes.

15. *Do you have any comments, suggestions, or recommendations regarding the site's management or operation?*

    Based upon the information provided in the Army's regular operating reports, I have no comments, suggestions or recommendations at this time.

Thank you for your participation in the process and we look forward to hearing from you as we move forward with the 5 year review process.

David Boyes REM, CHMM
DAWSON
Mobile: 401-440-0166
http://www.dawson8a.com
"Kupono Ka Hana" – Excellence in Service

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Appendix G

Applicable Documents

From: Barounis, Thomas
To: Albrecht, Linda B CIV USARMY IMCOM (US)
Cc: Smith, Nicholas B CIV USARMY IMCOM (US); Amy Hadiaris
Subject: [Non-DoD Source] RE: Remedy Pause
Date: Thursday, February 7, 2019 2:13:56 PM

Good afternoon, Linda.

Per Nick's question from last week, what I can tell you is that Amy and I received an e-mail from Mike Fix on April 17, 2015 informing us that the City of New Brighton stopped pumping and treating TCAAP-contaminated wells on April 15, 2015. This was subsequent to the City's receipt of an April 10 letter from the Minnesota Department of Health informing the City of the 1,4-dioxane problem.

We informed our management of these developments at the time. I cannot find an official "acknowledgment/shutdown approval" letter.

The content of Mike Fix's e-mail was as follows:

Amy / Tom,

Pursuant to our recent discussions regarding the discovery of 1,4-Dioxane in the City of New Brighton's drinking water, the Army is sending this e-mail to provide you with notice of the City of New Brighton's suspension of a portion of the Operable Unit 1 (OU1) remedy. On April 15, 2015, the City of New Brighton informed the Army that on that same day it had stopped pumping and treating TCAAP contaminated wells for use as its drinking water source and was using an alternative water supply. The City chose this course after receipt of a letter dated April 10, 2015 from the Minnesota Department of Health regarding low levels of 1,4-Dioxane above the recently promulgated health advisory level in the drinking water being treated for volatile organic compounds (VOCs). As you know, this suspension directly impacts a component of the OU1 remedy selected by the EPA with concurrence by the Minnesota Pollution Control Agency and the Army pursuant to Part XII of the FFA: specifically, the City has suspended the treatment of the off-site groundwater plume through the permanent granular activated carbon water treatment facility (GAC system). However, human health is not currently at risk because the City of New Brighton is using an alternative water supply not impacted by TCAAP contamination or the 1,4-Dioxane. Also, the Army continues to operate the other components of the OU1 Record of Decision's remedy, including the TCAAP Groundwater Recovery System and groundwater monitoring. The Army will conduct groundwater sampling in June 2015 and as part of the sampling event, we will include sampling for 1,4-Dioxane. Once the Army has the results of this sampling event, this will assist in the determination of what actions, if any, must and can be taken to address the City of New Brighton's suspension of the GAC system so that human health and the environment remain protected. In the Army's discussions with the City of New Brighton, the City has expressed the desire to continue to treat the contaminated groundwater if a method is found which will allow for the treatment of 1,4-Dioxane to acceptable levels, but this may take several years (estimated between 2-4 years) to implement.

The Army is in the process of determining options with respect to this unanticipated interruption in a component of the Army's remedy, and we are

also gathering information on the potential source(s) of the 1,4-Dioxane. In accordance with the FFA, Part XVI, the Army may propose additional work or a modification to work once we have a better understanding of options that are available. Also, pursuant to Part XIV, paragraph H, the Army will coordinate and consult with EPA and MPCA regarding review of submittals or modifications, including documents that may be necessary if the remedy is modified. Should additional information or documentation be required based on this information, or should you wish me to follow up with more formal written correspondence via mail, please let me know. The Army continues to be committed to working with all parties to address the issues raised by the recent discovery of 1,4-Dioxane in the City of New Brighton's drinking water.

Please acknowledge that this email is sufficient for FFA notification purposes.

Thanks,
Mike Fix

Tom Barounis, RPM
U.S. EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604
312-353-5577

-----Original Message-----
From: Smith, Nicholas B CIV USARMY IMCOM (US)
<nicholas.b.smith56.civ@mail.mil>
Sent: Wednesday, January 30, 2019 3:00 PM
To: Barounis, Thomas <barounis.thomas@epa.gov>
Cc: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Subject: Remedy Pause

Tom,

Was there a document sent to New Brighton from EPA or MPCA at the time of the remedy pause starting granting permission to stop pumping due to 1,4-Dioxane detections? I'm not sure if it was just done via word of mouth or if there is a paper trail.

Thank you,

Nick Smith
Environmental Engineer
US Army Environmental Command
(210) 466-1707 DSN: 450-1707
Government Cell: (210) 793-7873
2450 Connell Road, Bldg 2264
JBSA Ft Sam Houston, TX 78234-7664
nicholas.b.smith56.civ@mail.mil

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:
SR-6J

July 25, 2018

Mr. Nicholas B. Smith
U.S. Army Environmental Center
2450 Connell Road
Building 2264
JBSA Fort Sam Houston, TX 78234-7664

Subject: **Fifth Five-Year Review for the New Brighton/Arden Hills/Twin Cities Army Ammunition Plant Superfund Site, Arden Hills, Minnesota**

Dear Mr. Smith:

The purpose of this letter is to initiate the fifth five-year review (FYR) of the Superfund remedies for the subject New Brighton/Arden Hills/Twin Cities Army Ammunition Plant (NB/AH/TCAAP) Superfund Site, as required by the Comprehensive Environmental Response, Compensation, an Liability Act (CERCLA) and the National Contingency Plan (NCP).

In the fourth FYR for the NB/AH/TCAAP Site, completed on August 19, 2014, the U.S. Environmental Protection Agency (EPA) concluded that the selected remedies are protective of human health and the environment. To facilitate the timely completion of the fifth FYR, EPA requests that the U.S. Army (Army) initiate the preparation of the fifth FYR such that we can meet the following milestones and complete the FYR by August 19, 2019, five years after the completion of the fourth NB/AH/TCAAP FYR. EPA recommends that Army:

- initiate review of site-specific data collected since the last FYR; assess technical conditions; and evaluate land use and reuse
- publish the Five-Year Review public notice within the next three months
- plan for a site inspection within the next three to six months
- provide a draft FYR for review by February 2018

You will find the most current FYR guidance, including revised FYR summary form, evaluation of institutional controls, vapor intrusion assessment, FYR FAQs, and other relevant documents at EPA's Five-Year Review website:

https://www.epa.gov/superfund/superfund-five-year-reviews

If you have any questions or require additional information, please contact me by phone (312) 353-5577 or e-mail (Barounis.thomas@epa.gov).

Sincerely,

Tom Barounis
Remedial Project Manager

cc: Pat Hamblin, Acting Chief, RRB2/Section 5
Susan Prout, ORC
Amy Hadiaris, MPCA
Joan Jackson, USAEC

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Appendix H

Regulator Comments

Environmental Protection Agency (EPA) Comments
2019 FIVE-YEAR REVIEW REPORT
NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE
EPA ID: MN7213820908

Reviewer: EPA, Region 5

Respondent: DAWSON

1. Respondent concurs (C), does not concur (D), or takes exception (E).
2. Reviewer agrees (A) with response, or does not agree (D) with response.

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
1	iv	List of Tables		Thomas Barounis- This list refers to the Tables associated with the text. Section 9.0 is a list of 40 additional tables supporting the FYR. A note clarifying this point should be provided. In addition, the Tables in Section 5 do not match the tables as listed in the Table of Contents. Please review and correct. In addition, the TOC does not list Table 1-1.	**C**	**Concur.** The following was added below the "LIST OF TABLES" title: Note: The tables listed below are provided within the text of this Five-Year Review Report. The tables provided in Section 9.0 -TABLES, include 40 additional tables that include data in support of this Five-Year Review.	
2	iv	List of Figures		Thomas Barounis- This list refers to the only figure in the text. Section 10 is a list of 71 additional figures supporting the FYR. A note clarifying this point should be provided.	**C**	**Concur**. The following was added below the "LIST OF FIGURES" title: Note: The figure listed below is provided within the text of this Five-Year Review Report. Figures found in Section 10.0 - FIGURES ,include 71 additional figures that include data in support of this Five-Year Review.	

Comments on FIVE-YEAR REVIEW REPORT OF THE FINAL REMEDY FOR THE NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE Site No. MN7213820908

Reviewer: MPCA

Respondent: DAWSON

1. Respondent concurs (C), does not concur (D), or takes exception (E).
2. Reviewer agrees (A) with response, or does not agree (D) with response.

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
1	x	ES		Amy Hadiaris- The current remedy doesn't protect human health with respect to the NB municipal system, which is why it was shut down. Edit to clarify.	**D**	**Does Not Concur. The protectiveness statement has not been changed for OU1**. The point of the 5YR is make sure that the RAOs are being met as described in the ROD, ROD Amendments, and Decision Documents. Therefore, we respectfully disagree with your revision request of the Protectiveness Statement of OU1. We have, however, added a statement for 1,4-D that reads: "In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress."	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
2	x	ES		Amy Hadiaris- To be protective in the long term, a DX treatment train needs to be added to the remedy.	**C**	**Concur.** We recommended to issue a decision document to address 1,4-dioxane contamination. As noted previously, we have added a statement for 1,4-D as follows: "In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress."	
3	xi	ES		Amy Hadiaris- Site C has now been restored for recreational use; LUCRD has been revised accordingly.	**C**	**Concur.** Site C was deleted from paragraph.	
4	xi	ES		Amy Hadiaris- Include similar paragraph in OU1 section, above	**D**	**Does Not Concur.** Review of applicable or relevant and appropriate requirements (ARARs) upon which the groundwater cleanup levels were based showed that six groundwater contaminants of concern (COCs) were potentially affected by health risk limit (HRL) revisions. The HRL revisions had no impacts to groundwater and had no short-term impacts to the groundwater cleanup levels for OU1 shallow groundwater or OU1 deep groundwater. This is addressed in Question B of OU1.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
5	xii	Five Year Review Summary Form		Amy Hadiaris-Is this supposed to reflect the 5-year interval under review?	**C**	**Concur.** The date has been edited to reflect change.	
6	xiii	Five Year Review Summary Form		Amy Hadiaris- The current remedy (as reflected in the OU1 ROD) is not protective of human health, which is why the NBCGRS was shut down. The current remedy is protective for private wells (as stated), but that is a subset of receptors. The protectiveness of consumers of New Brighton's municipal water comes from the system being shut down, not from the remedy itself being protective.	**D**	**Does Not Concur**. Per EPA Guidance we cannot add any new COC without a Decision Document.	
7	xiii	Five Year Review Summary Form		Amy Hadiaris- Include comment about HRL revisions in OU1 section (as was done below for OU2)	**C**	**Concur. It will be added to text but not the protectiveness statement.** "Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater. Review of ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to groundwater and had no short-term impacts to the groundwater cleanup levels for OU1 groundwater or OU1 deep groundwater."	
8	xiii	Five Year Review Summary Form		Amy Hadiaris- And removal of DX via the new treatment train.	**D**	**Does Not Concur.** The protectiveness will not change for OU1but has been edited to include 1,4-D. Reads as follows below: "The remedy at OU1 currently protects human health and the	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
						environment because the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur. However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure protectiveness in the long term: #3-Extracting groundwater from the North Plume using the NBCGRS; #4-Removal of VOCs by a pressurized GAC system, and #5-Discharging all the treated water to the New Brighton Municipal distribution system. In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.	
9	xiii	Five Year Review Summary Form		Amy Hadiaris- Recreational use OK here.	**C**	**Concur.** This has been edited. Site C has been deleted.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
10	1-1	1.0 Introduction		Amy Hadiaris- Page x above says Oct 2018, change one or the other as needed.	**C**	**Concur.** Date has been changed to November 2, 2018.	
11	1-4	1.0 Introduction		Amy Hadiaris- Why is this here? This is not a “site” and it makes it sound like uncharacterized areas were closed out with NFA.	**D**	**Does Not Concur.** This is a site according to the IAP. This has been edited to add TCAAP-26 as listed in reports.	
12	1-4	1.0 Introduction		Amy Hadiaris- The western portion of 135-PTA has been cleaned up to allow for recreational use, LUCRD has been revised accordingly.	**C**	**Concur.** This has been edited. Now reads, “**The western portion of 135-PTA has been cleaned up to allow for recreational use.** As of the date of this Five-Year Review report, no remedy has been selected for Round Lake.”	
13	2-2	Table 2-1		Amy Hadiaris- Update table to include key events after Aug 2014 (e.g. discovery of DX in GW, shut-down of OU1 remedy, etc,)	**C**	**Concur.** Keys events have been added to table. 1) City of New Brighton was notified by the Minnesota Department of Health that 1,4-dioxane had been detected. 2) Remedy Time-Out due to discovery of 1,4-dioxane. 3) Ultraviolet / Peroxide Advanced Oxidation Potential Pilot Study 4)Installation of a new UVPhox treatment system. TCAAP Operable Unit Remedy Review (Optimization Report)	
14	4-16	4.3.6		Amy Hadiaris- This makes it sound like I wasn’t previously aware that a DX system was being installed, please edit to clarify. “Amy Hadiaris, a hydrogeologist with MPCA, was pleased to find out the New Brighton	**C**	**Concur.** Text has been edited. “Amy Hadiaris, a hydrogeologist with MPCA, stated that she was aware of the proposed schedule for the New Brighton treatment system coming	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
				treatment system would be coming back on line shortly with 1,4-dioxane treatment in place."		back on line with the 1,4-dioxane treatment in place. "	
15	4-18	4.4.2		Amy Hadiaris-Editorial- Change to 4-7	**C**	**Concur.** Change has been made. From 4.6 to 4.7	
16	4-18	4.4.2		Amy Hadiaris- The above paragraph says they are ARARs	**C**	**Concur.** The paragraph has been edited. Below has been deleted: "The HRLs and RALs were identified in the OU1 ROD as To Be Considered (TBC)."	
17	4-19	4.4.2		Amy Hadiaris- Editorial- Change to 4-7	**C**	**Concur.** Text has been changed to 4-7.	
18	4-19	Table 4-7		Amy Hadiaris- Why isn't TCE included in this table?	**C**	**Concur.** TCE has been added to Table 4-7.	
19	4-19	4.4.2		Amy Hadiaris-0.4 ug/L for TCE is a HRL (ARAR), established in 2015, see MDH website:	**C**	**Concur.** This has been edited. It was added in the body text and table.	
20	4-19	4.4.2		Amy Hadiaris- And TCE in 2015	**C**	**Concur.** This has been edited.	
21	4-20	4.4.3		Amy Hadiaris- What about DX? The remedy was shut down due to it's not being protective of New Brighton residents	**D**	**Does not Concur.** 1,4-D is being added as an issue and a recommendation. At this point according to EPA Guidance it does not affect Question C's answer. There will be no changes to Question C at this point.	
22	5-9	5.1.2.3		Amy Hadiaris- This is not currently being implemented, as all of the Site I monitoring wells were sealed during demolition/soil cleanup around Bldg 502 (as described below in Site I GW section).	C	**Concur.** This has been edited and a footnote has been added to address the sealed monitoring wells.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
23	5-11	5.1.3.1		Amy Hadiaris-??? All LUCs have been completed	**C**	**Concur.** This has been edited to reassure that no new LUCs are being suggested or were added.	
24	5-11	5.1.3.1		Amy Hadiaris- I don't understand this. The blanket LUC for OU2 that was established in 2010 (or so) includes these areas. No additional LUCs are needed.	**C**	**Concur.** This section has been rewritten to clear up confusion in presentation.	
25	5-13	5.1.3.6		Amy Hadiaris- With the revised HRL for TCE, the discharge limit to Rice Creek would change. It would be helpful to include a table in this section similar to Table 4-7, above, which summarizes the ROD cleanup standards and any subsequent changes based on MCL or HRL revisions.	**D**	**Does Not Concur.** An additional table will not be added.	
26	5-15	5.1.4		Amy Hadiaris-DELETION OF PARAGRAPH- No, as stated above, Revision 5 was for the 108 acres which is a different part of TCAAP, unrelated to Site I.	**C**	**Concur.** The deletions have been accepted. Below has been deleted: "The 2018 Revision 5 of the OU2 LUCRD did not affect LUCs at Site A, Site K, or Building 102Following additional soil investigation and remediation completed by Ramsey County in 2014/2015, Site I is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. The Revision 5 OU2 LUCRD formally removes Site I soil LUCs. The final annual LUC inspection of Site I was	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
						conducted by the Army, MNARNG, and PIKA, and the inspection checklist is included in Appendix C."	
27	5-16	Table 5-4		Amy Hadiaris- Where is this note? The Soil LUC is a blanket LUC that encompasses these sites, not just the sites themselves.	**C**	**Concur.** Note added. Reads as below: "A 'blanket LUC' is one considered to apply to a significant portion of the federally-owned property, or a significant portion of the Ramsey County property (with respect to groundwater LUCs)."	
28	5-17	5.1.5.4		Amy Hadiaris-Update name (do global search and replace)	**C**	**Concur.** Name updated to "Northrup Grumman Innovation Systems"	
29	5-25	5.3.4.5		Amy Hadiaris- Edit for clarity, GW monitoring has not been conducted for several years	**C**	**Concur.** This has been edited. "Conducted" has been deleted.	
30	5-26	5.3.4.6		Amy Hadiaris- This isn't correct, the existing monitoring network at Site K has several Unit 1 monitoring wells.	**C**	**Concur.** This text has been edited to reflect changes. This sentence has been deleted "All monitoring wells for Unit 1 were permanently abandoned, as approved by USEPA and MPCA.	
31	5-27	5.3.4.6		Amy Hadiaris- I believe DX is present in this well.	**C**	**Concur.** This text has been edited to add the 1,4-D presence. Paragraph now reads as the following: "The Unit 3 sentinel well (03U621) was sampled in June 2016 shown in Figures 45, 46, and 65 (Section 10, Figures). The results of the sample collected during FY 2016 showed	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
						there were no COCs detected in the Unit 3 sentinel well at concentrations above the method detection limit; however, 1,4-dioxane exceeded the HRL in this well in 2015 and 2016, and decreased from 9.3 ug/L in FY 2016 to 8.4 ug/L in FY 2017."	

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
3	iv	List of Figures		Editorial- Strikethrough	**C**	**Concur.** It has been revised.	
4	x	ES	Line 3	Bonnie & Thomas- Please revise date as indicated.	**C**	**Concur.** It has been revised.	
5	xi	ES		Susan Prout & Thomas Barounis - Shouldn't it be 'drilling advisories in the SWBCA?" see yellow below	**C**	**Concur.** It has been revised.	
6	xi	ES		Susan Prout- Insert drilling advisories.	**C**	**Concur.** It has been revised to say drilling advisories in the SWBCA.	
7	xiii	Five Year Review Summary Form		Bonnie- Please provide date/month/year. This is needed for EPA data entry.	**C**	**Concur.** It has been revised to 09/30/2024.	
8	xiii	Five Year Review Summary Form		Susan Prout- Editorial – Verb Tense	**C**	**Concur.** It has been revised to 'is.'	
9	xiii	Five Year Review Summary Form		Susan Prout- Insert "drilling advisories in" see yellow above	**C**	**Concur.** It has been revised to say drilling advisories in the SWBCA.	
10	4-13	Table 4-4		Bonnie & Thomas- Tom Barounis: Do the increasing trends for TCE in the 4 wells indicate that the plume is expanding or migrating, especially since an increasing trend has been observed since 2011 (prior to shutdown of NBCGRS in 2015)?	**C**	**Concur.** It has been revised. According to the Pika-Arcadis TCAAP Operable Unit Remedy Review dated June 22, 2018, the trends show a steady OU1 TCE plume footprint. Comparison of the OU1 TCE plume footprint over the past 20 years, as summarized in the last four five-year reviews, indicates	

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
						a stable OU1 bedrock TCE plume footprint. Without performing a GW modeling study, which is outside the scope of this 5-year review, DAWSON cannot support additional evaluations beyond what has been performed by others. The following statement was added to the report: According to the OU Remedy Review report, the trends show a steady OU1 TCE plume footprint. Comparison of the OU1 TCE plume footprint over the past 20 years, as summarized in the last four five-year reviews, indicates a stable OU1 bedrock TCE plume footprint.	
11	4-13	Table 4-4		Bonnie and Thomas- Tom Barounis: This is indicating that the OU1 plume is shifting. Is this another indication that the plume is migrating?	**C**	**Concur.** See response to comment 10.	
12	4-21	4.6 Issues		Nerfertiti DiCosmo & Bonnie- The remedy was put into time-out because of 1,4 dioxane. This contaminant needs to be addressed more transparently in the FYR and a recommendation should be added that an ESD is needed to add 1,4 Dioxane to the list of COCs and document the new remedy components of the treatment system. **Issue:** 1,4 Dioxane was found in the ground water plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology into the OU1 RAOs. **Recommendation**: Issue a decision document	**C**	**Concur.** The following issue was added: 1,4-Dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology. The following recommendation was added: Issue a decision document to address 1,4-dioxane contamination.	

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
				that incorporates 1,4 Dioxane as a COC and selects a remedial action to restore groundwater to beneficial use.			
13	4-22	4.7		Thomas Barounis- Editorial- And the term "…in the long term:" INSERTED	**C**	**Concur.** Accepted Insertion.	
14	5-16	Table 5-4		Bonnie- This column should include the actual LUCs, not the document indicating what they will be. The status of each LUC is unclear. Earlier it states that the status of the LUCs is "LUCs ongoing" (under Remedy Implementation). Implemented LUCs specified by name and date should be in this column. Planned LUCs would be included and it should indicate they are planned. If all required LUCs are not in place, then this would be also discussed in Technical Assessment, included as an issue/recommendation, and included in the protectiveness statement.	**C**	**Concur.** It has been revised. Changed the right-hand column title to '**Land Use Controls** . The column now describes the LUCs. The LUCs have been implemented and the "ongoing" wording was revised to clarify. Inserted the following statement to clarify: 'All LUCs were implemented when the USEPA and MPCA approved the OU2 LUCRD document in 2010, unless otherwise noted in Table 5-4.' All required LUCs are in place.	
15	5-20	Table 5-5		Bonnie- The table in the FYR Template includes additional columns for "current status" with a drop down box of selections, and "completion date/if applicable". Please revise all "Progress Since Last FYR" tables to include this information per: https://semspub.epa.gov/work/HQ/100000001.pdf	**C**	**Concur.** It has been revised. Dates were added to the Current Status narrative as instructed in the alternative suggestion.	

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
				Alternatively, the Current Status column can incorporate this information by stating the status (for ex., recommendation has been completed) and provide the date (month/day/year). (EPA tracks issues and recommendations in SEMS and uses the information from these tables.)			
16	5-22	Footnote		Nefertiti DiCosmo-1,4 Dioxane is a contaminant not anticipated by the ROD but will need to be addressed at this site with additional remedial actions documented in a revised decision document. The FYR should not ignore 1,4 Dioxane just because it is not in the ROD.	**C**	**Concur.** It has been revised. Removed language stating 1,4-dioxane is not discussed in the report; added 1,4-dioxane to technical assessment.	
17	5-22	Footnote		Bonnie- Agreed. Please discuss in Technical Assessment; add an issue/recommendation; add to protectiveness statement.	**C**	**Concur.** It has been revised. Added 1,4-dioxane information to technical assessment, and added an issue and recommendation. The following issue was added: 1,4-Dioxane was found in the groundwater plume but there is no remedial decision document to incorporate the cleanup standards or treatment technology. The following recommendation was added: Finalize and implement the currently proposed ESD to address 1,4-dioxane contamination. Protectiveness statement now includes the following statement: 'The Army is proactively addressing	

Comment No.	Page	Section	Paragraph / Line	Comment	C, D, or E	Response	A or D
						1,4-dioxane contamination through an ESD that is currently underway.	
18	5-22	Footnote		Thomas- Additionally, please include a timetable for response to 1,4-dioxane contamination.	**C**	**Concur.** It has been revised. Timetable included as a milestone date under recommendation table.	

From: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Sent: Thursday, August 1, 2019 6:40 AM
To: Oliver, Terrence B CIV USARMY IMCOM AEC (USA); David Boyes; Cullen, Joan T CIV CELRL CELRD (US)
Subject: FW: TCAAP 5 year review (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

David,
The EPA found some minor things they'd like corrected (mainly table call-outs but a few minor wording changes) that they'd like changed before the final is issued. They are in the email below

I expect the state to reply by COB, but the only thing they have said so far is they would like to be a signatory, so please add that. They suggested separate signature pages so that you could just insert the signed pages later.

Lastly both the EPA and MPCA would like a hard copy as well as electronic.

Feel free to call 865-599-0055
Linda
Linda B. Albrecht, P.E., C.H.M.M., C.E.M
Midwest ESSD
US Army Environmental Command
2450 Connell Road,
Fort Sam Houston, TX 78234-7664
-----Original Message-----
From: Barounis, Thomas [mailto:barounis.thomas@epa.gov]
Sent: Thursday, August 1, 2019 8:32 AM
To: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>; Hadiaris, Amy

(MPCA) <amy.hadiaris@state.mn.us>
Subject: [Non-DoD Source] RE: TCAAP 5 year review (UNCLASSIFIED)

Good morning, Linda.

Yes, it is basically fine. A few questions came up which I had to discuss with my attorney and with Amy which we resolved, although I think Amy has one additional point regarding the acknowledgment of the change in Minnesota's HRL for TCE, which should be noted but which does not alter the short-term protectiveness decision.

Additionally, my attorney Sue Prout pointed out a couple of things (see below). Note the "Table Error" designations on the review version. I guess I just assumed that that was a review artifact which will be corrected in the final.

Page XI states the solution at OU1 is to "issue a decision document to address 1,4." This should more accurately be stated as "issue a decision document to address 1,4-dioxane and implement a remedy."

Page 4-6 States: Table Error! No text of specified style in document.-21 OU1 Remedial Action Objectives. Please fix.
Page 4-13 States: Table Error! No text of specified style in document.-32 NBCGRS Groundwater Extraction Data Page 4-14 States: Table Error! No text of specified style in document.-43 Maximum COC Exceedances OU1 ROD Cleanup Page 4-15 States: Figure Error! No text of specified style in document.-1 Sequence of Geological Units Page 4-16 states Table Error! No text of specified style in document.-54 Well Page 4-23 States: Table Error! No text of specified style in document.-76 Non-Functioning Remedy Also on page 4-25: Table Error! No text of specified style in document.-87 ROD

Please check all the tables below, they say "Table Error!
Pages 5-1, 5-4, 5-17, 5-22, 5-34, 5-39, 5-40, 5-42, 5-43, 5-44, 5-45, 5-47, 5-50, 5-54, 5-55 Please check all tables in the rest of the referral for "Table Error

Let me know if you have any questions. If we can get the final document at the beginning of next week, I can route it through the program for concurrence. FYI, I will be out of the office on AL for a couple of weeks, August 12 - 23.

Thanks.

Tom Barounis, RPM
U.S. EPA Region 5

77 W. Jackson Boulevard
Chicago, IL 60604
312-353-5577

-----Original Message-----
From: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Sent: Thursday, August 01, 2019 8:08 AM
To: Barounis, Thomas <barounis.thomas@epa.gov>; Hadiaris, Amy (MPCA) <amy.hadiaris@state.mn.us>
Subject: TCAAP 5 year review (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Good Morning
I just wanted to verify that you were both fine with the five year review and it could be issued final. I had noted that MPCA wanted to be a signatory and you both wanted a hard copy as well as the electronic. If that is the only change, I will have the report issued as final.

Please let me know as soon as possible so we can get the document to you.

Linda
Linda B. Albrecht, P.E., C.H.M.M., C.E.M Midwest ESSD US Army Environmental Command
2450 Connell Road,
Fort Sam Houston, TX 78234-7664

CLASSIFICATION: UNCLASSIFIED
CLASSIFICATION: UNCLASSIFIED

From: Albrecht, Linda B CIV USARMY IMCOM (US)
To: David Boyes; Cullen, Joan T CIV CELRL CELRD (US); Krista O"Hara
Cc: Oliver, Terrence B CIV USARMY IMCOM AEC (USA)
Subject: FW: TCAAP 5 year review (UNCLASSIFIED)
Date: Thursday, August 1, 2019 3:37:59 PM

CLASSIFICATION: UNCLASSIFIED

Dave
Attached are Amy's comments. Please note she still wants a table added and feels we were dismissive of her request.
Linda

-----Original Message-----
From: Hadiaris, Amy (MPCA) [mailto:amy.hadiaris@state.mn.us]
Sent: Thursday, August 1, 2019 2:29 PM
To: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Cc: Tom Barounis (Barounis.Thomas@epamail.epa.gov) <Barounis.Thomas@epamail.epa.gov>
Subject: [Non-DoD Source] RE: TCAAP 5 year review (UNCLASSIFIED)

Hi Linda,
Two things from me:

1. The 5-year interval under review is inconsistent in different parts of the text (pages x, xii, 1-1).

2. The response to MPCA comment #25 is not acceptable. I'll provide a little more background as to why I made the comment, but regardless, a response of "An additional table will not be added" was surprisingly dismissive. At the very least I would expect an explanation as to why a simple request like adding a table would be rejected outright.

Under Minnesota Rule, discharges to Rice Creek must meet drinking water standards (MDH Health Risk Limit). The HRL for TCE is now 0.4 ppb. There should be a transparent acknowledgement of the lowered HRL as it applies to discharge of Site K treated groundwater to Rice Creek, and an evaluation/statement as to whether the current treatment system is achieving a reduction of TCE to that level.

Let me know if you have any questions about the above, Regards, Amy

-----Original Message-----
From: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Sent: Thursday, August 01, 2019 8:33 AM
To: Barounis, Thomas <barounis.thomas@epa.gov>; Hadiaris, Amy (MPCA) <amy.hadiaris@state.mn.us>
Subject: RE: TCAAP 5 year review (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Thanks Tom! I will pass all these on to Dawson to fix.
Linda

-----Original Message-----
From: Barounis, Thomas [mailto:barounis.thomas@epa.gov]
Sent: Thursday, August 1, 2019 8:32 AM
To: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>; Hadiaris, Amy (MPCA) <amy.hadiaris@state.mn.us>
Subject: [Non-DoD Source] RE: TCAAP 5 year review (UNCLASSIFIED)

Good morning, Linda.

Yes, it is basically fine. A few questions came up which I had to discuss with my attorney and with Amy which we resolved, although I think Amy has one additional point regarding the acknowledgment of the change in Minnesota's HRL for TCE, which should be noted but which does not alter the short-term protectiveness decision.

Additionally, my attorney Sue Prout pointed out a couple of things (see below). Note the "Table Error" designations on the review version. I guess I just assumed that that was a review artifact which will be corrected in the final.

Page XI states the solution at OU1 is to "issue a decision document to address 1,4." This should more accurately be stated as "issue a decision document to address 1,4-dioxane and implement a remedy."

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Please check all the tables below, they say "Table Error!
Pages 5-1, 5-4, 5-17, 5-22, 5-34, 5-39, 5-40, 5-42, 5-43, 5-44, 5-45, 5-47, 5-50, 5-54, 5-55 Please check all tables in the rest of the referral for "Table Error

Let me know if you have any questions. If we can get the final document at the beginning of next week, I can route it through the program for concurrence. FYI, I will be out of the office on AL for a couple of weeks, August 12 - 23.

Thanks.

Tom Barounis, RPM
U.S. EPA Region 5
77 W. Jackson Boulevard
Chicago, IL 60604
312-353-5577

-----Original Message-----
From: Albrecht, Linda B CIV USARMY IMCOM (US) <linda.b.albrecht.civ@mail.mil>
Sent: Thursday, August 01, 2019 8:08 AM
To: Barounis, Thomas <barounis.thomas@epa.gov>; Hadiaris, Amy (MPCA) <amy.hadiaris@state.mn.us>
Subject: TCAAP 5 year review (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Good Morning
I just wanted to verify that you were both fine with the five year review and it could be issued final. I had noted that MPCA wanted to be a signatory and you both wanted a hard copy as well as the electronic. If that is the only change, I will have the report issued as final.

Please let me know as soon as possible so we can get the document to you.

Linda
Linda B. Albrecht, P.E., C.H.M.M., C.E.M Midwest ESSD US Army Environmental Command
2450 Connell Road,
Fort Sam Houston, TX 78234-7664

From: David Boyes
To: Albrecht, Linda B CIV USARMY IMCOM (US); Cullen, Joan T CIV CELRL CELRD (US); Oliver, Terrence B CIV USARMY IMCOM AEC (USA)
Cc: Krista O"Hara; Charlene Torres
Subject: State and EPA Comments on Draft Final TCAAP 5 YR.
Date: Wednesday, August 7, 2019 3:24:22 PM
Attachments: 20190807_DAWSON Comments Response to STATE_Rev 03.docx

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Hi Linda and Joan

We have addressed the comments for both the EPA and State of MN. The attached reflects the revised RTC of Amy's concerns and includes the following responses:

5	xii	Five Year Review Summary Form		Amy Hadiaris-Is this supposed to reflect the 5-year interval under review?	**D**	**Does Not Concur.** According to EPA guidance and CX comments, the review period corresponds to the period during which the FYR team performs its tasks, not to the five-year period being assessed in the report. Generally, the review period extends from the initial kickoff of the FYR project to signature on the FYR report. The dates have been changed to reflect the date of the kickoff meeting and projected signature date.
25	5-13	5.1.3.6		Amy Hadiaris- With the revised HRL for TCE, the discharge limit to Rice Creek would change. It would be helpful to include a table in this section similar to Table 4-7, above, which summarizes the ROD cleanup standards and any subsequent changes based on MCL or HRL revisions.	**C**	**Concur.** An additional table was not added as suggested, but Table 5-15 was edited to include the State Standards. The current MDH values were added to Table 5-15 & renamed **"Table 5-15 ROD Cleanup Standards & Current Agency (FEDERAL & STATE) Limits for Groundwater COCs".** **A Footnote on Page 5-14 was added stating: For state-accepted discharge limits (MDH Health Risk Limits), refer to Table 5-15, ROD Cleanup Standards & Current Agency (FEDERAL & STATE) Limits for Groundwater COCs on page 5-52.**

With respect to Tom's e-mail from the EPA, we inserted the recommended language in regard to OU1. All the "Table Error" and "Figure Error" designations were a review artifact and have been removed. Both EPA and STATE comments with responses have been added to the document as an Appendix.

A hard copy should be delivered tomorrow to both Amy and Tom.

We will send the .pdf file by AMRDEC to you all shortly.

Dave

David Boyes REM, CHMM
Conservation and Planning Program Manager
DAWSON
Mobile: 401-440-0166
http://www.dawson8a.com
"Kupono Ka Hana" – Excellence in Service

Comments on FIVE-YEAR REVIEW REPORT OF THE FINAL REMEDY FOR THE NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE
Site No. MN7213820908

Reviewer: MPCA

Respondent: DAWSON

1. Respondent concurs (C), does not concur (D), or takes exception (E).
2. Reviewer agrees (A) with response, or does not agree (D) with response.

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
1	x	ES		Amy Hadiaris- The current remedy doesn't protect human health with respect to the NB municipal system, which is why it was shut down. Edit to clarify.	**D**	**Does Not Concur. The protectiveness statement has not been changed for OU1**. The point of the 5YR is make sure that the RAOs are being met as described in the ROD, ROD Amendments, and Decision Documents. Therefore, we respectfully disagree with your revision request of the Protectiveness Statement of OU1. We have, however, added a statement for 1,4-D that reads: "In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress."	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
2	x	ES		Amy Hadiaris- To be protective in the long term, a DX treatment train needs to be added to the remedy.	**C**	**Concur.** We recommended to issue a decision document to address 1,4-dioxane contamination. As noted previously, we have added a statement for 1,4-D as follows: "In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress."	
3	xi	ES		Amy Hadiaris- Site C has now been restored for recreational use; LUCRD has been revised accordingly.	**C**	**Concur.** Site C was deleted from paragraph.	
4	xi	ES		Amy Hadiaris- Include similar paragraph in OU1 section, above	**D**	**Does Not Concur.** Review of applicable or relevant and appropriate requirements (ARARs) upon which the groundwater cleanup levels were based showed that six groundwater contaminants of concern (COCs) were potentially affected by health risk limit (HRL) revisions. The HRL revisions had no impacts to groundwater and had no short-term impacts to the groundwater cleanup levels for OU1 shallow groundwater or OU1 deep groundwater. This is addressed in Question B of OU1.	
5	xii	Five Year Review Summary Form		Amy Hadiaris-Is this supposed to reflect the 5-year interval under review?	**D**	**Does Not Concur.** According to EPA guidance and CX comments, the review period corresponds to the period during which the FYR team	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
						performs its tasks, not to the five-year period being assessed in the report. Generally, the review period extends from the initial kickoff of the FYR project to signature on the FYR report. The dates have been changed to reflect the date of the kickoff meeting and projected signature date.	
6	xiii	Five Year Review Summary Form		Amy Hadiaris- The current remedy (as reflected in the OU1 ROD) is not protective of human health, which is why the NBCGRS was shut down. The current remedy is protective for private wells (as stated), but that is a subset of receptors. The protectiveness of consumers of New Brighton's municipal water comes from the system being shut down, not from the remedy itself being protective.	**D**	**Does Not Concur**. Per EPA Guidance we cannot add any new COC without a Decision Document.	
7	xiii	Five Year Review Summary Form		Amy Hadiaris- Include comment about HRL revisions in OU1 section (as was done below for OU2)	**C**	**Concur. It will be added to text but not the protectiveness statement.** "Water quality trends indicate that progress towards aquifer restoration continues to occur in both shallow and deep groundwater. Review of ARARs upon which the groundwater cleanup levels were based showed that six groundwater COCs were potentially affected by HRL revisions. The HRL revisions had no impacts to groundwater and had no short-term impacts to the groundwater cleanup levels for OU1 groundwater or OU1 deep groundwater."	
8	xiii	Five Year Review		Amy Hadiaris- And removal of DX via the new treatment train.	**D**	**Does Not Concur.** The protectiveness will not change for	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
		Summary Form				OU1but has been edited to include 1,4-D. Reads as follows below: "The remedy at OU1 currently protects human health and the environment because the alternate water supply and well abandonment program, along with the drilling advisories in the SWBCA, are mitigating potential risks associated with private wells. The OU1 water quality trends indicate that progress towards aquifer restoration continues to occur. However, for the remedy to be protective in the long-term, the following remedy components will need to resume operations to ensure protectiveness in the long term: #3-Extracting groundwater from the North Plume using the NBCGRS; #4-Removal of VOCs by a pressurized GAC system, and #5-Discharging all the treated water to the New Brighton Municipal distribution system. In addition, a new treatment train is recommended, along with the issuance of a decision document, to address 1,4-dioxane contamination. The Army is proactively addressing the 1,4-dioxane contamination through an ESD, which is currently in progress.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
9	xiii	Five Year Review Summary Form		Amy Hadiaris- Recreational use OK here.	**C**	**Concur.** This has been edited. Site C has been deleted.	
10	1-1	1.0 Introduction		Amy Hadiaris- Page x above says Oct 2018, change one or the other as needed.	**C**	**Concur.** Date has been changed to November 2, 2018.	
11	1-4	1.0 Introduction		Amy Hadiaris- Why is this here? This is not a “site” and it makes it sound like uncharacterized areas were closed out with NFA.	**D**	**Does Not Concur.** This is a site according to the IAP. This has been edited to add TCAAP-26 as listed in reports.	
12	1-4	1.0 Introduction		Amy Hadiaris- The western portion of 135-PTA has been cleaned up to allow for recreational use, LUCRD has been revised accordingly.	**C**	**Concur.** This has been edited. Now reads, “**The western portion of 135-PTA has been cleaned up to allow for recreational use.** As of the date of this Five-Year Review report, no remedy has been selected for Round Lake.”	
13	2-2	Table 2-1		Amy Hadiaris- Update table to include key events after Aug 2014 (e.g. discovery of DX in GW, shut-down of OU1 remedy, etc,)	**C**	**Concur.** Keys events have been added to table. 1) City of New Brighton was notified by the Minnesota Department of Health that 1,4-dioxane had been detected. 2) Remedy Time-Out due to discovery of 1,4-dioxane. 3) Ultraviolet / Peroxide Advanced Oxidation Potential Pilot Study 4)Installation of a new UVPhox treatment system. TCAAP Operable Unit Remedy Review (Optimization Report)	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
14	4-16	4.3.6		Amy Hadiaris- This makes it sound like I wasn't previously aware that a DX system was being installed, please edit to clarify. "Amy Hadiaris, a hydrogeologist with MPCA, was pleased to find out the New Brighton treatment system would be coming back on line shortly with 1,4-dioxane treatment in place."	**C**	**Concur.** Text has been edited. "Amy Hadiaris, a hydrogeologist with MPCA, stated that she was aware of the proposed schedule for the New Brighton treatment system coming back on line with the 1,4-dioxane treatment in place. "	
15	4-18	4.4.2		Amy Hadiaris-Editorial- Change to 4-7	**C**	**Concur.** Change has been made. From 4.6 to 4.7	
16	4-18	4.4.2		Amy Hadiaris- The above paragraph says they are ARARs	**C**	**Concur.** The paragraph has been edited. Below has been deleted: "The HRLs and RALs were identified in the OU1 ROD as To Be Considered (TBC)."	
17	4-19	4.4.2		Amy Hadiaris- Editorial- Change to 4-7	**C**	**Concur.** Text has been changed to 4-7.	
18	4-19	Table 4-7		Amy Hadiaris- Why isn't TCE included in this table?	**C**	**Concur.** TCE has been added to Table 4-7.	
19	4-19	4.4.2		Amy Hadiaris-0.4 ug/L for TCE is a HRL (ARAR), established in 2015, see MDH website:	**C**	**Concur.** This has been edited. It was added in the body text and table.	
20	4-19	4.4.2		Amy Hadiaris- And TCE in 2015	**C**	**Concur.** This has been edited.	
21	4-20	4.4.3		Amy Hadiaris- What about DX? The remedy was shut down due to it's not being protective of New Brighton residents	**D**	**Does not Concur.** 1,4-D is being added as an issue and a recommendation. At this point according to EPA Guidance it does not affect Question C's answer. There will be no changes to Question C at this point.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
22	5-9	5.1.2.3		Amy Hadiaris- This is not currently being implemented, as all of the Site I monitoring wells were sealed during demolition/soil cleanup around Bldg 502 (as described below in Site I GW section).	C	**Concur.** This has been edited and a footnote has been added to address the sealed monitoring wells.	
23	5-11	5.1.3.1		Amy Hadiaris-??? All LUCs have been completed	**C**	**Concur.** This has been edited to reassure that no new LUCs are being suggested or were added.	
24	5-11	5.1.3.1		Amy Hadiaris- I don't understand this. The blanket LUC for OU2 that was established in 2010 (or so) includes these areas. No additional LUCs are needed.	**C**	**Concur.** This section has been rewritten to clear up confusion in presentation.	
25	5-13	5.1.3.6		Amy Hadiaris- With the revised HRL for TCE, the discharge limit to Rice Creek would change. It would be helpful to include a table in this section similar to Table 4-7, above, which summarizes the ROD cleanup standards and any subsequent changes based on MCL or HRL revisions.	**C**	**Concur.** An additional table was not added as suggested, but Table 5-15 was edited to include the State Standards. The current MDH values were added to Table 5-15 & renamed **"Table 5-15 ROD Cleanup Standards & Current Agency (FEDERAL & STATE) Limits for Groundwater COCs".** A Footnote on Page 5-14 was added stating: For state-accepted discharge limits (MDH Health Risk Limits), refer to Table 5-15, ROD Cleanup Standards & Current Agency (FEDERAL & STATE) Limits for Groundwater COCs on page 5-52.	
26	5-15	5.1.4		Amy Hadiaris-DELETION OF PARAGRAPH- No, as stated above, Revision 5 was for the 108 acres which	**C**	**Concur.** The deletions have been accepted. Below has been deleted:	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
				is a different part of TCAAP, unrelated to Site I.		"The 2018 Revision 5 of the OU2 LUCRD did not affect LUCs at Site A, Site K, or Building 102Following additional soil investigation and remediation completed by Ramsey County in 2014/2015, Site I is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. The Revision 5 OU2 LUCRD formally removes Site I soil LUCs. The final annual LUC inspection of Site I was conducted by the Army, MNARNG, and PIKA, and the inspection checklist is included in Appendix C."	
27	5-16	Table 5-4		Amy Hadiaris- Where is this note? The Soil LUC is a blanket LUC that encompasses these sites, not just the sites themselves.	**C**	**Concur.** Note added. Reads as below: "A 'blanket LUC' is one considered to apply to a significant portion of the federally-owned property, or a significant portion of the Ramsey County property (with respect to groundwater LUCs)."	
28	5-17	5.1.5.4		Amy Hadiaris-Update name (do global search and replace)	**C**	**Concur.** Name updated to "Northrup Grumman Innovation Systems"	
29	5-25	5.3.4.5		Amy Hadiaris- Edit for clarity, GW monitoring has not been conducted for several years	**C**	**Concur.** This has been edited. "Conducted" has been deleted.	

Comment No.	Page	Section	Paragraph/ Line	Comment	C, D, or E	Response	A or D
30	5-26	5.3.4.6		Amy Hadiaris- This isn't correct, the existing monitoring network at Site K has several Unit 1 monitoring wells.	**C**	**Concur.** This text has been edited to reflect changes. This sentence has been deleted "All monitoring wells for Unit 1 were permanently abandoned, as approved by USEPA and MPCA.	
31	5-27	5.3.4.6		Amy Hadiaris- I believe DX is present in this well.	**C**	**Concur.** This text has been edited to add the 1,4-D presence. Paragraph now reads as the following: "The Unit 3 sentinel well (03U621) was sampled in June 2016 shown in Figures 45, 46, and 65 (Section 10, Figures). The results of the sample collected during FY 2016 showed there were no COCs detected in the Unit 3 sentinel well at concentrations above the method detection limit; however, 1,4-dioxane exceeded the HRL in this well in 2015 and 2016, and decreased from 9.3 ug/L in FY 2016 to 8.4 ug/L in FY 2017."	